

IEEE Guide

Adoption of PMI Standard

A Guide to the Project Management Body of Knowledge

Sponsor

**Software Engineering Standards Committee
of the
IEEE Computer Society**

Approved 25 June 1998

IEEE-SA Standards Board

Abstract: The subset of the Project Management Body of Knowledge that is generally accepted is identified and described in this guide. “Generally accepted” means that the knowledge and practices described are applicable to most projects most of the time, and that there is widespread consensus about their value and usefulness. It does not mean that the knowledge and practices should be applied uniformly to all projects without considering whether they are appropriate.

Keywords: body of knowledge, project, project management

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Introduction

(This introduction is not part of IEEE Std 1490-1998, IEEE Guide—Adoption of PMI Standard—A Guide to the Project Management Body of Knowledge.)

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IEEE Guide

Adoption of PMI Standard

A Guide to the Project Management Body of Knowledge

Overview

IEEE Std 1490-1998 is an adoption of PMI, A Guide to the Project Management Body of Knowledge (Guide to PMBOK).

References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

IEEE Std 610.12-1990, IEEE Standard Glossary of Software Engineering Terminology.¹

IEEE Std 1028-1997, IEEE Standard for Software Reviews.

IEEE Std 1044-1993, IEEE Standard for Classification of Software Anomalies.

IEEE Std 1044.1-1995, IEEE Guide to Classification for Software Anomalies.

IEEE Std 1045-1992, IEEE Standard for Software Productivity Metrics.

IEEE Std 1058, 1998 Edition, IEEE Standard for Software Project Management Plans.

IEEE Std 1074-1995, IEEE Standard for Developing Software Life Cycle Processes.

IEEE Std 12207.0-1996, IEEE/EIA Standard—Industry Implementation of ISO/IEC 12207: 1995, Standard for Information Technology—Software life cycle processes.

¹IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

IEEE Std 12207.1-1997, IEEE/EIA Guide—Industry Implementation of ISO/IEC 12207: 1995, Standard for Information Technology—Software life cycle processes—Life cycle data.

IEEE Std 12207.2-1997, IEEE/EIA Guide—Industry Implementation of ISO/IEC 12207: 1995, Standard for Information Technology—Software life cycle processes—Implementation considerations.

IEEE adoption implementation considerations

Terminology correlation

The purpose of this clause is to correlate key terminology in the Guide to PMBOK and IEEE software engineering standards. Three key terms are examined: life cycle, process, and project.

Life cycle

project life cycle: A collection of generally sequential project phases whose name and number are determined by the control needs of the organization or organizations involved in the project. (PMI, Guide to PMBOK)

software life cycle: The period of time that begins when a software product is conceived and ends when the software is no longer available for use. (IEEE Std 610.12-1990)

Both definitions have a time dimension. The scope of the PMI definition is limited to a specific project. The PMI definition focuses on the control aspect of the project, whereas the scope of the IEEE definition includes the entire life of the software product. The IEEE definition focuses on the software product and its role.

Process

process: A series of actions bringing about a result. (PMI, Guide to PMBOK)

process: A set of interrelated activities, which transforms inputs into outputs. (IEEE Std 12207.0-1996)

Note—The term “activities” covers use of resources.

Conceptually, the two definitions are the same.

Project

project: A temporary endeavor undertaken to create a unique product or service. (PMI, Guide to PMBOK)

software project: The set of work activities, both technical and managerial, required to satisfy the terms and conditions of a project agreement. A software project should have specific starting and ending dates, well-defined objectives and constraints, established responsibilities, and a budget and schedule. A software project may be self-contained or may be part of a larger project. In some cases, a software project may

span only a portion of the software development cycle. In other cases, a software project may span many years and consist of numerous subprojects, each being a well-defined and self-contained software project. (IEEE Std 1058, 1998 Edition)

At the conceptual level both terms have similar semantics. The PMI definition focuses on the essence of a project. The IEEE definition includes a description of the characteristics of a project.

Errata

Page 11: In Section. 2.1.1, change “text” in the third paragraph to “test.”

Page 13: In Figure 2-2 and Section 2.1.3, change the reference to DoD5000.2 dated 26 February 1993 and the terminology used for the phases and milestones. The current document is DoD5000.2-R dated 15 March 1996, and the terminology is:

Milestone 0: Approval to Conduct Concept Studies
Milestone I: Approval to Begin a New Acquisition Program
Milestone II: Approval to Enter Engineering and Manufacturing Development
Milestone III: Production or Fielding/Deployment Approval
Phase 0: Concept Exploration (CE)
Phase I: Program Definition and Risk Reduction (PDRR)
Phase II: Engineering and Manufacturing Development (EMD)
Phase III: Production, Fielding/Deployment, and Operational Support

Pages 15 and 16: In Figure 2-5 and Section 2.1.3, a preferred reference is:

Boehm, Barry W., “A Spiral Model of Software Development and Enhancement,” IEEE Computer, vol. 215, pp. 61–72, May 1988.

Page 27: In Section 3.1, the second sentence should read as follows:

Project processes are performed by people or machines, and generally fall into one of two major categories:

Page 27: In Section 3.1, the first paragraph, second bulleted item, delete reference to Appendix F.

Page 29: In Section 3.2, last paragraph, delete italics for phrase “rolling wave planning.”

Page 110: In Figure 10-3, replace the table with the following:

WBS Element	Budget (\$)	Earned Value (\$)	Actual Cost (\$)	Cost Variance		Schedule Variance	
				(\$)	(%)	(\$)	(%)
1.0 Pre-pilot planning	63,000	58,000	62,500	-4,500	-7.8	-5,000	-7.9
2.0 Draft checklists	64,000	48,000	46,800	1,200	2.5	-16,000	-25.0
3.0 Curriculum design	23,000	20,000	23,500	-3,500	-17.5	-3,000	-13.0
4.0 Mid-term evaluation	68,000	68,000	72,500	-4,500	-6.6	0	0.0
5.0 Implementation support	12,000	10,000	10,000	0	0.0	-2,000	-16.7
6.0 Manual of practice	7,000	6,200	6,000	200	3.2	-800	-11.4
7.0 Roll-out plan	20,000	13,500	18,100	-4,600	-34.1	-6,500	-32.5
Totals	257,000	223,700	239,400	-15,700	-7.0	-33,300	-13.0
Note: All figures are project-to-date.							

A GUIDE TO THE PROJECT MANAGEMENT BODY OF KNOWLEDGE

A GUIDE TO THE PROJECT MANAGEMENT BODY OF KNOWLEDGE

PMI Standards Committee

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PREFACE TO THE 1996 EDITION



This document supersedes PMI's *Project Management Body of Knowledge (PMBOK)* document that was published in 1987. To assist users of this document who may be familiar with its predecessor, we have summarized the major differences here.

1. *We changed the title to emphasize that this document is not the PMBOK.* The 1987 document defined the PMBOK as "all those topics, subject areas and intellectual processes which are involved in the application of sound management principles to ... projects." Clearly, one document will never contain the entire PMBOK.
2. *We have completely rewritten the Framework section.* The new section consists of three chapters:
 - *Introduction*, which sets out the purpose of the document and defines at length the terms "project" and "project management."
 - *The Project Management Context*, which covers the context in which projects operate—the project life cycle, stakeholder perspectives, external influences, and key general management skills.
 - *Project Management Processes*, which describes how the various elements of project management interrelate.
3. *We have developed a revised definition of "project."* We wanted a definition that was both inclusive (it should not be possible to identify any undertaking generally thought of as a project that does not fit the definition) and exclusive (it should not be possible to describe any undertaking which satisfies the definition and is not generally thought of as a project). We reviewed many of the definitions of project in the existing literature and found all of them unsatisfactory in some way. The new definition is driven by the unique characteristics of a project: *a project is a temporary endeavor undertaken to create a unique product or service.*
4. *We have developed a revised view of the project life cycle.* The 1987 document defined project phases as subdivisions of the project life cycle. We have reordered this relationship and defined the project life cycle as a collection of phases whose number and names are determined by the control needs of the performing organization.
5. *We have changed the name of the major sections from "function" to "knowledge area."* The term "function" had been frequently misunderstood to mean an element of a functional organization. The name change should eliminate this misunderstanding.
6. *We formally recognized the existence of a ninth knowledge area.* There has been widespread consensus for some time that project management is an integrative process. Chapter 4, Project Integration Management, recognizes the importance of this subject.
7. *We have added the word "project" to the title of each knowledge area.* Although this may seem redundant, it helps to clarify the scope of the document. For example, Project Human Resource Management covers only those aspects of managing human resources that are unique or nearly unique to the project context.

8. *We have chosen to describe the knowledge areas in terms of their component processes.* The search for a consistent method of presentation led us to completely restructure the 1987 document into 37 “project management processes.” Each process is described in terms of its inputs, outputs, and tools and techniques. Inputs and outputs are documents (e.g., a scope statement) or documentable items (e.g., activity dependencies). Tools and techniques are the mechanisms applied to the inputs to create the outputs. In addition to its fundamental simplicity, this approach offers several other benefits:
 - It emphasizes the interactions among the knowledge areas. Outputs from one process become inputs to another.
 - The structure is flexible and robust. Changes in knowledge and practice can be accommodated by adding a new process, by resequencing processes, by subdividing processes, or by adding descriptive material within a process.
 - Processes are at the core of other standards. For example, the International Organization for Standardization’s quality standards (the ISO 9000 series) are based on identification of business processes.
9. *We added some illustrations.* When it comes to work breakdown structures, network diagrams, and S-curves, a picture is worth a thousand words.
10. *We have significantly reorganized the document.* The following table provides a comparison of the major headings of the 1987 document and this one:

1987 Number and Name	1996 Number and Name
0. PMBOK Standards	B. Evolution of PMI’s <i>A Guide to the Project Management Body of Knowledge</i>
1. Framework: The Rationale	1. Introduction (basic definitions)
2. Framework: An Overview	2. The Project Context (life cycles)
3. Framework: An Integrative Model	1. Various portions
4. Glossary of General Terms	2. Various portions
A. Scope Management	3. Various portions
B. Quality Management	3. Project Management Processes
C. Time Management	4. Project Integration Management
D. Cost Management	IV. Glossary
E. Risk Management	5. Project Scope Management
F. Human Resource Management	8. Project Quality Management
G. Contract/Procurement Management	6. Project Time Management
H. Communications Management	7. Project Cost Management
	11. Project Risk Management
	9. Project Human Resource Management
	12. Project Procurement Management
	10. Project Communications Management

11. *“To classify” has been removed from the list of purposes.* Both this document and the 1987 version provide a structure for organizing project management knowledge, but neither is particularly effective as a classification tool. First, the topics included are not comprehensive—they do not include innovative or unusual practices. Second, many elements have relevance in more than one knowledge area or process such that the categories are not unique.

We plan to update this document regularly. Your comments are both welcome and requested. Please send them to:

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THE PROJECT MANAGEMENT FRAMEWORK



1. Introduction
2. The Project Management Context
3. Project Management Processes

NOTES

INTRODUCTION

The *Project Management Body of Knowledge* (PMBOK) is an inclusive term that describes the sum of knowledge within the profession of project management. As with other professions such as law, medicine, and accounting, the body of knowledge rests with the practitioners and academics who apply and advance it. The full PMBOK includes knowledge of proven, traditional practices which are widely applied as well as knowledge of innovative and advanced practices which have seen more limited use.

This chapter defines and explains several key terms and provides an overview of the rest of the document. It includes the following major sections:

- 1.1 Purpose of this Document
- 1.2 What is a Project?
- 1.3 What is Project Management?
- 1.4 Relationship to Other Management Disciplines
- 1.5 Related Endeavors

1.1 PURPOSE OF THIS DOCUMENT

The primary purpose of this document is to identify and describe that subset of the PMBOK which is *generally accepted*. Generally accepted means that the knowledge and practices described are applicable to most projects most of the time, and that there is widespread consensus about their value and usefulness. Generally accepted does *not* mean that the knowledge and practices described are or should be applied uniformly on all projects; the project management team is always responsible for determining what is appropriate for any given project.

This document is also intended to provide a common lexicon within the profession for talking about project management. Project management is a relatively young profession, and while there is substantial commonality around what is done, there is relatively little commonality in the terms used.

