Chapter 1

Challenges of Managing Projects in a Technology World

APPLE IPHONE 5

Photo courtesy of Apple Inc.

When Apple introduced its newest smartphone iPhone 5 at the Yerba Buena Center in San Francisco in late 2012, it was positioned for success. "iPhone 5 is the most beautiful consumer device that we've ever created," said Philip Schiller, Apple's senior vice president of Worldwide Marketing. "We've packed an amazing amount of innovation and advanced technology into a thin and light, jewel-like device with a stunning 4-inch retina display, blazing-fast A6 chip, ultrafast wireless, even longer battery life; and we think customers are going to love it."

The announcement marked the end of an 18-month product development cycle that included intricate collaboration with several software developers, dozens of component manufacturers, partners and the iPhone fabrication at Hon Hai Precision Industry (also known as Foxconn in Zhengzhou, China). Indeed, the new product is state of the art. It is the thinnest and lightest iPhone ever, completely redesigned to feature the new display screen, the world's most advanced mobile operating system, and over 200 new features such as new maps, turn-by-turn navigation, Facebook, Passbook, and more Siri® features.

However, recovering the investment for product development and rollout of the new 16 GB iPhone is not without challenges. For one thing, the cost to produce the phone is high. At over $200 per unit, Apple had to count on wireless companies to subsidize the purchasing price. Nevertheless, business analysts were optimistic that the iPhone 5 would be profitable in the long run—and as it turned out, their

optimism was not misplaced. Following up on the impressive success of the iPhone 5, in September 2013, Apple introduced the iPhone 5S and the iPhone 5C.

1.1 PROJECT MANAGEMENT IN A CHANGING WORLD: CHALLENGES AND OPPORTUNITIES

The complexities and challenges faced by Apple in developing the iPhone 5 might look modest by comparison to super projects, such as major aerospace missions, the relocation of Tata's steel plant to the Gulf of Bengal, or the organization of the next Summer Olympics. Yet, the iPhone 5 has all of the characteristics that we find in millions of technology-intensive projects. Project management has become an important variable for success in today's complex business environment, where projects span organizational lines, involving a broad spectrum of personnel, support groups, subcontractors, vendors, partners, government agencies, and customer organizations. Hence, successful execution relies on effective linkages, cooperation, and alliances among various organizational functions, critical for proper communication, and decision making. Top-down control no longer works in most of these environments, but authority must be earned and team commitment must be built as critical conditions to successful project management.

Despite its challenges, this changing environment—especially advances in computers, IT, and communication technology—creates enormous opportunities for enterprises across all industries. It is possible to execute larger, more complex projects, with leaner budgets and more predictable schedules, and to connect with a wide spectrum of resources across the world. However, technology creates its own challenges, requiring additional investment in equipment, software, infrastructure, services, and skill sets. Advances in technology have also accelerated the changes in our business environment, leading to tougher competition, lower barriers of market entry, and shorter product life cycles, requiring more agile and flexible approaches to project management. These changes have shifted the project paradigm with strong impact on business performance. This got the attention of management across all industries, many of them recognizing project management as a critical toolset for providing common language and methodology for executing multidisciplinary ventures.

1.2 GLOBAL DIMENSIONS

The changes in the global business environment have pushed these challenges to an even higher level. To succeed in our ultracompetitive, interconnected world of business, companies are continuously searching for ways to improve effectiveness. They look for partners that can perform the needed work better, cheaper and faster. Speed especially has become one of the great equalizers of competitive performance. In the case of the iPhone,

a new product may be obsolete in less than a year, unless provisions for continuous upgrading and enhancement have been built into the system and are implemented in response to evolving market needs. This results in complex project organization and execution processes, involving joint ventures, alliances, multinational sourcing and elaborate vendor relations across the globe, ranging from R&D to manufacturing, and from customer relations to field services.

Project complexity has been increasing in virtually every segment of industry and government, including computer, pharmaceutical, automotive, health care, transportation, and financial businesses, just to name a few of the most noticeable ones. New technologies, especially in computers and communications, have radically changed the workplace and transformed our global economy, focusing on effectiveness, value and speed. These technologies offer more sophisticated capabilities for cross-functional integration, resource mobility, effectiveness and market responsiveness, but they also require more sophisticated skill sets both technically and socially, dealing effectively with a broad spectrum of contemporary challenges, including managing conflict, change, risks and uncertainty.

