ASCE Manuals and Reports on Engineering Practice No. 73

Quality in the Constructed Project

A Guide for Owners, Designers, and Constructors

Third Edition

ASCE

CONSTRUCTION INSTITUTE

ASCE MANUALS AND REPORTS ON ENGINEERING PRACTICE NO. 73

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THIRD EDITION

ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS

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MANUALS AND REPORTS ON ENGINEERING PRACTICE

(As developed by the ASCE Technical Procedures Committee, July 1930, and revised March 1935, February 1962, and April 1982)

A manual or report in this series consists of an orderly presentation of facts on a particular subject, supplemented by an analysis of limitations and applications of these facts. It contains information useful to the average engineer in his or her everyday work, rather than findings that may be useful only occasionally or rarely. It is not in any sense a "standard," however; nor is it so elementary or so conclusive as to provide a "rule of thumb" for nonengineers.

Furthermore, material in this series, in distinction from a paper (which expresses only one person's observations or opinions), is the work of a committee or group selected to assemble and express information on a specific topic. As often as practicable, the committee is under the direction of one or more of the Technical Divisions and Councils, and the product evolved has been subjected to review by the Executive Committee of the Division or Council. As a step in the process of this review, proposed manuscripts are often brought before the members of the Technical Divisions and Councils for comment, which may serve as the basis for improvement. When published, each work shows the names of the committees by which it was compiled and indicates clearly the several processes through which it has passed in review, in order that its merit may be definitely understood.

In February 1962 (and revised in April 1982) the Board of Direction voted to establish a series entitled "Manuals and Reports on Engineering Practice," to include the Manuals published and authorized to date, future Manuals of Professional Practice, and Reports on Engineering Practice. All such Manual or Report material of the Society would have been refereed in a manner approved by the Board Committee on Publications and would be bound, with applicable discussion, in books similar to past Manuals. Numbering would be consecutive and would be a continuation of present Manual numbers. In some cases of reports of joint committees, bypassing of Journal publications may be authorized.

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Dedicated to James W. Poirot, P.E.
1931–2011

The third edition of this very important ASCE manual is dedicated to James W. Poirot, P.E., President of ASCE in 1994 and principal advocate for the material contained in this manual.

In November 1984, nearly 100 members of the design and construction industry convened for a workshop in Chicago to discuss ways of attaining quality in planning, design, and construction. Those attending agreed on several related points. First, accidents, design flaws, cost overruns, and other similar problems were occurring at a serious rate. The collapse of two suspended walkways in the Kansas City Regency in 1981, killing 114 and injuring 185, was one of the more recent tragic incidents. But not all incidents or problems were as serious or as widely publicized as the Regency. Losses measured in dollars without loss of life were also serious concerns that were addressed.

It was agreed that the American Society of Civil Engineers, the principal sponsor of the Chicago workshop, should develop and publish a comprehensive guide to quality in design and construction (Manual of Professional Practice for Quality in the Constructed Project). James Poirot volunteered to lead the steering committee, which consisted of 40 authors and some 90 reviewers from throughout the industry—a daunting task.

Thanks to Poirot's determination and leadership the task was successful and led to the initial publication of the preliminary edition for trial use and comment in 1988. His work remains as the very substantial foundation for this third edition.

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PREFACE TO THE THIRD EDITION

The idea for this Guide arose during a series of meetings in 1983–1985 among leaders of the design and construction industry who convened to discuss opportunities to improve quality in constructed projects. The group decided that the American Society of Civil Engineers (ASCE) would develop and publish a guide with information and recommendations geared toward helping people improve the quality of the projects they own, design, and/or construct.

In 1987, ASCE published a Preliminary Review Draft of the Guide that was distributed to more than 1,000 professionals, including owners, design professionals, constructors, agency personnel, legal experts, educators, and others. Their comments were addressed and incorporated into a Trial Use and Comment Edition, published in 1988 and purchased by more than 15,000 people in the construction industry. The Trial Use and Comment Edition yielded approximately 1,500 additional comments, which were addressed in the First Edition, published in 1990. In 1997, ASCE appointed a committee to update the Guide for the Second Edition, which was published in 2000.

The Second Edition carried on the originators' intent that the Guide be a living document. The Committee to Update Manual 73 worked with authors to produce four new or entirely rewritten chapters that address important industry changes during the period 1990 to 2000:

- "Project Delivery Systems" (Chapter 3);
- "Computers and Project Quality" (Chapter 21);
- "Partnering" (Chapter 24);
- "Value Engineering" (Chapter 25).

In addition, reviewers updated the existing chapters from the First Edition. The new and updated chapters were reviewed by representative groups of owners, design professionals, and constructors. The entire Guide was then reviewed by the appointed committee, 13 professional associations, a forum of legal experts, and a peer review team. Altogether, more than 125 industry professionals participated in producing the Second Edition.

The Second Edition also included new features to increase the day-to-day utility of the Guide, including summaries of project participant activities for each chapter, a page layout format to provide space for notes, more references to relevant publications and Internet resources, and Internet links to the latest editions of standard-form contract documents.

This Third Edition maintains the features of the Second Edition and provides relevant information developed since the publication of the Second Edition. More than 50 industry professionals have participated in producing the Third Edition.

This Guide is written primarily for the three principal project participants in a traditional design-bid-build (DBB) project—the owner, design professional, and constructor. It is also intended to be valuable to other project participants, including regulatory agency staff, subcontractors, subconsultants, and suppliers, as well as educators and students. Topics are organized in approximate project chronology, beginning with the owner's role and the selection of a project delivery system, the selection of other team members, design, construction, start-up, and operations and maintenance.

This Guide also highlights areas in which alternate forms of project delivery, such as design-build, may shift project responsibilities and risks to different participants. In cases where the Guide describes functions that would typically be performed by many people on larger projects, the reader may infer that these functions may be carried out by one person or a few people on smaller projects.

This Guide is not a substitute for the exercise of good judgment by the owner, designer, and constructor, nor should the procedures suggested in any way affect the specific contractual provisions governing a particular project. Users of this Guide are advised to consult knowledgeable and experienced legal counsel concerning the subjects addressed herein.

ASCE will continue to revise this Guide at appropriate intervals; comments are welcome at any time. Please address comments in writing to the Construction Institute, ASCE, 1801 Alexander Bell Drive, Reston, VA 20191, or via the Internet at ci@asce.org.

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EXECUTIVE SUMMARY

This Guide discusses principles and procedures that, in the experience of the authors and reviewers, are effective in achieving quality in constructed projects. It is written for project owners, design professionals, and constructors. Other project participants, such as regulatory agency personnel, subcontractors, subconsultants, and suppliers, may also find this guide useful. The material focuses on the typical requirements, responsibilities, roles, relationships, and limits of authority of the principal participants in constructed projects.

In this Guide, the principal members of the project team are the owner, design professional, and constructor. Topics are generally approached from the perspective of traditional design-bid-build (DBB) project delivery, the widely used form of contracting under which the design professional and the constructor are individually bound to the owner and their respective responsibilities specified by separate contractual agreements.

Quality in the Constructed Project *is an "aspirational" guide.*

On some projects, alternate forms of project delivery, such as design-build (wherein a single entity performs both design and construction) can enhance overall quality. Therefore, while this Guide usually discusses project activities from the DBB perspective, it also notes instances under alternate forms of project delivery in which team members may be responsible for tasks other than, or in addition to, those described.

Given its broad intended use, this Guide is an "aspirational" document with the goal of educating users and stimulating them to identify areas where they may raise the quality level of their involvement in the design and construction process. This Guide is not a technical standard, nor a compilation of standard industry practices.

Quality is defined as the delivery of products and services in a manner that meets the reasonable requirements and expectations of the owner, design professional, and constructor, including conformance with contract requirements, prevailing industry standards, and applicable codes, laws, and licensing requirements.

➢ Chapter 1, "Introduction"

Responsibilities refer to the tasks that a participant is expected to perform to accomplish the project objectives as specified by contractual agreement and applicable laws, codes, standards, and regulatory guidelines.

Requirements are what each team members expects to achieve or needs to receive during and after their participation in a project.

This definition of quality hinges on the degree to which the requirements of project participants are met. Therefore, this Guide focuses on practices and procedures that encourage participants to express their requirements with clarity.

PROJECT ORGANIZATION

➢ Chapter 2, "The Owner's Role and Requirements"
➢ Chapter 4, "The Project Team"

A successful project begins with the owner. As the first member of the project team, the owner identifies the need for a project, establishes the main goals, selects the other team members, defines the basic allocation of risk among project participants, and communicates the project goals to the other team members. The owner also secures funding and pays for the services of the other participants.

➢ Chapter 3, "Project Delivery Systems"

In the early stages of project development, the owner is responsible for a fundamental decision: the selection of an appropriate project delivery system. While DBB remains the predominant system for organizing a project team, other forms of project delivery may better meet the owner's needs, including the following:

- **Owner-provided.** The owner performs all design activities and acts as a general contractor, hiring construction subcontractors as needed.
- **Program manager.** The owner hires a single entity to extend owner capabilities in planning, design, and/or construction management to complete the project.
- **Design-build.** The owner hires a single entity to complete both design and construction.
- **Construction manager at risk.** The owner retains a contractor to provide pre-construction services during the project design period and to act as a general contractor to construct the project after the design is completed, or as the design progresses to completion.
- **Design-build variations.** The owner hires a design-builder who may also share the project's financial risk and/or operate the constructed project for a specified period before turning the facility over to the owner.

Fast-tracking is not a form of project delivery. Rather, it is a management strategy that can be utilized within the delivery systems listed above in which the construction of underlying elements begins before design is complete for elements that are to be built later. Fast-tracking is most commonly undertaken on design-build projects (see 3.6 "Fast-Tracking: A Distinction").

➢ Chapter 5, "Coordination and Communication"

The coordination of project activities under any method of delivery is essential to project quality. Coordination depends on the ability of participants to tailor their communications to the project delivery system being used.

To help improve the quality of decisions during the early stages of a project, the owner may engage the design professional before specific objectives have been developed to acquire additional planning expertise in project conceptualization, design, and construction. The owner may further enhance the effectiveness of early project decision making by seeking advice on legal, insurance, financial, real estate, land use, and other matters, in addition to procuring design and construction services.

SELECTING THE DESIGN PROFESSIONAL

The owner's criteria and process for selecting the design professional (or design-builder) have a major impact on project quality. A professional services agreement (PSA), negotiated by an owner and a design professional and reached through qualifications-based selection (QBS) procedures, provides the most flexibility in exploring solutions to design problems. This ultimately helps control project cost and improve quality. Under the QBS process, the owner:

➢ Chapter 6, "Selecting the Design Professional"

- Establishes a procedure for requesting and evaluating the qualifications of interested design professionals;
- Receives and evaluates the qualifications of design professionals and develops a short list of candidates to design the project;
- Solicits proposals from short-listed design professionals and selects the design professional submitting the proposal that is most responsive to the selection criteria;
- Confers with the selected design professional to determine the scope of the work;
- Negotiates the owner–design professional agreement with the selected design professional, based on the mutually developed scope of work.

➢ Chapter 7, "Agreement for Professional Services"

The PSA defines the roles and responsibilities of each party, the project objectives, the scope of services that the design professional is to provide, compensation, project budget and schedule, risk allocation, and other contractual matters. It is in the interest of each party to express their understandings and requirements in the agreement, as it governs the activities of those who sign it, as well as others who will provide the design services. Standard-form professional service agreements often provide a good initial framework for individual agreements. A legal review of the contract terms and language is in the best interest of all parties.

In some cases (typically public-sector projects), owners may use competitive low bidding or a two-envelope selection system to procure design services. These systems offer less flexibility in addressing design issues as a project evolves and neglect life-cycle cost analysis.

DEVELOPING THE PROJECT DESIGN

After signing the PSA, the owner and design professional develop a conceptual design that meets the owner's project goals. Sometimes known as alternative investigation (or pre-design), this phase of the project includes

➢ Chapter 8, "Alternative Studies and Project Impacts"

- Amplifying and refining the previously stated project goals;
- Developing specific objectives to meet those goals;
- Formulating and studying conceptual alternatives to meet the objectives;
- Selecting the most favorable alternative;
- Completing project conceptualization;
- Developing preliminary facility layouts and other design criteria;
- Developing preliminary cost estimates;
- Documenting these activities to guide the design effort.

The design professional is typically responsible for studies, project planning, reports, and other activities, as specified by the agreement and directed by the owner. Technical specialists may be engaged for particular tasks, such as geotechnical exploration, noise and air quality analysis, water quality studies, and other activities. The owner is responsible for reviewing and approving the design professional's end product, usually known as a preliminary design report.

DESIGN ACTIVITIES

In DBB contracting, the design professional, acting under the terms of the PSA, is usually responsible for producing the completed design for the owner's approval. The services to be provided by the design professional are documented in the project plans and project specifications, cost estimates, and other construction contract documents used in the selection of the constructor and procurement of construction services. The design professional presents the completed documents to the owner and the owner's legal advisers for review and approval.

The design professional follows the preliminary design report approved by the owner for the planning and execution of the design effort and is primarily responsible for design phase activities, which typically include

➢ Chapter 9, "Planning and Managing Design"

➢ Chapter 10, "Design Discipline Coordination"

- Planning and managing the design;
- Maintaining coordination and communication among design discipline leaders and other team members during design;
- Monitoring and controlling design costs and schedule;
- Developing estimated construction costs;
- Developing the anticipated construction schedule;
- Providing qualified staff;
- Performing design-related quality control functions;
- Arranging for appropriate design reviews, constructability reviews, operability and maintainability reviews, and peer reviews.

➢ Chapter 11, "Guidelines for Design Activities"

The design professional is responsible for providing services in a manner that complies with local, state, and federal laws and applicable codes of ethics. In addition, the design professional can make a substantial contribution to project quality by addressing sustainable development concerns and incorporating features to reduce impacts on natural resources, the environment, and future users.

PLANNING FOR CONSTRUCTION

➢ Chapter 12, "Pre-Contract Planning for Construction"

The key aspects of pre-construction planning include the assessment of the owner's capabilities, the evaluation of resources available for construction, compliance with regulatory laws and guidelines, the completion of any necessary site preparation, and the review of construction alternatives and contractual arrangements. These planning activities aid the owner in setting up an effective field organization.

SELECTING THE CONSTRUCTOR

As the pre-construction and design phases conclude, the central project activity (under DBB) becomes the selection of the constructor. The design professional may assist the owner in evaluating constructor bids, but the owner is responsible for choosing the constructor. Procedures for selecting the constructor range from structured public bidding, to priced or best value proposals, to selection based on constructor qualification or on favorable past performance and/or relationships with the owner.

➢ Chapter 13, "The Construction Team"

The most important steps in the selection process are the constructor's presentation of qualifications to demonstrate an ability to perform under the conditions of the contract and the evaluation of these qualifications by the owner and design professional. Constructor competition based on qualification may lead to a negotiated contract with the owner; it may place the constructor on a short list of invited bidders; or it may pre-qualify the constructor to bid on one or more public projects.

➢ Chapter 14, "Procedures for Selecting the Constructor"

One of the key tasks of the design professional during the selection of the constructor is the preparation of the bidding package for the owner's approval. The package contains both the contract documents that define the project and the procedures for submitting competitive bids or proposals. The design professional may also assist the owner in administering the bidding process, evaluating bids or proposals received, and preparing the contracts.

THE CONSTRUCTION CONTRACT

After the constructor is selected, the construction contract documents become the basis of understanding between the owner and constructor. The contract package usually includes the owner-constructor contract, general and supplementary conditions, project drawings and project specifications, addenda issued before bid closing, the constructor's bid, notice of award, performance and payment bonds, insurance certificates, and contract change orders issued as construction proceeds. The constructor is responsible for performing in accordance with the terms of the contract and for constructing the project as described in the documents.

➢ Chapter 15, "The Construction Contract"

MANAGING CONSTRUCTION, SUBMITTALS, AND CONTRACT ADMINISTRATION

The constructor takes on a major role as construction begins. The constructor's activities include determining the means, methods, and sequencing of construction; managing and paying subcontractors and suppliers; initiating and maintaining quality control for construction activities; and meeting applicable codes, permit requirements, and other public agency regulations. The owner takes an active role in promoting site safety by assigning overall project safety responsibility and authority to a specific organization or individual (often the constructor) that is qualified in construction safety principles, rules, and practices appropriate for the particular project (see ASCE Policy Statement 350, "Construction Site Safety").

➢ Chapter 16, "Planning and Managing Construction"

The constructor ultimately depends on the owner for the review and approval of completed construction. The owner, in turn, may delegate certain construction-period administrative responsibilities to the design professional. Though under traditional DBB contracting the design professional has no contractual relationship with the constructor, the design professional is often actively involved in construction administration activities under the terms of the owner–design professional agreement. These activities typically include providing technical services, clarifying contract documents, and reviewing change orders and submittals, as well as reviewing and approving completed construction on behalf of the owner.

➢ Chapter 17, "Construction Contract Documentation and Submittals"

The constructor is usually required to submit information for review and approval by the owner and the design professional (if so designated by the owner). Known as submittals, this information may include:

- Contract compliance documentation;
- Schedules;
- Quality control plans;
- Cash-flow estimates;
- Health and safety plan;
- Structure of lump-sum bid items;
- Structural component shop drawings;
- Equipment shop drawings;
- Mechanical and electrical component shop drawings;
- Performance data for equipment assemblies;
- Drawings for temporary construction;
- Vendor and material submittals;
- Results of independent testing.

The preparation and initial approval of submittals is the responsibility of the constructor, assisted by supporting suppliers, equipment manufacturers, and subcontractors, including detailers and fabricators. The owner, often with the aid of the design professional, is responsible for reviewing and approving the constructor's submittals for the limited purposes stated in the contract documents. The design professional and constructor may assign responsibilities to their respective subconsultants or subcontractors and agree on procedures and communication to facilitate the smooth flow of submittals.

➢ Chapter 18, "Construction Contract Administration"

In administering the construction contract, the owner is responsible for fulfilling contractual obligations to the constructor and focusing on issues that directly affect project quality, particularly those related to the quality of materials, craftsmanship, and safety. The owner may assign selected contract administration responsibilities to the design professional. However, construction contract administration does not extend to actually managing the construction, which is the responsibility of the constructor.

OPERATIONS AND MAINTENANCE

➢ Chapter 19, "Operation and Maintenance"

The successful operation and maintenance (O&M) of a completed project are derived from and closely associated with the level of quality in the design and construction process. Even if design and construction proceed smoothly, overall quality may suffer if the project is costly or cumbersome to operate and maintain. O&M characteristics affect a project's service reliability, durability, efficiency, and life-cycle costs, as well as the environment, public health, user safety, and other external aspects of the completed project.

OTHER ASPECTS OF PROJECT QUALITY

In addition to the activities above, this Guide provides information on several topics that do not fit neatly into a chronological discussion of constructed project activities, yet are crucial to project quality. These are described below.

Quality Assurance and Quality Control (QA/QC)

Project quality is the result of aggressive and systematic quality assurance activities by the owner and quality control efforts by the designer and constructor. QA/QC measures include the following:

➢ Chapter 20, "Quality Assurance and Quality Control"

- **The Owner** may supply project-specific quality standards to the design professional and constructor or require that each adapt their typical QA/QC procedures to the project;
- **The Design Professional** implements a project QC plan addressing staff needs, communication, design procedures, reviews, the use of specialty advisors, and other concerns;
- **The Constructor** implements a project QC plan addressing personnel, materials, communication, scheduling, cost control, reviews, project environment, safety, and other concerns.

Computers

Computers improve productivity by automating office and design tasks and improving coordination capabilities for the entire team. Powerful desktop and portable computers, networks, e-mail, and the Internet have transformed the way construction industry professionals can work together. Among their many functions, computers aid the owner in managing project activities and operating the completed project, provide the design professional with computer-aided design and drafting capabilities, and offer the constructor greater flexibility in calculating quantities of materials, scheduling, and overall project management.

➢ Chapter 21, "Computer Technology and Project Quality"

Peer Review

The peer review is an independent critique of a project conducted by a team of seasoned engineering or construction professionals with the goal of offering a fresh, unbiased look at the functioning of an organization or a clearly specified area of a particular project's design. While peer reviews do not focus exclusively on costs, they often generate savings by identifying ways to reduce schedule requirements and/or improve the quality of project elements.

➢ Chapter 22, "Peer Review"

Risk, Liability, and Handling Conflict

All constructed projects involve risks. These risks may be grouped in four general categories: safety, financial, professional, and legal. Participants benefit from identifying potential risks and liabilities, developing a clear and fair plan to allocate and manage them, and securing insurance (where appropriate) before making commitments to other parties. While disagreements are natural in work situations, the selection of mature team members, the alignment of common interests, and the fair allocation of risk can help minimize the adverse impacts of conflict.

➢ Chapter 23, "Risk, Liability, and Handling Conflict"

Partnering

➢ Chapter 24, "Partnering"

Partnering can enhance project quality by improving relationships among team members. It emphasizes mutually beneficial problem solving, improves risk management, helps reduce claims and cost overruns, increases general job satisfaction, and reduces litigation. Partnering helps develop good working relationships by creating an atmosphere of respect and trust. Partnering is sometimes known as "dispute avoidance."

Value Engineering

➢ Chapter 25, "Value Engineering"

Value engineering (VE) is a structured, utilitarian methodology for reviewing and enhancing project design. VE involves a unique and detailed process, known as function analysis, that gauges the value of individual project elements. The goal of the VE process is to identify alternatives that will maximize the relationship of function, performance, and quality to cost.

SUMMARY

Quality in the constructed project is achieved when the project team works together to fulfill their responsibilities to complete the project objectives in a manner that satisfies the requirements of each participant.

The agreement between the owner and design professional, and the contract between the owner and constructor, are the cornerstones of project quality. The process of developing these documents provides a structured forum for participants to express their requirements and align their interests. As a project proceeds, these documents are a key source of understanding for project objectives and the responsibilities of each team member. The level of project quality is directly related to the clarity with which the team members understand and express their requirements.

This Guide benefits from the experience and input of hundreds of industry professionals from a wide range of owners, designers, and constructors. The information and recommendations presented here are intended to aid users in developing an approach to their work and practice that meets their individual needs, as well as the objectives of particular projects in which they may be involved. ❑

CHAPTER **1**

INTRODUCTION

In this chapter

The purpose of this Guide is to provide project owners, design professionals, and constructors with information and recommendations on opportunities to enhance the quality of constructed projects.

While written for these three traditional project participants, this Guide is also intended to be useful to others who are involved in project design and construction, including subcontractors, vendors, operations and maintenance personnel, inspectors, and project users. Additionally, the information in this Guide may be of value to government officials, educators, students, legal professionals, and general readers with an interest in design and construction.

Given its broad intended use, this Guide is an "aspirational" document with the goals of educating and stimulating users to identify areas where they may raise the quality level of their practice. This document is not a technical standard, nor a compilation of standard industry practices.

Quality in the Constructed Project *is an "aspirational" guide.*

Users should not infer that simply following the practices discussed herein will automatically result in improved project quality. Many other factors, some beyond the control of the project team, can affect project outcomes. Project participants are therefore encouraged to modify or vary the processes described in this Guide to achieve the desired quality results for specific projects.

1.1 THE MEMBERS OF THE PROJECT TEAM

Under traditional design-bid-build (DBB) project delivery, the project team consists of three principal participants: the owner, design professional, and constructor. Under alternate forms of contracting, the team may include a design-build contractor (performing the roles of both the design professional and constructor), a construction manager, a consulting design professional, a private developer, and/or other participants. While this Guide is written primarily from the DBB perspective, the authors and reviewers have addressed considerations related to other forms of project delivery, such as design-build or owner-provided, where appropriate.

The choice of the word "team" to describe the project participants highlights the desirability of cooperative relationships. Individually and collectively, participants control quality and benefit from its being achieved.

Owner: The individual or entity that initiates a construction project and is responsible for financing it

Design Professional: A person or entity qualified and licensed to perform engineering or architectural services, including:

- Developing project requirements;
- Creating and developing project design documents;
- Preparing project drawings, project specifications, and project bidding documents;
- Delivering design services during construction and start-up.

Constructor: The individual or entity responsible for performing and completing the construction of a project as specified by the contract documents.

Contractual agreements define and control each participant's role, responsibilities, and limits of authority. In DBB contracting, these are the owner-design professional agreement and the owner-constructor contract.

Under DBB contracting, the owner is the originator and provider of funds for the project, and is therefore responsible for selecting the other team members and leading the effort. The owner selects qualified team members—usually through qualifications-based selection (QBS) for the design professional and competitive bid contracting for the constructor—and guides them through the negotiation and administration of agreements and contracts.

Under alternate forms of project delivery, the owner may contract with a single entity for project services. In addition, the owner may share a larger portion of the project's financial responsibilities, risks, and rewards with a design-build contractor or a third-party developer.

1.2 TEAM MEMBER REQUIREMENTS

Each team member brings a unique set of requirements or expectations that he or she wishes to have met in the course of completing the project. These requirements are what a participant may reasonably expect of fellow participants. These are distinct from responsibilities (see 1.3 below).

Typical Requirements of Project Team Members

Owner	Design Professional	Constructor
• Adequate function and appearance of the new facility. • Project completion on time and within budget. • Desirable balance of life-cycle and initial capital costs. • Operability and maintainability. • Addressing of environmental, health, permitting, safety, user impacts, and sustainable development considerations. • A fair and reasonable process for resolving disputes.	• An adequate project scope definition. • An adequate budget. • A reasonable schedule. • Timely decisions from the owner. • Realistic and fair sharing of project risks. • Adequate communication with the owner regarding performance. • A fair and reasonable process for resolving disputes. • Timely payment and a reasonable profit.	• A well-defined set of contract documents. • A reasonable schedule. • Timely decisions from the owner and design professional. • Realistic and fair sharing of project risks. • Adequate communication with the owner regarding performance. • A fair and reasonable process for resolving disputes. • Timely payment and a reasonable profit.

In addition to the three principal team members, regulatory and funding agencies often participate in a project, bringing their own requirements related to public health and safety, environmental considerations, utility service, as well as compliance with applicable laws, regulations, codes, standards, and policies.

1.3 TEAM MEMBER RESPONSIBILITIES

In this Guide, responsibilities refer to the tasks that each participant is expected to perform. These are summarized as follows:

Typical Responsibilities of Project Team Members

Owner	Design Professional	Constructor
• Fulfillment of contractual obligations to other team members, including furnishing site and related information, and timely payment. • Compliance with applicable laws, regulations, codes, standards, and practices. • Provision of adequate funding. • Provision of necessary real estate or right(s) of way. • Provision of project QA oversight to verify established goals and objectives. • Fulfillment of insurance and legal requirements. • Assignment of site safety responsibility. • Acceptance of completed project.	• Fulfillment of contractual obligations to other team members. • Compliance with applicable laws, regulations, codes, standards, and practices. • Fulfillment of professional standards. • Development and drafting of well-defined project contract documents. • Responsiveness to project schedule, budget, and program. • Provision of construction-phase design services.	• Fulfillment of contractual obligations to other team members. • Compliance with applicable laws, regulations, codes, standards, and practices. • Interpretation of project drawings and specifications. • Construction of facility as described in contract documents. • Management of construction site activities and safety program. • Management, quality control, and payment of subcontractors and vendors.

In the interest of depicting the responsibilities of each team member with respect to the activities discussed in this Guide, most chapters conclude with a matrix summarizing the typical responsibilities described in the chapter and the relationship (primary, assist/advise, review, or none) of each team member to those activities. In addition to columns for the three principal participants under traditional design-bid-build contracting, each matrix includes a column for the design-builder. These matrices are provided for purposes of general information only; contract documents and laws control the activities of participants on specific projects. Therefore, the user is cautioned not to place undue reliance on the responsibilities allocated in these matrices.

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor**	Design-Builder*
Initiate project, define goals and objectives	●	⦿		
Select design professional	●			
Produce design	⦿	●	○	
Select constructor	●	⦿		
Carry out construction	⦿	⦿	●	
Accept facility	●	○	⦿	
Operate facility	●	⦿	⦿	

**Design-Builder typical responsibilities are included as indicated in following chapters.*
***Performs as part of the Design-Builder team in a design-build situation.*

● = Primary Responsibility ⦿ = Assist or Advise ○ = Review

1.4 DEFINING KEY TERMS

In this Guide, quality is defined as the delivery of products and services in a manner that meets the reasonable requirements and expectations of the owner, design professional, and constructor, including conformance with contract requirements, prevailing industry standards, and applicable codes, laws, and licensing requirements. The relationship between responsibilities and requirements is central to this definition, as they are directly related to the fulfillment of broad project goals and specific objectives.

Therefore, in this Guide the following definitions apply:

Goals: Broad aims of the project, usually conceptual, as expressed by the owner.

Objectives: Specific descriptions of project location, function, size, performance characteristics, schedule needs, financial matters, and other items as established by the owner, often with the assistance of the design professional. Objectives taken as a whole are equal to the project goals.

Responsibilities: The tasks that a participant is expected to perform to accomplish the project objectives as specified by contractual agreement and applicable laws, codes, standards, and regulatory guidelines.

Requirements: Requirements are what each team member expects to achieve or needs to receive during and after his or her participation in a project.

Role: The scope of a project participant's activities as defined by the participant's responsibilities.

The team's success in achieving project quality depends on

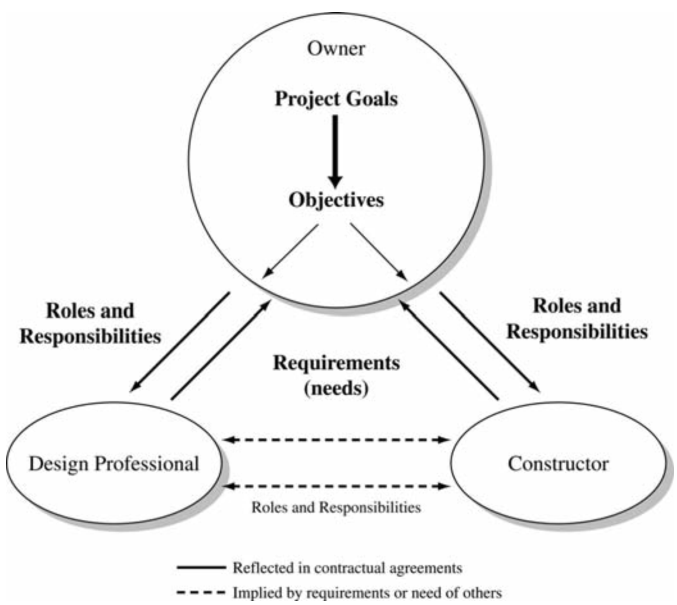
1. How well and clearly the project goals are expressed.
2. How well the goals are translated into specific objectives.
3. How clearly the objectives are defined and allocated as responsibilities.
4. How fairly and reasonably responsibilities are allocated among team members.
5. How well the team members articulate their requirements to each other.
6. How well the team members fulfill their roles and responsibilities to meet contractual and professional obligations.