This document provides a basic reference for anyone interested in the profession of project management. This includes, but is not limited to:

- Project managers and other project team members.
- Managers of project managers.
- Project customers and other project stakeholders.
- Functional managers with employees assigned to project teams.
- Educators teaching project management and related subjects.
- Consultants and other specialists in project management and related fields.
- Trainers developing project management educational programs.

As a basic reference, this document is neither comprehensive nor all-inclusive. Appendix E discusses application area extensions while Appendix F lists sources of further information on project management.

1.1 Purpose of this Document

1.2 What is a Project?

1.3 What is Project Management?

1.4 Relationship to Other Management Disciplines

1.5 Related Endeavors

This document is also used by the Project Management Institute to provide a consistent structure for its professional development programs including:

- Certification of Project Management Professionals (PMPs).
- Accreditation of degree-granting educational programs in project management.

1.2 WHAT IS A PROJECT?

Organizations perform work. Work generally involves either *operations* or *projects*, although the two may overlap. Operations and projects share many characteristics; for example, they are:

- Performed by people.
- Constrained by limited resources.
- Planned, executed, and controlled.

Operations and projects differ primarily in that operations are ongoing and repetitive while projects are temporary and unique. A project can thus be defined in terms of its distinctive characteristics—a *project is a temporary endeavor undertaken to create a unique product or service*. *Temporary* means that every project has a definite beginning and a definite end. *Unique* means that the product or service is different in some distinguishing way from all similar products or services.

Projects are undertaken at all levels of the organization. They may involve a single person or many thousands. They may require less than 100 hours to complete or over 10,000,000. Projects may involve a single unit of one organization or may cross organizational boundaries as in joint ventures and partnering. Projects are often critical components of the performing organization's business strategy. Examples of projects include:

- Developing a new product or service.
- Effecting a change in structure, staffing, or style of an organization.
- Designing a new transportation vehicle.
- Developing or acquiring a new or modified information system.
- Constructing a building or facility.
- Running a campaign for political office.
- Implementing a new business procedure or process.

1.2.1 Temporary

Temporary means that every project has a definite beginning and a definite end. The end is reached when the project's objectives have been achieved, or when it becomes clear that the project objectives will not or cannot be met and the project is terminated. Temporary does not necessarily mean short in duration; many projects last for several years. In every case, however, the duration of a project is finite; projects are not ongoing efforts.

In addition, temporary does not generally apply to the product or service created by the project. Most projects are undertaken to create a lasting result. For example, a project to erect a national monument will create a result expected to last centuries.

Many undertakings are temporary in the sense that they will end at some point. For example, assembly work at an automotive plant will eventually be discontinued, and the plant itself decommissioned. Projects are fundamentally different because the project *ceases* when its declared objectives have been attained, while non-project undertakings adopt a new set of objectives and *continue* to work.

The temporary nature of projects may apply to other aspects of the endeavor as well:

- The opportunity or market window is usually temporary—most projects have a limited time frame in which to produce their product or service.
- The project team, as a team, seldom outlives the project—most projects are performed by a team created for the sole purpose of performing the project, and the team is disbanded and members reassigned when the project is complete.

1.2.2 Unique Product or Service

Projects involve doing something which has not been done before and which is, therefore, *unique*. A product or service may be unique even if the category it belongs to is large. For example, many thousands of office buildings have been developed, but each individual facility is unique—different owner, different design, different location, different contractors, and so on. The presence of repetitive elements does not change the fundamental uniqueness of the overall effort. For example:

- A project to develop a new commercial airliner may require multiple prototypes.
- A project to bring a new drug to market may require thousands of doses of the drug to support clinical trials.
- A real estate development project may include hundreds of individual units.

Because the product of each project is unique, the characteristics that distinguish the product or service must be progressively elaborated. *Progressively* means “proceeding in steps; continuing steadily by increments” while *elaborated* means “worked out with care and detail; developed thoroughly” [1]. These distinguishing characteristics will be broadly defined early in the project and will be made more explicit and detailed as the project team develops a better and more complete understanding of the product.

Progressive elaboration of product characteristics must be carefully coordinated with proper project scope definition, particularly if the project is performed under contract. When properly defined, the scope of the project—the work to be done—should remain constant even as the product characteristics are progressively elaborated. The relationship between product scope and project scope is discussed further in the introduction to Chapter 5.

The following two examples illustrate progressive elaboration in two different application areas.

Example 1. A chemical processing plant begins with process engineering to define the characteristics of the process. These characteristics are used to design the major processing units. This information becomes the basis for engineering design which defines both the detail plant layout and the mechanical characteristics of the process units and ancillary facilities. All of these result in design drawings which are elaborated to produce fabrication drawings (construction isometrics). During construction, interpretations and adaptations are made as needed and subject to proper approval. This further elaboration of the characteristics is captured by “as built” drawings. During test and turnover, further elaboration of the characteristics is often made in the form of final operating adjustments.

Example 2. The product of a biopharmaceutical research project may initially be defined as “clinical trials of XYZ” since the number of trials and the size of each is not known. As the project proceeds, the product may be described more explicitly as “three Phase I trials, four Phase II trials, and two Phase III trials.” The next round of progressive elaboration might focus exclusively on the protocol for the Phase I trials—how many patients get what dosages and how frequently. In the project’s final stages, the Phase III trials would be explicitly defined based on information gathered and analyzed during the Phase I and Phase II trials.

1.3 WHAT IS PROJECT MANAGEMENT?

Project management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project. Meeting or exceeding stakeholder needs and expectations invariably involves balancing competing demands among:

- Scope, time, cost, and quality.
- Stakeholders with differing needs and expectations.
- Identified requirements (needs) and unidentified requirements (expectations).

The term *project management* is sometimes used to describe an organizational approach to the management of ongoing operations. This approach, more properly called *management by projects*, treats many aspects of ongoing operations as projects in order to apply project management to them. Although an understanding of project management is obviously critical to an organization that is managing by projects, a detailed discussion of the approach itself is outside the scope of this document.

Knowledge about project management can be organized in many ways. This document has two major sections and 12 chapters as described below.

1.3.1 The Project Management Framework

Part I, The Project Management Framework, provides a basic structure for understanding project management.

Chapter 1, **Introduction**, defines key terms and provides an overview of the rest of the document.

Chapter 2, **The Project Management Context**, describes the environment in which projects operate. The project management team must understand this broader context—managing the day-to-day activities of the project is necessary for success but not sufficient.

Chapter 3, **Project Management Processes**, describes a generalized view of how the various project management processes commonly interact. Understanding these interactions is essential to understanding the material presented in Chapters 4 through 12.

1.3.2 The Project Management Knowledge Areas

Part II, The Project Management Knowledge Areas, describes project management knowledge and practice in terms of its component processes. These processes have been organized into nine knowledge areas as described below and as illustrated in Figure 1-1.

Chapter 4, **Project Integration Management**, describes the processes required to ensure that the various elements of the project are properly coordinated. It consists of project plan development, project plan execution, and overall change control.

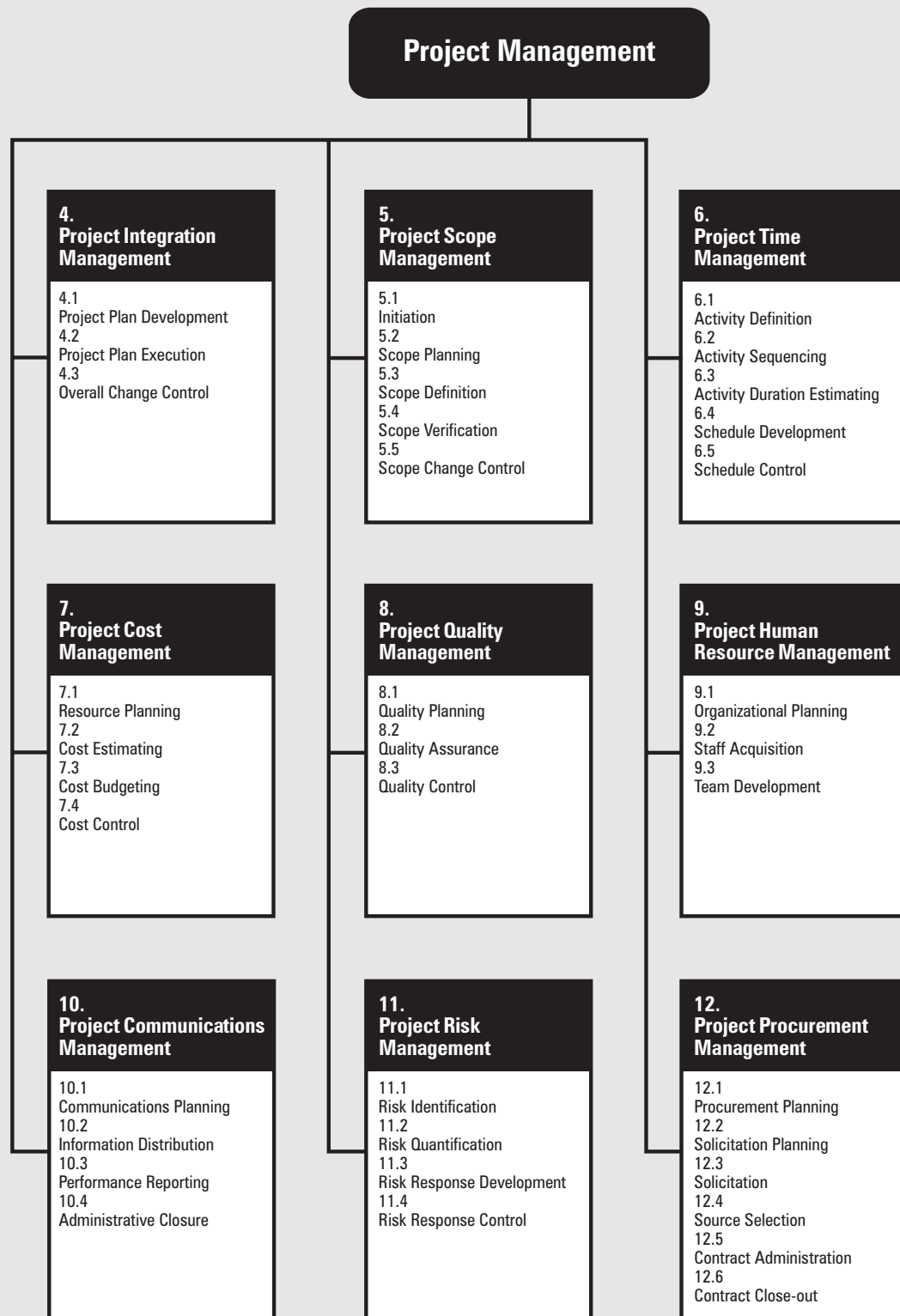
Chapter 5, **Project Scope Management**, describes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully. It consists of initiation, scope planning, scope definition, scope verification, and scope change control.

Chapter 6, **Project Time Management**, describes the processes required to ensure timely completion of the project. It consists of activity definition, activity sequencing, activity duration estimating, schedule development, and schedule control.

Chapter 7, **Project Cost Management**, describes the processes required to ensure that the project is completed within the approved budget. It consists of resource planning, cost estimating, cost budgeting, and cost control.

Chapter 8, **Project Quality Management**, describes the processes required to ensure that the project will satisfy the needs for which it was undertaken. It consists of quality planning, quality assurance, and quality control.

Figure 1-1. Overview of Project Management Knowledge Areas and Project Management Processes



Chapter 9, **Project Human Resource Management**, describes the processes required to make the most effective use of the people involved with the project. It consists of organizational planning, staff acquisition, and team development.

Chapter 10, **Project Communications Management**, describes the processes required to ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information. It consists of communications planning, information distribution, performance reporting, and administrative closure.

Chapter 11, **Project Risk Management**, describes the processes concerned with identifying, analyzing, and responding to project risk. It consists of risk identification, risk quantification, risk response development, and risk response control.

Chapter 12, **Project Procurement Management**, describes the processes required to acquire goods and services from outside the performing organization. It consists of procurement planning, solicitation planning, solicitation, source selection, contract administration, and contract close-out.

1.4 RELATIONSHIP TO OTHER MANAGEMENT DISCIPLINES

Much of the knowledge needed to manage projects is unique or nearly unique to project management (e.g., critical path analysis and work breakdown structures). However, the PMBOK does overlap other management disciplines as illustrated in Figure 1–2.

