SEVENTH EDITION

PROJECT MANAGEMENT
IN PRACTICE

JACK MEREDITH | SCOTT SHAFER

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Project Management in Practice

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To the memory of Sam Mantel, Jr.: Scholar, author,
mentor, friend.

J. R. M. and S. M. S.

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Preface

APPROACH

The use of projects and project management continues to accelerate in our global societies. With the addition of Agile, project management is now also being used for dynamic, "quasi" projects: initiatives where the scope, budget, and deadline are changing constantly. One of the more interesting areas of growth, however, has been in the use of projects for achieving the strategic goals of organizations through the use of sponsors, portfolio management, project management offices, and program managers. The growth of membership in the Project Management Institute (PMI) is further convincing evidence, as are the sales of computer software devoted to project management. Several societal forces are driving this growth, and many economic factors are reinforcing it. We describe all these in Chapter 1 of this book.

A secondary effect has also been a major contributor to the use of project management. As the use of projects has grown, its very success as a way of getting all kinds of activities carried out successfully has become well established, especially when a tight budget or timeline or both were involved. The result has been a striking increase in the use of projects to accomplish jobs that in the past would simply have been turned over to someone with the comment "Take care of it."

What happened then was that some individual undertook to carry out the job with little or no planning, minimal assistance, few resources, and often with only a vague notion of what was really wanted. Some of these projects were large, but most were quite small. Some were complex, but most were relatively straightforward. Some required the full panoply of project management techniques, but most did not. All of them, however, had to be managed and thus required a great many people to take on the role of project manager in spite of little or no education in project management.

One result was rising demand for education in project management. The number of college courses grew apace, as did the number of consulting firms offering seminars and workshops. Communications from some instructors in these institutions told us that they would like a textbook that was shorter and focused more directly on the "technical" aspects of project management than those currently available. They were willing to forego most of the theoretical aspects of management, particularly if such were not directly tied to practice. Their students, who were not apt to take advanced course work in project management, had little use for understanding the historical development of the field nor the latest academic research. Finally, instructors asked for increased use of project management application software, though they added that they did not want a replacement for the many excellent "step-by-step" and "computing-for-dummies" types of books that were readily available. They wanted the emphasis to be on managing projects, and not on managing project management software.

These requests sounded sensible to us, and we have tried to write such a book.

ORGANIZATION AND CONTENT

With few exceptions, both readers and instructors are most comfortable with project management texts that are organized around the project life cycle, and this book is so organized. In Chapter 1 we start by defining a project and differentiating project management from general management. After discussing the project life cycle, we cover project selection, the project management office, and the project portfolio. We feel strongly that project managers who understand why a project was selected by senior management and who will be supporting their efforts will then also understand the firm's objectives for the project. Understanding those things, we know, will be of value

in making the inevitable trade-offs between time, budget, and the specified output of the project, as well as how to handle the inevitable changes and risks that will arise to threaten the project.

Chapter 2 is devoted to the various roles the project manager must play and to the skills required to play them effectively. In addition, we cover the various ways in which projects can be organized. The nature of project teams, including multidisciplinary teams, and the behavioral aspects of projects are also discussed.

Project and risk planning, budgeting, and scheduling are covered in Chapters 3−5. Planning the project initiates our discussion in Chapter 3, where we introduce the work breakdown structure and other planning aids such as the RACI matrix and end with a thorough discussion and illustration of risk management planning. Project budgeting is then described in Chapter 4 where we introduce the use of simulation through software such as Crystal Ball® to analyze financial risk. Risk analysis using Oracle's Crystal Ball® (CB) simulations is demonstrated in several chapters with detailed instructions on building and solving simulation models. Software is used throughout the book, where relevant, to illustrate the use and power of such software to aid in managing projects. Chapter 5 initially uses standard manual methods for building project schedules, and Microsoft Project® (MSP) is then demonstrated for doing the same thing.

Chapter 6 deals with resource allocation problems in a multiproject setting. A major section of this chapter is devoted to the insights of E. Goldratt in his book *Critical Chain*.* Chapter 7 concerns monitoring and controlling the project, especially through the use of earned value analysis, which is covered in detail. The final chapter deals with auditing, evaluating, and closing the project.

Interest in risk management has grown rapidly in recent years, but the subject gets only minimal attention in most introductory-level project management textbooks. We deal with risk throughout this book, introducing methods of risk management and analysis where relevant to the subject at hand. For example, simulation is used in Chapter 4 for solving a project budgeting problem, in Chapter 5 on a scheduling problem, and in Chapter 6 for examining the impact of a generally accepted assumption about probabilistic project schedules that is usually false, and also to test the usually false assumption that multitasking is an efficient way to improve productivity.

We are certainly aware that no text on project management could be structured to reflect the chaos that seems to surround some projects throughout their lives, and a vast majority of projects now and then. The organization of this book reflects a tidiness and sense of order that is nonexistent in reality. Nonetheless, we make repeated references to the technical, interpersonal, and organizational glitches that impact the true day-to-day life of the project manager.

PEDAGOGY

The book includes several pedagogical aids. The end-of-chapter material includes *Review Questions* that focus on the textual material. *Discussion Questions* emphasize the implications and applications of ideas and techniques covered in the text. Where appropriate, there are *Exercises* that are primarily directed at developing skills in the technical areas of project management as well as familiarizing the student with the use of relevant software.

In addition to the above, we have included *Incidents for Discussion* in the form of caselettes. In the main, these caselettes focus on one or more elements of the chapter to which they are appended. Several of them, however, require the application of concepts and techniques covered in earlier chapters so that they also serve an integrative function.

More comprehensive *Cases* are also appended to each chapter. A special set of these, beginning in Chapter 1, is associated with the *same* project—the planning, building, and marketing of an assisted living facility—which continues on through the following chapters. That is, each chapter is followed by a continuation of this case calling upon the ideas and methods covered in that chapter. With all these cases, integration with material in previous chapters is apt to be required.

We include Learning Objectives for each chapter but instead of putting them at the beginning of the chapter, we have added them to the Instructors' Manual. Many teachers feel that

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* Goldratt, E. M. *Critical Chain*. Great Barrington, MA: North River, 1997.

their students should have the Learning Objectives as they begin each chapter. Many don't. Many teachers like to use their own LOs. Many do not like to use LOs because they feel that students focus solely on the listed objectives and ignore everything else. Given our LOs in the Instructor's Manual, each teacher may opt for his/her own notion on the matter.

We have used Excel® spreadsheets where appropriate throughout the book. Microsoft Office® is widely available, and with few exceptions students and professional project managers are familiar with its operation.

Each copy of the text also comes packaged with a registration card, which professors and students can use to download a free trial edition of Oracle's Crystal Ball®. Crystal Ball was chosen because it works seamlessly with Excel and is user friendly. For those professors using an e-book version of the text, instructions for accessing Crystal Ball (CB) are posted on the instructor companion website for the text. If you have questions, please contact your local Wiley sales rep. We have demonstrated in Chapters 4–6 some of the problems where the use of statistical decision models and simulation can be very helpful in understanding and managing risk. In addition, several end-of-chapter problems are available for solution by Microsoft Project and Crystal Ball. The solutions can be found in the *Instructor's Manual* along with added instructions for use of the software.

As we have noted elsewhere, projects have often failed because the project manager attempted to manage the software rather than the project. We feel strongly that students and professionals should learn to use the basic project management techniques by hand—and only then turn to software for relief from their manual efforts.

As is true with any textbook, we have made some assumptions about both the students and professionals who will be reading this book. We assume that they have all had some elementary training in management, or have had equivalent experience. We also assume that, as managers, they have some slight acquaintance with the fundamentals of accounting, behavioral science, finance, and statistics. We even assume that they have forgotten most of the statistics they once learned and have therefore included an appendix on relevant elementary statistics and probability as a memory refresher.

WHAT'S NEW

Trade-Offs

Risk

Strategic

Best Practice

PMBOK Guide

Both students and instructors have been generous and kind with their comments on the earlier editions of this book. They have given us very useful suggestions and feedback, which we appreciate. To further improve the student's perspective of project management from the view of project managers in actual practice, we describe project management from the perspective of the two primary roles of the project manager: (1) the need to constantly manage trade-offs between the three main goals of scope, time, and cost, and (2) managing risk. To highlight these areas where we talk about trade-offs and risk, we have added icons to the book margins where important discussion on these topics appear. We also use an icon to indicate areas of discussion where there are strategic issues that the project manager should be aware of and also topics that we believe exemplify "best practice" in the project management field. And we have expanded our references to locations in PMBOK® that discuss the topic at hand for those who are also studying for the Project Management Professional® (PMP) or other certification exams offered by the Project Management Institute.

Specific additions and changes are listed below:

- We have added a number of new topics to Chapters 1 and 2: the importance of stakeholder consultation in developing the business case for the project, the danger of bias from various behavioral factors when developing the business case, how to best provide organizational support for the team developing the business case, the inevitable changes that will occur in the business case and thus also in the project plan, and what three measures are best to gauge the success of the project. In Chapter 8, we address more fully how to engage the ultimate users of the project to ensure that the anticipated benefits of the project are realized. We also clarify the difference between the Project Plan Closeout Report and the Business Case Closeout Report

and who is responsible for each report. We also cut back on some discussions, such as matrix organization (Chapter 2), and updated and simplified the references and bibliographies.

- Project governance, strategy, and the business case are currently major topics in project management, involving the new roles of the project manager, the program manager, the project office, the portfolio manager, the sponsor, the client, the user, the project owner, the steering committee, and other internal and external stakeholders in the project. We have added many new references on these topics, primarily in Chapter 1, Chapter 2, and Chapter 8.

- We have significantly expanded the discussion of Agile project management by distributing and integrating the material throughout the chapters where it applies rather than presenting it as an alternative approach to the standard Waterfall project management. We felt that these two approaches to managing projects were not separately complete alternatives but that there was a spectrum of combinations, called Hybrid, that, depending on the project context, could be used together to best manage the project.

- Last, we added more material in Chapter 8 concerning the importance of engaging the project users early to make sure they would be comfortable with the changes the project entailed and felt confident in their ability to use the project's outputs to gain the benefits envisioned for the project.

SUPPLEMENTS

The *Instructor's Manual* will provide assistance to the project management instructor in the form of answers/solutions to the questions, problems, incidents for discussion, and end-of-chapter cases. This guide will also reference relevant Harvard Business School type cases and readings, teaching tips, and other pedagogically helpful material. Wiley maintains a website for this and other books. The address is *www.wiley.com/go/meredith/projectmanagement7e*. The site contains an electronic version of the *Instructor's Manual*, an extensive set of PowerPoint slides, and test questions to test student understanding.

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The World of Project Management

Once upon a time there was a heroine project manager. Her projects were never late. They never ran over budget. They always met contract specifications and invariably satisfied the expectations of her clients. And you know as well as we do, anything that begins with "Once upon a time . . ." is just a fairy tale.

This book is not about fairy tales. Throughout these pages we will be as realistic as we know how to be. We will explain project management practices that we know will work. We will describe project management tools that we know can help the project manager (PM) and team come as close as Mother Nature and Lady Luck will allow to meeting the expectations of all who have a stake in the outcome of the project.

Our approach in this book is to primarily address the issues that PMs and their team members will be facing during the project. But it is also important for them to understand the bigger picture surrounding the project like: Why are we doing this project? What is it supposed to achieve (refer to Einhorn et al., 2020)? What documents and paperwork will be needed during the project? Who else besides us are interested in the project and what are their roles (refer to Zwikael et al., 2018)? We will not go into these topics in depth. But as we continue to improve the success rate of our projects, yet fail to realize the benefits the projects were meant to achieve, it has become more important for everyone associated with the projects to better understand this bigger picture about the equally critical "soft side" of the projects.

Strategic

The accomplishment of important tasks and goals in organizations today is being achieved increasingly through projects. As a result, a new kind of organization is emerging to deal with the accelerating growth in the number of multiple, simultaneously ongoing, and often interrelated projects in organizations. This project-oriented organization, often called "enterprise project management" (Levine, 1998), "management by projects" (Boznak, 1996), and similar names, was created to tie projects more closely to the organization's goals and strategy and to integrate and centralize management methods for the growing number of ongoing projects.

1.1 WHAT IS A PROJECT?

Why this emphasis on project management? The answer is simple: Daily, organizations are asked to accomplish work activities that do not fit neatly into business-as-usual. A software group may be asked to develop an application program that will access U.S. government data on certain commodity prices and generate records on the value of commodity inventories held by a firm; the software must be available for use on April 1. The Illinois State Bureau for Children's Services may require an annually updated census of all Illinois resident children, aged 17 years or younger, living with an illiterate single parent; the census must begin in 18 months. A manufacturer initiates a process improvement project to offset higher energy costs.

Note that each work activity is *unique* with a specific *deliverable* aimed at meeting a *specific need or purpose*. These are *projects*. The routine issuance of reports on the value of commodity inventories, the routine counseling of single parents on nurturing their offspring, the day-to-day activities associated with running a machine in a factory—these are not projects. The difference

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between a project and a *nonproject* is not always crystal clear. For almost any precise definition, we can point to exceptions. At base, however, projects are unique, have a specific deliverable, and have a specific due date. Note that our examples have all those characteristics. The Project Management Institute (PMI) defines in its *Project Management Body of Knowledge (PMBOK Guide)*, 6th edition, a project as "A temporary endeavor undertaken to create a unique product, service, or result" (Project Management Institute, 2017).

Projects vary widely in size and type. The writing of this book is a project. The reorganization of Procter & Gamble (P&G) into a global enterprise is a project, or, more accurately, a program, a large integrated set of projects. The construction of a fly-in fishing lodge in Manitoba, Canada, is a project. The organization of "Cat-in-the-Hat Day" so that Mrs. Payne's third grade class can celebrate Dr. Suess's birthday is also a project.

Both the hypothetical projects we mentioned earlier and the real-world projects listed just above have the same characteristics. They are unique, specific, and have desired completion dates. They all qualify as projects under the PMI's definition. They have an additional characteristic in common—they are multidisciplinary. They require input from people with different kinds of knowledge and expertise. This multidisciplinary nature of projects means that they tend to be complex, that is, composed of many interconnected elements and requiring input from groups outside the project. The various areas of knowledge required for the construction of the fly-in fishing lodge are not difficult to imagine. The knowledge needed for globalization of a large conglomerate like P&G is quite beyond the imagination of any one individual and requires input from a diversified group of specialists. Working as a team, the specialists investigate the problem to discover what information, skills, and knowledge are needed to accomplish the overall task. It may take weeks, months, or even years to find the correct inputs and understand how they fit together.