As a result of this paradigm shift we have seen a change in the dynamics of teamwork and a change in managerial focus from efficiency to effectiveness, and from a focus on traditional performance measures, such as the quadruple constraint, to include a broader spectrum of critical success factors that support innovation, work integration, organizational collaboration, human factors, business process agility, and strategic objectives. Traditional linear work processes and top-down controls are no longer sufficient, but are gradually being replaced with alternate organizational designs, new management techniques and business processes, such as agile processes, concurrent engineering, User-Centered Design, and Stage-Gate protocols (Thamhain 2011). These techniques offer more sophisticated capabilities for cross-functional integration, resources mobility, effectiveness, and market responsiveness, but they also require more sophisticated management skills and leadership.

1.3 PROJECT DESERVE SPECIAL ATTENTION WITHIN THE ENTERPRISE

Projects are different from ongoing operations. They are one-time undertakings, such as the Apple's iPhone development, with a specific mission, purpose, and objective, usually driven by the needs and wants of a sponsor or customer, who could be an individual or an organization, internal or external to the enterprise, or both. In essence, this description identifies the components and uniqueness of projects:

Producing specific deliverables within given time, resource and quality constraints that satisfy the project sponsor/customer.

It also identifies the boundary conditions of time, resources, quality, and customer satisfaction, referred to as *quadruple constraint*, to be discussed in the next chapter in more detail.

By their very nature projects are multidisciplinary, requiring resources and support from many organizational units. This is disruptive to the ongoing operations of the enterprise. It interferes with the mission and objectives of functional departments, and is inconsistent with established central management processes for command, control, and communications.

Thus, to minimize interference with ongoing operations, projects need to be organized and managed separately from the ongoing operations, yet well integrated with the enterprise. With the emergence of contemporary project management, virtually every enterprise with project-related activities established its own project management system with various degrees of formality and sophistication. The aim is to have a common infrastructure with methodologies, supportive processes, tools, and measurement systems that ensures consistent project delivery across the enterprise. Communication is at the heart of any of these management systems for effectively connecting among all team members, including partners, support organizations and other internal and external stakeholder communities.

As it has evolved over the past 60 years, modern project management provides the type of disciplined yet flexible framework for effectively planning, organizing, and executing projects. It has its own body of knowledge, providing a common language and methodology with tools and techniques for managing multidisciplinary ventures, regardless of their size, shape, or industry.

1.4 THE UNIQUE NATURE OF TECHNOLOGY PROJECTS

Technology-intensive projects have their unique characteristics and challenges. By definition, these projects have to deal with *technology*, a fast-changing knowledge area associated with risk and uncertainty. The problems to be solved are often complex and solutions untried, requiring experimental, iterative approaches, innovation and creativity, and highly specialized skill sets. Although one could make an argument that these issues also exist in many low-technology projects, they are amplified as dependence on technology intensifies, such as we see in the iPhone example. Therefore, it is not surprising that managers of technology-based projects see their work environment as different, requiring unique organizational structures, policies, interaction among people, and support systems. Yet the classification of projects along technology lines is not easy. Let's first look into the unique characteristics of technology-intensive projects before suggesting a specific classification based on degree of technology and complexity.

WHAT IS DIFFERENT ABOUT TECHNOLOGY-INTENSIVE PROJECTS?

In our highly connected world, most project managers must deal with technology. They must function in a business environment that uses technology for competitive advantage, and their projects are heavily steeped in technology. Virtually every segment of industry and government tries to leverage technology to improve effectiveness, value, and speed. Traditional linear work processes and top-down controls are no longer sufficient, but are gradually being replaced by alternate organizational designs and new, more agile management techniques and business processes, such as concurrent engineering, design-build, stage-gate and user-centered design. These techniques offer more sophisticated capabilities for cross-functional integration, resources mobility, effectiveness, and market responsiveness, but they also require more sophisticated skills to effectively deal with a broad spectrum of contemporary challenges, both technically and socially, including higher levels of conflict, change, risks, and uncertainty, and a shifting attention from functional efficiency to process integration effectiveness, emphasizing organizational interfaces, human factors, and the overall business process. Taken together, technology-intensive projects can be characterized as follows:

