Project Scheduling and Cost Control

Planning, Monitoring and Controlling the Baseline

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DEDICATION

To Taylor Ashton Bailey,
my first grandchild and surely
the most beautiful young lady on this planet

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PREFACE

Projects fail most often because of poorly written or misinterpreted requirements. But once a project is begun, controlling schedule and cost is the most difficult aspect of the project manager's job. I have wanted to write a book on schedule and cost control for many years, but other projects and my teaching schedule have delayed this dream. Now, however, I have finally managed to collect what I think are the most important aspects of schedule and cost control in one place—this book.

I also have tried to make this a practical book on project management principles, tools, and techniques by explaining the complex in as simple a fashion as possible and by incorporating many templates and examples of how all these tools work. Most project managers want prescriptive directions about how to run a successful project; that really is not possible. If project management were prescriptive, then the process of managing a project would become simply an administrative task. Yet we certainly can make the process practicable inasmuch as the tools provided can aid the project manager today; that is, all the principles, tools, and techniques discussed in this book can be applied as soon as the project manager returns to his or her office. That is my objective.

There are several books on the market that address the problem of schedule and cost control, and you might wonder: Why another book on the subject? I do not think a practicing, professional project manager can read or learn too much on the subject. Read everything you can get your hands on and use the tips and ideas from all those sources that most improve your expertise and performance. I have tried, in this book, to address what seem

to be—based upon extensive conversations with many practicing project managers and my many students and my own 38 years of experience as a project manager—the most challenging project management issues and to clarify the problems associated with these issues. Furthermore, I have arranged the book in the order that most of these schedule and cost control issues occur as a project manager and his or her team progress through the life cycle of a project.

The first chapter introduces the subject of schedule and cost control and discusses in more detail why it is needed. Then the most challenging of project management issues—requirements development—is immediately addressed in Chapter 2. Once the requirements are developed, understood, and agreed upon by all stakeholders, the next step in the project process is to describe the project scope through the development of the work breakdown structure, from which the cost and schedule baselines can be developed. This process is fully described in Chapter 3.

Because developing costs is so crucial and difficult, I have included two chapters on the subject; Chapter 4 describes cost estimating generally, and Chapter 5 provides significant detail about the different cost categories a project manager must be aware of and also provides significant detail about what is important when assessing one contract bid against another.

Chapter 6 then discusses schedule development. Many professional project managers insist that the budget should be set before the schedule is developed. That usually is not possible since most customers have an operational need to field the deliverable by a particular date. Therefore, the schedule is usually the driving force behind budget development. However, for the most part, schedule and cost development is an iterative process with the objective of optimizing both. Hence, my personal practice is to develop the two together. Chapter 6 describes the process of developing the schedule, but the reader should consider Chapters 4, 5, and 6 as one group that is necessary for developing budgets and schedules.

The next logical step in preparing to implement a project is the planning phase, which is discussed in Chapter 7. Chapters 8 and 9 also should be considered as one unit; Chapter 8 discusses general implementation procedures and issues, while Chapter 9 discusses earned value management, which is the preferred approach to monitoring and controlling the progress of a project. I opted to separate these topics in order to place proper emphasis on the earned value methodology, but the two chapters can be considered as the implementation phase of a project.

Finally, Chapter 10 discusses the project closing process. The closing phase of a project is often the most difficult phase because all the team members are being pulled away from the project to begin work on new projects. But the closing phase is all-important because this is the time the customer accepts or does not accept the project deliverables, which, of course, are the reason for the project in the first place.

I have also been careful to write this book so that everything in it is consistent with the Project Management Institute's standards. Where there are differences between PMI®'s approach and my own opinion, I so note. Having said that, the final objective of this book is, first, to instruct the project manager who needs help in controlling project costs and schedules and, second, to provide additional instruction for those who are preparing to take their Project Management Professional (PMP®) certification exam. It is my hope that this book will be a good reference for PMP® certification.

Jim Taylor
Peachtree City, Georgia

ABOUT THE AUTHOR

James C. Taylor is a certified Project Management Professional (PMP®) with over 39 years of highly diversified experience in project and program management, marketing, and business development in both the public and private sectors. His principal experience is in the information technology and engineering training industries and includes the design and development of flight simulator equipment and computer-based flight-training courses for the U.S. military.