A secondary effect of using multidisciplinary teams to deal with complex problems is conflict. Projects are characterized by conflict. As we will see in later chapters, the project schedule, budget, and specifications conflict with each other. The needs and desires of the client conflict with those of the project team, the senior management of the organization conducting the project, and others who may have a less direct stake in the project. Some of the most intense conflicts are those between members of the project team. Much more will be said about this in later chapters. For the moment, it is sufficient to recognize that projects and conflict are often inseparable companions, an environment that is unsuitable and uncomfortable for conflict avoiders.

It is also important to note that projects do not exist in isolation. They are often parts of a larger entity or program, just as projects to develop a new engine and an improved suspension system are parts of the program to develop a new automobile. The overall activity is called a program. Projects are subdivisions of programs. Likewise, projects are composed of *tasks*, which can be further divided into *subtasks* that can be broken down further still. The purpose of these subdivisions is to allow the project to be viewed at various levels of detail. The fact that projects are typically parts of larger organizational programs is important for another reason, as is explained in Section 1.6.

Finally, it is appropriate to ask "Why projects?" The reason is simple. We form projects in order to fix the responsibility and authority for the achievement of an organizational goal on an individual or small group when the job does not clearly fall within the definition of routine work.

1.1.1 TRENDS IN PROJECT MANAGEMENT

Many recent developments in project management are being driven by quickly changing global markets, technology, and education. Global competition is putting pressure on prices, response times, and product/service innovation. Computer and telecommunication technology, along

with rapidly expanding higher education across the world, allows the use of project management for types of projects and in regions where these sophisticated tools had never been considered before. The most important of these recent developments are covered in this book.

Achieving Strategic Goals There has been a growing use of projects to achieve an organization's strategic goals, and a new role has arisen to help attain the target benefits desired by the funder of the project: a project "owner" (Section 1.6). Additionally, existing major projects are screened to make sure that their objectives support the organization's strategy and mission. Projects that do not have clear ties to the strategy and mission are not approved. A discussion of this is given in Section 1.7, where the Project Portfolio Process is described.

Strategic

As well, the growth of project management into giant, multiorganizational, billion-dollar, multiyear, complex "mega-projects," as they are now known (Bisenthal et al., 2018), is now commonplace and is testing our understanding of organizational coordination. Such super-large projects push the limits of not only our technical and behavioral knowledge but also our abilities regarding organizational coordination and cooperation (Shenhar et al., 2017). As a result, there has been an urgent push in the field for more research and studies to better understand these issues.

Strategic

Agile Project Management In an environment characterized by constantly evolving technology and more sophisticated customers, the functionality to be incorporated into new software is often not well understood at the beginning of a software development project. This results in the need to continuously update the requirements throughout the project or deliver a product that falls short of important customer requirements. To address this challenge, Agile project management approaches were developed to provide greater flexibility to respond to changing customer requirements and ultimately complete projects more efficiently. While initially developed to address the challenges faced in software development projects, Agile techniques are becoming increasingly used in a wide variety of industries and types of projects. A survey conducted by the Project Management Institute of almost 6,000 senior executives and project management professionals across a wide variety of industries found that 23 percent of projects were completed using Agile approaches and another 23 percent of projects were completed using a combination of Agile and other approaches. Given the increasing popularity of Agile project management, the topic of Agile is integrated throughout this book beginning in Section 1.3 in this chapter. An Agile icon is displayed in the margin to facilitate locating these discussions.

Agile

PMOs for Improving Project Effectiveness A variety of efforts are being pursued to improve the process and results of project management, whether strategic or tactical. These efforts are typically now being led by a formal Project Management Office (PMO), or Enterprise Project Management Office (EPMO; Section 2.5) that helps provide or coordinate training in project management skills and techniques such as the use of phase gates and Agile (Section 3.4), earned value (Section 7.3), critical ratios (Section 7.4), and other such approaches. These offices also continually evaluate and help improve the organization's project management "maturity" (Section 7.5), educate PMs about the evolving *ancillary goals* of the organization (Section 8.1), and generally oversee the organization's portfolio of programs and projects (Section 1.7).

Strategic

Virtual Projects With the rapid increase in globalization of industry, many projects now involve global teams whose members operate in different countries and different time zones, each bringing a unique set of talents to the project. These are known as virtual projects because the team members may never physically meet before the team is disbanded and another team reconstituted. Advanced telecommunications and computer technology allow such virtual projects to be created, do their work, and complete their project successfully (see Section 2.1).

A project, then, is a temporary endeavor undertaken to create a unique product or service. It is specific, timely, usually multidisciplinary, and typically conflict ridden. Projects are often parts of overall programs and may be broken down into tasks, subtasks, and further, if desired. Current trends in project management include achieving strategic goals, implementing Agile techniques, improving project effectiveness, and dealing with virtual projects.

1.2 PROJECT MANAGEMENT VERSUS GENERAL MANAGEMENT

As is shown in Table 1.1, project management differs from general management largely because projects differ from what we have referred to as "nonprojects." The naturally high level of conflict present in projects means that the PM must have special skills in conflict resolution. The fact that projects are unique means that the PM must be creative and flexible and have the ability to adjust rapidly to changes. When managing nonprojects, the general manager tries to "manage by exception." In other words, for nonprojects, almost everything is routine and is handled routinely by subordinates. The manager deals only with the exceptions. For the PM, almost everything is an exception.

1.2.1 MAJOR DIFFERENCES

Certainly, general management's success is dependent on good planning. For projects, however, planning is much more carefully detailed and project success is absolutely dependent on such planning. The project plan is the result of integrating all information about a project's deliverables, generally referred to as the "scope" of the project, and its targeted date of completion. "Scope" has two meanings. One is "product scope," which defines the performance requirements of a project, and "project scope," which details the work required to deliver the product scope (see Chapter 5 of PMBOK, 2017). To avoid confusion, we will use the term scope to mean "product scope" and will allow the work, resources, and time needed by the project to deliver the product scope to the customer to be defined by the project's plan (discussed in detail in Chapter 3). Therefore, the scope and due date of the project determine its plan, that is, its budget, schedule, control, and evaluation. Detailed planning is critically important. One should not, of course, take so much time planning that nothing ever gets done, but careful planning is a major contributor to project success. Project planning is discussed in Chapter 3 and is amplified throughout the rest of this book.

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Project budgeting differs from standard budgeting, not in accounting techniques, but in the way budgets are constructed. Budgets for nonprojects are primarily modifications of budgets for the same activity in the previous period. Project budgets are newly created for each project and often cover several "budget periods" in the future. The project budget is derived directly from the

Table 1.1 Comparison of Project Management and General Management

Dimension	Project Management	General Management
Type of work activity	Unique	Routine
Management approach	Ability to adapt to change	Manage by exception
Planning	Critical	Important
Budgeting	Start from scratch, multiple budget periods	Modify budget from previous budget period
Sequence of activities	Must be determined	Often predetermined
Location of work	Crosses organizational units	Within an organizational unit
Reporting relationships	Informal	Well defined

project plan that calls for specific activities. These activities require resources, and such resources are the heart of the project budget. Similarly, the project schedule is also derived from the project plan.

In a nonproject manufacturing line, the sequence in which various things are done is set when the production line is designed. The sequence of activities often is not altered when new models are produced. On the other hand, each project has a schedule of its own. Previous projects with deliverables similar to the one at hand may provide a rough template for the current project, but its specific schedule will be determined by the time required for a specific set of resources to do the specific work that must be done to achieve each project's specific scope by the specific date on which the project is due for delivery to the client. As we will see in later chapters, the special requirements associated with projects have led to the creation of special managerial tools for budgeting and scheduling.

The routine work of most organizations takes place within a well-defined structure of divisions, departments, areas, and similar subdivisions of the total enterprise. The typical project cannot thrive under such restrictions. The need for technical knowledge, information, and special skills almost always requires that departmental lines be crossed. This is simply another way of describing the multidisciplinary character of projects. When projects are conducted side-by-side with routine activities, chaos tends to result—the nonprojects rarely crossing organizational boundaries and the projects crossing them freely. These problems and recommended actions are discussed at greater length in Chapter 2.

Even when large firms establish manufacturing plants or distribution centers in different countries, a management team is established on-site. For projects, "globalization" has a different meaning. Individual members of project teams may be spread across countries, continents, and oceans and speak several different languages. Some project team members may never even have a face-to-face meeting with the PM, though transcontinental and intercontinental video meetings combining telephone and computer are common.

The discussion of structure leads to consideration of another difference between project and general management. In general management, there are reasonably well-defined reporting relationships. Superior–subordinate relationships are known, and lines of authority are clear. In project management this is rarely true. The PM may be relatively low in the hierarchical chain of command. This does not, however, reduce his or her responsibility of completing a project successfully. Responsibility without the authority of rank or position is so common in project management as to be the rule, not the exception.

1.2.2 NEGOTIATION

With little legitimate authority, the PM depends on negotiation skills to gain the cooperation of the many departments in the organization that may be asked to supply technology, information, resources, and personnel to the project. The parent organization's standard departments have their own objectives, priorities, and personnel. The project is not their responsibility, and the project tends to get the leftovers, if any, after the departments have satisfied their own need for resources. Without any real command authority, the PM must negotiate for almost everything the project needs.

It is important to note that there are three different types of negotiation, *win–win* negotiation, *win–lose* negotiation, and *lose–lose* negotiation. When you negotiate the purchase of a car or a home, you are usually engaging in win–lose negotiation. The less you pay for a home or car, the less profit the seller makes. Your savings are the other party's losses—win–lose negotiation. This type of negotiation is never appropriate when dealing with other members of your organization. If you manage to "defeat" a department head and get resources or commitments that the department head did not wish to give you, imagine what will happen the next time you need

something from this individual. The PM simply cannot risk win–lose situations when negotiating with other members of the organization.

Lose–lose negotiation occurs when one party is unwilling to assert his or her position aggressively and at the same time resists cooperating with the other party. This often occurs in situations where one or both of the parties are conflict avoiders. When one party is not willing to help the other party achieve his or her objectives and at the same time is unwilling to pursue his or her own objectives, the end result is that both parties lose.

Within the organization, win–win negotiation is mandatory. In essence, in win–win negotiation both parties must try to understand what the other party needs. The problem you face as a negotiator is how to help other parties meet their needs in return for their help in meeting the needs of your project. When negotiation takes place repeatedly between the same individuals, win–win negotiation is the only sensible procedure. PMs spend a great deal of their time negotiating. General managers spend relatively little. Skill at win–win negotiating is a requirement for successful project managing (see Fisher et al., 1983).

One final point about negotiating: Successful win–win negotiation often involves taking a synergistic approach by searching for the "third alternative." For example, consider a product development project focusing on the development of a new printer. A design engineer working on the project suggests adding more memory to the printer. The PM initially opposes this suggestion, feeling that the added memory will make the printer too costly. Rather than rejecting the suggestion, however, the PM tries to gain a better understanding of the design engineer's concern.

Based on their discussion, the PM learns that the engineer's purpose in requesting additional memory is to increase the printer's speed. After benchmarking the competition, the design engineer feels the printer will not be competitive as it is currently configured. The PM explains his fear that adding the extra memory will increase the cost of the printer to the point that it also will no longer be cost competitive. Based on this discussion, the design engineer and PM agree that they need to search for another (third) alternative that will increase the printer's speed without increasing its costs. A couple of days later, the design engineer identifies a new ink that can simultaneously increase the printer's speed and actually lower its total and operating costs.

Project management differs greatly from general management. Every project is planned, budgeted, scheduled, and controlled as a unique task. Unlike nonprojects, projects are often multidisciplinary and usually have considerable need to cross departmental boundaries for technology, information, resources, and personnel. Crossing these boundaries tends to lead to intergroup conflict. The development of a detailed project plan based on the scope and due date of the project is critical to the project's success.

Unlike their general management counterparts, PMs have responsibility for accomplishing a project, but little or no legitimate authority to command the required resources from the functional departments. The PM must be skilled at win–win negotiation to obtain these resources.

1.3 AGILE PROJECT MANAGEMENT

In the traditional approach to project management, one phase of the project is completed before the next phase is started. This is typically referred to as the waterfall method. For example, software development projects are often broken down into phases such as requirements, design, development, integration, testing, and deployment. As another example, Six Sigma process improvement projects often follow the define, measure, analyze, improve, and control phases.

In an effort to lower costs, improve project outcomes, and reduce project completion times, a group of 17 software developers and project experts met in 2001 to discuss and identify the

characteristics shared by successful projects. Based on these discussions and leveraging lean management principles, the group developed a new approach to project management. Foundational values for this new approach were spelled out in a declaration entitled the "Manifesto for Agile Software Development" (agilemanifesto.org):

Agile

> *We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:*
>
> **Individuals and interactions** *over processes and tools*
>
> **Working software** *over comprehensive documentation*
>
> **Customer collaboration** *over contract negotiation*
>
> **Responding to change** *over following a plan*
>
> > *That is, while there is value in the items on the right, we value the items on the left more.*

The first value, individuals and interactions over processes and tools, addresses the objective of providing an effective and efficient way to solve problems and build cohesive teams. An important implication associated with this value is that agile teams must be staffed with people who can work effectively with others.

The second value, working software over comprehensive documentation makes it clear that the emphasis is on producing products with working functionality. It is also implied that barely sufficient product development activities, project documents, meetings, and other administrative activities should be used. In other words, product development work and administrative overhead should be kept to the minimum needed to achieve the project's objectives. This is in contrast to gold-plating where unneeded effort is expended in the completion of tasks, holding meetings, and creating documents. Along these lines, with Agile there is a concerted effort to ensure fewer reports and documents are created. Additionally, the ones that are used are streamlined to make them easier to maintain and provide greater visibility into how the project is progressing. This allows the team to spend more time on the work of the project and less time on administrative activities. As a practical tip toward eliminating unneeded reports, stop creating a report and see if anyone complains!

Best Practice

The third value in the Agile Manifesto, customer collaboration over contract negotiation, clearly defines the central role the customer plays in product development projects. With the traditional waterfall approach, customers are involved at the start of the project, when the scope of the project needs to change, and at the end of the project. Aside from these times, customer input is discouraged, which often results in creating an adversarial relationship between the project team and the customer. Furthermore, the practice of developing a detailed contract at the start of a project is a bit ludicrous given that this is the point in the project where the least amount is known about the project. The Agile approach recognizes this reality and the value of fostering a collaborative relationship between the project team and customers as opposed to fostering more confrontational relationships.