The team achieves quality in a constructed project when the completed project meets the requirements of the participants and when the project participants fulfill their responsibilities to each other (see Figure 1-1). The definition of project quality in this Guide does not focus exclusively on criteria such as durability, cost, number of users, or other strictly quantitative measures.

Quality is determined by the degree to which the project participants fulfill their responsibilities to each other.

For example, an inexpensive temporary pump station—though it may have sheet metal housing, high operating costs, a short life expectancy, and aesthetic deficiencies—may be considered a quality project if the owner's requirements call for an inexpensive temporary facility. Similarly, a large "signature"

Figure 1-1 Project Participant Relationships



project, though impressive, may not embody quality if its construction involves significant cost or schedule overruns, litigation, adverse environmental impacts, or detrimental effects on public health and safety.

As a corollary, this definition of quality places a high value on teamwork as a means to achieve quality in design and construction. If the owner, design professional, and constructor are to be truly motivated to produce a quality constructed project, benefits must accrue to all three. A team approach improves communication, which increases the opportunities for participants to express their requirements and for them to better understand those of fellow team members. Therefore, teamwork is an essential aspect of project quality.

1.5 BALANCING TEAM MEMBER REQUIREMENTS

While project participants may share the goal of completing the project successfully, each comes to the project with different requirements. A quality project involves balancing of these requirements to respect and provide for

Teamwork is an essential aspect of project quality.

- **The owner's** cost and schedule needs, desired operating characteristics, construction materials, and project specifications.
- **The design professional's** need for a schedule, scope, and budget that allow the development of concepts and contract documents that meet the owner's requirements while earning a reasonable profit.
- **The constructor's** need to build the facility using feasible means and methods of construction within a reasonable schedule, maintain a safe construction site, and earn a reasonable profit.

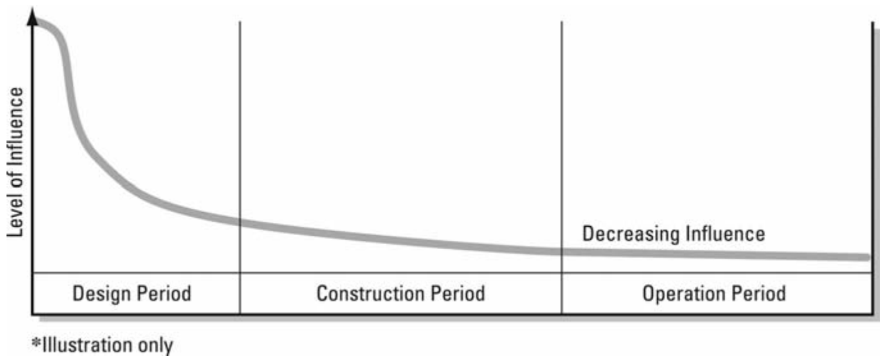
These differing needs, while inherent in the nature of the respective participant organizations, can affect the balance necessary to meet the requirements of each team member. Owners often weigh their project goals and objectives against economic considerations and the possibility of failure. The design professional strives to fulfill his or her responsibilities to the owner and constructor but is also obligated to meet applicable codes and regulations. The constructor is bound to execute construction safely and according to the contract documents while working efficiently and making good use of construction resources.

Early planning allows the project team to address the needs of each participant. Figure 1-2 illustrates the degree to which project characteristics may be influenced by design during successive phases of development. As shown, the impacts of revising the project early in the planning and design phases tend to be less than making changes after the design has been finalized or construction has begun. Major changes during the later phases of a project may jeopardize the ability of participants to fully realize their requirements. Therefore, a common understanding of each participant's requirements aids in defining project objectives and allocating each member's related responsibilities.

1.6 THE OBLIGATIONS OF TEAM MEMBERS

Team member obligations begin with the obvious: They must work together to complete the project and are therefore obligated to cooperate for the duration of the effort. They are also obligated to complete their work and produce

Figure 1-2 Design Influence on Project Characteristics*



the specified facility in a manner that complies with the contractual agreements, professional and industry practices and standards, and applicable codes, laws, and regulations.

However, beyond these immediately evident obligations is a deeper set of professional values upon which team member relationships are founded. A team spirit, based on ethical principles and integrity, and mutual respect of each other's requirements, fosters quality in project activities at every level. Professional behavior is essential in creating the atmosphere of mutual trust and respect, accommodation, and understanding that promotes quality.

The owner, design professional, and constructor have an additional obligation to undertake only work that they are qualified to perform and to honor the established contracting processes.

1.7 PRINCIPAL THEMES OF THIS GUIDE

Project quality is related to many factors. This Guide focuses on subjects that, in the experience of the authors and reviewers, are central to achieving quality in the constructed project. These are listed below, along with the chapter(s) in which they are principally discussed.

Subject	Chapter(s)
Clearly defined and assigned roles and responsibilities	1, 2, 13
The selection of an appropriate form of project delivery	3
A common understanding of each team member's requirements	4
Effective, timely, honest, and open communication	5
Appropriate owner processes for selecting team members	6, 14
Contract documents that clearly define the responsibilities of team members	7, 15
The use of standard-form agreements and other contract documents	7, 15
Systematic study of project alternatives and impacts	8

(continues on the next page)

Subject	Chapter(s)
Adequate scope definition, schedule, risk management, and liability protection	9, 10, 23
Appropriate procedures for managing design and construction	11, 16
Participation of the design professional during construction and start-up	12, 19
Well-managed construction contract administration and the timely flow of documentation and submittals (including shop drawings)	17, 18
Consideration of operation and maintenance issues throughout project development	19
Appropriate quality assurance and quality control (QA/QC) procedures	20
Effective and appropriate use of computer technology	21
Peer review(s)	22
Conflict avoidance and alternative dispute resolution, including dispute review boards and mediation	23
Strategies to enhance teamwork, such as partnering	24
Value engineering	25

SUMMARY

Achieving quality in the constructed project depends on the members of the project team taking a proactive approach to project activities. Project quality is defined as the delivery of services and products in a manner that meets the expressed and reasonable requirements of the participants; therefore, the level of quality achieved is directly related to the clarity with which the participants express, understand, and respect those requirements. ❑

CHAPTER 2

THE OWNER'S ROLE AND REQUIREMENTS

A successfully constructed project begins with the owner. This chapter describes the general role and responsibilities of the owner, as well as the owner's typical requirements. The owner's role typically involves

- Developing complete, attainable, and practical project goals and objectives;
- Establishing an understanding of those goals and objectives, as well as participant roles and responsibilities, among team members.

There are many terms to describe a project and the specific tasks that are necessary to build it. This Guide uses "goals" to refer to the broad aims of a project, and "objectives" for the detailed tasks that participants carry out to achieve project goals. See 1.4 for full definitions.

In this chapter

2.1 THE OWNER'S ROLE

The owner holds the principal role in assuring the quality and success of a constructed project. As the initial member of the project team, the owner identifies the need for a project, establishes primary goals, selects the members of the project team, and communicates adopted requirements about how the project is to be executed.

Goals: Broad project aims.

Objectives: Specific descriptions of project facilities, structures, processes, or services necessary to achieve the project goals.

Responsibilities: The tasks a participant is expected to perform to accomplish the project objectives as defined and assigned to various team members by contractual agreement.

Requirements: What a participant expects to achieve or needs to receive when participating in a project.

➢ Chapter 7, "Agreement for Professional Services"

Within this broad set of duties, the owner is responsible for defining objectives with regard to cost, performance, appearance, and function. To establish these parameters effectively, the owner should be familiar with basic project management concepts and practices, such as preliminary planning, design, life-cycle cost analysis, peer review, alternative studies, value engineering, construction, contract administration, and the shop drawing review and approval process. During the early phases of refining broad goals into defined objectives, the owner may wish to retain design and construction professionals to supplement internal staff.

In addition to setting goals, the owner is responsible for securing and managing funds and paying team members.

Depending on the scope of the project, the nature of the owner's organization, and the delivery system selected, the owner may delegate specific responsibilities to other project team members. Therefore, an owner's role can vary from being a highly involved and interactive team member to providing broad "hands-off" project-wide supervision. The right approach depends on the owner, available resources, the project objectives, and contractual responsibilities and obligations.

➢ Chapter 4, "The Project Team"

Given the wide array of roles that a project owner can choose, it is essential that the owner and team members understand each other's roles and responsibilities thoroughly. This understanding, which includes each participant's authority and responsibilities, is typically formalized in agreements, which are the primary source for defining project duties and responsibilities. Other sources for describing participant roles include scope definitions, design memoranda, project work plans, memoranda of agreement, and letters of understanding.

2.2 PROJECT GOALS

The owner's role and responsibilities in achieving project goals are affected by the following factors:

- The fundamental need for the project;
- Past experience in, or responsibility for, completing projects;
- Observation of other owners' activities on similar projects;
- Support from consulting design professionals and construction advisers;
- Legal advice.

2.3 ACHIEVING PROJECT GOALS

Project owners typically express their basic project goals with a focus on three key criteria: quality, timeliness, and budget. The owner's general strategies for achieving these goals include the following:

- Defining general quality expectations in terms that are easily understood and meaningful to the project participants;
- Communicating the significance of these expectations to team members and requesting acknowledgment that they are understood and agreed upon;
- Developing realistic schedules and budgets that are accepted by the other team members;
- Monitoring project participants through quality assurance (QA) activities to enforce the fulfillment of their roles and responsibilities;
- Maintaining a consistent project scope—and not changing conditions or requirements without allowances for impacts on the schedule and budget of all team members.

Obstacles are those frightful things you see when you take your eyes off your goal.

Henry Ford

2.4 ESTABLISHING PROJECT OBJECTIVES

The specific objectives for each particular project will be far more detailed and comprehensive than the goals listed above. Effective objectives refer to specific aspects of a project, such as function, operation, maintainability, sustainability, schedule, life-cycle costs, technical specifications, safety, aesthetics, finances, administration and management, and regulatory requirements. It is also important that project objectives include a method for measuring results. This method for measuring results becomes the basis for the owner's QA plan.

Beyond the broader project goals, owners have specific project objectives that must be achieved, and sometimes these objectives are not fully expressed.

However, an owner's failure to adequately define and clearly communicate project objectives can create a gap in understanding of the objectives by other team members. Ultimately this could increase the risk that team members would not achieve the owner's objectives.

The failure to adequately spell out project goals and objectives can create a gap in understanding.

Closing this "understanding gap" begins with a thorough examination of objectives. This examination should be undertaken by the owner, other project members, and, if necessary, qualified technical consultants. The purpose of this examination is to eliminate or revise unattainable and impractical items from the project scope and provide a realistic evaluation of costly or time-consuming items. In some cases, it may be necessary to revise the objectives in order to achieve the original goals of a project.

The owner plays the central role in establishing the objectives. The ability to achieve these objectives is enhanced when the owner communicates as clearly and comprehensively as possible with the other team members. The owner accomplishes this by developing open and trusting relationships to promote the candid exploration, identification, and realistic evaluation of the owner's expectations. This process begins with brainstorming and culminates with the translation of project goals into written project objectives. These written objectives lead to the development of budgets, schedules, contracts, specifications, and definitions of scope, all of which form the road map for identifying and allocating responsibilities to the project team members.

2.4.1 Private Owners

An owner's organizational structure and culture have a direct bearing on the formulation of project objectives, as well as on the owner's role.

Private owners may be able to expedite projects more quickly than public owners. However, private owners carrying out projects in highly regulated industries, such as electric power production, gas utilities, telecommunication, and aviation, may face rigorous constraints, processes, and procedures that affect project progress.

All owners have an economic interest in completing projects quickly. However, compared to public owners, private owners are often more influenced by, and subject to, economic factors, such as short- and long-term financing, the amount of capital investment, return on investment, profitability, cash flow, and economic risk. Other project aspects that may have greater influence on private project owners include demand, marketability, aesthetics, and general fiscal performance. The success of a private project tends to be measured with a strong emphasis on the value to customers and investors. New laws and agency regulations, especially those dealing with energy, transportation, health, safety, and the environment, can also affect established project objectives for private projects.

2.4.2 Public Owners

Public owners are usually subject to a greater degree of scrutiny than private owners.

Public project owners include cities, towns, counties, school boards, special districts such as utility districts, and local, state, and federal agencies. Like private owners, public owners must follow relevant project development processes and procedures as outlined in local laws, ordinances and regulations, and applicable state and federal laws and regulations. Public owners are usually subject to a greater degree of public scrutiny and oversight than private owners. For example, public review and comment can require further studies on high-profile projects.

Public projects must often conform to pre-established funding limits, and the project objectives tend to be oriented toward performance and compliance. The success of a public project typically relies on a greater number of factors than a private project. These factors may include the benefits to the wider public (not just those with a direct stake in the success of the enterprise), utility to the community, potential increases in accessibility, and protection of the environment.

Finally, project objectives for public projects may be influenced by political change, especially if planning and funding involve lengthy processes. Over time, the owner's representatives, budgets, programs, and even prospective users may change, creating direct impacts on project objectives. New laws and agency regulations, especially those dealing with energy, transportation, health, safety, and the environment, can also affect established project objectives for public projects.

2.5 TEAM MEMBER REQUIREMENTS

➢ Chapter 5, "Coordination and Communication"

In order to address a project's objectives, each team member brings individual requirements, interests, and values to the effort. Naturally, the interests of some team members conflict—especially when large numbers of participants are involved. In these situations, the owner benefits from establishing clear lines of communication and an unambiguous system for identifying and resolving differences in a prompt, mutually satisfactory manner.

Therefore, communication among project team members should begin as early as possible. Team members have a better opportunity to develop an accurate understanding of the project goals and objectives, and a heightened commitment to achieving them, if they assist in the development process. Early communication also allows team members to gain an awareness of each others' requirements and expectations, allowing them to be better prepared to deal with potential conflict.

2.6 TIMING AND DURATION OF PARTICIPATION

The involvement of different team members during appropriate periods of the project is critical for achieving the project objectives and the owner's requirements. In general, the earlier team members become involved and the greater the continuity of their participation, the greater the benefit to the owner. The growing popularity of alternative project delivery systems reflects the owner's quest for new ways to benefit from a consistent, cohesive project team from the outset to the completion of the project.

One strategy for achieving greater continuity is for the owner to engage a design professional as an adviser early in the conceptual development phase. After completing traditional preliminary and final design services, the design professional may also play a role in the construction phase, quality assurance, and start-up.

In general, the earlier a team member becomes involved, the greater the benefit.

In the case of the constructor, similar continuity is desirable. While private owners are free to bring constructors onto the project team at any point, public owners may be constrained by local, state, and federal requirements that limit constructor participation in the early phases of a project. In such cases, the owner may engage a construction adviser with relevant experience to review the feasibility of construction, which is generally known as a constructability review.

The owner can enhance the caliber of team member participation by being an exemplary communicator. Communication at every level, every phase, and in many relationships, is a key to the fulfillment of the project objectives and the meeting of participant requirements. This is particularly true in overcoming the loss of continuity when key personnel depart. To improve communication, the owner should make available pertinent information to internal managers and the team members through regular update meetings, disseminate appropriate documents, and visit the project site. The owner may also reduce the risk of unforeseen site conditions, and associated disputes, claims, and disruptions, by sponsoring an adequate investigation of site conditions and sharing this information with appropriate team members. Such extra efforts usually save more than they cost.

SUMMARY

The project owner is the primary force behind the translation of concepts, ideas, and goals into the objectives that lead to quality in the completed project.

For a project to fulfill the owner's requirements, the owner must create the conditions under which the project team can work together effectively and develop a common understanding of project objectives and the specific roles and responsibilities of each team member. During the early stages of a project, the owner is at the center of shaping the relationships among team members that allow the broad project goals to be fleshed out as project objectives.

As the initial force behind a project, the owner benefits from good communication and agreement among team members on how the project objectives will be developed and implemented. Owners are more likely to have their requirements understood and met when those requirements are reflected in project objectives that are clearly specified in written agreements, contracts, specifications, and drawings. ❑

Chapter 2: The Owner's Role and Requirements

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor*	Design-Builder
Establish project goals	●	⦿	⦿	⦿
Develop project objectives	●	⦿		
Communicate project objectives to team members	●	⦿	⦿	⦿
Develop financing	●	⦿		
Implement project	●	⦿	●	●

**For a design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

● = Primary Responsibility ⦿ = Assist or Advise

CHAPTER 3

PROJECT DELIVERY SYSTEMS

In this chapter

Owners, design professionals, and constructors make the decisions, provide the services, and perform the work to deliver constructed projects. These activities are known collectively as project delivery, and the generic term "project delivery system" describes how the participants are organized to interact, transforming the owner's project goals and objectives into a finished facility.

When deciding how project resources are to be organized, the owner considers a number of general but significant factors, including

- Past practices, traditions, and experience;
- The advice of consultants;
- Funding sources and constraints;
- The effective use of staff and working capital;
- The interests of other project stakeholders.

The most common method of project delivery for public projects, and for many private projects as well, is known as design-bid-build (DBB). This Guide refers to DBB, unless stated otherwise. However, there are other project delivery systems that are often effective in meeting an owner's needs. In the public sector the Design-Build delivery system is gaining wide acceptance. This chapter summarizes traditional DBB contracting and introduces several other types of project delivery systems that are becoming more prominent in the United States.

The owner has total control of the project until other parties are invited to participate. The questions of who to ask for help, when to engage that help, and the specific assignment of tasks to other parties depend heavily on the owner's desire to retain control or to delegate responsibilities. Project control can also be influenced by the project type and applicable laws.

Consider four hypothetical owners. The first may have clearly defined project goals and objectives and may prefer to closely guide team members through each step. The second, also with well-defined goals and objectives, may instead choose to delegate many management responsibilities to other team members. The third owner, unfamiliar with contracting processes, may be well served by managing the project closely so that each step of planning and construction may be understood and be approved. The fourth owner, like the third, may be unfamiliar with engineering and construction processes but may, like the second, prefer to delegate responsibilities to parties more experienced in construction.

These four owners illustrate that retaining and delegating project control and responsibilities are largely matters of owner preferences. Therefore, the owner's choice of a project delivery system to match adopted requirements is a critical step in achieving project quality. In the public sector, an agency's choice of project delivery systems may be prescribed by policy or legislation. Alternatively, the agency may make a deliberate choice based on a formal acquisition plan and strategy.

In general, risk and reward are structured to be in proportion to the amount of control retained or delegated. However, the owner cannot delegate some project responsibilities, such as providing the project site (or the criteria for selecting the site), determining the general approach to financing, and setting the goals for the new facility.

The owner's decision on how to proceed with design and construction may be rooted in tradition. However, tradition also usually dictates a reliance on the advice of staff and other knowledgeable sources, such as design professionals, construction experts, and legal counsel, to select a project delivery system that defines appropriate roles for the primary project participants.

Project financing has become one of the more significant factors in selecting an appropriate project delivery system.

Financing can be a significant factor in selecting an appropriate project delivery system. If grants or loans are available, the financing agency might specify a method of delivery and control, even designating key players, as a condition of putting its funds at risk. The need to expend or commit funds in accordance with a fixed budget or budget cycle might sway an owner toward some variation of design-build, if the law permits it. If the owner is willing to delegate even more responsibilities to a public or private developer who would finance, design, build, and perhaps operate the facility, one of the turnkey methods of delivery might be preferable.

The terms and definitions used in this chapter are subject to frequent change.

The marketplace is continuously transforming and redefining many of the project delivery alternatives discussed in this chapter. Therefore, it is important that parties entering discussions about project delivery be clear about their terms, as the definitions used in this chapter do not enjoy universal acceptance.

3.1 OWNER-PROVIDED DELIVERY

On projects where the scope of work is within their range of skills, experience, and resources, owners often choose to perform some or all of the design services and construction work themselves. Projects that involve simple modifications to an existing facility, as well as projects that are limited in cost or complexity, are good candidates for owner-provided delivery. An owner might also elect to keep repetitive projects in-house.

The owner may supplement internal professional staff with design specialists such that the design services are essentially self-provided. Construction may also be accomplished using the owner's resources entirely, or with the owner serving as the general contractor and subcontractors performing much of the work. Of course, the owner must meet professional registration and contracting licensure requirements. Many larger private and public entities provide some of their design professional services in-house and may perform some construction using their own resources.

3.2 TRADITIONAL DESIGN-BID-BUILD

Design-bid-build provides the owner with a high degree of control over the project.

In the United States, DBB contracting has for many years been the form of project delivery required by law for the owners of most public-works projects. Owners of many private projects also frequently choose DBB contracting. DBB is effective on projects where the owner needs both professional design services and construction services. DBB is also effective in cases where the design professional does not require detailed knowledge of the means and methods of construction. DBB provides the owner with a high degree of control and is therefore often the preferred project delivery system for owners who may desire one or more of the following:

- Wish to closely monitor projects (even conventional ones);
- Are public owners whose customers require a high degree of requirements definition and control during the design stage;
- Are obligated by statute to procure professional design services by qualifications-based selection (QBS) regulations and constructors by competitive bidding;
- Need continuous, experienced professional representation throughout the entire design and construction process;
- Wish to prescriptively specify project requirements.

Apart from such needs, the owner of a complex project may simply view the sequential nature of development under DBB as a benefit to quality.

Under DBB delivery, the owner defines project goals and objectives, secures the financing, and specifies the standards and contract terms. The owner may perform planning, conceptual design, and full design or may engage an outside design professional for some or all of these tasks. During this planning and preliminary design stage of a project, the owner and design professional generally work as a team to obtain required permits and conduct the necessary site investigations.

The design professional then prepares the construction bid documents to reflect the owner's project goals and objectives, the project's site conditions, and sound engineering practices. The bid documents should be sufficiently complete, detailed, and clear in describing the project objectives and may even include a quantity take-off schedule for quoting unit prices to assist in obtaining comparable and responsive bids.

➢ Chapter 14, "Procedures for Selecting the Constructor"

Prospective constructors prepare their bids from the complete and specific bid documents. Each bidder typically evaluates risk and uncertainty to identify potential conditions that could affect cost or schedule.

➢ Chapter 23, "Risk, Liability, and Avoiding Conflict"

The bidders submit their proposals to the owner, who, often with the assistance of the design professional, determines the most responsive bid—typically the lowest bid meeting the project objectives. Alternatively, private owners, and public owners if permitted by statute, may establish criteria to select the constructor according to a value-based selection system in which cost is one of several factors considered.

In certain circumstances, an owner may be justified in selecting a constructor outright and negotiating contract terms directly. The contract price may be lump sum (perhaps with shared savings), "cost-plus," "cost-plus with a maximum," or may be based on unit prices applied to presumed quantities.

➢ 18.1, "Owner's Resident Project Representative"

During construction, a member of the owner's staff, or the construction manager or a member of the design professional's organization if designated by the owner, usually serves as the owner's resident project representative (RPR). This person administers the construction contract, with responsibilities that include reviewing the constructor's submittals and work for conformance with the requirements of the contract documents and evaluating the constructor's payment applications for work completed.

3.3 CONSTRUCTION MANAGEMENT

Construction Management Association of America: http://www.cmaanet.org

Many owners engage construction managers to assist in developing bid documents and overseeing project construction. In the broadest sense, a construction manager (CM) is a professional or firm trained in the management of construction processes; CMs tend to be less involved with the detailed implementation of those processes. Organizationally, a CM is generally interposed between the owner and some or all of the other participants. There are two general types of construction managers: the agency construction manager (ACM) and the construction manager-at-risk (CM-at-risk). However, CM roles and responsibilities often vary. Therefore, participants benefit from defining construction management for the project at hand.

Some advocates of construction management say the CM should first act purely in the ACM relationship, with the owner engaging the design professional. When the project is well defined (or even designed completely), the CM then shifts to the CM-at-risk role. Others argue that an ACM should only remain as the owner's adviser during construction. Ultimately, the decisions regarding these roles depend on the owner's desires and requirements for delegating responsibility and authority. The owner may add and define new roles for the CM as the project unfolds, such as assisting in the determination of the independence of design and construction functions, the effective coordination of those functions, and/or options for combining roles.

3.3.1 Agency Construction Manager

A construction manager acting as an agent of the owner extends the owner's internal capabilities in performing traditional owner responsibilities. However, an ACM functions wholly within the policies, procedures, and practices of the owner's organization. The level of service by the ACM can range from on-call advice to full project management. For an owner undertaking few projects, the ACM might become, in effect, the entire technical staff.

In some cases, the owner hires the ACM before design begins. The ACM may participate in the selection of and contracting with the design professional or might even be the design professional. Before the development of the construction contract, the owner and ACM agree on the scope of the ACM's services during construction. The scope and scale of these services varies with the ACM's effort and authority. An ACM may function within any of the project delivery systems described in this chapter, with the owner transferring some control and risk to the ACM.

3.3.2 Construction Manager-at-Risk

Project delivery under the construction manager-at-risk arrangement increases significantly the owner's delegation of control and risk. A CM-at-risk typically contracts with the owner in two stages. The first stage encompasses services during the conceptual and preliminary design phases, during which the CM-at-risk and the design professional, perhaps acting as the CM-at-risk's subconsultant, manage and undertake those functions, with variable participation by the owner. During this stage, the CM-at-risk is usually a paid consultant. When the design is complete, the owner and CM-at-risk then agree on a price and schedule for the construction work.

Project Delivery Systems: CM at Risk (Doc. 4160), Design-Build Institute of America

The second stage involves the completion of construction for a negotiated fixed or guaranteed maximum price. At this point, the CM-at-risk and the owner agree on the contractual terms that will apply to the project. Acting as a general contractor, the CM-at-risk then engages specialty and trade subcontractors necessary to complete construction.

Several states have begun to allow construction management-at-risk.

Construction management-at-risk is popular for owners of private projects, and some states now allow CMs-at-risk on some public-works projects.

3.4 DESIGN-BUILD

Under design-build delivery, the owner contracts with a single entity to provide the design (or at least a final, detailed design) and to construct the project according to that design. Under design-build, the owner first assesses his or her own in-house capabilities. The contract might be negotiated with a single design-builder or might result from competitive proposals. The selection of the design-builder can be based on low price only or on a set of value criteria where factors such as similar project experience, key staff availability and experience, bonding capacity, and other factors, are considered along with price.

Design-Build Institute of America: http://www.dbia.org

➢ 12.1, "Assessing the Owner's Capabilities"

Design-build provides the owner with a single point of contact for project responsibilities, eliminating the need to assist in resolving designer-constructor disputes. With the constructor playing a major role in design, costs are typically defined and maintained to a greater degree, and the coordination of fast-track management to achieve early completion is greatly simplified.

➢ 10.2.3, "The Design-Build Project"
➢ 3.6, "Fast-Tracking: A Distinction"

The design-builder makes many decisions that the owner would make under DBB. The owner delegates to the design-builder greatly increased authority to fulfill an increased number of responsibilities. For many owners, design-build delivery leads to very satisfactory projects. However, if the parties are not experienced with design-build and do not cooperate, the transfer of control and risk can be disappointing. The potential benefits and the degree to which they are realized is related to the owner's ability and willingness to structure his or her internal procedures to accommodate the design-build approach. Compared to DBB contracting, this involves a significantly different set of requirements and expectations for processes, timeliness, and communication.

📖 *Handbook on Project Delivery,* American Institute of Architects California Council, 1996.

A clear understanding and documentation of design-build processes enhances the quality of design-build projects. The owner, usually with in-house design staff and/or an independent design professional, typically prepares descriptive conceptual documents and develops a preliminary design. This level of detail aids the owner in communicating the project goals and objectives to design-build proposers, helping to reduce uncertainty, contingency allowances, and the potential for disputes.

➢ 6.2, "Qualifications-Based Selection"

The owner typically pre-qualifies a short list of design-builders who demonstrate the necessary experience, reputation, financial resources, and other qualifications to complete the design-build effort. The owner's request for a proposal is issued only to the short-listed firms. The owner sometimes provides a stipend to competing firms as partial compensation for the cost of preparing their proposals, a practice that is intended to improve the quality of the proposals offered.

Under design-build, the design professional is engaged by the design builder, not the owner.

For value-based selection of the design-builder, the owner evaluates proposals using a predetermined matrix of factors and awards the project to the design-builder with the best overall score. Therefore, the bid price, while usually heavily weighted, is but one of several factors considered in making an award. Federal guidelines for this two-step procurement method attest to the value of pre-qualification and value-based selection, but applicable statutes vary in each state.

In some instances, design-build delivery involves an adjustment on the part of participants to this contracting role. One of the most significant departures from DBB delivery is that the design professional completing final design is engaged by the design-builder, not the owner.

➢ 17.3.3, "Shop Drawings for Manufactured Structural Components"

Another significant departure from traditional DBB delivery is that the focus of the design professional's effort is on meeting the project objectives as planned by the constructor. Therefore, issues that affect design, such as constructability, the use of particular equipment or erection methods, the choice of construction materials, and schedules, are directed by the constructor. The design professional is responsible for meeting the owner's stated objectives, as well as applicable codes and standards, but the design professional's client is the design-builder, not the owner. It is important to note, however, that the design professional's responsibility for specifying performance specifications for manufactured structural items and reviewing shop drawings for conformance with the design is the same, whether the design professional is engaged as part of the design-build team or as an independent consultant.

In other instances, the design professional may hire contractors and subcontractors to perform the construction, or the constructor may have sufficient in-house professional staff to perform the design function.

3.5 DESIGN-BUILD VARIATIONS

A variety of contractual arrangements exist for providing additional project functions (other than design and construction), such as financing, leasing, and operating the completed facility. The following sections briefly discuss these arrangements.

3.5.1 Funding Option Variations

Private capital and developer participation offer private owners several variations on design-build project delivery. A typical arrangement is sometimes called lease-develop-operate, under which the owner gives a private operator a long-term lease to use, operate, and expand an existing facility. This operator finds external funding for the owner to borrow to pay for the improvements, and the owner dedicates part of the lease payments to amortizing its resulting debt. The operator engages a conceptual design consultant to prepare conceptual and preliminary designs for the improvements that meet the project objectives and then hires a design-builder to complete the project.

Other variations may be called a "public-private partnership" or a "wraparound." In such an arrangement, ownership of or fiduciary responsibility for a project is assigned to a private party. That party then designs, builds, and may even own, operate, and maintain the new facility, eventually transferring it back to the owner.