Mr. Taylor has taught graduate courses in project management, leadership, and negotiation skills and strategies at Marymount University in Virginia and in project management at George Washington University in Washington, D.C. He has designed, developed, and taught numerous core and IT project management courses as well as contracting courses for project managers. He also was previously the Senior Advisor at ESI International, the world's largest provider of project management training, and actively managed the development and update of all of ESI's project management courses. He has been an active speaker over the years and has authored numerous articles and books in the field of project management.

Mr. Taylor has a B.S. in mathematics and a B.S. and M.S. in aerospace engineering from Auburn University, an M.S. in organizational development from Marymount University, and a D.Sc. (all but dissertation) in engineering from George Washington University. He is a consultant in project management and project management training. Mr. Taylor lives in Peachtree City, Georgia.

ACKNOWLEDGMENTS

I have been either practicing or teaching project management for over 38 years. It is impossible to mention all those who have been my teachers and mentors, but I want to thank you all. I have been blessed to have had teachers and mentors who were excellent project managers, and all of them constantly and patiently shared their knowledge and experience with me. This book comes not so much from my independent thinking but rather from the collective experience, knowledge, and thinking of the many who have guided me in a long and successful project management career. For that, I'll always be grateful.

But mostly I want to acknowledge all the students whom I have taught over the years. Surely, the best way to learn is to teach, and all my students continue to challenge me intellectually and professionally. I can't imagine a better way to finish my career than to impart whatever knowledge and experience I have to others. And I look forward to every day as an opportunity to meet and help another project management student.

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Downloads available for *Project Scheduling and Cost Control: Planning, Monitoring, and Controlling the Baseline* consist of scheduling and cost control templates and a slide presentation highlighting critical points related to these components.

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INTRODUCTION

The reason most often cited for project failure is that requirements are not clearly defined or stated or that they are misinterpreted. Consequently, every study of schedule and cost control typically begins by describing needs and requirements and how to ensure they are accurately presented and interpreted. In that regard, this book is similar. What is different about this book is that, in addition to describing requirements and requirements analyses in detail, it discusses how to incorporate these requirements into a project plan and how to set up and implement a monitoring and control system to ensure that projects are successfully completed on time and on budget.

This book describes processes, tools, and techniques necessary and available to manage any project. The terminology, tools, and techniques generally will not be new to someone who has any project management experience, but they are presented so that the members of a project team—even those who have little experience—can apply them immediately to better implement, monitor, and control their projects.

THE NATURE OF SCHEDULE AND COST CONTROL

Before describing ways of monitoring and controlling projects, there are two questions about schedule and cost control that need to be asked and answered:

1. *What* is schedule and cost control?
2. *Why* do we need schedule and cost control?

What Is Schedule and Cost Control?

Schedule and cost control encompasses four aspects or elements of project work that are primary concerns for the project manager and his or her team:

- Directing progress
- Directing actions
- Controlling results
- Conserving resources

Directing Progress

This element of project management refers to the efforts involved in directing the progress of a project against the project plan, particularly in regard to those efforts that impact the cost, schedule, and scope. Almost everything the project team does—every decision that is made—potentially affects one or all of these three components. Cost, for example, affects both schedule and scope, schedule affects cost and scope, and scope affects cost and schedule. Accordingly, if the schedule slips, then it costs more to bring the project back to its original planned timeline, or if the schedule must be met, the customer may prefer to modify the scope by eliminating some of the functionality of the product. Simply stated, directing progress in a way that minimizes negative impacts or directing progress to take advantage of positive impacts is the key to successful project management.

Directing Actions

Directing actions involves taking the proper action to minimize the variances between the planned and actual progress. If, for example, a project is determined to be over budget, then some action is required to bring the spending back into line with the planned budget. Sometimes the action will require some adjustment to the schedule or to the scope, but every action will have a ripple effect; other components of the project will be affected, requiring additional action.

Controlling Results

Controlling results means being cognizant of the fact that any action taken must have a strategy or tactic to control the impact to the project as a whole and to the other components of schedule, cost, and scope. There is no gain

if an action taken pushes the project in an unchecked direction. Being able to predict and control the results of the actions taken will ultimately move the project back to its planned track if it is determined that there is some variance from the original plan.

Conserving Resources

Conserving or controlling resources is the one element of project management that causes the project manager the most grief. There almost never are enough resources available to implement and run a project properly. Therefore, the project manager is responsible for apportioning and conserving resources in the most optimal way possible. Otherwise, the project is doomed before it ever begins.