General management encompasses planning, organizing, staffing, executing, and controlling the operations of an ongoing enterprise. General management also includes supporting disciplines such as computer programming, law, statistics and probability theory, logistics, and personnel. The PMBOK overlaps general management in many areas—organizational behavior, financial forecasting, and planning techniques to name just a few. Section 2.4 provides a more detailed discussion of general management.

Application areas are categories of projects that have common elements significant in such projects but not needed or present in all projects. Application areas are usually defined in terms of:

- Technical elements, such as software development, pharmaceuticals, or construction engineering.
- Management elements, such as government contracting or new product development.
- Industry groups, such as automotive, chemicals, or financial services.

Appendix E includes a more detailed discussion of project management application areas.

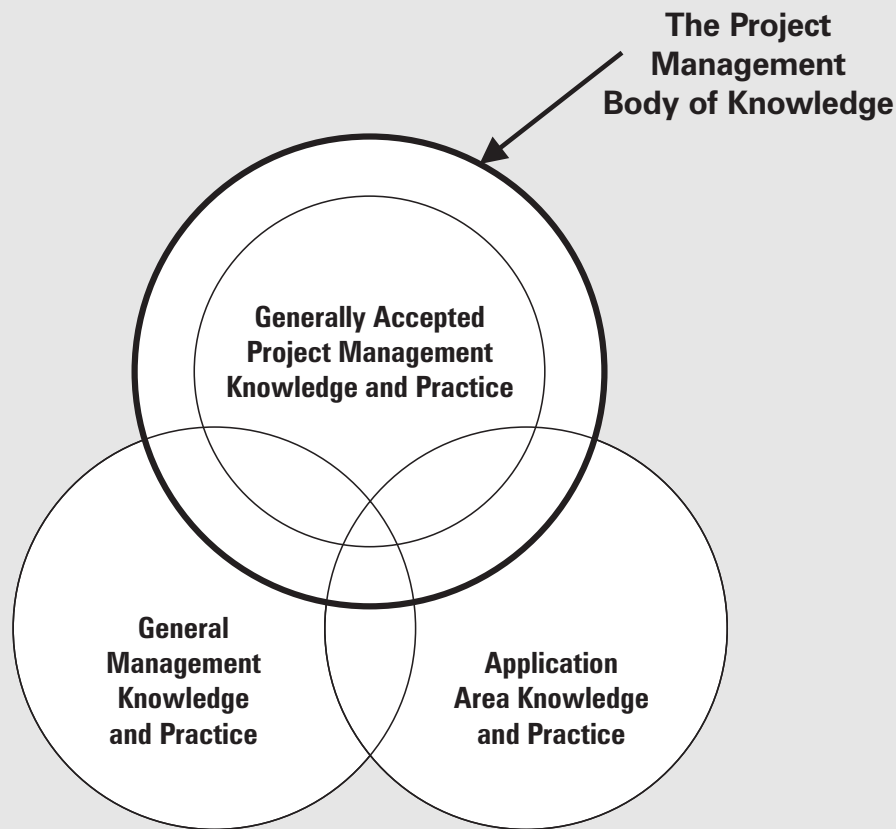
1.5 RELATED ENDEAVORS

Certain types of endeavors are closely related to projects. These related undertakings are described below.

Programs. A *program* is a group of projects managed in a coordinated way to obtain benefits not available from managing them individually [2]. Many programs also include elements of ongoing operations. For example:

- The “XYZ airplane program” includes both the project or projects to design and develop the aircraft as well as the ongoing manufacturing and support of that craft in the field.
- Many electronics firms have “program managers” who are responsible for both individual product releases (projects) and the coordination of multiple releases over time (an ongoing operation).

Figure 1-2. Relationship of Project Management to Other Management Disciplines



This figure is a conceptual view of these relationships. The overlaps shown are not proportional.

Programs may also involve a series of repetitive or cyclical undertakings, for example:

- Utilities often speak of an annual “construction program,” a regular, ongoing operation which involves many projects.
- Many non-profit organizations have a “fundraising program,” an ongoing effort to obtain financial support that often involves a series of discrete projects such as a membership drive or an auction.
- Publishing a newspaper or magazine is also a program—the periodical itself is an ongoing effort, but each individual issue is a project.

In some application areas, program management and project management are treated as synonyms; in others, project management is a subset of program management. Occasionally, program management is considered a subset of project management. This diversity of meaning makes it imperative that any discussion of program management versus project management be preceded by agreement on a clear and consistent definition of each term.

Subprojects. Projects are frequently divided into more manageable components or *subprojects*. Subprojects are often contracted out to an external enterprise or to another functional unit in the performing organization. Examples of subprojects include:

- A single project phase (project phases are described in Section 2.1).
- The installation of plumbing or electrical fixtures on a construction project.
- Automated testing of computer programs on a software development project.
- High-volume manufacturing to support clinical trials of a new drug during a pharmaceutical research and development project.

However, from the perspective of the performing organization, a subproject is often thought of more as a service than as a product, and the service is unique. Thus subprojects are typically referred to as projects and managed as such.

THE PROJECT MANAGEMENT CONTEXT

2

Projects and project management operate in an environment broader than that of the project itself. The project management team must understand this broader context—managing the day-to-day activities of the project is necessary for success but not sufficient. This chapter describes key aspects of the project management context not covered elsewhere in this document. The topics included here are:

- 2.1 Project Phases and the Project Life Cycle
- 2.2 Project Stakeholders
- 2.3 Organizational Influences
- 2.4 Key General Management Skills
- 2.5 Socioeconomic Influences

2.1 PROJECT PHASES AND THE PROJECT LIFE CYCLE

Because projects are unique undertakings, they involve a degree of uncertainty. Organizations performing projects will usually divide each project into several *project phases* to provide better management control and appropriate links to the ongoing operations of the performing organization. Collectively, the project phases are known as the *project life cycle*.

2.1.1 Characteristics of Project Phases

Each project phase is marked by completion of one or more *deliverables*. A deliverable is a tangible, verifiable work product such as a feasibility study, a detail design, or a working prototype. The deliverables, and hence the phases, are part of a generally sequential logic designed to ensure proper definition of the product of the project.

The conclusion of a project phase is generally marked by a review of both key deliverables and project performance in order to (a) determine if the project should continue into its next phase and (b) detect and correct errors cost effectively. These phase-end reviews are often called *phase exits*, *stage gates*, or *kill points*.

Each project phase normally includes a set of defined work products designed to establish the desired level of management control. The majority of these items are related to the primary phase deliverable, and the phases typically take their names from these items: requirements, design, build, test, start-up, turnover, and others as appropriate. Several representative project life cycles are described in Section 2.1.3.

2.1.2 Characteristics of the Project Life Cycle

The project life cycle serves to define the beginning and the end of a project. For example, when an organization identifies an opportunity that it would like to respond to, it will often authorize a feasibility study to decide if it should undertake a project. The project life cycle definition will determine whether the feasibility study is treated as the first project phase or as a separate, stand-alone project.

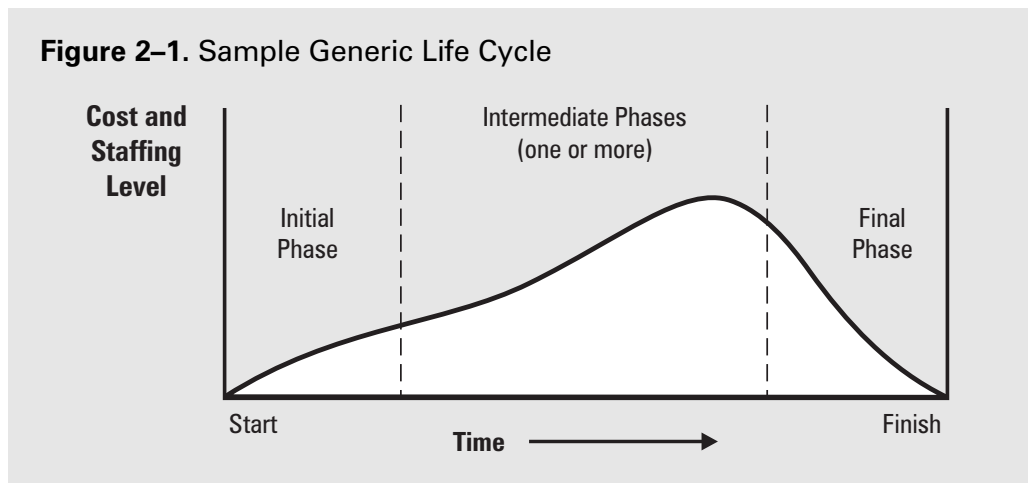
2.1 Project Phases and the Project Life Cycle

2.2 Project Stakeholders

2.3 Organizational Influences

2.4 Key General Management Skills

2.5 Socioeconomic Influences

Figure 2-1. Sample Generic Life Cycle

The project life cycle definition will also determine which transitional actions at the end of the project are included and which are not. In this manner, the project life cycle definition can be used to link the project to the ongoing operations of the performing organization.

The phase sequence defined by most project life cycles generally involves some form of technology transfer or hand-off such as requirements to design, construction to operations, or design to manufacturing. Deliverables from the preceding phase are usually approved before work starts on the next phase. However, a subsequent phase is sometimes begun prior to approval of the previous phase deliverables when the risks involved are deemed acceptable. This practice of overlapping phases is often called *fast tracking*.

Project life cycles generally define:

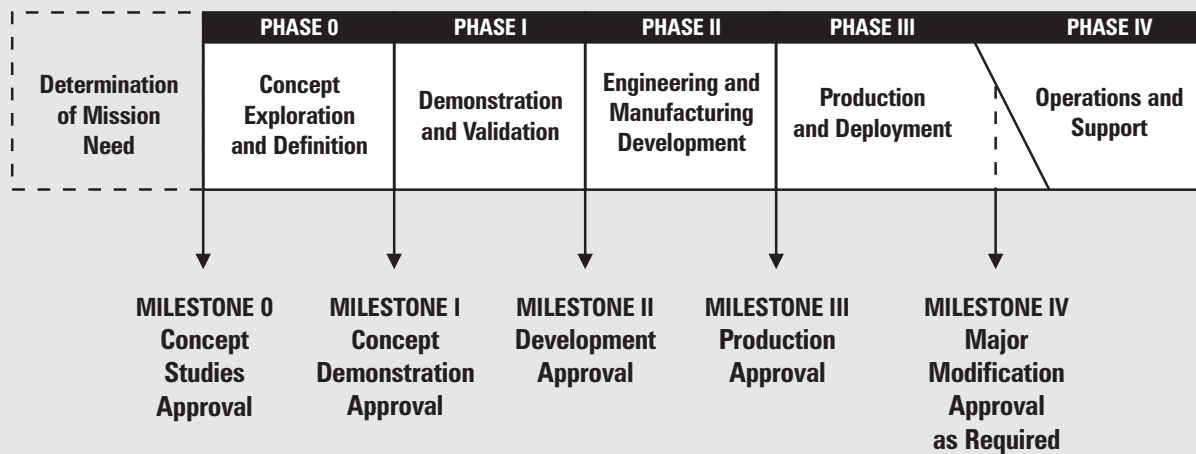
- What technical work should be done in each phase (e.g., is the work of the architect part of the definition phase or part of the execution phase?).
- Who should be involved in each phase (e.g., concurrent engineering requires that the implementors be involved with requirements and design).

Project life cycle descriptions may be very general or very detailed. Highly detailed descriptions may have numerous forms, charts, and checklists to provide structure and consistency. Such detailed approaches are often called project management methodologies.

Most project life cycle descriptions share a number of common characteristics:

- Cost and staffing levels are low at the start, higher towards the end, and drop rapidly as the project draws to a conclusion. This pattern is illustrated in **Figure 2-1**.
- The probability of successfully completing the project is lowest, and hence risk and uncertainty are highest, at the start of the project. The probability of successful completion generally gets progressively higher as the project continues.
- The ability of the stakeholders to influence the final characteristics of the project product and the final cost of the project is highest at the start and gets progressively lower as the project continues. A major contributor to this phenomenon is that the cost of changes and error correction generally increases as the project continues.

Care should be taken to distinguish the *project* life cycle from the *product* life cycle. For example, a project undertaken to bring a new desktop computer to market is but one phase or stage of the product life cycle.

