Project Management Institute

Construction

Extension to A Guide to the Project Management Body of Knowledge

PMBOK® Guide — 2000 Edition

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Construction

Extension to A Guide to the Project Management Body of Knowledge (PMBOK® Guide) — 2000 Edition

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Preface

In 2002, PMI published the Government Extension to the *PMBOK® Guide* - 2000 Edition. This fulfilled PMI's intent to supplement the information in *A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*) by providing industry-specific application area extensions. *The Construction Extension to the PMBOK® Guide* is the second such application area extension continuing PMI's intent to provide support to project management practitioners in specific industry areas. This extension is a supplement to the *PMBOK® Guide* - 2000 Edition and should be used in conjunction with the *PMBOK® Guide* - 2000 Edition.

The *PMBOK® Guide* describes the "generally accepted" knowledge and practices applicable to most projects most of the time, upon which there is widespread consensus about their value and usefulness. The Construction Extension to the *PMBOK® Guide* describes knowledge and practices that are "generally accepted" for construction projects most of the time. As an extension to the *PMBOK® Guide*, there are limits on what can be included. These are:

Chapters 1 through 3 (introduction, context, and processes): Specific sections of these chapters describe features that are particular to construction projects; otherwise you use the information in the *PMBOK® Guide* - 2000 Edition because it has equal value for construction projects.

Chapters 4 through 12: Information is presented in one of two forms:

A. Introduction: Describes features of the chapter's subject matter that are particular to construction projects.

B. Level 4 items: Apart from the introductions, changes to Chapters 4 through 12 should be at level 4. (Examples: The first level 4 item in Chapter 4 is 4.1.1.1 "Other Planning Outputs". The last level 4 item in Chapter 12 is 12.6.3.2 "Formal Acceptance and Closure"). For each item:

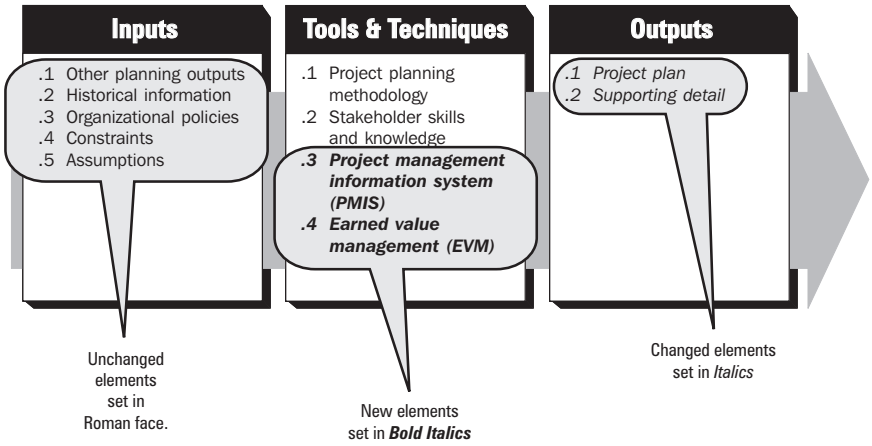
- You may find no change to the information in the *PMBOK® Guide* - 2000 Edition and you will be referred back to the appropriate level 4 section of the *PMBOK® Guide* - 2000 Edition. (If there are no changes to any items below level 2 you will be referred back to the appropriate level 2 of the *PMBOK® Guide* - 2000 Edition rather than going down to each level 4.)
- You may find additional discussion or information about the existing *PMBOK® Guide* - 2000 Edition level 4 item, describing features that are particular to construction projects.
- You may also find new level 4 items that are particular to construction projects that are not found in the *PMBOK® Guide*.
- And finally you may find that a particular level 4 item in the *PMBOK® Guide* - 2000 Edition does not apply to construction projects.

The reader is alerted to these differences by reviewing the Inputs, Tools and Techniques, and Outputs graphic in each section of the Chapters 4-12.

THE *PMBOK® GUIDE* - 2000 Edition Processes-inputs, tools and techniques, and outputs

The *PMBOK® Guide* - 2000 Edition describes the inputs, tools and techniques, and outputs of each project management process in Chapters 4 - 12. For each process it includes a table that lists these elements. This document includes similar tables. In each table, the elements have this format:

- Elements that remain unchanged from the *PMBOK® Guide* - 2000 Edition are shown in plain text.
- New items are shown in ***Bold Italics.***
- Changed elements are shown in *Italics.*



The Construction Extension to the *PMBOK® Guide* also includes Construction Industry unique Knowledge Areas (Chapters 13 - 16) that are not in the *PMBOK® Guide* - 2000 Edition because they do not apply to most projects most of the time. These Construction Industry unique Knowledge Areas are included in Section III.

PMI is currently updating the *PMBOK® Guide* - 2000 Edition and will publish the *PMBOK® Guide* - Third Edition in the Fall of 2004. In 2004, PMI will begin an update project to align this provisional *Construction Extension to the PMBOK® Guide* - 2000 Edition to the *PMBOK® Guide* - Third Edition. *A Construction Extension to the PMBOK® Guide* - Third Edition will be available in 2005.

SECTION I

THE PROJECT MANAGEMENT FRAMEWORK

Chapter 1

Introduction

A Guide to the Project Management Body of Knowledge (*PMBOK® Guide*) - 2000 Edition describes the principles of project management that are generally accepted for all types of projects. Throughout this document, *A Guide to the Project Management Body of Knowledge* will be referred to as the *PMBOK® Guide*. All references are to the 2000 Edition.

This extension is a supplement to the *PMBOK® Guide* - 2000 Edition. It describes the generally accepted principles for construction projects that are not common to all project types. The general organization of knowledge areas and processes found in the *PMBOK® Guide* - 2000 Edition are also used in this extension to ease reference.

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

1.1 PURPOSE OF THIS DOCUMENT

The primary purpose of *A Guide to the Project Management Body of Knowledge is* "to identify and describe that subset of the PMBOK® that is generally accepted."

Appendix E of the *PMBOK® Guide* - 2000 Edition describes application area extensions. It says "Application area extensions are necessary when there are generally accepted knowledge and practices for a category of projects in one application area that are not generally accepted across the full range of project types in most application areas. Application area extensions reflect:

- Unique or unusual aspects of the project environment of which the project management team must be aware in order to manage the project efficiently and effectively.
- Common knowledge and practices that, if followed, will improve the efficiency and effectiveness of the project (e.g., standard work breakdown structures)."

This is an application area extension for construction projects. The key characteristics of these projects are listed in Section 1.2.

1.1.1 Why Is the Construction Extension Needed?

It is true that much of the *PMBOK® Guide* - 2000 Edition is directly applicable to construction projects. In fact, the practices and project management of construction projects were one of the foundations of the original 1987 document, *The Project Management Body of Knowledge.* Since that time, a growing awareness of the values of project management to all kinds of projects and industries has led to a broadening of concepts and an inclusiveness that, because of its more universal nature, does not, in some respects; fully cover present-day project management practices found in the worldwide construction industry. For this reason, while the changes may not be substantial, they are different enough from other industries and applications to warrant an extension.

1.1.2 What Is the Goal of the Construction Extension?

This extension aims to improve the efficiency and effectiveness of the management of construction projects and to include material specifically applicable to construction that is not presently covered in the *PMBOK® Guide* - 2000 Edition.

1.2 WHAT MAKES CONSTRUCTION PROJECTS UNIQUE?

- Construction projects, with the possible exception of residential projects, do not produce a product as such; but rather a facility that will make or house the means to make a product or provide service facilities such as dams, highways and parks.
- They deal with geographical differences and natural events in every case and may have a significant effect on the environment.
- Often, if not usually, they involve a team of hired specialists in design and construction disciplines.
- In today's world they have to involve many stakeholders, particularly, environmental and community groups that many other types of projects do not.
- Construction projects often require large amounts of materials and physical tools to move or modify those materials

1.3 WHAT IS PROJECT MANAGEMENT?

See Section 1.3 of the *PMBOK® Guide* - 2000 Edition. The nine knowledge areas in the *PMBOK® Guide* - 2000 Edition are all applicable to construction projects. However, in this extension, they have been modified to include certain aspects that are particular to the construction industry and to emphasize those activities that are of particular importance in construction. There are additional important knowledge areas for construction projects that may not apply to most other project management activities. They are: Safety Management, Environmental Management, Financial Management and Claim Management. While some aspects of these areas may be found in parts of the nine basic knowledge areas, their importance and universality in construction call for them to be treated as added knowledge areas.

1.3.1 The Project Management Framework

See Section 1.3.1 of the *PMBOK® Guide* - 2000 Edition.

1.3.2 The Project Management Knowledge Areas

See Section 1.3.2 of the *PMBOK® Guide* - 2000 Edition. Four knowledge areas particularly applicable to construction projects have been added:

Chapter 13, **Safety Management**, describes the processes required to assure that the construction project is executed with appropriate care to prevent accidents that cause or have the potential to cause personal injury or property damage.

Chapter 14, **Environmental Management**, describes the processes required to ensure that the impact of the project execution to the surrounding environment will remain within the limits stated in legal permits.

Chapter 15, **Financial Management**, describes the processes to acquire and manage the financial resources for the project and is more concerned with revenue source and analyzing/updating net cash flows for the construction project than is cost management.

Chapter 16, **Claim Management**, describes the processes required to eliminate or prevent construction claims from arising and for the expeditious handling of claims if they do occur.

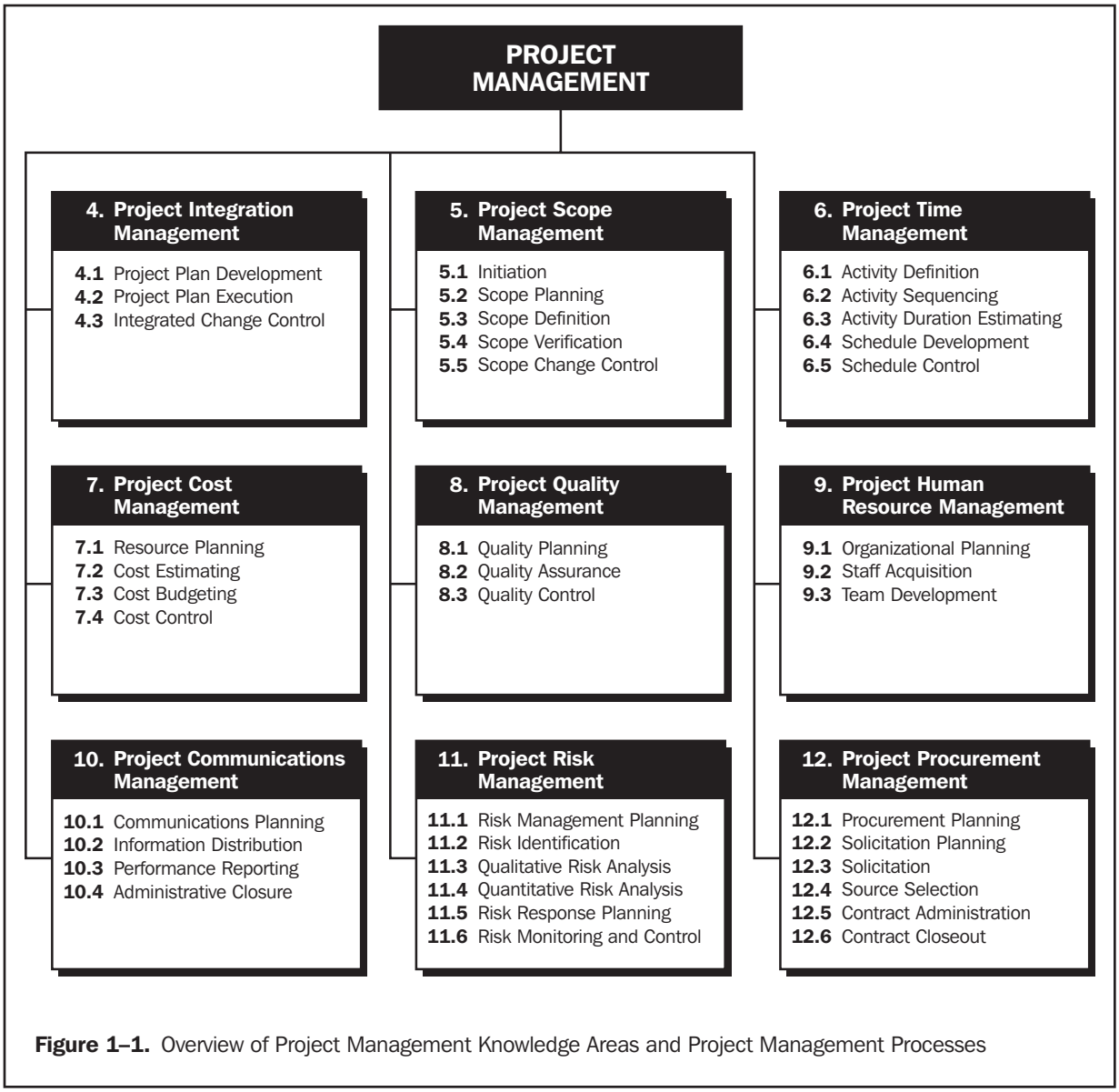


Figure 1–1. Overview of Project Management Knowledge Areas and Project Management Processes

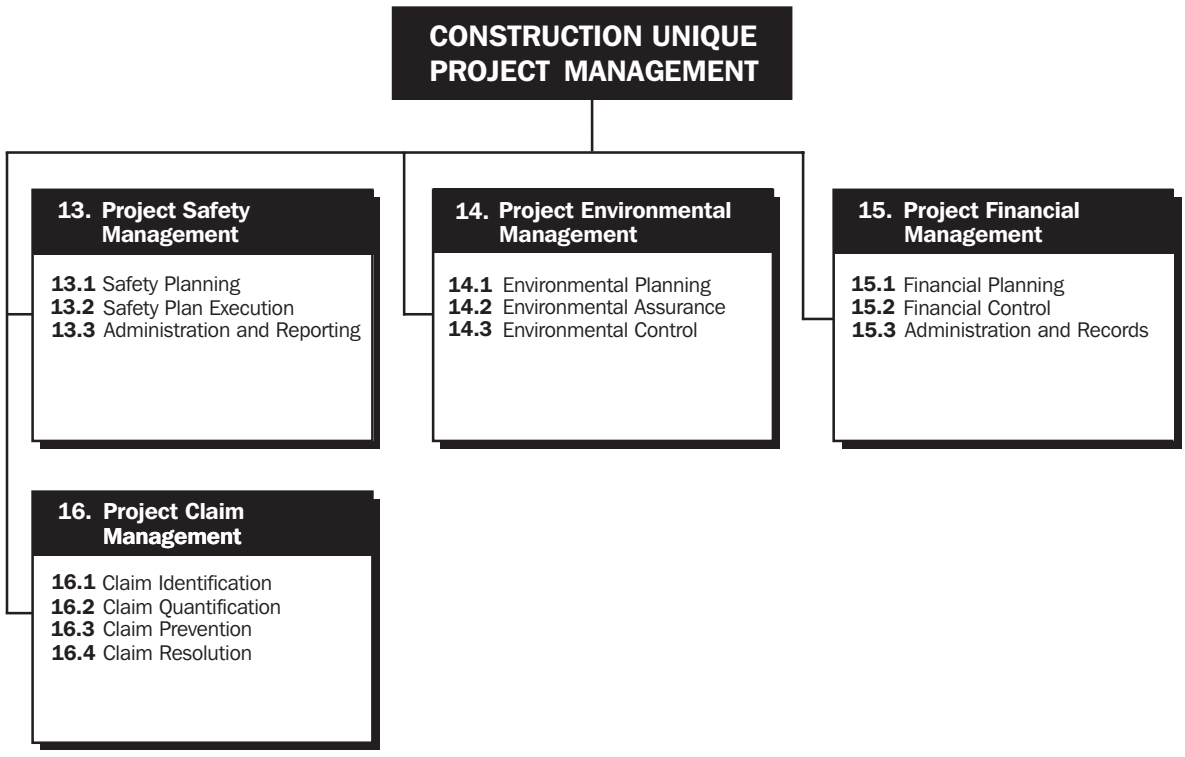


Figure 1–2. Overview of Construction Unique Project Management Knowledge Areas and Project Management Processes

1.4 RELATIONSHIP TO OTHER MANAGEMENT DISCIPLINES

See Section 1.4 of the *PMBOK® Guide* - 2000 Edition.

1.5 RELATED ENDEAVORS - PROGRAMS OF PROJECTS

The *PMBOK® Guide* - 2000 Edition defines a program as "a group of projects managed in a coordinated way to obtain benefits not available from managing them individually." The Government Extension rightly says, "Programs are more common in the government than in the private sector." Still, construction is one of the main activities that governments use to carry out their programs. A current example is the management of the construction of a number of new schools in different geographical areas. By treating these as a program and awarding a contract to one firm (or the same group of firms) for the management of all of the schools, the government is assured of a consistent approach and a single point of responsibility. The private sector may employ the same design and construction team to do several projects. These projects are not usually treated as a program, instead as individual projects done by the same group.

The *PMBOK® Guide* - 2000 Edition definitions of programs, subprojects and portfolio management are also valid in the construction field.

Chapter 2

The Project Management Context

The *PMBOK® Guide* - 2000 Edition advises, "Projects and project management operate in an environment broader than the project itself." Section 1.2 describes some of the unique features of this environment for construction projects. Most of the content of this chapter listed in the five topics in the *PMBOK® Guide* - 2000 Edition is closely applicable to construction projects.

2.1 PROJECT PHASES AND THE PROJECT LIFE CYCLE

The *PMBOK® Guide* - 2000 Edition states "Organizations...will usually divide each project into several project phases..." This technique is particularly important in a construction project where each phase has defined decision points, deliverables or completion milestones which, when observed, provide a smooth flow and improved control over the life of the project.

2.1.1 Three Standard Phases

See Section 2.1.1 of the *PMBOK® Guide* - 2000 Edition.

2.1.2 Characteristics of the Project Life Cycle

This section of the *PMBOK® Guide* - 2000 Edition generally defines the phases or stages for a construction project. The stages are shown in Figure 2-3 of the *PMBOK® Guide* - 2000 Edition. However, there are variations as there are differences in the project delivery system. There are two primary delivery systems: design-bid-build (DBB) and design-build.

In design-bid-build, the owner or owner's agent produces a set of plans and specifications in sufficient detail that all competent contractors will have a good understanding of what is required. A contract is awarded to the lowest cost qualified bidder.

In design-build, the owner or owner's agent produces a partial design and or a set of functional specifications and then hires a contractor to complete the design and construct the resulting project. Much of the design is performed while construction is in progress. Further variations include

build-operate-transfer (BOT), design-build-operate-maintain (DBOM) and other similar combinations.

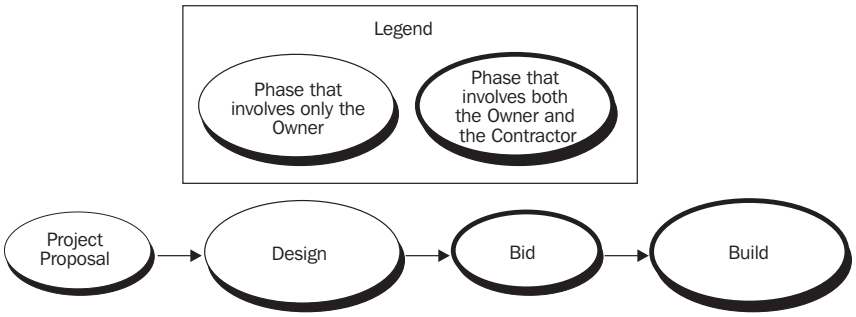


Figure 2–1a. Typical Design-Bid-Build Project Lifecycle

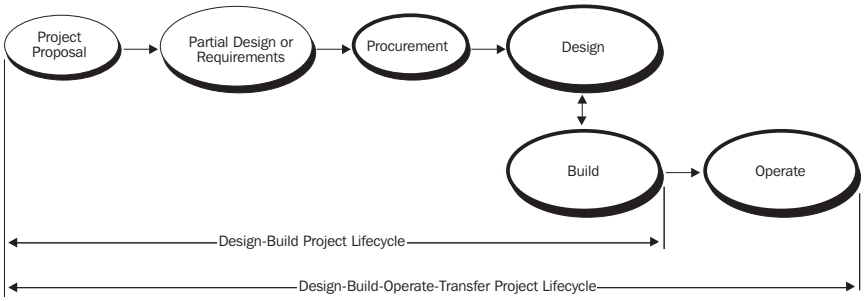


Figure 2–1b. Typical Design-Build and Design-Build-Operate-Transfer Project

In the context of project and construction management however, the portions of the contracted services that extend beyond the completion of the facility itself (i.e., maintenance or operation) are not considered a part of the management of a construction project. So, while such services may be a part of contracted services, and certainly need to be carefully considered, planned and executed, they take place in the field of "operations" and are not included in the body of knowledge related to the management of construction projects.

2.1.3 Representative Project Life Cycles

This section of the *PMBOK® Guide* - 2000 Edition includes a good summary of the stages of a construction project and is depicted in Figure 2-3, Life-Cycle Stages.

When we think of a construction project we are usually referring to a project not performed within a single organization, although those do exist and are construction projects as well; but the more common type of construction project is one performed outside of the initiating organization by a team of specialists.

The construction life cycle typically involves three main players; the owner, the designer and the constructor (contractor). Each plays a major role in a construction project although their responsibilities may vary widely depending on the type of project plan and contract form selected.

Commonly, the owner determines the need for a new facility or improvement and then performs, or has performed, a further study (often called a feasibility study) to more clearly define the viability and form of the project that will produce the best or most profitable result. The study usually involves a review of alternates that may satisfy the need (value management) and the desired form of financing (financial management). The owner may perform this study "in house" if the capability exists; or, more typically, may employ the services of an engineer(s) or an engineer/contractor to do most of the work. While this pre-project activity can utilize some input from a contractor; often it does not. It may be performed by an engineer/contractor firm that possesses both design and construction capability.

The successful completion of the feasibility study marks the first of several transition milestones and probably the most important. This is the starting point of the chosen project by the owner if the project is approved. Sometimes the project is not approved or the feasibility study shows that the chosen project does not meet the financial criteria, and the project is cancelled. It is better to cancel the project at an early stage rather than spend more money on an ultimately failed project.

Most projects can be viewed in five phases, although they are sometimes shortened to four; each one of these phases can be treated like a project in themselves with all of the process groups operating as they do for the overall project. These phases are Concept, Planning (&Development), Detailed Design, Construction, and Start-up and Turnover.

The concept phase is essentially the feasibility study, which ends with its completion and approval of the project. In the planning and development phase, the concept is defined further, the project criteria are established and basic drawings are produced along with a schedule, budget and work plan of how the detailed design, construction and start-up are to be performed. It is customary, and often critical, that the client or owner approve these basic drawings, criteria and work plan, which then become the baseline configuration for the project. In the detailed design phase, all design details are completed and drawings and specifications are issued for construction. This can be done one of two ways;

- the first is the more traditional design-bid-build project delivery method and results in completing all of the design work and then calling for competitive construction bids;
- the second method, called design-build or phased design has design and construction proceeding largely in parallel. This method, although not new, is seeing a current surge in popularity. Design is performed in sequential packages, which are then bid or constructed in the order released. Design-build's main advantage is an earlier completion date.

When construction is complete, the project is ready for final testing and start-up operations followed by turnover to the owner. For major and usually industrial projects, the start-up phase is often done in sequential segments following the process flow and culminates in finally running the plant or project as it was designed.

The critical milestones for construction projects are:

- initial approval of the concept (feasibility study),
- approval of the project criteria (baseline configuration),

- readiness to initiate start-up,
- and contractual completion of the project.

Project success depends a great deal on clearly establishing these milestones and the criteria that define them.

2.2 PROJECT STAKEHOLDERS

The *PMBOK® Guide* - 2000 Edition states "Project stakeholders are individuals and organizations that are actively involved in the project, or whose interests may be ...affected as a result of project execution or project completion; they may also exert influence over the project and its results." The *PMBOK® Guide* - 2000 Edition then lists the following five key stakeholders on every project:

- Project Manager
- Customer
- Performing organization
- Project team members
- Sponsor

However, in addition to the basic five, every construction project involves one additional stakeholder and many involve a second:

Regulatory agencies - Federal, state, local, perhaps international agencies, who issue permits and otherwise control certain aspects of the construction process.

General public - These can be organized groups or simply citizens who are affected by the construction project in the building process or the facility's operation after completion. Such public groups have had increasing influence, particularly in the U.S., in delaying, modifying the scope of or, in some cases, effecting the cancellation of projects. A very important stakeholder in today's world, they need to be included in the analysis of stakeholder needs.

2.3 ORGANIZATIONAL INFLUENCES

See Section 2.3 of the *PMBOK® Guide* - 2000 Edition.

2.3.1 Organizational Systems

See Section 2.3.1 of the *PMBOK® Guide* - 2000 Edition. The *PMBOK® Guide* - 2000 Edition lists two types of organizational categories. This extension deals with those organizational systems that the *PMBOK® Guide* - 2000 Edition says "derive their revenue primarily from performing projects for others..."

2.3.2 Organizational Cultures and Styles

As the *PMBOK® Guide* - 2000 Edition says, " most organizations have developed unique and describable cultures." In construction, cultural importance may be emphasized when the performing organization's (the design and construction entities) culture differs from that of the owner or customer.

This is particularly important to the project when an owner hires the services of an engineer or construction manager to be a part of an integrated project team consisting of employees of the owner and the contractor. Such melding of different cultures needs to be recognized as a constraint to be dealt with for the project to be successful.

2.3.3 Organizational Structure

The *PMBOK® Guide* - 2000 Edition has a good discussion of various types of project organizations but generally more applicable to the owner's or customer's organizations and overall project organizations. Large engineering firms or engineer/constructors will likely utilize a matrix organization, such as shown in Figure 2-11 of the *PMBOK® Guide* - 2000 Edition, while a contractor will be organized more along the lines of a projectized organization (Figure 2-8 of the *PMBOK® Guide* - 2000 Edition). The management of construction is sometimes made difficult when several organizational structures intersect because of the various stakeholders' differing viewpoints and agendas. The challenge is to effectively manage the decision process recognizing these differences.

2.3.4 Project Office

See Section 2.3.4 of the *PMBOK® Guide* - 2000 Edition.

2.3.5 Influencing the Organization

See Section 2.3.5 of the *PMBOK® Guide* - 2000 Edition.

2.4 KEY GENERAL MANAGEMENT SKILLS

All of the general management activities are found in and are a part of managing construction projects.

2.4.1 Leading

The comments in the *PMBOK® Guide* - 2000 Edition relating to the project manager are also applicable to the construction manager who is, in effect, the field project manager.

2.4.2 Communicating

See section 2.4.2 of the *PMBOK® Guide* - 2000 Edition.

2.4.3 Negotiating

See section 2.4.3 of the *PMBOK® Guide* - 2000 Edition.

2.4.4 Problem Solving

See section 2.4.4 of the *PMBOK® Guide* - 2000 Edition. All of the skills described are characteristic of the requirements of managing the construction project, particularly those involved in negotiating and problem solving.

2.5 SOCIO-ECONOMIC INFLUENCES

See Section 2.5 of the *PMBOK® Guide* - 2000 Edition. All of the influences listed in this section are to be found in construction projects. Of particular importance are a sensitivity and responsiveness to environmental and community concerns as well as all mandated regulations. For companies operating outside their home country, understanding international and local rules, customs and cultural differences is particularly important.

Chapter 3

Project Management Processes

Chapter 3 of the *PMBOK® Guide* - 2000 Edition describes five process groups.

- Initiating processes
- Planning processes
- Executing processes
- Controlling processes
- Closing processes.

These groups are also the fundamental groups in the construction project. The *PMBOK® Guide* - 2000 Edition goes on to outline the interaction between and within each group. The description of these linkages is directly applicable to the construction project with only a few additions noted below.

3.3.2 Planning Processes

As one of the facilitating processes the *PMBOK® Guide* - 2000 Edition lists:

- Procurement Planning (12.1) - determining what to procure and when.

In the construction industry determining how to procure the item is just as important as the other two. In most procurement actions there are several options available for purchases or (sub) contracts; fixed price competition, sole source, cost reimbursable, and design-build to name a few. Determining which to use depends on several factors, which are discussed in Chapter 12.

3.3.5 Closing Process

The *PMBOK® Guide* - 2000 Edition shows only two core processes:

12.6 Procurement - contract closeout

10.4 Communication - administrative closure

Closure of the team is often a substantial effort in a construction project; therefore, an additional process has been added:

9.4 Human Resources - team closeout. This is the activity covering the closeout and dissolution of the project team, primarily at the end of the project.

Process Groups / Knowledge Area	Initiating	Planning	Executing	Controlling	Closing
4. Project Integration Management		4.1 Project Plan Development	4.2 Project Plan Execution	4.3 Integrated Change Control	
5. Project Scope Management	5.1 Initiation	5.2 Scope Planning 5.3 Scope Definition		5.4 Scope Verification 5.5 Scope Change Control	
6. Project Time Management		6.1 Activity Definition 6.2 Activity Sequencing 6.3 Activity Duration Estimating 6.4 Schedule Development	6.6 Activity Weights Definition	6.5 Schedule Control 6.7 Progress Curves Development 6.8 Progress Monitoring	
7. Project Cost Management		7.1 Resource Planning 7.2 Cost Estimating 7.3 Cost Budgeting		7.4 Cost Control	
8. Project Quality Management		8.1 Quality Planning	8.2 Quality Assurance	8.3 Quality Control	
9. Project Human Resource Management		9.1 Organizational Planning 9.2 Staff Acquisition	9.3 Team Development		9.3 Project Completion
10. Project Communications Management		10.1 Communications Planning	10.2 Information Distribution	10.3 Performance Reporting	10.4 Administrative Closure
11. Project Risk Management		11.1 Risk Management Planning 11.2 Risk Identification 11.3 Qualitative Risk Analysis 11.4 Quantitative Risk Analysis 11.5 Risk Response Planning		11.6 Risk Monitoring and Control	
12. Project Procurement Management		12.1 Procurement Planning 12.2 Solicitation	12.3 Solicitation 12.4 Source Selection 12.5 Contract Administration		12.6 Contract Closeout
13. Project Safety Management		13.1 Safety Planning	13.2 Safety Plan Execution		13.3 Administration & Reporting
14. Project Environmental Management		14.1 Environmental Planning	14.2 Environmental Assurance	14.3 Environmental Control	
15. Project Financial Management		15.1 Financial Planning		15.2 Financial Control	15.3 Administration & Records
16. Project Claim Management		16.1 Claim Indentification 16.2 Claim Quantification		16.3 Claim Prevention	16.3 Claim Resolution

Figure 3–1. Mapping of Project Management Processes and Construction Management Processes to the Process Groups and Knowledge Areas

SECTION II

THE PROJECT MANAGEMENT KNOWLEDGE AREAS

4. Project Integration Management
5. Project Scope Management
6. Project Time Management
7. Project Cost Management
8. Project Quality Management
9. Project Human Resource Management
10. Project Communications Management
11. Project Risk Management
12. Project Procurement Management

Chapter 4

Project Integration Management

The *PMBOK® Guide* - 2000 Edition says, "Project Integration Management includes the processes required to ensure that the various elements of the project are properly coordinated. It involves making tradeoffs among competing objectives and alternatives to meet or exceed stakeholder needs and expectations." It goes on to describe "the processes required ensuring that the various elements of the project are properly coordinated" and lists the following three major processes:

4.1 Project Plan Development. Integrating and coordinating all project plans to create a consistent, coherent document.

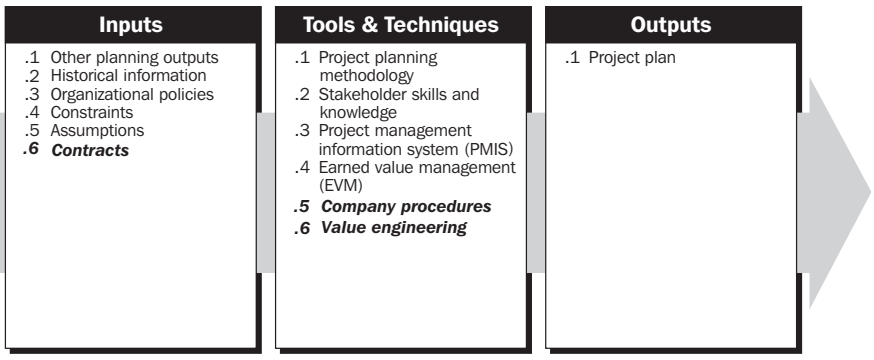
4.2 Project Plan Execution. Carrying out the project plan by performing the activities included therein.

4.3 Integrated Change Control. Coordinating changes across the entire project.

All of these apply to projects in the construction industry with only slight additions or modifications. The need to have all elements integrated and for them to quickly reflect changes in the project plan as it is executed is particularly important in construction.

4.1 PROJECT PLAN DEVELOPMENT

Starting with the importance of the WBS (scope), construction closely follows the project plan development described in this section of the *PMBOK® Guide* - 2000 Edition. Virtually all construction projects are carried out under the terms of a written contract between the owner and the contractor(s). In some cases the contract can be considered an input to Project Plan Development and in others it may be the output. For the purposes of this section it will be considered to be an input. Consequently, the contract for these terms provides an overall constraint or boundary for the development of the project plan and a foundation of a portion of the plan itself, control.



4.1.1 Inputs to Project Plan Development

In addition to the various inputs listed by the *PMBOK® Guide* - 2000 Edition in this section, construction projects may have requirements for operator training or other special requirements called for by the contract.

.1 Other planning inputs. See 4.1.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Historical information. See 4.1.1.2 of the *PMBOK® Guide* - 2000 Edition. Historical information can be and usually is very valuable to construction projects because of the use of many similar repeatable elements.

.3 Organizational policies. See 4.1.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Constraints. See 4.1.1.3 of the *PMBOK® Guide* - 2000 Edition.

.5 Assumptions. The *PMBOK® Guide* - 2000 Edition states, "assumptions are factors that, for planning purposes, are considered to be true, real, or certain." It is vital that assumptions involved in a construction project be outlined in the plan. For example, it may be assumed that there is no competition for labor at the time the project is planned but this may change later with a significant effect on the project. It is particularly important to list assumptions in developing estimates that form the basis for the project's budget. These assumptions and bases of estimates often become the baseline for determining changes to the work.

.6 Contracts. While the *PMBOK® Guide* - 2000 Edition does mention contracts as one of the constraints under .4 above, contracts and their limitations are so important in the construction industry they deserve separate mention. Any project plan must include, if not start with, the ideas and rules dictated by the contract.

4.1.2 Tools and Techniques for Project Plan Development

See section 4.1.2 of the *PMBOK® Guide* - 2000 Edition for a discussion of sub items .1 through .4. Two new items have been added: Company procedures and Value engineering. Value engineering is particularly useful in developing the project plan and scope. United States OMB circular A-131 defines value engineering as "an organized effort directed at analyzing the functions of systems, equipment, facilities, services and supplies for the purpose of achieving the essential functions at the lowest life cycle cost consistent with required, quality, reliability and safety". As such, whether formal or informal, this process can have a major impact on the success of a project.

.5 Company procedures. Many companies, engineer/contractors and contractors, have a standard set of policies and procedures that guide the company's approach to developing a project plan. While it is necessary to develop a distinct plan for each project many of the aspects of this process can make good use of the company's standard procedures.