Why Do We Need Schedule and Cost Control?

The problems of keeping a project on track by directing and controlling the impacts to scope (deliverables, quality), cost (resources, budget), and schedule (activities, time) were mentioned in the previous section. These three elements make up what is known as the *triple constraint,* shown in Figure 1.1. The triple constraint typically is shown as a triangle because each facet

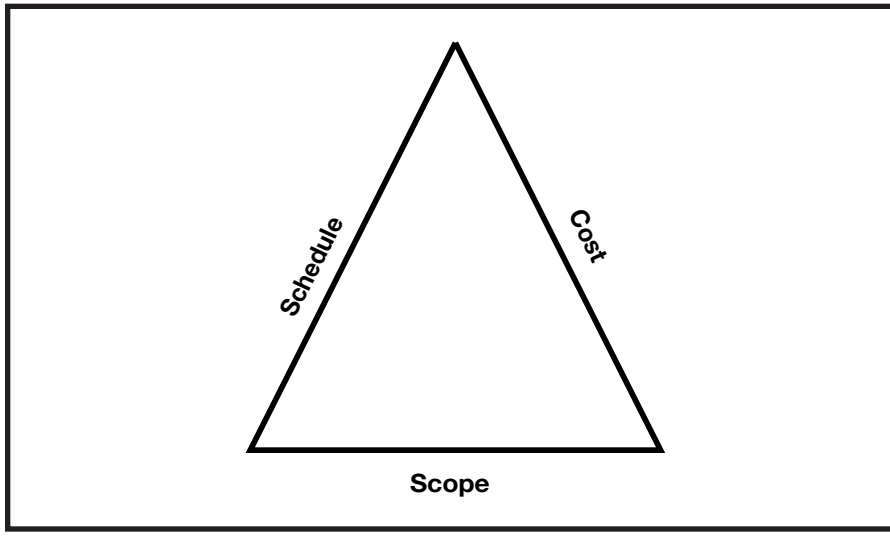

FIGURE 1.1. The Project Management Triple Constraint Triangle

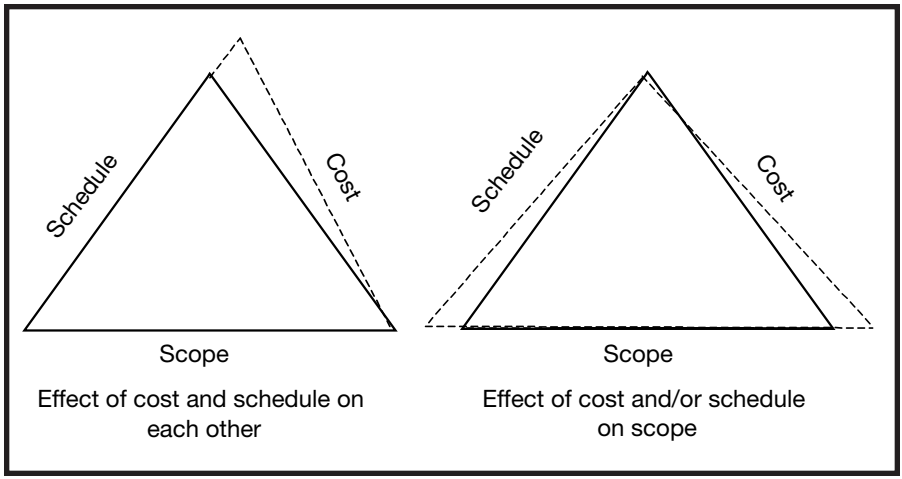

FIGURE 1.2. Effect of Project Management Triangle Component Changes

is critical; none is more important than the others, at least in terms of project control. When one component of the triangle is changed, almost invariably one or both of the others changes.

The triple constraint is a useful view of important components of project management. It is often referred to as the project management triple constraint. The three elements encapsulate a total project. If one of them is changed, then at least one of the others is affected; often both are. For example, if a project goes over budget, scope may have to be decreased to get the project back on the budget plan. If a project is behind schedule (time), more resources may have to be added to get it back on schedule, but adding resources means added costs. These change effects are illustrated in Figure 1.2.

In the left triangle in Figure 1.2, it is clear that if the schedule increases, then the costs must increase because of the additional resources to accommodate or reduce the schedule overrun. Often the reverse is true: if there is an increase in costs, the schedule must be extended to reduce the number of resources needed. The right triangle shows that to reduce the schedule and the costs back to the original estimates, the scope of the project must be reduced.