The final value, responding to change versus following a plan, recognizes that having the flexibility to adapt to changing requirements is invaluable to the pursuit of developing superior products and services. In the traditional waterfall approach, the project team relies on detailed and structured change management procedures that ultimately discourage changes and stifle creativity. This results in project team members adhering to a plan that may be of questionable value and not capitalizing on opportunities to enhance the value of the project deliverables. In contrast, Agile approaches have built-in mechanisms that encourage and welcome change, thereby providing opportunities to incorporate the most up-to-date information throughout the project.

In addition to the Agile Manifesto, the group of 17 also developed a list of 12 Agile Principles that support the values articulated in the Agile Manifesto. More specifically, the Agile

Principles were developed as guidelines to assist project teams in implementing the Agile methodology and techniques. The 12 Principles are as follows (agilemanifesto.org):

We follow these principles:

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.

2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.

3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

4. Business people and developers must work together daily throughout the project.

5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.

6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.

7. Working software is the primary measure of progress.

8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.

9. Continuous attention to technical excellence and good design enhances agility.

10. Simplicity—the art of maximizing the amount of work not done—is essential.

11. The best architectures, requirements, and designs emerge from self-organizing teams.

12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Based on the Agile Manifesto and the 12 Principles, a variety of Agile methodologies, frameworks, techniques, and tools have been developed such as scrum, lean product development, and extreme programming (XP). Prior to 2008, the waterfall method was still the most common project management approach used for software development. However, since 2008, approaches based on Agile techniques have been used more frequently for software development projects. While Agile was developed for software development, it can be adapted to other types of projects, especially ones associated with developing new outputs. Such outputs include products and services that contain a set of features that provide value to a customer.

While there are a number of different Agile approaches, they are all based on the Agile Manifesto and the 12 Principles, and they all share the following general characteristics:

- The project is divided into iterations most commonly called sprints.

- Based on its roots in lean management, there is an emphasis on simplicity.

- Project teams are self-managing.

- Progress on the project is measured in terms of working product functionality.

Scrum is the most popular Agile approach and was developed by Ken Schwaber and Jeff Sutherland in the early 1990s as a framework for creating and delivering complex products. The scrum framework defines specific scrum team roles within the scrum team (discussed in more

detail in Chapter 2), project events (discussed in more detail in Chapters 3 and 7), documents for planning and reviewing projects referred to as artifacts (discussed in more detail in Chapter 3), and rules that govern the relationship among the roles, events, and artifacts. Scrum has been applied in a variety of industries and types of projects including software and hardware development, by governments and educational institutions, for identifying new markets, developing autonomous cars, developing cloud operating environments, and for developing services.

With scrum, the project work is completed in sprints that typically last 1 to 2 weeks but occasionally last as long as 4 weeks. Importantly, the duration of the sprints is held constant for a given project. Each sprint has specific targets in terms of product functionality to be completed. Then the quality of the work completed during the sprint is evaluated. Verifying the quality of the work during the sprint well positions the project team to identify the causes of quality problems and implement improvements in subsequent sprints. In more traditional project management approaches, long gaps between the creation and identification of problems can impede correcting the problems and implementing countermeasures to eliminate the problems.

Associated with the scrum framework are three specific team roles including the product owner, developers, and the scrum master (each discussed in more detail in Chapter 2). Furthermore, there are specific documents referred to as artifacts that are used in conjunction with scrum and specific events associated with scrum such as the daily scrum meeting. The Agile artifacts and events will be discussed at appropriate times throughout this book. Finally, to conclude this introduction to Agile, listed below are several of the most significant benefits organizations have obtained through the adoption of Agile methods:

- Higher customer satisfaction as a result of receiving customer input and feedback throughout the project

- Increased flexibility to incorporate changing requirements

- Less waste on nonproductive work

- Faster delivery of products with working functionality

- Higher quality and faster problem detection

- Reduced risk of project failure

- Increased collaboration among stakeholders and team members

- Higher team morale resulting from the use of self-managed teams

- Enhanced performance visibility

- Improved predictability of key project outcomes

Agile project management techniques were developed to lower costs, improve project outcomes, and reduce project completion times. The Agile Manifesto lists the values underlying Agile approaches and the 12 Principles provide guidelines for implementing them. While Agile was originally developed for software development projects, it has been used in a variety of industries. Scrum is the most popular Agile approach. With scrum, the project work is completed in sprints that typically last 1 to 2 weeks but occasionally last as long as 4 weeks. Associated with the scrum methodology are three specific team roles including the product owner, developers, and the scrum master. The significant benefits organizations acquired through Agile make it increasingly popular.

1.4 WHAT IS MANAGED? THE THREE GOALS OF A PROJECT

The performance of a project, commonly called its "efficiency," is assessed on the basis of three criteria, variously known as the "triple constraints," the "iron triangle," the "golden constraints," and so on. Is the project on time or early? Is the project on or under budget? Does the project deliver the scope to the agreed-upon specifications? Figure 1.1 shows the three goals of a project. The performance of the project and the PM is measured by the degree to which these goals are achieved. A recent issue, however, has arisen: Meeting a project's triple constraints often does not achieve the aims of the project for the client, known as the project's "effectiveness"; that is, the project didn't deliver the benefits the client was hoping to gain. However, not meeting the project's triple constraint usually dooms the project to failure. This issue is discussed further in Section 1.6.

One of these goals, the project's specifications or "scope," is set primarily by the client (although the client agrees to all three when contracting for the project). It is the client who must decide what capabilities are required of the project's deliverables—and this is what makes the project unique. Some writers insist that "quality" is a separate and distinct goal of the project along with time, cost, and scope. We do not agree because we consider quality an inherent part of the project scope.

If we did not live in an uncertain world in which best-made plans often go awry, managing projects would be relatively simple, requiring only careful planning. Unfortunately, we do not live in a predictable (*deterministic*) world, but one characterized by chance events (*uncertainty*). This ensures that projects travel a rough road. Murphy's law seems as universal as death and taxes, and the result is that the most skilled planning is upset by uncertainty. Thus, the PM spends a great deal of time adapting to unpredicted changes. The primary method of adapting is to trade off one objective for another. If a construction project falls behind schedule because of bad weather, it may be possible to get back on schedule by adding resources—in this case, probably labor using overtime and perhaps some additional equipment. If the budget cannot be raised to cover the additional resources, the PM may have to negotiate with the client for a later delivery date of the building. If neither cost nor schedule can be negotiated, the client may be willing to cut back on some of the features in the building in order to allow the project to finish on time and budget (e.g., substituting carpet for tile in some of the spaces). As a final alternative, the contractor may have to "swallow" the added costs (or pay a penalty for late delivery) and accept lower profits.
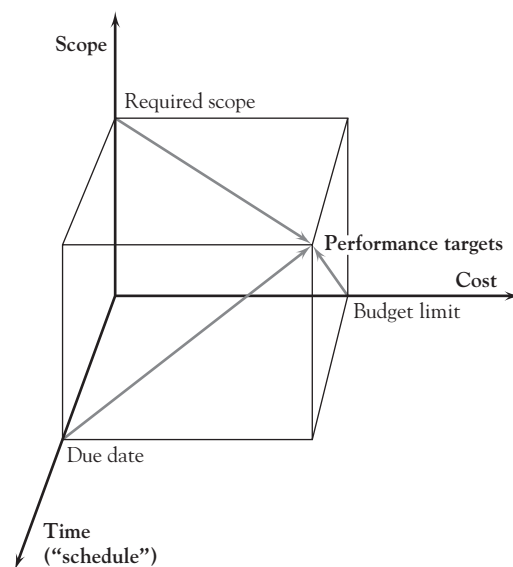
Trade-Offs

FIGURE 1.1 Scope, cost, and time project performance targets

This example illustrates a fundamental point. Namely, managing the trade-offs among the three project goals is in fact one of the primary roles of the PM. Furthermore, managing these trade-offs in the most effective manner requires that the PM have a clear understanding of how the project supports broader organizational goals. Thus, the organization's overall strategy is the most important consideration for managing the trade-offs that will be required among the three project goals.

Trade-Offs

All projects are always carried out under conditions of uncertainty. Well-tested software routines may not perform properly when integrated with other well-tested routines. A chemical compound may destroy cancer cells in a test tube—and even in the bodies of test animals—but may kill the host as well as the cancer. Where one cannot find an acceptable way to deal with a problem, the only alternative may be to stop the project and start afresh to achieve the desired deliverables.

As we note throughout this book, projects are all about uncertainty. Therefore, in addition to effectively managing trade-offs, the second major role of the PM is dealing with uncertainty, that is, managing risks. The time required to complete a project, the availability and costs of key resources, the timing of solutions to technological problems, a wide variety of macroeconomic variables, the whims of a client, the actions taken by competitors, even the likelihood that the output of a project will perform as expected, all these exemplify the uncertainties encountered when managing projects. While there are actions that may be taken to reduce the uncertainty, no actions of a PM can ever eliminate it.

Projects are complex and include interfaces, interdependencies, and many assumptions, any or all of which may turn out to be wrong. Also, projects are managed by people, which adds to the uncertainty. The uncertainties include everything from legislation that can change how we do business, to earthquakes and other "acts of God." Therefore, in today's turbulent business environment, effective decision-making is predicated on an ability to manage the ambiguity that arises while we operate in a world characterized by uncertain information. (Risk management is discussed in Chapter 11 of PMBOK, 2017.)

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The first step in managing risk is to identify these potentially uncertain events and the likelihood that any or all may occur. This is called *risk analysis*. Different managers and organizations approach this problem in different ways. Expect the unexpected; some managers suggest considering those things that keep one awake at night. Many organizations keep formal lists, a "risk register," and use their PMO (discussed in Chapter 2) to maintain and update the list of risks and approaches that have been successful in the past in dealing with specific risks. This information is then incorporated into the firm's business-continuity and disaster-recovery plans. Every organization should have a well-defined process for dealing with risk, and we will discuss this issue at greater length in Section 3.5. At this point we simply overview risk analysis.

Risk

The essence of risk analysis is to make estimates or assumptions about the probability distributions associated with key parameters and variables and to use analytic decision models or Monte Carlo simulation models based on these distributions to evaluate the desirability of certain managerial decisions. Real-world problems are usually large enough that the use of analytic models is very difficult and time consuming. With modern computer software, simulation is not difficult.

Best Practice

A mathematical model of the situation is constructed that models the relationship between unknown input variables and important outcomes. The model is run (or replicated) repeatedly, starting from a different point each time based on random choices of values from the probability distributions of the input variables. Outputs of the model are used to construct statistical distributions of outcomes of interest to decision makers, such as costs, profits, completion dates, or return on investment. These distributions are the *risk profiles* of the outcomes associated with a decision. Risk profiles can be analyzed by the manager when considering a decision, along with many other factors such as strategic concerns, behavioral issues, fit with the organization, cost and scheduling issues, and so on.

Risk

Thus in this book, we adopt the point of view that the two primary roles of the PM are managing trade-offs and managing risks. Because these two roles are fundamental to the work of the PM, icons are displayed throughout the book in the left margin when these topics are discussed. It is also important to point out that these two roles are highly integrated with each other. Indeed, managing risk is actually tightly coupled with managing the three traditional goals of project management. For example, the more uncertainty the PM faces, the greater the risk that the project will go over budget, finish late, and/or not meet its original scope. However, beyond these rather obvious relationships, there is also a more subtle connection. In particular, project risk can actually be thought of as a fourth trade-off opportunity at the PM's disposal. For example, the project's budget can be increased in order to collect additional data that in turn will reduce the uncertainty related to how long it will take to complete the project. Likewise, the project's deadline can be reduced, but this will increase the uncertainty about whether it will be completed on time.

Trade-Offs

Most of the trade-offs PMs make are reasonably straightforward if the organization's strategy is well understood, and trade-offs are discussed during the planning, budgeting, and scheduling phases of the project. Usually they involve trading time and cost, but if we cannot alter either the schedule or the budget, the scope of the project may be altered or additional risk accepted. Frills on the finished product may be foregone, capabilities not badly needed may be compromised. From the early stages of the project, it is the PM's duty to know which elements of project performance are sacrosanct.

One final comment on this subject: Projects must have some flexibility. Again, this is because we do not live in a deterministic world. Occasionally, a senior manager (who does not have to manage the project) presents the PM with a document precisely listing a set of deliverables, a fixed budget, and a firm schedule. This is failure in the making for the PM. Unless the budget is overly generous, the schedule overlong, and the deliverables easily accomplished, the system is, as mathematicians say, "overdetermined." If Mother Nature so much as hiccups, the project will fail to meet its rigid parameters. A PM cannot be successful without flexibility to manage the trade-offs.

The two primary roles of the PM are to manage trade-offs among three interrelated objectives and to manage risks. The three interrelated objectives are: to (1) meet the budget, (2) finish on schedule, and (3) generate deliverables that satisfy the client. Because we live in an uncertain world, as work on the project proceeds, unexpected problems are bound to arise. These chance events will threaten the project's schedule or budget or scope. The PM must now decide how to trade off one project goal against another (e.g., to stay on schedule by assigning extra resources to the project may mean it will run over the predetermined budget). If the schedule, budget, and scope are rigidly predetermined, the project is probably doomed to failure unless the preset schedule and budget are overly generous or the difficulty in meeting the specifications has been seriously overestimated.

1.5 THE LIFE CYCLES OF PROJECTS

Strategic

All organisms have a *life cycle*. They are born, grow, wane, and die. This is true for all living things, for stars and planets, for the products we buy and sell, for our organizations, and for our projects as well. A project's life cycle starts with the initiation of the project as a proposal during the "front end" by the project's "champion." With appropriate support from top management (Amoako-Gyampah et al., 2018; Zwikael et al., 2019), a "business case" (Einhorn et al., 2020) is constructed that lays out the idea in more detail such as how long it will take, what it will cost, and, most importantly, what benefits it will bring to the organization. This stage includes a variety of different managers such as the champion, the project "owner" (described in more detail in the

next section), a committee or representative of the funding entity (e.g., the CEO), and other key stakeholders with interests in the project. If the proposal is approved, then a PM and team are appointed to execute the project, with the project owner overseeing the project and preparing the final users of the project's output to deliver the benefits that were expected from the project.

Following the execution stage, the project owner works with the users during the benefits realization stage to ensure the benefits are delivered as expected. The project owner then closes out the business case with a final report detailing the success of the project based on three measures: the success of achieving the project plan, the success of achieving the business case, and the success of the investment for the funder (Meredith et al., 2019). The subject of project life cycles is discussed in PMBOK's Chapter 4 on Project Integration Management.