.6 Value engineering. This process which seeks the "best" or optimal way of accomplishing many of the activities of a project is a useful tool in developing the project plan. While its main use may be in defining the scope (see 5.2.2) it can also be applied to a host of other activities. For example, in a closely-sited industrial plant with restricted access it may ultimately be less costly to use underground conduit runs so roads can be opened for the balance of construction rather than use overhead tray and conduit which can block large equipment access.

4.1.3 Outputs from Project Plan Development

See section 4.1.3 of the *PMBOK® Guide* - 2000 Edition.

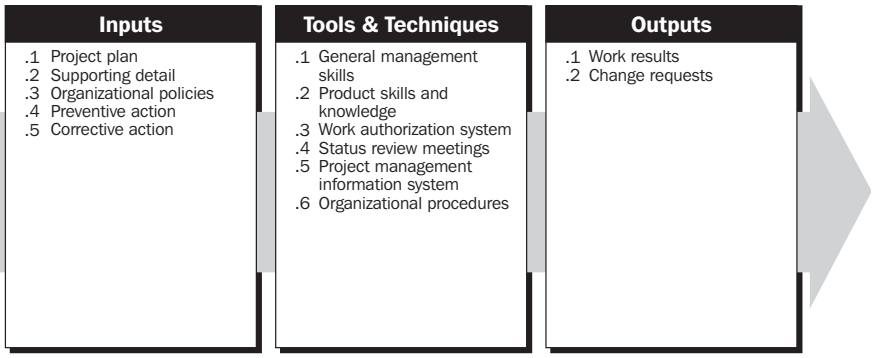
.1 Project plan. The construction process develops a project or work plan that is aligned with all of the content of this section of the *PMBOK® Guide* - 2000 Edition. The plan provides the basis for the total organization and integration of the project effort and serves as the fundamental baseline for execution of the project. Perhaps, most important, it describes how the project will be executed - what delivery system(s) will be utilized, who and what organizations (including the owner) will perform what tasks and what forms of procurement and contracting will be used.

For example, the plan will describe what work will be self-performed and what will be subcontracted, and of the subcontracted work what type of contract will be proposed; they may not all be competitively bid. Procurement of major long-lead material and equipment may be or have been purchased by the owner and later furnished to the contractor. All of these types of decisions and assumptions are an important part of the project work plan. Limits of authority need to be defined in the project plan. The Project and Construction Manager's authority to commit his/her company and/or the owner on behalf of the project must be specified and further upward authority named.

Each contracting entity should have a separate work plan to fit within the constraints of the overall project goals.

4.2 PROJECT PLAN EXECUTION

See the introduction to this section in the *PMBOK® Guide* - 2000 Edition.



4.2.1 Inputs to Project Plan Execution

See section 4.2.1 of the *PMBOK® Guide* - 2000 Edition.

4.2.2 Tools and Techniques for Project Plan Execution

See section 4.2.2 of the *PMBOK® Guide* - 2000 Edition.

4.2.3 Outputs from Project Plan Execution

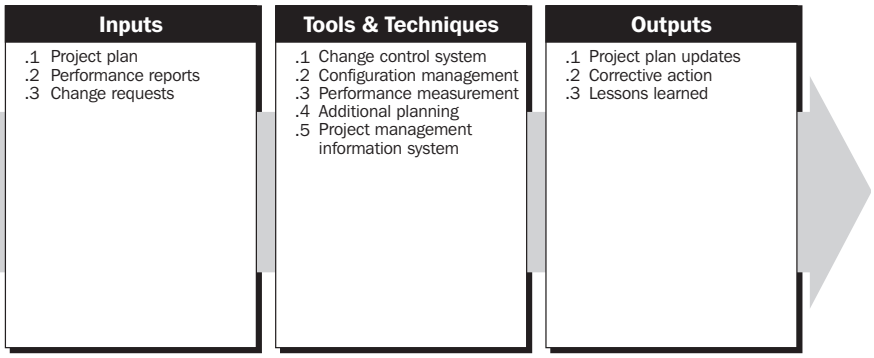
See section 4.2.3 of the *PMBOK® Guide* - 2000 Edition.

4.3 INTEGRATED CHANGE CONTROL

The *PMBOK® Guide* - 2000 Edition says that "Integrated change control is concerned with:

- influencing the factors that create changes to ensure that changes are agreed upon,
- determining that a change has occurred,
- and managing the actual changes when and as they occur."

One of the most important aspects of plan execution in construction is the "control" of changes to the project. Changes may occur for a variety of reasons and from different participating areas of the project. It is the task of Integrated Change Control as described in this section of the *PMBOK® Guide* - 2000 Edition to identify possible changes, review them for their effect on project scope, cost and schedule, see that they are approved or not and that a proper project record is made of the disposition of the change. There are a number of change control and configuration management systems that perform this function, but every construction project must have one that has proven effective. The lack of or a deficient change control system can often produce the most negative effect upon a construction project and the reputation of the contractor performing it.



4.3.1 Inputs to Integrated Change Control

See section 4.3.1 of the *PMBOK® Guide* - 2000 Edition.

4.3.2 Tools and Techniques for Integrated Change Control

.1 Change control system. See the comments above in 4.3.1 and in this section of the *PMBOK® Guide* - 2000 Edition. It is usual in construction that ultimate control or approval of changes rests with the owner who approves changes or not and often is the source of changes to the project. Should the owner not approve the change it may result in a claim by the contractor. It is the responsibility of the engineer/contractor to identify changes in a timely manner and advise the owner of their effect upon the quality, cost and time of performance of the project. In larger projects and in some public projects, as stated in the *PMBOK® Guide* - 2000 Edition, there may be a more formal "control board" that performs the analysis and renders the approval or rejection of changes on behalf of the owner. It is vital that changes and their effect be reviewed periodically-usually no less often than monthly. There are different layers of changes on a typical construction project from subcontracts, purchase orders and other agreements which may or may not relate to changes to the project's contracting authority.

.2 Configuration management. See section 4.3.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Performance measurement. See section 4.3.2.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Additional planning. See section 4.3.2.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Project management information system. PMIS is described in Section 4.1.2.3 of the *PMBOK® Guide* - 2000 Edition.

4.3.3 Outputs from Integrated Change Control

.1 Project plan updates. See section 4.3.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Corrective action. Corrective action is described in Section 4.2.1.5 of the *PMBOK® Guide* - 2000 Edition.

.3 Lessons learned. *PMBOK® Guide* - 2000 Edition advises, "lessons learned should be documented so that they become part of the historical database for both this project and other projects of the performing organization."

In some cases, owners who anticipate future requirements will ask that a Final Report of the project be prepared which describes and documents the history of the project including what went well and what did not. In the event that the owner does not want or require such a report, the contractor should prepare the report for its own information and help with future projects of this or other types. Some things that are important when trying to compare project performance include climate effects, labor problems and productivity, and unusual events that had a significant effect but are unlikely to repeat on a typical project. Tools that can be used to gather information for a project history include project de-briefing sessions with the various participating entities, project evaluation forms, and interviews of the principal participants by independent third parties.

Chapter 5

Construction Project Scope Management

The *PMBOK® Guide* - 2000 Edition defines Project Scope Management as "the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully." Chapter 5 of the *PMBOK® Guide* - 2000 Edition describes five processes.

5.1 Initiation
5.2 Scope Planning
5.3 Scope Definition
5.4 Scope Verification
5.5 Scope Change Control

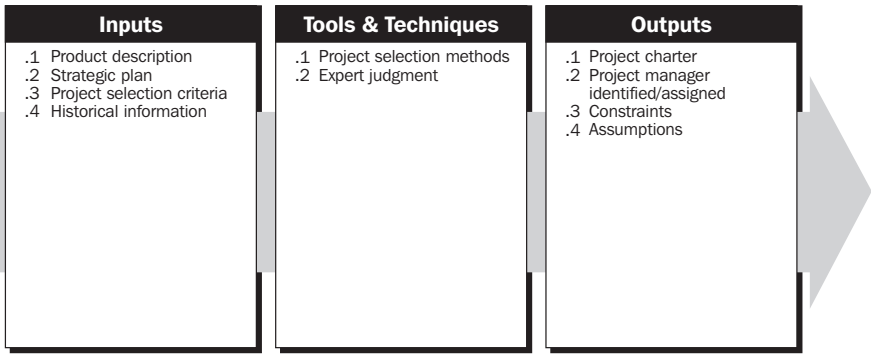
5.1 INITIATION

The *PMBOK® Guide* - 2000 Edition says "Initiation is the process of formally recognizing that a new project exists or that an existing project should continue into its next phase (see Section 2.1 of the *PMBOK® Guide* - 2000 Edition for a more detailed discussion of project phases)." It is important to remember that this process is repeated for each phase.

The *PMBOK® Guide* - 2000 Edition lists typical reasons for initiating a project.

- A market demand
- A business need
- A customer request
- A technological advance
- A legal requirement
- A social need.

Each of these also occurs on construction projects as a reason for initiating construction projects. Construction projects are most often initiated by an owner's need, for example, a new building as a result of an owner's expansion, a new bridge or upgrading a highway as a result of a government decision.



5.1.1 Inputs to Initiation

Section 5.1.1 of the *PMBOK® Guide* - 2000 Edition discusses inputs to Initiation.

.1 Product description. See Section 5.1.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Strategic plan. See Section 5.1.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Project selection criteria. See Section 5.1.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Historical information. See Section 5.1.1.4 of the *PMBOK® Guide* - 2000 Edition.

These are all used on construction projects.

5.1.2 Tools and Techniques for Initiation

Section 5.1.2 of the *PMBOK® Guide* - 2000 Edition defines the tools and techniques as:

.1 Project selection methods. See Section 5.1.2.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Expert judgement. See Section 5.1.2.2 of the *PMBOK® Guide* - 2000 Edition.

These are both used on construction projects.

5.1.3 Outputs from Initiation

Section 5.1.3 of the *PMBOK® Guide* - 2000 Edition discusses outputs from Initiation.

.1 Project charter. See Section 5.1.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Project Manager identified/assigned. See Section 5.1.3.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Constraints. See Section 5.1.3.3 of the *PMBOK® Guide* - 2000 Edition.

The *PMBOK® Guide* - 2000 Edition mentions that contract provisions are considered a restraint. Beside the budget there may also be one or more fixed end dates, all of which are common constraints to construction projects.

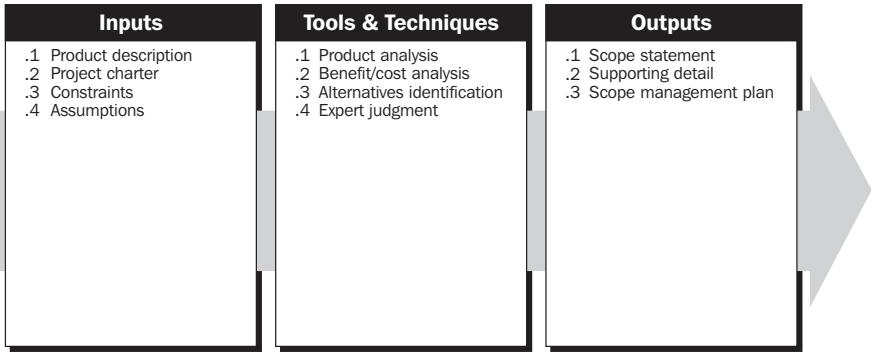
.4 Assumptions. See Section 5.1.3.4 of the *PMBOK® Guide* - 2000 Edition.

These are all produced on construction projects.

5.2 SCOPE PLANNING

The *PMBOK® Guide* - 2000 Edition says, "Scope planning is the process of progressively elaborating and documenting the project work (project scope) that produces the product of the project. Project scope planning starts with the initial inputs of product description, the project charter, and the initial definition of constraints and assumptions."

For a construction project to be successful scope planning should involve all the key players at all levels, the owner, the consultant, the general contractor, sub-contractors and suppliers. Although each will only be involved in their respective areas, success increases with interactive involvement. As mentioned earlier in 4.1.2 value engineering, included here under Product Analysis, can be most useful in scope planning as a tool and technique to obtain an optimal result



5.2.1 Inputs to Scope Planning

Section 5.2.1 of the *PMBOK® Guide* - 2000 Edition discusses inputs to Scope Planning.

.1 Product description. See Section 5.2.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Project charter. See Section 5.2.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Constraints. See Section 5.2.1.3 of the *PMBOK® Guide* - 2000 Edition.

The *PMBOK® Guide* - 2000 Edition refers to section 5.1.3.3 which includes reference to contract provisions. In fact the contract may define a large part of the scope depending in what phase of the construction project it is issued and certainly forms an important part of the input to scope planning.

.4 Assumptions. See Section 5.2.1.4 of the *PMBOK® Guide* - 2000 Edition.

These are all used on construction projects.

5.2.2 Tools and Techniques for Scope Planning

Section 5.2.2 of the *PMBOK® Guide* - 2000 Edition defines the tools and techniques as:

.1 Product analysis. During the development of the facility (product) value engineering can be used to review several options for design, ways of accomplishing work and reviewing alternates to achieve the essential functions of the facility at the lowest life cycle cost consistent with other important parameters (see Section 4.1.2 in this Extension and .3 below).

.2 Benefit/cost analysis. See Section 5.2.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Alternatives identification. One of the major uses of value engineering is to examine the alternate ways of providing the functions of a facility and provide a means for determining which of them furnish the optimum result. Under the formal system of value engineering a team of engineers may also review such things as; improving productivity, simplifying work, conserve energy and water and re-evaluate service contracts. SAVE International is an organization dedicated to the application and standardization of the value engineering process and can provide a wealth of information on the subject. Sometimes contractors may furnish better and lower cost ways of accomplishing work if they are allowed to submit alternate bids. This is discussed further in Chapter 12.

.4 Expert judgement. See Section 5.2.2.4 of the *PMBOK® Guide* - 2000 Edition.

These are all used on construction projects.

5.2.3 Outputs from Scope Planning

Section 5.2.3 of the *PMBOK® Guide* - 2000 Edition discusses outputs from Scope Planning.

.1 Scope statement. See Section 5.2.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Supporting detail. See Section 5.2.3.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Scope management plan. See Section 5.2.3.3 of the *PMBOK® Guide* - 2000 Edition.

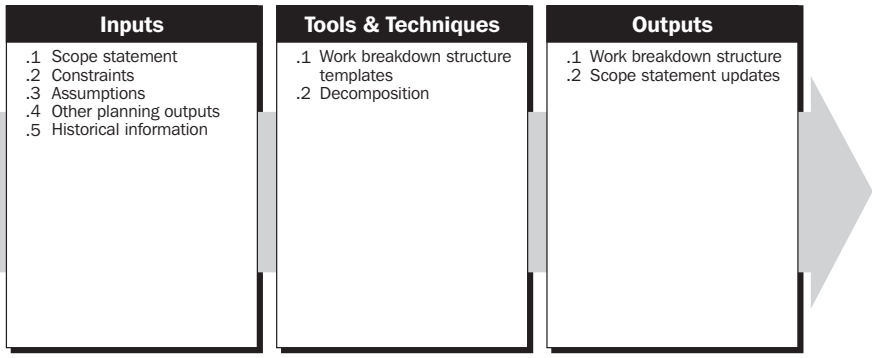
These are all produced on construction projects.

5.3 SCOPE DEFINITION

The *PMBOK® Guide* - 2000 Edition says "Scope definition involves subdividing the major project deliverables (as identified in the scope statement as defined in Section 5.2.3.1) into smaller, more manageable components to:

- Improve the accuracy of cost, duration, and resource estimates.
- Define a baseline for performance measurement and control.
- Facilitate clear responsibility assignments.

Proper scope definition is critical to project success. "When there is poor scope definition, final project costs can be expected to be higher because of the inevitable changes which disrupt project rhythm, cause rework, increase project time, and lower the productivity and morale of the workforce."



5.3.1 Inputs to Scope Definition

Section 5.3.1 of the *PMBOK® Guide* - 2000 Edition discusses inputs to Scope Definition.

.1 Scope statement. Since virtually all construction projects are performed under some form of contract it is important to stress clarity of the contract language to avoid or minimize errors in interpretation and misunderstandings.

.2 Constraints. See Section 5.3.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Assumptions See also 4.1.1.5

.4 Other planning outputs. See Section 5.3.1.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Historical information. See Section 5.3.1.5 of the *PMBOK® Guide* - 2000 Edition.

These are all used on construction projects.

5.3.2 Tools and Techniques for Scope Definition

Section 5.3.2 of the *PMBOK® Guide* - 2000 Edition defines the tools and techniques as:

.1 Work breakdown structure templates. See Section 5.3.2.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Decomposition. Some tasks may have to be tailored to meet the specific needs of the owner or prime contractor.

These are all used on construction projects.

5.3.3 Outputs from Scope Definition

Section 5.3.3 of the *PMBOK® Guide* - 2000 Edition discusses outputs from Scope Definition.

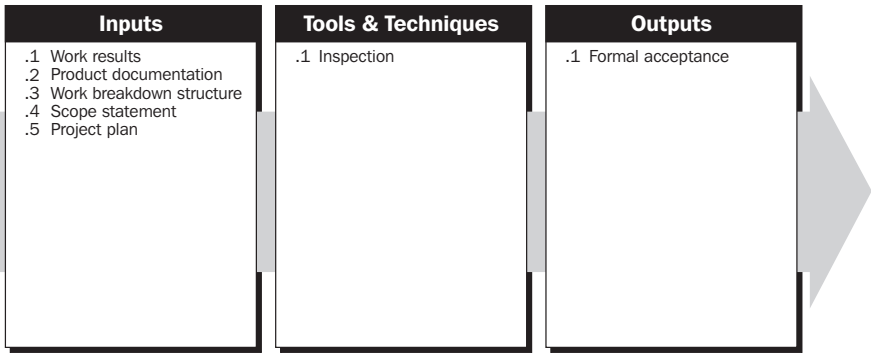
.1 Work breakdown structure. See Section 5.3.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Scope statement updates. See Section 5.3.3.2 of the *PMBOK® Guide* - 2000 Edition.

These are all produced on construction projects.

5.4 SCOPE VERIFICATION

The *PMBOK® Guide* - 2000 Edition says, "Scope verification is the process of obtaining formal acceptance of the project scope by the stakeholders (sponsor, client, customer, etc.). It requires reviewing deliverables and work results to ensure that all were completed correctly and satisfactorily." While this definition is aimed at the ultimate acceptance of the work by the owner or authorizing party, construction projects are conducted in clearly defined phases and there are other verification steps along the way that are required. The first is at the end of the concept phase when the project is approved. The contractor may or may not be involved in this process but it results in a preliminary scope and most likely a contract generally outlining what is to be constructed. The next phase is a definition phase when sufficient plans and specifications have been developed to provide a baseline criteria, budget and schedule. The final phase is described by this section of the *PMBOK® Guide* - 2000 Edition the acceptance of the project as being properly completed in accordance with the contract. Completion of each of these steps should be marked by a formal verification process before proceeding to the next step. The processes listed in this section can be used to obtain this verification also.



5.4.1 Inputs to Scope Verification

Section 5.4.1 of the *PMBOK® Guide* - 2000 Edition discusses inputs to Scope Verification.

.1 Work results. See Section 5.4.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Product documentation. See Section 5.4.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Work breakdown structure. See Section 5.4.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Scope statement. See Section 5.4.1.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Project plan. See Section 5.4.1.5 of the *PMBOK® Guide* - 2000 Edition.

These are all used on construction projects.

5.4.2 Tools and Techniques for Scope Verification

Section 5.4.2 of the *PMBOK® Guide* - 2000 Edition defines the tools and techniques as:

.1 Inspection. See Section 5.4.2.1 of the *PMBOK® Guide* - 2000 Edition.

This is used on construction projects.

5.4.3 Outputs from Scope Verification

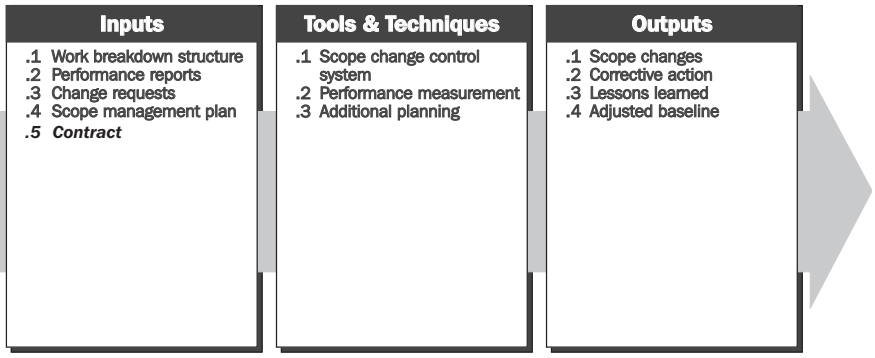
Section 5.4.3 of the *PMBOK® Guide* - 2000 Edition discusses outputs from Scope Verification.

.1 Formal acceptance. See Section 5.4.3.1 of the *PMBOK® Guide* - 2000 Edition.

This is produced on construction projects.

5.5 SCOPE CHANGE CONTROL

The *PMBOK® Guide* - 2000 Edition says, "Scope change control is concerned with a) influencing the factors that create scope changes to ensure that changes are agreed upon, b) determining that a scope change has occurred, and c) managing the actual changes when and if they occur. Scope change control must be thoroughly integrated with the other control processes (schedule control, cost control, quality control, and others, as discussed in Section 4.3)."



5.5.1 Inputs to Scope Change Control

Section 5.5.1 *PMBOK® Guide* - 2000 Edition discusses inputs to Scope Change Control.

.1 Work breakdown structure. See Section 5.5.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Performance reports. In most construction projects, performance, that is whether or not the project is on schedule, and budget does not affect the scope. However, in some cases under a reimbursable contract, a budget overrun might result in a necessary reduction in scope. Similarly, an under run might allow the owner to add features that were not included in the original scope.

.3 Change requests. Not all changes arise as a result of requests. Some changes are required as a result from natural causes such as floods, wind damage and fires.

.4 Scope management plan. See Section 5.5.1.4 of the *PMBOK® Guide* - 2000 Edition.

These are all used on construction projects.

5.5.2 Tools and Techniques for Scope Change Control

Section 5.5.2 of the *PMBOK® Guide* - 2000 Edition defines the tools and techniques as:

.1 Scope change control. See Section 5.5.2.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Performance measurement. See Section 5.5.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Additional planning. See Section 5.5.2.3 of the *PMBOK® Guide* - 2000 Edition.

These are all used on construction projects.

5.5.3 Outputs from Scope Change Control

Section 5.5.3 of the *PMBOK® Guide* - 2000 Edition discusses outputs from Scope Change Control.

.1 Scope changes. See Section 5.5.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Corrective action. See Section 5.5.3.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Lessons learned. See Section 5.5.3.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Adjusted baseline. See Section 5.5.3.4 of the *PMBOK® Guide* - 2000 Edition.

These are all produced on construction projects.

Chapter 6

Project Time Management

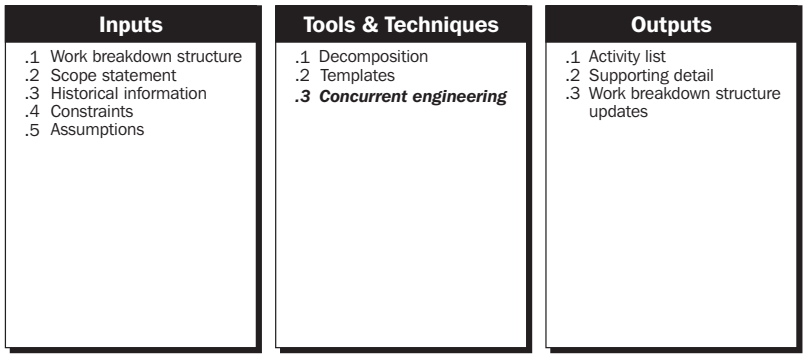
Project time management has evolved from simple roots to the more complex, computer-aided process it is today. The use of CPM and the predominant variation of the precedence diagramming method may tend to overshadow the value of more simple and effective techniques inherent in the bar-charting process (Gantt Charts) for many applications. For simple projects and for fragments of more complex projects, a bar chart may be all that is needed to effectively manage the time process. It is certainly a matter of judgement and must be used carefully to avoid missing important interdependencies. But there is nothing clearer than a bar chart to show what has to be done. In essence, choose the easiest and most effective way of time management to fit the project at hand.

Chapter 6 of the *PMBOK® Guide* - 2000 Edition describes 5 processes:

6.1 Activity Definition.
6.2 Activity Sequencing.
6.3 Activity Duration Estimating.
6.4 Schedule Development.
6.5 Schedule Control. For construction, other processes are also usually required. They are:
6.6 Activity Weights definition. Determining the relative and absolute weights for each project activity.
6.7 Progress curves development. Analyzing activity weights and project schedule to create progress curves.
6.8 Progress monitoring. Monitoring project progress.

6.1 ACTIVITY DEFINITION

Section 6.1 of the *PMBOK® Guide* - 2000 Edition says, "Activity definition involves identifying and documenting the specific activities that must be performed to produce the deliverables and sub deliverables identified in the Work Breakdown Structure (WBS)."



6.1.1 Inputs to Activity Definition

.1 Work breakdown structure. The WBS used in the scheduling process must be consistent with those of the cost and human resource management processes so that integration between schedule, cost, and responsibilities can be achieved (see Section 5.3.3.1 of the *PMBOK® Guide* - 2000 Edition for a more detailed discussion of the WBS).

.2 Scope statement. See Section 6.1.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Historical information. See Section 6.1.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Constraints. In construction projects, contractual milestones are common. They involve specific events which are initially fixed and are considered as constraints.

.5 Assumptions. See Section 6.1.1.5 of the *PMBOK® Guide* - 2000 Edition.

6.1.2 Tools and Techniques for Activity Definition

.1 Decomposition. Care should be given not to break the project elements with too many components in order to avoid having a level of detail that results uncontrollable. The adequate level of detail must be carefully planned for the intent of the schedule.

.2 Templates. See Section 6.1.2.1 of the *PMBOK® Guide* - 2000 Edition.

.3 Concurrent Engineering. This technique is based in constructability analysis and is commonly used in engineering-procurement-construction projects. It involves the mobilization of construction experts in the engineering phase to help engineering specialists decide between design options such as materials, construction techniques, and plant layout arrangements. The goal with this technique is to have the least expensive, fastest, and easiest-to-build design possible that still meets all of the functional requirements (value engineering).

6.1.3 Outputs from Activity Definition

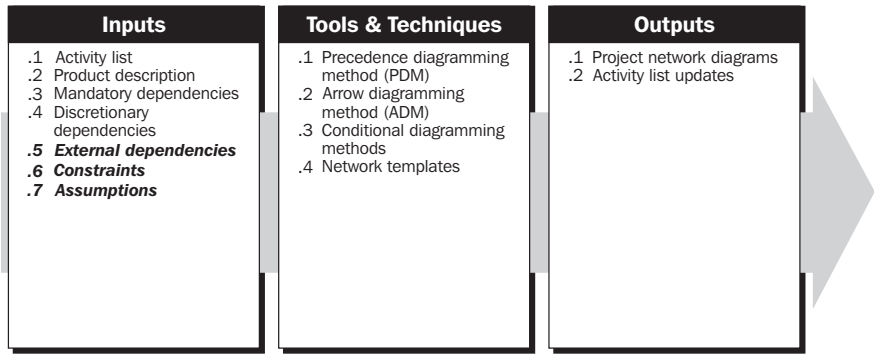
.1 Activity list. See Section 6.1.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Supporting detail. See Section 6.1.3.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Work breakdown structure updates. The update process must include a review of the cost and organizational breakdown structures so that those structures remain integrated throughout the project.

6.2 ACTIVITY SEQUENCING

Section 6.2 of the *PMBOK® Guide* - 2000 Edition says activity sequencing involves identifying and documenting interactivity logical relationships. Assessing those logical relationships is essentially a manual process, while documenting them is usually performed with the aid of a computer.



6.2.1 Inputs to Activity Sequencing

The *PMBOK® Guide* - 2000 Edition lists the following items which are applicable to construction:

.1 Activity list. See Section 6.2.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Product description. See Section 6.2.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Mandatory dependencies. See Section 6.2.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Discretionary dependencies.A particular case of discretionary dependencies are safety dependencies. Some construction sequences have no technical interdependencies but, due to the proximity of the work areas or safety issues, may bring injury risk to the crews. Safety specialists should consider analyzing the schedule or activities list and determine such dependencies.

.5 External Dependencies. See Section 6.2.1.5 of the *PMBOK® Guide* - 2000 Edition.

.6 Constraints. See Section 6.2.1.6 of the *PMBOK® Guide* - 2000 Edition.

.7 Assumptions. See Section 6.2.1.7 of the *PMBOK® Guide* - 2000 Edition.

6.2.2 Tools and Techniques for Activity Sequencing

.1 Precedence diagramming method (PDM).

.2 Arrow diagramming method (ADM). This method, although valid for project networks, is not commonly used.

.3 Conditional diagramming methods. These diagramming techniques are not commonly used.

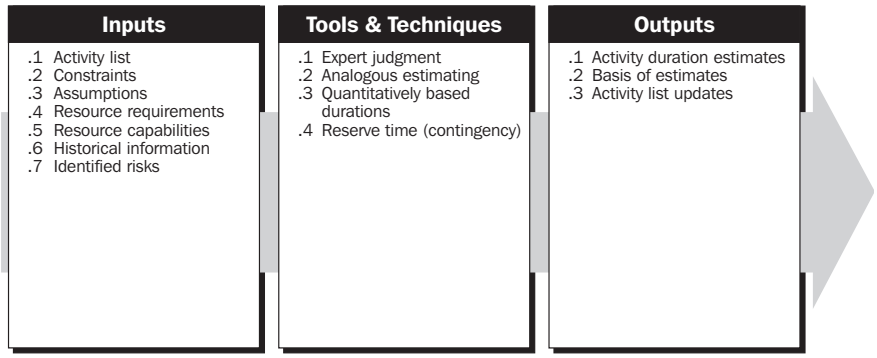
.4 Network templates. See Section 6.2.2.4 of the *PMBOK® Guide* - 2000 Edition.

6.2.3 Outputs from Activity Sequencing

See Section 6.2.3 of the *PMBOK® Guide* - 2000 Edition.

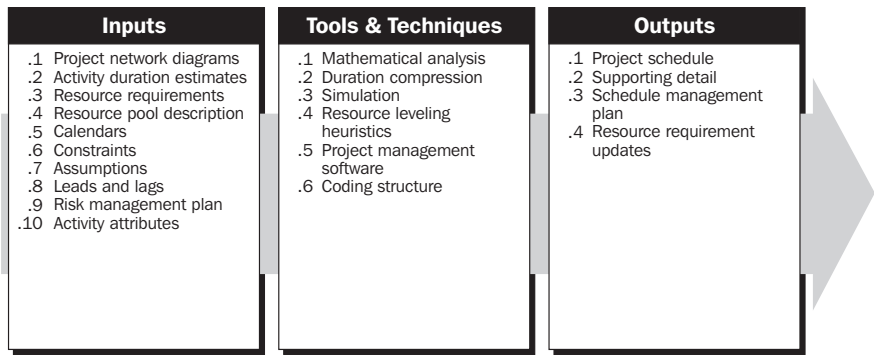
6.3 ACTIVITY DURATION ESTIMATING

See Section 6.3 of the *PMBOK® Guide* - 2000 Edition.



6.4 SCHEDULE DEVELOPMENT

See Section 6.4 of the *PMBOK® Guide* - 2000 Edition.



6.4.1 Inputs to Schedule Development

Section 6.4 of the *PMBOK® Guide* - 2000 Edition describes the following inputs for schedule development:

.1 Project network diagrams. See Section 6.4.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Activity duration estimates. See Section 6.4.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Resource requirements. See Section 6.4.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Resource pool description. See Section 6.4.1.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Calendars. See Section 6.4.1.5 of the *PMBOK® Guide* - 2000 Edition.

.6 Constraints. Under the constraints, Section 6.4 of the *PMBOK® Guide* - 2000 Edition lists:

- Imposed dates
- Key events or major milestones. A key event, which is also an imposed date on most construction contracts, is the project completion date. This is the date when all contract scope should be turned over to the Client and is usually referred to as the Completion Date, Commercial Operation Date, and Provisional Acceptance or similar. A post-delivery date is often defined in terms of a period after that one, and is called the Final Acceptance date. This is the date when the contract is actually closed, remaining for that project a relationship with the Client for warranty aspects only.
- Statutory requirements. Development of the schedule needs to consider any limits and restrictions or other obligations placed on the project by federal, state or local regulations. For example, there may be load limits on road travel during certain times of the year which may restrict delivery of heavy machinery.

.7 Assumptions. See Section 6.4.1.7 of the *PMBOK® Guide* - 2000 Edition.

.8 Leads and lags. See Section 6.4.1.8 of the *PMBOK® Guide* - 2000 Edition.

.9 Risk management plan. See Section 6.4.1.9 of the *PMBOK® Guide* - 2000 Edition.

.10 Activity attributes. While the activities' relative and absolute weights are also attributes, they are treated as part of a separate process under this knowledge area, as they require specific inputs and tools to be produced.

6.4.2 Tools and Techniques for Schedule Development

Section 6.4.2 of the *PMBOK® Guide* - 2000 Edition describes the following tools and techniques for schedule development:

.1 Mathematical analysis. The most widely known mathematical analysis techniques are:

- Critical Path Method (CPM).
- Graphical Evaluation and Review Technique (GERT). This technique is not commonly used in today's construction business.
- Program Evaluation and Review Technique (PERT)-According to the *PMBOK® Guide* - 2000 Edition PERT itself is seldom used today.

.2 Duration compression. The *PMBOK® Guide* - 2000 Edition says, "Duration compression is a special case of mathematical analysis that looks for ways to shorten the project schedule without changing the project scope (e.g., to meet imposed dates or other schedule objectives)." Duration compression includes techniques such as:

- Crashing. In construction projects, a common way to perform crashing is to increase resources and/or work hours. This technique is subject to some constraining factors, such as local working laws or labor union agreements, site conditions of temperature and light, physical state of the workers, safety conditions and others.
- Fast tracking.
- Pre-assembly. A special case of duration compression in construction projects is called pre-assembly. This is an erection technique that consists in joining parts to form bigger sets before installation in the final

field location. Pre-assembling parts allows work to be performed more safely and under a controlled environment, such as a warehouse or fabrication shop, where weather conditions, access, and facilities availability are more suitable. Furthermore, pre-assembly allows on-site resources to perform other tasks and minimizes interference with other activities.

.3 Simulation. See Section 6.4.2.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Resource leveling heuristics. See Section 6.4.2.4of the *PMBOK® Guide* - 2000 Edition.

.5 Project management software. See Section 6.4.2.5 of the *PMBOK® Guide* - 2000 Edition.

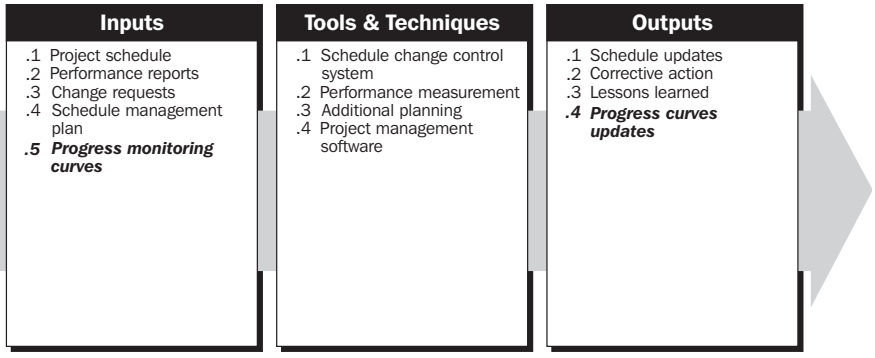
.6 Coding structure. See Section 6.4.2.6 of the *PMBOK® Guide* - 2000 Edition.