Keeping the three elements of the triple constraint in balance is one of the aims of a project manager and team; doing so is a juggling act that is

sometimes very difficult and requires a good grasp of a number of management skills, such as communication, risk management, contracting, reporting, team building, selling, and many others.

To summarize the three aspects of the triple constraint triangle, the following may be useful in understanding the exact meaning of each of the sides:

- **Scope**—The *PMBOK® Guide* defines scope as the *sum of the products and services to be provided.* In other words, project scope is the work to be done in a project to meet project requirements.
- **Cost**—The money, labor, equipment, and other resources needed to complete a project.
- **Schedule**—The time it takes to complete a project or to reach intermediate points or milestones within an overall project.

The concept of the triple constraint is used early in the planning stages of a project to understand the customer's needs and to consider how each factor interacts with the others and how together they contribute to the whole project. The triple constraint is also useful during the course of a project in dealing with changes, contingencies, risks, assumptions, replanning, and issues that may arise. In short, every process, every phase, and every activity of project management are all performed against the backdrop of the triple constraint.

THE PROJECT LIFE CYCLE

Every project has a life cycle that is comparable to a biological life cycle in that it begins slowly and quickly builds as the project work starts to produce deliverables. As a project reaches its final days, activity slows down and tapers off. A project life cycle shows the project effort (and costs) as the work takes place and maps this over time, often shown as a graphic.

There are no standard life cycle models. Each industry uses its own model, and variations of the model are found even within an industry. Moreover, the names used for the phases in each model are not always the same; the names differ from industry to industry or even according to an organization's preference. For example, one organization may refer to the first phase as the initiation phase whereas another may call it the concept phase; some indus-

tries use four life cycle phases for their projects, whereas others use seven or more phases. Regardless of what the phases are named or how many exist, the project management activities and the tools and techniques available are generally very much the same across all industries.

In the life cycle model in Figure 1.3, the five phases are *concept, planning, design and development, implementation,* and *closeout.* Each of these phases has its own subphases, steps, or stages, and these usually are defined by an organization to suit the way it defines and develops its projects. Generally, the activities for each phase can be described as:

- Concept
- Planning
- Design and development
- Implementation
- Closeout

Concept

This is the data-gathering phase. The project is just beginning, and who the project manager and team members are has not yet been determined. (Note that there has usually been a previous phase to select the project; in almost every case, a project manager is not involved in project selection. Rather, a project is handed to the project manager after decisions have been made to pursue the project and for what purposes.) During the concept phase, the project manager will determine, to the best extent possible, what the requirements are and what the resource commitment needs to be.

Planning

The planning phase takes the concept phase into the details of planning, where the requirements definition is more specifically developed, a work breakdown structure is prepared, schedule and cost estimates are developed, and the project plan is written. It is also the phase during which the project team is organized.

Design and Development

Blueprinting of the project occurs in this phase. The project manager conducts design meetings as needed to gather all information necessary to create

Concept	Planning	Design and Development	Implementation	Closeout
■ Gather data ■ Identify need ■ Establish: □ Goals, objectives □ Basic economics, feasibility □ Stakeholders □ Risk level □ Strategy □ Potential team ■ Guesstimate resources ■ Identify alternatives ■ Present proposal ■ Obtain approval for next phase	■ Appoint key team members ■ Conduct studies ■ Develop scope baseline: □ End product(s) □ Quality standards □ Resources □ Activities ■ Establish: □ Master plan □ Budget, cash flow □ Work breakdown structure □ Policies and procedures ■ Assess risks ■ Confirm justification ■ Present project brief ■ Obtain approval to proceed	■ Set up: □ Organization □ Communications ■ Motivate team ■ Detail technical requirements ■ Establish: □ Work packages □ Information control systems ■ Procure goods and services ■ Execute work packages	■ Direct/monitor/ forecast/control: □ Scope □ Quality □ Time □ Cost ■ Resolve problems	■ Finalize product(s) ■ Review and accept ■ Settle final accounts ■ Transfer product responsibility ■ Evaluate project ■ Document results ■ Release/redirect resources ■ Reassign project team

FIGURE 1.3. A Project Life Cycle

the design documents. The project manager, subject matter experts, and other stakeholders must review and approve the design document before development begins. The actual work on the project deliverables, or project products, starts and takes place during this phase. The key functions of scheduling and cost control occur here, inasmuch as variances from the plan (or baseline) are measured and control strategies are implemented to keep actual progress as close to the plan as practical.