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The first duty of the project owner and the PM after project approval is to prepare a "project plan" (see Chapter 3) for the project. However, they both need to understand that the business case will probably change during the execution stage (Kloppenborg et al., 1990), and this will then alter the project plan as well. As the project goes further into the execution stage, the PM's job becomes that of keeping the project on budget and schedule—or, when chance interferes with progress, negotiating the appropriate trade-offs to correct or minimize the damage. Toward the end of the execution stage, the PM turns into a "fuss-budget" to assure that the specifications in the final version of the business case are truly met, handling all the details of closing out the project plan, making sure there are no loose ends, and that every "i" is dotted and "t" crossed.

Trade-Offs

Many projects are like building a house. A house-building project starts slowly with a lot of discussion and planning. Then construction begins, and progress is rapid. When the house is built, but not finished inside, progress appears to slow down and it seemingly takes forever to paint everything, to finish all the trim, and to assemble and install the built-in appliances. Progress is slow-fast-slow, as shown in Figure 1.2.

It used to be thought that the S-shaped curve of Figure 1.2 represented the life cycle for all projects. While this is true of many projects, there are important exceptions. Anyone who has baked a cake has dealt with a project that approaches completion by a very different route than the traditional S-curve, as shown in Figure 1.3.

The process of baking a cake is straightforward. The ingredients are mixed while the oven is preheated, usually to 350°F. The mixture (technically called "goop") is placed in a greased pan, inserted in the oven, and the baking process begins. Assume that the entire process from assembling the ingredients to finished cake requires about 45 minutes—15 minutes for assembling the materials and mixing and 30 minutes for baking. At the end of 15 minutes we have goop. Even after 40 minutes, having baked for 25 minutes, it may look like cake but, as any baker knows, it is still partly goop inside. If a toothpick (our grandmothers used a broom straw) is inserted into the middle of the "cake" and then removed, it does not come out clean. In the last few minutes of the
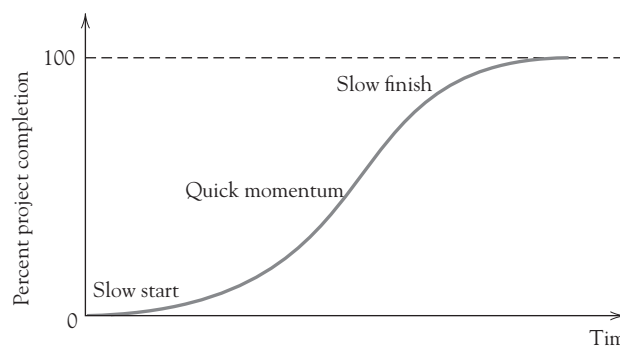
FIGURE 1.2   The project life cycle
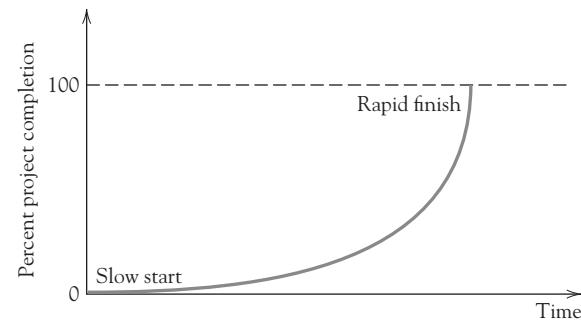
FIGURE 1.3   An alternate project life cycle

process, the goop in the middle becomes cake. If left a few minutes too long in the oven, the cake will begin to burn on the bottom. Project Cake follows a J-shaped path to completion much like Figure 1.3.

There are many projects that are similar to cake—the development of computer software and many chemical engineering projects, for instance. In these cases the PM's job begins with great attention to having all the correct project resources at hand or guaranteed to be available when needed. Once the "baking" process is underway—the integration of various sets of code or chemicals—one cannot usually add missing ingredients. As the process continues, the PM must concentrate on determining when the project is complete—"done" in the case of cake, or a fully debugged program in the case of software.

In later chapters, we will also see the importance of the shape of the project's life cycle on how management allocates resources or reacts to potential delays in a project. Management does not need to know the precise shape of the life cycle, but merely whether its completion phase is concave (Figure 1.2) or convex (Figure 1.3) to the baseline.

There are two different paths (life cycles) along which projects progress from start to completion. One is S-shaped, and the other is J-shaped. It is an important distinction because identifying the different life cycles helps the PM to focus attention on appropriate matters to ensure successful project completion.

1.6 SELECTING PROJECTS TO MEET ORGANIZATIONAL OBJECTIVES

★
Best Practice

🔗
Strategic

As noted earlier, a major trend occurring in organizations is the use of project management to implement the organization's strategic objectives, especially organizational change. Organizations spend about $100 billion a year on creating competitive strategies (Morgan et al., 2007, p. 1), yet 90 percent of them (thousands) fail due to poor execution of these projects. This has stimulated a variety of new research into why these projects, even when successful, often don't attain the strategic benefits the organization desired. Some of these research streams are called "change management," "benefits realization management," and other such terms. One new approach gaining attention has been the creation of a new position in the project governance structure called the "project owner," an agent of the funding organization with the responsibility of ensuring that the project results deliver the strategic benefits desired by the funder (Meredith et al., 2020; Zwikael et al., 2019b). The project owner works closely with the PM and the executive "sponsor" (typically, the champion) of the project in the PM's organization, as well as all project stakeholders, to ensure that the strategic benefits are realized when the project is eventually implemented and operationalized.

Not all of an organization's projects will be strategy implementation or organizational change projects, but all of the projects in the organization's portfolio should be consistent with

the organization's strategic goals. In what follows, we first discuss a variety of common project selection methods. We then describe the process of strategically selecting the best set of projects for implementation, called the Project Portfolio Process. Recent research has found that the most effective support from top management during the project front end is *having a process*, rather than "adding resources" or "fostering better communication," as is typically the case in the later stages of projects (Meredith et al., 2020). Having a formalized process for developing business cases and selecting projects helps minimize the behavioral factors that misrepresent projects such as optimism bias, ownership feelings, and unrealistic assumptions.

Project selection is the process of evaluating individual projects or groups of projects and then choosing to implement a set of them so that the objectives of the parent organization are achieved. Before a project begins its life cycle, it must have been *selected* for funding by the parent organization. Whether the project was proposed by someone within the organization or an outside client, it is subject to approval by a more or less formal selection process. Often conducted by a committee of senior managers, the major function of the selection process is to ensure that several conditions are considered before a commitment is made to undertake any project. These conditions vary widely from firm to firm, but several are quite common: (1) Is the project potentially profitable and does it have a chance of meeting our return-on-investment hurdle rate? (2) Is the project required by law or the rules of an industrial association; i.e., a "mandate?" (3) Does the firm have, or can it easily acquire, the knowledge and skills to carry out the project successfully? (4) Does the project involve building competencies that are considered consistent with our firm's strategic plan? (5) Does the organization currently have the capacity to carry out the project on its proposed schedule? (6) In the case of R&D projects, if the project is technically successful, does it meet all requirements to make it economically successful? This list could be greatly extended.

The selection process is often complete before a PM is appointed to the project. Why, then, should the PM be concerned? Quite simply, the PM should know exactly why the organization selected the specific project because this sheds considerable light on what the project, and hence the PM and project owner are expected to accomplish, from senior management's point of view. The project may have been selected because it appeared to be profitable, or a way of entering a new area of business, or a way of building a reputation of competency with a new client or in a new market. This knowledge can be very helpful to the PM by indicating senior management's goals for the project, which will point to the desirability of some trade-offs and the undesirability of others.

Trade-Offs

There are many different methods for selecting projects, but they may be grouped into two fundamental types, nonnumeric and numeric. The former does not use numbers for evaluation; the latter does. At this point it is important to note that many firms select projects before a detailed project plan has been developed. Clearly, if the potential project's scope, budget, and due dates have not been determined, it will be quite impossible to derive a reasonably accurate estimate of the project's success. Rough estimates may have to suffice in such cases, but specific plans should be developed prior to final project selection. Obviously, mandated projects are an exception. For mandates, budget estimates do not matter but scope and due dates are still important. But mandates *must* be selected. We will deal further with the selection problem when we consider the PMO in Chapter 2.

1.6.1 NONNUMERIC SELECTION METHODS

The Sacred Cow At times, the organization's Chief Executive Officer (CEO) or other senior executive either formally or casually suggests a potential product or service that the organization might offer to its customers. The suggestion often starts, "You know, I was thinking that we might . . ." and concludes with ". . . Take a look at it and see if it looks sensible. If not, we'll drop the whole thing."

Whatever the selection process, the aforementioned project will be approved. It becomes a "Sacred Cow" and will be shown to be technically, if not economically, feasible. This may seem irrational to new students of project management, but such a judgment ignores senior management's intelligence and valuable years of experience—as well as the subordinate's desire for long-run employment. It also overlooks the value of support from the top of the organization, a condition that is necessary for project success (Green, 1995).

The Operating/Competitive Necessity This method selects any project that is necessary for continued operation of a group, facility, or the firm itself. A "mandated" project obviously must be selected. If the answer to the "Is it necessary . . . ?" question is "yes," and if we wish to continue using the facility or system to stay in business, the project is selected. The Investment Committee of a large manufacturing company started to debate the advisability of purchasing and installing pumps to remove 18 inches of flood water from the floor of a small, but critical production facility. The debate stopped immediately when one officer pointed out that without the pumps the firm was out of business.

The same questions can be directed toward the maintenance of a competitive position. Some years ago, General Electric almost decided to sell a facility that manufactured the large mercury vapor light bulbs used for streetlights and lighting large parking lots. The lighting industry had considerable excess capacity for this type of bulb and the resulting depressed prices meant they could not be sold profitably. General Electric, however, felt that if they dropped these bulbs from their line of lighting products, they might lose a significant portion of all light bulb sales to municipalities. The profits from such sales were far in excess of the losses on the mercury vapor bulbs.

Comparative Benefits Many organizations have to select from a list of projects that are complex, difficult to assess, and often noncomparable, for example, United Way organizations and R&D organizations. Such institutions often appoint a selection committee made up of knowledgeable individuals. Each person is asked to arrange a set of potential projects into a rank-ordered set. Typically, each individual judge may use whatever criteria he or she wishes to evaluate projects. Some may use carefully determined technical criteria, but others may try to estimate the project's probable impact on the ability of the organization to meet its goals. While the use of various criteria by different judges may trouble some, it results from a purposeful attempt to get as broad a set of evaluations as possible.

Rank-ordering a small number of projects is not inherently difficult, but when the number of projects exceeds 15 or 20, the difficulty of ordering the group rises rapidly. A *Q-sort** is a convenient way to handle the task. First, separate the projects into three subsets, "good," "fair," and "poor," using whatever criteria you have chosen—or been instructed to use. If there are more than seven or eight members in any one classification, divide the group into two subsets, for instance, "good-plus" and "good-minus." Continue subdividing until no set has more than seven or eight members. Now, rank-order the items in each subset. Arrange the subsets in order of rank, and the entire list will be in order. Last, review the stack and shift any cards that seem out of place until the classifications are satisfactory.

The committee can make a composite ranking from the individual lists any way it chooses. One way would be to number the items on each individual list in order of rank, and then add the ranks given to each project by each of the judges. Projects may then be approved in the order of their composite ranks, at least until the organization runs out of available funds.

1.6.2 NUMERIC SELECTION METHODS

Financial Assessment Methods Most firms select projects on the basis of their expected economic value to the firm. Although there are many economic assessment methods

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*The Q-sort is a handy, useful, and easy-to-use technique. See Helin et al., 1974.

available—payback period, average annual rate of return, internal rate of return, and so on—we will describe here two of the most widely used methods: *payback period* and *discounted cash flow*.*

The payback period for a project is the initial fixed investment in the project divided by the estimated annual net cash inflows from the project (which include the cash inflows from depreciation of the investment). The ratio of these quantities is the number of years required for the project to return its initial investment. Because of this perspective, the payback period is often considered a surrogate measure of risk to the firm: the longer the payback period, the greater the risk. To illustrate, if a project requires an investment of $100,000 and is expected to return a net cash inflow of $25,000 each year, then the payback period is simply 100,000/25,000 = 4 years, assuming the $25,000 annual inflow continues at least 4 years. Although this is a popular financial assessment method, it ignores the time value of money as well as any returns beyond the payback period. For these reasons, it is not recommended as a project selection method, though it is valuable for cash budgeting. Of the financial assessment methods, the discounted cash flow method discussed next is recommended instead.

Risk

The discounted cash flow method considers the time value of money, the inflation rate, and the firm's return-on-investment (ROI) hurdle rate for projects. The annual cash inflows and outflows are collected and discounted to their *net present value* (NPV) using the organization's *required rate of return* (a.k.a., the *hurdle rate* or *cutoff rate*).

$$\text{NPV}\left(\text{project}\right) = I_o + \sum_{t=1}^{n} F_t \,/\, \left(1+k\right)^t$$

where

I_0 = the initial investment, which will be negative because it is an outflow

F_t = the net cash flow in period t

k = the required rate of return or hurdle rate

n = number of periods in life of project

If one wishes to include the potential effects of inflation or deflation in the calculation, it is quite easily done. The discounting term, $(1 + k)^t$, simply becomes $(1 + k + p_t)^t$, where p_t is the estimated rate of inflation or deflation for period t. If the required rate of return is 10 percent and we expect the rate of inflation will be 3 percent, then the discount term becomes $(1 + .10 + .03)^t = (1.13)^t$ for that period.

In the early years of a project when outflows usually exceed inflows, the NPV of the project for those years will be negative. If the project becomes profitable, inflows become larger than outflows and the NPV for those later years will be positive. If we calculate the present value of the net cash flows for all years, we have the NPV of the project. If this sum is positive, the project may be accepted because it earns more than the required rate of return. The following boxed example illustrates these calculations. For clarity and convenience in the analysis, we have chosen to illustrate the calculations using Excel®'s NPV function rather than using the NPV formula.

Perhaps the most difficult aspect related to the proper use of discounted cash flow is determining the appropriate discount rate to use. While this determination is made by senior management, it has a major impact on project selection, and therefore, on the life of the PM. For most projects the hurdle rate selected is the organization's cost of capital, though it is often arbitrarily set too high as a general allowance for risk. In the case of particularly risky projects, a higher hurdle rate may be justified, but it is not a good general practice. If a project is competing for funds with alternative investments, the hurdle rate may be the *opportunity cost of capital*, that is, the rate

Risk

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*Explanations of the theory and methods of calculating the NPV of cash inflows are beyond the scope of this book. We recommend that the reader who could benefit from an explanation turn to any standard college textbook on finance.