3.5.2 Turnkey

Turnkey project delivery has the characteristics of design-build but adds to the design-builder's responsibilities the operation and/or maintenance of the completed project. Turnkey delivery further reduces oversight demands on the owner, so the contractor "turns over the keys" when the project is complete. Turnkey delivery, through this transfer of responsibility and risk, has the potential for bringing a new project online more quickly.

Three forms of turnkey project delivery are described below. The terminology is often subject to interpretation, so all parties should clarify definitions.

Turnkey delivery allows the design-build constructor to simply "turn over the keys" to the completed project to the owner.

3.5.2(a) Design-Build-Operate-Transfer

Projects in which the period that the contractor operates the completed facility is limited are known as design-build-operate-transfer, or DBOT, projects. The turnkey design-build contractor typically operates and maintains the facility for approximately one year or to the end of the first warranty period.

3.5.2(b) Design-Build-Operate-Maintain

Design-build-operate-maintain, or DBOM, project delivery, also called "super turnkey," is most often used on projects where the period of contractor operation and maintenance is about 10 to 15 years. The performance goals for

DBOM projects typically provide incentives to the DBOM contractor to minimize maintenance costs.

3.5.2(c) Design-Build-Own-Operate-Transfer

The design-build-own-operate-transfer, or DBOOT, method of project delivery is a broader type of turnkey, typically used for a toll road, bridge, or other elements of revenue-generating public infrastructure. The owner might rely on tax-exempt revenue bonds for initial financing. The DBOOT entity is then responsible for and acts as the owner of the facility for a specified period, using operating revenue to meet the bond amortization schedule. Thus, the length of time that the DBOOT entity operates and maintains the project is often considerably longer and may require repairs and component replacements.

DBOOT delivery can also be carried out using private financing secured through a developer. Like public bonds, the private capital, plus interest, is repaid from the operating revenues of the facility. Since the term and scope of the contractor's operating and maintenance role extends over a significant portion of the project's design life, the DBOOT entity might form a separate business unit that operates the completed facility until it is turned over to the owner.

3.5.3 Developer-Financed Projects

For highly specialized projects and circumstances, financing from a private or public developer or other third parties can offer additional variations on design-build and turnkey project delivery, each with new roles for owners, designers, and constructors.

3.5.4 Turnkey Variations

Variations on turnkey delivery add financing as a key component. While the financing arrangements are unique for each project, developer-financed projects generally resemble one of the turnkey delivery methods:

- **FDBT**—Finance, design, build, transfer;
- **FDBOT**—Finance, design, build, operate, transfer;
- **FDBOOT**—Finance, design, build, own, operate, transfer.

In each case, the transfer of the project occurs only after the developer's interests and financial obligations have been satisfied, whether the developer owns the facility for the specified period or simply operates it.

Developer-financed project delivery occurs most frequently in the United States on private projects. It has also been employed on a limited number of public-works projects. Developer financing provides the owner with facilities or services that would otherwise not be available through owner financing. While the developer might use the owner's funds, it is more common that additional financing is sought. Sometimes complex financing packages are assembled that rely on funds from a variety of sources, including bonds, loans, and grants.

3.6 FAST-TRACKING: A DISTINCTION

Simply stated, the goal of employing fast-tracking is to reduce the project schedule. The fast-track approach compresses the schedule by sequencing the start of construction on underlying project elements, such as foundations and basic supporting structures, before final design (or even conceptual planning) is complete for interior or adjacent elements.

Fast-tracking is not a method of project delivery; rather, it is a management strategy within the delivery methods discussed above. While often successful in achieving schedule reductions, problems on fast-track contracts can create a domino effect on follow-on contracts for the project. In other cases, newly constructed elements may need to be modified or eliminated if they cannot accommodate subsequently designed components or structures. However, if properly implemented, the short-term costs of fast-tracking may allow the owner to achieve greater benefits over the long term.

Fast-tracking is most successful on projects that are straightforward and have a high level of predictability. Fast-tracking is also preferred when time is so important to the owner that the additional costs due to changes or non-competitive pricing are less important. However, the parties involved in fast-tracking should be experienced in this type of project and should understand both the benefits and risks of this kind of acceleration.

SUMMARY

The owner's selection of a project delivery system is one of the most important decisions affecting quality. Construction industry professionals with experience in relevant systems of project delivery are important resources in the owner's evaluation of internal capabilities, development of project objectives and plans, and assessment of various stakeholder interests. ❑

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CHAPTER **4**

THE PROJECT TEAM

In this chapter

The members of the project team and the way they are organized to work together have a significant impact on project quality. Successful projects require thoughtful conception, skillful planning, up-to-date design, and well-executed construction. Most projects are too large and complex for one team member to perform all the necessary planning, design, and construction. Under traditional design-bid-build (DBB) contracting, the team carrying out these tasks consists of an owner, a design professional, and a constructor. Under alternative project delivery systems, a single team member may hold both the design and construction roles and may subcontract others who perform tasks or services requiring specialization, unique qualifications, and/or other professional registrations.

Each team member contributes to overall project quality by fulfilling their respective responsibilities competently, cooperatively, and in a timely manner. This chapter discusses the organizational relationships of team members to each other and to other project participants.

4.1 TRADITIONAL TEAM ORGANIZATION AND VARIATIONS

Under traditional DBB contracting, the owner heads the team, designating a project manager who is a member of the owner's organization or is hired independently (see Figure 4-1). The owner establishes reporting authority with the design professional and constructor by entering into separate contracts with each. The designer and constructor do not enter into contracts with each other, though they do communicate and should work cooperatively to achieve their respective requirements, consistent with the definitions and relationships in this Guide.

➢ 1.4, "Defining Key Terms"

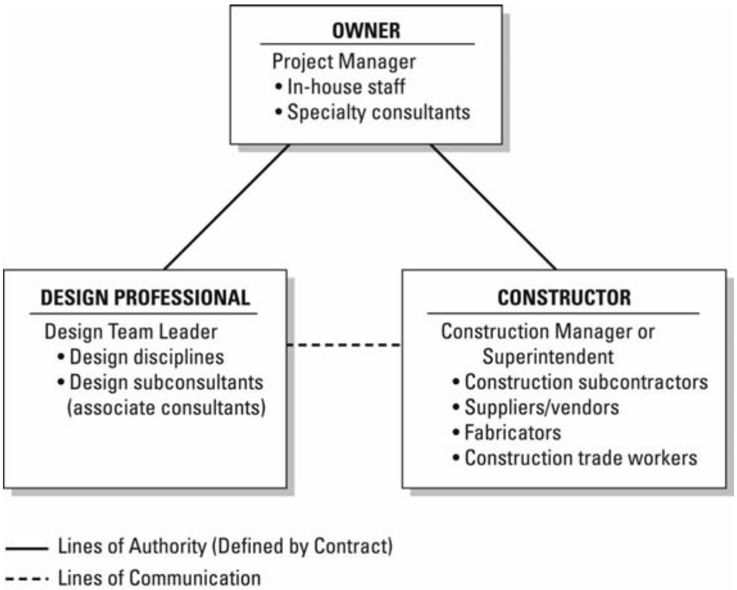
The traditional project organization can be adapted to address the wide range of variables encountered on modern construction projects. These include uniquely or specifically defined requirements of public or private owners and instances where one team member performs two or more primary project functions. Some of these variations include the following:

- Owner-employed design staff (construction contract only);
- Owner-employed construction staff (design contract only);
- Owner directly employs both design and construction staff;
- Owner retains a construction manager (CM);

➢ Chapter 3, "Project Delivery Systems"

- Owner selects a single contractor to complete design and construction (design-build);
- Owner selects a single entity to complete the design and construction and provide some level of financing, and/or operate and maintain the facility for a specified period (design-build variation).

Figure 4-1 Traditional Construction Project Organization



4.2 THE OWNER'S TEAM

➢ 2.2 "Project Goals"
➢ 2.3, "Achieving Project Goals"

On even modest-sized projects, the number and complexity of decisions often require that the owner assemble a group of expert advisers.

As the initiator of the project, the owner guides the effort by defining project objectives and setting the standard for quality. But even on modest-sized projects, the number and complexity of decisions often require that the owner assemble a group of expert advisers that may consist of in-house staff, independent consultants, or a combination of both, to provide the level of expertise and effort needed to successfully complete the project.

The members of the owner's team report to the owner but consult regularly with the project manager, design professional, and constructor. The owner may also delegate authority to a representative empowered to act on his or her behalf.

In addition to assembling a team with appropriate technical expertise, the owner must establish realistic goals and objectives for the project. This reduces the potential for confusion about project objectives among team members, increasing the associated benefits to the project cost and schedule.

➢ 2.4, "Establishing Project Objectives"

In many cases, the owner's team includes operators, maintenance technicians, and future occupants. Each member is considered a primary stakeholder with a crucial role in achieving project quality. Therefore, the team benefits when the workloads and technical level of the tasks assigned reflect the capabilities of the owner's team.

The owner's team participates in the establishment of the project objectives and overall performance standards. The core activities of the owner's team include

- Identifying and articulating the basic need for the project;
- Assisting in establishing project objectives;
- Securing funding;
- Acquiring property and applicable permits;
- Addressing zoning considerations and acquiring applicable permits;
- Selecting the design professional and constructor;
- Establishing material, equipment, and operational standards;
- Making design and construction decisions;
- Integrating the project with existing facilities;
- Monitoring and managing the performance of the design professional and constructor by implementing the project quality assurance (QA) plan;
- Facilitating payment of the design professional and constructor.

4.2.1 Basic Functions

The basic function of the owner's team is to initiate and generally guide the project through the planning, design, and construction processes so that the project meets the stated goals and objectives. Though the design professional and constructor are contractually responsible for the vast majority of specified project tasks, several important responsibilities are unique to the owner. These include the following:

- Addressing financial, insurance, and legal requirements;
- Meeting fiduciary responsibilities to shareholders, ratepayers, or taxpayers;
- Providing a safe and reasonable work environment for their employees;
- Meeting applicable regulatory requirements;
- Making decisions concerning matters under their control;
- Assigning responsibility for construction site safety.

📖 ASCE Policy Statement 350, "Construction Site Safety"

Legal requirements, funding agreements, and contractual arrangements may obligate the owner to additional responsibilities. As projects proceed, new information often becomes available, and it is essential that the owner share this information with other members of the project team, even if it adversely affects project progress in the short term. Likewise, the design professional and constructor should share relevant information with the owner. Open and honest communication among project team members is essential.

➢ Chapter 5, "Coordination and Communication"

The members of the owner's team play two key roles that are sometimes contradictory in nature: they seek the best design possible to maximize the operating efficiency of the facility, yet they also seek to minimize costs.

Quality requires investment.

The potential conflict in these dual roles can surface in efforts to achieve appropriate quality in design. In the case of design, this investment involves both time to identify and clearly communicate project requirements and funding to determine that the design is fully developed and will provide a facility that meets those objectives.

📖 *Team-Based Project Management,* James P. Lewis, 1998

Cutting corners on design funding can increase future construction and operating costs. Therefore, the owner's team benefits from establishing a realistic schedule for design and securing adequate funding for the design effort. The owner's team benefits by developing the project scope in as much detail as possible before contracting with a design professional or constructor. This helps control costs by reducing the number of revisions during design and construction.

When the owner delegates authority to a representative, this person is empowered to act on the owner's behalf.

4.2.2 The Owner's Project Manager

"Project manager" is a generic title for the person or firm representing the owner that holds overall responsibility for the coordination and management of project activities. Depending on the project scenario, the project manager may be

- The owner (typically on smaller projects);
- The design professional, acting under the direction of a public agency's board of supervisors, such as a city council;
- A member of the constructor's staff (usually under the design-build approach);
- An independent construction manager under contract to the owner.

Depending on the project objectives, the owner may contract with more than one design professional, use multiple construction contracts, and/or procure materials directly. In any of these situations, a separate firm may be engaged to serve as the project manager.

The project manager guides the effort from inception to completion.

The project manager is the focal point for project communication and coordination. The project manager oversees the entire range of project activities from start to finish, including initiation, planning and scheduling, administration of owner-design professional and owner-constructor contracts, communication and decision management, start-up, and project closeout. While different individuals may serve as the project manager during various phases of the project, continuity of personnel is a benefit to project quality.

The project manager's responsibilities begin with project planning and the development of a realistic scope for project design and construction activities. The project manager then obtains commitments from project team participants to complete these activities in a manner that meets the project requirements and prepares a formal project team organization chart along with a statement of responsibilities for each participant.

Next, the project manager develops and confirms the project schedule, including major milestones and critical path items for both design and construction.

With the scope and schedule established, the project manager then identifies the budget needed to perform the specified scope of work within the project schedule. The project manager continually monitors the scope and schedule, adjusting them as necessary to meet the established budget or time-frame objectives. If the team determines that the scope and schedule become unattainable as the project proceeds, then additional funding and/or time may be necessary.

With the initial planning complete, the project manager finalizes the contractual agreement with the design team and begins design start-up activities. These usually include a pre-design meeting, during which the participants establish policies and practices; review requirements and expectations; and address concerns related to program, schedule, budget, project data, quality control formats, and standards. The project manager benefits from making extra efforts in communication during design start-up.

After design start-up, the project manager's role shifts to focus on the coordination and administration of the overall effort. Progress meetings and design reviews are effective opportunities to communicate with team members, compare actual progress with the schedule, evaluate design elements, ensure contract compliance, monitor costs, and enhance individual performance.

4.3 THE DESIGN PROFESSIONAL'S TEAM

The design professional's team develops project concepts, plans, and design solutions that fulfill the owner's project objectives. The owner may engage the design professional for a narrow or wide variety of services, from initial site investigations, to preliminary design and design completion, to the preparation of plans and specifications—as well as design-related services during construction and start-up. The design professional may be an employee of the owner or an independent individual or firm, in which case the relationship and responsibilities to the owner are governed by contract.

For the purposes of this Guide the term "design professional" shall include the "engineer of record," who is the prime design professional, engineering firm, or organization that is legally responsible for the engineering design.

Most constructed projects are sufficiently complex as to require that the design professional supplement its staff with additional specialized consultants, as only the largest firms usually have the full range of design disciplines in house. Typical design professional subconsultants include geotechnical, mechanical, electrical, plumbing, fire protection engineering, structural engineering, environmental planning, field surveying, materials testing, and other technical specialists. In some cases, design specialists may contract directly with the owner but still function as members of the design team.

➢ 10.1 "Levels of Design Discipline Organization"

The general functions and responsibilities of the design professional include

- Being fully qualified and licensed to offer and provide the services contractually undertaken and provided;
- Applying appropriate skills to the design;
- Being proactive and clear in communication;
- Being responsive to the established budget, schedule, and program;
- Making timely interpretations, evaluations, and decisions;
- Disclosing fully related external interests;
- Perform QC functions in accordance with terms of the professional services agreement;
- Avoiding conflicts of interest;

- Complying with applicable codes, regulations, and laws;
- Interpreting contract documents impartially;
- Representing the owner's interests as required by contract;
- Performing project-specific duties outlined in the contract between the design professional and the owner.

➢ Chapter 6, "Selecting the Design Professional"

The owner typically uses a qualifications-based selection (QBS) process to engage a design team with professionals who have experience and skills that correspond to the project requirements. The basic task of the team is to design a project that meets the project requirements and to provide the project drawings, project specifications, and other contract documents to the level of completion specified in the contract. In most cases, this means complete design documents from which the entire project may be constructed.

In summary, the owner's project role is that of "initiator," while the design professional's role is that of project "implementer." To successfully fulfill this role, the design professional must provide the leadership, technical skills, and experience that are appropriate for the design effort.

4.4 THE CONSTRUCTOR'S TEAM

➢ Chapter 13, "The Construction Team"

The constructor's role on the project team is to plan, manage, and properly execute the construction activities necessary to build the project according to the project drawings, project specifications, and other contract documents prepared by the design professional. The constructor enters into a contract with the owner to carry out these activities.

The constructor assembles a team of material and equipment suppliers, specialty subcontractors, material fabricators, construction trade workers, and others to complete the construction. These team members generally contract directly with the constructor.

The constructor's general responsibilities include the following:

- Establishing the means and methods of construction;
- Fulfilling the obligations of the contract and approved change orders;
- Building project elements according to the project drawings and project specifications provided;
- Performing QC functions in accordance with terms of the contract;
- Ordering materials and equipment;
- Being proactive and clear in communication;
- Accepting responsibility from owner for construction site safety, including the development and implementation of a comprehensive safety plan (if so delegated);
- Making decisions in a timely manner;
- Being responsible for the performance of subcontractors and suppliers;
- Providing skilled construction trade workers;
- Coordinating activities with other project team members in a cooperative manner;
- Complying with applicable codes, regulations, and laws.

The constructor provides work that complies with the specifications of the contract documents and is often required to implement an appropriate quality control (QC) program.

➢ Chapter 20, "Quality Assurance and Quality Control"

4.5 COMMON INTERESTS

Ideally, the members of the project team communicate clearly and often, resolve their differences amicably, and complete projects successfully. However, team members inherently bring differing interests and requirements to a project that can, at times, make it difficult to achieve the project "ideal." Table 4-1 highlights the types of differences that can arise among team members and strategies to resolve them.

Table 4-1 Team Member Differences and Resolution Strategies

Issue	Typical Differences	Strategies for Resolution
Money	• Owner is strongly motivated to contain costs. • Designer and constructor must operate profitably and receive payments on time. • Owner may delay payments due to cash flow problems.	• Owner seeks information on prevailing industry costs. • Design professional and constructor seek a profit commensurate with the risk, level of effort, and skills required. • Owner pays design professional and constructor in a timely manner.
Schedule	• Owner benefits from completing a project as quickly as possible. • Design professional and constructor require sufficient time to ensure quality in design and construction.	• Owner provides design professional with sufficient time to study alternatives and develop a realistic schedule. • Participants are informed on permitting needs and construction sequencing.
Decision making	• Owner (especially on public projects) may need to delay construction decisions to accommodate changing circumstances. • Delays can interrupt the workflow of project participants. • Constructor may experience cost impacts related to inefficient use of labor and materials.	• Team members are sensitive to the benefits that timely decision making has on the actions of each other and the project as a whole.
Performance	• Team members may find fault with each other's performance in liability situations.	• Team members strive to define the roles and responsibilities of each party in contract documents.* Parties are accountable for their actions and accept the financial and professional liabilities associated with their decisions. • Risk should be fairly and clearly allocated by contract to the team member best able to control that risk. • Team members engage in activities, such as partnering and alternate dispute resolution, that are expected to reduce and resolve conflict and maximize performance.

**The process of defining terms is itself a benefit in reducing conflict, and the resulting language provides a clear guide for resolving conflicts that do occur.*

SUMMARY

Project participants establish the roles, relationships, and rules that form the project team. The owner holds the central role in forming this team and the contracts that define the relationships among its members. The owner acts as, or designates, a project manager to oversee the wide range and large number of responsibilities involved in coordinating and completing project design and construction.

Team members bring inherently different interests and requirements to a project. Successful project teams are made up of participants who acknowledge these differences and yet share a common commitment to quality. Desirable team member characteristics include a willingness to accept responsibility, a drive for economy and efficiency, cooperation and coordination with other team members, adherence to the established budget, schedule, and program, and an insistence on quality.

The structuring of contracts and the effort to clearly define participant roles and responsibilities as early as possible help avoid adversarial relationships that can diminish project quality. ❑

Chapter 4: The Project Team

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor*	Design-Builder
Designate project delivery system	●	◉	◉	○
Select and assemble qualified internal staff	●	●	●	●
Select and assemble members of project team	●	●	◉	●
Designate project manager	●	◉	○	◉
Complete design to contractually specified level	◉	●	○	●
Construct the project according to contract documents	◉	◉	●	●
Identify common interests and resolve conflicts	●	●	●	●

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

● = Primary Responsibility ◉ = Assist or Advise ○ = Review

CHAPTER 5

COORDINATION AND COMMUNICATION

In this chapter

No matter what the size or scope of a constructed project, the participants must coordinate their efforts to get the job done. Effective coordination is characterized by appropriate organization, well-defined procedures, the fulfillment of roles and responsibilities, good controls, the effective use of participants' skills and experiences, the commitment to good communication, and understanding and respect for the requirements of each participant.

Communication is perhaps the most important tool in achieving effective project coordination. Coordination and communication are closely related but are distinct in their respective scopes. Coordination includes the broad range of project activities related to the management of people and resources. Communication is the flow of information to support project activities, as practiced in meetings, telecommunication, and written documents.

Good project communication may be broadly defined as the free exchange of accurate and relevant information among the right individuals in a timely manner. Good communication among project team members should be clear, honest, open, and frequent, but not excessive. Therefore, achieving effective project coordination depends on the communication skills of the participants and their ability to tailor their communication style and techniques to the project at hand.

This chapter discusses the relationship between project coordination and communication, describes the roles and responsibilities of team members related to these two areas, and outlines communication tools and methods that contribute to quality in the constructed project.

5.1 KEY TEAM MEMBERS

In successful projects, each team designates key contact people to manage coordination and communication. The titles of these positions can vary, depending on the project:

Owner	Design Professional	Constructor
• Project Manager • Project Representative • Construction Manager	• Project Executive • Design Team Leader	• Project Manager • Superintendent • Construction Subcontractors • Suppliers/vendors • Fabricators • Construction trade workers

The more elaborate our means of communication, the less we communicate.

Joseph Priestley

The people in these positions are usually responsible for overseeing coordination activities. They are responsible for maintaining good communication with the other key team contacts, as well as overseeing communication activities within their own organizations. Successful coordination and communication management requires, at the outset, a clearly defined project scope, accurate descriptions of participant duties, and the establishment of appropriate project controls to monitor progress.

5.2 DEVELOPING COORDINATION PROCESSES

Coordination responsibilities and the activities of team members vary widely according to project size and complexity. Building a deck for a home involves less coordination than a deck for a bridge. Highway repairs in congested cities require more coordination than identical repairs in remote areas.

The owner selects the other team members and determines when they join the project.

The design professional and constructor often possess valuable experience in project coordination. Yet the owner's role is critical in defining coordination processes. Therefore, it is desirable that the owner work closely with the other team members to develop and refine strategies for coordinating the work of the entire team. In addition, coordination and communication requirements of team members evolve as the project progresses. Therefore, all team members should periodically review the effectiveness of these processes.

The following are basic tools and tactics to achieve project coordination:

- A clear definition of the owner's project objectives;
- Coordination procedures that are appropriate for the project scope;
- Schedules and regular updates, which should be tied directly into submittal, and material and equipment procurement schedules;
- Budgets, cost studies, and alternative proposals;
- Written contract clarifications;
- Progress reports, either written or oral;
- Joint reviews of documents, models, budgets, and schedules;
- Adequate distribution and review of field reports and lab tests;
- Joint visits to worksites, vendors, fabrication shops, and test facilities;
- Formal compliance reporting;
- Procedures for reporting design and/or construction discrepancies;
- Well-defined contract change order procedures; and
- Coordination meetings.

Table 5-1 summarizes these responsibilities during successive project phases of a traditionally managed project.

In addition, the contract documents may include additional requirements with regard to communication, including written notice requirements and strict guidelines for frequency and types of meetings, meeting minutes, submittals, and progress reporting. Responsibility for various communications varies depending on the project delivery system selected by the owner.

Table 5-1 Typical Team Member Coordination Responsibilities (DBB)

	Conceptual	Design	Construction	Completion/ Post Completion
Owner	• Form and inform the team. • Outline project requirements for the design professional. • Submit appropriate permit applications.	• Provide timely decisions in support of design. • Perform quality assurance functions for design activities. • Participate in design reviews. • Communicate changes in a timely manner when necessary. • Administer design contract.	• Provide qualified quality assurance verification as required by contract documents and regulatory agencies. • Administer contracts.	• Maintain team coordination and focus on follow up and completion items.
Design Professional	• Assist in outlining and interpreting project objectives and requirements. • Lead the development of the coordination process for the entire team.	• Lead the design effort. • Involve the owner and others at appropriate times. • Prepare and coordinate necessary project drawings and project specifications. • Perform quality control of design activities. • Assist with obtaining environmental permits.*	• Interpret project drawings and project specifications, review shop drawings and submittals, and assist with field problems. • Perform field observation. • Document communications, decisions, and observations.	• Prepare final punch list. • Assist with follow-up. • Assemble required manuals and record documentation. • Assist with start-up.*
Constructor	• Be an early participant. • Contribute to alternative studies and constructability reviews.*	• May perform vendor and subcontractor selection. • Assist in constructability reviews.*	• Perform the construction work. • Perform quality control activities for all construction activities. • Supervise and coordinate subcontractors, vendors, and others for shop drawings, inspections, and other appropriate activities. • Supervise in the field.	• Lead project close-out. • Lead and supervise subcontractors and vendor completion and punch list activities. • Provide warranties, O&M manuals, and record project drawings and project specifications.

**If permitted by law and selected by owner to participate during this phase of the project.*

5.3 TEAM MEMBER RELATIONSHIPS

Like any group, constructed project teams evolve from a collection of individuals to a team as they work together. For constructed projects, there are four general stages of a team's evolution. The coordination activities associated with these stages are described in Table 5-2.

Successful progress through these stages also depends on an atmosphere of honest, open communication. Problems that are not identified, acknowledged, and addressed as they arise can cause a ripple of compounding difficulties throughout a project. In worst-case situations, team members may not be able to fully correct such problems and must then rely on ad hoc strategies to mitigate undesired impacts.

Team members should be able to expect reasonable adherence to standards of professional performance from fellow team members. These performance expectations include integrity, honesty, and trust in working relationships; competence in respective professional fields; compliance with contractual and other responsibilities; a commitment to achieving project requirements; honest and open communication; and the dissemination of complete information.

Of these expectations, honest and open communication and the dissemination of complete information can be among the most difficult to fulfill, as they require collective and individual action. For example, team members who attempt to shield project leaders and co-workers from "bad news," such as poor product quality, risk the credibility of their organization as well as legal and financial liability for any problems. This is especially true should the information concern the safety of team members or occupants or the required performance of the completed project.

The importance of open and honest communication does not, however, excuse impulsive, volatile, or punitive expressions of any team member's perspective.

Table 5-2 Stages of Project Team Coordination

Stage	Team Member Activities
1	Develop a grasp of the project's technical requirements and coordination needs.
2	Assess specific compatibility and agreements with individual team members and their staffs.
3	Develop specific responsibilities for team members with regard to project requirements, work scope, procedures, schedules, budgets, and communication.
4	Execute a cohesive team effort through cooperative and coordinated actions, clear and timely communication, appropriate decisions, prompt problem resolution, and the fulfillment of commitments.

Such negative communications tend to cause positive, productive communications to break down, as people entrench themselves to protect their respective positions. Hastily written and poorly worded e-mails can cause tension and even suspicion between the communicating parties, especially since e-mails lack the context of other direct communication methods (face-to-face and phone).

5.4 CHARACTERISTICS OF GOOD COMMUNICATION

Nothing is so simple that it cannot be misunderstood.

J. R. Teague

In the construction industry, some people view communication as a luxury—something that can wait until after the real work is done. However, effective communication saves money and enhances reputations. It helps prevent coordination problems that can cause frustration and dissatisfaction among team members and lead to project failures.

Studies by project owners of failures, near failures, and problems with newly constructed projects indicate that at least one in four such events results from poor communication or lack of coordination among the project team. Insurance studies show that when owners resort to legal action, litigation is not usually related to imperfections in the project itself but rather to coordination and communication problems among the project team. These include last-minute surprises, frustration about issues that have not been addressed, the absence of positive personal relationships, a perceived lack of concern, or incomplete information. The frequency of lawsuits seems to be highest among owners who do not place adequate emphasis on communication or who have limited construction experience.

📖 *Dynamic Communication for Engineers,* Richard H. McCuen, Peggy A. Johnson, and Cynthia Davis, ASCE, 1993

📖 *"Excellent Communication Skills Required" for Engineering Managers,* Todd A. Shimoda, ASCE, 1994

5.4.1 Defining Project Communication

Project communication is the sending and receiving of relevant information to and from appropriate team members. This is a varied and complex process that requires many different levels of effort, skill, discipline, and judgment.

The speaker, or sender, must decide what information is appropriate for the intended audience, the best forum to present it, and the optimal time to deliver it. The listener, or receiver, must grasp the explicit or factual information, ideas, and concepts presented—and ask questions if the message is unclear. The receiver's understanding is also impacted by subtle or implied aspects of the message, such as the tone of delivery, body language, vividness of descriptions, and personal feelings expressed.

➢ 17.2, "Contract Documentation"

In the exchange of information, it is vital that both sender and receiver strive to identify the following:

- Project-related information and objective data;
- Concerns, opinions, feelings, or subjective items and the degree to which these are (or should be) revealed; and
- Requests for action.

Following the exchange of information, it is often helpful for the receivers to summarize to the sender, either verbally or in brief written form, their understanding of the information so that misperceptions may be corrected immediately.

5.4.2 Documentation

As important as communication is for the success of the project, of equal (or arguably greater) importance is the use of appropriate project document control and maintenance procedures. Project participants are responsible for maintaining their own project documentation file. In addition, contractual requirements are generally imposed on specific project parties, most notably the design professional, constructor, and, if utilized, the construction manager. Table 5-1 identifies the design professional as the party that is typically assigned the compilation of the project documentation files. However, both the owner and the constructor (and the construction manager, if used) are required to support this compilation through the maintenance and distribution of certain documents that each is responsible for.

5.4.3 Forms of Communication

Different forms of communication are appropriate in different project situations and for different participants. For example, a four-word e-mail from the project manager asking, "Where is that report?" will likely be acted upon with greater swiftness and enthusiasm than a four-page memo from Human Resources describing a complicated change in policy.

The following sections describe three general forms of communication and their strengths in the context of a constructed project.

5.4.3(a) Direct Communication

Face-to-face meetings and consultations, either in groups or one-on-one, are useful for defining and addressing issues, problems, or complex matters. Direct communication is valuable for its interactive nature, which promotes brainstorming and creative problem solving and consensus building. Direct communication also lends weight to important announcements, actions, and decisions. Direct communication is often the best opportunity for fostering clear understanding.

5.4.3(b) Telecommunication

Telephone calls, teleconferences, and two-way radio are useful for sharing information quickly and connecting people when schedules or geographic distance make face-to-face meetings impractical. With the proliferation of cellular phones, pagers, and other wireless devices, telecommunication is enhancing its most considerable advantage: immediacy.

5.4.3(c) Written Communication

Memos, e-mails, letters, faxes, reports, newsletters, and other documents and publications are valuable for the transmission of information that requires more formality than a conversation or phone call. Written documents (in paper and electronic formats) are the principal form in which project decisions, agreements, and actions are recorded. E-mail, though often used with the frequency and casual nature of a telephone call, is a permanent record.