Figure 2–2. Representative Life Cycle for Defense Acquisition, per US DOD 5000.2 (Rev. 2/26/93)

Although many project life cycles have similar phase names with similar work products required, few are identical. Most have four or five phases, but some have nine or more. Even within a single application area there can be significant variations—one organization’s software development life cycle may have a single design phase while another’s has separate phases for functional and detail design.

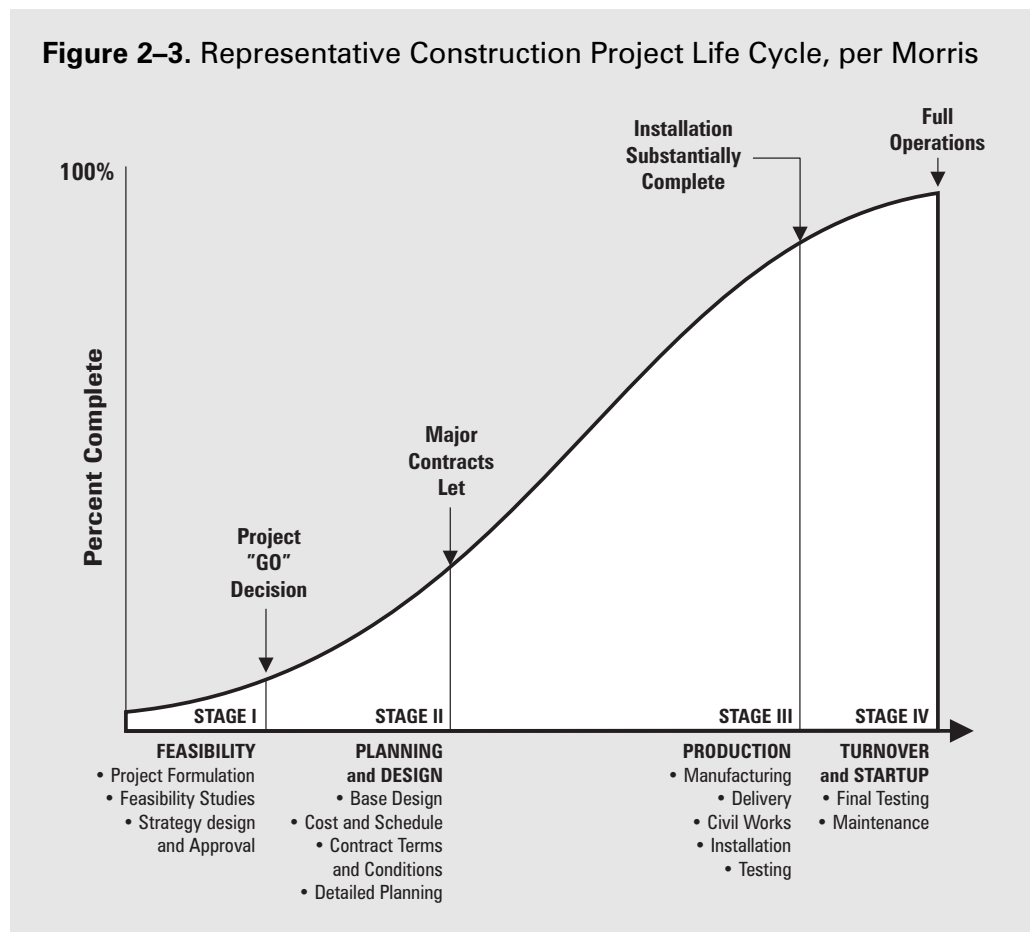
Subprojects within projects may also have distinct project life cycles. For example, an architectural firm hired to design a new office building is first involved in the owner’s definition phase when doing the design and in the owner’s implementation phase when supporting the construction effort. The architect’s design project, however, will have its own series of phases from conceptual development through definition and implementation to closure. The architect may even treat designing the facility and supporting the construction as separate projects with their own distinct phases.

2.1.3 Representative Project Life Cycles

The following project life cycles have been chosen to illustrate the diversity of approaches in use. The examples shown are typical; they are neither recommended nor preferred. In each case, the phase names and major deliverables are those described by the author.

Defense acquisition. The U.S. Department of Defense directive 5000.2, as revised February 1993, describes a series of acquisition milestones and phases as illustrated in **Figure 2–2**.

- Determination of Mission Need—ends with Concept Studies Approval.
- Concept Exploration and Definition—ends with Concept Demonstration Approval.
- Demonstration and Validation—ends with Development Approval.
- Engineering and Manufacturing Development—ends with Production Approval.
- Production and Deployment—overlaps ongoing Operations and Support.

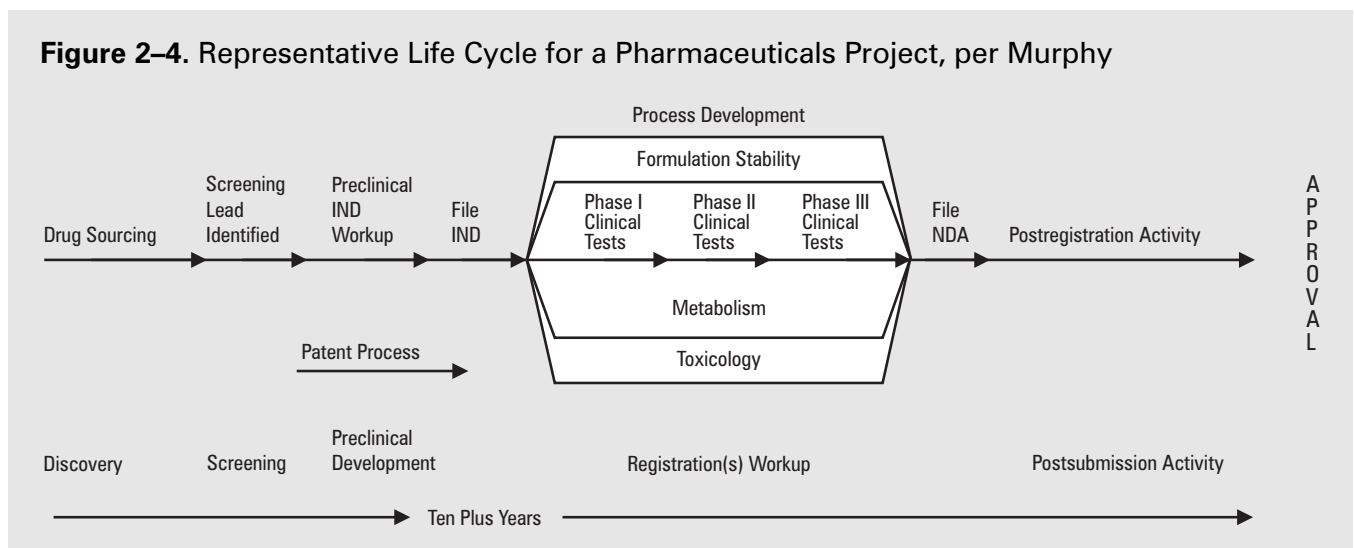


Construction. Morris [1] describes a construction project life cycle as illustrated in Figure 2-3:

- Feasibility—project formulation, feasibility studies, and strategy design and approval. A go/no-go decision is made at the end of this phase.
- Planning and Design—base design, cost and schedule, contract terms and conditions, and detailed planning. Major contracts are let at the end of this phase.
- Production—manufacturing, delivery, civil works, installation, and testing. The facility is substantially complete at the end of this phase.
- Turnover and Start-up—final testing and maintenance. The facility is in full operation at the end of this phase.

Pharmaceuticals. Murphy [2] describes a project life cycle for pharmaceutical new product development in the United States as illustrated in Figure 2-4:

- Discovery and Screening—includes basic and applied research to identify candidates for preclinical testing.
- Preclinical Development—includes laboratory and animal testing to determine safety and efficacy as well as preparation and filing of an Investigational New Drug (IND) application.
- Registration(s) Workup—includes Clinical Phase I, II, and III tests as well as preparation and filing of a New Drug Application (NDA).
- Postsubmission Activity—includes additional work as required to support Food and Drug Administration review of the NDA.

Figure 2–4. Representative Life Cycle for a Pharmaceuticals Project, per Murphy

Software development. Muench, et al. [3] describe a spiral model for software development with four cycles and four quadrants as illustrated in **Figure 2–5**:

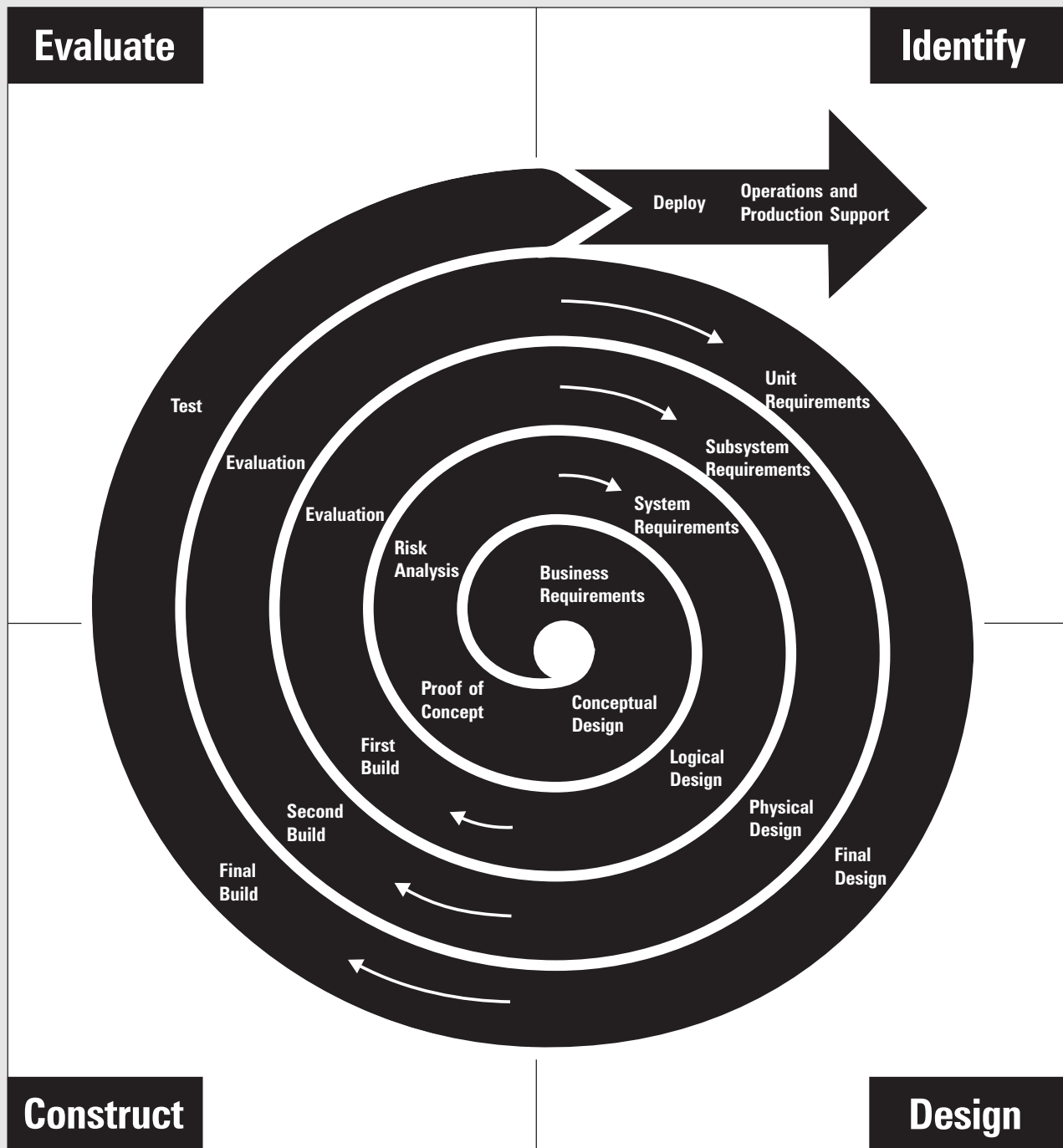
- Proof-of-concept cycle—capture business requirements, define goals for proof-of-concept, produce conceptual system design, design and construct the proof-of-concept, produce acceptance test plans, conduct risk analysis and make recommendations.
- First build cycle—derive system requirements, define goals for first build, produce logical system design, design and construct the first build, produce system test plans, evaluate the first build and make recommendations.
- Second build cycle—derive subsystem requirements, define goals for second build, produce physical design, construct the second build, produce system test plans, evaluate the second build and make recommendations.
- Final cycle—complete unit requirements, final design, construct final build, perform unit, subsystem, system, and acceptance tests.