- Value creation by applying technology
- Strong need for innovation and creativity
- High task complexities, risks, and uncertainties
- Resource constraints and tight end-date-driven schedules despite tough performance requirements
- Highly educated and skilled personnel, broad skill spectrum
- Specific technical job knowledge and it competency
- Need for sophisticated people skills, ability to work across different organizational cultures and values, and to deal with organizational conflict, power, and politics
- Complex project organizations and cross-functional linkages
- Complex business processes and stakeholder communities
- Technology used as a tool for managing projects
- Replacement of labor with technology
- Advanced infrastructure
- High front-end expenditures early in the project life cycle
- Low short-term profitability in spite of large capital investment
- Fast-changing markets, technology, regulations
- Intense global competition, open markets, and low barriers to entry
- Short product life cycles affect time to market
- Need for quick market response
- Complex decision-making processes
- Many alliances, joint ventures, and partnerships

1.4.1 Characteristics of Technology-Intensive Projects

Although technology and management practices vary considerably among companies, specific characteristics can be defined to describe technology-intensive projects as part of their dynamic environment and organizational interaction as summarized in 16 categories:

1. **Value creation by applying technology.** Technology-based projects create value primarily by leveraging technology. They exploit or commercialize technology. Examples range from plastics and fiber optics to financial services and e-commerce. The technology-based enterprise competes through technological innovation. Project management provides the process, fueled by technology, for creating new and unique products, services, systems, equipment, or advanced materials. This added value is part of the innovation process, where the final product, such as the Internet service or computer chip, is worth a lot more than its ingredients. Hence, "Innovation is the key driver to competitiveness . . . and long-term economic growth" (US Department of Commerce 2012).
2. **High task complexity, risks, and uncertainty.** Given their technical complexity, market uncertainties, changing technologies, and regulatory ambiguities, technology-based projects can be very risky in terms of economics and technical success. Because of these uncertainties, technology-intensive projects utilize unique organizational structures, work processes, decision-making tools, and leadership styles.
3. **Resource constraints and tight end-date driven schedules despite tough performance requirements.** Because of time-to-market pressures and intense competition typical for technology-based projects, resources and schedules are often very tight despite complex requirements and uncertainties, all adding to the challenges of project managers.
4. **Highly educated and skilled personnel.** Technology-intensive projects require special knowledge, skill sets, and competencies to do the technical work. They also require sophisticated people skills, the ability to deal with organizational conflict, power, and politics, and the ability to work effectively in teams across functional lines toward project integration.
5. **Complex project organizations and cross-functional linkages.** Because of the need to integrate among many disciplines, contractors, and partners, as well as the intricate work processes that often span wide geographic areas, high-tech projects are rarely organized according to conventional structures, such as the matrix or projectized organization. Instead, they are arranged as "studios" where team members organize themselves around tasks, determining their responsibilities, work interfaces, and deliverables, sharing accountability and decision-making among the task owners and their interfaces. The evolving project organizations are usually hybrids of conventional structures

capable of working within established project execution templates, such as stage gate, concurrent, spiral, or agile/scrum, and interfacing with complex business processes and stakeholder communities.

6. **Technology used as a tool for managing projects.** High-tech projects use technology extensively in support of their projects execution. This includes sophisticated communication and reporting systems, computer simulation and modeling, advanced testing, and the latest software for project planning, tracking, and control. Often, these project-specific technologies are integrated with other enterprisewide management systems such as SAP or Oracle to gain operational advantages that lead to more predictable, cost-effective, faster, and market-focused project implementation.
7. **Replacement of labor with technology.** Technology-intensive projects are often part of a technology enterprise, such as computers, automotive, or pharmaceutical, that utilizes a wide spectrum of technology with the objective to gain economic benefits, speed, better quality, and reliability. The added value requires additional resources in the form of more advanced equipment, infrastructure, and software, but reduces labor, explaining the fact that technology-intensive projects and their host companies are mostly *capital* (rather than labor).
8. **Advanced infrastructure.** Technology-intensive projects utilize special state-of-the-art equipment, facilities, infrastructure, software tools, and training in support of the project work to be performed.
9. **High front-end expenditures early in the project life cycle.** The effort and resources needed at the front-end project work, such as planning, feasibility assessment, and R&D, seem to increase with the degree of technology used. For example, expenditures for planning and feasibility assessment of high-tech projects run typically above 10 percent of the total budget, double the average across all projects.
10. **Low short-term profitability in spite of large capital investment.** Technology-intensive projects often need large amounts of cash for capital equipment for reasons just discussed, sometimes more than they can generate. They are the classical "stars" in BCG's Growth-Share Matrix (Grant 2010). As a result, strong financial leveraging and low profitability are quite common, in addition to joint ventures, partnerships, and extensive outsourcing, even for well-established high-tech giants, such as Amazon, Boeing, Intel, Microsoft, Pfizer, and Seagate.
11. **Changing markets, technology, and regulations.** Technology-based projects are likely to operate in continuously changing business environments with fast-changing markets and technologies, low barriers to entry, and high exposure to liabilities and regulations.
12. **Intense global competition, open markets, low barriers to entry.** Traditional barriers to entry, such as infrastructure, brand loyalty, and established supply chains, are virtually nonexistent for high-tech businesses. In particular "new and emerging technologies" can reset the competitive field to "ground zero," whipping out any competitive advantage of established products and services (Andrew and Sirkin 2003).