Implementation

The implementation of the project deliverables, or project products, takes place during this phase. The project manager continues to monitor variances from the plan and implement strategies to keep the project on course. Any problems need to be resolved in order to achieve a successful closeout.

Closeout

This is often the most difficult phase because a project manager loses team members to other projects as the current project in seen to be winding down. Furthermore, many organizations do not support the activities of this phase as strongly as they should because they are moving on to other projects. Yet this phase is critical to the success of a project in a way different from all other phases: this is the phase that delivers the final efforts to customers. It is concerned with conducting a scope review to determine that everything planned (or promised) has been accomplished and delivered, obtaining customer acceptance of deliverables, and closing out administrative and contractual paperwork. It is also the time to develop lessons learned documentation, without which process improvement is made less effective.

REQUIREMENTS REVIEW

Reviewing what is involved in developing requirements is important and adds value. A frequently mentioned reason for project failure is poorly stated or unclear requirements. Moreover, even with clearly stated requirements, the project team can misinterpret what the customer means or wants.

Writing clear requirements is truly an art. We can all think of the many instances when we thought we understood a person to say one thing when in

fact he or she said or meant something else entirely. Therefore, it is always wise to list all the requirements as they are understood and then reexamine each one with the customer to ensure nothing has been missed and to get the customer's agreement that the requirements have been interpreted correctly.

The requirements review is also the time to identify the project stakeholders. *Stakeholders* are those people or organizations that have an interest in a project, are affected by some or all of a project's activities, or, by virtue of their positions, can make or break a project. A serious mistake that inexperienced project managers often make is overlooking those people or organizations that think they are stakeholders, even though they may not fit the strict definition of the term. If in doubt, it is far better to include a person or organization in the stakeholder analysis than to exclude a possible stakeholder that may have the power to negatively affect the project if they feel left out or snubbed.

Of course, the real reason for doing requirements analyses is to determine what needs to be accomplished. However, just as importantly, without a complete understanding of the requirements, it is impossible to develop the cost, time (schedule), and scope targets, which are the baselines against which project progress will be measured.

Finally, when performing a requirements review, it is imperative that the project manager includes acceptance criteria and obtains sign-off on these from the customer. *Acceptance criteria* are a statement of what will be used to conclude whether the project meets its desired outcomes or objectives. Without a mutual and agreed understanding of the "measuring sticks" for completion, the project manager cannot ascertain when the project activities are actually complete. As such, a project could easily become never-ending.

SCHEDULE AND COST CONTROL DOCUMENTATION

The basis for a solid scheduling and cost control system is to use some key tools. As with any aspect of project management, the development of good analyses, detailed documentation, and accurate estimates (to the extent possible) is key to successfully completing a project.

In the case of schedule and cost control, some particularly useful documentation tools can add good value and should be kept in mind for use throughout a project and especially during the planning process. These documents include:

- Project charter
- Scope statement
- Project requirements document
- Work breakdown structure
- Time and cost estimates
- Responsibility matrix
- Risk management plan
- Change control process plan

Project Charter

The project charter is signed by the senior manager who has functional authority over all the resources and organizations working on a project. The principal function of the project charter is to name the project manager and authorize him or her to lead the project. The project manager usually prepares the project charter because he or she knows more about the project than anyone else. However, a senior manager signs it, and usually all the functional managers who have joint responsibility for supporting a project also sign it. An example of a project charter format is depicted in Figure 1.4.

Scope Statement

The scope statement describes a project and its purpose. Depending upon what other documentation accompanies a project (such as a contract, specifications, and engineering drawings), the scope statement can range in detail from a high-level statement of the work to a complete description of the project requirements.