CERAMIC SCIENCES, INC.

Ceramic Sciences, Inc. (CSI) is a large producer of decorative ceramic pots. The firm is considering the installation of a new manufacturing line that will, it is hoped, improve the quality of its pots as well as their vases designed to hold artificial flowers.

The plant engineering department has submitted a project proposal that estimates the following investment requirements: an initial investment of $125,000 to be paid upfront to the Pocketa Machine Corporation, an additional investment of $100,000 to install the machines, and another $90,000 to add new material handling systems and integrate the new equipment into the overall production system. Delivery and installation is estimated to take 1 year, and integrating the entire system should require an additional year. Thereafter, the engineers predict that scheduled machine overhauls will require further expenditures of about $15,000 every second year, beginning in the fourth year. They will not, however, overhaul the machinery in the last year of its life.

The project schedule calls for the line to begin production in the third year, and to be up-to-speed by the end of that year. Projected manufacturing cost savings and added profits resulting from higher quality are estimated to be $50,000 in the first year of operation and are expected to peak at $120,000 in the second year of operation, and then to follow the gradually declining pattern shown in Table A.

Project life is expected to be 10 years from project inception, at which time the proposed system will be obsolete and will have to be replaced. It is estimated that the machinery will have a salvage value of $35,000. CSI has a 13 percent hurdle rate for capital investments and expects the rate of inflation to be about 2 percent per year over the life of the project. Assuming that the initial expenditure occurs at the beginning of the year and that all other receipts and expenditures occur as lump sums at the end of the year, we can prepare the Net Present Value analysis for the project as shown in Table A. Note that Excel's built-in NPV function was used to facilitate the analysis. The NPV function has two arguments: the discount rate and the range that contains the cash flows to be discounted.

Because the first cash flow of − $125,000 occurs at the beginning of the first period, there is no need to discount it as it is already in present value terms. The remaining cash flows

Table A Discounted cash flow analysis of new manufacturing line

	A	B	C	D
1	Hurdle Rate	13.0%		
2	Inflation Rate	2.0%		
3				
4	Year	Inflow	Outflow	Net Flow
5	20X0*	$0	$125,000	−$125,000
6	20X0	$0	$100,000	−$100,000
7	20X1	$0	$90,000	−$90,000
8	20X2	$50,000	$0	$50,000
9	20X3	$120,000	$15,000	$105,000
10	20X4	$115,000	$0	$115,000
11	20X5	$105,000	$15,000	$90,000
12	20X6	$97,000	$0	$97,000
13	20X7	$90,000	$15,000	$75,000
14	20X8	$82,000	$0	$82,000
15	20X9	$100,000	$0	$100,000
16	Total	$759,000	$360,000	$399,000
17	NPV			$17,997

=B5−C5 [Copy to D6:D15]

=$65,000 cost savings + $35,000 salvage value

=D5+NPV(B1+B2,D6:D15)

*t = 0 at the beginning of 20X0

are assumed to occur at the end of their respective periods. For example, the $115,000 cash flow associated with 20X4 is assumed to occur at the end of the fifth period. According to the results, the NPV of the project is positive, and, thus, the project can be accepted. (The project would have been rejected if the hurdle rate had been 15 percent or if the inflation rate was 4 percent, either one resulting in a discount rate of 17 percent.)

of return the firm must forego if it invests in the project instead of making an alternative investment. Another common, but misguided practice is to set the hurdle rate high as an allowance for resource cost increases. Neither risk nor inflation should be treated so casually. Specific corrections for each should be made if the firm's management feels it is required. We recommend strongly a careful risk analysis, which we will discuss in further detail throughout this book.

Because the present value of future returns decreases as the discount rate rises, a high hurdle rate biases the analysis strongly in favor of short-run projects. For example, given a rate of 20 percent, a dollar 10 years from now has a present value of only $.16, $(1/1.20)^{10} = 0.16$. The critical feature of long-run projects is that costs associated with them are spent early in the project and have high present values while revenues are delayed for several years and have low present values.

The discounted cash flow methods of calculation are simple and straightforward. Like the other financial assessment methods, it has a serious defect. First, it ignores all nonmonetary factors except risk. Second, because of the nature of discounting, all the discounted methods bias the selection system by favoring short-run projects. Let us now examine a selection method that goes beyond assessing only financial profitability.

Financial Options and Opportunity Costs A more recent approach to project selection employs financial analysis that recognizes the value of positioning the organization to capitalize on future opportunities. It is based on the financial options approach to valuing prospective capital investment opportunities. Through a financial option an organization or individual acquires the right to do something but is not required to exercise that right. For example, you may be familiar with stock options. When a person or organization purchases a stock option, they acquire the right to purchase a specific number of shares of a particular stock at a specified price within a specified time frame. If the market price of the stock moves above the specified option price within the specified time frame, the entity holding the option can exercise its right and thereby purchase the stock below the fair market price. If the market price of the stock remains below the specified option price, the entity can choose not to exercise its right to buy the stock.

To illustrate the analogy of financial options to project selection, consider a young biotech firm that is ready to begin clinical trials to test a new pharmaceutical product in humans. A key issue the company has to address is how to produce the drug both now in the low volumes needed for the clinical trials and in the mass quantities that will be needed in the future should the new drug succeed in the clinical trial phase. Its options for producing the drug in low volumes for the clinical trials are to invest in an in-house pilot plant or to immediately license the drug to another company. If it invests in an in-house pilot plan, it then has two future options for mass producing the drug: (1) invest in a commercial-scale plant or (2) license the manufacturing rights. In effect then, investing now in the pilot plant provides the pharmaceutical company with the option of building a commercial-scale plant in the future, an option it would not have if it chooses to license the drug right from the start. Thus by building the in-house pilot plant, the pharmaceutical company is in a sense acquiring the right to build a commercial plant in the future. While beyond the scope of this book, we point out to the reader that in addition to the traditional approaches to project selection, the decision to build the pilot plant can also be analyzed using valuation techniques from financial options theory. In this case the value of having the option to build a commercial plant can be estimated.

In addition to considering the value of future opportunities a project may provide, the cost of *not* doing a project should also be considered. This approach to project selection is based on the well-known economic concept of "opportunity cost." Consider the problem of making an investment in one of only two projects. An investment in Project A will force us to forgo investing in Project B, and *vice versa*. If the return on A is 12 percent, making an investment in B will have an opportunity cost of 12 percent, the cost of the opportunity forgone. If the return on B is greater than 12 percent, it may be preferred over selecting Project A.

The same selection principle can be applied to timing the investment in a given project. R&D projects or projects involving the adoption of new technologies, for example, have values that may vary considerably with time. It is common for the passage of time to reduce uncertainties involved in both technological and commercial projects. The value of investing now may be higher (or lower) than investing later. If a project is delayed, the values of its costs and revenues at a later period should be discounted to their present value when compared to an investment not delayed.

Occasionally, organizations will approve projects that are forecast to lose money when fully costed and sometimes even when only direct costed. Such decisions by upper management are not necessarily foolish because there may be other, more important reasons for proceeding with a project, such as to:

- Acquire knowledge concerning a specific or new technology

- Get the organization's "foot in the door"

- Obtain the parts, service, or maintenance portion of the work

- Allow them to bid on a lucrative, follow-on contract

- Improve their competitive position

- Broaden a product line or line of business

Of course, such decisions are expected to lose money in the short term only. Over the longer term they are expected to bring extra profits to the organization. It should be understood that "lowball" or "buy-in" bids (bidding low with the intent of cutting corners on work and material, or forcing subsequent contract changes) are unethical practices, violate the PMI Code of Ethics for Project Managers (see PMBOK, 2017), and are clearly dishonest.

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Scoring Methods Scoring methods were developed to overcome some of the disadvantages of the simple financial profitability methods, especially their focus on a single criterion. The simplest scoring approach, the *unweighted 0–1 factor method*, lists multiple criteria of significant interest to management. Given a list of the organization's goals, a selection committee, usually senior managers familiar with both the organization's criteria and potential project portfolio, check off, for each project, which of the criteria would be satisfied; for example, see Figure 1.4. Those projects that exceed a certain number of check-marks may be selected for funding.

Best Practice

All the criteria, however, may not be equally important and the various projects may satisfy each criterion to different degrees. To correct for these drawbacks, the weighted *factor scoring method* was developed. In this method, a number of criteria, n, are considered for evaluating each project, and their relative importance weights, w_j, are estimated. The sum of the weights over all the j criteria is usually set arbitrarily at 1.00, though this is not mandatory. It is helpful to limit the criteria to just the major factors and not include criteria that are only marginal to the decision, such as representing only 2 or 3 percent importance. A rule of thumb is to keep n less than eight factors because the more important factors with weights of say 20 percent or more force the weights of the less important factors to be insignificant. The importance weights, w_j, can be determined in any of a number of ways: a particular individual's subjective belief, available objective

Project _____

Rater _____Date _____

	Qualifies	Does Not Qualify
No increase in energy requirements	x	
Potential market size, dollars	x	
Potential market share, percent	x	
No new facility required	x	
No new technical expertise required		x
No decrease in quality of final product	x	
Ability to manage project with current personnel		x
No requirement for reorganization	x	
Impact on work force safety	x	
Impact on environmental standards	x	
Profitability		
Rate of return more than 15% after tax	x	
Estimated annual profits more than $250,000	x	
Time to break-even less than 3 years	x	
No need for external consultants		x
Consistency with current line of business		x
Impact on company image		
With customers	x	
With our industry		x
Totals	12	5

FIGURE 1.4 A sample project selection form, an unweighted 0–1 scoring model

factors such as surveys or reports, group composite beliefs such as simple averaging among the group members, and so on.

In addition, a score, s_{ij}, must be determined for how well each project i satisfies each criterion j. Each score is multiplied by its category weight, and the set of scores is summed to give the total weighted score, $S_i = \Sigma_j\, s_{ij}\, w_j$ for each project, i, from which the best project is then selected. Typically, a 5-point scale is used to ascertain these scores, though 3-, 7-, and even 9-point scales are sometimes used. The top score, such as 5, is reserved for excellent performance on that criterion such as a return on investment (ROI) of 50 percent or more, or a reliability rating of "superior." The bottom score of 1 is for "poor performance," such as an ROI of 5 percent or less, or a reliability rating of "poor." The middle score of 3 is usually for average or nominal performance (e.g., 15–20 percent ROI), and 4 is "above average" (21–49 percent ROI) while 2 is "below average" (6–14 percent ROI). Notice that the bottom score, 1, on one category may be offset by very high scores on other categories. Any condition that is so bad that it makes a project unacceptable, irrespective of how good it may be on other criteria, is a *constraint*. If a project violates a constraint, it is removed from the set and not scored.

Note two characteristics in these descriptions. First, the categories for each scale need not be in equal intervals—though they should correspond to the subjective beliefs about what constitutes excellent, below average, and so on. Second, the 5-point scales can be based on either quantitative or qualitative data, thus allowing the inclusion of financial and other "hard" data (cash flows, NPV, market share growth, costs) as well as "soft" subjective data (fit with the

organization's goals, personal preferences, attractiveness, comfort). And again, the soft data also need not be of equal intervals. For example, "superior" may rate a 5 but "OK" may rate only a 2. The general mathematical form of the weighted factor scoring method is

$$S_i = \sum_{j=1}^{n} s_{ij} w_j$$

where

S_i = the total weighted score of the ith project

s_{ij} = the score of the ith project on the jth criterion

w_j = the weight or importance of the jth criterion

USING A WEIGHTED SCORING MODEL FOR AN ELECTION CAMPAIGN PROJECT

As the campaign manager to elect Jennifer Allison to the city council, you have determined that winning the election is largely dependent on Jennifer's name recognition. One idea for increasing Jennifer's name recognition is to distribute car bumper stickers with her name on them. In selecting a vendor to design and print the bumper stickers, you have two primary criteria of equal importance, cost and the reliability of the printer to complete the work on time. You have a limited budget for the bumper stickers and would like to spend no more than $4,200. Beyond cost and reliability, the reputation of the vendor for developing bold and aesthetically pleasing designs is also an important consideration. Upon further reflection and since this is only a bumper sticker, you determine that the reputation of the vendor is only half as important as either cost or reliability. Table B shows a set of scales you created for the three criteria, converted into quantitative scores.

You have identified three possible vendors to design and print the bumper stickers. In Table C, you have scored each of the vendors on each of the criteria, calculated their weighted scores, and summed them to get a total. The weights for the criteria were obtained from the following logic: If Y is the importance weight for Cost, then Y is also the importance for Reliability and ½Y is the importance for Reputation. This results in the formula

$$Y + Y + \tfrac{1}{2}Y = 1.00 \text{ or } Y = 0.4$$

Thus, Cost has 0.4 importance weight, as does Reliability, and Reputation has 0.2 importance.

Based on this assessment, it appears that Vendor 3 with a total weighted score of 3.0 may best satisfy your need for bumper stickers. As shown in Table D, spreadsheets are a particularly useful tool for comparing options using a weighted scoring model.

Table B Criteria Scales and Equivalent Scores

Criterion	1	2	3	4	5
			Scores		
Cost	>$5,000	$4,000–5,000	$3,000–4,000	2,000–3,000	<$2,000
Reliability	Poor	Mediocre	Ok	Good	Great
Reputation	Poor	Fair	Satisfactory	Good	Excellent

Table C Weighted Total Scores for Each Vendor

Alternative vendor	Cost (0.4)	Reliability (0.4)	Reputation (0.2)	Total
Vendor 1	3 × 0.4 = 1.2	2 × 0.4 = 0.8	4 × 0.2 = 0.8	2.8
Vendor 2	2 × 0.4 = 0.8	4 × 0.4 = 1.6	1 × 0.2 = 0.2	2.6
Vendor 3	4 × 0.4 = 1.6	3 × 0.4 = 1.2	1 × 0.2 = 0.2	3.0

Table D   Creating a Weighted Scoring Model in a Spreadsheet

	A	B	C	D	E
1	**Criteria**	**Cost**	**Reliability**	**Reputation**	
2	**Weights**	**0.4**	**0.4**	**0.2**	
3					
4	**Alternative vendor**	**Cost**	**Reliability**	**Reputation**	**Total**
5	Vendor 1	3	2	4	2.8
6	Vendor 2	2	4	1	2.6
7	Vendor 3	4	3	1	3.0
8					
9	**Formula**				
10	Cell E5	=SUMPRODUCT(B$2:D$2,B5:D5)			
11		(copy to cells E6:E7)			

Project selection is an inherently risky process. Throughout this section we have treated risk by "making allowance" for it. Managing and analyzing risk can be handled in a more straight-forward manner. By estimating the highest, lowest, and most likely values that costs, revenues, and other relevant variables may have, and by making some other assumptions about the world, we can estimate outcomes for the projects among which we are trying to make selections. This is accomplished by simulating project outcomes. In Section 4.5, we will demonstrate how to do this using Crystal Ball® (CB) on a sample selection problem.