2.2 PROJECT STAKEHOLDERS

Project stakeholders are individuals and organizations who are actively involved in the project, or whose interests may be positively or negatively affected as a result of project execution or successful project completion. The project management team must identify the stakeholders, determine what their needs and expectations are, and then manage and influence those expectations to ensure a successful project. Stakeholder identification is often especially difficult. For example, is an assembly line worker whose future employment depends on the outcome of a new product design project a stakeholder?

Key stakeholders on every project include:

- Project manager—the individual responsible for managing the project.
- Customer—the individual or organization who will use the project product. There may be multiple layers of customers. For example, the customers for a new pharmaceutical product may include the doctors who prescribe it, the patients who take it, and the insurers who pay for it.
- Performing organization—the enterprise whose employees are most directly involved in doing the work of the project.
- Sponsor—the individual or group within the performing organization who provides the financial resources, in cash or in kind, for the project.

Figure 2-5. Representative Software Development Life Cycle, per Muench

In addition to these there are many different names and categories of project stakeholders—internal and external, owners and funders, suppliers and contractors, team members and their families, government agencies and media outlets, individual citizens, temporary or permanent lobbying organizations, and society at large. The naming or grouping of stakeholders is primarily an aid to identifying which individuals and organizations view themselves as stakeholders. Stakeholder roles and responsibilities may overlap, as when an engineering firm provides financing for a plant it is designing.

Managing stakeholder expectations may be difficult because stakeholders often have very different objectives that may come into conflict. For example:

- The manager of a department that has requested a new management information system may desire low cost, the system architect may emphasize technical excellence, and the programming contractor may be most interested in maximizing its profit.
- The vice president of research at an electronics firm may define new product success as state-of-the-art technology, the vice president of manufacturing may define it as world-class practices, and the vice president of marketing may be primarily concerned with the number of new features.
- The owner of a real estate development project may be focused on timely performance, the local governing body may desire to maximize tax revenue, an environmental group may wish to minimize adverse environmental impacts, and nearby residents may hope to relocate the project.

In general, differences between or among stakeholders should be resolved in favor of the customer. This does not, however, mean that the needs and expectations of other stakeholders can or should be disregarded. Finding appropriate resolutions to such differences can be one of the major challenges of project management.

2.3 ORGANIZATIONAL INFLUENCES

Projects are typically part of an organization larger than the project—corporations, government agencies, health care institutions, international bodies, professional associations, and others. Even when the project is the organization (joint ventures, partnering), the project will still be influenced by the organization or organizations that set it up. The following sections describe key aspects of these larger organizational structures that are likely to influence the project.

2.3.1 Organizational Systems

Project-based organizations are those whose operations consist primarily of projects. These organizations fall into two categories:

- Organizations that derive their revenue primarily from performing projects for others—architectural firms, engineering firms, consultants, construction contractors, government contractors, etc.
- Organizations that have adopted *management by projects* (see Section 1.3).

These organizations tend to have management systems in place to facilitate project management. For example, their financial systems are often specifically designed for accounting, tracking, and reporting on multiple simultaneous projects.

Non-project-based organizations—manufacturing companies, financial service firms, etc.—seldom have management systems designed to support project needs efficiently and effectively. The absence of project-oriented systems usually makes project management more difficult. In some cases, non-project-based organizations will have departments or other sub-units that operate as project-based organizations with systems to match.

Figure 2-6. Organizational Structure Influences on Projects

Project Characteristics	Organization Type	Functional	Matrix			Projectized
			Weak Matrix	Balanced Matrix	Strong Matrix	
Project Manager's Authority		Little or None	Limited	Low to Moderate	Moderate to High	High to Almost Total
Percent of Performing Organization's Personnel Assigned Full-time to Project Work		Virtually None	0–25%	15–60%	50–95%	85–100%
Project Manager's Role		Part-time	Part-time	Full-time	Full-time	Full-time
Common Titles for Project Manager's Role		Project Coordinator/ Project Leader	Project Coordinator/ Project Leader	Project Manager/ Project Officer	Project Manager/ Program Manager	Project Manager/ Program Manager
Project Management Administrative Staff		Part-time	Part-time	Part-time	Full-time	Full-time

The project management team should be acutely aware of how the organization's systems affect the project. For example, if the organization rewards its functional managers for charging staff time to projects, the project management team may need to implement controls to ensure that assigned staff are being used effectively on the project.

2.3.2 Organizational Cultures and Style

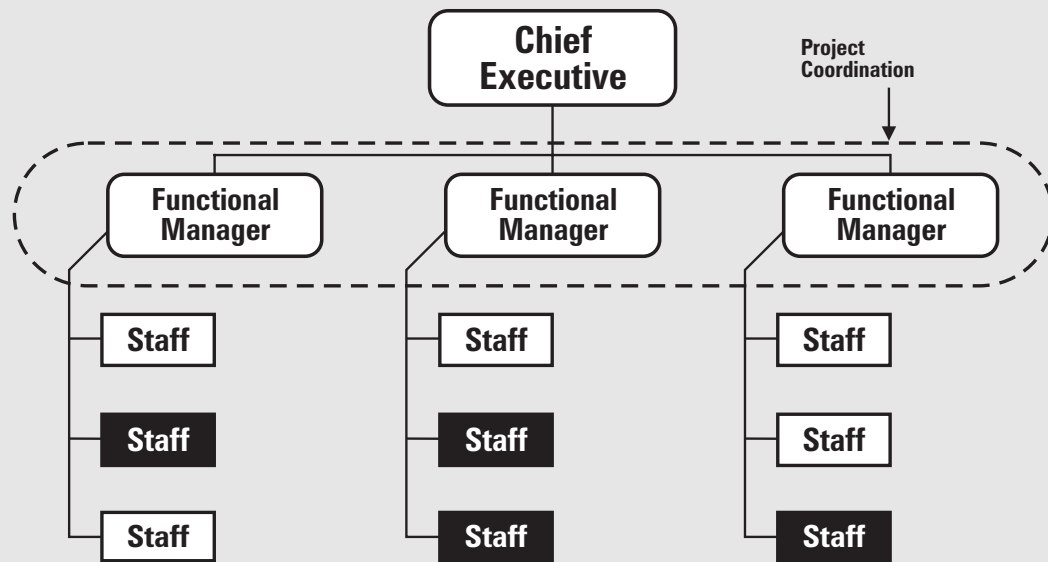
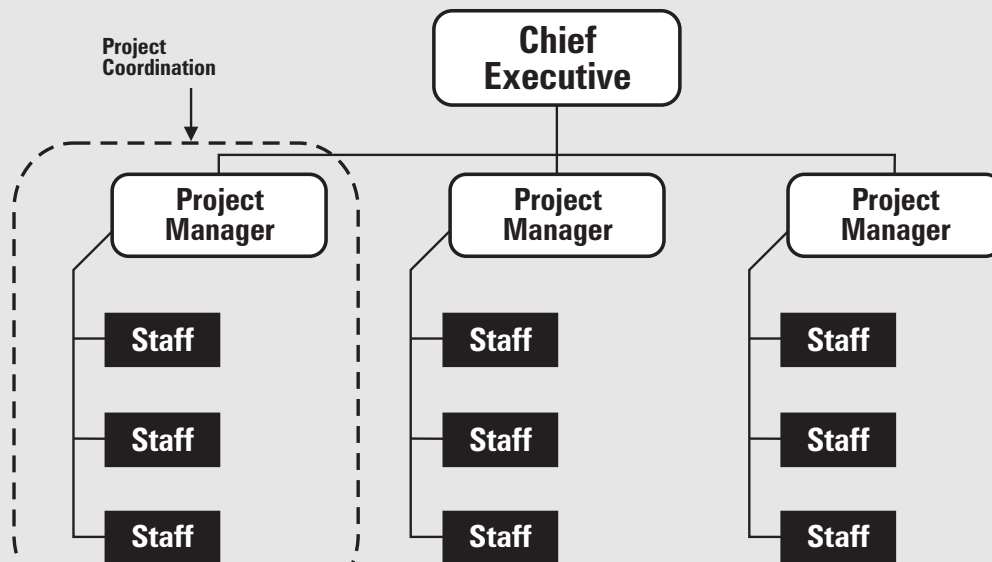
Most organizations have developed unique and describable cultures. These cultures are reflected in their shared values, norms, beliefs, and expectations; in their policies and procedures; in their view of authority relationships; and in numerous other factors. Organizational cultures often have a direct influence on the project. For example:

- A team proposing an unusual or high-risk approach is more likely to secure approval in an aggressive or entrepreneurial organization.
- A project manager with a highly participative style is apt to encounter problems in a rigidly hierarchical organization, while a project manager with an authoritarian style will be equally challenged in a participative organization.

2.3.3 Organizational Structure

The structure of the performing organization often constrains the availability of or terms under which resources become available to the project. Organizational structures can be characterized as spanning a spectrum from *functional* to *projectized*, with a variety of matrix structures in between. **Figure 2-6** details key project-related characteristics of the major types of enterprise organizational structures. Project organization is discussed in Section 9.1, Organizational Planning.

The classic *functional organization* shown in **Figure 2-7** is a hierarchy where each employee has one clear superior. Staff are grouped by specialty, such as production, marketing, engineering, and accounting at the top level, with engineering further subdivided into mechanical and electrical. Functional organizations still have projects, but the perceived scope of the project is limited to the boundaries of

Figure 2-7. Functional Organization**Figure 2-8.** Projectized Organization

the function: the engineering department in a functional organization will do its work independent of the manufacturing or marketing departments. For example, when a new product development is undertaken in a purely functional organization, the design phase is often called a “design project” and includes only engineering department staff. If questions about manufacturing arise, they are passed up the hierarchy to the department head who consults with the head of the manufacturing department. The engineering department head then passes the answer back down the hierarchy to the engineering project manager.

At the opposite end of the spectrum is the *projectized organization* shown in Figure 2–8. In a projectized organization, team members are often collocated. Most of the organization’s resources are involved in project work, and project managers have a great deal of independence and authority. Projectized organizations often have organizational units called departments, but these groups either report directly to the project manager or provide support services to the various projects.

Matrix organizations as shown in Figures 2–9 through 2–11 are a blend of functional and projectized characteristics. Weak matrices maintain many of the characteristics of a functional organization and the project manager role is more that of a coordinator or expeditor than that of a manager. In similar fashion, strong matrices have many of the characteristics of the projectized organization—full-time project managers with considerable authority and full-time project administrative staff.

Most modern organizations involve all these structures at various levels as shown in Figure 2–12. For example, even a fundamentally functional organization may create a special project team to handle a critical project. Such a team may have many of the characteristics of a project in a projectized organization: it may include full-time staff from different functional departments, it may develop its own set of operating procedures, and it may operate outside the standard, formalized reporting structure.

2.4 KEY GENERAL MANAGEMENT SKILLS

General management is a broad subject dealing with every aspect of managing an ongoing enterprise. Among other topics, it includes:

- Finance and accounting, sales and marketing, research and development, manufacturing and distribution.
- Strategic planning, tactical planning, and operational planning.
- Organizational structures, organizational behavior, personnel administration, compensation, benefits, and career paths.
- Managing work relationships through motivation, delegation, supervision, team building, conflict management, and other techniques.
- Managing oneself through personal time management, stress management, and other techniques.

General management skills provide much of the foundation for building project management skills. They are often essential for the project manager. On any given project, skill in any number of general management areas may be required. This section describes key general management skills that are *highly likely to affect most projects* and that are not covered elsewhere. These skills are well documented in the general management literature and their application is fundamentally the same on a project.

There are also many general management skills that are relevant only on certain projects or in certain application areas. For example, team member safety is critical on virtually all construction projects and of little concern on most software development projects.