6.4.3 Outputs from Schedule Development

See Section 6.4.3 of the *PMBOK® Guide* - 2000 Edition.

6.5 SCHEDULE CONTROL

The *PMBOK® Guide* - 2000 Edition describes the following inputs, tools and techniques, and outputs to schedule control:



6.5.1 Inputs to Schedule Control

.1 Project schedule. See Section 6.5.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Performance reports. See Section 6.5.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Change requests. See Section 6.5.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Schedule management plan. See Section 6.5.1.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Progress monitoring curves. The progress monitoring curves are part of the performance reports. They are described in Section 6.8 of this Extension to the *PMBOK® Guide* - 2000 Edition.

6.5.2 Tools and Techniques for Schedule Control

See Section 6.5.2 of the *PMBOK® Guide* - 2000 Edition.

6.5.3 Outputs from Schedule Control

.1 Schedule updates. See Section 6.5.3.1 of the *PMBOK® Guide* - 2000 Edition.

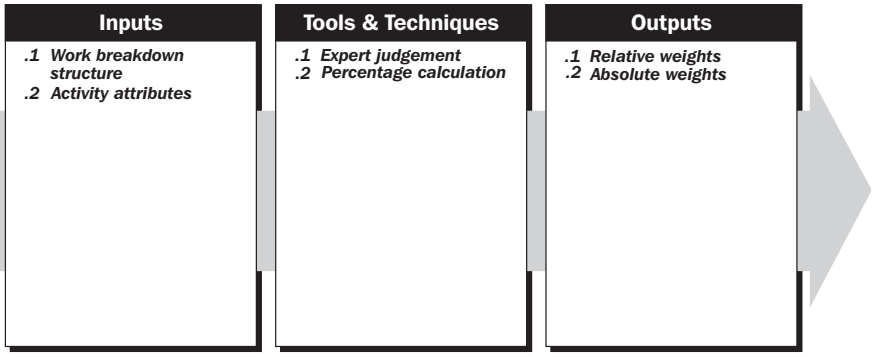
.2 Corrective action. See Section 6.5.3.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Lessons learned. See Section 6.5.3.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Progress Curves updates. A progress curve update is any modification to progress information caused by a modification in the project schedule, the WBS, or both. Appropriate stakeholders must be notified as needed. Progress curves updates may or may not require adjustments to other aspects of the project plan.

6.6 ACTIVITY WEIGHTS DEFINITION

Activity weights definition involves evaluating activities characteristics and attributes in order to assess the contribution of each particular project activity to the overall project progress or to the progress of a given phase or deliverable of the project.



6.6.1 Inputs to Activity Weights Definition

.1 Work Breakdown Structure. The WBS is the primary input to activity definition (see Section 5.3.3.1 of the *PMBOK® Guide* - 2000 Edition for a more detailed discussion of the WBS).

.2 Activity attributes. Activity attributes, in the context of activity weights definition, are any characteristics that are common for a group of activities. Durations, costs, labor hours, and quantities are examples of activity attributes. Other attributes include:

- Duration estimates and the basis of estimates. These estimates show what characteristic of the activity drives its duration. That aspect should be taken into account when determining the activity weights (see Section 6.3.3 of the *PMBOK® Guide* - 2000 Edition for a more detailed discussion on duration estimates).
- Resource requirements and rates. Resource requirements and rates for each activity may be used in conjunction with duration estimates for determining the activity weights (see Chapter 7 of the *PMBOK® Guide* - 2000 Edition for a more detailed discussion of the resource requirements and rates).

6.6.2 Tools and Techniques for Activity Weights Definition

.1 Expert judgement. Specialists can determine which activity attribute should be used for determining activity weights for each level of the WBS. In the first levels of the WBS, the attribute is usually the deliverable cost. When the decomposition level is sufficient to identify another attribute that is common to all activities in that level, the attribute should be used. When decomposition level reaches project activities, there is usually more than one common attribute and expert judgment is used to determine which of them should be used.

.2 Percentage calculation. Based on the attributes used to determine the weight of each project deliverable or activity, a summation of those attributes is made and transformed into a percentage.

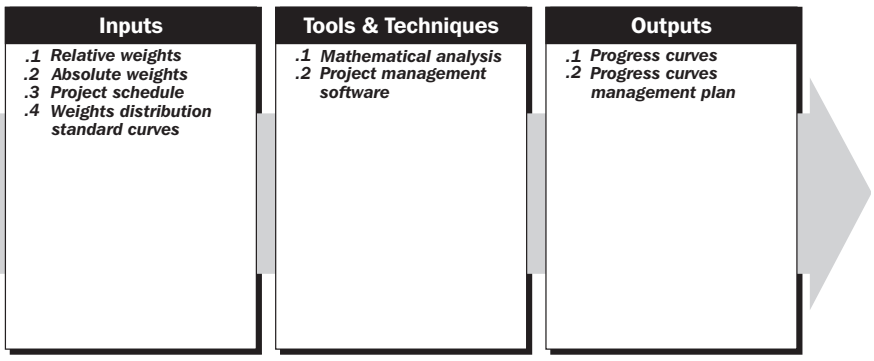
6.6.3 Outputs from Activity Weights Definition

.1 Relative weights. Relative weights are percentage weights to the activities decomposed from project. The relative weight of an activity represents its contribution to the project.

.2 Absolute weights. Absolute weights are weights calculated by multiplying the relative weight of each deliverable to the total weight of the project. The absolute weight of an activity represents its contribution to the production of the overall project.

6.7 PROGRESS CURVES DEVELOPMENT

Progress curves development is the creation of a progress baseline; in a similar fashion as a cost baseline is created (see Section 7 of the *PMBOK® Guide* - 2000 Edition for a more detailed discussion of cost baseline). Actual progress is then plotted against the baseline as the project progresses providing an on-going trend line which can be very helpful in forecasting future progress.



6.7.1 Inputs to Progress Curves Development

.1 Relative weights. Relative weights are discussed in the Section 6.6.3 of this Extension.

.2 Absolute weights. Absolute weights are discussed in the Section 6.6.3 of this Extension.

.3 Project schedule. The project schedule determines the start and finish dates for each project activity, and hence distributes its weights in time (see Section 6.4.3 of the *PMBOK® Guide* - 2000 Edition for a more detailed discussion about project schedule).

.4 Weights distribution standard curves. Each activity weight is calculated based on a particular activity attribute, such as man-hours consumption or material applied. For example, the length of time for back filling an area is a function of the volume of soil deposited in that area; the soil deposition rate is determined by the equipment capabilities and is linearly distributed along the activity duration.

6.7.2 Tools and Techniques for Progress Curves Development

.1 Mathematical analysis. Mathematical analysis is used to calculate the weight distribution along the project duration. Each activity has its weight and it is utilized according to standard curves. Computing the weight completed for each activity in a work period gives the overall project progress for that work period. Repeating the analysis for all project work periods gives the overall project progress curve.

.2 Project Management software. Project Management software can be used to automate the process of performing the mathematical analysis (see Section 6.4.2 for a more detailed discussion on project management software).

6.7.3 Outputs from Progress Curves Development

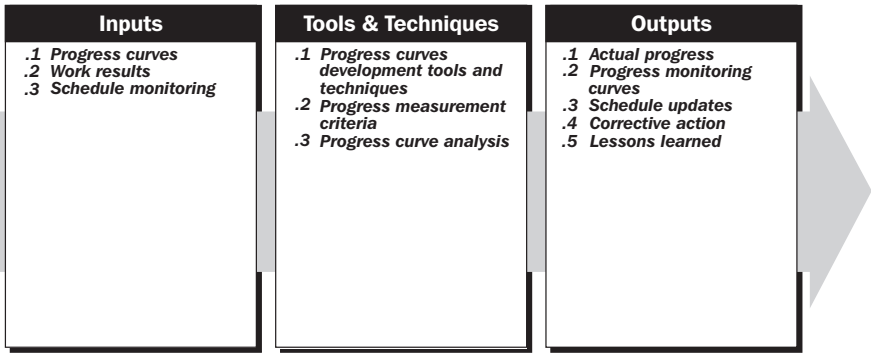
.1 Progress curves. Progress curves are a graphic representation of the progress of the project. It can be represented as:

- Period or Cumulative. Reflecting period progress or cumulative progress of the project.
- Early or Late. Whether the activity dates used in the calculations are based on early or late dates.
- Overall or Partial. Whether progress is represented for the overall project or for particular WBS deliverables. In Engineering-procurement-construction (EPC) projects, progress curves are usually plotted for both the overall project and the E, P, and C phases.

.2 Progress curves management plan. A progress curve management plan describes how progress will be measured and monitored for actual progress calculations. It may also describe how changes to the progress curves will be managed, but they usually are results of schedule changes. It may be formal or informal, highly detailed or broadly framed, based on the needs of the project.

6.8 PROGRESS MONITORING

Progress monitoring is evaluating actual project progress compared to the baseline.



6.8.1 Inputs to progress monitoring

.1 Progress curves. Progress curves are used as the basis for comparison to the baseline (see Section 6.7.3 of this Extension to the *PMBOK® Guide* - 2000 Edition for a more detailed discussion of the progress curves).

.2 Work results. The work performed up to the time when progress information is taken.

.3 Schedule monitoring. The actual start and finish dates for the project activities are the basis for actual progress calculation.

6.8.2 Tools and Techniques for progress monitoring

.1 Progress Curves Development Tools and Techniques. Progress Curves Development Tools and Techniques are discussed in the Section 6.7.2 of this Extension to the *PMBOK® Guide* - 2000 Edition.

.2 Progress Measurement Criteria. Progress Measurement Criteria are methods to determine how much progress has been accomplished for an activity if it is under progress in the data date. Some common methods are:

- 0%-100%. The weight of an activity is entered into progress calculations only when it is 100% completed. This applies to short duration activities only (one month or less).
- 20%-80%. When the activity starts, 20% of its weight can be used for progress calculations. When it finishes, 100% of the weight is considered. This convention has varying percentages, such as 30%-70% or 50%-50%.
- Percentage of the activity duration. The percentage of the activity weight to be considered is the same as the percentage calculated by dividing the duration from the activity start to the data date by its original duration and multiplying the result by 100.

Pre-established progress measurement criteria are used to avoid conflict between stakeholders when assessing project progress.

.3 Progress curve analysis. Progress curve analysis involves evaluating actual progress versus baseline in order to take preventive action toward accomplishing the progress for those activities. The evaluation includes examining the activities involved and their characteristics.

6.8.3 Outputs from progress monitoring

Some of the following curves are used in conjunction with the earned value analysis discussed in section 10.3.2 of this Extension of the *PMBOK® Guide* - 2000 Edition.

.1 Actual progress. The actual progress is the summation of weights, based on the pre-established progress measurement criteria, accomplished in or up to a work period.

.2 Progress monitoring curves. The progress monitoring curves are the graphical representation of the actual progress achieved in each control period, usually compared to a progress baseline.

.3 Schedule updates. A schedule update may be originated by the observation that progress targets are constantly failing to be met. The schedule update in this case will be a consequence of changes in the activity durations and basis of estimates (see Chapter 6 of the *PMBOK® Guide* - 2000 Edition for a more detailed discussion on schedule updates, activity durations, and basis of estimates).

.4 Corrective action. Corrective action is anything done to bring expected progress performance in line with the project plan. Corrective action is usually taken in another aspect of the project and reflected in enhanced progress accomplishment.

.5 Lessons learned. The causes of variances, the reasoning behind the corrective action chosen, and other types of lessons learned from progress monitoring should be documented, so that they become part of the historical database for both this project and other projects of the performing organization.

Chapter 7

Project Cost Management

The *PMBOK® Guide* - 2000 Edition says, "Project Cost Management includes the processes required to ensure that the project is completed within the approved budget" and provides an overview of the following major processes:

7.1 Resource Planning. Determining what resources (people, equipment, materials) and what quantities of each should be used to perform project activities.

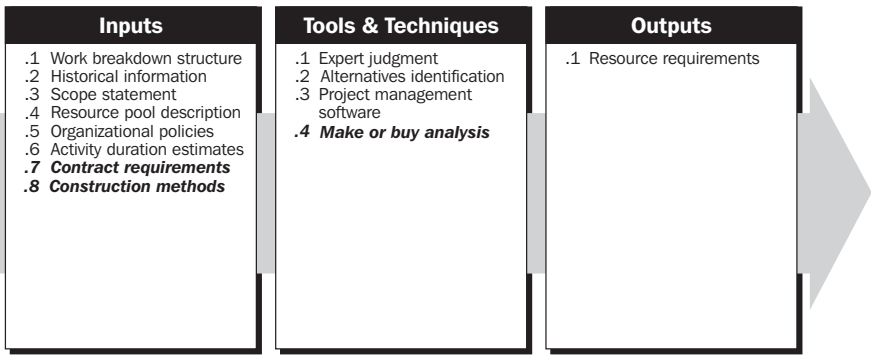
7.2 Cost Estimating. Developing an approximation (estimate) of the costs of the resources needed to complete project activities.

7.3 Cost Budgeting. Allocating the overall cost estimate to individual work activities.

7.4 Cost Control. Controlling changes to the project budget.

All these major processes are used in Construction Projects. Lifecycle costing together with value engineering techniques (see Section 4.1.2)and constructability analysis are used in Construction Projects to reduce cost and time, improve quality and performance, and optimize the decision-making.

7.1 RESOURCE PLANNING



7.1.1 Inputs to Resource Planning

.1 Work breakdown structure. See Section 7.1.1.1of the *PMBOK® Guide* - 2000 Edition.

.2 Historical information. See Section 7.1.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Scope statement. The *PMBOK® Guide* - 2000 Edition says "The scope statement (described in Section 5.2.3.1) contains the project justification and the project objectives, both of which should be considered explicitly during resource planning". For design/construction projects, details about project requirements, called the Statement of Requirements, is necessary for effective resource planning. It should include details about the site, outline of design parameters, outline of engineering requirements, technical definitions, construction timescale, applicable codes-standards, inspection-testing requirements, safety related requirements, and spare policy.

.4 Resource pool description. The *PMBOK® Guide* - 2000 Edition says "Knowledge of what resources (people, equipment, material) are potentially available is necessary for resource planning. The amount of detail and the level of specificity of the resource pool description will vary". For example, during the engineering phase the pool may include "engineers" in large numbers. During the construction phase of the same project, however, the pool may require a larger number of skilled and unskilled "workers" than "engineers". On both domestic and international projects the contractor must become familiar with the local labor work force availability and factors affecting the local work force such as political demands and requirements. These factors also have a significant effect on the criteria used for cost estimating (see section 7.2.3). If it is planned to use a formal value engineering program it needs to be identified so that appropriate provisions for it may be made.

.5 Organizational policies. See Section 7.1.1.5 of the *PMBOK® Guide* - 2000 Edition.

.6 Activity duration estimates. Time durations (described in Section 6.3.3.1).

.7 Contract requirements. Contracts may include requirements that are not listed in the WBS such as providing staff assistance to the owner or office furnishings.

.8 Construction methods. Preparation of the estimate needs to be based on the expected methods of construction to be utilized throughout the project.

7.1.2 Tools and Techniques for Resource Planning

.1 Expert judgment. See Section 7.1.2.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Alternatives identification. See Section 7.1.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Project management software. See Section 7.1.2.3 of the *PMBOK® Guide* - 2000 Edition.

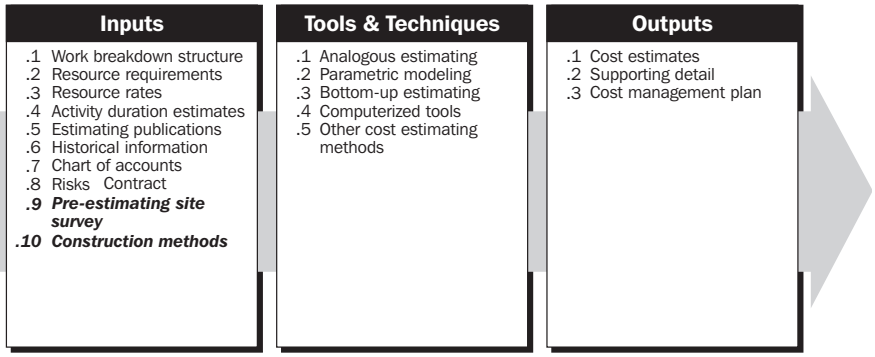
.4 Make or buy analysis. An essential analysis and subsequent decision necessary for resource planning is to identify which activities to perform with the contractor's own forces and which ones to subcontract out. For example, a company can decide to concentrate only on its core competencies and decide to contract out remaining scope of work.

7.1.3 Outputs from Resource Planning

.1 Resource requirements. See Section 7.1.2.3. of the *PMBOK® Guide* - 2000 Edition. For design and construction projects, when the resources are required is also an important output.

7.2 COST ESTIMATING

See Section 7.2. of the *PMBOK® Guide* - 2000 Edition.



7.2.1 Inputs to Cost Estimating

.1 Work breakdown structure. See Section 7.2.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Resource requirements. Resource requirements are described in Section 7.2.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Resource rates. See Section 7.2.1.3 *PMBOK® Guide* - 2000 Edition. As Construction Projects are labor intensive, labor productivity should be factored in. Rates vary depending on location, working conditions, hours of shift and other such factors.

.4 Activity duration estimates. See Section 7.2.1.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Estimating publications. See Section 7.2.1.5 of the *PMBOK® Guide* - 2000 Edition.

.6 Historical information. See Section 7.1.1.6 of the *PMBOK® Guide* - 2000 Edition.

.7 Chart of accounts. See Section 7.1.1.7 of the *PMBOK® Guide* - 2000 Edition.

.8 Risks. See Section 7.2.1.8 of the *PMBOK® Guide* - 2000 Edition.

.9 Pre-estimating site survey. A survey of the project or work site is required to understand the site conditions, facilities available and logistic requirements. A checklist of items can be prepared to make sure all issues are covered. These issues must be factored in the cost estimate.

7.2.2 Tools and Techniques for Cost Estimating

.1 Analogous estimating. See Section 7.2.2.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Parametric modeling. See Section 7.2.2.2 of the *PMBOK® Guide* - 2000 Edition. Industrial construction projects often use a variety of parameters depending on the type of construction involved (piping, electrical or concrete for example) to develop a broad outline cost estimate.

.3 Bottom-up estimating. See Section 7.2.2.3 *PMBOK® Guide* - 2000 Edition.

.4 Computerized tools. See Section 7.2.2.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Other cost estimating methods. See Section 7.2.2.5 *PMBOK® Guide* - 2000 Edition.

7.2.3 Outputs from Cost Estimating

.1 Cost estimates. The *PMBOK® Guide* - 2000 Edition says "Cost estimates are quantitative assessments of the likely costs of the resources required to complete project activities. They may be presented in summary or in detail. Costs must be estimated for all resources that will be charged to the project. This includes, but is not limited to, labor, materials, supplies, and special categories such as an inflation allowance or cost reserve. Cost estimates are generally expressed in units of currency (dollars, euros, yen, etc.) to facilitate comparisons both within and across projects. In some cases, the estimator may use units of measure to estimate cost, such as staff hours or staff days, along with their cost estimates to facilitate appropriate management control.

Cost estimating generally includes considering appropriate risk response planning, such as contingency plans. Cost estimates may benefit from being refined during the course of the project to reflect the additional detail available". For example, during the earlier phase of piping cost estimating, methods like estimating by length, estimating by weight, or estimating by ratio can be used. During later phases of the project, however, accurate quantities are known and can be used. The *PMBOK® Guide* - 2000 Edition further says "In some application areas, there are guidelines for when such refinements should be made and what degree of accuracy is expected. For example, The Association for the Advancement of Cost Engineering (AACE) International has identified a progression of five types of estimates of construction costs during engineering: order of magnitude, conceptual, preliminary, definitive, and control."

.2 Supporting detail. See Section 7.2.3.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Cost management plan. See Section 7.2.3.3 of the *PMBOK® Guide* - 2000 Edition.

7.3 COST BUDGETING

See Section 7.3. of the *PMBOK® Guide* - 2000 Edition.

7.4 COST CONTROL

See Section 7.4 of the *PMBOK® Guide* - 2000 Edition.

Chapter 8

Project Quality Management

The *PMBOK® Guide* - 2000 Edition says, "Project Quality Management includes the processes required to ensure that the project will satisfy the needs for which it was undertaken." In the construction industry, this consists of ensuring that the project specifications, (see 8.1 Quality Planning below), in terms of product(s), (see below), and processes, are satisfied within the agreed schedule and budget. It includes "all activities of the overall management function that determine the quality policy, objectives, and responsibilities and implements them by means such as quality planning, assurance, control, and improvement, within the quality system (1).

Figure 8-1 of the *PMBOK® Guide* - 2000 Edition provides an overview of the following major project quality management processes:

8.1 Quality Planning. Identifying which quality standards are relevant to the project and determining how to satisfy them.
Note: in the construction industry quality standards are usually referred to as project specifications, which consists of the customer's requirements and all of the stated and implied regulatory requirements.

8.2 Quality Assurance. Evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards.

8.3 Quality Control. Monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance, as well as identify means to remedy to the non-compliance identified.

The ensuing discussion and explanations in this Section of the *PMBOK® Guide* - 2000 Edition also apply to projects performed in the construction industry..

As stated in the *PMBOK® Guide* - 2000 Edition, "the project management team must be careful not to confuse quality with grade. Grade is "a category or rank given to entities having the same functional use but different technical characteristics" (3). Low quality is always a problem; low grade may not be." For example, an office building may be of high quality (appropriate floor layout, absence of leakage, functioning mechanical and electrical systems) and low grade (no wood trim or marble floors), or of low quality (floor space difficult to use, roof leakage, improperly balanced

heating and ventilation system) and high grade (wood trim and marble floors). Determining and delivering the required levels of both quality and grade are the responsibilities of the project manager and the project management team.

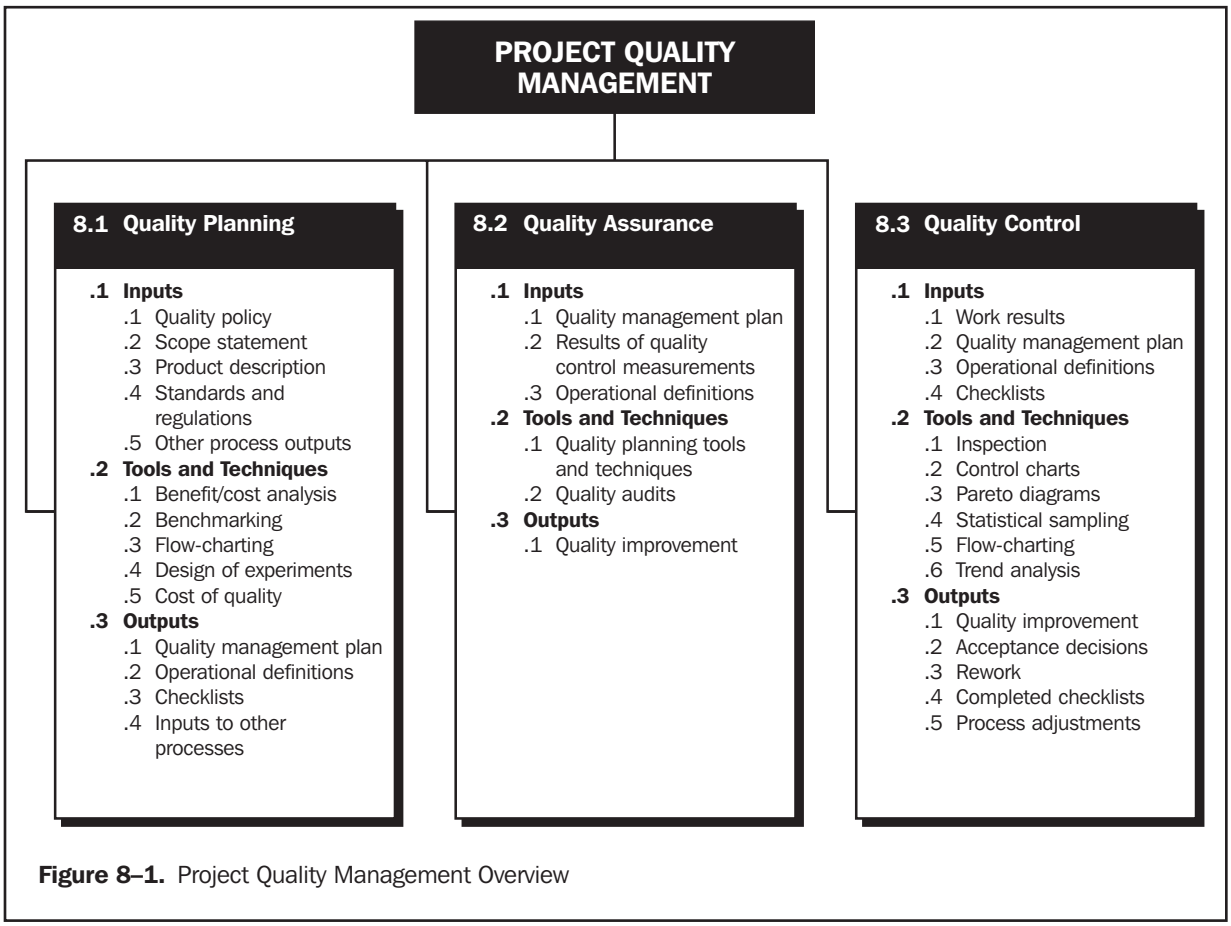
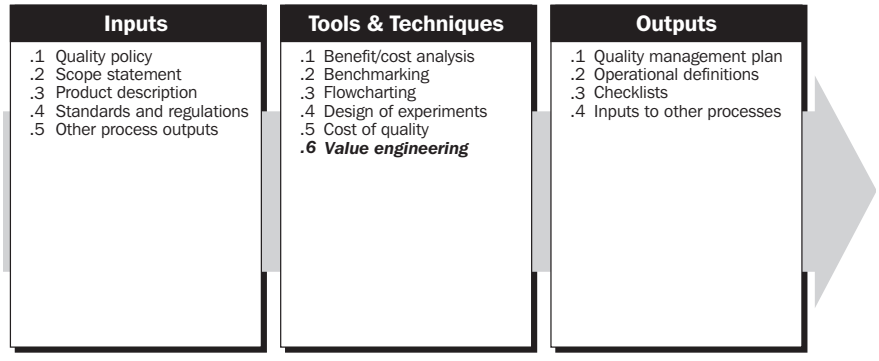


Figure 8–1. Project Quality Management Overview

8.1 QUALITY PLANNING

See Section 8.1 in the PMBOK® Guide - 2000 Edition



8.1.1 Inputs to Quality Planning

.1 Quality policy. Quality policy is "the overall intentions and direction of an organization with regard to quality, as formally expressed by top management" (4). The quality policy of the performing organization can often be adopted "as is" for use by the project. However, if the performing organization lacks a formal quality policy, or if the project involves multiple performing organizations, (as with a joint venture), then the project management team will need to develop a quality policy for the project. In some instances, the customer may impose compliance to its own quality policy as part of the project specifications. Additionally, for a project of exceptional nature, it is advisable to jointly develop a common project vision and quality policy between the performing organization(s), the customer, and other main project stakeholders.

Regardless of the origin of the quality policy, the project management team is responsible for ensuring that the project stakeholders are fully aware of it (e.g., through appropriate information distribution, as described in Section 10.2).

.2 Scope statement. The scope statement (described in Section 5.2.3.1) is a key input to quality planning since it documents major project deliverables, as well as the project objectives that serve to define important stakeholder requirements.

.3 Product description. Although elements of the product description (described in Section 5.1.1.1) may be embodied in the scope statement, the product description will often contain details of technical issues and other concerns that may affect quality planning.

.4 Standards and regulations. The project management team must consider any application area-specific standards or regulations that will affect the project. Section 2.5.1 discusses standards and regulations. In the Construction industry these usually involve local, regional and national building codes, national and international engineering standards, regional and national safety regulations, as well as local, regional, national, and international environmental regulations. Some construction projects may have additional requirements due to their nature, example, the nuclear industry.

In the construction industry project specifications issued by the customer include the project scope statement, the product description, and make reference to all applicable standards and regulations.

.5 Other process outputs. In addition to the scope statement and product description, processes in other knowledge areas may produce outputs that should be considered as part of quality planning. For example, procurement planning (described in Section 12.1) may identify contractor quality requirements that should be reflected in the overall quality management plan.

8.1.2 Tools and Techniques for Quality Planning

.1 Benefit/cost analysis. See Section 8.1.2.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Benchmarking. See Section 8.1.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Flowcharting. See Section 8.1.2.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Design of experiments. Seldom used in construction.

.5 Cost of quality. See Section 8.1.2.5 of the *PMBOK® Guide* - 2000 Edition.

.6 Value engineering. Creative process seeking to identify the best alternative in terms of methods, materials, processes in order to optimize the construction of the final product while taking into consideration issues such as its long term operating costs and usability. Quality is not the only application for value engineering-see Section 4.1.2 .

8.1.3 Outputs from Quality Planning

The *PMBOK® Guide* - 2000 Edition *PMBOK® Guide* 2000 lists the following outputs from quality planning all of which apply to construction projects:

.1 Quality management plan. See Section 8.1.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Operational definitions. See Section 8.1.3.2 of the *PMBOK® Guide* - 2000 Edition.

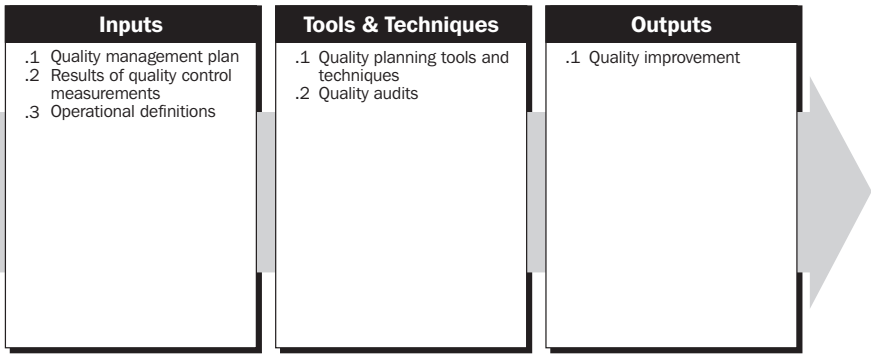
.3 Checklists. See Section 8.1.3.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Inputs to other processes. See Section 8.1.3.4 of the *PMBOK® Guide* - 2000 Edition.

8.2 QUALITY ASSURANCE

The *PMBOK® Guide* - 2000 Edition says,"Quality assurance is all the planned and systematic activities implemented within the quality system to provide confidence that the project will satisfy the relevant quality standards (6)."

In a construction project, quality assurance is everybody's responsibility (the project management team, as well as the construction manager, superintendent, foremen and skilled trades). Quality Assurance will be provided to the project management team and to the management of the performing organization, as well to the customer and others not actively involved in the work of the project.



8.2.1 Inputs to Quality Assurance

The *PMBOK® Guide* - 2000 Edition describes three inputs to quality assurance:

.1 Quality management plan. See Section 8.2.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Results of quality control assessments. See Section 8.2.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Operational definitions. See Section 8.2.1.3 of the *PMBOK® Guide* - 2000 Edition.

8.2.2 Tools and Techniques for Quality Assurance

.1 Quality planning tools and techniques. The quality planning tools and techniques described in Section 8.1.2 can be used for quality assurance as well.

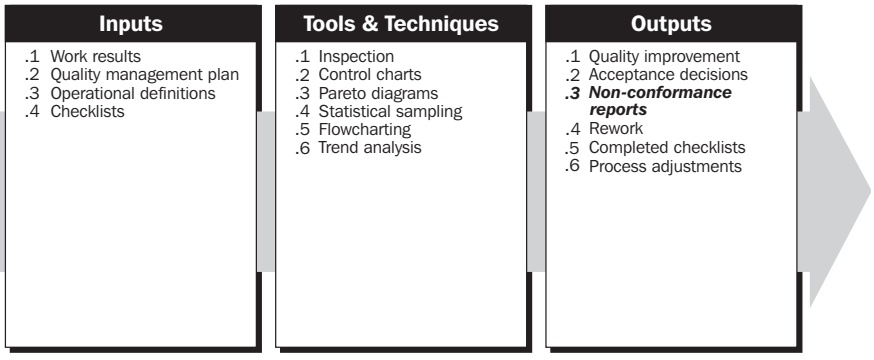
.2 Quality audits. See Section 8.2.2.2 of the *PMBOK® Guide* - 2000 Edition. A quality audit is a structured review of the quality of the management of the project. The objective of a quality audit is to assess the relevance and effectiveness of the established project management processes and procedures, to evaluate compliance with all applicable processes and procedures, as well as to define corrective actions for the non-conformance encountered, and to identify preventive actions seeking to improve the overall quality management of the project.

8.2.3 Outputs from Quality Assurance

.1 Quality improvement. See Section 8.2.3.1 of the *PMBOK® Guide* - 2000 Edition.

8.3 QUALITY CONTROL

The *PMBOK® Guide* - 2000 Edition says, "Quality control involves monitoring specific project results to determine if they comply with relevant quality standards, and identifying ways to eliminate causes of unsatisfactory results. It should be performed throughout the project."



8.3.1 Inputs to Quality Control

.1 Work results. Work results (described in Section 4.2.3.1) include both process results and product results.

.2 Quality management plan. The quality management plan is described in Section 8.1.3.1 of the *PMBOK® Guide* - 2000 Edition.

.3 Operational definitions. Operational definitions are described in Section 8.1.3.2 of the *PMBOK® Guide* - 2000 Edition.

.4 Checklists. Checklists are described in Section 8.1.3.3 of the *PMBOK® Guide* - 2000 Edition.

8.3.2 Tools and Techniques for Quality Control

.1 Inspection. See the *PMBOK® Guide* - 2000 Edition. Some customary inspections in construction include construction sampling, and non destructive testing procedures such as ultra sound and x-rays. Inspections are also variously called reviews, audits, and walkthroughs. In the construction industry, the outcome of such inspections during the close-out phase of the project is usually documented by the use of a punchlist.

.2 Control charts. Not often used in construction.

.3 Pareto diagrams. Not often used in construction.

.4 Statistical sampling. This technique is used for construction projects. Probably the most common use is in sampling concrete for strength control and there are other sampling applications as well.

.5 Flowcharting. Seldom used in construction as a quality control tool.

.6 Trend analysis. Useful in specific areas of construction to predict the effectiveness of the quality control program

8.3.3 Outputs from Quality Control

The *PMBOK® Guide* - 2000 Edition lists five outputs from quality control; a sixth, non-conformance reports, has been added because of its frequent usage in construction projects.

.1 Quality improvement. Quality improvement is described in Section 8.2.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Acceptance decisions. The items inspected will be either accepted or rejected. Rejected items may require rework (described in Section 8.3.3.3).

.3 Non conformance reports. Items that are inspected and found not to conform to requirements commonly have a non conformance report prepared outlining the deficiencies. The report may also indicate the action needed to bring the items into conformance.

.4 Rework. Rework is action taken to bring a defective or nonconforming item into compliance with requirements or specifications. Rework, especially unanticipated rework, is a frequent cause of cost and schedule overruns in construction projects. The project team should make every reasonable effort to minimize rework. Often the cause of rework is deficient vendor-supplied equipment or material. This kind of deficiency can be prevented or minimized by the imposition of an approved quality control program at the supplier's plant.