Risk

The PM should understand why a project is selected for funding so that the project can be managed to optimize its advantages and achieve its objectives. There are two types of project selection methods: numeric and nonnumeric. Both have their advantages. Of the numeric methods, there are two subtypes—methods that assess the profits associated with a project and more general methods that measure nonmonetary advantages in addition to the monetary pluses. Of the financial methods, the discounted cash flow is best. In our judgment, however, the weighted scoring method is the most useful.

The Project Portfolio Process (PPP) attempts to link the organization's projects directly to the goals and strategy of the organization. This occurs not only in the project's initiation and planning phases but also throughout the life cycle of the projects as they are managed and eventually brought to completion. This topic is compared to project and program management in PMBOK's Chapter 1: Introduction. Thus, the PPP is also a means for monitoring and controlling the organization's strategic projects, as will be reiterated in Chapter 7: Monitoring and Controlling the Project. On occasion this will mean shutting down projects prior to their completion because their risks have become excessive, their costs have escalated beyond their expected benefits, another (or a new) project does a better job of supporting the goals, or any of a variety of similar reasons. The steps in this process generally follow those described in Longman et al. (1999) and Englund et al. (1999).

The first step is to appoint a Project Council to establish and articulate a strategic direction for projects. The Council should report to a senior executive since it will be responsible for

1.7 THE PROJECT PORTFOLIO PROCESS

Strategic

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allocating funds to those projects that support the organization's goals and controlling the allocation of resources and skills to the projects. In addition to senior management, other appropriate members of the Project Council include program managers, PMs of major projects, the head of the PMO, and general managers who can identify key opportunities and risks facing the organization.

Next, various project categories are identified so the mix of projects funded by the organization will be spread appropriately across those areas making major contributions to the organization's goals. In addition, within each category, criteria are established to discriminate between very good and even better projects using the weighted scoring model previously discussed. The criteria are also weighted to reflect their relative importance.

The first task in this step is to list the goals of each existing and proposed project—that is, the mission, or purpose, of each project. Relating these to the organization's goals and strategies should allow the Council to identify a variety of categories that are important to achieving the organization's goals. One way to position many of the projects (particularly product/service development projects) is in terms of the extent of product and process changes. Wheelwright et al. (1992) have developed a matrix called the *aggregate project plan* illustrating these changes, as shown in Figure 1.5. Based on the extent of product change and process change, they identified four separate categories of projects:

1. **Derivative projects**   These are projects with objectives or deliverables that are only incrementally different in both product and process from existing offerings. They are often meant to replace current offerings or add an extension to current offerings (lower priced version, upscale version).

2. **Platform projects**   The planned outputs of these projects represent major departures from existing offerings in terms of either the product/service itself or the process used to make and deliver it, or both. As such, they become "platforms" for the next generation of organizational offerings, such as a new model of automobile or a new type of insurance plan.
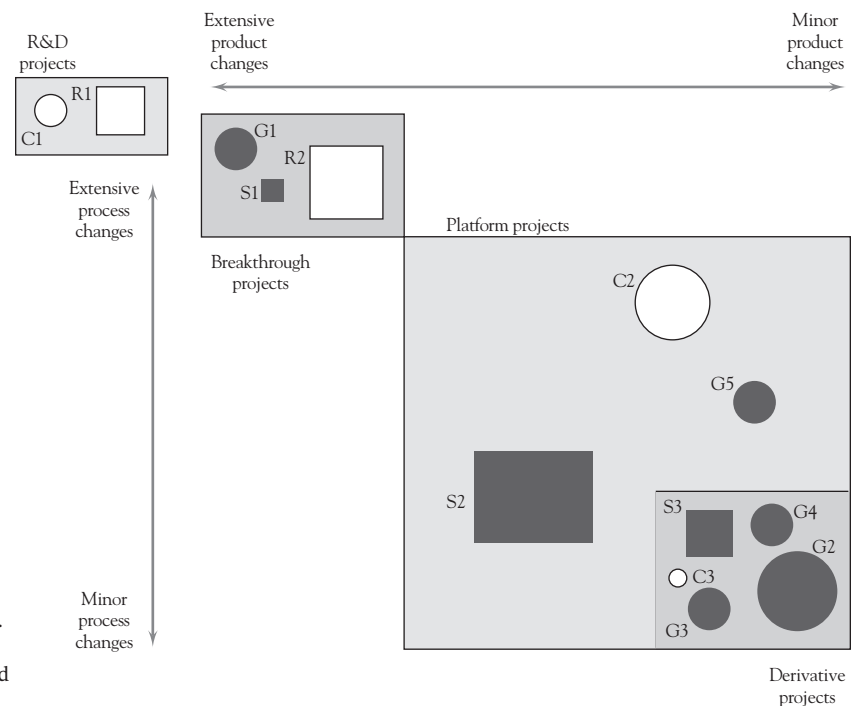

FIGURE 1.5   An example aggregate project plan

Source: Based on Steven C. WheelwrightKim B. Clark, Creating Project Plans to Focus Product Development, March–April 1992 Issue. Harvard Business Review.

They form the basis for follow-on derivative projects that attempt to extend the platform in various dimensions.

3. **Breakthrough projects** Breakthrough projects typically involve a newer technology than platform projects. It may be a "disruptive" technology that is known to the industry or something proprietary that the organization has been developing over time. Examples here include the use of fiber-optic cables for data transmission, cash-balance pension plans, and hybrid gasoline-electric automobiles.

4. **R&D projects** These projects are "blue-sky," visionary endeavors, oriented toward using newly developed technologies, or existing technologies in a new manner. They may also be for acquiring new knowledge, or developing new technologies themselves.

The size of the projects plotted on the array indicates the size/resource needs of the project, and the shape may indicate another aspect of the project (e.g., internal/external, long/medium/short term, or whatever aspect needs to be shown). The numbers indicate the order, or time frame, in which the projects are to be (or were) implemented, separated by category, if desired.

The aggregate project plan can be used to:

- View the mix of projects within each illustrated aspect (shape)

- Analyze and adjust the mix of projects within each category or aspect

- Assess the resource demands on the organization, indicated by the size, timing, and number of projects shown

- Identify and adjust the gaps in the categories, aspects, sizes, and timing of the projects

- Identify potential career paths for developing PMs, such as team members of a derivative project, then team member of a platform project, manager of a derivative project, member of a breakthrough project, and so on

For each existing and proposed project, assemble the data appropriate to that category's criteria. Include the timing, both date and duration, for expected benefits and resource needs. Use the project plan, a schedule of project activities, past experience, expert opinion, whatever is available to get a good estimate of these data. If the project is new, you may want to fund only enough work on the project to verify the assumptions.

Next, use the criteria score limits, or constraints as described in our discussions of scoring models, to screen out the weaker projects. For example, have costs on existing projects escalated beyond the project's expected benefits? Has the benefit of a project lessened because the organization's goals have changed? Also, screen *in* any projects that do not require deliberation, such as projects mandated by regulations or laws, projects that are competitive or operating necessities (described above), projects required for environmental or personnel reasons, and so on. The fewer projects that need to be compared and analyzed, the easier the work of the Council.

When we discussed financial models and scoring models, we urged the use of multiple criteria when selecting projects. ROI on a project may be lower than the firm's cut-off rate, or even negative, but the project may be a platform for follow-on projects that have very high benefits for the firm. Wheatly (2009) also warns against the use of a single criterion, commonly the return on investment (ROI), to evaluate projects. A project aimed at boosting employee satisfaction will often yield improvements in output, quality, costs, and other such factors. For example, Mindtree, of Bangalore, India, measures benefits on five dimensions; revenue, profit, customer satisfaction, employee satisfaction, and intellectual capital created—in sum, "Have we become a better company?"

Next, assess the availability of both internal and external resources, by type, department, and timing. Timing is particularly important, since project resource needs by type typically vary

up to 100 percent over the life cycle of projects. Needing a normally plentiful resource at the same moment it is fully utilized elsewhere may doom an otherwise promising project. Eventually, the Council will be trying to balance aggregate project resource needs over future periods with resource availabilities, so timing is as important as the amount of maximum demand and availability. Many managers insist on trying to schedule resource usage as closely as possible to system capacity. This is almost certain to produce a catastrophe (see Section 6.3, subsection on Resource Loading/Leveling and Uncertainty).

Then use multiple screens to reduce the number of competing projects. The first screen should be each project's support of the organization's goals, but other possible screens might be:

1. Whether the required competence exists in the organization

2. Whether there is a market for the offering

3. The likely profitability of the offering

4. How risky the project is

5. If there is a potential partner to help with the project

6. If the right resources are available at the right times

7. If the project uses the organization's strengths, or depends on its weaknesses

8. If the project is synergistic with other important projects

9. If the project is dominated by another existing or proposed project

10. If the project has slipped in its desirability since the last evaluation

Now apply the scores and criterion weights to rank the projects within each category. It is acceptable to hold some hard-to-measure criteria out for subjective evaluation, such as riskiness, or development of new knowledge. Subjective evaluations can be translated from verbal to numeric terms easily by the Delphi* Method, pairwise comparisons, or other methods.

Finally, select the projects to be funded and those to be held in reserve. That is, determine the mix of projects across the various categories and time periods. Next be sure to leave some percentage (e.g., 20 percent) of the organization's resource capacity free for new opportunities, crises in existing projects, errors in estimates, and so on. Then allocate the categorized projects in rank order to the categories according to the mix desired. It is usually good practice to include some speculative projects in each category to allow future options, knowledge improvement, additional experience in new areas, and so on. The focus should be on committing to fewer projects but with sufficient funding to allow project completion. Document why late projects were delayed and why any were defended.

Be sure to make the results of the PPP widely known, including the documented reasons for project cancellations, deferrals, and nonselection as was mentioned earlier. Top management must now make their commitment to this PPP totally clear by supporting the process and its results. This may require a PPP champion near the top of the organization. As project proposers come to understand and appreciate the workings and importance of the PPP, their proposals will more closely fit the profile of the kinds of projects the organization wishes to fund. As this happens, it is important to note that the Council will have to concern itself with the reliability and accuracy of proposals competing for limited funds. Senior management must fully fund the selected projects. It is unethical and inappropriate for senior management to undermine PPP and the Council as well as strategically important projects by playing a game of arbitrarily cutting χ percent from project budgets. It is equally unethical and inappropriate to pad potential project budgets on the expectation that they will be arbitrarily cut.

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*The Delphi Method, developed more than 50 years ago, is still unequaled as a method for transforming the diverse subjective opinions of a group into a numeric scale. See Dalkey (Dalkey, 1969).

Finally, the process must be repeated on a regular basis. The Council should determine the frequency, which to some extent will depend on the speed of change within the organization's industry. For some industries, quarterly analysis may be best, while in slow-moving industries yearly may be fine.

In an article on competitive intelligence, Gale (2008) reports that Cisco Systems Inc. constantly tracks industry trends, competitors, the stock market, and end users to stay ahead of their competition and to know which potential projects to fund. Pharmaceutical companies are equally interested in knowing which projects to drop if competitors are too far ahead of them, thereby saving millions of dollars in development and testing costs.

> Projects are often subdivisions of major programs. Long-run success is determined by the organization's portfolio of projects. Classified by the extent of innovation in product and process, there are four types of projects: derivative, breakthrough, platform, and R & D projects. The actual mix of projects is a direct expression of the organization's competitive strategy. A proper mix of project categories can help ensure its long-run competitive position. It is important for the Project Council or PMO to preplan project portfolio adjustments to respond to significant changes in the state of competition and other environmental changes.

1.8 THE MATERIALS IN THIS TEXT

When reading a text, it is helpful to understand how the book is organized and where it will take the reader. Following this introductory chapter, our attention goes to the various roles the PM must play and the ways projects are organized. Chapter 2 focuses on the behavioral and structural aspects of projects and their management. It describes the PM's roles as communicator, negotiator, and manager. It also includes a discussion of project management as a profession and reports briefly on the Project Management Institute (PMI), the PM's professional organization. Then attention turns to the ways in which projects can be organized within the parent establishment. *Matrix organization* is discussed at length as are the conflicts and managerial problems that matrix organizations tend to foster. Finally, the chapter moves to the *project team*: its purposes and the widespread use of transdisciplinary teams. Using transdisciplinary teams to plan and carry out the project is a source of both creativity and conflict. The process of building effective teams is briefly covered.

The remainder of the book is designed to conform to the life cycle of any project, whatever the shape of the life cycle curve. Chapter 3 covers the process of *planning and launching the project*, construction of the *work breakdown structure* (WBS), and responsibility *assignment matrices*. These activities require the project team to estimate resource and time requirements for accomplishing what the project plan has described. The chapter ends with a full discussion of the topic of risk management. Chapter 4 discusses the construction of a *project budget* and further illustrates the use of risk management for budgeting.

Chapter 5 covers scheduling, the Program Evaluation Review Technique (PERT), the Critical Path Method (CPM), and Gantt charts, the most common ways of illustrating the *project schedule*. Schedules will be calculated under conditions of uncertainty in two ways: (1) using standard probability theory and (2) using simulation. In Chapter 6 *resource allocation* is discussed. To begin, we consider the problem of *crashing* a project, that is, using additional resources in order to shorten project duration. Then we deal with two fundamental problems of resource management. First, a schedule of resource usage must be prepared (a.k.a., *resource loading*). Second, we adjust the resource loads to avoid gluts and shortages of valuable resources (a.k.a., *resource leveling*). The problems of resource usage when there are multiple projects competing for a limited resource pool are then covered, as are ways of dealing with these problems. The chapter ends with a discussion of Goldratt's *Critical Chain* (1997).

The subjects of Chapter 7 are monitoring and controlling projects. The nature of project data collection is explained, and various types of project reports, including *earned value reports*,

are illustrated and discussed. Following this, we cover the general purposes and mechanisms for project control. The chapter ends with a section devoted to the *control of change* on a project. It is here that we discuss *scope creep* and how to control it.