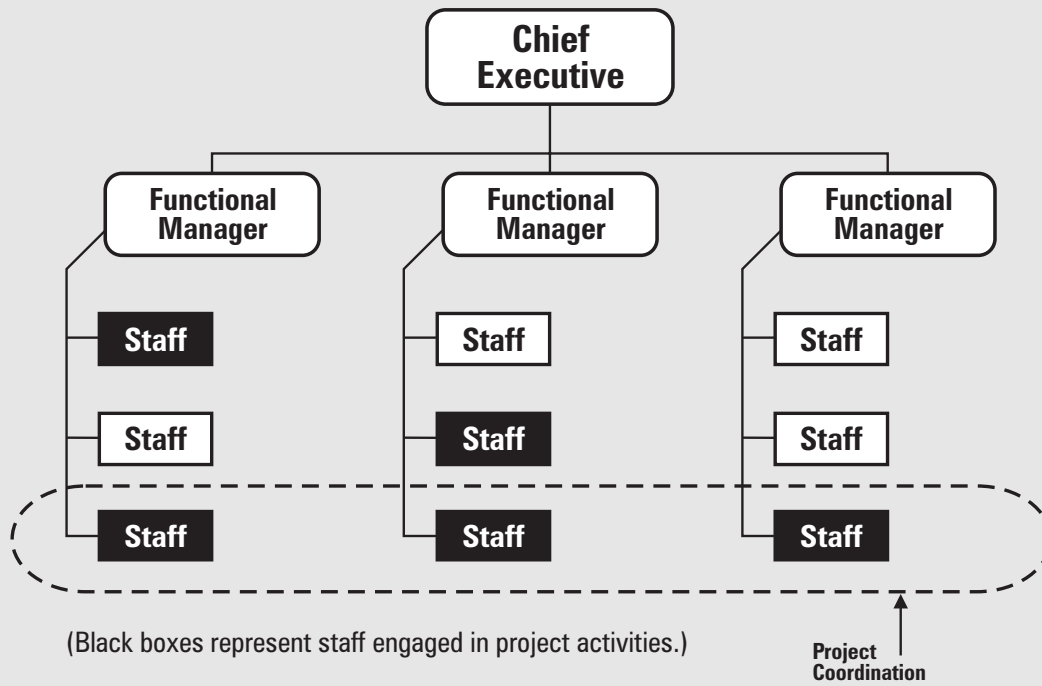
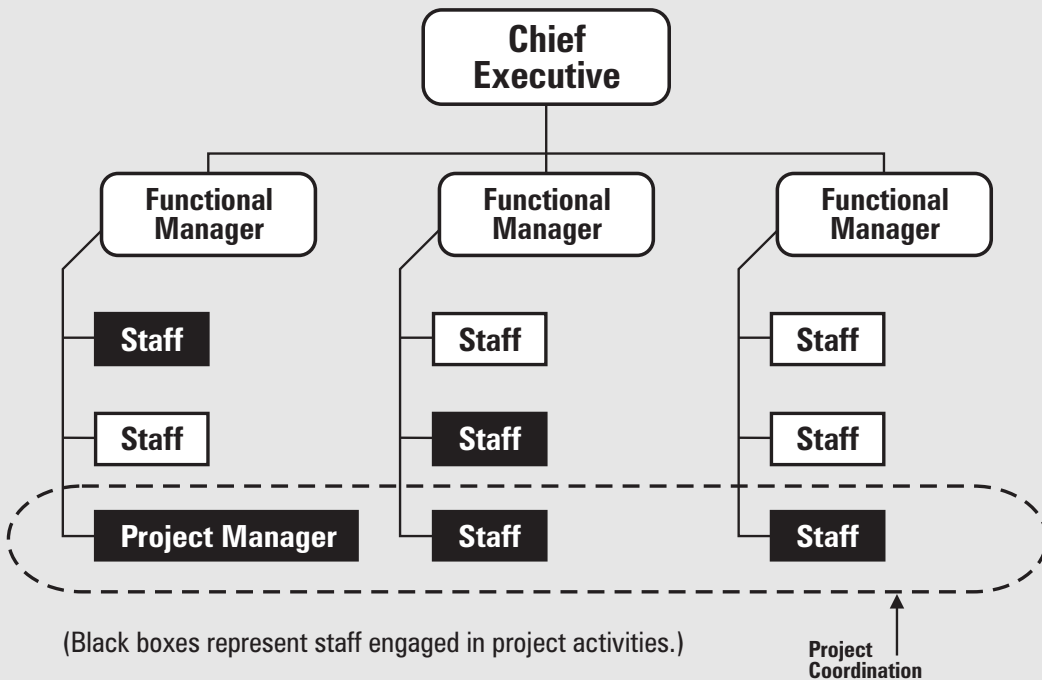
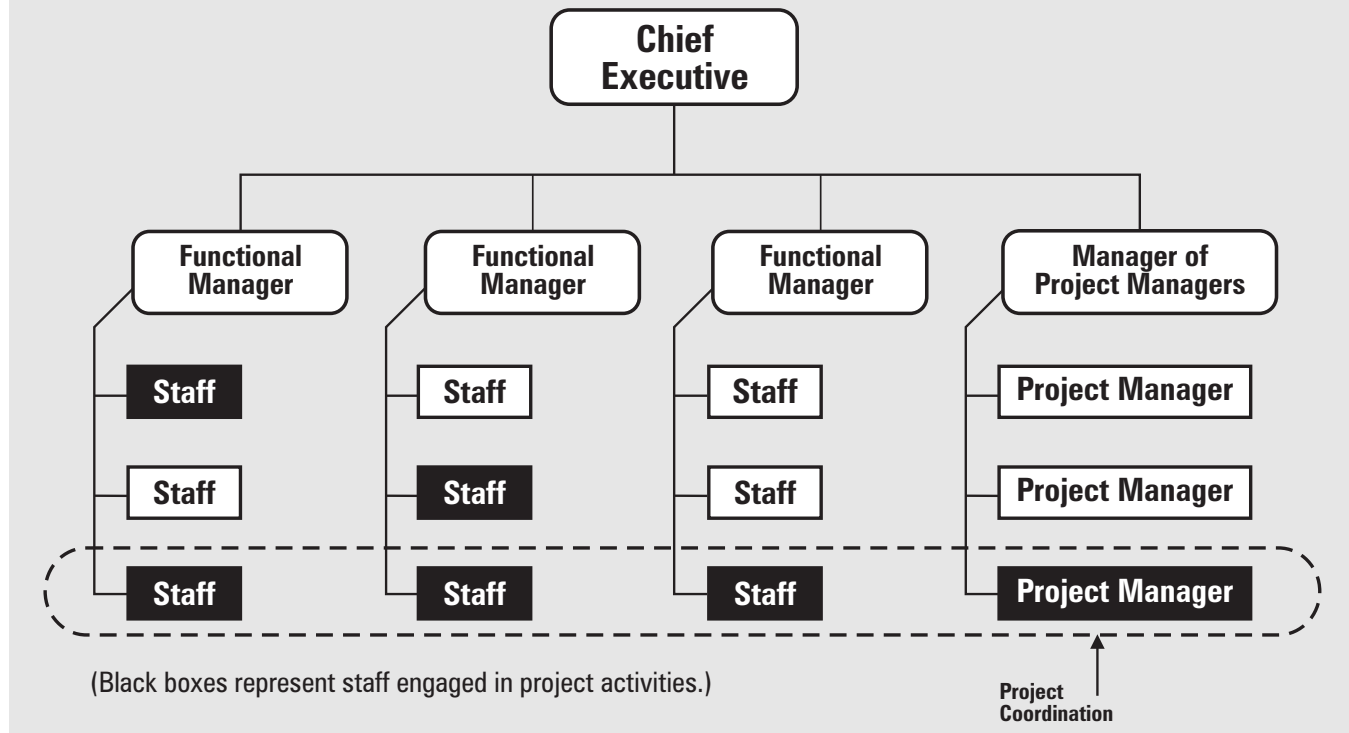
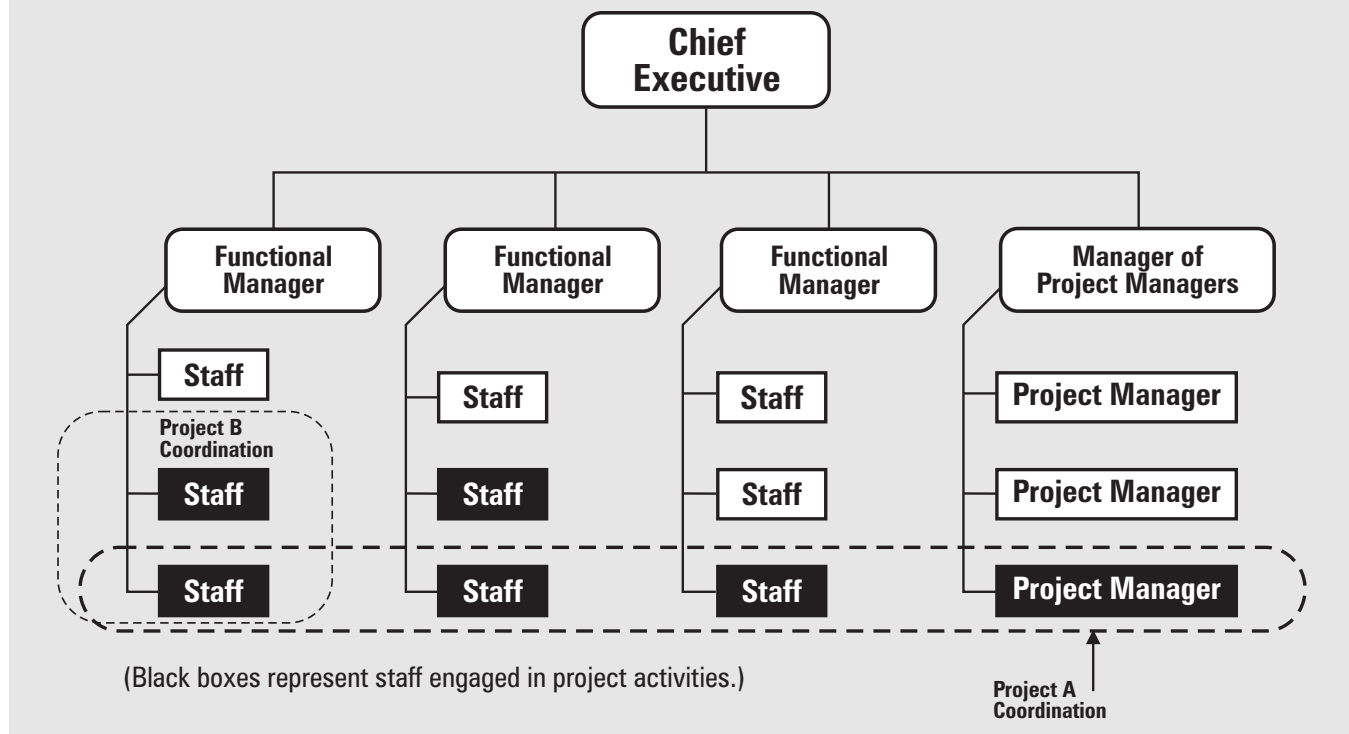
Figure 2-9. Weak Matrix Organization**Figure 2-10.** Balanced Matrix Organization

Figure 2-11. Strong Matrix Organization**Figure 2-12. Composite Organization**

2.4.1 Leading

Kotter [4] distinguishes between *leading* and *managing* while emphasizing the need for both: one without the other is likely to produce poor results. He says that managing is primarily concerned with “consistently producing key results expected by stakeholders,” while leading involves:

- Establishing direction—developing both a vision of the future and strategies for producing the changes needed to achieve that vision.
- Aligning people—communicating the vision by words and deeds to all those whose cooperation may be needed to achieve the vision.
- Motivating and inspiring—helping people energize themselves to overcome political, bureaucratic, and resource barriers to change.

On a project, particularly a larger project, the project manager is generally expected to be the project’s leader as well. Leadership is not, however, limited to the project manager: it may be demonstrated by many different individuals at many different times during the project. Leadership must be demonstrated at all levels of the project (project leadership, technical leadership, team leadership).

2.4.2 Communicating

Communicating involves the exchange of information. The sender is responsible for making the information clear, unambiguous, and complete so that the receiver can receive it correctly. The receiver is responsible for making sure that the information is received in its entirety and understood correctly. Communicating has many dimensions:

- Written and oral, listening and speaking.
- Internal (within the project) and external (to the customer, the media, the public, etc.).
- Formal (reports, briefings, etc.) and informal (memos, ad hoc conversations, etc.).
- Vertical (up and down the organization) and horizontal (with peers).