- *The Chicago Manual of Style,* 16th Edition, University of Chicago Press, 2010
- *The Elements of Style,* 4th Edition, William Strunk and E.B. White, Allyn & Bacon, 1999
- *The Elements of Business Writing,* Gary Blake and Robert Bly, Macmillan, 1991
- *The Elements of E-Mail Style,* David Angell and Brent Heslop, Addison-Wesley, 1994

5.4.4 Tools and Methods

The right communication methods for achieving good coordination vary with each project. Small projects, such as a garage or backyard landscaping, often succeed on the contractor's word and a handshake. However, for larger and more complex projects, communication must be more formal and frequent to coordinate the greater number of activities. Major construction projects today often involve hundreds of team members spread out over dozens of locations. These efforts require advanced telephone and computer networks, document tracking systems, couriers, meetings, and other communication tools to keep information flowing.

Typical communication activities and tools include the following:

- Team meetings with subconsultants and subcontractors as appropriate;
- Telephone calls and teleconferencing;
- Facsimiles (faxes);
- Meeting minutes or summaries noting follow-up responsibilities;
- Memos and letters with appropriate distribution;
- Transmittal letters;
- Newsletters and internal updates; and
- Couriers and overnight delivery services.

➢ Chapter 17, "Construction Contract Documentation and Submittals"

E-mail and the Internet have expanded the communication tools and strategies available to construction project teams. Advanced and specific applications of these tools continue to evolve rapidly. Common computer-based communications include the following:

➢ Chapter 21, Computer Technology and Project Quality

- E-mail and electronic file transfers, including entire texts of construction documents;
- Project websites;
- World Wide Web sites for external and secure internal use;
- Internet newsgroups; and
- Video conferencing.

We have become the tools of our tools.

Henry David Thoreau

5.4.5 Meetings

Of the many communication tools listed above, meetings deserve special attention because they can be among the most productive for providing continuing coordination for projects. However, to be effective, meetings should be brief, well-planned, and conducted by a knowledgeable meeting leader. Teleconferences with remote participants can be useful, but their efficacy depends even more heavily on these three characteristics.

There are two general types of project meetings:

1. Regular meetings (daily, weekly, monthly), which usually have a standard agenda and are held to track progress, identify problems, and resolve low-level conflicts.
2. Special meetings to address particular situations or problems.

In either type of meeting, the following guidelines for the meeting leader can help participants make the most of their time:

How to Hold Successful Meetings: 30 Action Tips for Managing Effective Meetings, Paul R. Timm, Career Press, 1997

- Call meetings when direct communication and/or problem solving are needed.
- Explain the purpose of the meeting and clearly define each agenda item as informational, needing discussion, or requiring action.
- Solicit approval of changes to the agenda to allow the meeting to flow smoothly.
- Estimate the amount of time needed for each agenda item, as well as for the entire meeting. Keep presentations and discussion moving.
- Encourage participation but ask that contributions be relevant.
- Use a large easel tablet or board to summarize important discussion points, decisions, responsibilities, dates, and other key information.
- Briefly critique the meeting with respect to its length, format, and usefulness to participants, as well as potential improvements.
- Prepare minutes or brief written summaries of actions, agreements, conclusions, continuations, and assignments. Distribute minutes to attendees as soon as possible.

It is very important for the meeting leader to timely publish accurate and complete meeting minutes, and to timely distribute such minutes to all attendees and to others who need to be aware of the information generated in the meeting. Meeting minutes should clearly state conclusions or further action required of specific individuals and time limits for the action.

5.4.6 Personal Differences

Good project communication requires the recognition of the inherent differences among team members. Owners, design professionals, and constructors have different backgrounds, qualifications, expertise, and expectations. They may also have different definitions of a successful project. There may be significant differences in individual preferences among the members of each team staff. These can include the following:

- Preferences for working alone versus in a group;
- A tendency to make decisions in a deliberate manner versus taking prompt action;
- Placing emphasis and value on creativity versus established procedures;
- Placing value on detailed analysis versus grasping broad concepts;
- The use of different methods for expressing and handling disagreements; and
- Preferences for deferential versus direct approaches in personal relationships.

For coordination and communication to be effective, team leaders must understand and compensate for individual differences. For example, a design team member who works best alone may need patient reminders to improve coordination with other team members. A gregarious, outgoing project manager may inspire creative problem solving but may need support to catch routine details that would otherwise slip through the cracks.

5.5 TIMING AND CRITICAL MOMENTS

Timing is another critical aspect of project communication. If information is premature, late, or not distributed to staff in the appropriate sequence, coordination suffers. Frequent contact among team members tends to promote the timely completion of project tasks. When team members receive key items late, such as changed objectives or specifications, they may react negatively, schedules or quality of work may be jeopardized, and financial losses for some or all parties can result.

The following are examples of times or situations in the life of a project when coordination and communication among team members become especially critical:

- During the process of defining the scope, budget, and schedule;
- During the definition of performance and quality criteria, and the reaching of an agreement on the refined project scope;
- While conducting alternative or feasibility studies affecting scope;
- When reviewing construction contract document language and requirements;
- When assessing economic or scheduling impacts;
- At major design phase milestones;
- When evaluating proposals from the constructor or a supplier for alternative methods, materials, or equipment;
- During unexpected situations that require changes in schedule, scope, procedures, costs, or materials;
- When dealing with significant problems of design or construction; and
- Upon achieving major construction milestones.

When team members are not appropriately involved during the periods listed above, or are not consulted about problems that directly concern them, they may develop negative, uncooperative attitudes that are not conducive to achieving quality.

5.6 FREQUENCY OF COMMUNICATION

The effectiveness of project coordination increases with the frequency of good communication. Frequent contact provides team members with increased opportunities to assess workloads, identify critical path items, and develop solutions to problems. Frequent contact can serve as a backup for other types of project communication. For example, a meeting offers team members the opportunity to clarify what may have been said in a letter. Frequent communication aids participants in building a common project vocabulary that further enhances understanding.

Frequent contact promotes the timely completion of tasks.

But as crucial as communication is to project success, there is a distinct danger of over-communicating. For example, if routine information is distributed widely regardless of its importance, the result may be that important issues are ignored. Over-communication detracts from the project team's effectiveness because people have to spend time trying to figure out if the information they just received is important. Good communication requires judgment in determining how much is enough (though over-communication is preferable to under-communicating). If information senders are not sure if they are striking the right balance, one strategy has proven effective in nearly every situation: ask the recipient.

5.7 CONFLICT AND DISAGREEMENT

➢ Chapter 24,"Partnering"

Although efforts to manage and improve coordination and communication reduce the likelihood of conflict, disagreements occur. In these cases, team leaders must increase their efforts to improve communication among the parties in conflict, even themselves, through a variety of strategies, including the following:

- Handling disagreements as soon as possible. Postponement can lead to frustration and the hardening of opposing positions.
- Identifying the project requirement at the heart of the disagreement to help the team avoid irrelevant issues.
- Addressing the easier issues first, proceeding one issue at a time.
- Encouraging participants to listen to all relevant facts and feelings before attempting to resolve the problem.
- Attempting to solve a problem too quickly can escalate or confuse the situation.
- Developing more than one alternative for resolution.
- Striving for team consensus on a course of action. Forced solutions can create distrust and/or dissatisfaction.
- Moving the dispute to a higher management level when the representatives closest to the problem cannot resolve their differences within a reasonable time. This ensures that the work at lower levels continues.

If the team cannot reach a consensus in resolving a technical or programmatic problem, it is the responsibility of the owner, after consulting with the other team members, to select a preferred alternative and move the project forward. The owner will benefit from clearly communicating the reasons for such an action to the team members. Prolonged indecision can be damaging, particularly if it disrupts project continuity. Each manager involved in the project organization must make the best use of his or her skills and authority to resolve conflicts prudently but quickly and at the lowest level of the organization possible.

SUMMARY

Project coordination and communication go hand in hand. Coordination relies on the selection and implementation of an appropriate set of management tools and strategies. An essential building block of successful coordination is the development of a mutual understanding of the duties for which each team member is responsible during different phases of the project. Team members must work together to develop coordination processes that reflect a clear definition of participants' respective responsibilities, the agreements entered into to fulfill those responsibilities, and supporting coordination tools to be used to achieve them.

While direct and written communications are central to achieving good coordination, the rapid evolution of telecommunications and computer-based information technology is transforming the patterns of project communication. In particular, cellular telephones, pagers, e-mail, project websites, and facsimiles have changed communication expectations and work patterns. The immediacy of telecommunication is both an advantage and an encumbrance among modern project teams. Good communication involves choosing the right tools—and exercising good judgment before using them. ❑

Chapter 5: Coordination and Communication

Typical Responsibilities

Responsibility ⇩	**Owner**	**Design Professional***	**Constructor***	**Design-Builder**
Planning the coordination process	●	⦿	⦿	⦿
Initiate frequent contacts	●	●	●	●
Evaluate quality of communication	●	●	●	●
Establish meeting schedules**	●	⦿	⦿	⦿
Initiate conflict management efforts	●	●	●	●

**For design-bid-build situation. In a design-build situation, the Design-Builder will be the responsible party.*
***May vary with project phase, i.e., planning, design, and construction.*

● = Primary Responsibility ⦿ = Assist or Advise

CHAPTER **6**

SELECTING THE DESIGN PROFESSIONAL

In this chapter

Selecting the design professional is a critical step in achieving project quality. The owner is the central figure in the process of selecting the design professional, with the responsibility for crafting and administering procedures to identify and engage a design professional with the necessary experience, technical resources, availability, and commitment to succeed. The owner's dedication to achieving a high-quality project is exemplified during the selection of the design professional when the qualifications-based selection process is used.

This chapter presents details on the procedures for selecting a design professional for a design-bid-build (DBB) project.

The owner's project goals and objectives are central in choosing an appropriate selection process, as well as the appropriate project delivery system. Under alternate forms of project delivery, such as design-build and turnkey, the owner may also use these processes to screen or select the design-build firm, or the constructor may use them to screen or select the design professional for the design-build or turnkey team.

6.1 PROJECT GOALS AND THE DESIGN PROFESSIONAL'S SCOPE OF SERVICES

As a first step in any selection process, the owner defines the general project goals. These are typically broad and include the type and size of the proposed project, the preliminary budget, schedule, site constraints, mitigation measures, legal constraints, safety concerns, and quality-related goals. Once established, the project goals are a key consideration in determining the appropriate procedure for selecting the project delivery system and the design professional, and for establishing the scopes of services to be provided.

Short-term budget concerns often put pressure on a public owner to ignore life-cycle cost considerations and opt for lowest cost design services. However, this is usually not in the owner's best interest. Design costs typically total less than 5% of life-cycle costs. Yet, during design, the major decisions that affect costs for construction, operation, and maintenance are made. There may be occasions where a private owner will transfer ownership of the project early in its useful life. In these cases, the private owner may wish to minimize design and construction costs and seek the lowest cost design services. However, even in these situations, it is likely that the increased sale price of a well-designed project will more than offset the increased design cost incurred by using the most qualified design professional. For both public and private

Life-Cycle Cost: The total cost of developing, designing, constructing, owning, operating, and maintaining a facility for its design life, as well as decommissioning costs.

owners, minimum cost design may omit the analysis of alternative solutions that could dramatically improve project outcomes.

The detail and specificity of the scope of design services vary with the size and complexity of the effort. The scope can range from a general statement of the facility's performance specifications to an extensive itemized description of each task. The scope should also specify the owner's requirements for professional design services during the construction and start-up phases.

Owners that manage construction projects, or those with large facilities departments, often have the in-house capability to prepare a well-defined scope of design services for use during the selection of the design professional. Owners who do not regularly undertake construction projects usually benefit from engaging an independent design professional to develop the scope of services. In general, greater precision in the scope of services produces a clearer understanding on the part of the owner and competing design professionals about the designer's expected qualifications to achieve the desired level of quality.

6.2 QUALIFICATIONS-BASED SELECTION

Qualifications-based selection (QBS) is the generally accepted practice for design-bid-build contracting, particularly on public-works projects. Under QBS, the owner selects the design professional on the basis of qualifications submitted before the final scope and fee are negotiated. QBS is required on federally funded projects and on projects administered by many states and municipalities. The 1972 Brooks Act (P.L. 92-582) requires QBS in the procurement of architectural and engineering services on federal projects. Many states and municipalities have adopted similar statutes, known as "mini-Brooks" acts.

📖 ASCE Manual 45, *How to Select and Work Effectively with Consulting Engineers: Getting the Best Project,* 2012 Edition, Appendix 2, "Engineer Selection Process: Typical Forms"

With QBS, design professionals submit statements of interest and qualifications in response to an owner's invitation or advertisement, known as a request for qualifications (RFQ). The owner and/or designated selection committee evaluates the responses according to the selection criteria provided in the RFQ. In many cases, the owner develops a short list of the top three ranked design professionals and conducts personal interviews with each before making a final selection.

Owners and design professionals tend to be more satisfied with the results from contractual agreements in which the parties agree on the design professional's fee after the full scope of services is established and understood. Depending on the size and complexity of the project, reaching this level of understanding may require extensive discussions and effort. Professional experience and knowledge play a crucial role in achieving a satisfactory contract agreement.

Brooks Act

📖 U.S.C. Title 40, *Public Buildings, Property and Works*, Chapter 10, "Management and Disposal of Government Property," Subchapter VI, ¶541–544

📖 *APWA Red Book on Qualifications-Based Selection: Guidelines for Public Agencies*, 2006

Sections 6.2.1 through 6.2.11 describe typical QBS elements and procedures. Private-sector owners may omit, modify, or combine some of these steps if a well-established and satisfactory relationship exists with the design professionals involved. Public-sector owners must comply with applicable law.

6.2.1 Owner's Selection Committee

On large projects (approximately $10 million and greater), the owner often designates a design professional selection committee. (On smaller projects, the owner typically carries out the following activities on his or her own.) This committee requests and evaluates the design professionals' qualifications, reviews proposals, makes appropriate inquiries, checks references, and conducts interviews. The owner's final selection of the design professional is based upon the recommendations of the committee.

Federal Highway Administration: http://www.fhwa.dot.gov/engineering

Ideally, the design professional selection committees include at least three individuals with the experience and qualifications to make insightful judgments about the ability of the design professional to meet the owner's requirements and project goals. To avoid conflicts of interest, committee members are not affiliated with competing design firms. Typical selection committee members may include

- At least one professional engineer or licensed architect;
- The owner's principal contact with the design professional;
- The owner's construction project manager;
- The operations manager of the future facility;
- An owner representative authorized to make subjective judgments on aesthetic project elements involving architecture or public perception.

On smaller projects, the owner may not formally convene a committee but may assemble experienced staff or even engage a consultant to assist in the selection of a qualified design professional.

6.2.2 Selection Criteria

Although many design firms possess similar qualifications, no two have identical strengths in experience, skills, resources, training, workload, technical capabilities, or project-specific expertise. Therefore, the owner and selection committee members work to craft selection criteria that simplify the task of separating design firms that have the appropriate qualifications from those that do not. Typical design professional selection criteria are summarized below.

Ethics: The professional and ethical reputation of the design professional, as determined by inquiries with previous clients and other references.

Professional Registration: Professional registration of the principals and other responsible members of the design professional's organization in its state of residence and registration or qualification to obtain registration in the state in which the project is to be located.

Specific Qualifications: The design professional's demonstrated qualifications and capability to perform the scope of services, including knowledge of codes or other governmental regulations.

Similar Experience: Evidence that the design professional has performed similar services on equal, or more difficult, projects.

Resources: Evidence that the design professional has the financial resources and business background to accept the assignment and provide full, continuous service.

Availability: The design professional's ability to provide appropriately qualified staff to the project and complete the required services within a time frame that supports the project schedule.

6.2.3 Request for Qualifications

In a qualifications-based selection procedure, the qualifications of the prospective design professionals are the basis for selection. The owner or selection committee issues an RFQ, which can be a direct invitation to specific design professionals or a public notice or advertisement stating the general nature of the proposed project and requesting statements of qualifications and experience from interested design professionals.

Downloadable RFQ Forms

SF 330:
http://www.gsa.gov/portal/forms/type/TOP

In the RFQ, the selection committee specifies the format for submission of the written qualifications. Although corporate resumes and marketing materials may be acceptable, designers are often asked to submit modified U.S. Government standard form 330, Architect-Engineer Qualifications. The standardized format allows the selection committee to easily compare the qualifications of key personnel and relevant project histories. Private owners may also use this standard form or a modified version of it for obtaining qualifications.

6.2.4 Evaluation of Qualifications

The committee evaluates the statements of qualifications received against the selection criteria. The committee contacts references, reviews the past performance of prospective design professionals, and identifies a minimum of three who appear to be qualified for the project. If more than three design professionals appear to be best qualified, the committee may ask more than three to continue with the selection process. The committee also advises design professionals that do not make the best qualified list that they will not receive further consideration.

6.2.5 Request for Proposal

The owner or committee next sends the three candidate design professionals (or more, if desired and qualified) the request for proposal (RFP). Unlike the more general RFQ, the RFP describes the proposed project in as much detail as possible and includes the scope of design services to be performed. The owner invites each RFP recipient to submit a proposal describing a work plan, key personnel to be assigned, the schedule planned for completion, the location where the work will be performed, the firm's financial capacity, and other appropriate information. For large or complex projects, the design professionals may be invited to a pre-proposal meeting, often held at the proposed project site, to review available information and ask questions.

At this stage of the selection process, the design professional may benefit from learning as much as possible about the owner's proposed project history, mission, and capacity to support the project.

6.2.6 Interviews

On receipt of proposals, the owner invites the design professionals to meet with the selection committee for separate interviews. At the interview, key personnel to be assigned to the project present their firm's and their own qualifications and experience record, capability to complete the work within the allotted time, resources to complete the project, and proposed project approach. This step allows the committee to better gauge each design professional's project understanding and ability to meet the project objectives (various state and federal agencies may modify the interview process).

6.2.7 Additional References

Following the interviews, the selection committee may broaden its reference investigations of each design professional under consideration. It is important to determine the quality of performance on projects other than those referenced by the design professional.

6.2.8 Recommendation for Negotiation

The selection committee then ranks the design professionals based on their ability to meet the selection criteria, as well as the information obtained at the interview and the reference check. Upon the acceptance of the selection committee's recommendations for negotiation of the design contract, the owner usually discharges the committee.

6.2.9 Negotiation

After accepting the selection committee's recommendation, the owner meets with the top-ranked design professional to finalize the scope of services. The owner invites the top-ranked design professional to appear for a second presentation. At this point, the owner and design professional combine their capabilities, experience, and judgment to fully develop the scope of services. If appropriate, participation in the construction phase and other activities such as right-of-way acquisition, equipment procurement, start-up, and preparation of operation and maintenance manuals can be negotiated and included in the professional services agreement.

Once the full scope of services responsive to the project goals and to the owner's schedule and budget is developed, the owner and design professional negotiate a fair and equitable compensation for the services to be provided. The owner evaluates the compensation requested based on previous experience and the range of compensation reported by other users of similar services. Fair compensation allows the design professional to utilize his or her full expertise, and thus is vital to the success of a quality project.

6.2.10 Subsequent Negotiation through the Ranks

If the owner cannot reach agreement with the top-ranked design professional, the owner terminates negotiations by written notice. The owner is then free to begin negotiations with the second most qualified design professional or the third, if necessary, until agreement is reached. The owner may also refine the project goals and begin the selection project again. All negotiations are strictly confidential, and the compensation discussed with one firm is not revealed to another.

6.2.11 Agreement for Professional Services

➢ Chapter 7, "Agreement for Professional Services"

When agreement has been reached on scope of services, level of effort, compensation, and schedule, the owner and selected design professional formalize their negotiations in a written agreement. The owner then promptly notifies the firms that were not selected.

6.3 COMPETITIVE BIDDING

This practice is used on DBB projects in some states and municipalities where permitted by law, as well as some design-build projects in which the owner delegates a great deal of control to the constructor. Federal regulations and some states, however, require a QBS procedure for short-listing firms for design-build projects before final selection.

Although professional engineering, construction, and architectural societies view low-price bidding for the procurement of professional design services as counterproductive to quality and not in the owner's best interest because it ignores life-cycle cost evaluations, low-price bidding is not considered inherently unethical. However, competitive bidding for design services is not allowed on federal projects or on many state and municipal projects under the Brooks Act and similar state statutes.

6.3.1 Competitive Bidding Procedures

Competitive bidding for design services is not allowed on federal projects or on many state and municipal projects.

In instances where competitive bidding is to be used to select the design professionals, the owner first prepares a complete and comprehensive scope of work, schedule, and contract provisions. Design professionals are invited to submit a price, either lump sum or an estimate not to exceed, for the described scope of work, along with their work plan. The owner compares the bids and typically selects the design professional submitting the lowest bid, either in terms of price or hours of effort. However, if the design professional with the lowest bid does not submit a work plan that supports the required level of effort to complete the scope of work within the owner's schedule, the owner may select the next lowest bid that meets the owner's requirements. The owner may require that the designer be pre-qualified, with the owner's agency or others, to be eligible to bid.

6.3.2 Disadvantages of Competitive Bidding

Competitive bidding often does not serve the best interest of overall project quality for a variety of reasons, including the following:

- The low bidder may not be fully qualified to perform the services.
- It is difficult to include all the design services required in an advertised scope of services. This can result in amendments to the design professional's agreement.
- The nature of having a very detailed scope of services may limit the ability to achieve a "meeting of the minds" on difficult project goals or objectives.
- Contracting on the basis of a limited scope and fee tends to reduce the number of opportunities for alternative studies and evaluation, and also limits the flexibility available to the owner and design professional in solving problems that may arise as a project proceeds.
- Skimping on design costs can result in an increase in the number of construction change orders, misunderstandings, and other unplanned events and reduces the attention paid to operating and maintenance efficiencies, all of which can drive up life-cycle costs.

6.4 TWO-ENVELOPE SELECTION

In the two-envelope system, each design professional submits a technical proposal to the owner in one envelope and a price proposal in another. The owner opens the "technical" envelopes first, evaluates the proposals in a manner similar to QBS procedures, and selects the best qualified design professional solely on the basis of technical merit.

➢ 6.2 "Qualifications-Based Selection"

After the selection of the best qualified design professional, the owner opens that firm's price envelope and uses that cost information as the basis for negotiating the agreement for design services. The owner may hold the remaining price envelopes unopened in case negotiations with the best qualified firm are unsuccessful. In that event, the owner may open the second-ranked firm's price envelope and begin negotiations. After the owner enters an agreement with a design professional, it is accepted practice that the remaining price envelopes are returned to the remaining firms unopened.

During the negotiation of the professional services agreement, the owner and best-qualified design professional may work together to establish the final scope of services. Upon agreement of scope, the price of services is negotiated to reflect changes from the owner's original scope or the design professional's technical proposal. This provides the owner with the benefit of the design professional's knowledge and expertise, similar to the QBS process.

➢ Chapter 3, "Project Delivery Systems"
➢ Chapter 7, "Agreement for Professional Services"

The owner may modify the two-envelope selection procedure and open the price envelopes of all proposing design professionals, thereby creating a modified version of the bidding process described above. However, the decision to open all of the price envelopes should be announced to the design professionals before the submittal of proposals—not after.

Because the Brooks Act and similar statutes prohibit public owners from engaging design services on the basis of competitive bidding, the two-envelope system has an advantage in design-build projects in which the owner intends for the design professional to take a lead role. The two-envelope system provides the owner with the benefits of the QBS process for design yet creates a competitive environment and secures a fixed price for construction by obligating the proposing firm to the price in its sealed bid. However, on design-build projects where the owner places the constructor in charge, constructors tend to prefer competitive bidding.

SUMMARY

Qualifications-based selection procedures generally offer the owner several advantages in procuring the services of a design professional. These include securing a designer that is fully capable of meeting the project goals with the experience and expertise to develop a specific scope of services, schedule, and budget before contract terms are finalized. QBS also allows the owner and design professional to agree on a fee that is fair and based on the scope of services. A negotiated agreement for design services generally provides more opportunities to achieve creative solutions to design problems that will ultimately control the project's life-cycle cost and quality.

Procuring the services of a design professional under competitive bidding or the two-envelope system is sometimes used to help meet the owner's short-term financial goals. These procedures limit the ability of the owner and design professional to fully address design concerns that may arise as the project proceeds. These procedures also ignore the life-cycle cost of the project and the role of the design professional in minimizing that cost.

The preferences for the design professional selection procedures described in this chapter, as well as the numerous variations used by owners, continue to evolve. The increasing popularity of design-build contracting and its various permutations has broadened the range of opinion on the best way to deliver the project. This, in turn, has affected owner requirements related to the selection of the design professional. Therefore, the owner benefits by investing time and energy in assessing the potential strengths, weaknesses, and risks of different design professional selection procedures, keeping in mind the particular goals and objectives of the specific project. ❑

Chapter 6: Selecting the Design Professional

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*
Establish selection policy and procedure	●	
Request for qualifications (RFQ)	●	
Submit qualifications	○	●
Invite design proposals	●	
Follow announced procedures for selection of designer	●	
Prepare preliminary scope of work	○	●
Estimate cost of scope	○	●
Agree on final scope and cost	●	●
Negotiate contract	●	●

**Chapter 6 details procedures for design-bid build delivery system selection. In a design-build delivery system, the Design-Builder would typically assume the same responsibilities as indicated for the Design Professional in a DBB situation.*

● = Primary Responsibility ○ = Review

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CHAPTER 7

AGREEMENT FOR PROFESSIONAL SERVICES

After the design professional is selected, the next step in defining and achieving quality in the constructed project is preparation of the professional services agreement (PSA) between the owner and the design professional. The PSA documents the commitments made during negotiations between these two parties for professional design services during each phase of the project.

The owner and design professional need sufficient time to negotiate, define, and write a clear and fair PSA. As these parties reach a meeting of the minds regarding their respective duties and responsibilities, each has the opportunity to review the project objectives and make improvements. Negotiations are an important first step in building mutual trust and shared project understanding, qualities that will help avoid problems and conflicts later.

Although most professional services agreements are prepared for a unique set of conditions and project objectives, standard-form agreements can be helpful in preparing an appropriate project-specific agreement. Obtaining a legal review of the contract terms and language is strongly recommended. A review of business issues and the practicality of performance is equally important.

This chapter discusses issues related to professional services agreements between the owner and the design professional in terms of the traditional design-bid-build (DBB) project delivery system. However, project delivery systems and the organization of the design professional's team can vary widely. Therefore, this chapter also addresses other design professional services-related contractual agreements, including subconsultant agreements, agreements between the owner and additional design specialists, construction management agreements, and design-build agreements.

While this chapter addresses the concerns of the owner engaging an outside design professional for design services, many owners possess in-house design capabilities, alleviating the need for outside design contracting. But internal design functions are similar to those of a design professional, including budgeting, estimating staff hours, and addressing legal concerns. Therefore, in-house directives benefit from many of the same considerations as formal PSAs with outside design professionals.

In this chapter

7.1 PURPOSE OF THE PROFESSIONAL SERVICES AGREEMENT

➢ Chapter 3, "Project Delivery Systems"

➢ Chapter 23, "Risk, Liability, and Handling Conflict"

📖 *Negotiation and Contract Management,* David C. Johnston, editor, ASCE, 1985

Pre-contract negotiations between owners and design professionals involve discussions on a wide range of subjects, including the respective requirements and expectations of each participant. These negotiations can be lengthy and involve many individuals. Therefore, the PSA is an especially important means of summarizing the negotiations and recording the consensus of the parties on the project, objectives, and responsibilities in relation to each party's role.

Ideally, the negotiation team should include the leaders from the owner and design professional parties as well as the staff members who will help execute the PSA. The participation of team leaders and senior staff members is important to create a written PSA that communicates their intentions and goals to many others who become involved with the project later. These others may include facility operators, those involved in related construction projects, and, in the event of a dispute, claims analysts, mediators, and legal professionals.

The design professional services agreement is more than a statement of the rights and responsibilities of the parties. Its development stimulates both parties to plan their actions and interaction. In some cases, parts of the contract may become a "procedures manual."

7.2 ELEMENTS OF THE AGREEMENT

A contract that has not been negotiated is a contract that neither party understands.

C. Edwin Vick, Jr.

Typical PSAs between the owner and design professional consist of two parts. The first part, known as the "scope/schedule/fee" section, establishes issues that are unique to the project, including the following:

- Scope of design services to be provided;
- Schedule/time of performance for the contracting parties;
- Fee (a short term for the more proper and comprehensive expression, compensation) for design professional services; and
- Owner's responsibilities.

The second part consists of the terms and conditions, often known as the general conditions or provisions. These sections address issues including but not limited to procedures for amending the agreement, standards of performance, insurance coverage, allocation of risks, and termination. The owner and design professional benefit from developing a thorough understanding of all the terms and conditions, including references to external documents. This is especially important in the context of construction industry norms and potential impacts to items in the scope/schedule/fee section.

In formal contract documents, the terms and conditions typically appear first, with the scope/schedule/fee provisions provided in exhibits. With less complex projects where simpler agreements are appropriate, such as letters or similar short forms, the scope/schedule/fee can be given first, with the terms and conditions attached and included by reference.

7.2.1 Project Phases and Scope of Services

The development of project phases and the scope of services that are to be provided by the design professional are closely related activities. This section discusses the different responsibilities that may be assigned to the design professional by the scope of services. It is beneficial for the PSA to include mechanisms during successive phases of a project and describes how the PSA addresses related issues.

The services that a design professional provides during a complete constructed project are generally considered to be divided into six parts, defined in ASCE Manual 45 as

1. The study and report phase;
2. The preliminary design phase;
3. The final design phase (producing contract documents);
4. The bidding, or negotiating, phase for construction services;
5. The construction phase; and
6. The post-construction, or operation, phase.

ASCE Manual No. 45, *How to Select and Work Effectively with Consulting Engineers: Getting the Best Project,* 2012 Edition, ASCE, 2012

Most participants in the design and construction industry advise that one design entity should furnish services through all six phases, especially during the construction phase. A single design professional provides continuity, consistency, and efficiency; enhances coordination; and establishes and maintains clearer lines of professional accountability to the owner, which improves quality. In addition, the use of a single design professional can help control costs because negotiation and "learning curve" time for new design professionals at each successive phase is reduced.

EJCDC

The Engineers Joint Contract Documents Committee (EJCDC) is a voluntary committee with members from ASCE, the National Society of Professional Engineers (NSPE), the American Council of Engineering Companies (ACEC), the Associated General Contractors of America (AGC), and the participation of more than 35 other professional engineering design, construction, owner, legal, and risk management organizations.

http://www.ejcdc.org/

The PSA specifies the project phases and the professional services to be provided in each. These are in turn subdivided into discrete, project-specific tasks. The mutually agreed-to definition of these tasks is referred to as the "scope of services" (a term preferred over "scope of work"). The negotiated scope forms the basis for the schedule and fee for each phase. The PSA includes the owner's responsibilities and the schedule under which they are to be performed.