.5 Completed checklists. See the *PMBOK® Guide* - 2000 Edition.

.6 Process adjustments. See the *PMBOK® Guide* - 2000 Edition.

Chapter 9

Project Human Resource Management

The *PMBOK® Guide* - 2000 Edition says "Project Human Resource Management includes the processes required to make the most effective use of the people involved with the project. It includes all the project stakeholders-sponsors, customers, partners, individual contributors, and others described in Section 2.2." Figure 9-1 of the *PMBOK® Guide* - 2000 Edition provides an overview of three of the following major processes. Because of the importance of project closing functions to resource management in construction projects, another process, Project Completion, has been added to the three listed by the *PMBOK® Guide* - 2000 Edition. The project work force, as it relates to construction projects can be divided into managerial and labor forces. The labor force, (construction trades), are the largest component of the site work force, generally much larger than the managerial force. This section will cover both work force components.

9.1 Organizational Planning. Identifying, documenting, and assigning project roles, responsibilities, and reporting relationships, including assessing the general requirements and availability of the labor work force.

9.2 Staff Acquisition. Getting the human resources needed assigned to and working on the project.

9.3 Team Development. Developing individual and group competencies to enhance project performance.

9.4 Project Completion. managing the dissolution of the project team; returning them to point of hire or to other assignments

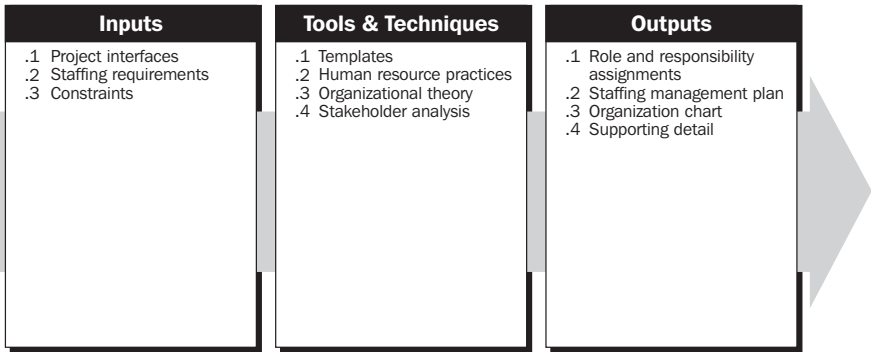
The *PMBOK® Guide* - 2000 Edition says, "These processes interact with each other and with the processes in the other knowledge areas as well. Each process may involve effort from one or more individuals or groups of individuals, based on the needs of the project."

One of the distinguishing features of human resource management in a construction project is the fact that almost always the project locale is different and is not "home". That is, the project team is not working in the familiar "cocoon" of their home office or trade association; but rather in an "artificial" environment that is the construction site. To some degree, alle-

giance is necessarily transferred from "home" to the project site, its temporary management, rules and whatever other cultural and geographic effects might apply. This situation creates additional and important demands on the function of human resource management above those described in the *PMBOK® Guide* - 2000 Edition and can require unique methods of dealing with them. As discussed later in this section, the methods and procedures for acquisition of labor for a construction project can vary significantly in different parts of the world, and managers of construction projects need to be very alert to local conditions and customs.

9.1 ORGANIZATIONAL PLANNING

The *PMBOK® Guide* - 2000 Edition says, "Organizational planning involves identifying, documenting, and assigning project roles, responsibilities, and reporting relationships." Roles, responsibilities, and reporting relationships may be assigned to individuals or to groups such as subcontractors for construction work or services.



9.1.1 Inputs to Organizational Planning

.1 Project interfaces. The *PMBOK® Guide* - 2000 Edition discusses three categories of interfaces:

- Organizational interfaces-formal and informal reporting relationships among different organizational units. The organizational interface for most design and construction projects is usually well defined as a result of long experience with this process: Owner, designer, contractor, subcontractors, finance and regulatory agencies and, in some cases the general public. The primary interface, of course, is usually between the Owner, designer and contractor(s). Organizational interfaces can become critical in effectively managing certain contract forms such as design-build and construction management. The project stakeholders' roles and responsibilities must be clearly identified at the project outset.
- Technical interfaces-formal and informal reporting relationships among different technical disciplines.
- Interpersonal interfaces-formal and informal reporting relationships among different individuals working on the project.

.2 Staffing requirements. See Section 9.1.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Constraints. The *PMBOK® Guide* - 2000 Edition discusses these constraints:

- Organizational structure of the performing organization.
- Collective bargaining agreements.
- Preferences of the project management team. In addition to what the *PMBOK® Guide* - 2000 Edition says about preferences, Owners often have preferences for union or non-union construction forces, certain suppliers and contractors because of trade relations. These do constrain project alternatives and should be accounted for in the project plan (4.1), as well as, management of project human resources. The owner (or client) often approves portions of the organizational plan either in the proposal or contract and it may be difficult to later change the structure without the owner's approval.
- Expected staff assignments.
- Funding sources may be from international aid or financing organizations and may have specific requirements relating to the use of local labor.
- Local governments may dictate that certain companies or individuals should be employed in various roles and capacities for public projects.

9.1.2 Tools and Techniques for Organizational Planning

.1 Templates. What the *PMBOK® Guide* - 2000 Edition has to say on this subject is particularly applicable to a construction project because of the long history of the process itself and the fact that most projects will fall into a relatively limited number of different types of projects. There is a wealth of information to be obtained from other similar projects done by the performing organization or even its competitors.

.2 Human resource practices. Many construction companies, particularly the larger ones, have a variety of policies, guidelines, and procedures that can help the management team or perhaps mandate various aspects of organizational planning and practices.

.3 Organizational theory. See Section 9.1.2.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Stakeholder analysis. See Section 9.1.2.4 of the *PMBOK® Guide* - 2000 Edition and Section 10.1.2.1 of this Extension.

9.1.3 Outputs from Organizational Planning

.1 Role and responsibility assignments. Project roles (who does what) and responsibilities (who decides what) must be assigned to the appropriate project stakeholders. Roles and responsibilities may vary over time. Most roles and responsibilities will be assigned to stakeholders who are actively involved in the work of the project, such as the project/construction manager, other members of the project management team, and the individual contributors. Project roles and responsibilities should be closely linked to the project scope definition and the WBS. A Responsibility Assignment Matrix (or RAM, see Figure 9-2 in the *PMBOK® Guide* - 2000 Edition) is usually prepared for this purpose.

.2 Staffing management plan. See the *PMBOK® Guide* - 2000 Edition.
This document is a key working element for the execution of the construction project. Tied closely to the scope of work, as it may change throughout the project, and the schedule which may also vary, the staffing management

plan needs to mirror the changing project needs. If either or both of these elements change the staffing plan must be adjusted accordingly. Most staffing plans for construction projects will consist of company team members who are a part of the often permanent construction cadre, and additional personnel hired (often locally) to fill positions more economically than moving in more permanent staff. As is true with any project, but particularly damaging to construction projects, events occur that were not contemplated in the staffing plan and some contingency needs to be provided in case these events happen. For example, a key staff member may become ill or leave the project for another job leaving an important assignment uncovered. In the case of a project on a site foreign to the home country this can prove to be a very serious and expensive situation to resolve.

.3 Organization chart. See Section 9.1.3.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Supporting detail. The *PMBOK® Guide* - 2000 Edition lists the following information frequently supplied as supporting detail:

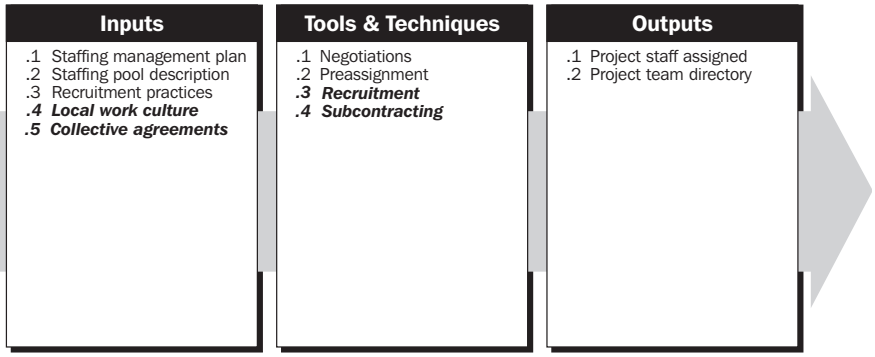
- Organizational impact-what alternatives are precluded by organizing in this manner.
- Job descriptions-written outlines by job title of the competencies, responsibilities, authority, physical environment, and other characteristics involved in performing a given job; also called position descriptions. Always a good idea, it is particularly important on a construction project, where most of the team is co-located, to provide a clear understanding of each member's role and competency insuring a smoother interpersonal interface.
- Training needs-if the staff to be assigned is not expected to have the competencies needed by the project, those competencies will need to be developed as part of the project. If it is not possible or probable to provide such training, additional and relevant supervisory strength should be supplied to counteract this deficiency.

.5 Manpower leveling. Since construction projects may have a large labor work force and the financial success of the project can be closely linked to productivity, manpower leveling is often used to keep the work force as productive as possible. Manpower leveling assigns the necessary workforce to each line item on the project schedule, projecting the total laborforce employed on a period basis. The output from this activity may indicate an unacceptable variation in the total force or in some of the trades components. In most cases the workforce can not be hired and fired on a regular basis without affecting the project's productivity and could also prove costly, due to excessive re-orienting and training. Non-critical path items should be adjusted to level the manpower required to the extent possible.

9.2 STAFF ACQUISITION

While the *PMBOK® Guide* - 2000 Edition's introduction to this section is certainly applicable to construction projects, those projects may have some more unusual aspects. Often construction staff is from the contractor's or engineer/contractor's permanent organization, supplemented by local hires in the vicinity of the project site where possible. However, in the case of a joint venture, the staff may be a mixture of personnel from the sponsoring

firm and other member firms of the joint venture. Sometimes a construction firm may be asked to provide personnel to an "integrated organization" consisting of its own staff and that of the Owner.



9.2.1 Inputs to Staff Acquisition

.1 Staffing management plan. See Section 9.2.1.1 of the *PMBOK® Guide* - 2000 Edition and Section 9.1.3.2 of this Extension.

.2 Staffing pool description. See Section 9.2.1.2 of the *PMBOK® Guide* - 2000 Edition. In addition to the factors mentioned in the *PMBOK® Guide* - 2000 Edition, construction projects also need to consider personal constraints such as family and spouse needs and disabilities that could affect willingness for the assignment or ability to perform, especially relevant in foreign assignments where the ability to make personnel changes are limited.

.3 Recruitment practices. See Section 9.2.1.3 of the *PMBOK® Guide* - 2000 Edition. Local governments and certain funding agencies may require the use of a local labor workforce (or percentage thereof). Such a defined workforce may not possess the skills required to perform the required tasks either from a quality or productivity standpoint.

.4 Local work culture. The work culture, practices, and ethics of the local workforce must be known in advance. Productivity, workmanship, and commitment can vary dramatically globally. Such factors may affect the composition of the teams and number of workers required for a specific task.

.5 Collective agreements. Union agreements must be reviewed with respect to renewal dates, payment provisions, and workplace restrictions. The management team should take precautionary steps in the event of work stoppages resulting from unsuccessful collective bargaining or other union contract violations.

9.2.2 Tools and Techniques for Staff Acquisition

.1 Negotiations. The *PMBOK® Guide* - 2000 Edition says "Staff assignments must be negotiated on most projects." Since in many cases the staff for a construction project may come from a company's organization, these negotiations take place between the project and other divisions or departments to obtain needed personnel. Also, other construction projects may compete for personnel. In addition, other negotiations are with the prospective personnel about the constraints in 9.2.1.2 above, as well as salary, fringe benefits, responsibilities, and related factors. These negotiations occur internally or with new hires initially external to the constructing firm.

Union trades workforce is usually obtained from the local union hiring hall. The contractor can negotiate with the union on the number and type of workers as well as pay scale and benefits on larger projects (usually through the collective bargaining process). The results of the negotiation can vary depending on the state of the construction economy and employment level of union members. For non-union projects it is usually the contractor's responsibility to acquire the workforce locally or from the contractor's own workforce data base.

.2 Preassignment. See Section 9.2.2.2 of the *PMBOK® Guide* - 2000 Edition. Managerial staff may sometimes be pre-assigned to the project. This is often the case when the project is the result of a competitive proposal and specific staff assignments were promised as part of the proposal.

.3 Recruitment. (The *PMBOK® Guide* - 2000 Edition calls this Procurement). While the process of recruiting new personnel for a construction staff is a "procurement" process, it is usually performed by a company's Human Resource or Personnel Department. When the project hires local personnel to augment the site staff, this recruitment is usually performed by the site staff individual assigned the human resource responsibility.

.4 Subcontracting. In cases of foreign projects or where a large labor force is required, the contractor may be forced to negotiate agreements with local firms that essentially control the available workforce or have a workforce meeting the requirements as set forth in section 9.2.1.3 of this Extension.

9.2.3 Outputs from Staff Acquisition

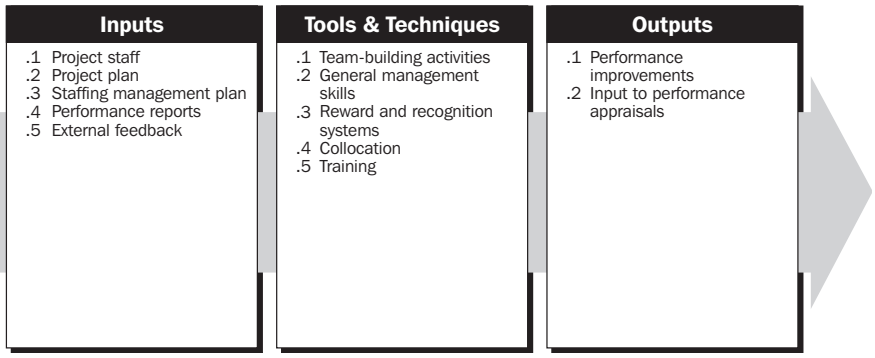
See Section 9.2.3 of the *PMBOK® Guide* - 2000 Edition.

9.3 TEAM DEVELOPMENT

Team development, according to the *PMBOK® Guide* - 2000 Edition "includes both enhancing the ability of stakeholders to contribute as individuals as well as enhancing the ability of the team to function as a team. Individual development (managerial and technical) is the foundation necessary to develop the team. Development as a team is critical to the project's ability to meet its objectives." While for other types of projects "individual team members are accountable to both a functional manager and the project manager", this is not often true on a construction project because of its relative autonomy. Nevertheless, there may be superior authority beyond that of the construction manager on a construction job site for the safety and quality functions in particular.

Typical construction projects can last six months to two years and sometimes much more. Within that timeframe several components requiring different teams of the labor force may be required. For example, the concrete foundation crew comprises different personnel than the crew involved in final fitting up and fixtures. It is therefore often difficult to apply team development strategies in the traditional sense for the labor workforce. Once each specialized team is identified, it is difficult to change within the context of a project without affecting the momentum of the project. Team development, as described in the *PMBOK® Guide* - 2000 Edition, can, how-

ever; be applied as a global effort within an organization over a series of projects.



9.3.1 Inputs to Team Development

The *PMBOK® Guide* - 2000 Edition lists the following inputs to team development:

.1 Project staff. See Section 9.3.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Project plan. See Section 9.3.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Staffing management plan. See Section 9.3.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Performance reports. The *PMBOK® Guide* - 2000 Edition says "Performance reports (described in Section 10.3.3.1) provide feedback to the project team about performance against the project plan. "They also form the basis for evaluation of individual performance, which becomes a part of permanent personnel records and support for salary increases and promotions. On projects with multiple repetitive tasks the labor workforce working with the managerial team can continually improve efficiency and quality, and thus produce positive performance. Where the labor force is largely furnished by subcontractors, the subcontractors overall performance can be graded and noted for future use.

.5 External feedback. In addition to what the *PMBOK® Guide* - 2000 Edition says about this item, external feedback for a construction project could include contract goals other than the usual schedule and cost targets. For example, in a cost-incentive-fee contract the team's performance is measured periodically (perhaps quarterly) on other items such as quality, safety, communication effectiveness, etc. and that rating determines a part of the contractor's fee for the period.

9.3.2 Tools and Techniques for Team Development

.1 Team-building activities. In addition to the activities mentioned by the *PMBOK® Guide* - 2000 Edition, construction projects often use sports contests, holiday outings, picnics and dinners to provide an environment to promote team building and awareness. Other more traditional team building activities are difficult to achieve on construction projects due to the duration and varied total team composition (as mentioned in the introduction to this section).

.2 General management skills. See the *PMBOK® Guide* - 2000 Edition.

.3 Reward and recognition systems. The reward and recognition discussion in the *PMBOK® Guide* - 2000 Edition is also applicable to construction projects. One additional form that is utilized more and more is reward for excellent safety performance by the construction team. For meeting or exceeding the project's safety goals the staff and sometimes also the workers are rewarded with a ceremonial lunch or dinner and given some token of the achievement; in some cases personal merchandise such as a cap or jacket or participation in lotteries for major prize items.

.4 Collocation. For a construction project virtually all members of the team are collocated but one important part of the project team may not be - the designer. Even for very large projects, only a part of the design team may be on site and then usually for a limited time. In this case, extra emphasis must be placed on effective communication (see Section 10 in the *PMBOK® Guide* - 2000 Edition) whether the constructing organization is an engineer/contractor or not.

.5 Training. The *PMBOK® Guide* - 2000 Edition discusses the need for and source of training in this section. Training for team members assigned or about to be assigned to a construction project can be more difficult than for other types of projects because many field assignments are not known far enough in advance to provide such training. In addition to the discussion in the *PMBOK® Guide* - 2000 Edition, there are some areas where needed skills can be supplemented on the job such as safety and quality. It is also often useful to have a short "seminar" for the team to understand the process they are constructing, as in the case of an industrial project, which would ideally involve suitable members of the Owner's operating team.

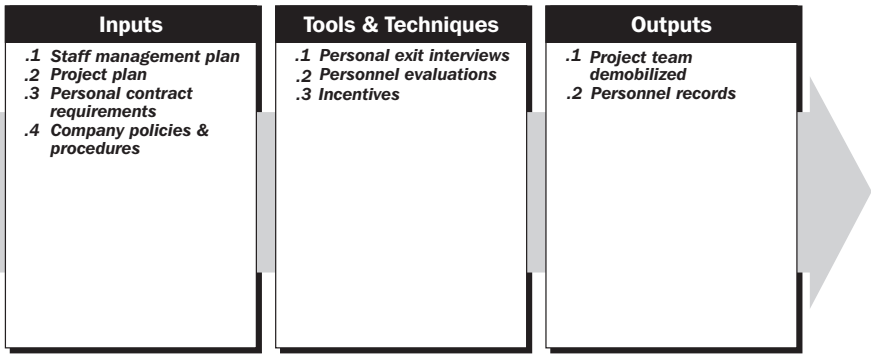
9.3.3 Outputs from Team Development

.1 Performance improvements. One area, in addition to those mentioned by the *PMBOK® Guide* - 2000 Edition, where team performance can improve is in communication which can have a measurable effect on project performance (see Section 9.3.2.4 in the *PMBOK® Guide* - 2000 Edition).

.2 Input to performance appraisals. See the *PMBOK® Guide* - 2000 Edition.

9.4 PROJECT TEAM CLOSEOUT

The close out and dissolution of the project team is a major consideration for a construction project. Usually the entire team will not stay together to the end of the project. As certain responsibilities are completed, those team members are released to (a) return to their source department, (b) be assigned to another (construction) project, or (c) be returned to their point of hire and the open job market. When the project is completed, all of the remaining team members, including the project/construction manager face this process. As the project ends some members will take steps to find subsequent employment before or delay the completion of their assignment which can cause considerable difficulty for the construction manager if not anticipated and provided for.



9.4.1 Inputs to Project Team Closeout

.1 Staff Management Plan. See 9.1.3.2 in this Extension.

.2 Project Plan - See Section 4.1 Project Plan Development in this Extension.

.3 Personal Contract Requirements. Sometimes with foreign construction assignments, staff personnel are engaged through the use of personal contracts which specify such things as salary, living accommodations, tax treatment and repatriation terms. At project closeout, these contract requirements need to be honored and may require extra attention from the project/construction manager and the staff member assigned the human resource responsibility.

.4 Company policies and procedures. For others, although there may not be a personal contract involved, company policy may dictate how the personnel are to be released from the project and what procedures are to be followed.

9.4.2 Tools and Techniques for Project Team Closeout

.1 Personal Exit Interviews. As a project winds down and personnel are released it is good practice to hold an exit interview with each staff member. During this interview, information can be obtained about any ongoing activities that have not been completed, relevant claim documentation, and other data that the project may need, as well as a discussion about the function of the project team and what lessons have been learned that may improve future performance.

.2 Personnel Evaluations. If periodic performance evaluations have not been done they should be done during the closeout period. Personnel deserve to know how well they have functioned and what kind of recommendation they will receive as a result of their work on the project.

.3 Incentives. In some cases staff members see the close of their assignment approaching and begin to take steps to seek follow-on employment elsewhere, which can leave the project seriously short-handed in the critical closing phases. One way to offset this problem is to offer a bonus for staying until the final close of the project. Obviously, the project/construction manager has to be careful in the use of this tactic or everyone could claim they are in a position where such a tactic would apply. Nevertheless, this has proved to be useful in those few times where such a situation has arisen.

9.4.3 Outputs from Project Team Closeout

.1 Project team demobilized. The team has completely left the site and future disposition has been completed for each member.

.2 Personnel Records. At the close of the project, all personnel records should be reviewed for completeness and forwarded to the company's Human Resource Department who normally maintains a permanent file on all employees.

Chapter 10

Project Communications Management

The *PMBOK® Guide* - 2000 Edition says, "Project Communications Management includes the processes required to ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information. It provides the critical links among people, ideas, and information that are necessary for success. Everyone involved in the project must be prepared to send and receive communications, and must understand how the communications in which they are involved as individuals affect the project as a whole." Perhaps no process is more important in the design and construction of a project because of the number and diversity of the key players, and because it is vital to the success of the project that the communication of information be timely and accurate. Consequently, considerable thought and planning is required to provide a system that meets these two criteria. For the construction project, the project team and primarily the project manager are the focal point of project communication, not just for distributing project generated information, but also for gathering, analyzing and responding to stakeholder initiated information (feedback).

The *PMBOK® Guide* - 2000 Edition says that the communication process includes the following major elements:

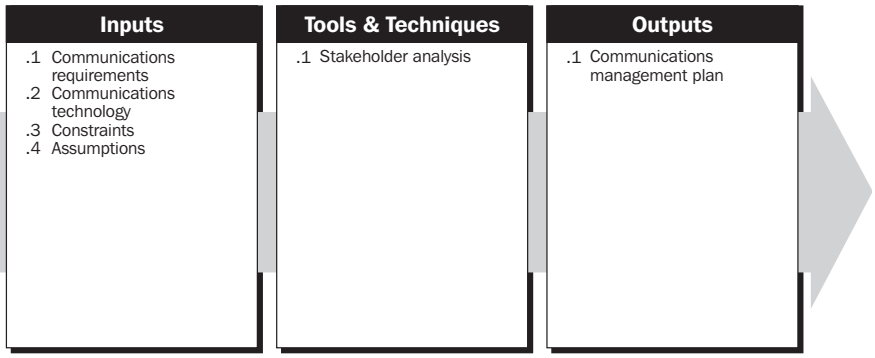
10.1 Communications Planning.
10.2 Information Distribution.
10.3 Performance Reporting.
10.4 Administrative Closure.

10.1 COMMUNICATIONS PLANNING

The *PMBOK® Guide* - 2000 Edition says that "communications planning involves determining the information and communications needs of the stakeholders: who needs what information, when they will need it, how it will be given to them, and by whom. While all projects share the need to communicate project information, the informational needs and the methods

of distribution vary widely. Identifying the informational needs of the stakeholders and determining a suitable means of meeting those needs is an important factor for project success. However, the results of this process should be reviewed regularly throughout the project and revised as needed to ensure continued applicability". All of this is especially true in design and construction projects. On most projects, the majority of communications planning is done as part of the earliest project phases, particularly the development of the project plan (see the *PMBOK® Guide* - 2000 Edition, Section 4.2).

One of the major considerations in planning a communication system for construction projects is how requests for information (RFI) are to be handled. These communications between the constructor and the designer/project manager can have a serious effect on the cost and schedule of a project and can lead to claims. Some attempt should be made to estimate how many RFIs there might be over the life of the project and to provide an efficient and rapid way of answering them and recording the results. Sometimes these guidelines are, or can be established in the project contract including the time allowed for answering them.



10.1.1 Inputs to Communications Planning

.1 Communications requirements. Communications requirements are the sum of the information requirements of all of the project stakeholders and particularly those of the design/construction team. The *PMBOK® Guide* - 2000 Edition states "requirements are defined by combining the type and format of information required with an analysis of the value of that information. Project resources should be expended only on communicating information that contributes to success or where a lack of communication can lead to failure. Information typically required to determine project communications requirements includes:

- Project organization and stakeholder responsibility relationships.
- Disciplines, departments, and specialties involved in the project.
- External information needs (e.g., communicating with the media).
- Logistics of how many individuals will be involved with the project and at which locations".

It is usually the case in design and construction projects that not all team members are co-located, placing greater demands on the communication system.

.2 Communications technology. The *PMBOK® Guide* - 2000 Edition says "the technologies or methods used to transfer information back and forth among

project stakeholders can vary significantly: from brief conversations to extended meetings, from simple written documents to immediately accessible online schedules and databases." For many, if not most, design/construction projects today this technology includes photographs, videos, reports, computer files, use of PDAs, cell and mobile phones, tape recorders, and digital cameras. The *PMBOK® Guide* - 2000 Edition lists the following communications technology factors that may affect the project:

- The immediacy of the need for information-is project success dependent upon having frequently updated information available on a moment's notice, or would regularly issued written reports suffice?
- The availability of technology-are the systems that are already in place appropriate, or do project needs warrant change?
- The expected project staffing-are the proposed communications systems compatible with the experience and expertise of the project participants, or will extensive training and learning be required? This might apply, for example, to a comprehensive project control system working through a web-based system.
- The length of the project-is the available technology likely to change before the project is over? While the use of new technology is often worthwhile, it may be limited by team knowledge and not worth the training involved unless the size and length of the project, and personnel interest warrant it.

.3 Constraints. The *PMBOK® Guide* - 2000 Edition notes that" When a project is performed under contract, there are often specific contractual provisions that affect communications planning". This is almost always true for construction projects. In addition, it may be important to restrict the distribution of sensitive information only to those who have a need to know. One of the important restrictions applies to those who are authorized to make changes, particularly relevant in the use of computer-generated and shared design. Another important required constraint involving change requests is the need for an agreed communication path for those requests to avoid the practice of some owners to issue changes to unauthorized construction personnel.

.4 Assumptions. See Section 4.1.1.5. of the *PMBOK® Guide* - 2000 Edition.

10.1.2 Tools and Techniques for Communications Planning

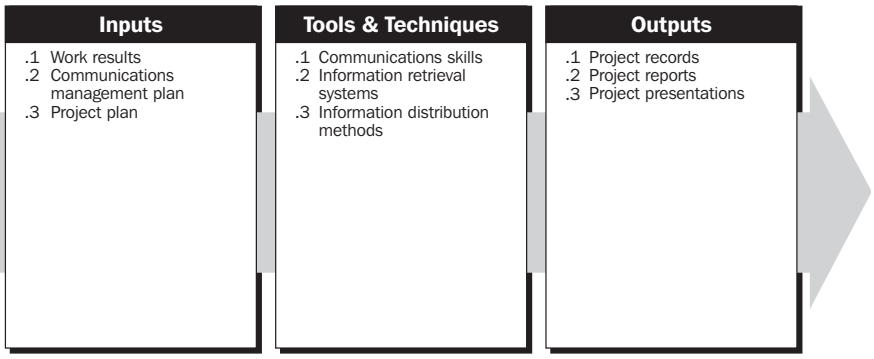
.1 Stakeholder analysis. The *PMBOK® Guide* - 2000 Edition states " The information needs of the various stakeholders should be analyzed to develop a methodical and logical view of their information needs and sources to meet those needs (project stakeholders are discussed in more detail in Section 2.2 of the *PMBOK® Guide* - 2000 Edition". Stakeholders for construction projects, beside the obvious ones of the customer and the design and construction team, might include utilities, government agencies, financial institutions, the general public and others who have an interest in or are affected by the project.

10.1.3 Outputs from Communications Planning

.1 Communications management plan. See Section 10.1.3 of the *PMBOK® Guide* - 2000 Edition.

10.2 INFORMATION DISTRIBUTION

The *PMBOK® Guide* - 2000 Edition says "information distribution involves making needed information available to project stakeholders in a timely manner. It includes implementing the communications management plan, as well as responding to unexpected requests for information."



10.2.1 Inputs to Information Distribution

.1 Work results. Work results are described in Section 4.2.3.1.of the *PMBOK® Guide* - 2000 Edition. Work results should also include forecasts of future activity that, for example, might be of great interest to an affected community as well as to the client.

.2 Communications management plan. The communications management plan is described in Section 10.1.3.1 of the *PMBOK® Guide* - 2000 Edition.

.3 Project plan. The project plan is described in Section 4.1.3.1.of the *PMBOK® Guide* - 2000 Edition.

10.2.2 Tools and Techniques for Information Distribution

.1 Communications skills. The *PMBOK® Guide* - 2000 Edition says " communications skills are used to exchange information. The sender is responsible for making the information clear, unambiguous, and complete, so that the receiver can receive it correctly, and for confirming that it is properly understood. The receiver is responsible for making sure that the information is received in its entirety and understood correctly." It may be that some skills do not exist within the project team and other professional services such as a public relations consultant may be required.

.2 Information retrieval systems. See Section 10.2.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Information distribution methods. Project information may be distributed using a variety of methods including kick-off and regular project meetings, hard-copy document distribution, shared access to networked electronic databases, fax, electronic mail, voice mail, videoconferencing, and project intranet. For some larger projects a "war room" may be established as a means of distributing much project information to those intimately involved with the project. In addition, the use of public relations or other specialty services may be required.

10.2.3 Outputs from Information Distribution

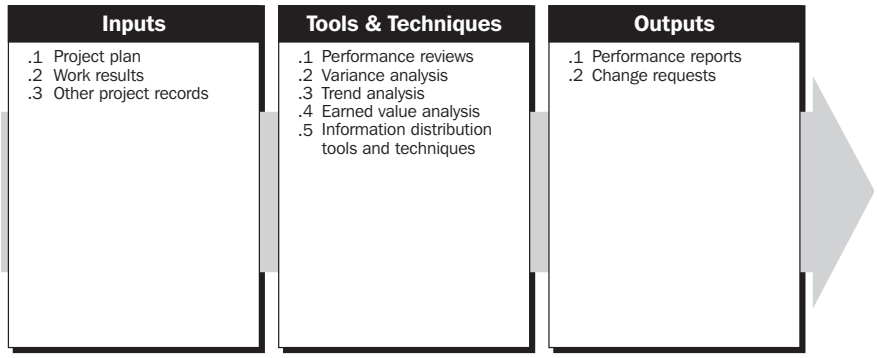
.1 Project records. Project records may include correspondence, memos, and documents describing the project, as well as purchase orders, (sub)contracts, cost and schedule records, photos, etc. This information should, to the extent possible and appropriate, be maintained in an organized fashion. Project team members may often, and are encouraged to, maintain personal records in a project notebook. Such information may later be important in resolving disputes over project changes.

.2 Project reports. See 10.2.3.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Project presentations. See 10.2.3.3 of the *PMBOK® Guide* - 2000 Edition.

10.3 PERFORMANCE REPORTING

Performance reporting involves collecting and disseminating performance information to provide stakeholders with information about how resources are being used to achieve project objectives. Information Distribution in a design/construction project is important enough to warrant a separate section for reporting.



The *PMBOK® Guide* - 2000 Edition states that this process includes:

- Status reporting-describing where the project now stands, for example, status related to schedule and budget metrics.
- Progress reporting-describing what the project team has accomplished, for example, percent complete to schedule, or what is completed versus what is in process.
- Forecasting-predicting future project status and progress. Performance reporting should generally provide information on scope, schedule, cost, and quality. Construction projects usually also require information on risk and procurement. Reports may be prepared comprehensively or on an exception basis.

10.3.1 Inputs to Performance Reporting

.1 Project plan. The project plan is discussed in Section 4.1.3.1. of the *PMBOK® Guide* - 2000 Edition.

.2 Work results. See Section 10.3.1.2 of the *PMBOK® Guide* - 2000 Edition. In addition, work results should include a cumulative and running record of the time required to respond to RFIs.

.3 Other project records. Project records are discussed in Section 10.2.3.1 of the *PMBOK® Guide* - 2000 Edition.

10.3.2 Tools and Techniques for Performance Reporting

The *PMBOK® Guide* - 2000 Edition lists the following tools and techniques:

.1 Performance reviews. Performance reviews are meetings held to assess project status and/or progress. Performance reviews are typically used in conjunction with one or more of the performance-reporting techniques described below. These review meetings are usually held with the Client often at monthly intervals. Depending on the type of project, periodic reviews may sometimes consist of a public hearing, which usually requires additional preparation and broader notification. The *PMBOK® Guide* - 2000 Edition includes these other performance-reporting techniques which are particularly applicable to construction projects.

.2 Variance analysis. See Section 10.3.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Trend analysis. See Section 10.3.2.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Earned value analysis. See Section 10.3.2.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Information distribution tools and techniques. See Section 10.3.2.5 of the *PMBOK® Guide* - 2000 Edition.

10.3.3 Outputs from Performance Reporting

.1 Performance reports. The *PMBOK® Guide* - 2000 Edition says " performance reports organize and summarize the information gathered and present the results of any analysis. Reports should provide the kinds of information and the level of detail required by various stakeholders, as documented in the communications management plan." Performance reports include periodic (often monthly) project status reports that describe the status of the project and a forecast of future activity of cost and earned value and also status of design, procurement, expediting, risk evaluation and quality activities of the project. It is also suggested that performance reporting include the RFI response record. The *PMBOK® Guide* - 2000 Edition describes common formats for performance reports including bar charts (also called Gantt charts), S-curves, histograms, and tables. Figures 10-2 and 10-3 of Section 10.3.2 of the *PMBOK® Guide* - 2000 Edition display samples of these types. Figure 10-1 shows a common form of a vital report for construction projects - a Cost and Comparison to Estimate Report.

