PART ONE

USING MODELS AND FRAMEWORKS TO MASTER COMPLEX SYSTEMS

As in previous editions, the wheel and axle model is the centerpiece—the basis for visualizing the overall project management process and for structuring the book's content. The theme of the book, and our metaphor for a great project team, is a symphony orchestra, each musician capable of solo performances, but committed

Note that the first violinist is systems engineering, the team's technical lead that, in project teams, frequently sets the pace and orchestrates the technical players in timing and intensity.

to teamwork. This edition emphasizes the pivotal role of systems engineering, the first violinist in the orchestra metaphor.

Visualizing Project Management, third edition, has four parts:

Part One draws on systems thinking to consider the project environment, highlighting the critical role of solution and stakeholder requirements.

Part Two applies our visual model to reveal the relationships and interdependencies among the major project success factors.

Part Three provides the tactics required to navigate skillfully in order to achieve the project goals.

Part Four describes how processes can best be deployed to achieve predictable performance improvements.

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MARGIN NOTES

PMBOK® Guide
This form of margin note is used for PMI *PMBOK® Guide* references.

INCOSE
This form of margin note is used for *INCOSE Handbook* references.

This third edition uses two forms of margin notes. As in previous editions, margin notes are used to emphasize a point or to annotate a diagram, such as the systems engineering role in the first paragraph. The second form, shown here in the margin, is used to reference specific sections of the PMI *PMBOK® Guide* and the *INCOSE Systems Engineering Handbook, Version 3 (2006).*

SECTIONS

We occasionally refer to specific chapters by number and to a section nearby. *Sections* are delimited by headings in all caps and centered, such as this one.

1

WHY ARE PROJECT REQUIREMENTS A CRITICAL ISSUE?

In the mid- to late-1980s, cellular phones had very limited operational range and were generally used only in large cities. A strong business case for a satellite-based mobile phone was made and the Iridium Program was born. By the time the 12-year development and deployment was complete, GSM cellular technology had matured and spread through all markets. Only a fraction of the potential Iridium customers remained. The consortium, unable to pay the $5 billion debt, filed bankruptcy. A realistic business case, appropriately updated, would have revealed that the program could not survive—and it would have revealed the problem years before any satellites were launched.

"It was a painful lesson to learn, but it was an engineer's dream. . . . I had a great time, but, in the end, it taught me a great lesson in business planning. You need to minimize the investment as well as reduce the risks. We all need to think in terms of business, not straight engineering anymore."

Roger Taur[1]
Dr. Taur was a member of the original Iridium development team.

This chapter speaks to the challenges of maintaining consistency of the business case, the project scope, and customer needs. Subsequent chapters address the many creative ways to maintain this consistency, including opportunity management. In the case of the Iridium Corporation, opportunity seekers bought the assets for about 2 percent of the original investment. By late 2004, the new team had enlisted 100,000 customers and could be headed for success in a more limited market and greatly reduced investment (the original Iridium Corporation needed 1.6 million subscribers to survive).

Projects and their solutions are the lifeblood of most businesses. Projects are either the main business, as in construction, or they are expected to provide new products, as in most commercial product

For some businesses, such as aerospace and communications, project management is the lifeblood of the enterprise and systems engineering is the heart of project management.

companies. Whether for survival or to sustain market leadership, projects are the key to succeeding in world competition. Project success is delivering a result that does what it is supposed to; when it is supposed to; for the predicted development, operating, and replication costs; and with the reliability and quality expected.

THE MARKETPLACE DYNAMICS DEMAND MORE RESPONSIVENESS AND AGILITY

Tougher competition demands shorter time to market and squeezes the break-even point.

Marketplace shifts often force abrupt changes of direction. Longer projects face particularly elusive targets. Budget and contingency planning rarely account adequately for market shifts and schedule slips. A prolonged project can face inflated labor and material costs and eroded prices when it eventually shoulders its way into the marketplace. Competitive danger signs include:

- Shorter market windows with higher risks.
- More contenders carving available markets.
- Pricing pressure reducing profit margins.
- Plethora of emerging technologies.

Outside influence is persistent—an increasing distraction.

Conditions such as inflation/recession cycles, lack of borrowing power, and stockholder pressures have always existed, but not so tightly coupled with technology shocks and worldwide competition. Diversionary pressures include:

- High rate of technology change.
- More attention to legal, ethical, and fair conduct.
- Greater international involvement.
- Internet-based worker mobility.

The only certainty is uncertainty, especially with regard to project requirements. The Agile Alliance, an organization formed to address the conflicting demands on software developers, has issued a set of principles and practices to deal with changing requirements. This excerpt of their principles acknowledges the inevitability of changing requirements:

- Requirements are not negotiated up front, but rather evolve as a result of constant collaboration between the customer and development team.
- Welcome changing requirements, even late in development.
- Agile processes harness change for the customer's competitive advantage.