Many factors determine which tasks will be in the design professional's scope of services, including the manner and timing of selecting the constructor and the owner's construction budget. For example, competitive bidding for construction services may require that design be completed in greater detail than with negotiated pricing. If the constructor joins the project team during design, the design scope might include more meetings with the constructor but fewer construction alternatives because the constructor can help guide the team to the most economical solutions.

EJCDC Doc. E-500, *Agreement Between Owner and Engineer for Professional Services, 2008*

In general, specific and detailed scopes of services lead to better quality projects. The owner and design professional benefit from quantifying, to the greatest extent practical, the level of effort required. This may include specifying the number of design alternatives to be explored, meetings, site visits, copies, and other deliverables. Expectations of each party are thereby clarified, the risk of surprises is reduced, and the potential for disputes is minimized.

The scope of services may include scheduled periods of inactivity between successive project phases for the owner's review and approval. Or the owner and design professional may agree to compress the project schedule by beginning successive design phases while the previous phase is being reviewed. Compressing the design schedule requires experience and trust, as well as greater budget contingencies but can be a benefit by saving critical time.

➢ 7.2.5, "Procedures to Amend the Agreement"

During many projects, the owner finds it advantageous or necessary to change the scope of design services. The owner benefits from making these changes in consultation with the design professional to ensure that the modifications in scope and schedule are clear, achievable, and matched with equitable compensation.

7.2.2 Instruments of Service

Under most PSAs, it is the design professional's responsibility to produce documents that are among the end results of the tasks outlined in the scope of services. These documents, often known as "instruments of service" or "deliverables," are described in the agreement. The sequence of their delivery to the owner sets the design professional's schedule. These deliverables may include the following:

- Schedules;
- Preliminary reports of project feasibility;
- Opinions of probable costs;
- Design quality control plan;
- Reports of alternative investigations and other studies;
- Reports of project impacts on the environment or infrastructure;
- Preliminary design and outline specifications;
- Final design;
- Construction contract documents, including project drawings and project specifications;
- Reports on construction activities;
- Record project drawings and final project reports; and
- Operating and maintenance manuals.

Standard industry forms for design-bid-build provide for the design professional to retain ownership and copyright in their design. This is to protect against use of design documents on future projects without the original designer's input and where design intent is violated to the owner's detriment. For example, the owner can be granted specific rights of use in connection with managing the completed project, and the owner may want the freedom to engage other design professionals for modifications; however, this should be subject to the obligation to indemnify the original design professional for any misuse or unauthorized modification of the subject documents. Similarly, the design professional has interest in preventing the unauthorized reuse of the documents, as well as retaining any special proprietary ownership of the concepts and details reflected in the deliverables.

7.2.3 Fee for Services

The PSA establishes the amount and terms of payment to the design professional for services provided. ASCE Manual No. 45 describes several methods of payment for professional services, including the following:

- Hourly or per diem rates;
- Retainer;
- Salary costs times multiplier plus direct non-salary expense;
- Cost plus fixed fee;
- Lump sum; and
- Percentage of construction cost.

In general, cost- or effort-related fees are appropriate where the services to be performed have not been, or cannot be, well defined. These methods may be used in a simple arrangement, or there may be auditing procedures added. Lump-sum fee arrangements are appropriate when the scope of services is set without ambiguity by mutual consent of the parties. It is always important to make clear which, if any, direct expenses are reimbursable and which are included in the lump sum. Fees based on a percentage of construction cost are less frequently used due to lack of certainty and equity.

Most PSAs include provisions for the timely payment of portions of the total fee as services are provided. The amounts and disbursement schedule are determined by

- Hours expended and costs incurred during an appropriate time interval (typically one month);
- Completion of design phases or project milestones as described in the agreement;
- Estimated percent completion of lump sum–related services, as estimated by the design professional and approved by the owner.

Fees (and their terms of payment) can occasionally generate misunderstandings. The owner and design professional should discuss contract payment provisions thoroughly and tailor the terms to the project circumstances.

7.2.4 Owner's Responsibilities

Overall project quality is closely related to the owner's willingness to be responsible for the timely and satisfactory performance of their responsibilities and associated tasks. These responsibilities and tasks, identified during

➢ Chapter 2, "The Owner's Role and Requirements"

negotiations with the design professional and then incorporated into the PSA, typically include

➢ 2.1, "The Owner's Role"

- Defining the project objectives;
- Providing adequate project financing;
- Establishing quality assurance (QA) standards;
- Providing existing information on the project and related site conditions;
- Arranging to obtain specialized design information, such as field surveys and subsurface investigations;
- Making project-related decisions promptly;
- Coordinating activities with other project team members;
- Arranging for permits and approvals from regulatory agencies;
- Paying earned fees to the design professional promptly;
- Communicating clearly and in a timely manner;
- Maintaining required project records;
- Dictating or approving the terms of the construction contract;
- Specifying insurance requirements;
- Carrying out other activities necessary for the design professional's performance; and
- Related auditing of expenditures as required.

7.2.5 Procedures to Amend the Agreement

Changes to the design professional's activities, schedule, and/or compensation are common on most design projects. Therefore, projects proceed more smoothly when the PSA includes procedures for changing the scope of services. These procedures are typically included in the terms and conditions section of the PSA. Such changes should be made in writing and approved by duly authorized representatives of the parties to the agreement except in case of emergency.

Practical procedures for the owner's authorization of amendments can help prevent disputes and delays. Provisions requiring prior top-level approval for each change may conflict with normal working procedures, especially in cases where quick scope changes improve the project. An owner governed by a group or board will benefit by delegating authority for certain types or sizes of contract changes to a knowledgeable representative. This representative works to protect the owner's interest but also expeditiously authorizes changes without breaching the PSA or causing delays. Owners with tiered authority may grant authority to the chief executive for contract amendments with large dollar or schedule impacts, while successively lower level administrators may approve smaller changes. Other owners often approve an initial amount equal to the anticipated costs plus a contingency and allow the owner's project manager to authorize changes as necessary, as long as the modified cost, scope, and schedule remain within the initial authorization. In any event, the owner's procedures affect the design professional's ability to continue during the project, and the PSA should be consistent with the actual procedures.

7.2.6 Other Provisions

Other typical items in the PSA include the following:

- Duration of the agreement;
- Termination of the agreement;
- Authority and responsibilities of parties' designated representatives;
- Ownership and reuse of deliverable documents;
- Insurance to be carried by the design professional and by the owner;
- Confidentiality, publicity, and rights of transmission to others;
- Limits of liability;
- Methods of dispute resolution;
- Assignment, beneficiaries, and severability of the agreement;
- The legal jurisdiction whose laws apply to the agreement; and
- An identification of the general conditions to be incorporated in the construction contract to help avoid conflict or ambiguity with the design agreement.

7.3 STANDARD-FORM AGREEMENTS

Although PSAs are structured for the project at hand, the use of standardized contract language and provisions provides benefits in fashioning the PSA. Standard-form PSAs offer provisions that reflect accepted industry practices, using language that has been tested in court. Standard-form PSAs help the owner and designer allocate risk fairly and set fair terms of compensation as well as reduce the time spent drafting and negotiating the PSA itself.

Sources for Standard-Form Agreements

- EJCDC: http://www.ejcdc.org/
- American Institute of Architects: http://www.aia.org
- ConsensusDOCS: http://consensusdocs.org

7.3.1 Professional Societies and Associations

EJCDC comprises four leading organizations, ASCE, the American Council of Engineering Companies, the Associated General Contractors of America, and the National Society of Professional Engineers. They collaborate to produce standard-form PSAs for use by owners and design professionals, as do the American Institute of Architects (AIA) and ConsensusDOCS. These associations also produce complementary commentaries, bidding and construction contract forms, and related instructional documents.

7.3.2 Government Agencies

Many government agencies at the federal, state, and local levels have their own standard PSAs that incorporate their legal constraints and contracting policies as public project owners. Design professionals benefit from reviewing carefully the terms of such PSA's, which sometimes resemble contracts for the purchase of goods or construction services and can include provisions that are inappropriate for design services. In general, the standard-form PSAs of public agencies that are the most experienced in contracting with design professionals are more helpful in developing professional PSAs.

7.3.3 Owners, Design Professionals, and Constructors

Private organizations that frequently prepare contracts for professional services may develop their own standard-form agreements. In general, these standard agreements are developed unilaterally by the party tendering the agreement. Careful review of the form, contract language, and contract terms is necessary to adapt the agreement for design services to the unique goals and objectives of the project and to provide equitable treatment of both contracting parties. EJCDC, AIA, and ConsensusDOCS standard forms provide a good basis of comparison.

7.4 SHORT-FORM AGREEMENTS

If a project is routine or relatively small and simple, a well-drafted short-form agreement for professional services may be appropriate. Short-form agreements can be

- A letter of understanding—often proposed by one party and countersigned by the other—outlining the essential elements of the agreement;
- A short-form professional services agreement proposed by either party with preprinted contract terms.

The potential time-saving benefit of short-form agreements is appealing. But short-form agreements may be incomplete in their project definitions and may fail to generate mutual understanding between the parties. The use of short forms can be hazardous to both parties if the documents were modeled after contracts originally intended for other purposes.

For example, industrial purchase orders, which are used for procuring goods or minor construction, might seem to simplify contract formation. But purchase orders probably include superfluous language about shipping details or acceptance testing. They typically contain provisions based on Uniform Commercial Code relating to guarantees and indemnification that are not appropriate for a design services agreement. The design professional's errors and omissions insurance may not cover such clauses, and such language may be less advantageous to the owner than appropriate terms and conditions.

Owners and designers who contemplate several similar projects can obtain advantages of short-form agreements by negotiating a single "master agreement." Such agreements outline the division of responsibilities, terms and conditions, general compensation matters, and other items that apply to all projects between the two parties during a specified period of time. The paperwork describing the scope, schedule, fee, and unique owner's responsibilities for each individual project under the master agreement is commonly known as a "task order."

7.5 OTHER DESIGN CONTRACTS

The design of a constructed project may involve other contractual relationships in addition to the prime agreement between an owner and the principal design professional. Whether a project follows the design-bid-build sequence or that of another delivery system, additional contracts also require thorough negotiation and documentation.

The following sections discuss additional types of agreements involving the design professional.

7.5.1 Subconsultant Agreements

When specialized design services are required on a project, the prime design professional often contracts with subconsultants. EJCDC, AIA, ConsensusDOCS, and other professional groups publish standard subcontract forms that assist in negotiating and writing clear agreements with design team subconsultants. For instance, the Council of American Structural Engineers (CASE), a structural consultant group within the American Council of Engineering Companies (ACEC), publishes a series of standard documents, including subcontract forms.

A key advantage of using standard professional society documents is that the language and provisions are consistent among the several contracts necessary for the project. All EJCDC, AIA, and ConsensusDOCS documents are thus coordinated and grouped into related "families" of documents for alternate methods of project delivery. (It is preferable not to mix documents on one project.)

7.5.2 Multi-Prime Agreements

Some owners prefer to contract directly with specialty designers to achieve greater control over the design process and reduce the prime designer's fee. The exploration of subsurface conditions and the analysis of the findings by a geotechnical engineer is one service for which owners often contract directly. The owner thus can directly balance higher costs of more extensive soil investigations with the lessening of potential subsurface surprises. Other specialty design professionals may be advantageous where their services do not impact the main design, perhaps due to separations of space or time. An owner may prefer contractual independence from the prime design professional, as with project peer reviews (see Chapter 22) or value engineering (see Chapter 25).

Less frequently, owners may contract directly with all specialists for a project under an arrangement known as "multi-prime" contracting. In either case, the owner has the opportunity to enhance quality by tailoring the relationship with each design professional to meet the project objectives, rather than relying on fixed standards. However, with more parties, the owner faces loss of sole source responsibility, increased administrative complexity, and cost of coordination with the added required interactions.

7.5.3 Construction Management Contracts

In the construction management method of project delivery, the role of the design professional depends on the agreement between the owner and the construction manager. Because there are many different construction management methods, contracts that clearly define relationships and responsibilities of all parties are necessary for project quality. In some cases, a CM may act as a member of the owner's staff, perhaps even preceding the selection and engagement of the design professional team. The status of this type of construction manager as an intermediary or representative of the owner in dealing with the design professional is formalized subsequently in the professional service agreement. This so-called agency construction manager (ACM) is in a contractual position between the owner and the design professional.

Subconsultant Standard Forms of Agreement

- EJCDC Doc. E-568, *Agreement Between Engineer and Architect for Professional Services,* 2010
- EJCDC Doc. E-570, *Agreement Between Engineer and Consultant for Professional Services,* 2010
- EJCDC Doc. E-564, *Agreement Between Engineer and Geotechnical Engineer for Professional Services,* 2010
- AIA Form C401, *Standard Form of Agreement Between Architect and Consultant*

Additional Standard Form Agreements

- EJCDC Doc. E-530, *Agreement Between Owner and Geotechnical Engineer for Professional Services,* 2010
- EJCDC Doc. E-581, *Agreement Between Owner, Design Engineer, and Peer Reviewers for Peer Review of Design,* 2011

Standard Forms for Design and CM

- AIA Form B132, *Agreement Between Owner and Architect*, Construction Manager-Adviser Edition
- AIA Form B144/ARCH-CM, *Amendment for the Agreement Between Owner and Architect Where the Architect Provides Construction Management Services as an Adviser to the Owner*
- Construction Management Association of America (CMMA) also has a variety of publications covering this area

Another contract alternative, sometimes known as a "construction manager-at-risk," involves the hiring of a firm that could act as a general contractor or could oversee a large number of construction craft trades, each having separate agreements with the owner. The resulting relationships between owner, CM, and constructors are incorporated in detail in the construction contracts. The design professional agreement specifying the designer's related role and responsibilities should, as always, reference the intended construction responsibilities, should be consistent in its description of the design professional's role under the intended CM-at-risk plan, and should be modified if the roles of the participants are revised at any time.

Construction Management Association of America: http://www.cmaanet.org

ConsensusDOCS: http://consensusdocs.org

➢ 3.3 "Construction Management"

EJCDC does not currently publish construction management forms. AIA offers a "CM-Adviser" and a "CM-Constructor" family of forms, and ConsensusDOCS also offers a CM series; either series may be applicable to some engineering projects with considerable care as to the selection of the appropriate set of forms. Firms offering CM services may provide standard forms for engaging designers.

7.5.4 Design-Build, Turnkey, and Developer-Financed Contracts

A design-build project can require two distinct roles of design professionals. The owner might engage a design team to help define the project goals and assemble the design-build procurement package. This design professional can also help the owner evaluate technical proposals and the performance of the design-builder.

Whether or not the above role is filled, there is always a role for the design professional who performs the actual design of a design-build project. This designer-of-record might be an in-house employee or department of the design-build firm or a consultant working for the design-builder.

Design-Build Standard-Form Agreements

- EJCDC Doc. D-505, *Subagreement Between Design-Builder and Engineer for Professional Services*, 2009
- EJCDC Doc. D-500, *Agreement Between Owner and Owner's Consultant for Professional Services*, 2009
- AIA Form B143, *Agreement Between Design-Builder and Architect*

Design-build projects are usually carried out at a faster pace than those under the traditional design-bid-build system. Therefore, quality in a design-build project depends in even larger measure on the owner's commitment to provide sufficient time to formulate, analyze, discuss, and record all the agreements among the parties. With rapidly emerging variations in design-build project delivery systems and similar departures from the design-bid-build approach, there are fewer fixed rules, assumptions, and accepted conventions for the owner and design-build contractor. Therefore, each participant in a design-build project will benefit from making an extra effort to clarify responsibilities.

Four sets of design-build contract forms that are valuable in forming contracts for design professionals on such projects are noted below:

1. EJCDC provides the most complete series, with forms of agreement between the owner and the "Owner's Consultant," as well as between the design-build firm and its design professional.
2. AIA publishes several regular forms that may be suitable for use in design-build contracting by a designer engaged by the owner to prepare what the AIA terms "bridging" documents. AIA form B143 is for an

architect contracting with a design-builder. These forms may also be appropriate on some engineering projects.

3. ConsensusDOCS series 400 forms deal with design-build projects, and ConsensusDOCS Form 420 covers the contract between the design-build constructor and the architect/engineer.
4. The Design-Build Institute of America (DBIA) series 500 publications are standard-form agreements for a variety of contracting arrangements that may be of benefit to the design professional.

ConsensusDOCS: http://consensusdocs.org

Design-Build Institute of America: http://www.dbia.org

Turnkey or developer-financed methods of project delivery are unique to each project. The parties should have legal counsel heavily involved in drafting each of these agreements, and no industry standard forms exist.

7.6 CAUTIONS CONCERNING NON-TRADITIONAL CONTRACTING RELATIONSHIPS

The large variety of types of contracting arrangements for design services provides the owner and design professional with unprecedented flexibility in selecting an appropriate contractual relationship for the project at hand. However, this variety can also create confusion, as it tends to change the traditional relationships in far-reaching and possibly unintended ways, perhaps leading to the inadvertent use of inappropriate language or forms.

7.7 JOINT VENTURE AND PARTNERING ARRANGEMENTS

Two types of documents may also be of benefit to owners and design professionals: joint venture agreements and partnering documents. These are not part of the owner–design professional agreement and should not be permitted to cloud that agreement by any inconsistency therewith.

7.7.1 Joint Venture Agreements

Most design services are rendered as a result of a contract between the owner and the prime design professional, who then may subcontract with other firms for specific design tasks. But in some instances, the design professionals collaborate in a formal joint venture arrangement with each other. Such entities, which are governed by internal joint venture agreements for each project, then contract with the owner. It is common for the joint venture to take the form of a limited liability company (LLC). Such LLCs limit the vicarious liability otherwise present in joint ventures, which are otherwise legally considered a partnership.

Joint Venture Standard-Form Agreements

- EJCDC Doc. E-580, *Joint Venture Agreement Between Engineers for Professional Services*
- AIA Form C101, *Joint Venture Agreement for Professional Services*

A joint venture agreement between design firms is a business arrangement and not a professional services agreement. As a service to engineers who wish to form joint venture relationships, EJCDC and AIA provide standard joint venture agreements. These standard forms should be tailored to the specific project and reviewed by legal experts familiar with local business laws.

7.7.2 Partnering Agreements

➢ Chapter 24, "Partnering"

Partnering is a management process through which members of a project team agree to cooperate and respect each others' roles. While partnering can be a valuable strategy in enhancing project quality, it does not constitute a business partnership or a binding agreement. Partnering agreements (perhaps better termed “charters” to eliminate connotations of legal standing) establish goals and guidelines for project communication and conflict resolution; they are not formal contracts or related documents that establish legal responsibilities. Partnering documents, and the actions of those who partner, are intended to complement the binding terms and conditions of the professional services agreement.

SUMMARY

Professional agreements for design services take many different forms, reflecting the profusion of new organizational arrangements of project teams. For traditional project delivery methods, excellent standard forms prepared by knowledgeable professional associations and organizations and by the most experienced owners offer reliable industry contracting conventions. Some owners may prefer to negotiate professional service agreements that provide them with additional direct control, while other owners prefer the opposite—delegating a larger portion of their traditional functions to the design professional or design-build contractor. For all project delivery systems, sound contracting procedures for professional design services are important to the quality of the constructed project. ❑

Chapter 7: Agreement for Professional Services

Typical Responsibilities—Design-Bid-Build

Responsibility ⇩	Owner	Design Professional	Constructor
Determine the form of the professional services agreement (prime-only, prime-with-subconsultants, multiple-prime)	●	⦿	
Decide if short-form or standard-form agreement(s) are to be used	●	⦿	
Conduct pre-contract negotiations	●	●	
Develop and review scope/schedule/fee sections of agreement	●	●	
Develop and review agreement	●	●	
Provide adequate time for contract review and revision	●	●	
Contract with and manage design subconsultants	●	●	
Coordinate agreement with construction management responsibilities	●	●	⦿

Project delivery methods involving construction managers (CMs) are not included, due to the wide variation of possible contractual relationships. See 3.3, “Construction Management,” for a summary of CM relationships.

● = Primary Responsibility ⦿ = Assist or Advise

Chapter 7: Agreement for Professional Services

Typical Responsibilities—Design-Build

Responsibility ⇩	Owner	Design-Builder
Prepare the design-build procurement package. This may either be in-house or by hired design consultant	●	
Conduct pre-contract negotiations	●	●
Develop and review agreement	●	●
Provide adequate time for contract review and revision	●	●
Contract with and manage design subconsultants	○	●
Coordinate agreement with construction management responsibilities	●	⦿

● = Primary Responsibility ⦿ = Assist or Advise ○ = Review

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CHAPTER **8**

ALTERNATIVE STUDIES AND PROJECT IMPACTS

In this chapter

Major construction projects typically involve the development and study of several alternatives. The evaluation of alternatives requires the cooperative efforts of the owner, design professional, constructor (if available), regulatory agencies, and often the public.

The study of alternatives and evaluation of their impacts can vary greatly, depending on the size and complexity of the project. Large complex projects, which usually require significant resources to study alternatives and impacts, benefit from a structured—and often agency-mandated—program of investigation. Small projects may use a more informal approach to the alternatives study process, but the process still involves a host of decisions, including those related to site selection, schedule, materials, and equipment.

Whatever a project's size or complexity, the project team can improve overall quality by following a systematic process to identify, screen, refine, and select alternatives. Such an approach is virtually a necessity on projects that are subject to federal, state, or local laws that require extensive project impact analysis, documentation, and reporting.

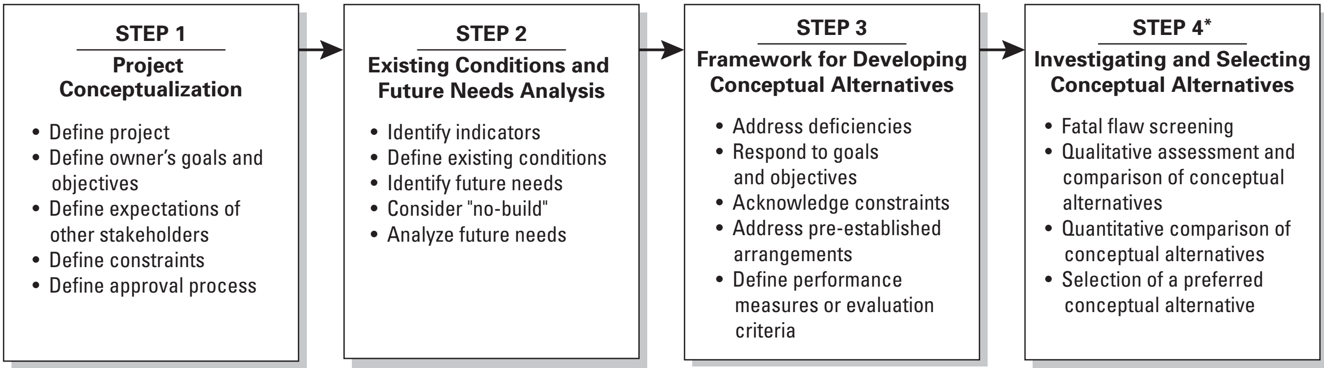
Using a systematic process to develop and select alternatives also helps the project team imagine how people with other perspectives may respond to the proposed project. This is an important aspect of project development, as drastic revisions to accommodate concerns raised during final design or construction are typically more costly and take longer than those raised during conceptual development and preliminary design.

Figure 8-1 summarizes the general steps in a systematic process of studying project alternatives and evaluating associated impacts. These steps provide the project team with a structured approach, yet one that offers sufficient flexibility in tailoring the team's efforts to adequately study alternatives, determine impacts, and make informed decisions. These steps are

1. Project Conceptualization;
2. Existing Conditions and Future Needs Analysis;
3. Framework for Developing Conceptual Alternatives;
4. Investigating and Selecting Conceptual Alternatives.

➢ Chapter 4, "The Project Team"

Figure 8-1 Alternatives Study and Impact Analysis Process



*See Figure 8.2

8.1 PROJECT CONCEPTUALIZATION

The project team begins the systematic process of studying alternatives and impacts with conceptualization. It is critical that the project team develop a clear statement and understanding of why the project is needed. During this step, the owner and design professional (or planning consultant or design-build contractor) establish as the topics for study, the extent of proposed investigations, the level of effort to be expended, reports to be submitted, and the decision-making process. Typical questions that the project team considers at this point include the following:

- Do all parties understand and support the owner's goals and objectives?
- What are the expectations of the owner, design professional, constructor, regulatory agencies, and the public?
- Are there unique or compelling opportunities or constraints that will influence design and construction?
- What agency-required documents, approvals, or permits are needed?
- Are there project constraints related to cost and schedule, physical size, or impacts?

➢ 9.2.3, "Associate Consultants"

The answers to these questions aid the team in prioritizing their activities during conceptualization. This information also assists individual members of the project team in defining their own roles, deciding what types of associate consultants may be necessary, and determining the extent of public and agency involvement.

8.2 EXISTING CONDITIONS AND FUTURE NEEDS ANALYSIS

The project team's understanding of existing conditions and likely future needs is the basis for the development of conceptual alternatives. This information is crucial for presenting the potential benefits and consequences of project alternatives to others involved in the planning process, including fellow team members, agency officials, and the general public.

The project team's selection of relevant indicators of existing conditions and future needs aids in determining the source of future facility demands, potential shortcomings, or new opportunities. The project team also determines what aspects of existing facilities, such as safety, security, capacity, operating efficiency, or maintenance limitations, could be modified or what type of new facilities would achieve the owner's goals and objectives.

Documenting existing conditions is necessary to provide a set of baseline conditions for assessing impacts. It is particularly important to record information that is related to the relevant indicators noted above, as well as environmental conditions.

Common Indicators of Current and Future Conditions

- Traffic
- Air quality
- Noise levels
- Water quality
- Aesthetic and historic impacts
- Number of users
- Overhead or operating costs
- Production rates
- Energy utilization
- Employment and economic impacts

The project team's assessment of future needs is crucial in establishing a no-action, or "no-build," alternative that estimates the impacts on existing and related facilities if the proposed project is not built. The no-build alternative serves as a baseline against which "build" alternatives are compared. This analysis often provides vivid examples of a project's potential benefits and further aids the project team in developing alternatives.

In some cases, the analysis of future needs involves issues that are not directly related to the existing or proposed facility itself. These may include changes in regulatory policy, land use, transportation systems, environmental protection regulations, pending legislation, or forecasts of changes in demand.

8.3 FRAMEWORK FOR DEVELOPING CONCEPTUAL ALTERNATIVES

After developing an understanding of existing and future conditions, the project team begins forming a framework for developing conceptual alternatives. This framework includes basic planning and design guidelines, policy guidelines, user preferences, public attitudes, environmental regulations, sustainable development issues, and other criteria. On public projects, the team should solicit user agency and public involvement in forming the framework; on private projects, the owner may seek input from those who will use, manage, and maintain the facility, as well as public involvement.

Conceptual alternatives, by their nature, are broad and developed only to a level of detail that provides an understanding of their potential ability to address the owner's goals and objectives. Typical conceptual alternatives include variations on a facility site and footprint, generic structure types, alternative modes of transportation, and generic construction materials and techniques.

At a minimum, a framework for developing conceptual alternatives should include the following considerations:

- Deficiencies in existing facilities and/or the need for new facilities;
- Responsiveness to the owner's goals and objectives;
- Acknowledgments of constraints related to applicable public policies, zoning restrictions, land uses, permits, financial resources, and laws;

- Addressing of pre-established arrangements among participants and affected parties;
- Analysis of functional efficiency, technical accuracy, cost-effectiveness, reasonable constructability, ample safety measures, environmental propriety, sustainability, and aesthetic elegance.

The development of conceptual alternatives is a collaborative process involving many participants and iterations of concepts. The process benefits from group brainstorming and a wide range of input, as well as individual efforts. Different organizations take different approaches to developing alternatives, depending on their professional strengths and experience. The appropriate number of alternatives can vary widely. Some projects can be investigated sufficiently with just one alternative (the no-action), while other projects may involve dozens of alternatives.

8.3.1 Achieving Quality

Given these variations, the constants for ensuring quality during the development of conceptual alternatives are the following: promoting good communication and coordination among participants; developing clear definitions of critical performance measures and evaluation criteria; and involving the public in the conceptual development phase to enhance the acceptance of the planning process.

8.3.2 Project Design Guidelines

The owner's goals and objectives for the project are an integral part of the alternative formulation process. These goals may be fairly easily specified quantitative design parameters, such as a specific loading for a bridge, or required flow rate and water quality for a wastewater treatment plant.

But the owner's goals and objectives can also be more qualitative in nature. The owner may only have a general idea of what the constructed facility should look like or how it should operate. In these cases, the project team at this stage should develop a set of basic design guidelines to refine the project goals. The guidelines may involve the preparation of studies to evaluate alternative concepts. The design team reviews the alternatives with the owner to reach agreement on the design approach that best meets the owner's goals and objectives within the project budget.

Viable design guidelines must comply with federal, state, and local codes and regulations. In some cases, regulatory agencies influence the investigation of alternatives and the design approach. It is important that discussions which include the owner, design professional, and regulatory agencies be initiated early in the design development effort and continue through final design to avoid unnecessary delays or surprises during the agency approval process.

Based on the clear understanding and agreement about the owner's goals, objectives and design approach, the project team develops specific project design guidelines to be used in the further development of the project. The agreement of the owner on the expected results of the design—and the documenting of this agreement in writing—is a fundamental step in ensuring project quality.

8.4 INVESTIGATING AND SELECTING CONCEPTUAL ALTERNATIVES

As new alternatives are formulated, the project team examines the merits and shortcomings of each, moving toward the selection of alternatives that merit more extensive analysis. Therefore, the selection of alternatives that meet the project objectives depends on the team's success in defining and forming a consensus on the evaluation criteria.