COST AND COMPARISON TO ESTIMATE REPORT

		Recorded Costs		Open Commitments	Cumulative Total	Continued Below
Acct.	**Description**	**Period**	**Cumulative to date**			
201	Concrete work	10,500	210,500	6,500	217,000	
301	Mechanical contract	300,000	5,400,000	80,000	5,480,000	
401	Electrical	110,000	2,300,000	120,000	2,420,000	

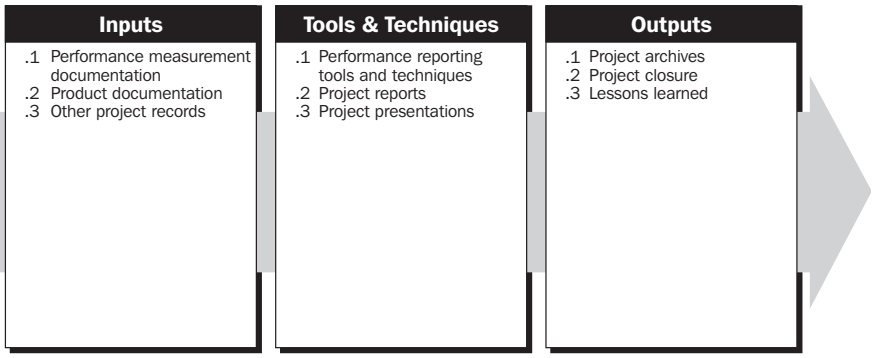
		Estimate to Complete	Estimate at Completion				Over (under)
Acct.	**Description**		**Current**	**Previous**	**Incr.(Decr.)**	**Budget**	**Budget**
201	Concrete work	51,000	268,000	250,000	18,000	260,000	8,000
301	Mechanical contract	120,000	5,600,000	5,600,000	0	5,600,000	0
401	Electrical	60,000	2,480,000	2,450,000	30,000	2,500,000	-20,000

Figure 10–1. Cost and Comparison to Estimate Report

.2 Change requests. Analysis of project performance often generates a request for a change to some aspect of the project. These change requests are handled as described in the various change control processes (e.g., scope change management, schedule control, etc.) and further detailed in Section 5.5 of the *PMBOK® Guide* - 2000 Edition.

10.4 ADMINISTRATIVE CLOSURE

An important phase in the life of a construction project is administrative closure, whether it comes after either achieving its objectives or being terminated for other reasons. The *PMBOK® Guide* - 2000 Edition states, "administrative closure consists of documenting project results to formalize acceptance of the product of the project by the sponsor, or customer. It includes collecting project records; ensuring that they reflect final specifications; analyzing project success, effectiveness, and lessons learned; and archiving such information for future use." Administrative closure activities should not be delayed until project completion; this is a particularly important point in connection with construction projects with their varied and large number of elements and typical lack of funding and personnel to complete the closure process. Each phase of the project should be properly closed to ensure that important and useful information is not lost. Critical among this information are as-built records of the construction showing actual dimensions and elevations of the completed work, especially underground work that may need to be repaired or modified later. Industrial projects are normally completed in order of the product process, which makes it possible and beneficial to complete and "close" portions of the project as the entire project moves to closeout. Also in this process, owners may begin occupying and running completed portions before the entire project is completed (beneficial occupancy).



10.4.1 Inputs to Administrative Closure

The *PMBOK® Guide* - 2000 Edition lists these inputs to Administrative Closure:

.1 Performance measurement documentation. See Section 10.4.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Product documentation. For construction projects these documents also include inspection and testing records and reports, operation and maintenance manuals, and similar records that are relevant to the completion and performance of the project.

.3 Other project records. Project records are discussed in Section 10.2.3.1.of the *PMBOK® Guide* - 2000 Edition.

10.4.2 Tools and Techniques for Administrative Closure

Section 10.4.2 of the *PMBOK® Guide* - 2000 Edition discusses these tools and techniques:

.1 Performance reporting tools and techniques. See Section 10.4.2.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Project reports. See Section 10.4.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Project presentations. See Section 10.4.2.3 of the *PMBOK® Guide* - 2000 Edition.

10.4.3 Outputs from Administrative Closure

.1 Project archives. See Section 10.4.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Project closure. The *PMBOK® Guide* - 2000 Edition states that closure is "confirmation that the project has met all customer requirements for the product of the project (the customer has formally accepted the project results and deliverables and the requirements of the delivering organization-for example, staff evaluations, budget reports, lessons learned, etc.)." Project closure may come in steps as significant portions of the project are completed and turned over to the owner for beneficial occupancy or provisional acceptance. In addition to the formal acceptance documents to be signed by the customer, many construction projects have other documentation required by governmental agencies to be prepared, executed and dis-

tributed. The formal action of final acceptance and closure will in almost all cases be guided by provisions of contractual documents under which the project was constructed.

.3 Lessons learned. Lessons learned are discussed in Section 4.3.3.3.of the *PMBOK® Guide* - 2000 Edition It is important that the information that form these lessons be gathered and documented while knowledgeable team members are still involved (see 9.4.2 of this Extension).

Chapter 11

Project Risk Management

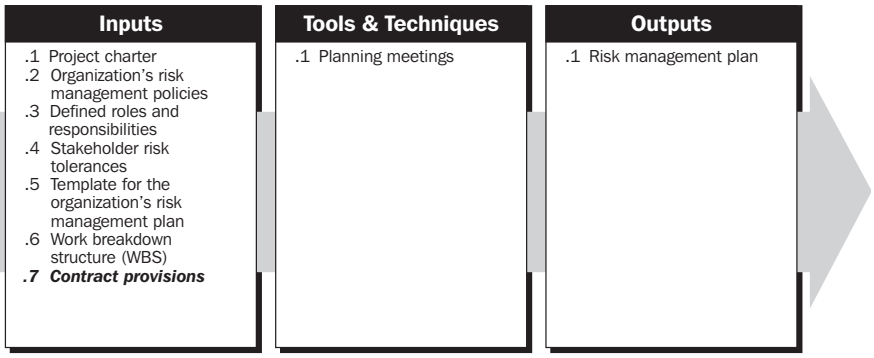
The *PMBOK® Guide* - 2000 Edition defines Project Risk management as "the systematic process of identifying, analyzing, and responding to project risk." Construction risk can be managed with the processes described there with reasonable adequacy.

The *PMBOK® Guide* - 2000 Edition describes six processes for project risk management:

11.1 Risk Management Planning.
11.2 Risk Identification.
11.3 Qualitative Risk Analysis.
11.4 Quantitative Risk Analysis.
11.5 Risk Response Planning.
11.6 Risk Monitoring and Control.

These processes can be executed beginning with the bidding phase or even earlier of a construction project, to help assess the contingency and management reserve that will be included in the bid total price.

11.1 RISK MANAGEMENT PLANNING



11.1.1 Inputs to Risk Management Planning

The inputs to risk management planning are discussed in the section 11.1.1 of the *PMBOK® Guide* - 2000 Edition. This extension will discuss only the aspects of the inputs that are specific to construction projects.

.1 Project charter. Two additional sources may apply to construction: during the bidding phase, the charter can be a Request For Proposal, Invitation for Bid or a similar document that the bidding team will use to guide risk analysis. When contract is signed, it should be considered, together with the proposal and bidding documentation, as the project charter.

.2 Organization's risk management policies. According to the *PMBOK® Guide* - 2000 Edition "Some organizations may have predefined approaches to risk analysis and response that have to be tailored to a particular project." This is to be strictly considered when operating under a Consortium.

.3 Defined roles and responsibilities. See Section 11.1.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Stakeholder risk tolerances. See Section 11.1.1.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Template for the organization's risk management plan. The *PMBOK® Guide* - 2000 Edition says "Some organizations have developed templates (or a pro-forma standard) for use by the project team." When the project is performed by a consortium or joint venture, templates from all companies can be considered and a particular template for the project can be developed, or the project team can decide to use one or none of them.

.6 Work Breakdown Structure (WBS). See Section 11.1.1.6 of the *PMBOK® Guide* - 2000 Edition.

.7 Contract provisions. The contract may contain clauses or other provisions that affect the contractor's project liability.

11.1.2 Tools and Techniques for Risk Management Planning

.1 Planning meetings. See Section 11.1.2 of the *PMBOK® Guide* - 2000 Edition.

11.1.3 Outputs from Risk Management Planning

The inputs to risk management planning are discussed in the section 11.1.3 of the *PMBOK® Guide* - 2000 Edition. This extension will discuss only the aspects of the inputs that are specific to construction projects.

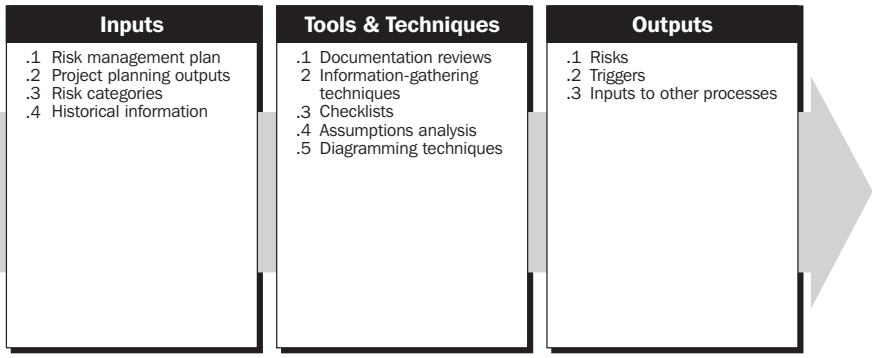
.1 Risk management plan. The *PMBOK® Guide* - 2000 Edition describes the risk management plan and the topics it should include. In construction projects, some specific issues should be addressed in those topics. This extension approaches those issues, taking the *PMBOK® Guide* - 2000 Edition as the reference.

- Methodology. The methodology addresses topics such as which phases to perform. Individual risk management processes and how its outputs will be linked to the overall project risk management. For example, in an EPCM (Engineering, Procurement, Construction & Management) project the engineering and construction phases may have individual risk management processes while procurement and management phases can be treated together. It also addresses how safety and environmental

risk management plans (see Sections 13 and 14) will interact with the overall construction risk management plan and how subcontractors' risk management plans will fit into the overall project risk management plan.
- Budgeting. Establishes a budget for risk management for the project, which should be equal or less than the amount allocated for that purpose in the bid price.
- Scoring and interpretation. For safety and environmental planning, there may be local standards, norms and laws regulating scoring and interpretation methods.

11.2 RISK IDENTIFICATION

Section 11.2.1 of the *PMBOK® Guide* - 2000 Edition discusses risk identification and its iterative nature. For construction projects, all iterations suggested in the section 11.2.1 of the *PMBOK® Guide* - 2000 Edition may be performed, including a former iteration that is performed while in the bidding process, to support pricing and contract negotiation decisions.



11.2.1 Inputs to Risk Identification

Section 11.2.1 of the *PMBOK® Guide* - 2000 Edition discusses the following four inputs to Risk Identification:

.1 Risk management plan. See Section 11.2.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Project planning outputs. All outputs listed in the section 11.2.1 of the *PMBOK® Guide* - 2000 Edition should be considered, and some of them have important aspects, as discussed below:
- Project charter. The Request For Proposal or Contract, depending on the project phase.
- Product description. All performance requirements of the facility which construction is the contract object have to be considered.
- Resource plan. Resource productivity estimates are a key input to risk identification, activity duration and cost estimates are based on those rates, particularly for engineering and construction phases.

.3 Risk categories. According to the *PMBOK® Guide* - 2000 Edition "Risks that may affect the project for better or worse can be identified and organized into risk categories." All particular categories of construction projects fit into one of those described in section 11.2.1.1 of the *PMBOK® Guide* - 2000 Edition. Some important aspects of those categories are noted below:

- Layout risks-as construction projects are highly dependent on human resources and equipment, respecting the schedule is a very important factor of success to the project. This is often addressed by resource leveling (see the *PMBOK® Guide* - 2000 Edition, Chapter 6) but a particular aspect can only be addressed by expert judgment: the facility layout. Formal resource leveling is usually performed on larger projects with a resource loaded schedule. Informal leveling is most often performed by site management to avoid crowding and crew stacking by sequencing the work using schedule logic.

  Depending on the layout designed by engineering, two major problems may arise:

  1) Resource overloading. This is related to the law of diminishing returns. If a productivity rate is achieved with a certain number of resources when more resources are allocated, the tendency is to have a decrease in the rate. The decrease is stronger if the layout is concentrated, with little room between different task fronts.
  2) Interference between task fronts. For example, if the engineering underground systems designers delay their output, construction of those systems can collide with heavy equipment erection, due to crane positioning or excavation clearances.
- Project-management risks-In this category, poor coordination of subcontractors' project plans appears besides others described in the *PMBOK® Guide* - 2000 Edition.

.4 Historical information.

11.2.2 Tools and Techniques for Risk Identification

Section 11.2.2 of the *PMBOK® Guide* - 2000 Edition discusses the following tools and techniques for risk identification.

.1 Documentation reviews. In construction projects, besides documents described in the *PMBOK® Guide* - 2000 Edition, documents such as layout drawings, plant location and access, equipment erection specifications, and others should be included in the review. Permits, licenses and agreements with labor unions and communities may also include requirements that bring risk to the project.

.2 Information-gathering techniques. See Section 11.2.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Checklists. For construction projects, checklists might include such items as: type of contract, unfavorable clauses, site and area factors, weather, regulatory and labor factors, knowledge of client and many others as well as the usual appraisal of construction equipment requirements, techniques needed and special materials

.4 Assumptions analysis. In construction projects, all assumptions made during the bidding phase should be reviewed from time to time.

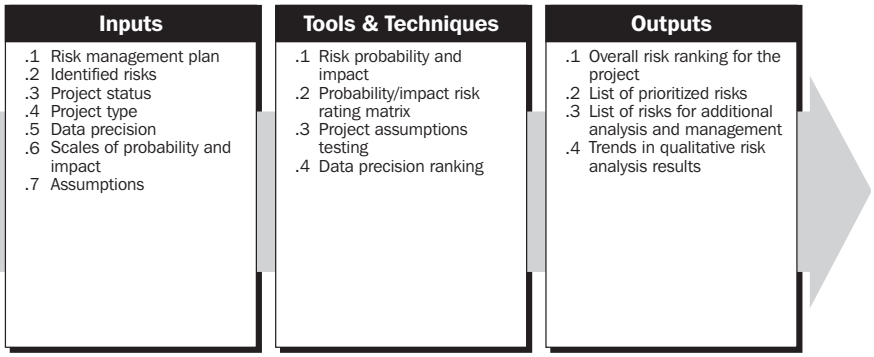
.5 Diagramming techniques. See Section 11.2.2.5 of the *PMBOK® Guide* - 2000 Edition.

11.2.3 Outputs from Risk Identification

Section 11.2.3 of the *PMBOK® Guide* - 2000 Edition discusses three outputs from risk identification.

.1 Risks. See Section 11.2.3.1 of the *PMBOK® Guide* - 2000 Edition.
.2 Triggers. See Section 11.2.3.2 of the *PMBOK® Guide* - 2000 Edition.
.3 Inputs to other processes. See Section 11.2.3.3 of the *PMBOK® Guide* - 2000 Edition.

11.3 QUALITATIVE RISK ANALYSIS



11.3.1 Inputs to Qualitative Risk Analysis

Section 11.3.1 of the *PMBOK® Guide* - 2000 Edition discusses inputs to qualitative risk analysis.

.1 Risk management plan. See Section 11.3.1.1 of the *PMBOK® Guide* - 2000 Edition.
.2 Identified risks. See Section 11.3.1.2 of the *PMBOK® Guide* - 2000 Edition.
.3 Project status. The *PMBOK® Guide* - 2000 Edition says, "The uncertainty of a risk often depends on the project's progress through its life cycle." In construction projects, the bidding phase is a stage of the project life cycle and should be considered a part of this analysis.
.4 Project type. See Section 11.3.1.4 of the *PMBOK® Guide* - 2000 Edition.
.5 Data precision. See Section 11.3.1.5 of the *PMBOK® Guide* - 2000 Edition.
.6 Scales of probability and impact. See Section 11.3.1.6 of the *PMBOK® Guide* - 2000 Edition.
.7 Assumptions. See Section 11.3.1.7 of the *PMBOK® Guide* - 2000 Edition.

11.3.2 Tools and Techniques for Qualitative Risk Analysis

Section 11.3.2 of the *PMBOK® Guide* - 2000 Edition discusses the tools and technique for qualitative risk analysis.

.1 Risk probability and impact. See Section 11.3.2.1 of the *PMBOK® Guide* - 2000 Edition.
.2 Probability/impact risk rating matrix. For assessing risk probability and impact with the use of a rating matrix, expert judgment is commonly used. However, in construction projects care should be taken with the use of expert judgment as those individuals may represent different stakeholders and different interests, introducing a bias in the risk analysis. For example, experts from the client, main contractor, subcontractors and government agencies may set much different values for the probability and impact of a given risk.

.3 Project assumptions testing. See Section 11.3.2.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Data precision ranking. See Section 11.3.2.4 of the *PMBOK® Guide* - 2000 Edition.

11.3.3 Outputs from Qualitative Risk Analysis

Section 11.3.3 of the *PMBOK® Guide* - 2000 Edition describes outputs from qualitative risk analysis.

.1 Overall risk ranking for the project. In construction projects, the risk ranking is a useful tool to support the go - no go decision to bid in answer to a RFP.

.2 List of prioritized risks. See Section 11.3.3.2 of the *PMBOK® Guide* - 2000 Edition.

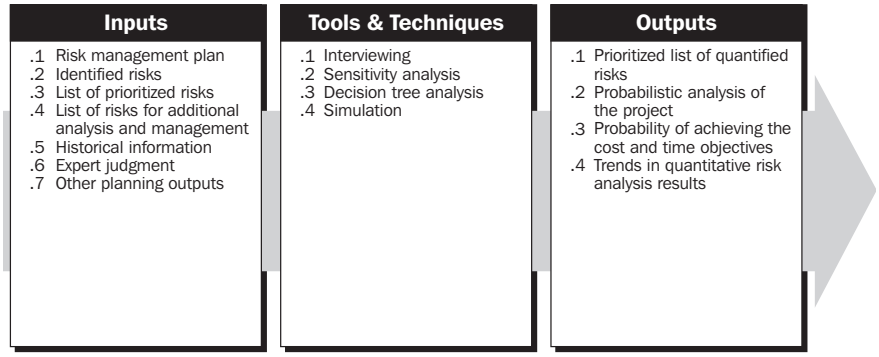
.3 List of risks for additional analysis and management. See Section 11.3.3.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Trends in qualitative risk analysis results. See Section 11.3.3.4 of the *PMBOK® Guide* - 2000 Edition.

11.4 QUANTITATIVE RISK ANALYSIS

The quantitative risk analysis process, although not very common in construction projects, is very useful to support project management decisions. This process uses techniques such as Monte Carlo simulation and decision analysis to determine many project assumptions. Some of them are discussed below:

- Determine the probability of achieving a specific project objective. When bidding, if the final project date is not determined by client, the project team can decide what completion date to inform (offer) based on the risk level they are willing to accept.
- Identify realistic and achievable cost, schedule, or scope targets. Acceleration plans are greatly benefited from this analysis and aggressive targets can be negotiated in a lower degree of uncertainty.



11.4.1 Inputs to Quantitative Risk Analysis

Section 11.4.1 of the *PMBOK® Guide* - 2000 Edition discusses inputs to quantitative risk analysis.

.1 Risk management plan. See Section 11.4.1.1 of the *PMBOK® Guide* - 2000 Edition.
.2 Identified risks. See Section 11.4.1.2 of the *PMBOK® Guide* - 2000 Edition.
.3 List of prioritized risks. See Section 11.4.1.3 of the *PMBOK® Guide* - 2000 Edition.
.4 List of risks for additional analysis and management. See Section 11.4.1.4 of the *PMBOK® Guide* - 2000 Edition.
.5 Historical information. See Section 11.4.1.5 of the *PMBOK® Guide* - 2000 Edition.
.6 Expert judgment. See Section 11.4.1.6 of the *PMBOK® Guide* - 2000 Edition.
.7 Other planning outputs. Besides the helpful planning outputs described by the *PMBOK® Guide* - 2000 Edition, resource productivity estimates that guide duration and cost estimates are used.

11.4.2 Tools and Techniques for Quantitative Risk Analysis

Section 11.4.2 of the *PMBOK® Guide* - 2000 Edition describes the tools and techniques for quantitative risk analysis.

.1 Interviewing. See Section 11.4.2.1 of the *PMBOK® Guide* - 2000 Edition.
.2 Sensitivity analysis. See Section 11.4.2.2 of the *PMBOK® Guide* - 2000 Edition.
.3 Decision tree analysis. See Section 11.4.2.3 of the *PMBOK® Guide* - 2000 Edition.
.4 Simulation. See Section 11.4.2.4 of the *PMBOK® Guide* - 2000 Edition.

11.4.3 Outputs from Quantitative Risk Analysis

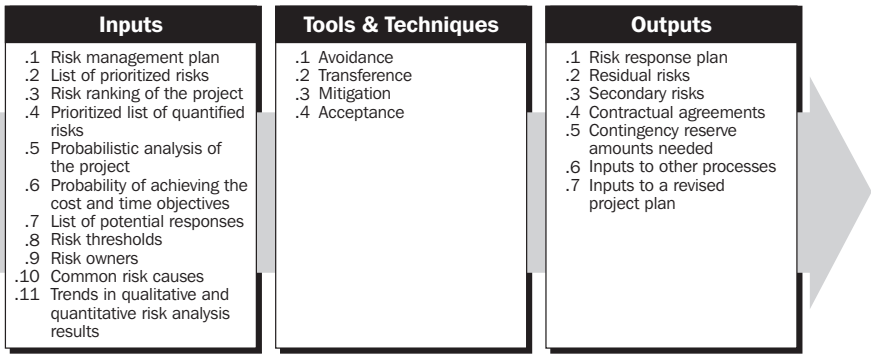
Section 11.4.3 of the *PMBOK® Guide* - 2000 Edition discusses the outputs from quantitative risk analysis.

.1 Prioritized list of quantified risks. See Section 11.4.3.1 of the *PMBOK® Guide* - 2000 Edition.
.2 Probabilistic analysis of the project. See Section 11.4.3.2 of the *PMBOK® Guide* - 2000 Edition.
.3 Probability of achieving the cost and time objectives. See Section 11.4.3.3 of the *PMBOK® Guide* - 2000 Edition.
.4 Trends in quantitative risk analysis results. See Section 11.4.3.4 of the *PMBOK® Guide* - 2000 Edition.

11.5 RISK RESPONSE PLANNING

The *PMBOK® Guide* - 2000 Edition says "Risk response planning is the process of developing options and determining actions to enhance opportunities and reduce threats to the project's objectives." It includes the identification and assignment of individuals or parties to take responsibility for each agreed risk response." In construction projects, where there is usually involvement of subcontractors, risk response planning is a more complex process, as risk responses may result in additional costs incurred by one party to influence outcomes of events that will impact another party. Timing

has to be carefully planned for risk management processes and risk responses have to be negotiated.



11.5.1 Inputs to Risk Response Planning

Section 11.5.1 of the *PMBOK® Guide* - 2000 Edition discusses inputs to risk response planning.

.1 Risk management plan. See Section 11.5.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 List of prioritized risks. See Section 11.5.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Risk ranking of the project. See Section 11.5.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Prioritized list of quantified risks. See Section 11.5.1.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Probabilistic analysis of the project. See Section 11.5.1.5 of the *PMBOK® Guide* - 2000 Edition.

.6 Probability of achieving the cost and time objectives. See Section 11.5.1.6 of the *PMBOK® Guide* - 2000 Edition.

.7 List of potential responses. The list of potential responses is very important for construction projects, once each response has associated cost, time and responsible party. The level of detail for this list should be more than superficial to allow better decision making.

.8 Risk thresholds. See Section 11.5.1.8 of the *PMBOK® Guide* - 2000 Edition.

.9 Risk owners. See Section 11.5.1.9 of the *PMBOK® Guide* - 2000 Edition.

.10 Common risk causes. See Section 11.5.1.10 of the *PMBOK® Guide* - 2000 Edition.

.11 Trends in qualitative and quantitative risk analysis results. See Section 11.5.1.11 of the *PMBOK® Guide* - 2000 Edition.

11.5.2 Tools and Techniques for Risk Response Planning

Section 11.5.2 of the *PMBOK® Guide* - 2000 Edition discusses tools and techniques for risk response planning.

.1 Avoidance. Risk avoidance is more effective during early project phases and contract negotiation. After a contract is signed, some of the major risks regarding plant performance and penalties cannot be avoided.

.2 Transference. The *PMBOK® Guide* - 2000 Edition says, "Risk transfer is seeking to shift the consequence of a risk to a third party together with ownership of the response. Transferring the risk simply gives another party responsibility for its management; it does not eliminate it." The most common form of transference is insurance. The construction industry uses a variety of insurance coverage to handle some of their liabilities: builder's risk, umbrella policies, and special types to take care of some of the environmental and currency risks. Subcontracting following trades disciplines, is also very common in construction projects; for many reasons, the greatest of them being the broad scope of construction contracts and the specialization of subcontractors. However, that decision is seldom made as a result of risk response planning. Risk transference can be more smoothly achieved if the response is planned before subcontract bidding process starts, so timing is again a critical factor in risk management of construction projects.

.3 Mitigation. See Section 11.5.2.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Acceptance. See Section 11.5.2.4 of the *PMBOK® Guide* - 2000 Edition.

11.5.3 Outputs from Risk Response Planning

Section 11.5.3 of the *PMBOK® Guide* - 2000 Edition discusses outputs from risk response planning.

.1 Risk response plan. See Section 11.5.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Residual risks. See Section 11.5.3.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Secondary risks. See Section 11.5.3.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Contractual agreements. One long-used and common clause is the "force majeure" clause relating to responsibilities resulting from "acts of God". A variety of clauses can be written to properly divide liabilities between the owner and contractor according to their ability to control them.

.5 Contingency reserve amounts needed. See Section 11.5.3.5 of the *PMBOK® Guide* - 2000 Edition.

.6 Inputs to other processes. See Section 11.5.3.6 of the *PMBOK® Guide* - 2000 Edition.

.7 Inputs to a revised project plan. See Section 11.5.3.7 of the *PMBOK® Guide* - 2000 Edition.

11.6 RISK MONITORING AND CONTROL

See section 11.6 of the *PMBOK® Guide* - 2000 Edition.

Chapter 12

Project Procurement Management

Project Procurement Management includes the processes required to acquire goods and services from outside the organization, to attain project objective, the constructed facilities. It involves capital projects development whether it is in the form of a new grass-root facility, expansion, renovation, improvement, or in some cases disposition of facilities. For simplicity, services, will generally be referred to as work. Figure 12-1 of the *PMBOK® Guide* - 2000 Edition provides an overview of the following major processes:

12.1 Procurement Planning. Determining what to procure, how, and when.

12.2 Solicitation Planning. Documenting product requirements and identifying potential sources.

12.3 Solicitation. Obtaining quotations, bids, offers, or proposals, as appropriate.

12.4 Source Selection. Choosing from among potential sellers.

12.5 Contract Administration. Managing the relationship with the seller.

12.6 Contract Closeout. Completion and settlement of the contract, including resolution of any open items.

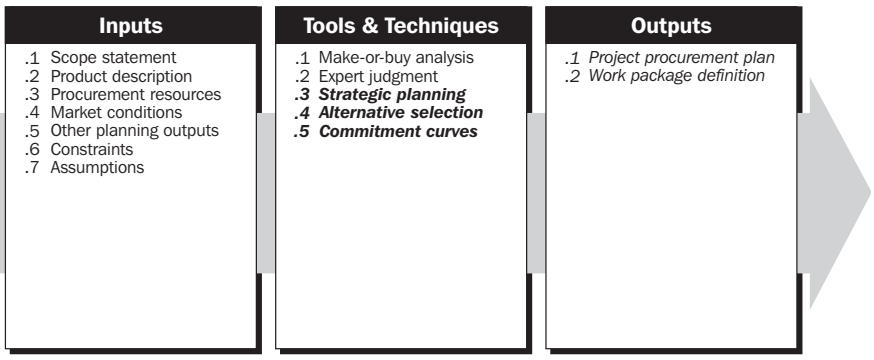
The *PMBOK® Guide* - 2000 Edition says "Project Procurement Management is discussed from the perspective of the buyer in the buyer-seller relationship. The buyer-seller relationship can exist at many levels on one project." The processes described here may apply to; an owner of the facilities being built, expanded or improved, his representatives (a construction management firm); or a general contractor responsible for building part or the whole of the facilities. Depending on the application area, the seller may be called a general contractor, a major subcontractor, a vendor, or a supplier.

As in the *PMBOK® Guide* - 2000 Edition, this chapter assumes that the seller is external to the performing organization

12.1 PROCUREMENT PLANNING

The *PMBOK® Guide* - 2000 Edition says "Procurement planning is the process of identifying which project needs can be best met by procuring products or services outside the organization and should be accomplished during the scope definition effort. It involves consideration of whether to procure, how to procure, what to procure, how much to procure, and when to procure." Procurement planning decisions normally questions whether it is better for an organization to perform the work internally or to buy it from the others; the buy or make decision. These decisions have a profound impact on the project success or failure and are normally tied up more to organizational strategic planning decisions rather than the project management domain. Thus, a project procurement strategy is an important aspect of the planning process. The project procurement strategy addresses the scope of work to be procured, the way the work is to be broken down into discrete packages, identify major types of project stakeholders, and timing of their participation. It also defines the level of involvement in the selection and control of lower tier players (contractors, subcontractors, vendors) by the owner of the facilities. Project Procurement strategy normally is generated from lessons learned by the organization in developing existing facilities and influenced by the existing organizational polices, culture, and procedures. While, the project procurement strategy might not be formally treated, the project procurement plans are more of a formal document.

Project procurement plans stems from the procurement strategy. The project procurement plan is a critical aspect of the project plan that has a profound influence over how project controls of cost, schedule, quality and functions will be exercised. It reflects senior management aptitude for risk taking and identifies major categories of risks and their allocation.



12.1.1 Inputs to Procurement Planning

The *PMBOK® Guide* - 2000 Edition lists seven inputs to procurement planning, all of which apply to construction projects:

.1 Scope statement. The scope statement (see Section 5.2.3.1 of the *PMBOK® Guide* - 2000 Edition) describes the current project boundaries. It provides important information about project needs and strategies that must be considered during procurement planning.

.2 Facility description. (Called product description in the *PMBOK® Guide* - 2000 Edition) The Facilities description is generally broader than a statement of work. A facilities description provides an overview of the facili-

ties required for the project. It defines the location of the facilities, conditions of operations, and existing interfaces. It provides a general description of the owner requirements in terms of functions, operations, maintenance, reliability, and ultimate life cycle. It constitutes a part of the Project Charter document.

.3 Procurement resources. See Section 12.1.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Market conditions. See Section 12.1.1.4 of the *PMBOK® Guide* - 2000 Edition.

.5 Other planning outputs. See Section 12.1.1.5 of the *PMBOK® Guide* - 2000 Edition.

.6 Constraints. Constraints are factors that limit the buyer's options. Examples are schedule considerations, owner preferences, corporate procurement policies, government regulations (including social responsibility requirements), and union agreements.

.7 Assumptions. See Section 12.1.1.7 of the *PMBOK® Guide* - 2000 Edition.

12.1.2 Tools and Techniques for Procurement Planning

.1 Make-or-buy analysis. See Section 12.1.2 of the *PMBOK® Guide* - 2000 Edition. In the construction industry this is the equivalent of self-performing work or subcontracting it out.

.2 Expert judgment. See Section 12.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Strategic Planning. It is the essential tool in project procurement planning. This is where the project strategic decisions that affect project procurement will be made. Decisions such as the mode of project execution, the level of owner involvement, the breakdown of project phases, the number of go/no-go points, etc. The more project phases, the more owner organization have control over the project outcomes. However, control comes with added responsibility and hence requires increased resources. Also, the sequence and interdependency of work packages are considered during project procurement planning, for instance, the procurement of long lead equipment, field surveying services, and basic design services.

.4 Alternative Selection. Is concerned with selecting the best strategy for project execution including the project procurement activities. This tool is the crux of project planning and the decisions made at this point largely impact the project outcome. This strategy determines which parts of the project are best suited to a particular execution approach depending upon a number of factors such as degree of definition, schedule, and cost requirements and uniqueness of requirement. Alternative selection requires the same general management skills employed for corporate strategic planning. Some of the alternative techniques that might be utilized include:

- Turnkey or design-build where the responsibility for both design and construction is obtained from a single source.
- Design-bid-build where the design and construction are performed by separate organizations. This is the traditional construction method where the construction is then performed by way of competitive bidding after the design is essentially complete.

- Construction management where the construction is executed like design-bid-build but the construction is coordinated by an overall construction manager. General contractors function much like this with their subcontractors.
- Single-source, non-competitive. In cases where the construction requirements are unique or where there is only one source for the desired result, a negotiated contract with the source is the usual way of accomplishing this.

.5 Commitment curves. When the procurement actions have been identified, they can be scheduled as commitments in time. Then as actions are placed and payments made, progress can be tracked against the procurement plan and schedule providing the procurement group and the project management an ongoing picture of procurement progress. These curves also play a part in the overall assessment of project progress and cost (see sections 6 and 7).

12.1.3 Outputs from Procurement Planning

.1 Project Procurement Management Plan. The project procurement management plan should describe how the remaining procurement processes (from solicitation planning through contract closeout) will be managed. For example:

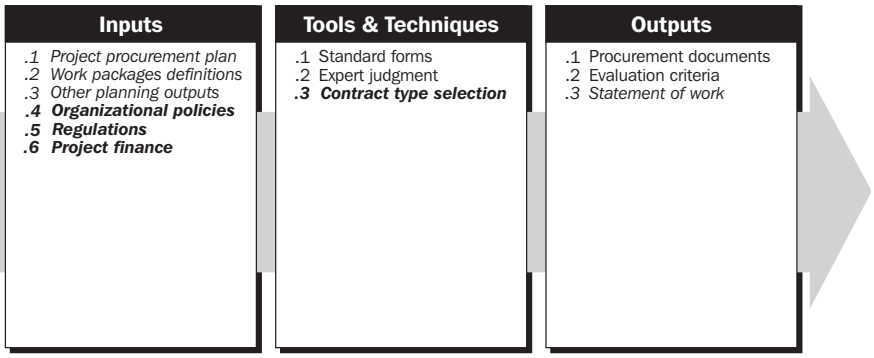
- What types of contractual instrument (such as contract, purchase order, task order) will be used?
- Who will prepare the independent estimates needed for the evaluation of the contractors' proposals and to which level of accuracy?
- Which procurement resources (expertise) are needed for the project and how to obtain them?

As the *PMBOK® Guide* - 2000 Edition says, "A project procurement plan may be formal or informal, highly detailed or broadly framed, based on the needs of the project. It is a subsidiary element of the project plan described in Section 4.1, Project Plan Development of the *PMBOK® Guide* - 2000 Edition.

.2 Work Package Definition. It describes the contents of each work package defined by the project procurement strategy. Work package definitions serve as the starting point for statement of work definition by project team members. It defines the outcome (deliverables or products) of each work package and defines the boundaries and interfaces with other work packages. It is also set up for resource requirements anticipated to be used to execute this work package. It specifies the criteria by which to measure completion or satisfaction of scope of work.

12.2 SOLICITATION PLANNING

The *PMBOK® Guide* - 2000 Edition says "Solicitation planning involves preparing the documents needed to support solicitation (the solicitation process is described in Section 12.3 of the *PMBOK® Guide* - 2000 Edition).



12.2.1 Inputs to Solicitation Planning

.1 Project Procurement Plan. The project procurement plan is described in Section 12.1.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Work Packages Definitions. (SOW) Refer to new section 12.1.3.2 above. The level of definition also affects the type of contract selection (Fixed Cost / Reimbursable).

.3 Other planning outputs. See Section 12.1.1.5 of the *PMBOK® Guide* - 2000 Edition.

In addition to the three listed by the *PMBOK® Guide* - 2000 Edition, construction projects include these outputs:

.4 Organizational Policies. Solicitation planning should consider organizational policies governing the tendering procedures.