This reality strongly influences the way projects are organized and managed, leading to more empowerment and autonomy at the project team level to promote the agility and speed needed for optimizing the project value under time-to-market pressure and changing conditions.

13. **Short product life cycles.** Driven largely by changing market conditions, emerging technologies and strong competition, life cycles of technology-based product are shorter, putting pressure on time to market as a critical project performance measure.
14. **Need for quick market response.** High-tech companies are fast, agile, and flexible in responding to business opportunities and threats. This also reflects in their project organizations and management style, empowering teams and relying on more autonomous work processes that enable quick reaction to changing conditions.
15. **Complex decision-making processes.** As a result of high risks, great uncertainties, and the dynamics that technology-intensive projects are exposed to, top-down or centralized management is usually ineffective. To a large extend, it is being replaced by *distributed* (or *team-based*) *decision making*, which promotes risk sharing, collaboration, and commitment at the project team level.
16. **Many alliances, joint ventures, and partnerships.** Because of the potentially high costs, risks, and complexities of high-tech project, virtually no company has the resources to handle all the facets of a technology development, its rollout and field support single-handed. Resource pooling, from cooperative agreements to joint ventures, partnerships and acquisitions are quite common among high-tech projects to raise the resources for implementing the new venture in a timely fashion.

To summarize the areas that are unique and different in managing technology-intensive projects, let us focus on six selected business subsystems, as graphically shown in Figure 1.1 and discussed next.

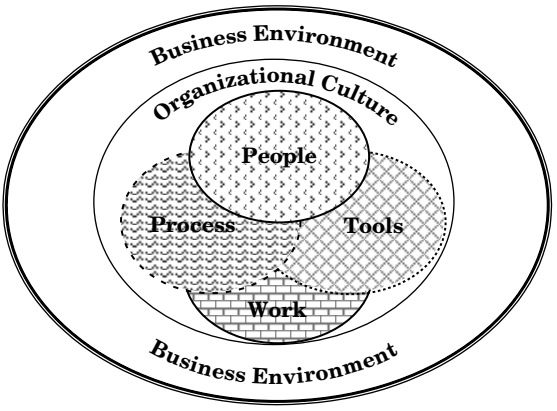

Figure 1.1 Business subsystems unique to technology-intensive project management

Work

Technology-oriented work is by and large more complex, requiring special skills, equipment, tools, processes, and support systems. The unit of work is often a project, organized and executed by multidisciplinary teams. Cross-functional integration, progress measurements and controlling the work toward desired results is usually more challenging with increasing technology orientation, involving creativity, risks, and uncertainties. Work processes are often nonlinear, with solutions evolving incrementally and iteratively with many cross-functional dependencies.

Impact areas: Organizational structure, work planning, work processes (e.g., project management), personnel recruiting, advancement and careers, skill development, management style, organizational culture, and business strategy.

People

Because of the type of work and its challenges, technology-oriented environments and their projects attract different people. On average, these people have highly specialized skills and can apply them effectively. They are better educated, self-motivated/directed, require a minimum of supervision, and enjoy autonomy and freedom of decision making, while willing to take on responsibilities. Hence, they enjoy empowerment and problem solving, and find challenges such as dealing with resource and schedule constraints to some degree motivating and intellectually stimulating. People in technology-oriented work environments often enjoy a sense of community and team spirit, while having little tolerance for personal conflict, anxieties, and organizational politics.