Chapter 8 deals with *evaluating*, *auditing*, and *closing down* projects. The project team often fears evaluation and auditing. Team members usually equate these activities with fault finding, but when correctly used they are valuable aids for the PM and team. Project closure is usually ignored or treated as a trivial problem in practice—and in most works on project management. We feel it is an important and complex process that may cause serious problems if not handled properly.

Throughout this book there are illustrations of the tools and reports used by PMs. Many of these were produced using Microsoft Project® (MSP), Crystal Ball® (CB), and Excel®. (All illustrations and applications generated by MSP, CB, Excel®, or any other application software will be clearly identified.) There are literally hundreds of project management software packages on the market. Most of them perform with reasonable competence in the tasks for which they were designed. Of the packages intended for overall project management, MSP is by far the favorite, with roughly half the total market. There is also a large number of specialized software packages, for example, report generators, and special risk management packages. Most are compatible with MSP or Excel®, often seamlessly so, and we mention some of them when relevant. In the past decade or two, spreadsheet software has become highly sophisticated. Excel®, for example, can perform simulations and statistical analysis as well as can handle the usual arithmetic, accounting, and financial calculations.

Risk

When one reads the literature of project management, one sees much about *risk management*. Too often, it may seem to the reader that risk management is a highly specific task. It isn't. Risk management is a reference to a class of ideas, methods, and techniques that aids the management of projects being carried out in an uncertain world. Outside factors can affect projects in a wide variety of ways, and so our discussions of risk management cannot be restricted to a chapter on the subject. They appear throughout the book. Tools and techniques are introduced as they are needed to deal with specific problems. The reader should note that these tools have wide application beyond project management and most are valuable for the general manager as well as the PM.

With this introduction, let us begin our study of project management.

REVIEW QUESTIONS	

1.1 What are the primary roles of a PM? How are the primary roles related to one another?

1.2 Contrast a project from a nonproject.

1.3 Contrast win–lose negotiation, lose–lose negotiation, and win–win negotiation and explain why the last one is so important in project management.

1.4 Identify the three goals of a project. What does it mean for a project to be "overdetermined?"

1.5 Contrast the two types of project life cycles and discuss why it is important to know which type the current project is following.

1.6 How does the weighted scoring approach avoid the drawbacks of the NPV approach? Can the two approaches be combined? How? What weights would be appropriate if they were combined?

1.7 Why is it suggested that factors with less than 2 percent or 3 percent impact not be considered in the weighted scoring approach?

1.8 Draw a distinction between a project and a program. Why is the distinction important?

1.9 Why are R&D projects in a company's Aggregate Project Plan significantly different in type from the firm's Derivative, Breakthrough, and Platform projects?

1.10 Contrast the waterfall approach with Agile in terms of how the work is structured.

1.11 What are the underlying values associated with Agile?

1.1 Contrast the three types of nonnumeric project selection methods. Could any specific case combine two of them, such as the sacred cow and the operating necessity, or the comparative benefits and the competitive necessity?

1.2 What errors in a firm's project portfolio might the Wheelwright and Clark aggregate project plan graphically identify?

1.3 You are the PM of a team of software specialists working on a project to produce a piece of application software in the field of project management. Give some examples of things that might go wrong on such a project and the sorts of trade-offs you might have to make.

1.4 In Figure 1.5, what distribution of large and small circles and squares across the four boxes would characterize a strong, well-positioned product development business? A weak business?

1.5 Give several examples of projects found in your city, region, or country—avoiding those used as examples in the chapter.

1.6 For each of the projects identified in the answer to Question 1.5, is the life cycle for the project S-shaped or J-shaped? Why?

1.7 Construct a list of factors, conditions, and circumstances you think might be important for a manufacturing firm to evaluate during the project selection process. Do the same for a computer repair shop.

1.8 How might you use project management for doing a major school work assignment?

1.9 What advantages are lost if the sum of the weights in a weighted scoring approach does not add to 1.0?

1.10 Why is it important for a project to have "flexibility?"

1.11 What do you see as the major themes in the 12 Agile Principles?

1.1 A 4-year financial project is forecast to have net cash inflows of $20,000, $25,000, $30,000, and $50,000 in the next 4 years. It will cost $75,000 to implement the project, payable at the beginning of the project. If the required rate of return is 0.2, conduct a discounted cash flow calculation to determine the NPV.

1.2 A town's council has established a project proposal team to select a project to improve local services for their citizens. Use a weighted scoring model to analyze three possible projects (A, B, C) for improving their services. The relative weights for each criterion are shown in the following table. A score of 1 represents unfavorable, 2 satisfactory, and 3 favorable.

Success Factor	Weight	Project A	Project B	Project C
Project cost	20	1	2	3
Timely completion	20	2	3	1
Service quality	10	2	1	3
Contractor relations	10	3	3	2
Affordability	10	2	1	1
Citizen satisfaction	25	1	2	3
County relations	5	2	2	2

1.3 **a)** Compare your answer in Exercise 1.2 to the answer you would have found if you had used an unweighted, 0-1 scoring model. Assume that a score of 1 means does not qualify and a 2 or 3 means it does qualify.

b) Next, revise the unweighted model by deleting all success factors that, as recommended, have a weight of less than 20 percent. Compare to your answer to (a) above and also Exercise 1.2. Which method seems best?

1.4 Using a spreadsheet for Exercise 1.2, find the following:

a) What would be your recommendation if the weight for citizen satisfaction went down to 10 and the weight for contractor relations went up to 25?

b) Suppose project A received a score of 3 for citizen satisfaction and project C received a score of 2. Would your recommendation change under these circumstances?

c) The Mayor has looked at your scoring model and feels that tax considerations should be included in the model with a weight of 15. In addition, the Mayor has scored the projects on tax considerations as follows: A-3, B-2, and C-1. How does this affect your recommendation?

1.5 Nina has been asked to lead a team that has been tasked with finding a new location for a boutique concept her company would like to test. The team has identified four candidate shopping centers to locate the new boutique in. Some cater to a higher class of clientele than others, some are in an indoor mall, some have a much greater volume than others, and, of course, rent varies considerably. Because of the nature of the boutique, the team has decided that the class of clientele is the most important consideration. Following this, the team considered expenses and rent as the next most important criterion—probably 90 percent as important as clientele. An indoor, temperature-controlled mall is a big help for stores such as the concept being considered where 70 percent of sales are from passersby slowly strolling and window shopping. Thus, the team rates this as about 95 percent as important as rent. Last, a higher volume of shoppers means more potential sales; thus the team rates this factor as 80 percent as important as rent.

As an aid in visualizing her location alternatives, the team has constructed the following table. A "good" is scored as 3, "fair" as 2, and "poor" as 1. Use a weighted score model to help Nina and her team come to a decision.

	Location			
	1	**2**	**3**	**4**
Class of clientele	Fair	Good	Poor	Good
Rent	Good	Fair	Poor	Good
Indoor mall	Good	Poor	Good	Poor
Volume	Good	Fair	Good	Poor

1.6 Using a spreadsheet for Exercise 1.5, determine how Nina's ability to negotiate a lower rent at location 3, thereby raising its ranking to "good," will affect the overall rankings of the four locations.

INCIDENT FOR DISCUSSION

Broken Welds

A manufacturer of mountain bicycles designed an automated system for welding bike frames. For 3 years, the system worked nicely, handling about 1,000 frames per shift. Production was scheduled for two shifts per day. The system was designed to weld the frame and then to check the quality of each weld. The welded frames were then transported to another plant for assembly.

Recently, a few of the frames had failed. Careful testing showed that a foreign substance in the welding rod purchased from an outside vendor possibly contributed to the failure. When checked, however, the rods conformed to the specifications given to the Purchasing Department and guaranteed

by the vendor. The Chief Engineer ordered the Production Department's Project Leader, Alison Passette, to create a project immediately to find out precisely what was causing the failures and to find a way to solve the problem. This project was to take priority over all other projects in the department.

Alison was familiar with the Chief Engineer's tendency to overreact to any glitches in the production process, so she decided to determine the impact of the proposed project on all the other projects in the department. She also discussed the problem with Ken Kelsey, one of her welding experts, who felt sure he could solve the welding problems by determining what foreign substance, if any, caused the problem. He could then set up a system to detect the presence of the substance and reweld the affected frames. Of course, he added, they would also have to change their specifications for the welding rod to eliminate the chemical responsible for the failures.

Questions

1. What information does Alison need to determine the probable impact of Kelsey's proposed project on the other projects in the department?

2. Should her findings affect her decision about Kelsey's project?

3. How?

CASE	Friendly Assisted Living Facility—1

Friendly Medical Center, an urban, nonprofit, 450-bed rehabilitation hospital, began to see a significant decline in admissions. Friendly Medical Center's mission focuses on inpatient and outpatient rehabilitation of the severely injured and catastrophically ill. While the patient census varied from month to month, it appeared to the Friendly Medical Center Board of Trustees that the inpatient population was slowly but steadily declining. The hospital's market researchers reported that fewer people were being severely injured due to the popularity of seat belts and bicycle/motorcycle helmets. In order to get a handle on the future of the organization, the Board, and the CEO, Fred Splient M.D. called for a major strategic planning effort to take place.

In January 20X6, Friendly Medical Center held a planning retreat to identify future opportunities. The outcome of the retreat was that the Medical Center needed to focus its efforts around two major strategic initiatives. The first, a short-run initiative, was to be more cost-effective in the delivery of inpatient care. The second, a long-run strategy, was to develop new programs and services that would capitalize on the existing, highly competent rehabilitation therapy staff and Friendly Medical Center excellent reputation in the region.

At the time of the retreat, Fred Splient's parents were living with him and his family. Fred was an active member of the "sandwich generation." His parents were aging and developing many problems common to the geriatric populace. Their increased medical needs were beginning to wear on Fred and his family. It crossed Fred's mind that life might be more pleasant if the hospital Board approved an expansion of the Medical Center's campus to include an assisted living facility.

In March 20X6, Fred had his Business Development team prepare a rough estimate of the potential return on the investment of an assisted living facility. He asked the team to identify different options for facility construction and the associated costs. The team also did a complete competitive analysis and examined the options for services to be offered based on Friendly Medical Center's potential population base and catchment area. The Business Development team visited several facilities across the country. The team also interviewed companies that could oversee the design, building, and operation of the facility for Friendly Medical Center. The development team produced a preliminary business plan based on the recommended structure for the facility, estimated capital expenditure needs, estimated income from operation of the facility, and projected revenues to other Medical Center programs resulting from the facility's population.

The plan was presented at the May 20X6 meeting of the Board of Trustees. Fred Splient and his team introduced the Board to the concept of opening an assisted living facility on Friendly Medical Center's campus. The facility would be set up as a for-profit subsidiary of the Medical Center so that it could generate a profit and not be subjected to the strict guidelines of the hospital's accrediting agencies. As a subsidiary organization, however, the Board would still have control.

The chosen facility design was a freestanding apartment-like facility with a sheltered connection to the Hospital for access to the kitchen and hospital services. The facility would have 100 units with 15 to 30 of the units classified as "heavy-assisted" and built to code to house the physically and medically disabled. The rest of the units would be "light-assisted,"

larger apartments. The population would be approximately 110 to 150 residents, with most being single occupants rather than couples.

The light-assisted apartments could hold residents who required only minor medical and social interventions. The residents of the heavy-assisted section would have more medical needs and would require assistance getting around. The Business Development team recommended this type of programming model, because many assisted living facilities were erected across the country, but few had a medical focus and offered the types of services that Friendly Medical Center could offer—physical and occupational therapy programs and behavior management programs to name a few.

The Board was assured that the facility would meet the strategic initiative of a growing business. The business plan projected an immediate increase in the number of referrals to the outpatient therapy programs. Another projected deliverable of the project was to enable Friendly Medical Center to strengthen its focus on reimbursable preventive and wellness programs for the healthier geriatric population. The project's longer-term goal was to increase the census in the hospital's inpatient units by having a location where people could age in place until they were in need of hospitalization, and then such a facility would be right next door.

Depending on the exact size of the apartments, their equipment, and the actual ratio of heavy- to light-assisted units, Fred estimated that the entire project would cost between $8,500,000 and $11,000,000 for the facility construction. That estimate included the cost of land, furnishings, and a sheltered connection to the hospital. When up and running, it was estimated that the net income would range between $9,000 and $12,000 per unit per year. The team estimated the net cash flow for the entire project to be around $1,500,000 per year.

Fred requested the Board to approve the concept and allow his team to prepare a pro forma plan to the Board for approval. The plan would include a recommended design for both heavy- and light-assisted apartments. It would also include all costs of land, construction, furnishings, and staffing. Income estimates would be included and would be conservatively biased. A timetable would also be included.

The Board conducted several executive sessions, and by the middle of May voted to approve the concept. They approved the architectural-construction-management firm recommended by the team, and they requested Splient to proceed with developing a complete project plan. The Board appointed two Board members to sit on Fred's planning group.

In June, Dr. Splient gathered his executive team together and presented the project mission and scope. He reported that the Board had approved a small budget to finance the planning process. The Board also stipulated that construction could not begin until after the November 20X6 city elections because two of the Board Members were running in that election, one for a city council seat and one as a county commissioner. The Board also stated that they would like a plan that would allow the facility to open by July 20X7, as research has shown that many adult children find the summer the easiest time to assist their parents in finding an alternative to independent living arrangements. The CEO and executive team were now confident that they were ready to launch the project to plan, build, and open an assisted living facility at Friendly Medical Center.

Questions

1. Identify as well as you can the three iron triangle constraints for this project: cost, time, and scope.

2. Identify the expected benefits of this project for Friendly Medical Center.

3. Comment on the strategic initiatives resulting from the Board's major strategic planning retreat. Would you consider this a productive retreat?

4. What "project selection" procedure was used here? How common do you think this is? How wise do you think it is?

CASE   Handstar Inc.

Handstar Inc. was created a little over 4 years ago by two college roommates to develop apps for smartphones. It has since grown to 10 employees with annual sales approaching $1.5 million. Handstar's original product was an expense report app that allowed users to record expenses on their smartphone and then export their expenses into a spreadsheet that then created an expense report in one of five standard formats. Based on the success of its first product, Handstar subsequently developed three additional apps: an app for tracking and measuring the performance of investment portfolios, a calendar app, and an email app.