.5 Regulations. Regulations often impact the tendering process and procedure particularly in government projects or projects funded by multinational institutions such as World Bank or United Nations, which may also include social responsibility requirements.

.6 Project Finance. Source and type of project finance (whether recourse or non-recourse finance) have a major impact on solicitation planning elements such as forms of contract, origins and qualifications of bidders, involvement of engineers and consultants, tendering procedure.

12.2.2 Tools and Techniques for Solicitation Planning

.1 Standard forms. See Section 12.2.2 of the *PMBOK® Guide* - 2000 Edition. Typically, standard forms of contracts are saved in an electronic format. The presence of an electronic library of forms of contracts and standard instructions for contract formation on organizations' Local Area Networks or Intranet site helps reduce the time of the solicitation planning process and improves its quality. Some organizations in the U.S. such as the Associated General Contractors and American Institute of Architects make standard formats available and there are similar organizations in other countries that do the same.

.2 Expert judgement. See Section 12.1.2.2. of the *PMBOK® Guide* - 2000 Edition.

.3 Contract Type Selection. This is the tactical level decision that is made further down the road from the project strategy and alternatives selection. Contracts type selection is governed by the project work package definitions, which is the outcome of the project procurement planning process.

The selection of contract types typically varies over the project life cycle with more reimbursable mode at the beginning of the project and more fixed price at the end of the project. However, the following are the factors that affect the contract type selected per a specific package:

- Level of detail available-certain types of contracts require a high level of definition in order to be the most effective contacting method. For example Lump Sum Contracts or Fixed Cost contracts requires a high level of work package definition and requirement specification. If the necessary level of detail is not available due to time constraint or restricted resources or expertise, then those types should be eliminated.
- Urgency of the procurement-typically, fixed price contracts are not appropriate for urgent procurements.
- Level of competition desired-A more limited number of contractors have the ability to undertake large contract work including turnkey and fixed price work. The decomposition of project work packages allows for more competition at lower-tier work packages.
- Level of competition available-in single source situations, the supplier can even dedicate the contract type and even the form of contract.
- Organization's risk utility or tolerance-the organization culture actually forms the risk utility within the organization. The risk allocation strategies used by the owner organization highly impacts the type of contracts to be selected. Priority of project objectives; Cost, Schedule, or Quality.

Examples of the major types of construction contracts are:

- Turn-Key Contracts. Contracts such as design-build where a contractor has an overall responsibility for delivering the project to an owner. In this scenario, the project, including the remaining design, is acquired from a single source contractor. These contracts may be fixed price, reimbursable cost with fee fixed, target incentive fee, or a guaranteed maximum price. In this case, a contractor must have in-house design capability or acquire the design services from a qualified consultant. Also, this type of contract is considered the most expensive approach.
- Fixed Price Contracts. Where the contractor typically performs the detailed engineering, procurement and construction work for a well-defined scope at a fixed lump sum price. The advantage of this type of contracts is that it reduces the risk of cost overrun for the projects. However, it requires pre-investment of the client of time and money to reach a well defined tender documents for the subject work package (i.e. it takes longer overall project schedule). Also, flexibility for changing project requirements is compromised for cost and schedule performance. While this type provide for an excellent cost and schedule control, it may not be the best approach for an owner anticipating changes during the construction of the project.
- Unit Rates Contracts. Where the contractor is typically engaged to perform a specific type of service (engineering or construction) for which the scope is not defined. This type of contract allows the bidding process to take place while the detailed design is carried out. This gives the buyer more control over the outcome of the project particularly with respect to quality. The unit rates fix contractor obligation towards client to perform a specific type of work for a certain rate. The work package cost is an estimated amount that is a function of the unit rates multiplied

by estimated quantities. However, quantity overrun risks are shifted towards the buyer. This approach increases Owner flexibility to change project scope and requirements during later phases of project implementation at predetermined rates. While this approach provides the most cost effective way of building the facilities, it possesses the worst scenario of cost and schedule control by owner.

- Time & Materials Contracts. Where the contractor is typically engaged to perform unspecified services and scope. The contractor is compensated for time spent and resources expended on the work package. This is the most risky contracting approach. It leaves the client totally exposed to project cost overruns and requires sound cost management by the client project management team. It is also requires the highest level of contact surveillance of contractors work processes. The advantage is that the contractor is deployed almost immediately and it is the type used most in cases of emergency.

There are several variations to the above major types of construction contracts.

12.2.3 Outputs from Solicitation Planning

.1 Procurement documents. See Section 12.2.3 of the *PMBOK® Guide* - 2000 Edition. Procurement documents should describe tendering procedures and conditions.

.2 Evaluation criteria. The *PMBOK® Guide* - 2000 Edition says "Evaluation criteria are used to rate or score proposals. They may be objective (e.g., "The proposed project manager must be a certified Project Management Professional, PMP®.") or subjective (e.g., "The proposed project manager must have documented, previous experience with similar projects."). Evaluation criteria are often included as part of the procurement documents."

Evaluation of major procurements may happen in two distinctive stages:

- Pre-qualification. Screening potential sources to establish that a short list of bidders possess the required technical and commercial capability to perform the work package, and
- Proposal Evaluation. Evaluating the specific technical and commercial proposal to establish that; (a) bidders understanding of work scope is correct, (b) bidders pre-planning activities are appropriate for the work package, and/or (c) bidders value proposition from the life cycle cost is positive or attractive.

Typically the selection of construction contractors to perform specific work packages is based largely on the cost to Owner criteria. However, other parameters may be considered also, such as delivery time, cost to administer this contractor, and the technical merits of the proposed solution. Many organizations tend to split the bid into two phases; technical and commercial. It is called the two-step (or envelope) system of bidding. The first phase involves establishing that all prospective bidders meet the minimum technical requirements. The second phase involves the pure commercial evaluation where cost is the governing factor in deciding which the best bidder is. In some cases, the final contract price is adjusted to reflect the effect of the other factors on the cost to owner in comparing several bids.

The first phase of the evaluation, for example, involves the evaluation of:

- Understanding of need-as demonstrated by the seller's proposal.
- Technical capability-does the seller have, or can the seller be reasonably expected to acquire the technical skills and knowledge needed?
- Management approach-does the seller have, or can the seller be reasonably expected to develop management processes and procedures to ensure a successful project?
- Financial capacity-does the seller have, or can the seller reasonably be expected to obtain, the necessary financial resources?

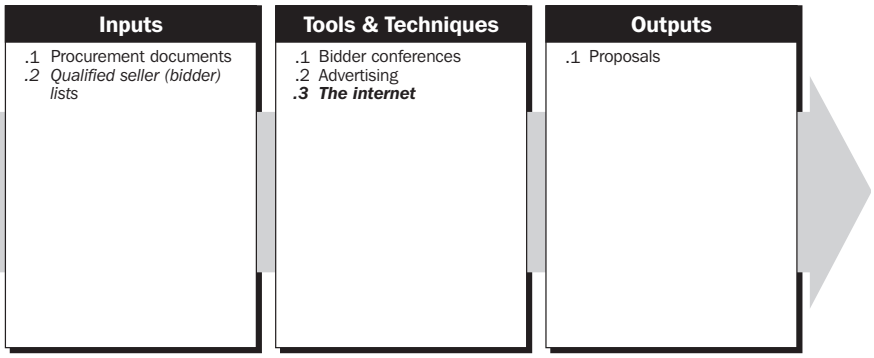
The second phase of evaluation involves the Capital Investment that needs to be made by the owner. Sometimes, when the bidder's quotation comes so close, then a life cycle cost evaluation is used as criteria. This means the Owner should select the bidder that offers him the least overall cost, including capital and operating & maintenance costs.

3. **Statement of Work.** The statement of work (SOW) describes the facilities to be constructed in sufficient detail to allow bidders of construction work package to determine if they are capable of providing them. "Sufficient detail" may vary, based on the nature of the facilities, the needs of the owner, or the expected contract form. Typically, engineering firms that are engaged in designing the project develop the SOW. However, in some cases where turnkey contract type is used, the owner only provides a Statement of Requirements (SOR) which defines the functional and aesthetic requirements of the facilities envisioned by the owner. Sometimes, the Statement of Work contains areas where it solicits the contractor input to propose solutions for certain problems.

   The statement of work should be as clear, as complete, and as concise as possible. Tenderers expend a considerable amount of money to prepare tenders for major procurements with a limited prospect for recovering these costs incurred (due to competition). Therefore, tender documents should be clear, concise and specific about tender requirements. Despite the best efforts, the resultant contract may still include some gray areas. These gray areas are usually covered by bidders by adding contingencies. The Statement of Work should include a description of any collateral services required, such as performance reporting or post-project operational support for the procured item. In some application areas, such as in public work, there are specific content and format requirements for a SOW.

12.3 SOLICITATION

The *PMBOK® Guide* - 2000 Edition says "Solicitation involves obtaining responses (bids and proposals) from prospective bidders on how owner's requirements can be met. Most of the actual effort in this process is expended by the bidders, normally at no cost to the project.



12.3.1 Inputs to Solicitation

.1 Procurement documents. See Section 12.2.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Qualified seller (bidders) lists. See Section 12.3.1.2 of the *PMBOK® Guide* - 2000 Edition. Sometimes organizational databases are not sufficient to provide up-to-date outsourcing information about project-specific sources. This may necessitate a specific pre-qualification exercise (market survey) where the project team compile a questionnaire to prospective sources to assess their capabilities.

12.3.2 Tools and Techniques for Solicitation

.1 Bidder conferences. See Section 12.3.2.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Advertising. See Section 12.3.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 The Internet. The internet technology is now being used to solicit bids for certain works, particularly in public bidding. Improvements of technology may make this media as mainstream media for solicitation in the future.

12.3.3 Outputs from Solicitation

.1 Proposals. See Section 12.2.3.1 of the *PMBOK® Guide* - 2000 Edition.

12.4 SOURCE SELECTION

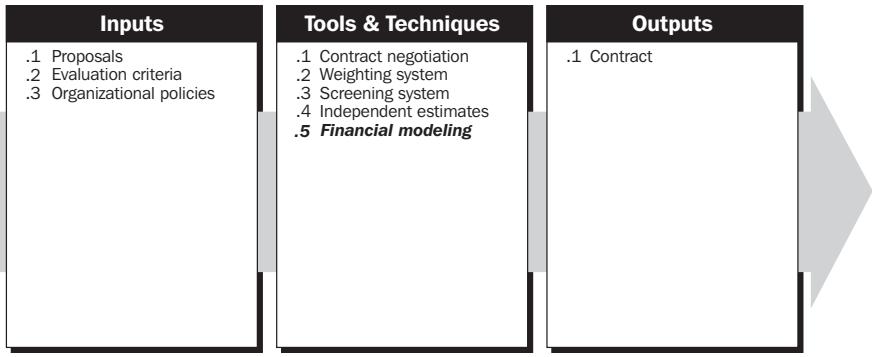
The *PMBOK® Guide* - 2000 Edition says "Source selection involves the receipt of bids or proposals and the application of the evaluation criteria to select a provider. Many factors aside from cost or price may need to be evaluated in the source selection decision process."

- Lowest price does not necessarily mean best value. Price should be compared against independent estimate to assess whether bidder understanding of work scope is correct, or he is buying the job, or worse a high potential of change requests will follow. Consideration should be given to high priced proposals to determine whether the cost premium is worth paying for or not. The lesson is that higher costs should not be discounted on face value. Technical evaluation should review the value

proposition made from a long-term perspective rather than a short term. Also source selection decision should be aligned in the first place with the project objectives and success criteria.

There are situations where procurement of work will come from single sources. However, justification for single sourcing is a requirement under most government procurement policies and regulations. Single sourcing may be allowed in the following cases:

- The supplier is the only qualified source for providing such work.
- Emergency situations
- Supplier familiarity with the works and the urgency of performing the works.
- The value of procurement is not significant to follow a competitive bidding process.



12.4.1 Inputs to Source Selection

See Section 12.4.1 of the *PMBOK® Guide* - 2000 Edition.

12.4.2 Tools and Techniques for Source Selection

See Section 12.4.2 of the *PMBOK® Guide* - 2000 Edition for the following four techniques:

.1 Contract Negotiation. See Section 12.4.2.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Weighting System. See Section 12.4.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Screening System. See Section 12.4.2.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Independent Estimates. See Section 12.4.2.4 of the *PMBOK® Guide* - 2000 Edition.

One additional technique is sometimes useful in source selection:

.5 Financial Modeling. Financial modeling sometimes is used to assess the long-term impact of a bidder's proposition against other bidders, particularly from a life cycle point of view. However, one must take care of bias included in any abstraction technique.

12.4.3 Outputs from Source Selection

.1 Contract. See Section 12.4.3 of the *PMBOK® Guide* - 2000 Edition.

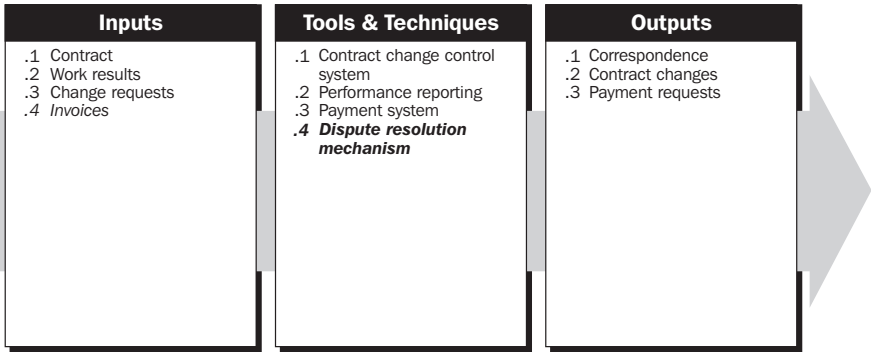
12.5 CONTRACT ADMINISTRATION

Contract administration is the process of ensuring that the contractor's performance meets contractual requirements. On larger projects with multiple work packages and contractors, a key aspect of contract administration is managing the interfaces among the various providers. The legal nature of the contractual relationship makes it imperative that the project team be acutely aware of the legal implications of actions taken when administering the contract.

Contract administration also has a financial management component. Payment terms should be defined within the contract and must involve a specific linkage between the contractors progress made and the contractors compensation paid. The contract also dictates many of the contractor's project management work processes. The following are examples of contractual provisions that govern the contractor's work processes:

- Project Planning and contents of project plan and level of details.
- Selection and approval of subcontractors and vendors.
- Frequency, type, and rigor of project review meetings.
- Approval of changes and change control.
- Work Breakdown Structure reporting levels.
- Schedule development and reporting levels.
- Schedule and budget controls.
- Cost estimate development levels, accuracy and probability.
- Quality planning and assurance.
- Staffing decisions.
- Project communication and information distribution.
- Performance reporting, structure, contents, level of detail, and frequency.
- Administrative closure and documentation turnover.
- Risk Management techniques and tools; insurance obligations, risk allocation, subcontracting, and subcontracts provisions.

The more project management processes are governed by the contract, the less flexibility for the contractor to perform at the most optimum cost. The need to control the contractor work processes should be balanced by the level of flexibility to be allowed to obtain work at an optimum price. The project objectives should always be kept in perspective when selecting such provisions. The controls vested on the supplier by the contractual provisions reflect owner organization culture and risk taking attitude. The controls that are dictated by the owner organization may not be the best suitable controls in the industry or type of business. The project manager should take into consideration the level of owner involvement, the resources available, type of contracts (the rigor of surveillance needed for contract administration is generally higher in reimbursable contracts and lower in fixed price contracts), and performance objectives.



12.5.1 Inputs to Contract Administration

See Section 12.5.1 of the *PMBOK® Guide* - 2000 Edition for these inputs:

.1 Contract. See Section 12.5.1.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Work results. See Section 12.5.1.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Change requests. See Section 12.5.1.3 of the *PMBOK® Guide* - 2000 Edition.

.4 Invoices. These are often called progress payments and represent an evaluation of the work performed in the prior period. Usually being an agreed percentage of the value of the WBS items the contractor has accomplished to the date of the payment. Often the contracts require a percentage of the total be held by the owner as a retainer until final payments are made.

12.5.2 Tools and Techniques for Contract Administration

See Section 12.5.2 of the *PMBOK® Guide* - 2000 Edition for the following three tools and techniques:

.1 Contract change control system. See Section 12.5.2.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Performance reporting. See Section 12.5.2.2 of the *PMBOK® Guide* - 2000 Edition.

.3 Payment system. See Section 12.5.2.3 of the *PMBOK® Guide* - 2000 Edition.

Another technique is often used in construction contracting:

.4 Dispute resolution mechanism. Both parties to a contract should institute at the beginning of any project or contract a dispute resolution mechanism that is appropriate for both parties. The construction industry is prone for conflicts on price, schedule, and quality issues. The way the industry is fragmented and structured, adds to the potential of disputes.

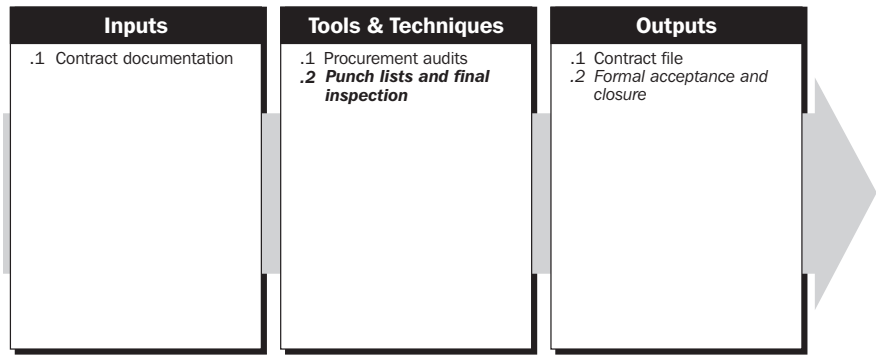
.5 Partnering. Recently a system of project specific partnering has gained increasing popularity as a method of contract administration that has the potential to achieve the participant's goals with a minimum of disputes. While it is not a legal agreement, the parties, at the outset of the project, agree to work cooperatively, sharing information freely for the "good of the project". When the process works well all parties benefit.

12.5.3 Outputs from Contract Administration

See Section 12.5.3 of the *PMBOK® Guide* - 2000 Edition.

12.6 CONTRACT CLOSEOUT

The *PMBOK® Guide* - 2000 Edition says "Contract closeout is similar to administrative closure (described in Section 10.4) in that it involves both product verification (Was all work completed correctly and satisfactorily?) and administrative closeout (updating of records to reflect final results and archiving of such information for future use). The contract terms and conditions may prescribe specific procedures for contract closeout. Early termination of a contract is a special case of contract closeout."



12.6.1 Inputs to Contract Closeout

.1 Contract documentation. Along with the documentation listed by the *PMBOK® Guide* - 2000 Edition, there are often manufacturers and builders guarantees that are very important to the completion of the project.

12.6.2 Tools and Techniques for Contract Closeout

.1 Procurement audits. See Section 12.6.2 of the *PMBOK® Guide* - 2000 Edition.

.2 Punch lists and final inspection. When a contract is virtually complete, a list of those remaining items (sometimes called a "punch list") is prepared to focus attention on those items. The record of a final inspection showing all work is complete is mandatory to proper contract closeout.

12.6.3 Outputs from Contract Closeout

The *PMBOK® Guide* - 2000 Edition lists these two outputs:

.1 Contract file. See Section 12.6.3.1 of the *PMBOK® Guide* - 2000 Edition.

.2 Formal acceptance and closure. See Section 12.6.3.2 of the *PMBOK® Guide* - 2000 Edition.

SECTION III

THE CONSTRUCTION EXTENSION UNIQUE PROJECT MANAGEMENT KNOWLEDGE AREAS

13. Project Safety Management

14. Project Environmental Management

15. Project Financial Management

16. Project Claim Management

Chapter 13

Project Safety Management

Safety Management includes the processes required to assure that the construction project is executed with appropriate care to prevent accidents that cause or have the potential to cause personal injury or property damage. Accidents and personal injuries and deaths that result, have been, and are still a major concern in the construction industry both in terms of humanitarian losses and the direct and indirect costs to the industry. In the United States alone construction accidents cost approximately 6 1/2% of constructed value or in the order of $50 billion annually. Studies have shown that every dollar spent on a good safety program can result in a four to eight dollar reduction in losses from accidents. Figure 13-1 provides an overview of the following major processes:

13.1 Safety Planning. Development of the approach to manage the various hazards to safety inherent in the project.

13.2 Safety Plan Execution. Carrying out the safety plan by performing the activitiesincluded therein.

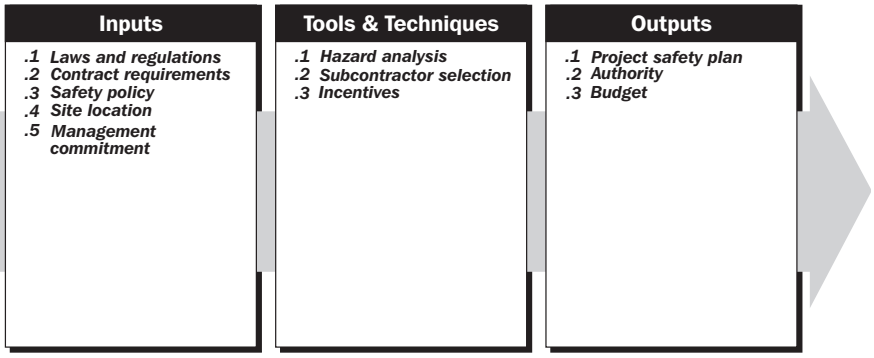
13.3 Administration and Reporting. Maintenance of safety records and reporting safety activities.

Safety Management is basically a subset of Risk Management but because it is functionally so specialized (traditionally unique) and important on every construction project it deserves a separate chapter. Good safety practice on a construction project can reduce or eliminate accidents and injury to personnel, improve effectiveness of performance and reduce total project cost. Because savings can approach ten times the cost of a successful safety program, contractors and owners have come to adopt effective safety planning and execution as a near requirement on construction projects.

13.1 SAFETY PLANNING

This portion of Safety Management is equivalent to the *PMBOK® Guide* - 2000 Edition Sections 11.1 to 11.4 of Risk Management. Safety planning for a construction project involves a job site analysis of the hazards inherent in the work and making decisions as to the measures to be taken to deal effectively with them. This analysis includes a survey of the geographical

and physical hazards of the site, as well as a review of the normal hazards involved in the type of construction anticipated. Government laws and regulations, contract and owner requirements also must be considered in developing the project safety plan which will be the guiding document for a safe project.



13.1.1 Inputs to Safety Plan Development

.1 Laws and regulations. Many governmental bodies both national and local may have laws and regulations regarding safety requirements during construction that must be observed.

.2 Contract requirements. The major contracts covering the project construction may also have specific owner requirements for safe practice.

.3 Safety policy. The prime or major contractors and subcontractors often have a company safety policy that dictates much of the way in which construction activities are carried out.

.4 Site location. The location of the site can have an important bearing on safety. For example, work on or over water often imposes additional safety requirements not necessary on dry land.

.5 Management commitment. The degree which a construction company's management is committed to safety can have a major impact on the effectiveness of a safety program.

13.1.2 Tools and Techniques for Safety Plan Development

.1 Hazard analysis. This is a systematic review of the construction process for the project for the purpose of identifying all of the many hazards to personnel involved in the construction, as well as the general public or suppliers who may have only a fleeting presence on site. Normally carried out by the senior safety officer of the constructor with the assistance of the WBS and key construction supervision, this is a part of the risk identification process outlined in Section 11.2 of this extension and the *PMBOK® Guide* - 2000 Edition.

.2 Subcontractor selection. One of the tools available to a major contractor in order to improve the chances for a safe project is to screen subcontractors for their safety programs and choose those who have a good record of safety performance.

.3 Incentives. One of the newer and effective ways of encouraging the work force to observe safe work practices is to offer incentives for a safe job. Many contractors post safety performance on a large board at the entrance

to the project "so-many hours worked without a lost time injury..." and periodically offer incentives such as jackets, informal banquets and even cash to promote safety awareness.

13.1.3 Outputs from Safety Plan Development

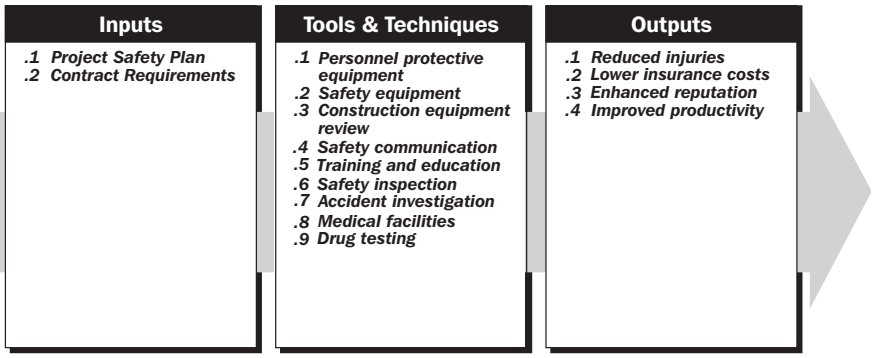
.1 Project safety plan. This the key document that guides the safe performance of work on the project seeking to protect the workers, other on -site personnel, as well as the general public and to provide guidelines for accident reduction and protection of property. The Safety Plan will include recommendations for any specialized personnel equipment that may be required (respirators for example) and provide for first aid supplies, the posting of all required notices relating to safety such as the telephone numbers and addresses of doctors and the nearest hospital. Above all, it will include procedures to be followed for the usual construction hazards such as high work excavation, fire danger, electrical hazards, and will stipulate regular work force safety meetings. It may also establish an introductory safety program to be given to all new hires (these are often in video form) and require them to signify that they have been so briefed.

.2 Authority. While safety is the responsibility of every worker on a construction site, as a part of the overall project plan and the responsibility matrix developed under 4.1.3 and 9.1.3 of this extension, authority should be granted to an experienced individual to act as the project Safety Officer. This authority gives the individual the authority to stop work if, in his or her opinion, work is not being performed safely or in accordance with the safety plan.

.3 Budget. The estimated cost of the safety plan must be included in the formation of the budget for construction of the project. See 7.3 of this extension.

13.2 SAFETY PLAN EXECUTION

Execution of the project safety plan involves the application and implementation of the safe construction practices on-site in accordance with the requirements of the plan. While it is good and often required practice to indoctrinate all workers in the requirements of the Project Safety Plan, it is usually the responsibility of the authorized project Safety Officer to oversee the implementation of such practices and to seek correction of any shortcomings. On a large construction project there may be a separate safety staff of several persons headed by the Safety Officer. Still, prevention of accidents is the most effective technique so that a well-informed and trained work force is the best way to assure a safe project.



13.2.1 Inputs to Safety Plan Execution

.1 Project Safety Plan. The Project Safety Plan described in Section 13.1.2 of this Extension.

.2 Contract Requirements. These include any special additional safety procedures and reporting.

13.2.2 Tools and Techniques for Safety Plan Execution

The following are examples of the types of tools and techniques that may be required under the Project Safety Plan depending upon the type of construction hazards encountered:

.1 Personnel protective equipment. Examples are harnesses, respirators, head and foot gear, and protective clothing.

.2 Safety equipment. Trench wall bracing, fire protection equipment, safety nets, warning devices, and similar equipment

.3 Construction equipment review. Periodic checks of equipment such as cranes and lifting devices for fitness, and verifying that site vehicles are fitted with working back-up alarms.

.4 Safety communication. This type of communication can cover a broad range of activities such as:

- Barriers and signs
- Bulletin boards
- Initial safety indoctrination meetings
- Tool box meetings
- Individual bulletins on a specific subject

.5 Training and education. Closely allied to communication, there may be a need to provide specific training for a special construction activity.

.6 Safety inspection. Daily inspection is usually carried out by the Safety Officer but others also may periodically inspect the project for its compliance with the safety plan - representatives of the owner, insurance companies and government agencies. Often the major contractor's senior safety manager will perform a safety audit in support of the on-site safety officer.

.7 Accident investigation. It is important that each accident be investigated, as to cause, and a complete report made of what happened and why, often with pictures. These reports are usually required by the insurance companies covering the resulting losses but the reports are also vital to the improvement of the contractor's safety performance.

.8 Medical facilities. Arrangements need to be made with a near by hospital and/or doctor's office for medical assistance in the event of an accident beyond the care of the on-site first aid station, as well as establishing and stocking the first aid station itself.

.9 Drug testing. Many major construction projects, particularly those that may be government financed, require some kind of personnel drug testing program as a safety requirement.

13.2.3 Outputs from Safety Plan Execution

.1 Reduced injuries. A well executed safety plan will reduce workers injuries and raise the morale of the work force.

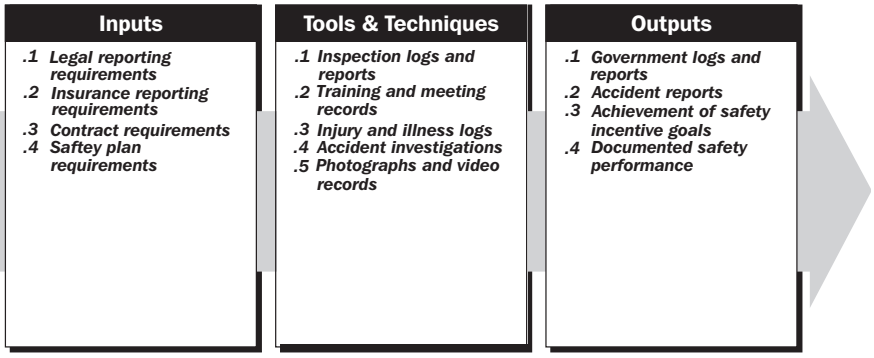
.2 Lower insurance costs. A lower accident and injury rate will reduce the cost of insurance premiums.

.3 Enhanced reputation. Owners are becoming more interested in working with contractors who have good safety records (owner's exposure is reduced also) and workers also want to work with firms that are interested in their safety.

.4 Improved productivity. Accidents result in measured decreases in jobsite productivity, which also weaken contractor's profits.

13.3 SAFETY ADMINISTRATION AND RECORDS

Along with governmental laws and regulations that apply to safe construction practice, there are often requirements for record-keeping and reporting. Insurance companies also usually require periodic activity and accident reports. The contract may also require additional records and reports. Finally, it is good business practice to keep track of safety performance for use in improving performance and for use in marketing future services.



13.3.1 Inputs to Safety Administration and Records

.1 Legal reporting requirements. There are, in many countries, requirements for recording and reporting such things as accidents, injuries, hours worked so that governmental agencies may keep track of safety performance in several workplace categories.

.2 **Insurance reporting requirements.** Contractor's insurers usually require reports of accidents and injuries that they may be responsible to provide for under their policy with the contractor.

.3 **Contract requirements.** Certain contract provisions may require that the contractor(s) maintain and report safety related activities such as accidents and injuries.

.4 **Safety plan requirements.** The project safety plan may require additional record keeping and reporting of general health data of employees, drug testing results, and other specialized data that may be related to environmental hazards.

13.3.2 Tools and Techniques for Safety Administration and Records

.1 **Inspection logs and reports.** This type of record is usually the result of safety inspections by the project safety officer and his/her staff and need to contain comments on the activity observed and any corrections made.

.2 **Training and meeting records.** Records should be maintained of training given and to whom, meetings held on the subject of safety, who attended and the date of instruction.

.3 **Injury and illness logs.** A record should be maintained of all injuries requiring treatment, even if minor, and employee illness resulting in absence from work.

.4 **Accident investigations.** All accidents should be investigated and documented completely as to cause and result, damage to property and equipment and injuries (see .3 above).

.5 **Photographs and video records.** An important part of documentation of accident and safety infraction reporting are photographs and video records. These can be used to show evidence to those who were not present at the event but who may have a direct interest such as insurers. Such records may also benefit the contractor by showing steps taken to enforce safety on the project in the face of possible governmental penalties.

13.3.3 Outputs for Safety Administration and Records

.1 **Government logs and reports.** These are the reports required by governmental agencies.

.2 **Accident reports.**See 13.3.2.3 and .4 above.

.3 **Achievement of safety incentive goals.** A record to verify that job site personnel have met the safety goals established for an incentive program.

.4 **Documented safety performance.** A record to show management, insurance companies, and future clients that the safety goals were met or exceeded.

Chapter 14

Project Environmental Management

Project Environmental Management includes the processes required to ensure that the impact of the project execution to the surrounding environment will remain within the limits stated in legal permits. It is related with identifying the environmental characteristics surrounding the construction site and the potential impacts the construction may bring to the environment; planning the approach towards avoiding environmental impacts and achieving environmental conservation (and improvement if possible); auditing the plan and controlling the results; and inspecting environmental conditions.

The project management team must be careful not to confuse environmental management with causing no environmental impact. Construction projects cause environmental impact due to their nature. The goal of a good environmental management plan is to keep the impacts within the limits foreseen in the legal permits.

Active communication must be implemented to clarify to all stakeholders what are the project objectives and the environmental changes its execution will bring. The neighbor community is a major stakeholder in this matter, more than in any other for construction projects, and special attention must be dedicated to their particular needs and expectations. However, as the communication management is addressed in Chapter 10 of the *PMBOK® Guide* - 2000 Edition and the present extension, it will not be detailed in this section.

Another major stakeholder is the environmental authority, usually composed by representative bodies from local, regional and federal government. Those bodies have their own stakeholders (e.g. the community) and respond to them in the ways described in the Government Extension to A Guide to the Project Management Body of Knowledge, which can have a great impact to the project, sometimes regardless of the existence of permits.

Figure 14-1 provides an overview of the following major environmental management processes:

14.1 Environmental planning. Identifying what are the characteristics of the environment surrounding the construction site and which environmental standards are relevant to the project, and determining what impact the project will bring to the environment and how to satisfy the identified environmental standards.

14.2 Environmental assurance. Evaluating the results of environmental management on a regular basis to provide confidence that the project will satisfy the relevant environmental standards.

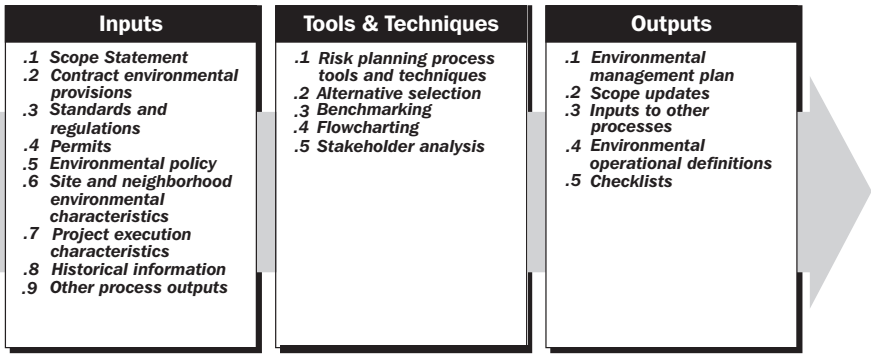
14.3 Environmental control. Monitoring specific project results to determine if they comply with relevant environmental standards and identifying ways to eliminate causes of unsatisfactory performance.

These processes interact with each other and with the processes in the other knowledge areas as well. Each process may involve effort from one or more individuals or groups of individuals, based on the needs of the project. Each process generally occurs at least once in every project phase. Although the processes are presented here as discrete elements with well defined interfaces, in practice they may overlap and interact in ways not detailed here. The basic approach to environmental management described in this section is intended to be compatible with that of the International Organization for Standardization (ISO), as detailed in the ISO 14000 series of standards and guidelines.