Impact areas: Because of the relationship between people and work issues, the two impact areas are similar. Organizational structure, work plans, and processes, personnel recruiting and advancement, skill development, management style, and organizational culture are the primary areas affected by people in technology.

Work Process

The nature of high-tech work and its business environment requires the ability to deal effectively with complexities, uncertainties, speed, and innovation. This influenced the evolution of work processes that are less sequential and centrally administered, but more team based, self-directed, agile, and structured for parallel, concurrent execution of the work. New organizational models and management methods, such as the *spiral, Stage-Gate, concurrent engineering, design-build*, and *agile/scrum* processes evolved together with the refinement of time-proven concepts such as the matrix and projectized management structures.

Impact areas: Because of the effect on the people and their work, the work process design affects primarily people issues, management style, and

organizational culture. In addition, the work process affects management tools, such as scheduling, budgeting, and project performance analysis, as well as operational effectiveness, such as time to market, cost, and flexibility.

Managerial Tools and Techniques

The unique nature of the work and its business environment creates the need for a special set of tools and techniques for effective administration and management in technology-based projects. Virtually all of the tools and techniques are being used in both high-tech and low-tech organizations, and in many cases, the tools were used long before the high-tech era. However, in their specific application and integration with the enterprise, these tools and techniques often fulfill a unique function and play a unique role. Examples are project schedules that have been tailored to respond to the pressures of a faster, more competitive, and more team-directed work environment. Today these schedules cover a wide spectrum of capabilities and sophistication, from simple milestone charts and bar graphs to PERT charts that show task dependencies and resource requirements, integrated, and trackable throughout the total project.

The wide spectrum of project management tools and techniques can be grouped into five major categories according to their application: (1) project acquisition, (2) project evaluation and selection, (3) project planning and organizing, (4) project tracking, review, and control, (5) contract administration, (6) project support, including legal, human resources (HR), accounting, and training, and (7) strategy. Since the application areas overlap, there is a great deal of overlap among the tools and techniques of the seven areas. In this book we will discuss primarily the first four categories focusing on project management.

Impact areas: The effectiveness of tools and techniques in the enterprise is strongly influenced by the people who use them. Therefore, stakeholder involvement during the tool selection, development, and implementation is critical. The application of many tools involves tradeoffs, such as efficiency versus speed, control versus flexibility, or optimization versus risk. All of these factors must be carefully considered. Getting consensus on specific tools for specific application and stakeholder buy-in for its use is a great challenge.

Organizational Culture

The challenges of technology-driven environments create a unique organizational culture with their own norms, values, and work ethics. These cultures are more team oriented in terms of decision making, work flow, performance evaluation, and workgroup management. Authority must often be earned. It emerges within the workgroup as a result of credibility, trust, and respect, rather than organizational status and position. Rewards come to a considerable degree from satisfaction with the work and its activities. Recognition of accomplishments becomes an important motivational factor for stimulating

enthusiasm, cooperation, and innovation. It is also a critical catalyst for unifying project teams, encouraging risk taking, and dealing with conflict.

Impact areas: Organizational culture has a strong influence on people and the work process. It affects organizational systems from hiring practices to performance evaluation and reward systems to organizational structure, teamwork, and management style.

Business Environment

Technology-oriented businesses operate in an environment that is fast changing in terms of markets, suppliers, and regulations. Short product life cycles, intense global competition, and strong dependency on other technologies and support systems are typical for these businesses, which operate in markets with low brand loyalty, low barriers to entry, and fast and continuously improving price-performance ratios. All of these factors strongly influence the type of projects selected for execution and their managerial processes.

Impact areas: The need for speed, agility, and efficiency affects not only the work process design, the organization and execution of work/projects, and the management methods, tools, and techniques, but also business strategy and competitive behavior, which often focuses on cooperation and resource leveling via alliances, mergers, acquisitions, consortia, and joint ventures, spanning part or all of the project life cycle and beyond.