The general management skill of communicating is related to, but not the same as, Project Communications Management (described in Chapter 10). Communicating is the broader subject and involves a substantial body of knowledge that is not unique to the project context, for example:

- Sender-receiver models—feedback loops, barriers to communications, etc.
- Choice of media—when to communicate in writing, when to communicate orally, when to write an informal memo, when to write a formal report, etc.
- Writing style—active vs. passive voice, sentence structure, word choice, etc.
- Presentation techniques—body language, design of visual aids, etc.
- Meeting management techniques—preparing an agenda, dealing with conflict, etc.

Project Communications Management is the application of these broad concepts to the specific needs of a project; for example, deciding how, when, in what form, and to whom to report project performance.

2.4.3 Negotiating

Negotiating involves conferring with others in order to come to terms or reach an agreement. Agreements may be negotiated directly or with assistance; mediation and arbitration are two types of assisted negotiation.

Negotiations occur around many issues, at many times, and at many levels of the project. During the course of a typical project, project staff are likely to negotiate for any or all of the following:

- Scope, cost, and schedule objectives.
- Changes to scope, cost, or schedule.
- Contract terms and conditions.
- Assignments.
- Resources.

2.4.4 Problem Solving

Problem solving involves a combination of problem definition and decision making. It is concerned with problems that have already occurred (as opposed to risk management that addresses potential problems).

Problem definition requires distinguishing between causes and symptoms. Problems may be internal (a key employee is reassigned to another project) or external (a permit required to begin work is delayed). Problems may be technical (differences of opinion about the best way to design a product), managerial (a functional group is not producing according to plan), or interpersonal (personality or style clashes).

Decision making includes analyzing the problem to identify viable solutions, and then making a choice from among them. Decisions can be made or obtained (from the customer, from the team, or from a functional manager). Once made, decisions must be implemented. Decisions also have a time element to them—the “right” decision may not be the “best” decision if it is made too early or too late.

2.4.5 Influencing the Organization

Influencing the organization involves the ability to “get things done.” It requires an understanding of both the formal and informal structures of all the organizations involved—the performing organization, the customer, contractors, and numerous others as appropriate. Influencing the organization also requires an understanding of the mechanics of power and politics.

Both power and politics are used here in their positive senses. Pfeffer [5] defines power as “the potential ability to influence behavior, to change the course of events, to overcome resistance, and to get people to do things that they would not otherwise do.” In similar fashion, Eccles [6] says that “politics is about getting collective action from a group of people who may have quite different interests. It is about being willing to use conflict and disorder creatively. The negative sense, of course, derives from the fact that attempts to reconcile these interests result in power struggles and organizational games that can sometimes take on a thoroughly unproductive life of their own.”

2.5 SOCIOECONOMIC INFLUENCES

Like general management, *socioeconomic influences* include a wide range of topics and issues. The project management team must understand that current conditions and trends in this area may have a major effect on their project: a small change here can translate, usually with a time lag, into cataclysmic upheavals in the project itself. Of the many potential socioeconomic influences, several major categories that frequently affect projects are described briefly below.

2.5.1 Standards and Regulations

The International Organization for Standardization (ISO) differentiates between standards and regulations as follows [7]:

- A *standard* is a “document approved by a recognized body, that provides, for common and repeated use, rules, guidelines, or characteristics for products, processes or services with which compliance is not mandatory.” There are numerous standards in use covering everything from thermal stability of hydraulic fluids to the size of computer diskettes.
- A *regulation* is a “document which lays down product, process or service characteristics, including the applicable administrative provisions, with which compliance is mandatory.” Building codes are an example of regulations.

Care must be used in discussing standards and regulations since there is a vast gray area between the two, for example:

- Standards often begin as guidelines that describe a preferred approach, and later, with widespread adoption, become *de facto* regulations (e.g., the use of the Critical Path Method for scheduling major construction projects).
- Compliance may be mandated at different levels (e.g., by a government agency, by the management of the performing organization, or by the project management team).

For many projects, standards and regulations (by whatever definition) are well known and project plans can reflect their effects. In other cases, the influence is unknown or uncertain and must be considered under Project Risk Management.

2.5.2 Internationalization

As more and more organizations engage in work which spans national boundaries, more and more projects span national boundaries as well. In addition to the traditional concerns of scope, cost, time, and quality, the project management team must also consider the effect of time zone differences, national and regional holidays, travel requirements for face-to-face meetings, the logistics of teleconferencing, and often volatile political differences.

2.5.3 Cultural Influences

Culture is the “totality of socially transmitted behavior patterns, arts, beliefs, institutions, and all other products of human work and thought” [8]. Every project must operate within a context of one or more cultural norms. This area of influence includes political, economic, demographic, educational, ethical, ethnic, religious, and other areas of practice, belief, and attitudes that affect the way people and organizations interact.

NOTES

PROJECT MANAGEMENT PROCESSES

3

Project management is an integrative endeavor—an action, or failure to take action, in one area will usually affect other areas. The interactions may be straightforward and well-understood, or they may be subtle and uncertain. For example, a scope change will almost always affect project cost, but it may or may not affect team morale or product quality.

These interactions often require trade-offs among project objectives—performance in one area may be enhanced only by sacrificing performance in another. Successful project management requires actively managing these interactions.

To help in understanding the integrative nature of project management, and to emphasize the importance of integration, this document describes project management in terms of its component processes and their interactions. This chapter provides an introduction to the concept of project management as a number of interlinked processes and thus provides an essential foundation for understanding the process descriptions in Chapters 4 through 12. It includes the following major sections:

- 3.1 Project Processes
- 3.2 Process Groups
- 3.3 Process Interactions
- 3.4 Customizing Process Interactions

3.1 Project Processes

3.2 Process Groups

3.3 Process Interactions

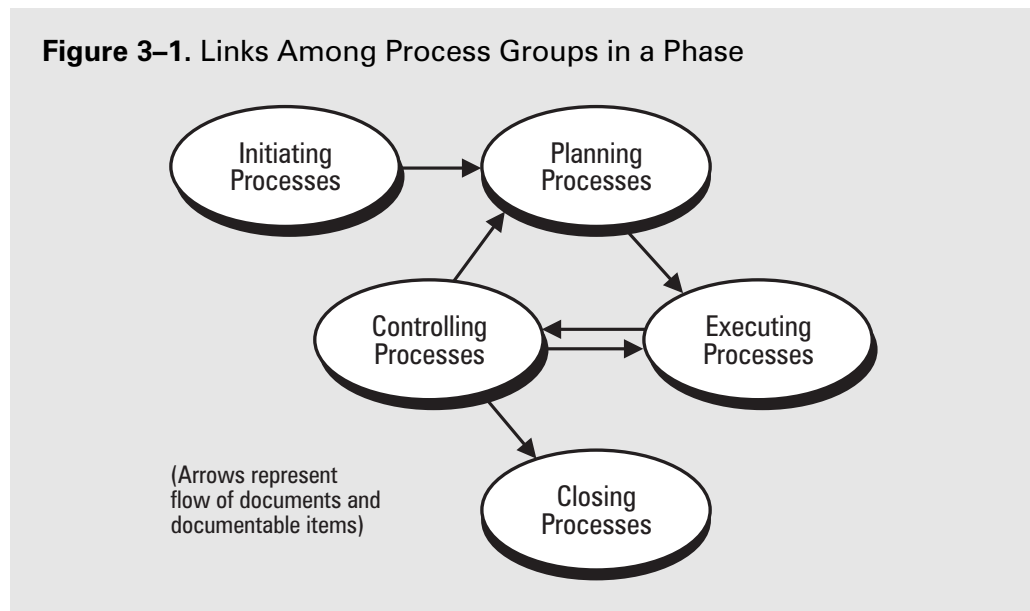
3.4 Customizing Process Interactions

3.1 PROJECT PROCESSES

Projects are composed of processes. A *process* is “a series of actions bringing about a result” [1]. Project processes are performed by people and generally fall into one of two major categories:

- *Project management processes* are concerned with describing and organizing the work of the project. The project management processes that are applicable to most projects, most of the time, are described briefly in this chapter and in detail in Chapters 4 through 12.
- *Product-oriented processes* are concerned with specifying and creating the project product. Product-oriented processes are typically defined by the project life cycle (discussed in Section 2.1) and vary by application area (discussed in Appendix F).

Project management processes and product-oriented processes overlap and interact throughout the project. For example, the scope of the project cannot be defined in the absence of some basic understanding of how to create the product.

Figure 3-1. Links Among Process Groups in a Phase

3.2 PROCESS GROUPS

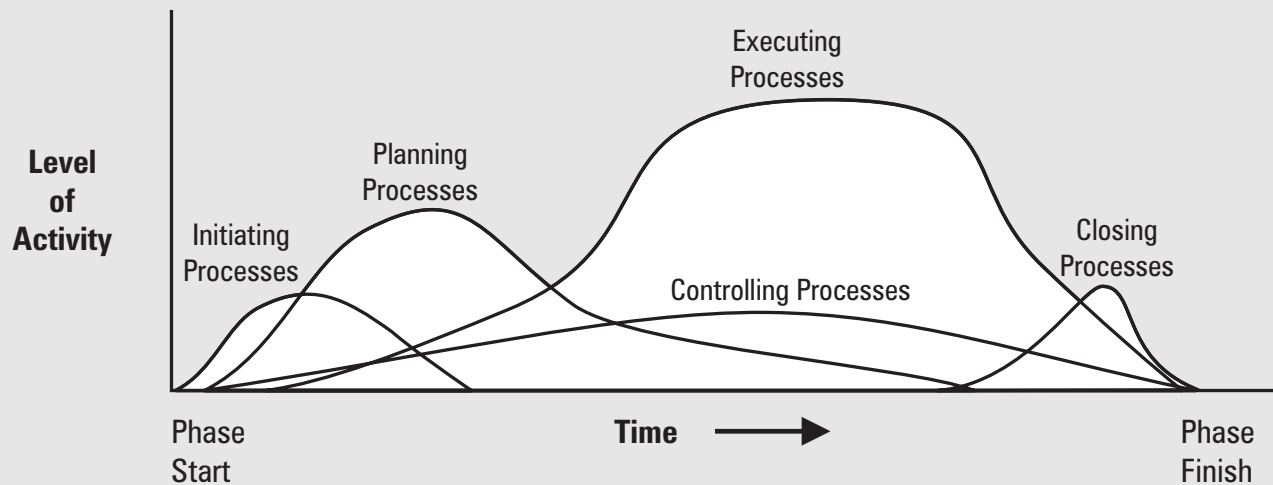
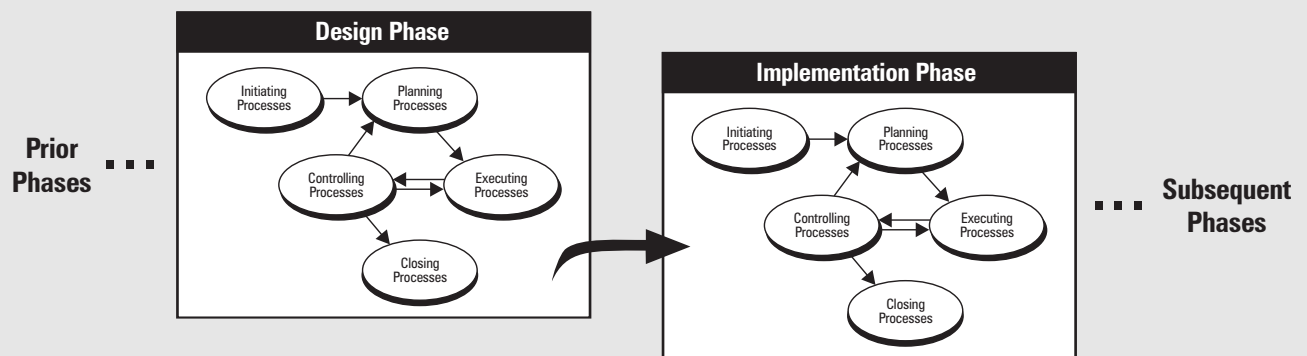
Project management processes can be organized into five groups of one or more processes each:

- Initiating processes—recognizing that a project or phase should begin and committing to do so.
- Planning processes—devising and maintaining a workable scheme to accomplish the business need that the project was undertaken to address.
- Executing processes—coordinating people and other resources to carry out the plan.
- Controlling processes—ensuring that project objectives are met by monitoring and measuring progress and taking corrective action when necessary.
- Closing processes—formalizing acceptance of the project or phase and bringing it to an orderly end.