These tactics do apply to some environments, especially in smaller projects, but they could lead to failure in others. Development tactics are addressed in Chapters 7 and 19.

PROJECT SUCCESS DEPENDS ON DELIVERING THE RIGHT SOLUTION, DONE RIGHT—THE FIRST TIME

We refer to the purpose and final result of any project as the *solution.* Delighting the customer with the right solution could be delivering a product or service as expected, or even resolving a problem. "Done right—the first time" means it was developed as intended without burning out the team.

Projects usually exist to address a business opportunity; therefore, to achieve project success, all decisions must be consistent with the business case (also known as the mission case for some government projects). It is often difficult to achieve cooperation and balance among the business and technical aspects. Business cases and technical issues are often subject to conflicting priorities and external forces, such as those in the previous section.

Business and technical conflicts are usually resolved through trade studies, negotiation, or similar processes.

MANAGE REQUIREMENTS TO MANAGE THE PROJECT

The Project Management Institute (PMI), the leading certification body for project management, defines project management as: *The application of knowledge, skills, tools, and techniques to project activities to meet project requirements.* Seasoned project teams view managing requirements and the project scope as the most critical elements of managing the project. The project and its requirements start with expressed needs and end only when those needs are satisfied as evidenced by successful user validation. Chapter 9 covers the end-to-end chain of technical and business development.

Nonessential or overspecified requirements frequently result in missing schedule and cost targets.

Once technical and business requirements are established as consistent, the balance (referred to as *congruency*) needs to be maintained. The budget and schedule must enable achievement of the technical requirements. Conversely, the technical requirements must be achievable within the budget and schedule. Projects without congruency at the outset are usually doomed and unrecoverable unless the inconsistencies are resolved very early (Figure 1.1). In some industries, projects of this type are known as a "suicide run." Throughout a project's duration, there is continual pressure to change the

Figure 1.1 The "suicide run." Reprinted by permission of United Feature Syndicate, Inc.

established agreements. Schedules are compressed, available resources decreased, and technical features added. The project team must be able to recognize and respond to serious inconsistencies. When implementing schedule, budget, and technical changes, congruency must be reestablished or the project will fail.

REQUIREMENTS MANAGEMENT: THE INTERSECTION OF PROJECT MANAGEMENT AND SYSTEMS ENGINEERING

Why are project requirements a critical issue? The answer to this question lies partially in the pervasiveness of the requirements, the diverging interests of project stakeholders, and confusion over roles. Just as we have done up to this point, stakeholders talk about managing requirements without a common understanding of just what—and who—it involves (Figure 1.2).

The two key stakeholders on the project team are the project manager and the systems engineer. The previous section began with the PMI's definition of project management, which emphasized the role of requirements. While we support and applaud that emphasis, our definitions that follow reflect the *interdependency* of project management and systems engineering in regard to managing requirements.

> *Project management:* The process of planning, applying, and controlling the use of funds, personnel, and physical resources to achieve a specific result.
>
> *Systems engineering:* The process of managing requirements to include user and stakeholder requirements, concept selection, architecture development, requirements flowdown and trace-

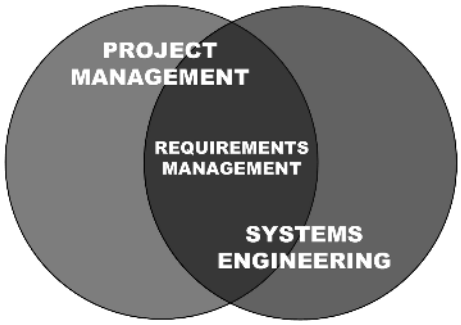

Figure 1.2 Requirements management: The intersection defined.

ability, opportunity and risk management, system integration, verification, validation, and lessons learned.

Requirements management: Management of the project business, budget, and technical baselines. The objective is to keep the three baselines congruent. The process includes baseline change management and authorization. Also included are requirements flowdown, traceability, and accountability.

The business case and the systems engineering management process provide the framework for requirements management—the place where project management and systems engineering intersect.

In many environments, project managers are held accountable for the cost and schedule performance of their projects even though the technical solution is being developed outside of their range of authority. Because the solution development usually consumes the largest portion of the budget and determines the schedule, this condition is likely to be unmanageable. Fortunately, this situation is changing as project management takes center stage and the project manager's role becomes better understood.

In a recent meeting of one of the largest PMI chapters, only 22 percent reported having resource control.

In environments where project managers are responsible for the development and deployment of the solution, the project manager should be skilled in the orchestration of solution development (systems engineering) or closely share that responsibility with someone who is.

The next chapter examines the intersection between project management and systems engineering in the context of the overall project solution environment.