14.1 ENVIRONMENTAL PLANNING

Environmental planning involves identifying which environmental standards are relevant to the project and determining how to satisfy them. It is one of the key facilitating processes during construction projects planning and should be performed regularly and in parallel with the other project planning processes.

It includes assessing the environmental conditions surrounding the project site, the nature of project activities and the consequences of their performance to the environment.



14.1.1 Inputs to Environmental Planning

.1 Scope statement. The scope statement (described in Section 5.2.3.1 of the *PMBOK® Guide* - 2000 Edition) is a key input to environmental planning, since it documents major project deliverables, as well as the project objec-

tives that serve to define important stakeholder requirements. Particularly, it will define if the attainment of any environmental permit is in the scope of the project.

.2 Contract environmental provisions. Owners have their own obligations and policies regarding environment conservation and transferring some of them to the contractor is a usual practice.

.3 Standards and regulations. The project management team must consider all governmental standards and regulations applicable to the project. Governmental standards and regulations may be federal, regional or local and address matters such as maximum allowable noise, non-work hours and/or days, effluent disposal requirements and others.

A particular case of governmental regulation is the requirement to issue an Environmental Impact Statement or Report, usual in many countries. This document may be done either by the owner or the contractor and has basically the same content as the environmental management plan, which is the main output of the environmental planning process. Thus, it should be done regardless of governmental requirements.

Some stakeholders have their own set of environmental standards and regulations (e.g. World Bank), which may have the same level of importance to the project.

.4 Permits. Permits are a primary input to environmental planning, as they establish objectives to be met and conditions for project execution. In some regions, permits are only granted after an Environmental Impact Statement or Report is issued and approved. In those cases, they are not available as an input to the process.

.5 Environmental policy. Environmental policy is the overall intentions and directions of an organization with regard to environmental care, as formally expressed by top management. The environmental policy can be adopted "as is" for use in the project, but an analysis must be made prior to deciding to use it or adapt it. It should be verified for compliance with particular constraints coming from legal permits and stakeholders' expectations. In the case the performing organization lacks a formal environmental policy, or if the project involves multiple performing organizations (as with a joint venture), then the project management team will need to develop an environmental policy for the project.

Regardless of the origin of the environmental policy, the project management team is responsible for ensuring that the project stakeholders are fully aware of it. In some cases, having stakeholders such as community leaders involved in the development of the project environmental policy may be the best way to communicate it, while gaining buy-in.

.6 Site and neighborhood environmental characteristics. The characteristics of the construction site and the surrounding environment must be known prior to project execution. They serve as a base for comparison of the results of actions regarding environment conservation.

For construction projects, environment is the surrounding neighborhood where the construction project is undertaken, including air, water, soil, natural sources, flora, fauna, human beings and their interrelations. Environment includes not only nature, but also cultural assets such as historical buildings or sites and economic or behavioral aspects of neighbor communities. For example, in a project to build a hydroelectric power plant, filling the lake may require moving an entire village to another site. The choice

of the new location must take into account the village's economic activities related to the environment, such as tourism, production of ceramics or agriculture.

.7 Project execution characteristics. The characteristics for execution of the project must be taken into account. Some steps may require blasting rock, working with noisy machines, removing vegetation, or interfering in any way with the surrounding neighborhood.

.8 Historical information. Lessons learned from previous projects using similar execution characteristics or performed in similar environments are useful to determine the solutions to eliminate, mitigate or repair environmental impacts. For example, history on past environmental accidents and results of recovery actions can provide valuable input when determining the best approach for environmental management.

.9 Other process outputs. In addition to scope statement and project execution characteristics, processes in other knowledge areas may produce outputs that should be considered as part of environmental planning. For example, time constraints may require using a construction methodology that brings higher exposure to environmental risk.

14.1.2 Tools and Techniques for Environmental Planning

.1 Risk planning processes tools and techniques. Risk planning processes, tools, and techniques are described in the Chapter 11 of the *PMBOK® Guide* - 2000 Edition. They can be used to identify, qualify, and quantify environmental risks, and to support response planning. They should be used in conjunction with the tools and techniques below to produce an integrated environmental management plan.

The information to be used as input here is available from the inputs listed in Section 11.1.1 and the outputs will be part of the environmental management plan.

.2 Alternatives selection. In construction projects, some activities can be performed with different processes for achieving the same result. For example, rock formations can be removed by blasting or by using pneumatic hammers; effluents from piping chemical cleaning can be treated at site or taken to an external facility for treatment. While all processes are usually analyzed with alternative selection methods, such as benefit/cost analysis and others, where time, cost, and quality aspects are balanced, meeting or exceeding environmental requirements is a mandatory constraint, once in this case non-compliance can cause the project to have its execution permit cancelled or not issued.

.3 Benchmarking. Benchmarking is described in Section 8.1.2.2 of the *PMBOK® Guide* - 2000 Edition. Benchmarking in neighbor companies can produce good results, once they share the same environment conditions and have common key stakeholders.

.4 Flowcharting. A flow chart is any diagram that shows how various elements of a system relate. One of the flowcharting techniques commonly used in environmental management is the cause-and-effect diagram, also called Ishikawa diagram or fishbone diagram. This flow chart is described in Section 8.1.2.3 of the *PMBOK® Guide* - 2000 Edition.

.5 Stakeholder analysis. The environment and construction requirements and the selected alternatives to balance them must be negotiated with the stake-

holders, including the surrounding community and the government in its various instances. While most of the stakeholders will participate during the elaboration process, some of them (usually government bodies), may require the study to be formally issued before an analysis is made. In this case, conformance to laws, regulations, and standards should be enough for an approval.

14.1.3 Outputs from Environmental Planning

.1 Environmental management plan. The environmental management plan should describe how the project management team will implement its environmental policy. In ABNT NBR ISO 14000 terminology, it should describe the project environmental management system: the part of the global management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources to develop, implement, reach, analyze, and maintain the environmental policy.

The environmental management plan provides input to the overall project plan (described in the Section 4.1 of the *PMBOK® Guide* - 2000 Edition and this extension) and must address environmental control, environmental assurance, and environmental improvement for the project. It must also include the management approach for environmental emergencies.

In areas where the issue of an environmental impact report is required, it can be adopted as the environmental management plan. The environmental impact report is a document that describes the environmental conditions found in the site neighborhood before project implementation and the foreseen impact from construction activities; both during and after project implementation, based on the management approach derived from the environmental policy.

In some countries, the elaboration of this report is dictated by law and the construction permit is not granted until the report is officially issued and approved. In this case, compliance with laws and regulations may be all that is required. Nevertheless, for other areas where construction activity is not so regulated the report should still be elaborated, as the adherence to an effective environmental policy can promote local good will, ease some of possible objections to construction, and in a larger sense, provide a sound basis for future work in the area and elsewhere, as a contractor who is sensitive to environmental considerations.

A typical environmental impact report for construction projects contains:

- Introduction about the project.
- Identification of the owner and main contractor.
- Description of the product to be built, mentioning its main systems.
- Characterization of the influence areas, including site localization. Influence areas can be divided into interference area and influence (direct and indirect) area.
- Neighbor projects, either finished, planned or in execution.
- Environmental assessment.
- Analysis of impacts of executing the project in the considered region or in another, or of not executing the project, regarding technological, juridical, economical, and social aspects.
- Identification and assessment of impacts to environment.

- Description of planned mitigating responses to negative impacts and maximizing actions to positive impacts.
- Monitoring program to ensure environmental conservation.

The environmental management plan may be formal or informal, highly detailed or broadly framed, based on the requirements of the project and applicable standards and regulations.

.2 Scope updates. Additional work may be required as a result of balancing environmental and construction requirements. For example, the several billion dollar expansion of the San Francisco airport was delayed for 6 months because of the discovery of an endangered garter snake, which then required fencing and other protection methods not originally foreseen in the project scope.

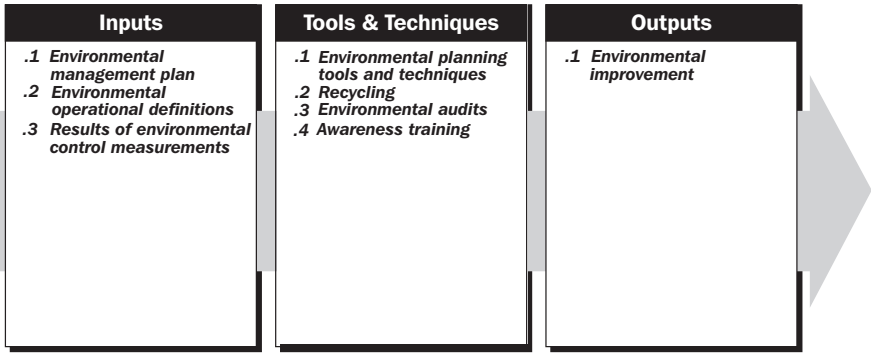
.3 Inputs to other processes. During the elaboration of the environmental management plan, some constraints may rise, such as non-work hours due to noise restrictions, requirement of special permits for handling hazardous substances, use of special devices for environmental protection or other restrictions. Those constraints may have significant lead times or costs, so they should be taken in consideration for other processes. The scope updates are a particular case of these inputs.

.4 Environmental operational definitions. An environmental operational definition describes, in very specific terms, what something is and how it is measured by the environmental control process. For example, it is not enough to say that the hazard caused by construction equipment will remain within the permissible limits; the project management team must also indicate whether only oil spills or also gas emissions will be measured; whether only heavy equipment or also vehicles will be inspected and, if so, if only the contractors' vehicles or all vehicles entering the site.

.5 Checklists. Checklists are described in the Section 8.1.3.3 of the *PMBOK® Guide* - 2000 Edition. Specific checklists should be developed for environmental management.

14.2 ENVIRONMENTAL ASSURANCE

Environmental assurance is all the planned and systematic activities implemented within the environmental system to provide confidence that the project will satisfy the relevant environmental standards. It should be performed throughout the project. Assurance should be provided to all stakeholders, as environment conservation is a matter of global interest.



14.2.1 Inputs to Environmental Assurance

.1 Environmental management plan. The environmental management plan is described in the Section 14.1.3.1 of this extension to the *PMBOK® Guide* - 2000 Edition.

.2 Environmental operational definitions. Environmental operational definitions are described in the Section 14.1.3.3 of this extension to the *PMBOK® Guide* - 2000 Edition.

.3 Results of environmental control measurements. Environmental control measurements are records of the environmental situation of the construction site and neighborhood in a format for comparison and analysis.

14.2.2 Tools and Techniques for Environmental Assurance

.1 Environmental planning tools and techniques. The environmental planning tools and techniques described in the Section 11.1.2 of this extension to the *PMBOK® Guide* - 2000 Edition can be used for environmental assurance as well.

.2 Recycling. Recycling is the reutilization of used material. It reduces the generation of waste and consumption of natural resources and so it is a technique for general environmental conservation and improvement. Recycling is a tendency around the world and its use should be foreseen in the environmental management plan, although it can be implemented even if not foreseen.

In construction projects there are many opportunities for recycling. For example, equipment wooden crates for transport can be used for storing tools at construction fronts and building provisional access ladders and stairs; water used for piping and drums hydrostatical tests may be stored for use in further tests.

In order to maximize the effects of recycling techniques, the selective waste collection technique should be implemented as well. It is a special case of recycling, through which the materials that will not be reused in construction activities are segregated for further recycling by third parties.

.3 Environmental audits. An environmental audit is a structured review of other environmental management activities. The objective of an environmental audit is to identify lessons learned that can improve the results of environment conservation efforts for this project or other projects within the performing organization. Environmental audits may be scheduled or random, and they may be carried out by properly trained in-house auditors or by third parties.

.4 Awareness training. All team members should be trained for awareness about the project environmental policy and environmental management plan. Workshops, team sessions, and training for specific construction activities are examples of awareness training, once all of them lead to environmental improvement. Awareness training may be extended to the surrounding community if an identified opportunity for environmental improvement involves increasing their awareness about the matter. Awareness is one of the key tenets of ABNT NBR ISO 14001.

14.2.3 Outputs from Environmental Assurance

.1 Environmental improvement. Environmental improvement includes taking action to increase the effectiveness and efficiency of the project to reduce environmental impact of the project execution and to provide added benefits to the project stakeholders. While team awareness is the major responsible for environmental improvement, in some cases implementing improvement actions may require preparation of change requests or taking of corrective action, which will be handled according to procedures for integrated change control, as described in the Section 4.3 of the *PMBOK® Guide* - 2000 Edition and this extension.

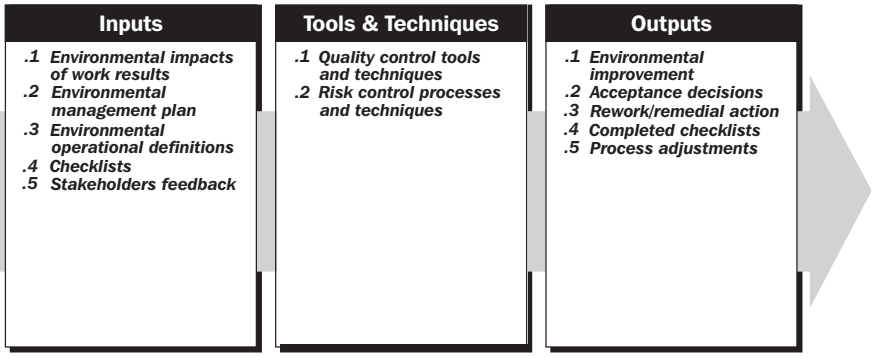
Environmental improvement can also come as a result of actions taken for conservation. For example, in hydroelectric power plant projects, before filling the lake it is usual to have a team collecting all animals living in the area to be flooded, so that wild life is protected, resulting in environment conservation. This was the case for the Brazilian Tucuruí hydroelectric plant, and the result was that dozens of unknown species were found.

14.3 ENVIRONMENTAL CONTROL

Environmental control involves monitoring specific project results to determine if they comply with relevant environmental standards, and identifying ways to eliminate causes and effects of unsatisfactory results. It should be performed throughout the project.

While quality control monitors project results for all aspects of the project, a specific control process should exist for environmental management due to its particular requirements expressed in standards and regulations and its importance to all stakeholders. Nevertheless, knowledge of statistical quality control is useful for environmental control.

Although environmental control is an important process, the tenet of prevention over inspection is maximized for environmental management. The onus of living with the consequences of an environmental accident such as an oil spill resulting from an accident with an oil carrier ship is priceless. The full awareness of every member of the project team and every stakeholder about the need for environment conservation must be a goal for the project management team.



14.3.1 Inputs to Environmental Control

.1 Environmental impacts of work results. Work results are described in the Section 4.2.3.1 of the *PMBOK® Guide* - 2000 Edition and their specific relation with control processes is discussed in the Section 8.3.1.1 of that same guide. For purposes of environmental control, specific characteristics of work results, such as environmental impacts, should be observed.

.2 Environmental management plan. The environmental management plan is described in the Section 14.1.3.1 of this extension to the *PMBOK® Guide* - 2000 Edition.

.3 Environmental operational definitions. Environmental operational definitions are described in the Section 14.1.3.4 of this extension to the *PMBOK® Guide* - 2000 Edition.

.4 Checklists. Environmental operational definitions are described in the Section 14.1.3.5 of this extension to the *PMBOK® Guide* - 2000 Edition.

.5 Stakeholders feedback. As stakeholders play an important role in environmental management, their feedback on this matter is of particular interest to the project management team. Feedback may be received in many ways: community group manifestations, official statements from governmental bodies, letters from Client, meetings or informal conversations with stakeholders.

The best way to receive feedback is to go ask for it. Stakeholders feel committed to the project's environmental goals and assume a proactive approach, while waiting for them to express themselves may cause feedback to come in a more aggressive way, with possible undesirable consequences to the project.

14.3.2 Tools and Techniques for Environmental Control

.1 Quality control tools and techniques. Quality control tools and techniques are described in the Section 8.2 of the *PMBOK® Guide* - 2000 Edition and tailored for construction projects in the Section 8.2 of this extension.

.2 Risk control processes tools and techniques. Risk control processes tools and techniques are described in the Section 11.6 of the *PMBOK® Guide* - 2000 Edition. They are used in conjunction with the techniques mentioned above to monitor environmental risk triggers, start corrective actions and workarounds.

14.3.3 Outputs from Environmental Control

.1 Environmental improvement. Environmental improvement is described in the Section 14.2.3.1 of this extension to the *PMBOK® Guide* - 2000 Edition.

.2 Acceptance decisions. The items inspected will be either accepted or rejected. While items rejected by the quality control process may require rework, this is not optional for environmental control, unless there is no possible rework or remedial action.

.3 Rework/remedial action. For environmental control purposes, rework is action taken to bring environmental conditions into compliance with requirements in the case environmental impacts are found. It should be minimized by mitigation plans, as a rework means there is an undesirable environment situation and there is always a risk that rework is not capable to restore suitable environmental conditions.

Oil spills from carrier ships are an example of environmental accidents where environmental conditions are seldom restored before many years have passed.

.4 Completed checklists. See Sections 8.1.3.3 and 8.3.3.4 of the *PMBOK® Guide* - 2000 Edition and the additions to those Sections provided by this extension.

.5 Process adjustments. Process adjustments, as described in the Section 8.3.3.5 of the *PMBOK® Guide* - 2000 Edition, are also an output of environmental control. Process adjustments may be performed both to eliminate causes of environmental impacts and to achieve environmental improvement.

Chapter 15

Project Financial Management

Introduction to Financial Management

Financial management includes the processes to acquire and manage the financial resources for the project and is more concerned with revenue source and analyzing/updating net cash flows for the construction project than is cost management.

In traditional construction projects the owner typically pays for the cost of the project by means of periodic (usually monthly) progress payments. The contractor thus has only to finance initial costs of set up and the first few months of work. Many contractors are able to finance this themselves or can obtain a short term loan to cover this initial period.

More recently however, the construction industry has faced increasing requirements to finance the entire project as a result of the use of several different types of project delivery methods. Some of these are design-build-own-operate (DBOO), design-build-operate-maintain (DBOM), some with lease-back provisions, large projects with joint venture partners, privatization of public projects and project that are non-recourse financed; that is the project provides the sole collateral for the investors. This trend requires the contractor, who often leads any consortium involved, to be conversant and somewhat knowledgeable about the subject and techniques of project financing.

Thus Financial Management is distinctly different from Cost Management which relates more to managing the day-to-day costs of the project for labor and materials. In this section the discussion is limited to financing the cost of construction of the project itself, although long-term financing may include both construction and operation, for example in the case of design-build-operate projects.

The major processes involved are as follows:

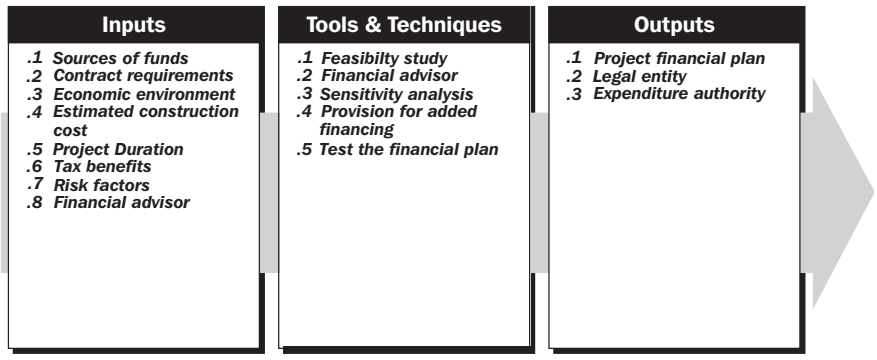
15.1 Financial planning. Identifying key financial issues to be addressed and assigning project roles, responsibilities and reporting relationships.

15.2 Financial Control. Monitoring key influences identified under Section 15.1 and taking corrective measures if negative trends are recognized.

15.3 Administration and Records. Designing and maintaining a financial information storage/retrieval database to enable financial control to proceed in a smooth way.

These processes interact with each other and with the processes in the other knowledge areas as well. Particular interaction is noted between cost, risk and time management knowledge areas. Each process may involve effort from one or more individuals or groups of individuals based on the needs of the project.

Although the processes are presented here as discrete elements with well-defined interfaces, in practice they may overlap and interact in ways not detailed here.



15.1 FINANCIAL PLANNING

Planning as with any other area is the starting phase of financial management for construction projects and is the phase where all project requirements of a financial nature are identified and provided for. Financial planning is no different than standard project planning and tasks must be identified, the requirements placed on a timescale and quantified, resources are also required to ensure that the financial tasks are completed timely.

15.1.1 Inputs

.1 Sources of funds. The source of funds for the traditional project are often from the company's central financing system, which may be a combination of borrowing from financial institutions, retained profits, financial reserves; and, as noted in the introduction, also met by down payments and progress payments by the client. The costs of financing are normally charged as interest to the projects cost account for construction projects.

For fully funded projects there are many possible sources: commercial paper backed by a bank credit facility, bank loans, public debt offerings, private placements in the U.S. and European markets, syndicated commercial long-term loans, and government entity loans to name a few. Final selection depends in large part on the credit quality of the project and upon how sensitive the project is to changes in interest rates. In almost all of this type of project the participants take some equity in the project.

.2 Contract requirements. For traditional projects, it is a good idea to check the client's financial status to determine that it has the means to pay for the

project. If there is some doubt it may be possible to obtain an irrevocable letter of credit, it is of prime importance to ensure that the client can service all payments due.

For projects to be contractor financed, the contract may contain important clauses that might restrict the contractor's ability to obtain favorable terms. Since this type of project often is awarded after a proposal process, there may be an opportunity to negotiate more favorable terms.

The Contract and the project plan will help define requirements for the financing needs in construction projects. The contractual terms of payment from the client are utilized as input in ascertaining the financial needs of a project as this will help in the estimation of the cash flow, which will influence the project finances.

All financial items affect the bottom line of the project and must be scheduled within the overall costs of the project - financial costs that should be taken into account include the following and should be assigned at least one level within the WBS:

- Currency hedging (if payment currencies are different to purchasing currencies or visa versa),
- Costs of bonds and bank guarantees - performance / down payment / warranty bonds, and
- Costs of interest on borrowings (should the project run with a negative cash flow).

It is also very important in volatile markets to consider interest rates especially on long-term construction projects as prices can increase dramatically over the running time of a project.

.3 Economic Environment. The Economic environment is an external factor that is not in the control of a project manager, but the project manager must be aware of all the risks in this area and to periodically ensure that the financial plan is updated to cater for these risks. Items include political, regulatory, social, and economic factors that affect the cost of money and similarly increase or decrease the cost of the project.

.4 Estimated Construction Cost. Lending institutions will examine the estimated cost of the project carefully before committing to lending or participating in the project.

.5 Project Duration. All participants will be affected by the length of the project which will determine the length of their investment and when they will recover it; together with any expected profit.

.6 Tax Benefits. Many long term projects may provide tax benefits that must be taken into account when arriving at the financial plan.

.7 Financial advisor. A contractor involved in a fully funded project is strongly advised to make use of an experienced financial advisor with access to and knowledge of public and private capital markets.

.8 Risk factors. A proper financial plan will allocate risks among participants, investors, customers, and interested third parties. Some of the risks most important to obtaining favorable financing are completion risk, cost overrun, regulatory and political risk, and technology risk. See Section 11.1.2

15.1.2 Tools and Techniques

.1 Feasibility study. For long term projects that are financed by the contractor, a study needs to be performed to determine if the project can be profitable with the given parameters; or, when proposing, whether the ultimate payments proposed will cover all of the costs and still provide a reasonable profit. As an example, there have been toll roads recently constructed in North America where the contractor (a consortium) receives tolls as payment for the project over a number of years. Of course, financing costs are an important factor in making the decision to accept such a project.

Cash flow measurement is a prime way of determining the viability of a project. Construction projects rely on cash inflow to balance out the costs incurred in order to keep financial costs to a minimum- based on the terms and conditions of payments for the construction contract, a project manager can identify when and how money inflow will occur.

Money outflow is basically the scheduled payments for the sub-contractors, vendors, and fees, insurance, taxes, direct labor, and support staff, including the cost of financing. The overall Project Plan provides the information to estimate what the periodic expenditures would be over the project life cycle. This outflow gives information on the financial requirement for each period.

By analyzing revenue and expenditure, the net cash flow (inflow minus outflow) and basic financing requirements are determined.

.2 Financial advisor. The financial advisor acting in this part of the process assumes the principal responsibility of developing a comprehensive marketing strategy which will implement the financing plan in an optimum manner. Lending institutions and other fund sources have to be contacted and interested in providing part of the financing required.

.3 Sensitivity Analysis. A sensitivity analysis should be performed varying several parameters to determine the effect upon the project's cash flow and the preliminary financing plan.

.4 Provision for added financing. A study should be conducted of possible added financing needs to cover such items as unexpected delays, scope revisions and other risks so that the financing plan can incorporate a provision for additional financing if needed.

.5 Test the financial plan. It is good practice to test the financial plan by contacting prospective lenders to assure the acceptability of unique features in the financing plan.

15.1.3 Outputs

.1 Project Financial Plan. With the above mentioned inputs, tools, and techniques, a comprehensive financial plan can be developed which would clearly identify all financial requirements of a construction project and means to finance them. All parties must understand by whom, and when, all of the necessary equity, debt, and insurance, in appropriate types and amounts are to be supplied during the construction period.

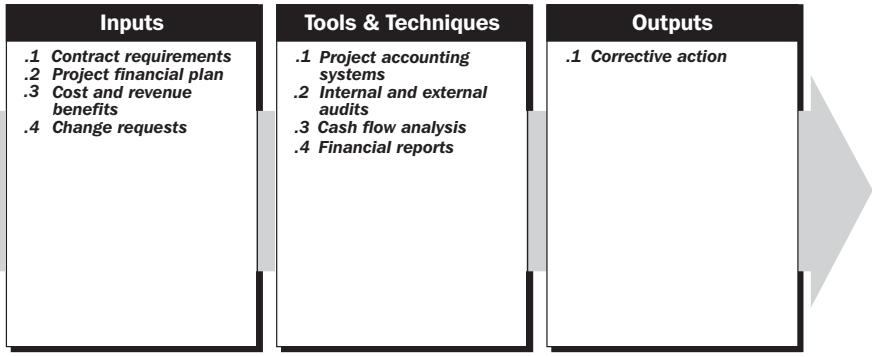
.2 Legal entity. The participants and the financial advisor must decide upon the legal form of the venture, which will maximize the anticipated benefits: partnership, corporation, trust, joint venture or a combination thereof.

.3 Expenditure authority. Authority for expenditure by the project manager is usually determined by company commitment policy and shown prefer-

ably in the organizational structure - it is normal that certain levels within a project can only spend to certain amounts before an additional signature is required. It is wise for all financial aspects to require dual signatories; but the delegation of authority also depends upon the size and the nature of the project. In the case of a newly formed entity, these authorities need to be incorporated into the legal structure of the new entity.

15.2 FINANCIAL CONTROL

Financial control ensures that the bonds are reduced when necessary, calls for funds from project partners are made as needed, and all insurance and bank withdrawals/deposits are done at the appropriate times. Financial control and cost controls are executed in the most effective way to ensure all items are within budget and the financial cash forecast.



15.2.1 Inputs

.1 Contract requirements. See Section 15.1.1.2 of this Extension.

.2 Project Financial Plan. See Section 15.1.3.1 of this Extension.

.3 Cost and revenue baselines. The budget and revenue forecasts developed for the financial plan serve as the net cash flow baselines for the project against which any adjustments are measured.

.4 Change requests. Any changes to the project that affect cost or revenue streams must be analyzed and incorporated into the financial plan for their effect on long or short term borrowing, insurance coverage and other features of the financial plan.

15.2.2 Tool and Techniques

.1 Project Accounting Systems. The project accounting system should be similar in structure to the WBS; showing the breakdown of the total project in more controllable modules. On small to medium size projects, the breakdowns can be kept on simple Excel generated S curves, but large project accounting systems would normally be a bit more sophisticated and ACCPAC or SAP could be utilized. Financial control is exercised by closely monitoring actual spending and revenue against budget and cash flow forecasts, adjusting either the work methods or problem areas where this mechanism shows deviations.

.2 **Internal and External Audits.** Internal and/or external audits ensure correct accounting methods and financial practices are being maintained. These audits are often very helpful to the project manager in uncovering problems that otherwise might not be seen. External audits are often a statutory requirement from local government.

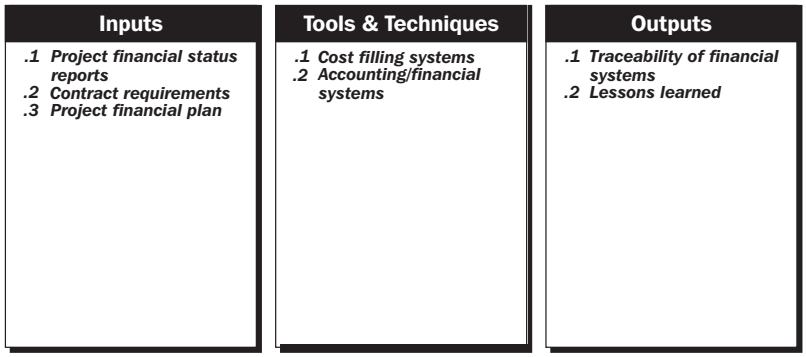
.3 **Cash flow analysis.** Updating all the actual financial and cost data regularly gives an up to date financial information system from which the project manager analyzes trends in the system based on unique characteristic of project - based on these trends and past actual data the forecast for the remaining duration can be revised. Utilizing cost and schedule updated information (See Sections 6, 7 and 10) an analysis can be made of cash flow trends and forecasts can be made to determine what adjustments may be required to the financial plan.

.4 **Financial reports.** For projects, even if they should not utilize partners, that require full financing, periodic financial reports are a requisite for management and for any lenders who may be involved. When projects are composed of some form of consortium or partnership, periodic (often monthly or quarterly) meetings are common during which project leaders present the status of the project and forecast its future, including the state of its financial health

15.2.2 Outputs

. 1 **Corrective action.** Based on the project health, financial status, and an analysis of financial status with relevant set criteria, an action plan can be prepared to correct any deviations in the original forecasts and plan. Budgets may need to be revisited and adjusted according to the current state of the project, which may again require approval from the participants. There may be a need to increase revenue from financial sources to cover any projected shortfalls.

15.3 FINANCIAL ADMINISTRATION AND RECORDS



.1 **Project Financial Status Reports.** See Section 15.2.3.1 of this Extension.

.2 **Contract Requirements.** Attention must be paid to contract clauses for invoicing and possible bond reductions that may require a certificate of tax paid and specific statements of completion. Some contracts require written

indemnities for the client, certification of salaries paid to employees, and subcontractors for payment of progress invoices. All items must be complied with, as without ensuring the correct contract documentation requirements are met can cause delays in payments and can seriously affect project cash flow.

.3 Project Financial Plan. See Section 15.1.3.1 of this Extension.

15.3.2 Tools and Techniques

.1 Cost filing systems. See Section 15.2.2.1 of this Extension.

.2 Accounting / financial systems. See Section 15.2.2.1 of this Extension.

15.3.3 Outputs

.1 Traceability of financial systems. Traceability/retrieval within financial systems is very important for audits/company management to evaluate the company's and the project's financial health. Traceability is easy if the storage of financial information is well defined and standardized. For computer aided financial information storage, traceability is very effective and less time consuming compared to the conventional filing and retrieval system.

.2 Lessons Learned. Financial records and reports indicate the problem areas previously encountered and corrective action taken. For projects with long durations, lessons learned from past experience can be valuable in avoiding similar problems over the future life of the project.

Chapter 16

Project Claim Management

Claim Management describes the processes required to eliminate or prevent construction claims from arising and for the expeditious handling of claims when they do occur.

Claim management is an important process in construction. Claims can be viewed from two perspectives: the party making the claim and the one defending against it. Webster's dictionary defines a claim as "A demand for something due or believed to be due", usually the result of an action or direction. In construction "something" is usually additional compensation for work claimed to be extra to the contract or an extension of time for completion or both. What distinguishes a claim from a change is the element of disagreement between the parties as to what is due or whether or not anything is due. If agreement is reached, then the claim disappears and becomes a change. If not, the claim may proceed to negotiation, mediation, arbitration, and finally to litigation before it is ultimately resolved. Often claims are thought of in terms of the contractor making claims against the owner or other prime party and by subcontractors against the contractor; but claims can also originate with the owner who believes that some requirement of the contract is not being performed by the contractor.

This section is not meant to be a primer on claims which is a very involved and complex subject that has plagued the construction industry for years and still does. Rather, this section presents an outline of approach to claim management to stimulate a careful approach to contract preparation and expeditious handling of claims should they arise.

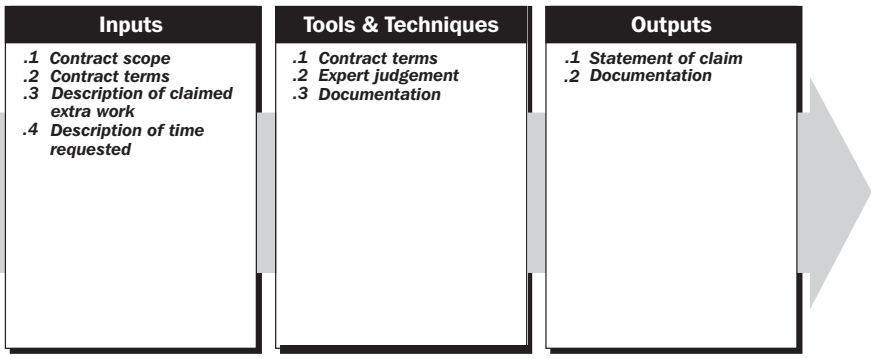
Claim management is, in some respects, similar to risk management and consists of the following four processes:

16.1 Claim Identification
16.2 Claim Quantification
16.3 Claim Prevention
16.4 Claim Resolution

16.1 CLAIM IDENTIFICATION

The identification of a claim starts with sufficient knowledge of the scope and contract terms to be aware when some activity appears to be a change

in scope or terms requiring a contract adjustment. Proper identification involves not only an interpretation of what the contract requires but also a documented description of the activity viewed as extra to that required by the contract.



16.1.1 Inputs to Claim Identification

.1 Contract scope. The scope of work as set forth in the contract including all plans and specifications.

.2 Contract terms. The various terms and conditions that apply to the work to be performed, especially terms relating to changes, changed conditions, schedule preparation and submittal, and notices to be given.

.3 Description of claimed extra work. A written description of the work believed to be extra to the contract, where and when it took place. A statement of why it is not covered in the contract scope and reference to the section of the contract that supports the contention.

.4 Description of time requested. A record of when the alleged extra work began, ended or when it is estimated to end. Time extension claims that result from delays to the work due to events such as unusual weather, strikes or other force majeure items outside the contractor's control may be valid while they may not be compensable. The contract and local law decisions often state which are compensable.

16.1.2 Tools and Techniques for Claim Identification

.1 Contract terms. The contract provisions relating to changes and notice provisions. In many cases, claims not made in a timely manner are invalid.

.2 Expert judgement. It is often worthwhile to reach a consensus among more than one person that the activity under question does merit claim status. In some cases of more important or larger claims, legal advice may be sought to add further support to the validity of the claim.

.3 Documentation. One of the most important factors in the claim process is the need for good supportive documentation. This may take the form of photographs and videos of the work in question, relevant contract sections and drawings, relevant statements of persons involved in or related to the claimed work. In addition, the time and days the work was performed should be noted. It is helpful to open a new cost account to cover the claimed work in order to clearly separate it from other contract work.