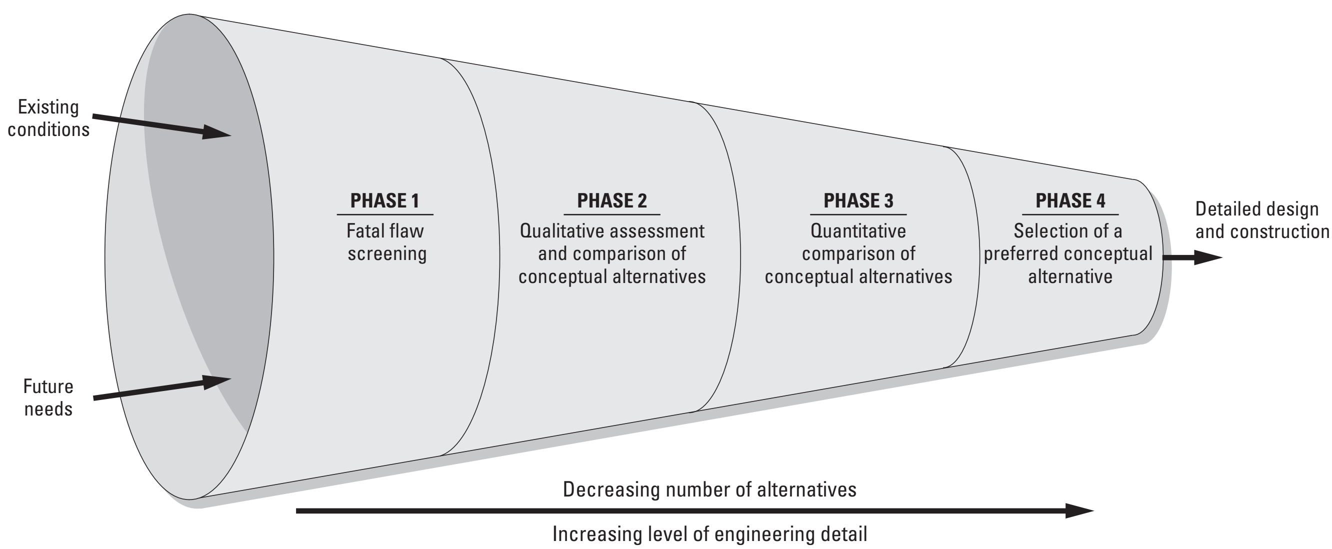
The team applies increasing analysis and scrutiny to the alternatives as the process proceeds.

Figure 8-2 describes the investigation and selection of conceptual alternatives in four general phases:

1. Fatal flaw screening
2. Qualitative assessment and comparison of conceptual alternatives
3. Quantitative comparison of conceptual alternatives
4. Selection of a preferred conceptual alternative

As the project team proceeds through these phases, increasing analysis and scrutiny are applied to the alternatives. As a practical matter, the detailed investigation of every possible alternative is neither cost-effective nor productive. Therefore, discarding those alternatives with less promise early on helps ensure that the team can focus project resources on the engineering, environmental, and cost evaluations for the most viable alternatives. During this process, the team also identifies and incorporates improvements to the alternatives under consideration.

Figure 8-2 Investigation and Selection of Conceptual Alternatives



8.4.1 Phase 1: Fatal Flaw Screening

➢ 2.2, "Project Goals"

➢ 2.4, "Establishing Project Objectives"

During the first phase of investigating alternatives, the project team applies fatal flaw screening to the conceptual alternatives developed. This allows the project team to discard those that are unfeasible or undesirable with respect to the owner's goals and objectives.

During fatal flaw screening, the team gets a better sense of the types and number of alternatives that merit further examination, as well as the extent of the planning and design effort necessary to carry out the evaluations competently. Fatal flaws may be the result of resource limitations, regulatory requirements, environmental protection laws, public or worker safety laws, technical limitations, owner preferences, or other factors.

➢ 2.4.1, "Private Owners"

➢ 2.4.2, "Public Owners"

➢ 8.6, "Public Involvement"

On public projects, it is recommended that the project team clearly document and inform the public about how and why certain alternatives are discarded. In some cases this may be a legal requirement, for NEPA, for example. This is important to minimize the impact of future legal disputes by citizens and/or affected parties. Private owners may need to follow the same strategy.

8.4.2 Phase 2: Qualitative Assessment and Comparison of Conceptual Alternatives

Sustainable Development: The consideration of sustainable development impacts—the environmental and societal effects of natural resource depletion and waste management—is integral to any constructed project.

☞ ASCE Policy Statement 418, The Role of the Civil Engineer in Sustainable Development

☞ U.S. Green Building Council: http://www.usgbc.org

☞ *Environmental Building News:* http://www.buildinggreen.com

☞ U.S. EPA Resource Conservation and Recovery Act (RCRA): http://www.epa.gov/rcraonline

☞ Context Sensitive Solutions (CSS): http://www.fhwa.dot.gov/context/index.cfm

In the second phase, the project team develops more refined engineering information for the surviving alternatives. The scope of study and effort vary considerably with each project, but in most cases the level of engineering detail is still considered "conceptual" and does not approach the generally accepted completion threshold for "preliminary" design of 10 percent.

While the project team continues to compile more information on the alternatives, Phase 2 evaluations tend to remain qualitative in nature. Ideally, the alternatives investigated provide the project team with a range of information, including potential project performance, schedule, security issues, aesthetic appearance, life-cycle costs, cost-benefit ratios, sustainable development elements used, socioeconomic benefits, and environmental impacts.

Although most of these measures are identified during early project planning, changes during this phase of investigating alternatives are not uncommon. Therefore, the owner and design professional benefit from incorporating enough flexibility in the scope and terms of their contractual agreement to allow them to adapt to changing conditions.

Project alternatives may vary widely in type and complexity. In general, alternative studies involve exploring the impact of manipulating variables that are significant to the project. The significance of variables is different for each project; for example, the impact of schedule variations is apt to be less critical on small, private projects than on major commercial or public endeavors.

Phase 2 Alternative Types and Variables

Alternative Type	Phase 2 Study Variables
Scheduling	• Compressed schedules, which can be an advantage in short construction seasons. • Time value of money in relation to bringing a commercial enterprise into service. • Construction schedules required by regulatory authorities to address environmental concerns that may range from mitigating traffic congestion to protecting the breeding and migration of sensitive species.
Alternate Concepts or Layouts	• Site locations and configurations. • Safety and security. • Alignments within a transportation or utility corridor. • Drainage methods. • Structural systems and materials. • Construction methods.
Construction Phasing	• Completion of the project in phases so portions of the facility can begin generating revenue sooner. • Spreading out construction activities over a longer period to reduce the magnitude of their impact on abutters or the environment.
Minimum Build	• Exploration of the minimum amount of constructed improvements that could be undertaken (although such strategies typically involve a degree of compromise in the project goals).
No-Build	• A default study inherent in every project that helps answer the question, "What happens if we don't build this project?"

In Phases 1 and 2, costs are typically expressed as "order of magnitude" estimates based on the costs of similar engineering and construction projects. Detailed cost estimates cannot be provided during this phase, as their development requires detailed engineering data—most of which has yet to be developed. Therefore, during the study of conceptual alternatives it is important that the project team focus on the relatively large differences in cost rather than small ones.

➢ 11.3.1, "Design Considerations"
➢ 11.3.4, "Construction Costs"

Although qualitative, Phase 2 analysis is closely tied to the evaluation criteria and target performance measures established previously by the project team. Depending on the potential of the alternatives to meet project needs, the project team selects the alternatives to be carried forward into Phase 3.

8.4.3 Phase 3: Quantitative Comparison of Conceptual Alternatives

In Phase 3, the project team performs engineering analyses on the remaining conceptual alternatives to a level sufficient to ensure that the elements can function. This degree of engineering detail also provides information for the quantitative assessment of each alternative and its consistency with established criteria and performance measures.

Examples of items that may be analyzed in Phase 3 are shown below:

Functional Alternatives	Cost Alternatives
• Safety and security	• Design cost
• Materials handling methods	• Capital cost of construction
• Traffic flow arrangements (patterns in air, water, land, people, or products)	• Operation and maintenance costs
• Types of travel modes (vehicle type, size, style)	• Life-expectancy or design-life periods
• Methods to provide fish passage at barriers in waterways	• Return on investment
• Space allocations	• Project phasing (initial opening or operating segments)
• Clear-span requirements in buildings	• Extra cost for aesthetics
• Public/private (joint development) options	• Cost-benefit ratios
• Methods to avoid or minimize impacts to the natural environment	

The project team develops quantitative data (based on more detailed engineering) on such features as utilities, construction costs, rights-of-way, safety, security, aesthetics, environmental and sustainable development compatibility and impacts, technical feasibility, constructability, construction sequencing, phased implementation, and risk.

Cost estimates for the conceptual alternatives during Phase 3 are refined from those developed earlier to reflect the more detailed information available on quantities of materials, construction methods, and schedule. However, a host of variables remain to be considered before the project team can develop a more realistic cost estimate. These variables include labor and material costs, the competitive climate among constructors in the local market, site conditions, the final scope of the project, and the schedule (including potential project phasing). Therefore, the evaluation of cost during Phase 3 remains focused on the relative differences among the conceptual alternatives.

Ordinal ranking can be a useful tool in Phase 3 conceptual alternative evaluations. In ordinal ranking (Figure 8-3), the project team develops a weighted numerical value system, with categories that reflect key aspects of the owner's goals and objectives. For example, on a project to reconstruct and expand an

Figure 8-3 Ordinal Ranking Example

Comparison Considerations	Scale Value (3 to 30)	Relative Rating/Value					
		Alternative 1		Alternative 2		Alternative 3	
		Rating (3 to 10)	Unit Value	Rating (3 to 10)	Unit Value	Rating (3 to 10)	Unit Value
Traffic Operations/Safety	10	3	30	5	50	10	100
Phased Implementation Expandability	10	5	50	10	100	6	60
Environmental and Community Impacts	5	10	50	4	20	8	40
Constructability	5	4	20	6	30	10	50
Construction Costs	5	3	15	6	30	10	50
Right–of–way Requirements	10	10	100	4	40	6	60
Compatibility with Public Transportation	10	10	100	3	30	4	40
Compatibility with Pedestrians/Bikes	5	5	25	10	50	8	40
Local Access and Circulation	15	8	120	6	90	10	150
Satisfies Operational & Design Requirements	10	10	100	3	30	5	50
Compatibility with Other Elements	10	7	70	10	100	5	50
Funding Feasibility	5	3	15	10	50	4	20
Total Scale Value	**100**						
Total (Index Value)			695		620		710

existing interchange, construction sequencing and maintaining traffic during reconstruction may be more critical than the amount of property to be acquired. The project team makes a quantitative comparison of the alternatives and assigns a numerical rank within the established range and weighting system for each category to each alternative. Ordinal ranking is a blend of qualitative and quantitative techniques, and while helpful, its value depends highly on the positive correlation of the ranking categories and the owner's goals and objectives.

8.4.4 Phase 4: Selection of a Preferred Conceptual Alternative

Engineering evaluation is a crucial, but not the only, factor in the selection of a preferred alternative. Community and agency involvement programs, environmental impacts and mitigation measures, and public policy may influence the alternatives considered, as well as the selection of a preferred alternative.

In general, the preferred alternative is the one that best balances competing objectives of the stakeholders in the project. The project team's functional evaluation of alternatives during Phase 3 provides the basis for their recommendation of a preferred alternative.

In the end, no matter how closely the members of the project team may have worked during the preceding three levels, the principal activity of Phase 4—selecting a preferred alternative—is the responsibility of the owner (or lead regulatory agency if a permit or federal funding is involved). In some cases, the owner may present two or more alternatives to a public agency, such as a metropolitan planning organization, for final selection.

Following adoption of a preferred conceptual alternative, the project team begins developing preliminary and final design drawings, specifications, a construction schedule, and an opinion of probable construction cost.

8.5 ENVIRONMENTAL DOCUMENTATION AND PERMITTING

The study of project alternatives and impacts is often closely tied to environmental documentation and permitting processes regulated by government agencies. Agency environmental regulations can consume a significant portion of the project team's effort during the study and evaluation of alternatives. Since 1969, when the U.S. Congress passed the National Environmental Policy Act (NEPA), public awareness and interest in the environment has increased. The act also sparked new sensitivities about the potential impacts of constructed projects. Environmental documentation and permitting processes are an important means of demonstrating potential project impacts and compliance with environmental law.

More than a dozen laws form the basis of the U.S. Environmental Protection Agency's programs.

http://www.epa.gov/lawsregs

8.5.1 Types of Environmental Impacts

Every constructed project affects its surrounding environment in some way. It is critical that the project team adhere meticulously to prescribed environmental evaluation processes; flaws in legally mandated environmental reviews can be the subject of litigation that can slow or derail a project. When developing alternatives, the owner and design professional need to address a wide range of environmental considerations, including impacts on

Environmental Impact and Related Procedures, Code of Federal Regulations (CFR) 23, Part 771

National Environmental Policy Act (NEPA) planning guidelines, 40 CFR Chapter 5

- Wetlands and water quality;
- Aquatic and wildlife resources;
- Farmlands;
- Human health;
- Scenic vistas;
- Navigable waterways;
- Natural streams or bodies of water;
- Natural vegetation, including forests;
- Cultural resources, including historic and archaeological features;
- Topographic features;
- Traffic congestion;
- Air quality;
- Noise and vibration;
- Waste management (including materials recycling and reuse).

Socioeconomic conditions are also considered part of the environment by many regulatory agencies. Therefore, the project team benefits by performing an evaluation of project impacts on the fabric of the community. These issues may include the following:

Environmental Justice: Assessing impacts on minority and low-income populations

Executive Orders 12898 (1994) and 13148 (2000)

- Residential or business displacements;
- Effects on property values and/or business vitality;

- The quality of life during and after construction in nearby residential neighborhoods and public/private institutions;
- The potential for disproportionate negative impacts on low-income or ethnic communities;
- Sustainable development concerns.

8.5.2 Permits

The project team is often required by federal, state, and local agencies to demonstrate the ability to mitigate potential environmental impacts during the process of obtaining the permits that are required before the start of construction. In addition to routine building and occupancy permits, some federal, state, or local permits or approvals may be required that are specifically related to the project's impact on the surrounding environment.

Types of Permits (partial list)

- Federal—U.S. Army Corps of Engineers Section 404, Section 4(f)
- State—Access permits to state highways
- Local—Planning and zoning approvals for development and design review

Before granting permits, agencies usually require the owner to submit documentation showing that potential environmental impacts have been evaluated and that appropriate measures to control and mitigate adverse effects will be implemented during construction and operation. Therefore, the project team benefits from involving permitting agencies in the project as early as possible to gain a full understanding of permitting procedures.

8.5.3 Documentation

Many states have specific environmental regulations that specify the type of documentation necessary to evaluate a proposed project's impacts. Most state environmental regulations have been promulgated since passage of NEPA and adopt a similar approach to environmental evaluation.

Types of Environmental Documentation (partial list)

- Environmental Assessments (EA)
- Environmental Impact Statements (EIS)
- Federal and state historical and preservation clearances
- Cultural resource clearances
- Threatened and endangered species studies

When owners understand that some projects or alternatives may be subjected to a potentially extensive federal, state, and local agency approval process, they can develop an appropriate approach to project-specific alternative studies. Early and active consideration of these matters by the owner, design professional, and other advisers can help determine what federal, state, or local laws and regulations apply to the proposed project. Once this is determined, the project team can identify the appropriate reviewing agencies and develop a strategy for providing the information these groups need to review and approve the project.

8.6 PUBLIC INVOLVEMENT

The coordination of public involvement with the process of studying alternatives is an essential—and often legally required—component of constructed projects. Public involvement may range from informal one-on-one meetings with people affected by construction to extensive programs that involve workshops, open houses, public hearings, and media relations.

The project team benefits from determining overall public involvement needs early in the planning process, usually as the project goals are taking shape. The guidelines for producing federal and state environmental documentation address public participation, such as hearings and other outreach activities, plus agency review and comments.

Agencies, elected officials, planning and zoning boards, commissions, and quasi-public authorities can wield considerable influence in project-related environmental decisions. Team members can make a considerable contribution to project quality by informing these parties early and regularly about project developments. Even if there are few new developments, regular updates demonstrate to the community the project team's commitment to quality.

Public Involvement Strategies (partial list)

- Workshops
- Visioning or brainstorming sessions
- Citizen advisory committees
- Open houses
- Focus groups
- Collaborative (multi-party) task forces
- Media outreach
- Internet websites
- Meeting facilitation
- Telephone surveys
- Videotapes/cable television programs

Public involvement is tailored to meet the participation needs of the project as it progresses. During the planning process, public involvement efforts tend to focus on building a consensus and obtaining the necessary approval to begin design and construction. Later, when construction actually begins, public concerns tend to turn toward traffic and environmental impacts in the immediate area of the project.

Therefore, workshops are often an appropriate forum for gathering public input during conceptual planning. Public hearings and abutter meetings are better suited to later phases of the planning process, when there are specific alternatives or plans to which the public may react.

Coordinated media relations also contribute to project quality. The project team benefits by designating one person—often a representative of the owner—to act as spokesperson and respond to media inquiries. Proactive efforts with the media are critical, especially in cases where road closures or other large-scale impacts make it impractical to contact every potentially affected party.

SUMMARY

The study of alternatives and impacts is common to constructed projects. Regardless of a project's size, a systematic approach to this process helps improve overall quality. Successful project teams generate a relatively wide range of potential solutions, screen out those with the least potential to meet the owner's goals, and apply engineering refinements to those alternatives with the greatest potential to successfully meet those goals. While the project team works together to produce a preferred alternative, the owner (or others to whom they may be obligated, such as a regulatory agency) is responsible for choosing the final alternative.

The project team in close coordination with the owner investigates design alternatives and then develops project design guidelines for the owner's review and approval based on the selected alternative. The project team also reviews the design guidelines with regulatory agencies when appropriate.

The success of the process of studying alternatives hinges on the skill of the project team in generating and evaluating the level of detail that is appropriate during each phase of analysis. Getting the right level of information at the right time applies not only to project engineering activities but also to agency and public involvement as well. ❏

Chapter 8: Alternative Studies and Project Impacts
Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor	Design-Builder
State goals and objectives	●			
Develop project conceptualization		●		●
Prepare existing conditions and future needs analysis	⦿	●		●
Implement framework for developing conceptual alternatives		●		●
Select a preferred conceptual alternative	⦿	●		●
Manage environmental documentation and permitting	⦿	●		●
Coordinate public involvement	●	⦿		⦿

**For a design-bid-build situation. In a design-build situation, the Design Professional is part of the Design-Builder team.*

● = Primary Responsibility ⦿ = Assist or Advise

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CHAPTER 9

PLANNING AND MANAGING DESIGN

In the design phase, the owner's goals and objectives for the project that were established during the conceptual phase take form as team members prepare the contract documents. Planning and managing the design effort involves organization, direction, control, and coordination, all of which are essential to achieving quality.

The complexity of the design effort varies with each project. This chapter describes a general process for planning and managing design that may be condensed for small projects or expanded for larger ones.

In this chapter

9.1 ORGANIZING FOR DESIGN

After developing a clear understanding of the owner's goals and objectives, the design professional prepares the design activity plan. This plan may take the form of an arrow diagram or flowchart identifying the activities required to deliver contract documents to the owner. The plan identifies the relationships among the various activities required for completion of the design and estimates the duration of each activity and associated staffing and labor. With a design activity plan, milestones can be set and related design costs defined. This information reflects the scope of services as outlined in the solicitation for professional services, or as modified in the alternative studies phase, contract agreement, and corresponding schedule and budget. A detailed list of activities assists in identifying necessary team members and areas of expertise, as well as in providing direction in establishing project record-keeping requirements.

9.1.1 Initiating Design (Start-Up)

Design efforts should begin with a design team meeting during which the design team leader reviews the owner's goals and objectives for the project with other design team members. The design team then reviews the scope of work and discusses the relationships among various tasks in the scope, the deliverable for each task, and the budget for each task. The team develops extensions of the design activity plan for achieving the goals and objectives within the established schedules and budgets. The meeting also provides an opportunity for the design team to confirm their ability to fulfill the responsibilities of the design effort.

Typical Phases of Design

1. Start-up
2. Production
3. QA/QC
4. Close-out

Upon securing the commitment of the design team, the design team leader meets with the owner to review the design schedule. If the owner requests a revision in the design schedule or deliverables, the design team leader reviews these changes with the design team for possible conflicts before starting design activities.

The ability to meet schedule commitments and remain within budget is directly related to the performance of both the design team and the owner. It is the owner's responsibility to provide the items specified in the owner-design professional agreement, including timely review and appropriate comment on submittals by the design team.

9.1.2 Producing Design Documents

The design team, under the direction of the design team leader and with the owner's review, produces the construction documents. These construction documents typically include as a minimum, project drawings, project specification, and construction cost estimate. To accomplish this, the design team leader develops a design activity plan, which serves as the guide for successful design completion.

Design team members discuss deviations from the design activity plan with the design team leader. The design team leader then evaluates changes that may be needed to ensure that the schedule and budget can be maintained while meeting the project goals and objectives and fulfilling contractual responsibilities to the owner. The design team develops recovery measures to keep the design effort on schedule and within budget. These measures may include staffing adjustments, overtime, use of associate consultants, and/or modifications to the original schedule and budget.

9.1.3 Quality Control

➢ Chapter 20, "Quality Assurance and Quality Control"

The design professional (or in-house design team) can help ensure project quality through several activities, including

- Developing a scope of services that meets the owner's requirements and the project goals and objectives;
- Developing a design activity plan for the project;
- Reviewing and confirming project design guidelines;
- Estimating accurately the hours of effort and costs involved to achieve a quality design;
- Developing and adhering to a schedule of QC design reviews, audits, and progress reporting as appropriate for internal control within the design team;
- Building flexibility into the design activity plan to allow for changes and future project development, as well as associated budget and schedule revisions;
- Developing a realistic schedule with appropriate milestones to confirm progress;
- Monitoring design progress constantly.

➢ 9.2.4, "Quality Control Reviewer"

One of the most important things the design team leader can do to ensure quality is to make sure that the team includes personnel who are experienced and knowledgeable in the assigned tasks and to make these personnel available to complete the necessary tasks. The design team leader also benefits from assigning an appropriate number of staff for the tasks at hand. Assigning too many or too few staff members can result in inefficient resource utilization or staff "burnout" from excessive overtime.

In addition, the design team leader can promote quality by assigning the responsibility for gathering site information and completing field surveys to experienced survey professionals. These survey professionals benefit from the use of a standardized checklist to investigate known or unknown buried structures, the capacities of existing utility lines and drainage facilities, and other site conditions that affect design and construction.

9.1.4 Design Close-Out

Design close-out is the process of completing scope of service items and archiving drawings, records, and as-built documentation. Design close-out activities provide an excellent short-term opportunity for the design team, associate consultants, and design team leader to ensure that the project design as described in the contract documents has been completed successfully. Design close-out also provides long-term benefits by assisting with the archiving of information for future reference by the owner.

➢ 16.3.7, "Project Close-Out"

Design close-out activities generally follow the steps below:

➢ 9.2.3, "Associate Consultants"

1. Design team members and associate consultants organize and submit their work to the design team leader.
2. The design team leader reviews the submittals for completeness.
3. The design team leader conducts a post-design and post-construction interview with the owner and constructor and completes the design portions of the project close-out checklists.
4. The design team leader ensures that design submittals are archived in accordance with the project design plan.

9.2 THE DESIGN TEAM

Assembling a qualified team that is specifically suited for the project is the first and most important step in ensuring design quality. Project design quality and completed project quality are directly related to continuity of the design team throughout the life of the project.

9.2.1 Design Team Leader

The design team leader is the key contact person for the design team. This person is responsible for accurately understanding the owner's goals and objectives for the project, relaying them to design team members, and making sure that they are addressed and/or incorporated in the design. To accomplish these general responsibilities, the design team leader conducts or monitors the following activities:

Project quality is directly related to continuity of the design team.

- Defines the project scope of work and expectations.
- Develops a design budget that reflects the resources and organization necessary to perform the work.
- Develops a design team staffing plan to include personnel with the necessary technical expertise and availability.

- Develops a design schedule that allows design review and construction to be successfully completed within the total amount of time available to complete the project
- Reviews and confirms the project's design guidelines.
- Establishes quality control (QC) procedures within the design activity plan.
- Develops assignments for the design team.
- Develops checklists for the contract documents and deadlines for the completion of design activities.
- Coordinates development of the project procedures.
- Manages the design team's performance, budget, schedule, and decision-making.
- Updates contract agreements necessitated by scope changes, schedule delays, or other events.
- Schedules in-house and owner reviews.

These responsibilities allow the design team leader to monitor overall progress of the design effort and identify potential problems in a timely manner.

9.2.2 Design Team Staff

Design team staff members are responsible for understanding and carrying out the necessary design tasks. These tasks may vary in scope and complexity, according to the goals and objectives of the owner. The design team staff usually includes experienced engineers, CAD drafters, architects, structural specialists, and administrative support personnel.

9.2.3 Associate Consultants

The design team may include associate consultants, often known as subconsultants, in the design process. Associate consultants are typically responsible for

- Developing a clear understanding of the owner's project goals and objectives and the overall design plan;
- Communicating specialized design activities to the design team leader;
- Leading design team efforts in a specific discipline.

If associate consultants do not have an opportunity to assist in developing the scope of services or if they are not consulted in a timely manner when problems arise, the quality of project design elements involving multiple disciplines may suffer.

9.2.4 Quality Control Reviewer

The quality control reviewer is a member of the design team who is responsible for monitoring the quality control activities. The quality control reviewer should be highly experienced in the aspects of the project design and not involved in the day-to-day design activities. This person should attend the start-up and close-out meetings and meet with the design team leader several times during the project to critically review the following:

- Design concept approach;
- Schedule compliance;
- Key decisions to be made;
- Anticipated and actual changes in the scope of work;
- Issues for resolution;
- Report on quality control reviews.

9.3 CONSTRUCTION COST ESTIMATE

Included in the design process is the refinement and completion of the construction cost estimate for the project. This process continues from the initial construction cost estimate developed during the alternative studies phase. The construction cost estimate is prepared during design for the purposes of budgeting, evaluating bids, and serving as guides in conducting negotiations and in establishing a schedule of payments during the construction phase. Cost estimates should be as accurate as possible, based on the latest design data and site information available, and should reflect the current fair market value of the local project site area. Typical construction cost estimates reflect the anticipated cost at the midpoint of the construction phase.

9.4 COORDINATION AND COMMUNICATION DURING DESIGN

The design team leader is responsible for keeping the owner and other design team members up-to-date on the status of the design progress. Monthly progress reports to the owner, with copies to members of the design team, are a typical means of accomplishing this. Complex or fast-moving projects may benefit from more frequent reporting. Design progress reports describe the meetings held and work accomplished during the reporting period and the activities scheduled for the upcoming reporting period. Design problems should be identified as early as possible so that potential conflicts with the established scope, budget, or schedule may be resolved. Depending on the resolution, the design team may need to revise the design plan.

As most projects involve more than one design discipline, the design team benefits from regular meetings. These meetings offer team members the opportunity to familiarize themselves with overlapping aspects of the design process.

Though each team member may be dedicated to achieving the design guidelines, conflicts may arise. The team benefits from resolving such conflicts quickly and at the lowest level of the organization possible. But if the proposed solution conflicts with the owner's goals and objectives for the project, the design team will benefit from meeting with the owner to discuss the conflict and devise appropriate solutions.

9.5 MONITORING AND CONTROLLING DESIGN COST AND SCHEDULE

Design costs are typically 5% of the life-cycle cost of a project, yet design is the single most important influence on project cost and quality.

The design team leader regularly monitors reports that reflect budgeted and actual expenditures. The information in these reports allows the design team leader to evaluate design progress to date and identify potential problems. If additional design services not specified in the professional services agreement are necessary to correct problems and meet overall project goals, it is in the project's best interest for the design team leader to communicate this information to the owner immediately and negotiate for the additional services.

A design activity plan typically includes milestone and submittal dates for the design progress reports. The owner's timely review and approval of interim submittals are important activities in maintaining the project schedule. Interim submittals offer the owner the opportunity to review design activities at a point in the design process when budgets and schedules can more easily accommodate change.

SUMMARY

During the design phase of a project, the relationship between the design professional and the owner is crucial. The professional services agreement between these two parties is the key document in defining this relationship along with the owner's goals and objectives for the project.

The owner benefits by furnishing the information specified in the agreement, as well as other assistance, in a timely manner. The owner monitors design activities by reviewing and approving contract documents, progress reports, and other submittals, which provide the opportunity for prompt decision making.

The design team leader, supported by the design team, organizes the overall design effort. This includes providing experienced and knowledgeable staff, developing appropriate design tasks, and monitoring the performance of the design team. The design team leader manages the design effort and communicates with the owner on matters affecting design progress, schedule, and budget.

Good design planning and management can reduce or eliminate the surprises and unexpected events that can adversely affect project quality. ❏

Chapter 9: Planning and Managing Design
Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor	Design-Builder
Initiate design start-up	○	●		●
Produce contract documents	○	●		●
QA/QC	○	●		●
Design close-out	○	●		●
Select design team staff	○	●		●
Coordinate and communicate during design	○	●		●

**For design-bid-build situation. In a design-build situation, the Design Professional is part of the Design-Builder team.*

● = Primary Responsibility ○ = Review

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CHAPTER **10**

DESIGN DISCIPLINE COORDINATION

In this chapter

This chapter discusses the coordination of multiple design disciplines, drawing examples from three types of projects: engineering design; architectural design; and design-build. Variations on these three types of multidisciplinary projects, as well as different delivery systems, form the growing variety of options available to project owners to meet the goals and objectives of their projects.

This chapter presents representative examples of multidisciplinary design interrelationships. The relationships of various design disciplines vary with the actual contractual responsibilities established for each project.

10.1 LEVELS OF DESIGN DISCIPLINE ORGANIZATION

There are typically three levels of design organization on multidisciplinary projects: the team leader, the lead discipline practitioners, and the contributing discipline practitioners.

10.1.1 Design Team Leader

The design professional designated as the leader of the design team has the primary responsibility to the owner for meeting the project's design objectives and for staffing the design team with individuals and subconsultants who are qualified and experienced in the lead and contributing technical disciplines.

The design team leader directs practitioners from each design discipline who integrate their technical knowledge with that of the other disciplines toward satisfying the project objectives. With alternate delivery systems, this coordination may require some short-term compromises in efficiency and cost so that design issues can be adequately explored. The design team leaders also resolve conflicts among technical discipline professionals. The design practitioners within each discipline must consider the safety of the user, the public, and the environment as they work with colleagues in other disciplines who are also striving to meet these objectives.

10.1.2 Lead Discipline Practitioners

These design professional members of the design team typically supply the technical expertise and carry out the design effort in areas of design, such as architectural, structural, site civil, mechanical, and electrical engineering design. They are also responsible for coordinating their services with other discipline practitioners on the project.

10.1.3 Other (Contributing) Discipline Practitioners

Other disciplines typically contributing to the lead designers include geotechnical investigation and analysis, materials testing, surveys, environmental, and hydrologic analysis. These disciplines may also include specialized fields, such as urban planning, landscaping, and traffic analysis, as well as scheduling and estimating.