Taken together, the business environment is quite different from what it used to be. New technologies and changing global markets have transformed our business communities and the way we manage projects. Contemporary project leaders who survive and prosper in this environment have the ability to deal with a broad spectrum of challenges that focus on speed, cost, and quality. They have also shifted their focus from managing the effective implementation of specific requirements to a more integrated business management approach that includes attention to human factors, organizational interfaces, business process, and an alignment of their projects with the strategy of the enterprise.

1.5 EVOLUTION AND GROWTH OF PROJECT MANAGEMENT AND TECHNOLOGY

Project management is not an invention of this century, but has been around for thousands of years, as shown in Table 1.1. The same is true for technology. Interestingly, for most of its history, mankind got along fine without sophisticated management tools and techniques. How did we get into such complex work processes and management methods? What role did technology play in this evolution? Technology has been around for a long time. Man's quest for survival led to the development of improved tools and techniques for simple projects, such as gathering food and building shelters, but also more complex projects, such as building monuments, cities, irrigation

Table 1.1 Evolution of Project Management

Time	Project Undertaking (Examples)	Concepts, Advances, Technology
3000 BCE	Pyramids, Damascus, Stonehenge, China Wall, Roman roads, aqueducts, irrigation, military campaigns	Crude projectized organizations, hierarchical structures of command, communication, and control
↓		
0	Colossus of Rhodes	Early methods of project planning, measuring, and controlling performance; autocratic leadership
↓	Ships	
↓	Castles	
↓	Cathedrals, monuments	
1800	Industrialization	
↓	Factories	Evolution of formal organization and management concepts
↓	Research programs	
1900	Movies	Scientific management, behavioral science
1940	Manhattan project	Formal concepts of teamwork, leadership, project management
1960	Sputnik, ICBM, Apollo	
1980	McIntosh computer	Widespread use of computers for project planning, tracking, control
1990	Human Genome Project	
2000	International Space Station	Strong focus on people
2010+	Mega infrastructure programs, (e.g., Brazil's $900 billion PAC-2)	Virtual, agile, collaborative, strategic alignment

systems, and war campaigns. Evidence of highly complex projects dates back more than 4,000 years. Egyptian pyramids, the Great Wall of China, the inauguration of a king, the Trojan horse, waterworks, Roman roads, and war machinery give testimony today of impressive projects completed during those times. Even by today's standards, these were large, complex, multidisciplinary projects. Basic management tools, such as project planning and control techniques, task definition, and scheduling were already known at these early times and eventually formed the foundation for today's project management systems.

Starting in the eighteenth century, the steam engine and Industrial Revolution spawned an enormous growth in technology with focus on mass production and economies of scale, leading to a wide spectrum of increasingly more complex projects in support of these industrial developments. Yet, it was not until the middle of the twentieth century when project management was recognized as a formal discipline, and organizations started to apply project management tools and techniques more systematically to complex projects.

1.5.1 The Onset of Modern Project Management

The classical model of organization and management first proved inadequate for military undertakings during World War II. Early signs of modern project management processes and techniques surfaced with military technology programs, such as the Manhattan Project and the German missile program. However, it was not until the 1950s that many projects, most noticeable defense-oriented engineering developments, such as ICBM-Atlas and Polaris, became too complex to be executed strictly within functional processes. The year 1956 is often identified as the beginning of modern project management. It coincides with the start of the Polaris submarine missile program. At $11 billion, Polaris was the largest undertaken by the US government at the time. The system complexity, the large number of multidisciplinary skill requirements, the number of subcontractors, and the need to reduce lead time, put pressure on the management team to explore project methods different from those previously used. Under the leadership of Vice Admiral William Francis Raborn, a project team of key technical and management personnel was assembled. This team had full authority over all technical, financial, and administrative matters, without the requirement for traditional reviews and approvals through administrative channels and echelons of organizational levels. The new team dynamics gradually changed the concept of hierarchical direction and control. As personnel assigned to projects took directions from both project managers and their functional department bosses, the concept of dual accountability emerged. This sharing of power and resources led to a new charter and definitions of individual responsibility, accountability, authority, and control in support of an integrated project management system, and eventually led to the concept known today as matrix management.

Polaris also adopted the concept of *concurrent engineering*, a method of proceeding with several task phases in parallel, plus other advanced project management techniques from the ICBM-Atlas program, which under the leadership of General Bernard Schriever also introduced a large spectrum of advanced project management methods that contributed to the foundation of modern project management. As the result of the work at Polaris and Atlas, many new tools, such as Program Evaluation and Review Technique (PERT), work breakdown structure (WBS), and methods for formal project planning, organizing and subcontracting were developed,

providing the framework for today's body of knowledge and project management process.