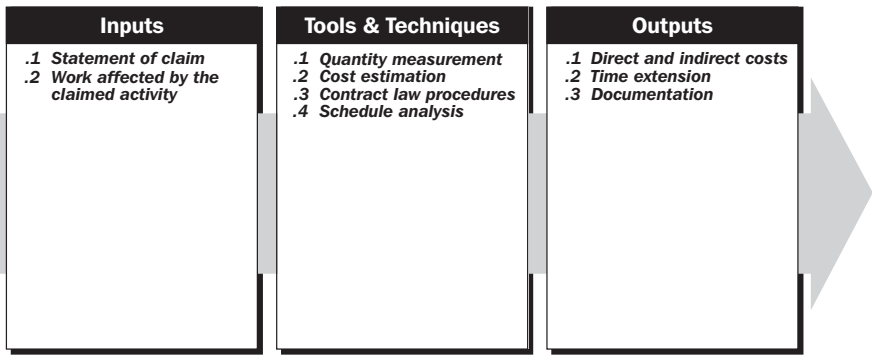
16.1.3 Outputs from Claim Identification

.1 Statement of claim. With the information gathered in 16.1.2 above, it is possible to prepare a complete statement of the claim and why it is considered extra to the contract.

2. Documentation. The documentation from Section 16.1.2.3 of this Extension.

16.2 CLAIM QUANTIFICATION

Once an activity has been reviewed and a decision made that it is worthy of pursuing as a claim, the next step is to quantify it in terms (usually) of additional compensation or a time extension to the contract completion or other milestone date. Those who have had experience with this side of claim management know that it is not unusual for the claimant to inflate the amount of the claim to the extent possible and thus it later becomes a form of bargaining process between the parties as a reasonable "truth" is sought. Nevertheless, there are proper and logical ways of determining the cost of the extra activity or damages both in terms of money and time. The process basically uses a cause and effect approach to determine the full effect of the claimed activity-what was the full effect on the construction work caused by the claimed activity? Sometimes the claimed activity has an indirect effect on other aspects of the construction project-making other work more costly, changing sequences, and delaying other activities. To the extent that these indirect effects can be justified and quantified, they are properly part of the total cost of the claim.



16.2.1 Inputs to Claim Quantification

.1 Statement of claim. See Section 16.1.3 of this Extension.

.2 Work affected by the claimed activity. In the event it occurs, this is the additional effect on the balance of the contract work caused by the claimed activity. These effects should be treated in the same manner and data collected as for the claimed activity itself.

16.2.2 Tools and Techniques for Claim Quantification

.1 **Quantity measurement.** Actual quantities of the claimed work in terms of cubic meters of concrete or earth, weight of steel, linear measures of piping and electrical work, and so forth. When disagreements arise, the first place to look for agreement is the quantity involved.

.2 **Cost estimation.** The cost of the labor, material, and equipment involved in the claimed work. If cost records are available, they will provide the basis of the estimate. If not, the cost will have to be estimated using current applicable rates. Additions for overhead and profit are common and usually proper as the claim is treated at this stage as though it will be considered a change. Sometimes the claimed work has an effect on other work on the project that causes additional cost. Usually this cost will have to be estimated, since the cause and effect relationship is not obvious. Often, though, the justification for this indirect effect is difficult to prove to the satisfaction of the opposing party.

.3 **Contract law precedents.** It is often helpful to be able to cite previous cases that will act to support the claim in those more complex situations where the contract does not provide a solution. Such cases may give guidance as to what may or may not be included in the claim or how the claim may be evaluated. In the U.S., for example, a court decision commonly referred to as "the Eichleay formula" set forth principles for determining the allocation of overhead in certain kinds of claims.

.4 **Schedule analysis.** The usual way of approaching the schedule effect of changes and claims is to compare the "as planned" schedule with the "as built" schedule to support the time extension requested not only for the claimed activity but also for the effect (if any) on the balance of the project. Schedule analysis with the aid of today's sophisticated computer programs can help, but also can make this analysis very complicated. The ultimate deciding factor is the effect on the critical path and it can become difficult to separate because of all of the other factors that can and do affect construction schedules.

16.2.3 Outputs from Claim Quantification

.1 **Direct and indirect costs.** The cost or damages resulting from the claimed activity with full support of the factors used in the calculation. Also, the cost, when justified, of the effects of the claimed activity on other aspects of the construction project calculated in the same manner as the direct costs.

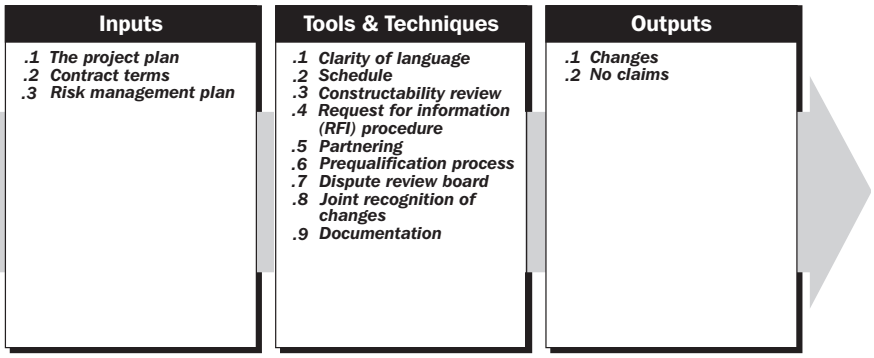
.2 **Time extension.** The result from the analysis in Section 16.2.2.4 of this Extension.

.3 **Documentation.** Proper backup of quantity calculations, time cards showing the extent of labor involved, and machine usage, wage rates, equipment rates, and invoices for material that are included in the claim are the kinds of documents needed for support of the quantification.

16.3 CLAIM PREVENTION

Clearly the best way to prevent claims is to have no claims to prevent! Thus, the emphasis is on how to avoid or prevent claims from arising. The per-

fect, well-scoped and risk allocated contract that is well executed will very likely not produce any claims. Since perfection is widely unobtainable, all that most owners and contractors can do is their best toward that goal. There are several general principles of practice described in this section for avoiding and preventing claims which, if followed, can work toward the elimination of the basis for, or at least minimize the occurrence of claims.



16.3.1 Inputs to Claim Prevention

.1 The project plan. The fundamental parts of the plan are the most important. A clear and carefully described scope of work, a reasonable schedule, and an appropriate method of project execution tailored to the type of project, and the degree of risk involved, all go a long way to the goal of eliminating claims.

.2 Contract terms. Fairly drawn contract terms that provide for possible changes and unknown site conditions, force majeure type delays, periodic reporting, fair notice provisions and approval times also provide a basis for minimizing claims.

.3 Risk management plan. Claims are minimized by the use of a risk management plan that allocates the risk between the parties on the basis of which one has the most control over the risk involved. A company owner's practice of often trying to have the contractor responsible for more and more risk, over some of which the contractor has little or no control, is an invitation to claims.

16.3.2 Tools and Techniques for Claim Prevention

.1 Clarity of language. The contract scope and specifications should be written in clear unambiguous terms.

.2 Schedule. The schedule requirements should be clearly stated and reasonable of accomplishment. Schedule update submission requirements should be fair and capable of providing good schedule positions without unnecessary or unneeded complexity.

.3 Constructability review. The use of a constructability review can avoid later field errors and unnecessary changes in construction methods all of which can lead to claims.

.4 Request for information (RFI) procedure. In contracts requiring designer or owner approval of shop drawings, materials of construction, RFIs, and like items should contain a clause stating a reasonable time for the answer to be given. It is true, if this time is not met, the contractor may have

grounds for a claim; but those grounds will be clear to all. Consequently, the time for answering should be realistic, not inordinately long nor so short that it will be difficult for the owner or designer to comply.

.5 **Partnering.** Projects that use the relatively new technique of (project specific) partnering, have an improved opportunity to eliminate claims because of the mutual dedication of the parties and much better communication requirements that are a part of this technique.

.6 **Prequalification process.** Projects that utilize prequalification of contractors have the benefit of dealing with seasoned and qualified contractors who are less likely to find themselves in desperate situations that might drive others to frantic claim activity.

.7 **Dispute review board (DRB).** Some projects, usually larger ones, establish a DRB at the outset of the project with good results. The DRB acts as a kind of arbitration panel over any disputes that arise during the project so that potential claims are turned into changes or are dismissed for good reason before the project is ended.

.8 **Joint recognition of changes.** One of the best ways of reducing claim potential is for the other party to recognize when a change has occurred. The tendency to fail to do this or to argue incessantly over every potential change, is a major factor in perpetuating claims. Both parties need to be realistic.

.9 **Documentation.** Good documentation can lead quickly to a recognized change, whereas poor documentation will likely only prolong any argument between the parties. Good documentation can also provide a good defense against claims. A complete factual analysis can defeat spurious or poorly supported claims.

16.3.3 Outputs from Claim Prevention

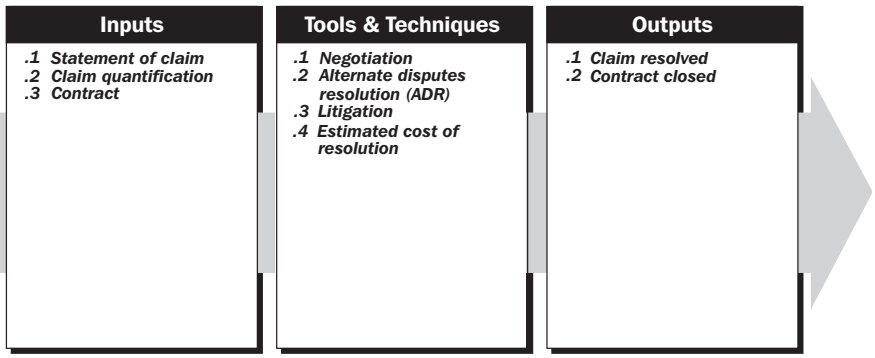
.1 **Changes.** Potential claims for compensation or requests for extensions of time, or both, that are agreed upon, are turned into changes and the claims disappear.

.2 **No claims.** Using the tools and techniques in Section 16.3.2 of this Extension there are no disputed requests for changes (claims) at the end of the project. None have arisen or, if they have, they have been disposed of as changes or withdrawn.

16.4 CLAIM RESOLUTION

Even with a concerted effort to prevent claims they still may arise. There may be a justifiable disagreement as to whether the claim in question is a change to the contract or not, or whether the claimed amount of compensation or time requested is correct. When this situation arises, there begins a step-by-step process to resolve these questions. It is axiomatic that the longer this process takes the more expensive and disruptive it is to both parties. Therefore, the goal is to settle these issues soon and at the lowest point in the organization as practicable. The process begins with negotiation, perhaps at more than one level, before moving on to mediation, arbitration, and litigation; depending on the remedies afforded by the contract. Because

of the proliferation of claims in construction and the expense of litigation, alternate methods of resolution have been increasingly used. Called ADR for Alternate Dispute Resolution, they include mediation, arbitration, and mini-trials.



16.4.1 Inputs to Claim Resolution

.1 Statement of claim. See Section 16.1 of this Extension.

.2 Claim quantification. See Section 16.2 of this Extension.

.3 Contract. The contract provides the ultimate baseline and means for resolution.

16.4.2 Tools and Techniques for Claim Resolution

.1 Negotiation. Always the first and best step to resolution. Sometimes the negotiation needs to be elevated to a higher level but it still is a negotiation between parties trying to find an equable solution.

.2 Alternate disputes resolution (ADR). These include mediation, arbitration, and mini-trials.

.3 Litigation. This is the usual result when all earlier attempts at settlement have failed. Construction lawsuits are commonly complex for a jury to understand and often take a long time to present. This is the "court of last resort" and is expensive in terms of cost and upset to the organizations involved. Parties in litigation really want to be sure that this is the only way the dispute can be resolved.

.4 Estimated cost of resolution. When the initial attempts at negotiation fail it is prudent for each of the parties to estimate the cost of carrying the dispute further. Mediators are costly (but can be cost effective) and some arbitration cases can approach the expense of litigation, due to the amount of discovery involved. An estimate of these costs can help in deciding just how important it is to keep pursuing a claim.

16.4.3 Outputs from Claim Resolution

.1 Claim resolved. One of the techniques in Section 16.4.2 of this Extension settles the claim.

.2 Contract closed. In cases where the contract cannot be closed because of a pending dispute, resolution of that dispute enables the contract to be closed.

SECTION IV

APPENDICES

Appendix A

The Project Management Institute Standards-Setting Process

The Project Management Institute (PMI) Standards-Setting Process was established initially as Institute policy by a vote of the PMI Board of Directors at its October 1993 meeting. In March 1998, the PMI Board of Directors approved modifications to the process. Then in March 1999, it was modified again to make it consistent with the concurrent change in PMI governance procedures.

A.1 PMI STANDARDS DOCUMENTS

PMI Standards Documents are those developed or published by PMI that describe generally accepted practices of project management, specifically:

- *A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*).
- Project Management Body of Knowledge Handbooks.

Additional documents may be added to this list by the PMI Standards Manager, subject to the advice and consent of the PMI Project Management Standards Program Member Advisory Group and the PMI Chief Executive Officer. Standards Documents may be original works published by PMI, or may be publications by other organizations or individuals. Standards Documents will be developed in accordance with the Code of Good Practice for Standardization developed by the International Organization for Standardization (ISO) and the standards development guidelines established by the American National Standards Institute (ANSI).

A.2 DEVELOPMENT OF ORIGINAL WORKS

Standards Documents that are original works developed by PMI, or revisions of such documents, will be handled as follows:

- Prospective developer(s) will submit a proposal to the PMI Standards Manager. The Manager may also request such proposals. The Manager will submit all received proposals to the PMI Standards Program Member Advisory Group who, with the Manager, will decide whether to accept or reject each proposal.
- The Manager will inform the prospective developer(s) as to the decision and the rationale for the decision. If an approved proposal requires funding in excess of that budgeted for standards development, the Manager will submit the proposal to the PMI Chief Executive Officer for funding.
- For all approved and funded proposals, the Manager will support the developer's efforts so as to maximize the probability that the end product will be accepted. Developer(s) will be required to sign the PMI Volunteer Assignment of Copyright.
- When the proposed material has been completed to the satisfaction of the developer(s), the developer(s) will submit the material to the PMI Standards Manager. The PMI Standards Program Member Advisory Group, with the Manager, will review the proposed material and decide whether to initiate further review by knowledgeable individuals or request additional work by the developer(s).
- The Manager will appoint, subject to review and approval by the PMI Standards Program Member Advisory Group, at least three knowledgeable individuals to review and comment on the material. Based on comments received, the Member Advisory Group will decide whether to accept the material as an exposure draft.
- The PMI Standards Manager will develop a plan for obtaining appropriate public review for each exposure draft. The plan will include a) a review period of not less than one month and not more than six months, b) announcement of the availability of the exposure draft for review in *PMI Today*® (and/or any other similarly appropriate publication media), and c) cost of review copies. The PMI Standards Program Member Advisory Group must approve the Manager's plan for public review. Each exposure draft will include a notice asking for comments to be sent to the PMI Standards Manager at PMI Headquarters and, noting the length of, and expiration date for, the review period.
- Exposure drafts will be published under the aegis of the PMI Publishing Department and must meet the standards of that group regarding typography and style.
- During the review period, the Manager will solicit the formal input of the Managers of other PMI Programs (e.g., Certification, Education, Components, and Publishing) that may be affected by the future publication of the material as a PMI Standard.
- At the conclusion of the review period, the PMI Standards Manager will review comments received with the PMI Standards Program Member Advisory Group, and will work with the developer(s) and others as

needed to incorporate appropriate comments. If the comments are major, the PMI Standards Program Member Advisory Group may elect to repeat the exposure draft review process.

- When the PMI Standards Manager and the PMI Standards Program Member Advisory Group have approved a proposed PMI Standards Document, the Manager will promptly submit the document to the PMI Chief Executive Officer for final review and approval. The PMI Chief Executive Officer will verify compliance with procedures and ensure that member input was sufficient. The PMI Chief Executive Officer will a) approve the document as submitted; b) reject the document; or c) request additional review, and will provide explanatory comments in support of the chosen option.

A.3 ADOPTION OF NON-ORIGINAL WORKS AS STANDARDS

Standards Documents that are the work of other organizations or individuals will be handled as follows:

- Any person or organization may submit a request to the PMI Standards Manager to consider a non-PMI publication as a PMI Standard. The Manager will submit all proposals received to the PMI Standards Program Member Advisory Group who, with the Manager, will decide whether to accept or reject each proposal. If accepted, the Manager will appoint, subject to review and approval by the PMI Standards Program Member Advisory Group, at least three knowledgeable individuals to review and comment on the material.
- During the review period, the Manager will solicit the formal input of the Managers of other PMI Programs (e.g., Certification, Education, Components, and Publishing) that may be affected by the future publication of the material as a PMI Standard.
- Based on comments received, the Member Advisory Group, with the Manager, will decide whether to a) accept the proposal as written as a PMI Standard, b) accept the proposal with modifications and/or an addendum as a PMI Standard, c) seek further review and comment on the proposal (that is, additional reviewers and/or issuance as an exposure draft), or d) reject the proposal. The Manager will inform the submitter as to the decision and the rationale for the decision.
- When the PMI Standards Manager and the PMI Standards Program Member Advisory Group have approved a proposed PMI Standards Document, the Manager will promptly submit the document to the PMI Chief Executive Officer for final review and approval. The Manager will prepare a proposal for the PMI Chief Executive Officer for consideration of a prospective relationship with the owner(s) of the material.
- The PMI Chief Executive Officer will verify compliance with procedures and will ensure that member input was sufficient. The PMI Chief Executive Officer will a) approve the document as submitted; b) reject the document; or c) request additional review, and will provide explanatory comments in support of the chosen option.

Appendix B

Evolution of the Construction Extension

In October 1998 the Construction Research Institute of Korea (CERIK) approached PMI's Chair and proposed that PMI develop a Construction Extension to the *PMBOK® Guide*. The Chair called on the Design-Procurement-Construction Specific Interest Group (SIG) to accept this assignment and the SIG appointed Sherrill Mc Donald as project manager of the Construction Extension. A core team was formed and spent the next year discussing the format and broad outline of the extension. The Project Charter was approved in October 1999 and the Project Plan followed about one month later. Originally based on the 1996 *PMBOK® Guide* work was later changed to base it on the 2000 *PMBOK® Guide*.

The intent of the project plan was to complete model chapter outlines which, after internal approval, would lead to drafts that would follow a common outline. After the first drafts from those outlines had been approved the balance of chapters could be drafted with confidence of acceptance. While a sincere attempt was made to follow this plan the membership of the team kept changing for a variety of reasons and never reached the size and constancy that would have made the plan fully operable.

While nearly 70 people were members of the team at one time or another there were never more than 20 members at any given time. Nevertheless, work in earnest began to be completed in 2001 and 2002. A marked increase in volunteers directed by PMI to the project helped improve progress. While much of the work is based on North American construction experience, the team has included members from Europe, Asia, Australia, South America and Africa. Most of the chapters were written by only one or two members. A web site for the project was established and completed work as well as important project documents and project progress reports were posted there for review by the team and others.

The completed draft contains material referenced to the twelve chapters of the *PMBOK® Guide* 2000 but, in addition, also includes four new chapters specifically applicable to the construction industry: Safety Management, Environmental Management, Financial Management and Claim Management. The team debated whether or not to make these new knowl-

edge areas or to try to include them in the existing nine knowledge areas. It was finally decided because of the amount of material and importance of these areas to make them additional chapters.

Early in 2003 as the first draft of the complete extension approached completion it was noted that following standard procedures the estimated publication would precede publication of the 2004 *PMBOK® Guide* by only a few months and hence the Extension would soon be based on an out-of-date document. Rather than delay publication further (until after the 2004 *PMBOK® Guide* had been published) it was decided to by-pass the exposure draft process and issue a Provisional Construction Extension which would likely provide essentially all of its value to the industry at a much earlier date. Any modifications to the extension resulting from publication of the 2004 *PMBOK® Guide* would be made at a later date and subjected to the exposure draft process before publication.

A nearly completed draft was reviewed by all team members and their comments solicited and incorporated before sending the final draft to selected subject matter experts - the final stage before publishing the Provisional Extension.

Appendix C

Construction Extension Team

Project Manager

Sherrill R. McDonald, PMP

Team Member Affiliations

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- Iesha Brown, PMI Certification Program Administrator
- Richard Schwartz, PMI Book Development Editor
- Danielle Moore, PMI Book Publishing Coordinator
- Regina Chapman, Editor

Appendix D

Notes

CHAPTER 1. INTRODUCTION

1. *PMBOK® Guide*-2000 Edition

CHAPTER 2. THE PROJECT MANAGEMENT CONTEXT

1. *Professional Construction Management,* Barrie & Paulson, McGraw-Hill, 1978
2. *Design-Build teaming Agreement Guide,* Design Build Institute of America, 2000
3. *PMBOK® Guide*-2000 Edition

CHAPTER 3. PROJECT MANAGEMENT PROCESSES

1. T*otal Construction project Management,* Ritz, Mc Graw-Hill, 1994
2. *PMBOK® Guide*-2000 Edition

CHAPTER 4. PROJECT INTEGRATION MANAGEMENT

1. *Total Construction project Management,* Ritz, Mc Graw-Hill, 1994
2. *Managing the Construction Project,* Trauner, John Wiley & Sons, 1993
3. *Management-Improving Capabilities,* Woodhead & Downs, Tedford, 2001
4. *Sustainable Federal Facilities,* Federal Facilities Council Tech. Report 142, National Academy Press, 2001
5. *Save International web site,* www.value-engineering.org, 2003
6. *PMBOK® Guide-2000 Edition*

CHAPTER 5. PROJECT SCOPE MANAGEMENT

1. *Professional Construction Management,* Barrie & Paulson, McGraw-Hill, 1978
2. *Project Management for Engineering & Construction,* Oberlender, Mc Graw-Hill, 1994
3. *Total Construction project Management,* Ritz, Mc Graw-Hill, 1994
4. *Management-Improving Capabilities,* Woodhead & Downs, Tedford, 2001
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6. *Save International web site,* www.value-engineering.org, 2003

7. *PMBOK® Guide*-2000 Edition

CHAPTER 6. PROJECT TIME MANAGEMENT

1. *Professional Construction Management,* Barrie & Paulson, McGraw-Hill, 1978
2. *Project-Level Model process for Implementing Constructability,* Radtke & Russell, Journal of Construction Engineering and Management, Vol.119, No.4, 1993
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CHAPTER 8. PROJECT QUALITY MANAGEMENT

1. *Professional Construction Management,* Barrie & Paulson, McGraw-Hill, 1978
2. *Modern Construction Management,* Harris & Mc Caffer, Blackwell Science Ltd., 2001
3. *TQM-An Industry Necessity,* Construction Industry Institute Conference, 1992
4. *ISO 9000*
5. *ISO 10000*
6. *PMBOK® Guide-2000 Edition*

CHAPTER 9. PROJECT HUMAN RESOURCE MANAGEMENT

1. *Project Management,* Kimmons & Lowell, Marcel Dekker Inc.,1989
2. *PMBOK® Guide*-2000 Edition

CHAPTER 10. PROJECT COMMUNICATIONS MANAGEMENT

1. *Professional Construction Management,* Barrie & Paulson, McGraw-Hill, 1978
2. *Managing the Construction Project,* Trauner, John Wiley & Sons, 1993
3. *Project Management,* Kimmons & Lowell, Marcel Dekker Inc.,1989
4. *PMBOK® Guide-2000 Edition*

CHAPTER 11. PROJECT RISK MANAGEMENT

1. *Managing the Construction Project,* Trauner, John Wiley & Sons, 1993
2. *Project Management,* Kimmons & Lowell, Marcel Dekker Inc.,1989
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CHAPTER 12. PROJECT PROCUREMENT MANAGEMENT

1. *Project Management for Engineering & Construction,* Oberlender, Mc Graw-Hill, 1994
2. *Total Construction project Management,* Ritz, Mc Graw-Hill, 1994
3. *Project Management,* Kimmons & Lowell, Marcel Dekker Inc.,1989
4. *PMBOK® Guide-2000 Edition*
5. *The Need to Distinguish Project Delivery from Procurement,* Design-Build Dateline August 2002, Design Build Institute of America

CHAPTER 13. PROJECT SAFETY MANAGEMENT

1. *Professional Construction Management,* Barrie & Paulson, McGraw-Hill, 1978

2. *Construction Contracting,* Clough & Sears, 6th ed.,John Wiley & Sons, 1994

CHAPTER 14. PROJECT ENVIRONMENTAL MANAGEMENT

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CHAPTER 15. PROJECT FINANCIAL MANAGEMENT

1. *MSc. Class notes,* International Construction Management & Engineering, Leeds University, 1994-1995

2. Project Management, Kimmons & Lowell, Marcel Dekker Inc.,1989

CHAPTER 16. PROJECT CLAIM MANAGEMENT

1. *A Contractual Guide to Major Construction Projects* Ed-1999 by John Scrvin, Nigel Pritchard and Jeff Delmon, Published by Sweet & Maxwell Limited, 100 Avenue Rd, London NW3 3PF, UK

2. *Causation and Delay in Construction Disputes* Ed=2000 by Nicholas J. Carnell. Published by Blackwell Science Ltd.

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7. *Partner Your Project,* Sue Dyer, Pendulum Publishing, 1997

Appendix E

Application Area Extensions

E.1 NEED FOR APPLICATION AREA EXTENSIONS

Application area extensions are necessary when there are generally accepted knowledge and practices for a category of projects in one application area that are not generally accepted across the full range of project types in most application areas. Application area extensions reflect:

- Unique or unusual aspects of the project environment that the project management team must be aware of in order to manage the project efficiently and effectively.
- Common knowledge and practices which, if followed, will improve the efficiency and effectiveness of the project (e.g., standard work breakdown structures).

Application area-specific knowledge and practices can arise as a result of many factors, including, but not limited to, differences in cultural norms, technical terminology, societal impact, or project life cycles. For example:

- In construction, where virtually all work is accomplished under contract, there are common knowledge and practices related to procurement that do not apply to all categories of projects.
- In bioscience, there are common knowledge and practices driven by the regulatory environment that do not apply to all categories of projects.
- In government contracting, there are common knowledge and practices driven by government acquisition regulations that do not apply to all categories of projects.
- In consulting, there are common knowledge and practices created by the project manager's sales and marketing responsibilities that do not apply to all categories of projects.

Application area extensions are:

- *Additions* to the core material of Chapters 1 through 12 of the *PMBOK® Guide* - 2000 Edition, *not substitutes* for it.
- Organized in a fashion similar to the *PMBOK® Guide* - 2000 Edition; that is, by identifying and describing the project management processes unique to that application area.
- Unique additions to the core material such as:
  - Identifying new or modified processes

- Subdividing existing processes
- Describing different sequences or interactions of processes
- Increasing elements to or modifying the common process definitions
- Defining special inputs, tools and techniques and/or outputs for the existing processes.

Application area extensions are *not*:

- "How to" documents or "practice guidelines"-such documents may be issued as PMI Standards, but they are not what are intended as extensions.
- A lower level of detail than is addressed in this document-such details may be addressed in handbooks or guidebooks which may be issued as PMI Standards, but they are not what is intended as extensions.

E.2 CRITERIA FOR DEVELOPMENT OF APPLICATION AREA EXTENSIONS

Extensions will be developed under the following criteria:

- There is a substantial body of knowledge that is both project-oriented and unique, or nearly unique to that application area.
- There is an identifiable PMI component (e.g., a PMI Specific Interest Group, College or a Chapter), or an identifiable external organization willing and able to commit the necessary resources to subscribe to and support the PMI Standards Program with the development and maintenance of a specific PMI Standard. Or, the extension may be developed by PMI itself.
- The proposed extension is able to pass the same level of rigorous PMI Project Management Standard-Setting Process as any other PMI Standard.

E.3 PUBLISHING AND FORMAT OF APPLICATION AREA EXTENSIONS

Application area extensions are developed and/or published by PMI, or they are developed and/or published by either a PMI component or by an external organization under a formal agreement with PMI.

- Extensions match the *PMBOK® Guide* - 2000 Edition in style and content. They use the paragraph and subparagraph numbers of the *PMBOK® Guide* - 2000 Edition for the material that has been extended.
- Sections and paragraphs of the *PMBOK® Guide* - 2000 Edition that are not extended are not repeated in extensions.
- Extensions contain a rationale/justification about the need for an extension and its material.
- Extensions are delimited in terms of what they are not intended to do.

E.4 PROCESS FOR DEVELOPMENT AND MAINTENANCE OF APPLICATION AREA EXTENSIONS

When approved in accord with the PMI Standards-Setting Process, Application area extensions become PMI Standards. They will be developed and maintained in accordance with the process described below.

- An extension must be sponsored by PMI, a formally chartered PMI component (e.g., a Specific Interest Group, College or a Chapter), or another organization external to PMI, which has been approved by the PMI Standards Program Member Advisory Group and the PMI Standards Program Manager. Co-sponsorship with PMI is the preferred arrangement. All approvals will be by formal written agreement between PMI and the sponsoring entity, which agreement will include, among other things, the parties' agreement as to intellectual property ownership rights and publications rights to the extension.
- A project to develop, publish and/or maintain an extension must be approved by the PMI Standards Program. Permission to initiate, develop and maintain an extension must be received from PMI, and will be the subject of an agreement between or among the organizations. If there is no other sponsoring organization, the PMI Standards Program may elect to proceed alone.
- The sponsoring group will notify and solicit advice and support from the PMI Standards Program Member Advisory Group and PMI Standards Program Manager throughout the development and maintenance process. They will concur with the appropriateness of the sponsoring organization for the extension proposed and will review the extension during its development to identify any conflicts or overlaps with other similar projects that may be under way.
- The sponsoring group will prepare a proposal to develop the extension. The proposal will include a justification for the project with a matrix of application-area-specific processes and the affected sections of this document. It will also contain the commitment of sufficient qualified drafters and reviewers; identification of funding requirements, including reproduction, postage, telephone costs, desktop publishing, etc.; commitment to the PMI procedures for PMI Standards extension development and maintenance; and a plan and schedule for same.
- Following acceptance of the proposal, the project team will prepare a project charter for approval by the sponsoring group and the PMI Standards Program Team. The charter will include sources of funding and any funding proposed to be provided by PMI. It will include a requirement for periodic review of the extension with reports to the PMI Standards Program Team and a "Sunset Clause" that specifies when, and under what conditions, the extension will be removed from active status as a PMI Standard.
- The proposal will be submitted to the PMI Standards Manager in accordance with the PMI Standards-Setting Process. The PMI Standards Manager will determine if the proposal can be expected to result in a document that will meet the requirements for a PMI Standard, and if adequate resources and sources of support have been identified. To help with this determination, the PMI Standards Manager will seek review and comment by the PMI Standards Program Member Advisory Group and, if appropriate, a panel of knowledgeable persons not involved with the extension.
- The PMI Standards Manager, with the support of the PMI Standards Program Member Advisory Group, will monitor and support the development of the approved project. A project charter must be approved by the sponsoring organization(s) and by the PMI Standards Program Team.

- The sponsoring organization will develop the extension according to the approved project charter, including coordinating with the PMI Standards Program Team for support, review and comment.
- When the extension has been completed to the satisfaction of the sponsoring organization, it will be submitted to the PMI Standards Manager, who will manage the final approval and publication processes in accordance with the PMI Standards-Setting Process. This final submittal will include listing of and commitment by the sponsoring organization to the PMI extension maintenance processes and efforts.
- Following approval of the extension as a PMI Standard, the sponsoring organization will implement the extension maintenance process in accordance with the approved plan.

SECTION V

GLOSSARY AND INDEX

Glossary

ACCPAC (International, Inc.). A business services and application software firm providing accounting software among other products.

Activity weights. The value assigned to activities, often in terms of worker hours.

ADR. Alternate dispute resolution. Methods, other than litigation, for resolving disputes including arbitration, mediation and mini-trials.

Consortium. Similar to a joint venture, a group of companies formed to undertake a project beyond the resources of any one member.

Constructability. The ease, safety, economy and clarity of construction of a project.

Currency hedging. A way of limiting exposure to future changes in the exchange rate of currencies.

Delivery systems. Various methods of performing design/construction projects such as design-bid-build and design-build.

Design-bid-build. Design is completed by a professional architect or engineer; a construction contract is awarded after competitive bids

Design-build. A single entity performs both design and construction of the project.

Design-build-operate-maintain (DBOM). Similar to DBOO except that the design builder has no ownership of the project.

Dispute review board. A board formed at the start of or early in the project to review and adjudicate any disputes that may arise.

Eichleay formula. A U.S. government method of calculating overhead due on certain changes.

EPC. Engineering-procurement-construction.

EPCM. Engineering-procurement-construction management.

Exit interviews. Interviews of construction (and project) staff as they leave the project.

Feasibility study. An early engineering and financial analysis of a proposed project to determine its viability.

Force majeure. An event not reasonably anticipated and acts of God such as weather, strikes or other uncontrollable events.

Fringe benefits. Costs of labor beyond wages. Such items as vacation, holidays, insurance and taxes.

General contractor. A contractor who does not specialize in one kind of work. Often the major contractor who employs specialty subcontractors.

Hazard analysis. A review of all the safety hazards that may be encountered in a project. Used to form a safety plan.

Job descriptions. A description of the responsibilities and authorities of an employee.

Joint venture. A partnership of two or more engineering, construction, manufacturing trading, or investing companies often of limited duration.

Layout risk. The risk associated with the designed physical layout of a project.

Non-conformance report. A report detailing the failure to meet specifications and often recommending a method of correction.

Non-recourse. A type of finance that relies on the project only as lending collateral.

Partnering (alliance). Alliance partnering is a long-term relationship between an owner and an engineer/contractor where the contractor acts as a part of the owner's organization for certain functions.

Partnering (project specific). An informal agreement of all major entities in a project to work closely and harmoniously together.

PDA. Personal Data Assistant. A portable handheld computerized device performing many communication and data storage functions.

Pre estimating survey. A survey of a construction site to determine relevant characteristics such as weather, local suppliers and contractors and available utilities.

Pre qualification list. A list of contractors or designers that have been preselected for further consideration based on their submitted qualifications.

Progress curves. Plots of (usually) progress in percent complete versus time. Used to display status and trends

Project specifications. The engineering and architectural plans and written requirements for a project. Similar to statement of work.

Punchlist. The items remaining to be completed after a final inspection.

Recourse. Financing that is based on the assets of the sponsoring entity for collateral.

RFI. Request for information. Typically a communication from a contractor to the designer.

SAP. A business services and application software firm providing accounting software among other products.

Self performed. Construction work that is performed by the major contractor's work force.

Sensitivity analysis. Varying several constituents of a calculated study to see what the effect is. Usually performed in connection with a feasibility study.

Short list. A list that is distilled from a larger group of proposers or bidders through the use of set criteria.

Sole source. A type of procurement where only one supplier is asked to bid. Often required to obtain proprietary products.

Toolbox meetings. A regular meeting of field supervisors and workers to review important work issues; particularly those pertaining to safety.

Trades. Workers in the various construction disciplines such as carpenters and ironworkers.

Turn key. A type of design build project where the design builder does all functions including start up before turning the project over to the owner.

Two-envelope system. A form of procurement also called "two step" that is performed in two phases. The first phase involves a firm's qualifications. If the firm qualifies the second phase involves pricing.

Unit rate contract. A contract for construction based on established (bid) prices for certain types of work where the final quantities may not be known.

Value management. Value engineering.

War room. A room used for project conferences and planning, often displaying maps, charts of cost and schedule status and other key project data

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