The services and coordination of all discipline practitioners usually continue beyond the completion of the construction contract documents. During the construction phase of the project, they may be called upon, under the terms of the professional services agreement (PSA), to interpret the implementation of the design by the constructor.

10.2 DESIGN DISCIPLINES AND PROJECT OBJECTIVES

The requirements and responsibilities of the team members from each design discipline involved depend on the type of project proposed, the project objectives, and the associated contractual relationships. The following sections present examples of three different general project organizational concepts and contractual relationships:

1. Engineering design projects,
2. Architectural design projects,
3. Design-build projects.

These types of projects often involve design delegation, a relatively prevalent practice in most forms of civil construction under which the design of a portion of the permanent project work is delegated to the constructor or specialty subcontractor. This entity typically engages a design professional to produce a design that is consistent with a preliminary or conceptual design that is furnished by the project's prime design professional.

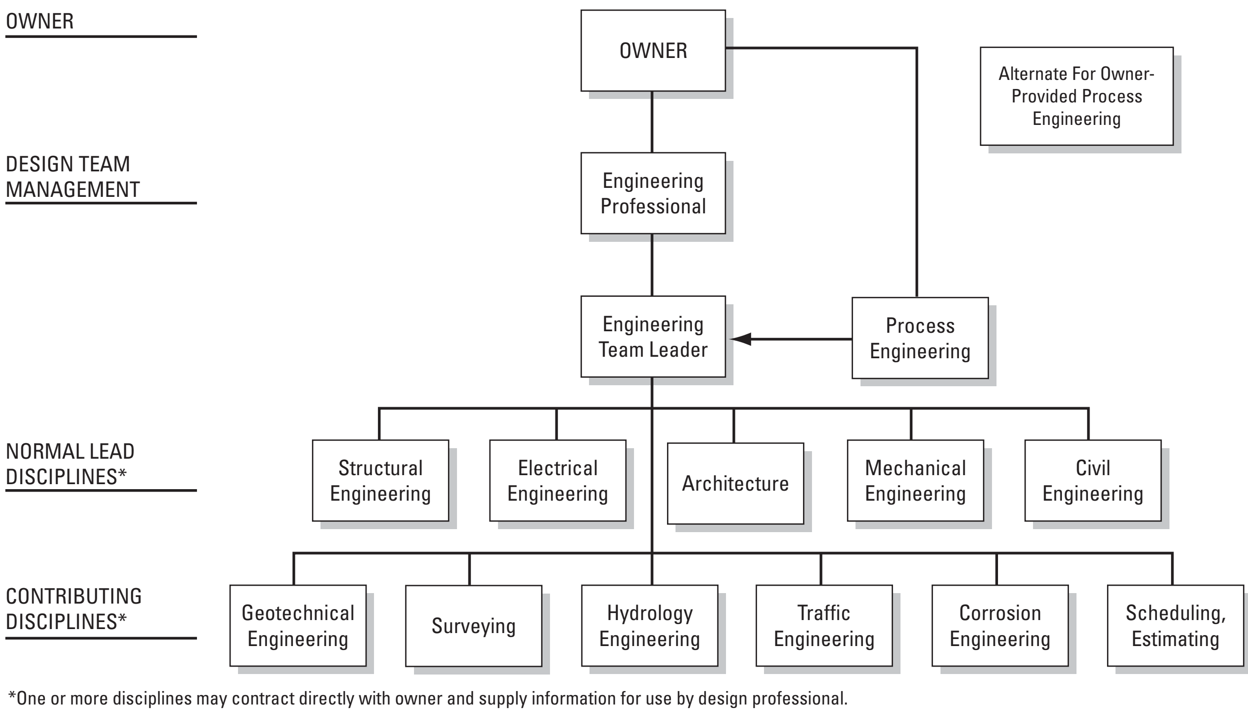
10.2.1 The Engineering Design Project

The objectives of an engineering-oriented project are usually determined by the functional objectives or owner-specified requirements of the completed project. Engineering projects (see Figure 10-1) include private facilities such as industrial plants and railroads, and public infrastructure such as wastewater treatment facilities, roads and highways, or transit systems. The design team leader for the engineering project usually has expertise directly applicable to the project. For example, mechanical engineers may lead a cement plant project, where the process flow determines the plant arrangement; structural engineers may lead a transit system project, where bridges or underground structures comprise the primary project components.

10.2.2 The Architectural Design Project

The objectives of an architectural project are determined primarily by aesthetics and function, as opposed to being principally focused on engineering considerations. Architectural projects include private office buildings, commercial

Figure 10-1 Multidiscipline Project Organization for Engineering Design Project



developments, and residential complexes; institutional facilities, such as educational buildings, hospitals, and correctional facilities; and public structures, including government buildings and monumental structures.

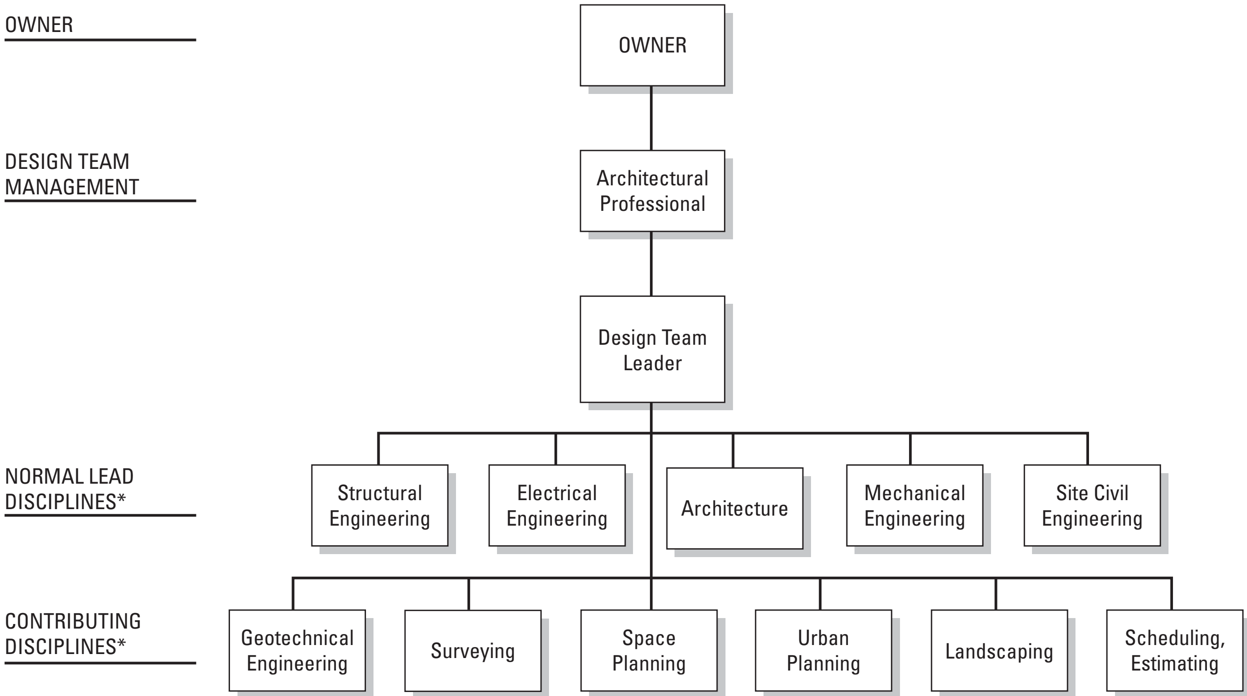
Like engineering projects, architectural projects (see Figure 10-2) require the coordination of several design disciplines. The distinguishing characteristic of the design organization in an architectural project is that the architecture designer typically fills the position as design team leader, and the typical lead and contributing disciplines form the remaining portion of the design organization.

10.2.3 The Design-Build Project

In a design-build project (see Figure 10-3), the project team coordinates all the design functions and the construction functions as well.

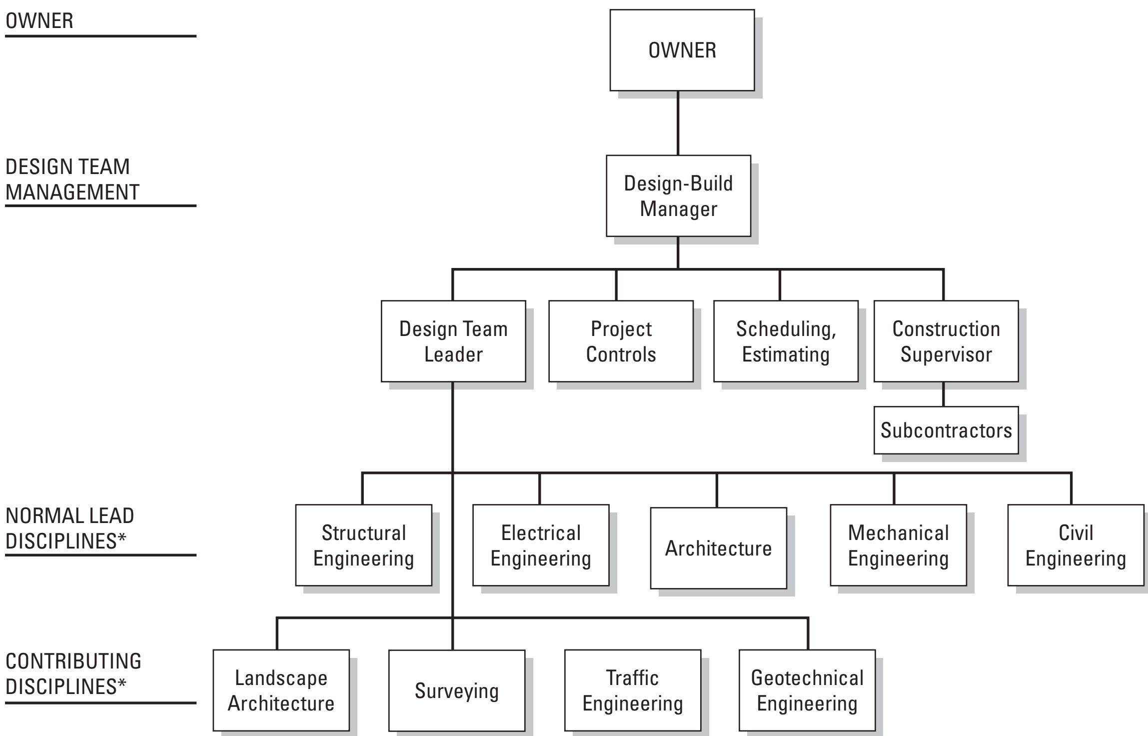
However, the internal organization of the design-build team shares some similarities with the traditional contracting approach. There are usually two subsidiary managers who report to the design-build manager: the design team leader and the construction team leader. The design team leader's organization is very similar to that of an engineering or architectural project. In constructor-led design-build projects, the constructor may independently retain multiple design professionals (rather than one prime with multiple subconsultants). As a variation of design delegation, as described in Section 10.2, trade subcontractors of the prime constructor on a constructor-led design-build

Figure 10-2 Multidiscipline Project Organization for Architectural Design Project



*One ore more disciplines may contract directly with owner and supply information for use by design professional.

Figure 10-3 Design-Build Project Organization



*One or more disciplines may contract directly with owner and supply information for use by design-builder.

project may retain their own specialized design professionals to design portions of the permanent work.

In addition, the design team, including subconsultants, may perform some of the design or construction planning that the stand-alone constructor would be expected to complete, including the design of temporary structures, lay-down areas, fabrication yards, and similar facilities.

10.3 GENERAL DESIGN TEAM COORDINATION CONSIDERATIONS

The project's functional objectives, budget, schedule, and other characteristics determine the design team's objectives. The team usually prepares a project plan describing these considerations, as well as constraints on design and construction, and associated building codes and technical criteria.

The main goal of the lead design discipline practitioner is to develop a coordinated design that satisfies the owner's goals and objectives in the areas of function, cost, quality, and schedule without compromising the public's health, safety, and welfare. Design coordination at the lead design discipline level involves negotiating compromises. One common area of compromise is that of initial capital cost versus long-term operating efficiencies. An owner may choose to minimize capital costs and accept higher operating costs if sufficient choices and cost-benefit analyses are not presented in a way that promotes informed decision making. Compromise may also involve trade-offs between design disciplines, such as mechanical engineers coordinating the size and location of equipment openings in structural members with the structural engineers.

The extent to which design compromises are made to accommodate the needs of a particular discipline is directly related to the project objectives, except when safety is concerned. The safety of the user and the public, as well as compliance with environmental protection laws, are primary requirements for team members of every discipline. With respect to compromises that are made, it is recommended that the design team leader adequately document in writing the basis for the compromise(s) and highlight the associated trade-offs.

The owner plays a crucial role in design discipline coordination. In many of the considerations noted above, only the owner can provide the guidance or clarification of project priorities that allow the design team to produce a design that meets the project objectives. A coordinated design benefits the owner by controlling construction costs through reduced changes, increasing the functional efficiency of project components, and enhancing the aesthetic qualities of the facility. Design discipline team members are often forced to decide whether to sacrifice peripheral design interests so that the owner's project goals may be achieved. While this would seem to be a basic principle, it can be difficult to follow during an active design effort. The design team leader, therefore, benefits from keeping the owner informed about potential and actual design compromises. The owner, in turn, benefits from taking an active role in making difficult choices. Contractual relationships between the owner and the various design disciplines take many forms. Depending on the type of PSA(s), there may be a single prime design consultant or a separate subconsultant for each design discipline. In the case of a large multidisciplinary firm, the required expertise in each discipline may be included as part of a single PSA. However, the basic structure of lead and contributing disciplines generally remains the same.

10.4 ROLE OF THE PROFESSIONAL DISCIPLINE LEADER DURING DESIGN

Design discipline leaders manage and oversee the design tasks within their respective disciplines. This must be done whether the design is undertaken within one organization or several. The design team should function as a seamless team.

Leaders of the lead design disciplines report to the design team leader for the project. Leaders of contributing design disciplines may report to an assigned lead discipline leader, the design team leader, or the owner, depending on their contracts. Design discipline leaders are responsible for ongoing dialogue with the design team leader and owner, making technical decisions, assembling qualified staff to meet technical and schedule objectives, managing the discipline team, and coordinating with team members from other disciplines.

Lead and contributing design discipline leaders are also responsible for

- Fulfilling contract obligations and project objectives;
- Maintaining technical correctness;
- Managing resources;
- Checking for compliance with codes and standards, standards, and regulations applicable to their disciplines.

The primary benefits of a multidisciplinary design team include the ability to produce an integrated project design that meets the owner's objectives by drawing upon the full array of specialized technical skills required to meet a project's objectives. Within the team, the professionals in each discipline are responsible for the appropriate application of relevant technical engineering principles, seeing that these applications are compatible with the design to achieve the overall project objectives. Foremost among the issues that design discipline practitioners address in this process are constructability, maintainability, capital cost, operating cost, and aesthetics. These issues are considered and evaluated critically to help achieve a quality design.

In general, measures of design quality include the following:

- Responsiveness to the owner's requirements in the areas of cost, quality, and schedule;
- Soundness of technical approach;
- Correctness and clarity of numerical and graphic representations;

- Degree of coordination and integration of necessary disciplines into the constructed project;
- Adequacy of project specifications.

As a decision-making member of the design team, each lead discipline leader is responsible for assisting other members in developing integrated design solutions. The discipline leader considers not only the project objectives that are applicable to a specific discipline but also the objectives that are applicable to other disciplines. Good design discipline leaders must develop an understanding of and sensitivity to the concerns and goals of other design disciplines. They must also be willing to be critical of their own design contributions, as well as those of other disciplines.

10.5 ROLE OF THE DESIGN PROFESSIONAL DURING CONSTRUCTION

In addition to design services, the design professional's agreement with the owner should include services during the construction phase of the project. The design professional's construction-phase services can contribute significantly to project quality because of the design team's close familiarity with the intent of the design with respect to the requirements of each discipline and the overall project objectives.

During construction, discipline leaders are typically responsible (depending on the terms of their contracts) for a variety of additional activities, including

- Coordinating with other discipline leaders;
- Monitoring and controlling the budget for their respective disciplines;
- Reviewing the submittals, including shop drawings, as required by and for the purposes stated in the contract documents;
- Becoming familiar with project progress at the construction site;
- Evaluating alternative materials and designs;
- Observing and evaluating construction work for general conformance with the contract documents;
- Evaluating modifications or changes;
- Reviewing and certifying the constructor's payment applications;
- Participating in start-up, testing, final review (close-out), and reporting.

➢ Chapter 25, "Value Engineering"

SUMMARY

Constructed projects almost always involve more than one design discipline. Therefore, the coordination of lead and contributing discipline activities is a key aspect of project quality. For multidisciplinary projects, the design team leader usually oversees and manages the work of practitioners in all the disciplines. Good coordination among the lead and contributing design disciplines is necessary for quality design.

While the practitioners in each discipline may find it necessary to compromise on some proposed design solutions to accommodate other disciplines, the hallmark of a quality design is one that meets the owner's project objectives.

Well-defined project team relationships benefit design discipline coordination. Alternate project delivery systems often shift the traditional roles and responsibilities of design discipline leaders and practitioners. However, the lead and contributing organizational structure of design disciplines enhances the coordination of multidisciplinary design activities.

While the design professional typically provides services during construction, some owners do not choose to involve the design professional in this phase. In such cases, the owner should be aware that if the design professional is not permitted to respond to questions regarding the interpretation of the design, correctly responding to requests for information (RFIs) may be impaired and the number of change orders may be greater. ❑

Chapter 10: Design Discipline Coordination
Typical Responsibilities

Responsibility ⇩	Owner	Design Professional	Constructor*	Design-Builder
Authorize formation of multidisciplinary design team	○	●		●
Assign multidisciplinary staff	○	●		●
Contract with subconsultants	○	●		●
Initiate and maintain communication and coordination for design effort	⦿	●		●
Make periodic presentations to owner on system choices and implications	○	●		●
Make decisions and provide guidance on design choices	●	⦿	○	⦿
Monitor and resolve conflicts among design disciplines	⦿	●		●

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

● = Primary Responsibility ⦿ = Assist or Advise ○ = Review

CHAPTER **11**

GUIDELINES FOR DESIGN ACTIVITIES

Appropriate design practices are vital to achieving project quality. This chapter provides guidelines for design activities, including the operations of the design professional's firm, design procedures, and design activities and responsibilities.

In this chapter

11.1 GENERAL OPERATION

Qualified personnel and design team chemistry are key components of a successful design firm operation. The quality of design activities is directly related to the experience of every member of the design team, as well as the ability of design team members to communicate and support common objectives. Staff participation in continuing education programs and professional groups is essential for helping staff stay up-to-date on current practices such as materials, design concepts, analysis methods, computer hardware and software for design and drafting, and current industry concerns. In some cases, particularly in small firms, the use of outside consultants can be of value, as it may not be possible to maintain a staff with experience in all the needed practice areas.

The selection of design team members is critical in achieving good team chemistry. The design team leader need not be an expert in any given field but should have experience in the anticipated phases of the project. The team should include people with special expertise in relevant design disciplines. In addition to technical considerations, the design team benefits from the inclusion of engineers with varying perspectives. This mixture of talents and temperaments often generates questions and discussions that uncover important aspects of quality. Design team members with different backgrounds who work together tend to develop superior solutions. The role of the design team leader is to guide team members in this process, drawing upon their personal strengths to foster the creative process, be assertive when necessary, ensure informal peer review, and maintain the project schedule and budget.

The organizational structure of successful design firms reflects the particular needs and objectives of the design team's current projects. Staff size, key personnel, office location and equipment, and other factors may vary significantly over the life of a project. The design firm may benefit from the use of a project organizational chart to help staff understand assignments, define responsibilities and authorities, and facilitate access to each other.

11.1.1 General Management of the Design Firm

Design firm management activities include hiring and retaining appropriately qualified staff, procuring design contracts, implementing sound financial and accounting procedures, establishing and communicating goals and objectives, as well as implementing standard operating procedures. Depending on the size of the firm and the diversity of functions performed, operations may be managed by a senior member of the technical staff or by an individual with special financial, management, or marketing skills. Design firms should have a designated manager to oversee administrative tasks, such as payroll and accounting, purchasing, and human resources.

11.1.2 Organization of Disciplines

Design firms benefit from organizing and deploying staff according to the needs of existing and expected workloads. One strategy for project organization is to assign qualified personnel to the design team from each of the relevant disciplines. These team members are, in effect, representatives of their respective disciplines, working under the guidance of the design team leader, to manage a particular project.

➢ Chapter 10, "Design Discipline Coordination"

Another effective strategy is to organize the design firm in departments based on individual disciplines (or appropriate combinations of disciplines). This type of organization can be effective in large firms with many projects under way at once.

11.1.3 General Procedures

General procedures for design firms vary widely, depending on the corporate culture, staff size, geographic location, and nature of work. This section provides some general guidelines that may benefit offices of any size.

Consistent personnel policies and procedures promote effective and efficient office functioning. Consistency provides a common reference point for different projects that the firm undertakes and helps improve overall quality. When members of the design team spend less time worrying about procedures or where to find things in the office, they are better able to concentrate on meeting the design objectives of the project at hand.

A standardized approach to firm organization is intended to support creativity, not inhibit it.

This standardized approach to firm organization is intended to support creativity, not inhibit it. Regular practices are a key element of a firm's "corporate culture," providing a foundation for the exploration of solutions to the unique objectives or cost of a particular project. Office quality control procedures should be considered flexible and should be amended when necessary to provide better support of a project.

There are a variety of publications available to aid in defining consistency in various design firm activities, including the following:

- Employee guide to personnel policies and procedures;
- Job descriptions;
- Style manual (i.e., *The Chicago Manual of Style*);
- Guide to editing (i.e., *The Elements of Style*);

- Dictionary (firm and individual offices should use one edition consistently);
- Project support services (including scheduling software and specialty consultants);
- Accounting (software programs and financial consultants);
- Computer hardware and software manuals.

11.2 DESIGN PROCEDURES

Design procedures include evaluation and computation, drafting, and file management. In each of these areas, a manual or guideline on design procedures is helpful. The manual or guideline usually addresses the purpose, process, and measurement of quality.

11.2.1 Evaluation and Computation Procedures

The design team develops and maintains standard procedures and guidelines for the engineering disciplines, such as structural engineering, that are required for the projects in which the firm is engaged. Design issues often present several alternatives for evaluation. A guideline that includes definition of resources, evaluation processes, and documentation should be developed and used consistently. Engineering computations should be based on standard procedures and methods and should be properly documented in project files.

Calculation sheets, which are the records of design loadings and other calculations that demonstrate structural stability, are particularly important documents of project activity. Calculation sheets are considered a major component of project services that may be referenced many years after project completion. As such, these records must present design criteria and assumptions clearly and must be checked for accuracy.

The development of consistent procedures for calculation sheets and other frequently used design procedures helps save time, reduce the likelihood of error, and increase the level of quality.

11.2.2 Drafting Procedures

The design professional's project drawings and project specifications provide the constructor with the necessary information on the design concept, complexity, and scope of the project, materials, performance, and quality objectives, as well as numbers and sizes of equipment or items to be provided.

The preparation of drawings, known as "drafting," is one of the most fundamental and important skills of the design professional. While drafting by hand remains an important capability, drafting today is primarily completed by computer-aided design and drafting, or CADD, technology. Drafting procedures include the following general steps, many of which are performed with some degree of automation through CADD assistance:

- Development of drawing standards, mechanics, data management, security, and filing practices through a written CADD plan;

- Preparation of a schedule and content outline of planned drawings;
- Use of precise, legible lettering, fonts, and layering;
- Coordination of project drawings and project specifications;
- Use of legible and consistent dimensioning;
- Use of standard symbols, abbreviations, and uniform terminology;
- Clear, well-organized drawings to improve the legibility of reduced-size reproductions;
- Preparation of rough layouts, to determine the placement and scale of the drawings on the sheets (interdisciplinary coordination is improved if corresponding project drawings are drawn to the same scale and arranged consistently).

Many owners have developed their own drafting standards. Discussing these standards with the owner before drafting begins can help prevent costly rework. A widely used CADD standard is called the United States National CAD Standard. This consensus standard was developed in conjunction with the American Institute of Architects, Construction Specification Institute, and the National Institute of Building Sciences. More information on this standard may be found at www.nationalcadstandard.org.

11.2.3 File Management Procedures

A document filing system for both paper and electronic products greatly increases efficiency. Effective filing systems focus on enhancing the speed and accuracy of document retrieval, not just storage. Filing systems typically use standard designations, classifications, and dates so that documents can be indexed correctly and located quickly. Examples of documents to be filed include the following:

- Project development materials,
- Correspondence and reports,
- Telephone and conversation logs,
- E-mails,
- Design calculations,
- Project drawings and project specifications,
- Quality control forms,
- Cost estimates,
- Schedules,
- Time sheets,
- Project costs,
- Value engineering or life-cycle cost information,
- Shop drawings and manufacturer's submittals,
- Construction reports to the owner or regulatory agencies, and
- Project close-out documents.

Large or complex projects may require separate files for each of the categories mentioned, while a single file may be sufficient for small projects. Files may also be arranged by project phase.

Documents should also be stored in electronic database files with similar file management structure as established for hard-copy files. Current software programs generally facilitate electronic "folders" for data management. Access to electronic files can be on a local project computer/network or from widely disbursed locations via the Internet. In any case access should be controlled to ensure proper security.

➢ 21.3, "Computers and the Design Professional"

The appropriate length of time to keep documents after a project is completed depends on contract provisions or on the potential need to refer to them for future work, subsequent claims, or historical documentation. State and federal agencies or statutes may require the retention of certain documents, to include electronic files, for specified periods after project completion. Duplicate printed copies may be discarded before filing and electronic copies of documents on computer disks or microfilm may help reduce storage and space needs.

11.3 DESIGN ACTIVITIES AND RESPONSIBILITIES

Design quality is measured by a wide range of criteria. These include adherence to basic engineering principles and professional standards, fulfillment of the owner's goals and objectives, and conformity with applicable codes and standards. In addition to meeting technical objectives, the design professional is more likely to achieve project quality by giving strong consideration to factors that relate to user acceptance, such as security, appearance, noise, traffic impacts, and relationships to surrounding buildings or neighborhoods. A quality design should also strive to provide project solutions that emphasize flexibility, adaptability, and expandability in a cost-effective manner.

Effective communication with the owner and the constructor plays an important role in achieving a quality design. The design team refines and expands owner requirements for the constructed project and then communicates the design intent to the constructor via the project drawings and project specifications. Design quality also benefits from a pre-established understanding and agreement among the project participants on how to process change orders, clarify details, correct mistakes, and resolve conflicts.

➢ Chapter 20, "Quality Assurance and Quality Control"
➢ Chapter 5, "Coordination and Communication"
➢ Chapter 24, "Partnering"

11.3.1 Design Considerations

Three important considerations influence project design quality:

- Serviceability,
- Life-cycle costs, and
- Construction phasing.

Serviceability refers to factors that affect the usefulness of a project. These include the subjective perceptions of users, as well as project elements that are designed to conform to codes and standards requirements. For example, in a building these factors include vibration, building sway from wind, and sound transmission. Partial or total mitigation of these phenomena may increase costs, so the design professional should discuss the benefits and costs of mitigation measures with the owner and reach an agreement on the degree to which these issues will be addressed.

Life-cycle costs consider the design and construction costs, operating and maintenance costs, and decommissioning costs taking into account the time value of money. Life-cycle cost determinations require analysis of initial capital costs, projected increases in costs, and the anticipated life span of materials, equipment, and finishes. For example, an owner may choose to pay greater initial capital costs for a mechanical system with lower operating costs to reduce expenses over the life of the project. In some cases, owners may deliberately choose low initial capital costs over lower life-cycle costs, especially if they plan to sell the project before major maintenance is required. In either case, the design professional achieves greater project quality by providing information on the various life-cycle cost options to assist project owners in meeting their requirements.

Construction phasing is a third design consideration in meeting project goals successfully. The design professional may accommodate an owner's desire to build quickly by adopting a phased (or fast-track) approach. Under fast-tracking, conceptual planning, design, and construction may take place concurrently so that the project, or portions of it, can open and begin generating revenue as soon as possible.

➢ 3.6, "Fast-Tracking: A Distinction"

However, fast-tracking limits design flexibility in responding to changing conditions or owner requirements. Initial savings from the fast-track approach may be offset by the larger design and construction contingency allowances necessitated by the greater number of unanticipated changes that typically occur during fast-track design and construction. Construction cost estimates are less precise because they must be based on incomplete project drawings and project specifications.

11.3.2 Sustainable Development

The consideration of sustainable development impacts is integral to a constructed project, and it is recommended that the project team address sustainability issues throughout planning, design, and construction.

The concept of sustainable development was introduced in 1983 and came to prominence with the acceptance of the report by the World Commission on Environment and Development in 1987. A broad definition, adopted at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, includes the key phrase, "meeting the needs of the present without compromising the ability of future generations to meet their own needs."

ASCE Policy Statement 418, "The Role of the Civil Engineer in Sustainable Development"

Sustainable development for the owners, design professionals, and constructors of projects is the incorporation of planning and design elements that take into account the environmental and socio-economic effects of natural resource depletion and effective waste management. For example, a sustainable development analysis of life-cycle costs would include the extended effects of raw materials and product manufacturing, as well as the subsequent decision for final waste disposal, reuse, or remanufacturing of the project components at the end of the design life of the facility (e.g., the costs of decommissioning a power plant). While current quantitative analysis methods do not often include ways to fix values on some of these sustainability concepts, a quality constructed project includes a study or comparison of potential construction materials with respect to relevant sustainability concerns.

The long-term impacts of failing to consider sustainability in project development will be a continuation of the trend toward natural resource exhaustion and environmental degradation. Neglect of sustainability issues also compromises the ability of future generations to meet their needs for adequate food, transportation, energy, shelter, and environmental quality of life.

Sustainable Development Resources

- U.S. Department of Energy: http://www.smartcommunities.ncat.org
- U.S. Green Building Council: http://www.usgbc.org
- *Environmental Building News:* http://www.buildinggreen.com

11.3.3 Design Reviews

Many owners require a deliverable of interim design product to ensure that efforts are on track for timely completion of the design. Typically these stages are referred to as the schematic design, design development phase, and construction documents phase. Following receipt of these documents construction managers, owners, future building occupants, and maintenance personnel may review the documents.

Other owners may require reviews at different stages of project design (e.g., 10, 30, and 60% complete).