The success of Polaris and ICBM-Atlas, and later especially NASA's Apollo space program, left a strong imprint on the evolution of project management. Although Apollo was not the largest US undertaking in terms of dollars or personnel, it was unique in terms of complexity, technological sophistication, schedule pressures, mission risk, and uncertainty. It required the development and integration of thousands of complex subsystems by widely dispersed laboratories, contractors, and technological facilities, involving over 20,000 subcontractors and some 400,000 workers employed by government and private industry, as well as over 200 universities. Managing such an effort was clearly beyond conventionally practiced methods of the time. This drove managerial innovations that shaped modern project management. In fact, it is the Apollo program that is often credited for formalizing cross-functional teamwork and hybrid organizations that became known as the *matrix*, a management concept that was refined and legitimized by NASA. It was also the Apollo program that developed and shaped most of the conventional management tools that we use today for project planning, tracking, and control toward the more mature and stable system that we know today.

1.5.2 Why Did It Take so Long?

Why did modern project management emerge so late, considering that the need for these special work processes and tools existed long before 1950? The answer can be found by examining the evolution of organization and management theories and practices as a whole. Traditionally, managerial power was vested with the owners of the enterprise, who represented the central authority accountable for economic gains or losses, success or failure. Work was performed by executing orders that were handed down in a rigid scalar chain of command.

At the beginning of the Industrial Revolution, these enterprises often modeled themselves after military or church organizations. There was no provision for sharing managerial power, dual accountability, resource negotiations, innovative thinking, agile implementation, or situational leadership. However, during this early era, there was also no need yet for strong project authority, intricate customer interfaces, cross-organizational integration, and extensive collaboration.

These traditional enterprises operated in an environment that was reasonable steady, stable, and predictable, with clear goals and employees that were trained to fit the organization and its values. No one really challenged organizational goals, decisions, or work processes. The central authority had all the wisdom and answers with regard to what should be done and how, and provided clear, top-down directions. It took the complexity and dynamics of a large program, such as Atlas, Polaris, and Apollo, to realize that traditional, centrally orchestrated methods of project management do not work

effectively in these situations. They need to be replaced, or at least augmented, by management systems that promote better cross-functional communication, collaboration, and integration, and that can work more adaptable in a changing environment. Today's modern project management systems have this capability.

Although each system is fine-tuned or custom-designed for the specific project to be executed, all systems have the same basic components for project planning, tracking, and control, which have their roots in the early concepts of formal project management of the 1950s. Furthermore, it is interesting to note that while formal project management evolved most noticeably from large military and aerospace programs, it is a toolset that is being applied today to millions of multidisciplinary missions in virtually all enterprises, in all industries, government organizations and NGOs.

1.6 WHERE ARE WE HEADING?

Predicting the future is difficult and risky. Yet there are clear trends and paradigms shifts that give us some reasonable indication of where the field of project management is heading. Look how far we have come just in the past 20 to 30 years. The astounding advances that brought us from a simple, mostly linear process that focused on planning, organizing, and executing projects, to enterprise-integrated project management systems, dashboards, spiral processes, user-centered design, and project portfolio management all happened in the past three decades. Technology, especially computers and communication technology (IT), made much of these advances possible and helped us to take on bigger and more complex projects with fewer resources in less time. In addition to technology, worldwide socioeconomic changes and the resulting globalization of business have transformed project management into a unique multidisciplinary field with its own terminology, standards, body of knowledge, and career paths. The new breed of project managers that evolved with this changing field has had to deal with new challenges, far beyond planning, tracking, and communicating projects. These skills are still important, but they have become threshold competencies. Future project managers must function more like "mini general managers." They must be social architects, leading and orchestrating the many organizations and stakeholder groups that need to collaborate during a typical project execution.

The current trends toward larger, more complex and riskier projects will also require an enhanced project management infrastructure, more effective use of communication technology, and virtual organizations to connect among all team members, including external partners, support groups, and users. Effective leadership and people skills will become critical success factors in this new, contemporary landscape.