The process groups are linked by the results they produce—the result or outcome of one becomes an input to another. Among the central process groups, the links are iterated—planning provides executing with a documented project plan early on, and then provides documented updates to the plan as the project progresses. These connections are illustrated in **Figure 3-1**. In addition, the project management process groups are not discrete, one-time events; they are overlapping activities which occur at varying levels of intensity throughout each phase of the project. **Figure 3-2** illustrates how the process groups overlap and vary within a phase.

Finally, the process group interactions also cross phases such that closing one phase provides an input to initiating the next. For example, closing a design phase requires customer acceptance of the design document. Simultaneously, the design document defines the product description for the ensuing implementation phase. This interaction is illustrated in **Figure 3-3**.

Repeating the initiation processes at the start of each phase helps to keep the project focused on the business need it was undertaken to address. It should also help ensure that the project is halted if the business need no longer exists or if the project is unlikely to satisfy that need. Business needs are discussed in more detail in the introduction to Section 5.1, Initiation.

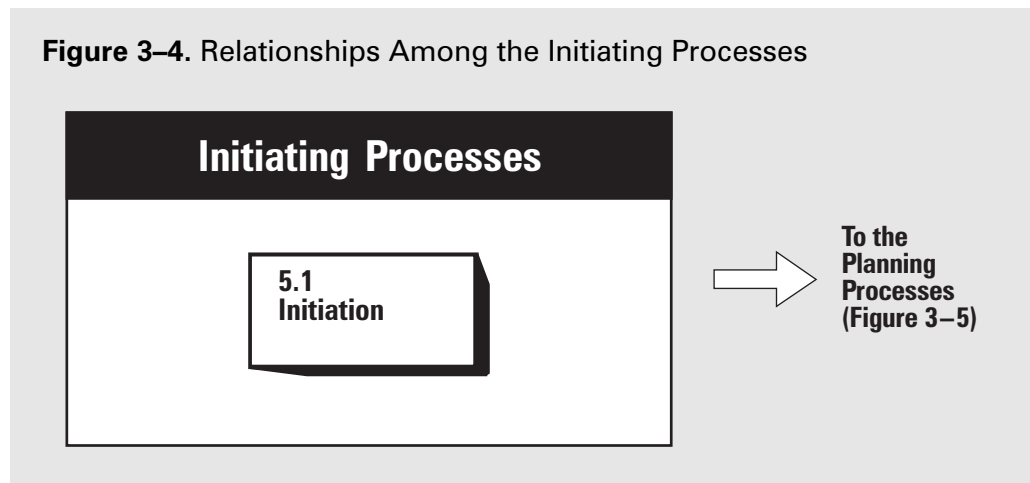
Figure 3–2. Overlap of Process Groups in a Phase**Figure 3–3.** Interaction Between Phases

Although **Figure 3–3** is drawn with discrete phases and discrete processes, in an actual project there will be many overlaps. The planning process, for example, must not only provide details of the work to be done to bring the current phase of the project to successful completion but must also provide some preliminary description of work to be done in later phases. This progressive detailing of the project plan is often called *rolling wave planning*.

3.3 PROCESS INTERACTIONS

Within each process group, the individual processes are linked by their inputs and outputs. By focusing on these links, we can describe each process in terms of its:

- Inputs—documents or documentable items that will be acted upon.
- Tools and techniques—mechanisms applied to the inputs to create the outputs.
- Outputs—documents or documentable items that are a result of the process.

Figure 3–4. Relationships Among the Initiating Processes

The project management processes common to most projects in most application areas are listed here and described in detail in Chapters 4 through 12. The numbers in parentheses after the process names identify the chapter and section where it is described. The process interactions illustrated here are also typical of most projects in most application areas. Section 3.4 discusses customizing both process descriptions and interactions.

3.3.1 Initiating Processes

Figure 3–4 illustrates the single process in this process group.

- Initiation (5.1)—committing the organization to begin the next phase of the project.

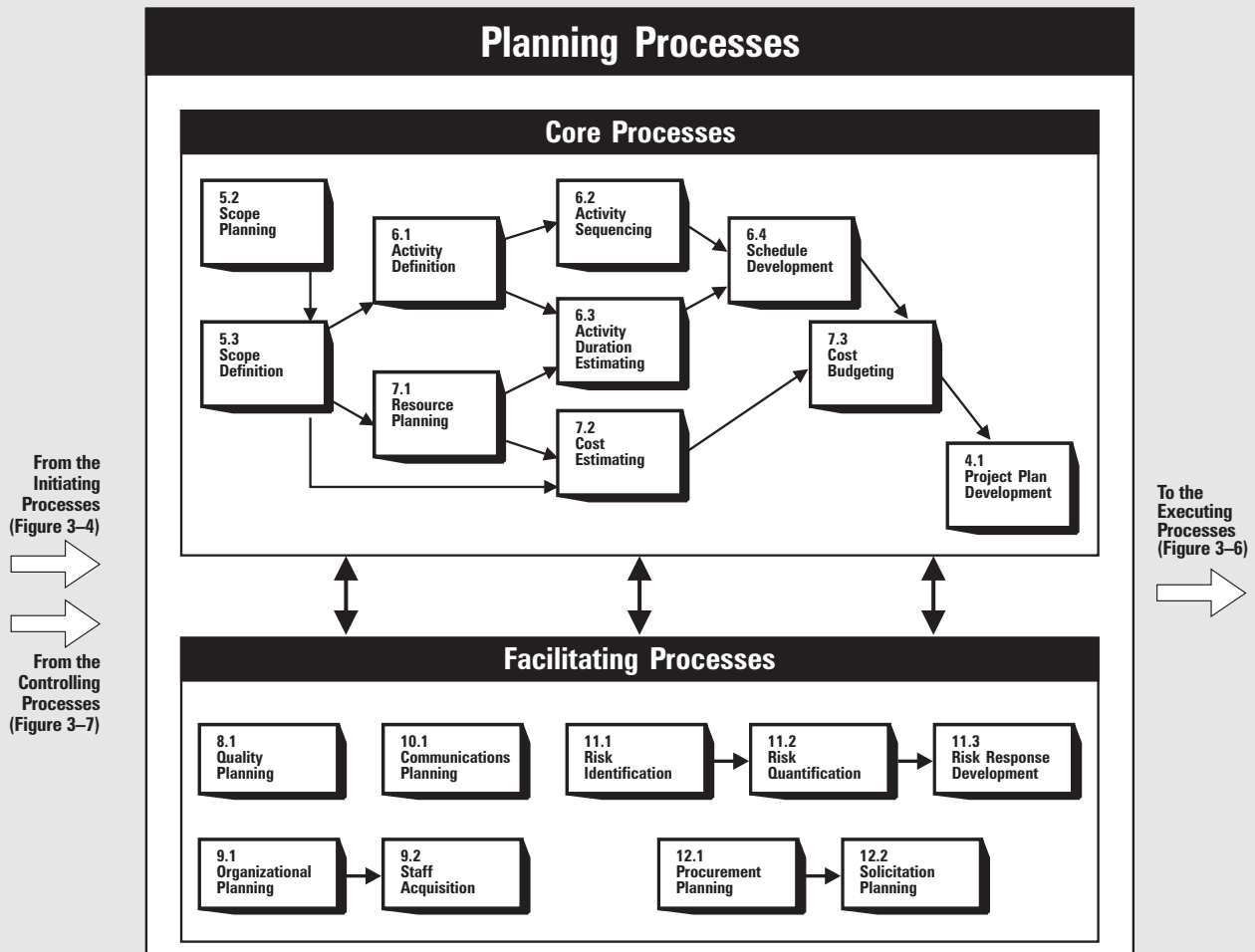
3.3.2 Planning Processes

Planning is of major importance to a project because the project involves doing something which has not been done before. As a result, there are relatively more processes in this section. However, the number of processes does not mean that project management is primarily planning—the amount of planning performed should be commensurate with the scope of the project and the usefulness of the information developed.

The relationships among the project planning processes are shown in Figure 3–5 (this chart is an explosion of the ellipse labeled “planning processes” in Figure 3–1). These processes are subject to frequent iterations prior to completing the plan. For example, if the initial completion date is unacceptable, project resources, cost, or even scope may need to be redefined. In addition, planning is not an exact science—two different teams could generate very different plans for the same project.

Core processes. Some planning processes have clear dependencies that require them to be performed in essentially the same order on most projects. For example, activities must be defined before they can be scheduled or costed. These *core planning processes* may be iterated several times during any one phase of a project. They include:

- Scope Planning (5.2)—developing a written scope statement as the basis for future project decisions.
- Scope Definition (5.3)—subdividing the major project deliverables into smaller, more manageable components.
- Activity Definition (6.1)—identifying the specific activities that must be performed to produce the various project deliverables.

Figure 3-5. Relationships Among the Planning Processes

- Activity Sequencing (6.2)—identifying and documenting interactivity dependencies.
- Activity Duration Estimating (6.3)—estimating the number of work periods which will be needed to complete individual activities.
- Schedule Development (6.4)—analyzing activity sequences, activity durations, and resource requirements to create the project schedule.
- Resource Planning (7.1)—determining what resources (people, equipment, materials) and what quantities of each should be used to perform project activities.
- Cost Estimating (7.2)—developing an approximation (estimate) of the costs of the resources needed to complete project activities.
- Cost Budgeting (7.3)—allocating the overall cost estimate to individual work items.
- Project Plan Development (4.1)—taking the results of other planning processes and putting them into a consistent, coherent document.

Facilitating processes. Interactions among the other planning processes are more dependent on the nature of the project. For example, on some projects there may be little or no identifiable risk until after most of the planning has been done and the team recognizes that the cost and schedule targets are extremely aggressive and thus involve considerable risk. Although these *facilitating processes* are performed intermittently and as needed during project planning, they are not optional. They include:

- Quality Planning (8.1)—identifying which quality standards are relevant to the project and determining how to satisfy them.
- Organizational Planning (9.1)—identifying, documenting, and assigning project roles, responsibilities, and reporting relationships.
- Staff Acquisition (9.2)—getting the human resources needed assigned to and working on the project.
- Communications Planning (10.1)—determining the information and communications needs of the stakeholders: who needs what information, when will they need it, and how will it be given to them.
- Risk Identification (11.1)—determining which risks are likely to affect the project and documenting the characteristics of each.
- Risk Quantification (11.2)—evaluating risks and risk interactions to assess the range of possible project outcomes.
- Risk Response Development (11.3)—defining enhancement steps for opportunities and responses to threats.
- Procurement Planning (12.1)—determining what to procure and when.
- Solicitation Planning (12.2)—documenting product requirements and identifying potential sources.

3.3.3 Executing Processes

The executing processes include core processes and facilitating processes as described in Section 3.3.2, Planning Processes. **Figure 3–6** illustrates how the following processes interact:

- Project Plan Execution (4.2)—carrying out the project plan by performing the activities included therein.
- Scope Verification (5.4)—formalizing acceptance of the project scope.
- Quality Assurance (8.2)—evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards.
- Team Development (9.3)—developing individual and group skills to enhance project performance.
- Information Distribution (10.2)—making needed information available to project stakeholders in a timely manner.
- Solicitation (12.3)—obtaining quotations, bids, offers, or proposals as appropriate.
- Source Selection (12.4)—choosing from among potential sellers.
- Contract Administration (12.5)—managing the relationship with the seller.

3.3.4 Controlling Processes

Project performance must be measured regularly to identify variances from the plan. Variances are fed into the control processes in the various knowledge areas. To the extent that significant variances are observed (i.e., those that jeopardize the project objectives), adjustments to the plan are made by repeating the appropriate project planning processes. For example, a missed activity finish date may require adjustments to the current staffing plan, reliance on overtime, or trade-offs between budget and schedule objectives. Controlling also includes taking preventive action in anticipation of possible problems.