Project Requirements Document

The project requirements document or PRD (depicted in Figure 1.5) is a document used to identify each of the requirements, assumptions, deliverables, and constraints, as well as several other pertinent facts. Because senior managers also sign the PRD, many people are confused about why it is necessary to sign off on both the project charter and the PRD. To simplify this distinction, the project charter deals with people, that is, *who* is performing the project; the PRD, on the other hand, deals with *what* the project is about. Therefore, senior management should sign both documents to formalize the

PROJECT CHARTER			
Project Name:	Project Ref./ID No.:	Preparer Name:	Preparer Signature:
Customer:	Customer Contact:	Contact Phone:	Date Prepared:

To (distribution):

From (initiating authority):

Assignment (include project manager's name, name of the project, customer's name):

Project Manager's Responsibility (describe the extent of the project manager's responsibility relative to planning, implementing, and delivering the project's product[s] or service[s]):

Project Manager's Authority (describe the level of project manager authority and the mechanisms and trigger points for escalating project issues to higher authority):

Functional Support (list all functional organizations and describe their responsibilities to the project):

Project Scope (briefly describe the scope and how the project supports the organization's strategic plan):

Authorizing Signature	Title	Date

FIGURE 1.4. Project Charter Format

PROJECT REQUIREMENTS DOCUMENT			
Project Name:	Project Ref. No.:	Preparer Name:	Preparer Signature:
Customer:	Customer Contact:	Contact Phone:	Date Prepared:
Project Summary/Background			
Project Objectives/Deliverables			
Key Milestones			
Assumptions and Constraints			
Risks			
Key Resource Requirements			
Acceptance Criteria			
Interrelated Projects			
Reviews			
Communications Plan			
Change Management Plan			
Financial Analysis			
Signatures			

FIGURE 1.5. Project Requirements Document Format

authority of the project manager and to indicate organizational commitment to performing the project.

Work Breakdown Structure

The work breakdown structure (WBS) is way to decompose a project into its lowest components and is the single most important tool in a project manager's tool kit. Decomposing a project into a WBS framework can be accomplished in two ways: the indented format and the graphic or tree format. These formats are depicted in Figures 3.2 and 3.3, respectively, where the WBS is discussed in detail.

With a fully developed and detailed WBS, every other tool can be developed and a project plan can be created. In short, the WBS is the basis for schedule and cost control. A WBS can be developed with either a product-oriented or a task-oriented focus, and one should be very careful about how each is used.

The product-oriented WBS has its place in high-level estimating, for communication purposes, or for beginning to understand a high-tech project by starting off with its deliverables. When it is necessary to accurately estimate schedules and costs as well as to manage a project, a WBS needs to be developed in detail, showing the task or the work package level.

Time and Cost Estimates

Time and cost estimates rightly follow the WBS because a network analysis (using precedence diagramming, discussed later) can be developed from the WBS and lead to final schedules. A project can have many schedules: a master schedule, task schedules, milestones, meetings and reports, and so on. After a practical schedule is developed, then the cost of the project can be determined.

Responsibility Matrix

The responsibility matrix serves several purposes. First, it documents who is responsible for each task in lead, approval, and support positions. Second, it is a handy management tool for keeping track of who is doing what task and is particularly useful as a "management by walking around" document. Third, it is a good communication tool. During status briefings or as a

supplement to status reports, it shows which stakeholders are responsible for various project tasks.

Risk Management Plan

The risk management plan is one of many plans that are part of the project plan, but it is highlighted here because it is the most important of all ancillary plans. Risk analysis and planning begin with the WBS and are performed throughout the entire life of a project. Without good risk planning, a project is more exposed and has an increased likelihood of failure.

Change Control Process Plan

The purpose of change control in general is to control scope creep; without it, scope creep is inevitable. *Scope creep* usually occurs when customers or other stakeholders want to add small enhancements to a project. However, unless these changes are made in a formalized fashion, scope will grow (creep) without an attendant increase in schedule (time) or budget (cost). (Recall the triple constraint.) Change control is a vital part of scope management, and available forms assist in the overall change control process (discussed in greater detail in Chapter 10).

Others

The "art" side of project management dictates that project managers must determine what tools, techniques, documents, or other aids are available and required to successfully control the schedule, cost, and scope baselines. Thus, as you gain experience in project management, you will find there are many other documentation tools that will make your job easier, adding to your ability to successfully complete a project. Unfortunately, there is no prescription for success in project management—only suggestions and a few important tips. There are other aids that you are bound to discover for yourself.

SUMMARY

Over half of all new projects fail. The concept of schedule and cost control is not new, and it should not come as a surprise that all organizations,

whether or not they employ project management practices in their business, are concerned about controlling work so that it meets its schedule and cost objectives.

The WBS is the most important tool for defining and developing schedule and cost control systems. With a well-developed WBS, every other project management tool can be developed. In short, it is the basis of schedule and cost control.

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