The two founders of Handstar have recently become concerned about the competitiveness of the firm's offerings, particularly since none of them has been updated since their

initial launch. Therefore, they asked the directors of product development and marketing to work together and prepare a list of potential projects for updating Handstar's current offerings as well as to develop ideas for additional apps. The directors were also asked to estimate the development costs of the various projects, product revenues, and the likelihood that Handstar could retain or obtain a leadership position for the given app. Also, with the increasing popularity of mobile computing, the founders asked the directors to evaluate the extent to which the products made use of the Web.

The product development and marketing directors identified three projects related to updating Handstar's existing products. The first project would integrate Handstar's current calendar app with its email app. Integrating these two apps into a single app would provide a number of benefits to users such as allowing them to automatically enter the dates of meetings into the calendar based on the content of an email message. The directors estimated that this project would require 1,250 hours of software development time. Revenues in the first year of the product's launch were estimated to be $750,000. However, because the directors expected that a large percentage of the users would likely upgrade to this new product soon after its introduction, they projected that annual sales would decline by 10 percent annually in subsequent years. The directors speculated that Handstar was moderately likely to obtain a leadership position in email/calendar apps if this project were undertaken and felt this app made moderate use of the Web.

The second project related to updating the expense report app. The directors estimated that this project would require 400 hours of development time. Sales were estimated to be $250,000 in the first year and to increase 5 percent annually in subsequent years. The directors speculated that completing this project would almost certainly maintain Handstar's leadership position in the expense report category, although it made little use of the Web.

The last product enhancement project related to enhancing the existing portfolio tracking app. This project would require 750 hours of development time and would generate first-year sales of $500,000. Sales were projected to increase 5 percent annually in subsequent years. The directors felt this project would have a high probability of maintaining Handstar's leadership position in this category and the product would make moderate use of the Web.

The directors also identified three opportunities for new products. One project was the development of a spreadsheet app that could share files with spreadsheet programs written for PCs. Developing this app would require 2,500 hours of development time. First-year sales were estimated to be $1,000,000 with an annual growth rate of 10 percent. While this app did not make use of the Web, the directors felt that Handstar had a moderate chance of obtaining a leadership position in this product category.

The second new product opportunity identified was an app for browsing the Web. Developing this app would require 1,875 development hours. First-year sales were estimated to be $2,500,000 with an annual growth rate of 15 percent. Although this app made extensive use of the Web, the directors felt that there was a very low probability that Handstar could obtain a leadership position in this product category.

The final product opportunity identified was a trip planner app. This product would require 6,250 hours of development time. First-year sales were projected to be $1,300,000 with an annual growth rate of 5 percent. Like the Web browser app, the directors felt that there was a low probability that Handstar could obtain a leadership position in this category, although the program would make extensive use of the Web.

In evaluating the projects, the founders believed it was reasonable to assume each product had a 3-year life. They also felt that a discount rate of 12 percent fairly reflected the company's cost of capital. An analysis of payroll records indicated that the cost of software developers is $52 per hour including salary and fringe benefits. Currently there are four software developers on staff, and each works 2,500 hours per year.

Questions

1. Which projects would you recommend Handstar pursue based on the NPV approach?

2. Assume the founders weigh a project's NPV twice as much as both obtaining/retaining a leadership position and making use of the Web. Use the weighted factor scoring method to rank these projects. Which projects would you recommend Handstar pursue?

3. In your opinion, is hiring an additional software development engineer justified?

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The Manager, the Organization, and the Team

Once a project has been selected, the next step is for senior management (e.g., the project owner as described in Meredith et al., 2019 and Zwikael et al., 2019) to choose a project manager (PM). It is the PM's job to make sure that the project is properly planned, implemented, and completed—and these activities will be the subjects of the chapters that follow this one.

While PMs are sometimes chosen prior to a project's selection, the more typical case is that the selection is announced following a meeting between the project owner and the prospective PM. This appointment sometimes comes as a complete surprise to the candidate whose only obvious qualification for the job is not being otherwise fully occupied on a task more important than the project (Patterson, 1991). At this meeting, the project owner describes the project and emphasizes its importance to the parent organization, and also to the future career of the prospective PM. (In the language of the Mafia, "It's an offer you can't refuse.") Occasionally, the project owner will add further information about the project including a fixed budget, a firm due date, and an extensive scope. This is an offer you must refuse, as politely as possible, because, as we noted in Chapter 1, some flexibility is required and there is little chance that you can be successful in meeting all three overdetermined targets.

After a brief consideration of the project, the PM comes to a tentative decision about what talents and knowledge are apt to be required. The PM and/or the project owner then calls a meeting of people who have the requisite talent and knowledge, and the planning begins. This is the *launch meeting*, and we will delay further consideration of it until Chapter 3 in which we take up the planning process in detail. First, we must examine the skills required by the person who will lead a team of individuals to carry out a carefully coordinated set of activities in an organizational setting seemingly designed expressly to prevent cooperation. It is helpful if we make a few mild assumptions to ease the following discussions. First, assume that the project's parent organization is medium-to-large size and is functionally organized (i.e., organized into functions such as marketing, manufacturing, R&D, human resources, and the like). Further assume that the project has some well-defined components or technologies and that the project's output is being delivered to an arm's-length client. These assumptions are not critical. They merely give a context to our discussions.

Before we proceed, an experienced project manager has suggested that we share with the reader one of her reactions to the materials in this book. To the student or the inexperienced PM, it is the project budgets, the schedules with Gantt charts and PERT/CPM networks, the reports and project management software, and the mysteries of resource allocation to multiple projects that appear to be the meat of the PM's job. But these things are not hard to learn, and once understood, can, for the most part, be managed by making appropriate inputs to project management software. The hard part of project management is playing the many roles of the PM. The hard part is negotiating

with stubborn functional managers and clients who have their own legitimate axes to grind. The hard part is keeping the peace among project team members, each of whom knows, and is quick to tell, the proper ways to do things. The hard part is dealing with senior managers who allow their wild guesses about budget and scope made in the early consideration of the project during the selection process to become fixed in concrete. The hard part is being surrounded by the chaos of trying to run a project in the midst of a confused mass of activity representing the normal business of the organization. These are the things we discuss in this chapter, because *these are the hard parts*. PMBOK (Project Management Institute, 2017) covers the material in this chapter primarily in Chapter 9 on Human Resources.

2.1 THE PM'S ROLES

Risk   Trade-Offs

In the previous chapter, it was noted that the primary roles of the PM were to manage trade-offs and manage risks. In addition to managing trade-offs and risks, the PM has several other important roles including serving as a facilitator, communicator, virtual project manager, and convener and chair of meetings.

2.1.1 FACILITATOR

First, to understand the PM's roles, it is useful to compare the PM with a functional manager. The head of a function such as manufacturing or marketing directs the activities of a well-established unit or department of the firm. Presumably trained or raised from the ranks, the functional manager has expertise in the technology being managed. He is an accountant, or an industrial engineer, or a marketing researcher, or a shop foreman, or so on. The functional manager's role, therefore, is mainly that of supervisor (literally "overseer"). Because the project's place in the parent organization is often not well defined and does not seem to fit neatly in any one functional division, neither is the PM's place neatly defined. Because projects are often multidisciplinary, the PM rarely has technical competence in more than one or two of the several technologies involved in the project. As a result, the PM is not a competent overseer and thus has a different role. The PM is a *facilitator*.

Facilitator versus Supervisor The PM must ensure that those who work on the project have the appropriate knowledge and resources, including that most precious resource, time, to accomplish their assigned responsibilities. The work of a facilitator does not stop with these tasks. For reasons that will be apparent later in this chapter, the project is often beset with conflict—conflict between members of the project team, conflict between the team and senior managers (particularly managers of the functional divisions), conflict with the client and other outsiders. The PM must manage these conflicts by negotiating resolution of them.

Actually, the once sharp distinction between the manager-as-facilitator and the manager-as-supervisor has been softened in recent years. With the slow but steady adoption of the participative management philosophy, the general manager has become more and more like the project manager. In particular, responsibility for the planning and organization of specific tasks is given to the individuals or groups that must perform them, always constrained, of course, by company policy, legality, and conformity to high ethical standards. The manager's responsibility is to make sure that the required resources are available and that the task is properly concluded. The transition from traditional authoritarian management to facilitation continues because facilitation is more effective as a managerial style.

A second important distinction between the PM and the traditional manager is that the former uses the *systems approach* and the latter adopts the *analytical approach* to understanding

and solving problems. The analytical approach centers on understanding the bits and pieces in a system. It prompts study of the molecules, then atoms, then electrons, and so forth. The systems approach includes study of the bits and pieces, but also an understanding of how they fit together, how they interact, and how they affect and are affected by their environment (Schoderbek et al., 1990). The traditionalist manages his or her group (a *subsystem* of the organization) with a desire to optimize the group's performance. The systems approach manager conducts the group so that it contributes to total system optimization. It has been well demonstrated that if all subsystems are optimized, a condition known as *suboptimization*, the total system is not even close to optimum performance. Perhaps the ultimate example of suboptimization is "The operation was a success, but the patient died."

Systems Approach To be successful, the PM must adopt the systems approach. Consider that the project is a system composed of tasks (subsystems), which are, in turn, composed of subtasks, and so on. The system, a project, exists as a subsystem of the larger system, a program, which is a subsystem in the larger system, a firm, and so on. Just as the project's objectives influence the nature of the tasks and the tasks influence the nature of the subtasks, so does the program and, above it, the organization influence the nature of the project. To be effective, the PM must understand these influences and their impacts on the project and its deliverables.

Think for a moment about designing a new airplane—a massive product development project—without knowing a great deal about its power plant, its instrumentation, its electronics, its fuel subsystems—or about the plane's desired mission, the intended takeoff and landing facilities, the intended carrying capacity, and the intended range. One cannot even start the design process without a clear understanding of the subsystems that might be a part of the plane and the larger systems of which it will be a part as well as those that comprise its environment.

Given a project and a deliverable with specifications that result from its intended use in a larger system within a known or assumed environment, the PM's job is straightforward. Find out what tasks must be accomplished to produce the deliverable. Find out what resources are required and how those resources may be obtained. Find out what personnel are needed to carry out production and where they may be obtained. Find out when the deliverable must be completed. In other words, the PM is responsible for planning, organizing, staffing, budgeting, directing, and controlling the project; the PM "manages" it. But others, the functional managers, for example, will staff the project by selecting the people who will be assigned to work on the project. The functional managers also may develop the technical aspects of the project's design and dictate the technology used to produce it. The logic and illogic of this arrangement will be revisited later in this chapter.

Micromanagement At times, the PM may work for a program manager or a project owner who closely supervises and second-guesses every decision the PM makes. Such bosses are also quite willing to help by instructing the PM exactly what to do. This unfortunate condition is known as *micromanagement* and is one of the deadly managerial sins. The PM's boss rationalizes this overcontrol with such statements as "Don't forget, I'm responsible for this project," "This project is very important to the firm," or "I have to keep my eye on everything that goes on around here." Such statements deny the value of delegation and assume that everyone except the boss is incompetent. This overweening self-importance practically ensures mediocre performance, if not outright project failure. Any project successes will be claimed by the boss. Failures will be blamed on the subordinate PM.

There is little a PM can do about the "My way or the highway" boss except to polish the résumé or request a transfer. (It is a poor career choice to work for a boss who will not allow you to succeed.) As we will see later in this chapter, the most successful project teams tend to adopt a *collegial style*. Intrateam conflict is minimized or used to enhance team creativity, cooperation is the norm, and the likelihood of success is high.

2.1.2 COMMUNICATOR

The PM must be a person who can handle responsibility. The PM is responsible to the project team, to the project owner and steering committee, to the client, and to anyone else who may have a stake in the project's performance or outcomes. Consider, if you will, the Central Arizona Project (CAP). This public utility moves water from the Colorado River to Phoenix, several other Arizona municipalities, and some American Indian reservations. The water is transported by a system of aqueducts, reservoirs, pipes, and pumping stations. Besides the routine delivery of water, almost everything done at the CAP is a project. Most of the projects are devoted to the construction, repair, and maintenance of their system. Now consider a PM's responsibilities. A maintenance team, for instance, needs resources in a timely fashion so that maintenance can be carried out according to a precise schedule. The PM's clients are municipalities. The drinking public (water, of course) is a highly interested stakeholder. The system is even subject to partisan political turmoil because CAP-supplied water is used as a political football in Tucson.

The PM is in the middle of this muddle of responsibility and must manage the project in the face of all these often-conflicting interests. CAP administration, the project teams, the municipalities (and their Native American counterparts), and the public all communicate with each other—often contentiously. In general, we often call this the "context" of the project. More accurately, given the systems approach we have adopted, this is the *environment* of the project.

Figure 2.1 shows the PM's position and highlights the communication problem involved in any project. The solid lines denote the PM's communication channels. The dotted lines denote communication paths for the other stakeholders in the project. Problems arise when some of these parties propagate communications that may mislead other parties, or directly conflict with other messages in the system. It is the PM and the project owner's responsibility to introduce some order into this communication mess.

For example, assume that a change in the business case calls for tighter cost control or even for a project cost reduction. The project team may react emotionally with a complaint that "They want us to cut back on project quality!" The PM must intervene to calm ruffled team feathers and, perhaps, ask the project owner to reassure the project team that high quality is an organizational objective, though not every gear, cog, and cam needs to be gold-plated.

Trade-Offs

Similarly, the client may drop in to speak with the project owner and ask "Would it be possible to alter the specs to include such-and-such?" To respond, the project owner must check with the PM to determine the cost of making such a change, as well as the added time that would be required. The project owner must then ask whether the client wishes to alter the project scope given the added cost and delayed delivery. This scenario is so common it has a name, *scope creep*. It is the PM's nightmare.

To compound these issues further, different stakeholders (e.g., clients, the parent organization, the project team, and the public) define success and failure in different ways (Meredith et al., 2019, 2020). For example, the client wants changes and the parent organization wants profits. Likewise, the individuals working on projects are often responsible to two bosses at the same time—a functional manager and the project manager (discussed in more detail later in this chapter). Under such conditions, conflict can arise when the two bosses have different priorities and objectives.
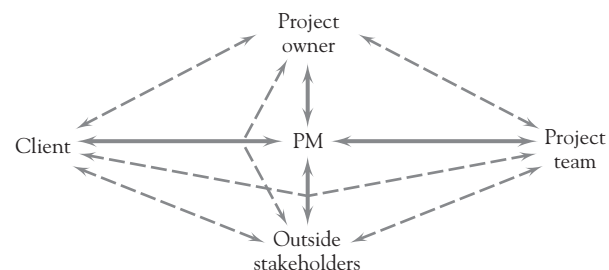

FIGURE 2.1 Communication paths between a project's stakeholders