Another major challenge will be sustainability, especially regarding large projects, both in terms of carbon footprint and maintenance cost. Project

managers will have to take more of a total life cycle approach, and become more creative in optimizing project delivery, as well as in maintaining and decommissioning projects, in order to satisfy increasing concerns of customers, sponsors, and society as a whole.

We also see an increased desire for *agile* management, and for simplifying and expediting validation procedures at various levels of the project life cycle. These trends drive the need for managing change and risk more predictably, a critical factor for project success in the future. We expect that these pressures will lead to new tools that focus especially on iterative and incremental project execution methods.

Project management will be increasingly recognized as a formal management discipline throughout the world, with especially sharp gains in economic growth areas of Asia and Africa, Finally, as project management gains further acceptance as a profession, formal project management knowledge, skill sets, and credentials will play a stronger role in decisions of staffing, rewards and promotion. As a result, skill sets, such as communication, negotiation, gaining commitment and collaboration, change management, conflict resolution and leadership will be equally important to technical competency, and senior managers together with their human resource partners will spend more of their time and resources on managing talent, professional development, and certification.

Looking into the future, it appears "the only constant is change," to quote the Greek philosopher Heraclitus, 500 BCE. For effective role performance, project managers need to adapt to the continuously changing business environments, new technologies, and work processes. Project management will become the principle strategic tool for effectively competing in our crowded global markets. Those who prepared for the future will also benefit from great opportunities. The challenge is to harness these opportunities in spite of shrinking resources and an increasingly complex sociopolitical environment. We can expect these trends to continue, together with pressures toward flatter, leaner organizations, collaboratively networked with higher levels of shared authority, operating-level autonomy, and automated work processes. To survive and prosper in this changing landscape, we have to understand these trends and prepare our organizations and people accordingly.

1.7 KEY POINTS, LESSONS, AND CONCLUSIONS

The following key points were made in this chapter:

- Projects are one-time undertakings with a specific mission, producing specific deliverables within given time, resource, and quality constraints.
- The boundary conditions are the time, resource, and quality specifications, plus the need for customer satisfaction. This set of four conditions is called the *quadruple constraint*.

- Projects are different from ongoing operations and need a unique management system.
- Technology-intensive projects are usually associated with higher risks and uncertainty, but also greater opportunity for profitably leveraging technology in the market.
- Technology-intensive projects often require unique organizational structures, policies, interaction among people, and support systems.
- Low-technology projects have similar issues as high-tech projects. However, the issues and challenges get amplified as dependence on technology intensifies.
- Project management has been practiced for several thousand years. However, it was not until the 1950s that project management emerged as a formal discipline with its own body of knowledge and toolsets, and was finally recognized as a profession starting in the 1970s.
- Six interconnected organizational subsystems uniquely influence managerial leadership style and process for effectively executing technology-intensive projects: (1) work content, (2) people, (3) work process, (4) managerial tools and techniques, (5) organizational culture, and (6) business environment.

1.8 QUESTIONS FOR DISCUSSION AND EXERCISES

1. Find 10 activities reported in your local newspaper that can be identified as "projects." Rank these projects by degree of (a) complexity, (b) difficulty, and (c) technological intensity (a total of three lists). Selecting the most complex project on your list, discuss the challenges of managing the project.
2. Define *project management* in your own words.
3. How do you define project success?
4. What makes technology-intensive projects unique, and why would they require a unique style of management and support system? Or why not?
5. What is the impact of globalization on project management?
6. Why did it take so long for formal project management systems to emerge and for project management to be recognized as a profession?
7. What trends do you see in our world of business that will affect the way we manage project in the future? What managerial changes do you predict?

1.9 *PMBOK*® REFERENCES AND CONNECTIONS

This first chapter introduces the 10 *knowledge areas* and five *processing groups* as defined by *PMBOK*®. It addresses most strongly the *context* of project management. That is, it brings the issues, challenges, and opportunities

of project management into perspective with today's global business environment. This broad contextual understanding of project management is necessary for effectively applying the *PMBOK*® standards to the study and practice of project management, and to prepare effectively for PMP® certification (Project Management Institute 2013).

INTERNET LINKS AND RESOURCES

Wikipedia: "Project Management," http://en.wikipedia.org/wiki/Project_management
Project Management Institute (PMI): "What Is Project Management?" www.Pmi.Org/About-Us/About-Us-What-Is-Project-Management.Aspx

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