Regardless of which system is used, the purpose is to confirm that the project objectives being developed are in accordance with the project goals. Similar reviews by the project team, even if the owner has no such requirement, may save the design professional considerable time and expense and improve project quality.

11.3.4 Construction Costs

The cost of construction is an important factor in the owner's decisions regarding project feasibility and financial planning. The design professional, although unable to guarantee construction costs, can provide an opinion of probable construction costs to the owner.

Often, the design team's opinion of probable construction costs is based on staff experience with similar projects. If such experience is not available directly from the design professional's staff, the design team leader may wish to engage experienced professionals to aid in developing construction cost opinions. In addition, owners may often elect to develop their own estimates of construction costs using professional cost estimators. It may be desirable to review these different construction cost estimates with an experienced constructor, allowing enough time to study the project drawings and project specifications thoroughly and do a complete inventory of material quantities (known as "take-offs"). The knowledgeable owner realizes that cost opinions and estimates, except proposals tendered by a constructor, are approximate and may be subject to influences outside the control of the design professional. Unless specifically represented as a binding proposal, construction cost opinions and estimates should be regarded as reasonable approximations.

➢ 9.3, "Construction Cost Estimate"

For this reason, the design professional's cost opinion should include a contingency that is dependent on the level of design development at the time the opinion is prepared.

Information on representative unit costs may be obtained from

- Construction cost indices in recognized industry publications;
- Local cost records published by construction associations;
- Unit prices published by state agencies, including local construction craft labor rates, local workforce availability, work conditions, and material costs;
- Information from bids for similar projects (especially valuable from specialty projects);
- Publications of AACE International
- Cost opinion solicitations from qualified manufacturers, vendors, and constructors.

AACE International Professional Resources: http://www.aacei.org/resources/

11.3.5 Constructability Reviews

Project constructability refers to the evaluation of a wide range of information that directly affects the ability of the constructor to actually complete the project. Constructability considerations include the adequacy and completeness of information in the project drawings and project specifications, site restrictions, economic considerations, availability of materials, construction equipment requirements, local workforce availability, contract-required construction phasing, and environmental considerations.

Constructability also involves the practicability of achieving specified tolerances, obtaining sufficient access and lay-down space, and resolving conflicts among architectural, mechanical, electrical, and structural requirements or elements. These issues often involve maintaining existing facility operations and ensuring continuous utility service. Some of these continuous utility service issues are best addressed by a written maintenance of plant operations (MOPO) plan. Three-dimensional models, both full and reduced scale, are an effective tool in evaluating constructability, training and educating construction personnel, coordinating system interfaces, and eliminating interference.

Periodic constructability reviews conducted by the design professional during the project design phase may reduce problems during construction and help control costs. Often, constructors can be solicited during project design to assist with constructability reviews.

When soliciting contractors to participate in constructability reviews, it is critical that the contractor not be placed in a position where a conflict of interest could occur. Contractors conducting constructability reviews must not be allowed to bid on the construction project being reviewed.

Another concern when conducting a review is the biddability of the design. One facet of this type of review evaluates the technology commonly used by local prime and subcontractors. Since many contractors specialize in the installation of building components using specific technologies, the design may impose constraints that would limit the use of technologies commonly used by the local contractors. The impact of general conditions, including risk allocation, may also reduce the number of potential bidders and increase the cost of the final construction.

11.3.6 Peer Reviews

Peer reviews are examinations of project procedures by independent experts to enhance overall quality. Such reviews are often done by a person or team not directly connected with the project, but with significant relevant expertise. Peer reviews are more common, and usually of greater benefit, on projects that involve innovative or unique systems and on large, complex projects with potential impacts on the public or the environment. Owners may contract and pay for peer reviews in a manner similar to the hiring of other technical consultants. Effective peer reviews require that the project schedule provide sufficient time for the review and implementation of recommendations that are agreed to by the project team.

➢ Chapter 22, "Peer Review"

11.3.7 Evaluation of Alternatives and Value Engineering

The evaluation of alternative designs and project approaches often helps the team develop economical solutions and improvements. Alternative evaluation also assists in broadening the benefits of a project to serve a wider scope and purpose.

➢ Chapter 8, "Alternative Studies and Project Impacts"

Value engineering (VE) is a common process for the systematic analysis of alternatives. VE involves the analysis of alternative designs by outside experts. The VE process provides the owners with an analysis of the costs and benefits of current and alternative project designs, which aid in refining the project design or affirming the existing approach. VE can also be an enhancement to peer and constructability reviews, if qualified team members participate in the VE study. VE reviews are most effective when conducted early in the project.

➢ Chapter 25, "Value Engineering"

11.3.8 Compliance with Codes and Standards

Codes and standards are developed by government agencies, industry associations, and professional societies to ensure the safety and health of project workers, users, and the general public. Local governing bodies may establish additional rules. It is important for the design professional to identify applicable codes and standards early in the design process to prevent delays and extra costs from the reworking of project drawings and project specifications to meet these requirements.

Specific codes and standards typically address a narrow aspect of design and construction, so the design professional should expect that many different codes and standards would apply to a single project. Codes and standards apply to civil and environmental engineers, electrical engineers, mechanical engineers, structural engineers, and architects.

The consistent application of codes and standards to design activities can be difficult, especially for design professionals working in unfamiliar geographic areas or jurisdictions. Local and regional codes are usually based on national codes but often incorporate local requirements. The design professional can enhance quality and expedite the permitting and approval process by obtaining the most recent versions of applicable codes and standards. Another alternative is to to have a local professional familiar with the local code situation conduct a peer review. The designer benefits from a proactive approach in this effort: even if codes and standards appear to be current, the design professional benefits from inquiring directly about proposed revisions that may take effect while the project is under way.

➢ Chapter 22, "Peer Review"

11.3.9 Regulatory Permits and Approvals

The design professional is required to exercise professional care in producing contract documents that comply with the requirements of regulatory agencies that issue approvals and permits. This care minimizes the potential for delay in the regulatory process.

The design professional benefits from developing a written list of assignments and roles in the regulatory process. The agreement for professional services usually assigns the responsibility for obtaining permits to the owner acting with the assistance of the design professional. Proactive attention on the part of the design professional in these activities benefits the entire project team. The design professional can enhance efficiency and quality with the early identification of the appropriate local, regional, state, or federal regulatory agencies and their permit requirements. If a project requires a variance from existing regulations, the design professional works with the owner through the appeal or variance process.

11.3.10 Public Funding

Government grants and loan programs are often part of the funding strategy for public projects. However, funding agency procedures and requirements may significantly increase the time and efforts required of the owner and design team and may impose limits on project design, construction, or operation. Special public funding requirements may increase construction costs in some cases, beyond the value of the funding assistance itself. It is a benefit to project quality when the design professional, the owner, and prospective funding agencies discuss funding considerations before finalizing the agreement for professional services. This discussion should include an understanding of any limitations attached to the funding.

11.3.11 Design Responsibility

Under state licensing laws, each design team member who signs and seals the project drawings and project specifications is responsible for the design. The signature of the design professional commits the design firm to this same responsibility. Therefore, it is in the interest of the owner and design professional to develop a complete understanding of the extent, degree, and limits of services to be performed. This understanding should be specified to the greatest extent possible in the agreement for design services.

When developing the scope of services, it is important that the design professional be assigned control of design throughout the project, including the construction phase. If possible, the agreement should avoid terms and phrases such as "complete design services," as they are vague and open to interpretation. Instead, the owner and design professional benefit from the use of standard professional association agreements. If nonstandard agreements or contracts are used or requested, the design professional should retain a qualified lawyer to review the agreement before signing the document.

The authority and responsibility of the design professional during construction should be defined as precisely as possible in the professional services agreement and in subsequent contract documents. For example, construction site safety, adequacy of formwork, shoring, and similar items are usually the responsibility of the constructor and are beyond the normal control and responsibility of the design professional. The authority and responsibility of the design professional on the construction site to interpret project drawings and project specifications, clarify details, correct errors, and review change orders are essential elements of a quality project and are normally provided for in the professional services agreement.

➢ Chapter 7, "Agreement for Professional Services"
➢ Chapter 15, "The Construction Contract"

Regardless of the specific scope of work that defines the design professional's responsibilities, if the design professional identifies issues related to safety of the constructor or project users or occupants, then such issues must be taken to project management personnel for further evaluation and action.

➢ Chapter 16, "Planning and Managing Construction"

SUMMARY

Design practice activities involve operation of the firm, design procedures, and design activities and responsibilities. Also included are activities that address codes and standards, regulatory agencies, and funding agencies. Establishing efficient practices, observing design quality guidelines, and closely following owner requirements and regulatory procedures are essential parts of a comprehensive program to achieve design quality in the constructed project. ❑

Chapter 11: Guidelines for Design Practices

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor*	Design-Builder
Manage design office		●		●
Manage design procedures		●		●
Communicate design requirements	●	⦿		⦿
Conduct design reviews	⦿	●		●
Estimate construction costs	○	●	⦿	●
Conduct constructability reviews	○	⦿	●	●
Initiate peer reviews	⦿	●		●
Conduct evaluation of alternatives and value engineering	⦿	●	⦿	●
Develop and implement design QC	○	●		●
Comply with applicable design codes and standards	○	●		●
Oversee regulatory compliance	●	⦿		⦿
Comply with public funding guidelines	●	⦿		⦿
Manage overall design	○	●		●

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

● = Primary Responsibility ⦿ = Assist or Advise ○ = Review

CHAPTER **12**

PRE-CONTRACT PLANNING FOR CONSTRUCTION

Before entering into a contract with the constructor, the owner begins developing general plans for construction. This planning does not include specific construction means, methods, or procedures, which are primarily the responsibility of the constructor. Instead, this planning focuses on issues that must be addressed before the constructor can begin work at the construction site. Principal among these are the specific project goals and objectives.

An owner is principally responsible for the planning that takes place before the award of the construction contract. This planning involves the close cooperation of the design, construction, legal, and financial professionals.

This chapter discusses the key aspects of pre-contract planning for construction, including the assessment of the owner's capabilities, the evaluation of resources available for construction, regulatory guidelines, construction site development, the review of construction alternatives, and contractual arrangements.

The information contained in this chapter focuses on the design-bid-build process. The principals presented here also adequately apply to the design-build process. Only organizational responsibilities differ.

In this chapter

12.1 ASSESSING THE OWNER'S CAPABILITIES

➢ 2.2, "Project Goals"

➢ 2.3, "Achieving Project Goals"

➢ 2.4, "Establishing Project Objectives"

As project complexity increases, owners tend to benefit from additional assistance during each phase of project development—from establishing project objectives through construction completion. Depending on the owner's experience in construction project management, owners may utilize specialized in-house staff or augment in-house staff with experienced people. But when a project requires highly specialized skills and a large number of additional staff, owners usually find that it is more cost-effective to engage design professionals and construction managers. This is especially true of owners who do not regularly oversee construction projects or do not have in-house engineering departments.

The owner is principally responsible for the quality of planning before the award of the construction contract.

The owner can enhance project quality by contracting with experienced designers and constructors who have been involved in similar projects. Before hiring outside experts, owners are advised to begin with an internal evaluation to determine the number and extent of project activities that can be completed or managed by existing staff. In addition to design and construction tasks, these may include financial, regulatory, and legal activities.

On especially large or complex projects, owners often find the recommendations of a construction management consultant valuable in assessing the capabilities of their own organizations—as well as in many of the other activities described in the sections that follow.

12.2 RESOURCES FOR QUALITY CONSTRUCTION

The resources available to the owner, design professional, and constructor strongly influence their respective decisions regarding the project objectives, planning and design, contracting strategies, and construction operations. The following sections discuss four general types of resources and their impact on pre-contract planning decisions: financial resources, construction materials, manufacturing capabilities of suppliers, and human resources.

12.2.1 Financial Resources

Owners are responsible for securing the funds to plan, design, build, and begin operating their projects. The total funding available and the cash flow schedule under which participants are paid are crucial determinants of project decisions—especially during the conceptual stage. Public agencies, for example, are often subject to regulations regarding the disbursement of funds and may have to arrange public financing or appropriations well in advance of construction activities. Private-sector owners may have necessary financial resources available or may also have to arrange financing.

Before proceeding with a project, the owner must develop a cash flow plan or budget to ensure that sufficient funds are available when required to advance the project. Initial activities requiring funding may be related to the establishment of project objectives and design criteria (i.e., preliminary planning, site selection, geological studies, subsurface exploration, alternative investigations, and other tasks). Adequate support for these pre-contract planning activities is a critical step toward ensuring that project goals and objectives are well-defined and that the risk of cost or schedule growth from unforeseen conditions is minimized. While cost or schedule surprises are often viewed as a sign of poor design or construction operations, they may actually be a consequence of inadequate financial resources for the support of pre-contract planning activities.

Each member of the project team has an interest in the financial health of the other members. Inadequate capitalization can create adverse impacts—such as inadequate staffing, delays in delivery, equipment failure, or shortages of construction materials—that hamper a participant's ability to deliver quality service.

In some cases, design professionals and/or constructors are able to enhance overall project quality by offering the owner financial management and consulting services (usually during the early planning stages). On public projects, this may include assistance in determining agency requirements for grants and reimbursement. On private-sector projects, this assistance may include identifying new sources of capital or lines of credit. Some constructors may be willing under certain conditions to finance the project. In such cases, little or no funds may be required from the owner until the project is complete, i.e., ready to begin operating and generating revenue.

For these reasons and many others, the consideration of financial resources, while a principal activity of the owner during pre-contract planning, has long-lasting impacts on the relationships among the team members and their contracts with the owner.

12.2.2 Construction Materials

The cost and availability of construction materials affect planning, design, and construction operations. During pre-contract planning, the project team should consider several questions related to natural materials, including

- What type of foundation is best suited for existing soil and geologic conditions?
- Can ground conditions be modified for other types of foundations?
- How would flooding or erosion affect the construction materials?
- Is aggregate for concrete available on the local market? Must it be manufactured or imported?
- Are fill materials available on the construction site? What are the other alternatives?
- Does the construction site influence the choice of materials or method of construction (i.e., congested urban area vs. a remote rural location)?

Estimating and Project Management for Building Contractors, Michael Kitchens, ASCE Press, 1996

Manufactured materials raise additional questions, such as these:

- What materials are readily available at a competitive cost?
- Will shortage of any basic materials, such as steel or cement, influence design choices or construction means?
- Does the choice of materials require extra lead times for critical components?
- How do transportation costs, especially to a remote construction site, affect cost?
- How do the storage and preparation of materials at a congested construction site affect construction operations?
- Can prefabricated or customized materials be provided in a timely manner?
- Are the tolerances associated with selected materials compatible with project requirements?
- Have maintenance and sustainability been thoroughly addressed during the materials selection process?
- Are there laws or public support for purchasing materials or equipment locally?
- Is the project subject to state or federal "Buy American" legislation?

Choosing the appropriate construction materials is a critical process that, by its nature, must be undertaken early in the planning process. Since construction materials must often be selected before the construction contract documents

During pre-contract planning, the owner may ask the constructor to evaluate proposed lead times, construction sequencing, and specified materials.

are prepared and the constructor is engaged, the owner and design professional may benefit from consulting with experienced construction management consultants or from engaging the constructor early (if permissible under any applicable procurement laws or regulations), to advise on the selection of materials.

If the constructor joins the project team later, additional insight on appropriate construction materials can still be added at that time. Therefore, during the pre-contract planning process, the owner may wish to build time into the construction schedule for a constructability review to evaluate proposed lead times, construction sequencing, and the compatibility of materials.

12.2.3 Manufacturing Capabilities of Suppliers

During pre-contract planning, the owner and project team address the need for specialized permanent equipment, components, or materials that may require sophisticated or specialized manufacturing. With the assistance, if necessary, of specialty advisers, the team reviews and evaluates the manufacturing and delivery capabilities of potential suppliers or vendors with respect to several areas, including the following:

- Project requirements and prospective suppliers' specialized manufacturing capabilities, especially regarding the ability to comply with performance specifications and the financial capabilities to support the attendant warranties and guarantees;
- The potential to meet project delivery demands;
- Quality control programs;
- The potential benefits of independent observation, expediting, and inspection of manufacturing and testing;
- The level of detail needed in the procurement documents to be provided to the supplier;
- Pre-qualification of firms meeting the manufacturing capability needs.

12.2.4 Human Resources

In the initial stages of project planning, the owner evaluates the human resources necessary to successfully complete the effort. Key factors in this evaluation are the continuity of principal professional and management personnel and the availability of a workforce with appropriate skills.

Staff continuity improves project quality.

The owner benefits when the involvement of design and construction staff has continuity since this supports professional relationships and project team experience, enhancement of communication, and reduction of the effort that must be spent to conquer the learning curve. At successive project phases, a project team develops an in-depth understanding and familiarity with the effort by working together through pre-contract planning, design, construction, start-up, and operation. When team members know each other and the project objectives well, they are more likely to identify potential problems, resolve conflicts effectively, and reduce the number and/or scope of change orders that may be necessary.

During the initial planning stages, the owner estimates the skills required to complete the project. This may involve discussions with the design professional, local construction firms, and construction managers to determine the availability of skilled professionals and craft workers that may be needed. To mitigate potential workforce shortages on large projects, the owner may

- Modify project facilities (e.g., including worker housing at remote construction sites);
- Break the project into smaller phases;
- Plan for additional quality control measures;
- Incorporate prefabricated elements to reduce the need for on-site labor.

12.3 REGULATORY REQUIREMENTS

Government agency regulatory requirements can have a considerable impact on pre-contract construction planning. Such agencies operate at the federal, state, and local levels. Members of the project team must comply with applicable laws and cooperate with agency personnel during each phase of a major project, from conceptual planning through the design and construction phases.

➢ 8.6 "Public Involvement"

The typical areas of agency monitoring and participation include

- Construction site safety;
- Compliance with goals for minority, female, and local residency hiring and disadvantaged business participation;
- Grant and loan guidelines;
- The use and disposal of hazardous materials;
- Environmental impact assessment and evaluation to assist the owner in obtaining the required permits;
- Public health and life safety laws;
- Special inspections;
- Compliance with state and federal disability accessibility laws;
- Codes and standards and disability access enforcement agencies.

Regulatory Agencies (partial list)

Federal

Occupational Safety and Health Administration (OSHA)

Environmental Protection Agency (EPA)

Federal Highway Administration (FHWA)

Federal Transit Administration (FTA)

State

Departments of environmental protection

Departments of capital planning

Departments of transportation

Local

Regional or metropolitan planning authorities

City departments of transportation

Some agencies may specify unique requirements for particular projects, depending on their nature and location. The owner and design professional benefit from identifying such special requirements early in the planning process. If special requirements affect the proposed project significantly, the project team can work closely with the agency to identify viable alternative approaches, develop compatible designs, and gain preliminary agency approval. For example, the International Building Code (IBC) standard now requires that the owner provide a "special inspector" to inspect aspects of structural work on buildings for compliance with code and standard requirements. This code-driven quality assurance requirement is an example of requirements that should be identified in the pre-planning and permitting activities.

Direct contact with agency officials is a crucial aspect of the regulatory process. The laws, codes, and guidelines under which regulatory agencies supervise projects are often subject to interpretation. Good relationships with regulatory officials can help improve communication and understanding—and keep minor issues from becoming major project slowdowns.

Typically, the project owner is responsible for obtaining required permits, though the owner may assign permit management responsibilities to the design professional and/or constructor.

12.4 CONSTRUCTION SITE DEVELOPMENT

Some construction site development activities may take place during the planning and design phases—before the completion of the construction contract documents.

These activities include the following:

- Obtaining easements and property rights;
- Determining phasing;
- Obtaining preconstuction permits;
- Constructing access roads and rail sidings;
- Demolition and removal of existing facilities and/or structures;
- Arranging for temporary and/or permanent utilities;
- Constructing temporary buildings and other facilities;
- Setting up construction lay-down areas and fabrication yards;
- Planning for traffic control;
- Relocating utilities, highways, rail, and other facilities.

Each of these steps may take time and require early expenditures, well in advance of the actual construction contract. Construction contracts for road and utility work may be issued before (and separately from) the contract for project construction. Utility extensions and relocations may need to be done by the utility company affected, though it is often cost-effective to include utility work in the main construction package.

Construction site development work may also be included in the main construction contract, though many considerations, such as scheduling, site congestion, construction sequencing, and cost, must be addressed as part of pre-contract planning. Construction site development also affects the timing of contract awards.

12.5 REVIEWING DESIGN AND CONSTRUCTION ALTERNATIVES

➢ Chapter 8, "Alternative Studies and Project Impacts"

The owner's consistent involvement in the review of design and construction alternatives is one of the most important aspects of pre-contract planning. At appropriate points in the evaluation of project alternatives, the project team reviews alternatives with regard to several crucial considerations:

- Estimated cost;
- Schedule;
- Quality;

- Construction sequencing;
- Plant or equipment layout;
- Sustainable development issues;
- Constructability;
- Safety; and
- Security.

As the project moves forward, the team conducts reviews that are more detailed and modifies designs where appropriate and practical. Special construction concerns are noted in the contract documents. The design team's documentation of the owner's involvement and of all decisions made regarding alternatives adopted is a critical aspect to the planning process.

12.6 CONSTRUCTION CONTRACT ARRANGEMENTS

The last major pre-construction contract planning activity is the establishment of construction contractual arrangements. The owner, as the principal project advocate, is responsible for establishing the construction contracting strategy. In general, effective construction contracting strategies

1. Meet the owner's project goals and objectives for cost, schedule, and quality;
2. Reflect the owner's capabilities; and
3. Specify the responsibilities of the constructor.

➢ Chapter 3, "Project Delivery Systems"
➢ Chapter 7, "Agreement for Professional Services"
➢ Chapter 15, "The Construction Contract"

SUMMARY

Pre-contract planning is an investment for quality construction. By exploring the range of issues that can affect construction, the owner can minimize or eliminate many potential obstacles that drive up project costs or create delays. Pre-contract planning is a fluid process; project objectives are often still being developed, new members are joining the project team, information is often not complete, and a host of other variables may still be unresolved. Therefore, the owner's investment involves both time and financial resources.

The owner is at the center of pre-contract planning activities. The owner holds primary responsibility for nearly all related activities, including the evaluation of their own capabilities. While many owners rely on the experience of the design professional for assistance with these tasks, the quality of large or complex projects may be improved when the owner seeks the advice and services of a construction management consultant. ❑

Chapter 12: Pre-Contract Planning for Construction

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor*	Design-Builder
Assess owner capabilities	●	●	◉	●
Secure financial resources**	●	◉	◉	◉
Assess construction material needs and availability	●	◉	●	●
Evaluate supplier capabilities	●	◉	●	●
Evaluate human resource needs and availability	●	◉	◉	◉
Address regulatory requirements**	●		●	●
Address permitting requirements	●	◉	◉	◉
Address construction site development issues	●	●	●	●
Address sustainable development concerns	●	●	●	●
Review design and construction alternatives**	●	●	●	●
Define contractual arrangements	●	○	○	○

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

***Often in process or completed before pre-contract planning.*

● = Primary Responsibility ◉ = Assist or Advise ○ = Review

CHAPTER 13

THE CONSTRUCTION TEAM

The construction team is the group of people who work together to build the project. This chapter discusses how the construction team is assembled, the role of the agreements in organizing the team, team representatives who participate at the construction site, and the value of construction specialty advisers.

As with the other phases of a project, construction involves the coordinated efforts of skilled individuals who have access to adequate resources. The owner, design professional, and constructor form the core of the construction team, though these roles may vary if design-build or other delivery systems are utilized.

The owner has the unique responsibility of selecting the team members who participate during construction (as well as previous project phases). The project goals and objectives guide the owner's decisions about the degree to which and frequency with which team members participate during construction, as well as the presence of team representatives at the construction site itself. The construction team may include participants from outside the core team, including representatives of regulatory agencies, subcontractors, suppliers, and specialty advisers.

➢ 1.4, "Defining Key Terms"
➢ 2.2, "Project Goals"
➢ 2.3, "Achieving Project Goals,"
➢ 2.4, "Establishing Project Objectives"

In general, the greater the number of participants, the more important it is that team members understand their roles and responsibilities. Regular, clear, effective and efficient communication among team members add significantly to such understanding. Partnering programs may also be valuable in achieving this goal.

13.1 ASSEMBLING THE CONSTRUCTION TEAM

The process of assembling the construction team actually begins before the constructor is engaged. The owner's decisions during the conceptual phase of the project, as well as those made during planning, design, and the preparation of construction contract documents, shape the performance expectations and personnel needs of the construction team. By the time that the owner and constructor sign a contract and begin designating and assigning construction roles, many fundamental assumptions about the composition of the team are already in place. These may include the designer's degree of involvement in the construction phase, as well as the number of personnel that the owner and constructor will have on-site.

➢ Chapter 2, "The Owner's Role and Requirements"
➢ Chapter 24, "Partnering"

Before selecting a constructor, the owner and design professional work together to formulate a plan of construction activities. For relatively simple projects, the owner may have the necessary in-house expertise to develop a successful construction plan. However, for most large projects, the owner benefits by seeking construction planning assistance from the design professional or an experienced independent construction planner. The constructor, if selected at this point in the project development, may also review the design and planning work related to construction operations.

➢ Chapter 12, "Pre-Contract Planning for Construction"

The owner's selection of the constructor under design-bid-build contracting takes place in one of two ways. For public-sector projects, the owner typically places advertisements in leading industry publications with a request for proposals (RFP) or solicitation for sealed bids from prospective constructors for project construction. On private-sector projects, the owner may extend an invitation to bid to a selected list of pre-qualified construction firms.

Although many governmental agencies by law must engage in open bidding and award procedures, public-sector projects may involve pre-qualification procedures, as well. This procedure provides constructors an opportunity to demonstrate their capabilities, record of experience, previous performance, financing capability, availability of professional talent, and access to necessary construction equipment to the owner.

13.2 CONTRACTING STRATEGIES AND TEAM ORGANIZATION

The contracting strategy, or project delivery method, strongly influences the composition and organization of the construction team. The owner is responsible for establishing the contracting approach, usually during the planning phase.

The contracting strategy, or project delivery method, strongly influences the composition and organization of the construction team.

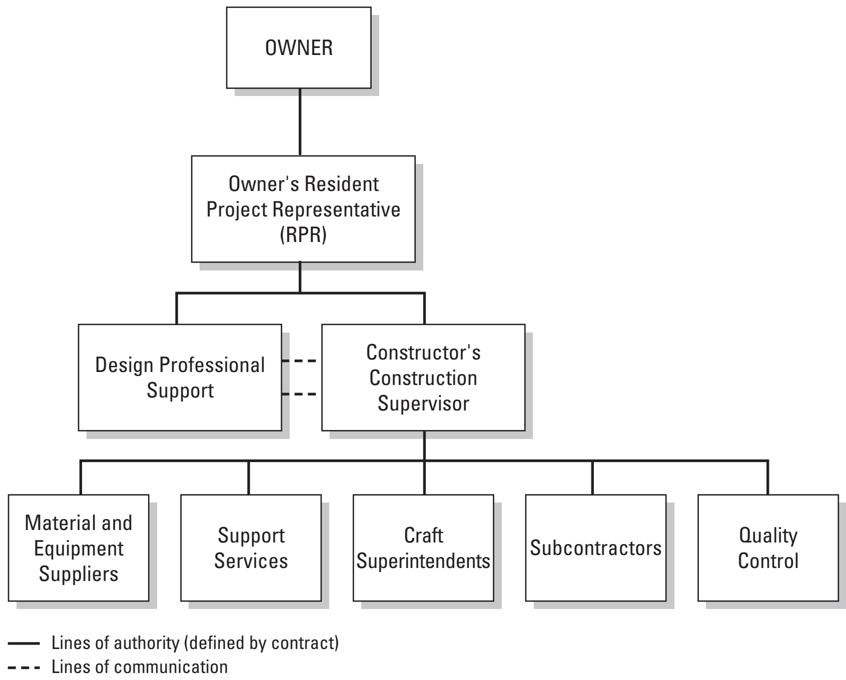
Contracts define the responsibilities that the construction team participants are expected to fulfill. Therefore, contracts are fundamental tools in helping teams avoid conflict. Good contracts clearly define the scope of work, level of quality expected, the roles of participants, expectations for coordination and communication, divisions of authority, and other relationships.

In developing the construction contract provisions, it is in the owner's interest to clearly specify

- The responsibilities of the constructor and the owner;
- The responsibilities of the constructor regarding quality control;
- The responsibilities of the owner regarding quality assurance;
- Fair and equitable arrangements among the team members;
- The participation of qualified personnel;
- Procedures for timely payment of invoices;
- Approval procedures for contract change orders;
- Procedures for enforcing contract terms and conditions.

➢ Chapter 15, "The Construction Contract"

Figure 13-1 Typical Construction Team Organizational Chart



In addition to the construction contract and the contract documents, the provisions of the owner–design professional agreement define the scope of services to be provided by the design professional during the construction phase. The construction contract and contract document provisions relating to the role and responsibilities of the design professional must be consistent with the terms of the owner–design professional agreement.

➢ Chapter 7, "Agreement for Professional Services"

A variety of contracting arrangements are available to the owner to define appropriate lines of authority among construction team members. While some owners still prefer to organize their teams according to a traditional organizational chart with the design professional and constructor reporting directly to the owner (see Figure 13-1), many owners now favor a less hierarchical organizational structure to promote cooperation and collaboration.

13.3 ON-SITE CONSTRUCTION TEAM REPRESENTATIVES

Safe and productive construction operations depend on the presence of appropriate team representatives at the construction site. The constructor is responsible for construction site activities and usually for safety (as designated by the owner), and therefore generally controls access to the construction site during all phases of construction. The size and complexity of the project determine the frequency of visits and monitoring by the owner and design professional to evaluate whether the work, when completed by the constructor, will comply with the requirements of the contract documents. In many cases, the owner and design professional do not need to be at the construction site all the time for that purpose. In addition to requests by team participants, the contract may specify intervals for construction site, material source sites, and manufacturer or fabricator site visits or observations by the owner and design professional.

13.3.1 Owner's Resident Project Representative

➢ 18.1, "Owner's Resident Project Representative"

The owner's resident project representative is a key member of the construction team. This person may be the owner, a senior member of the owner's staff, a member of the design professional's staff (a resident engineer), a member of the constructor's staff (typical under the design-build approach), or an independent construction manager retained by the owner. The owner's contracts with the design professional and constructor specify the type of owner representation, as well as the level of on-site authority and responsibility for each participant.

The owner benefits from designating an owner's representative as early as possible so that this person is able to develop a factual understanding of project goals and objectives. An early assignment also helps establish an "institutional memory" of key decisions, strategies, and procedures, and provides an opportunity to develop sound and constructive relationships with other team representatives. Early selection also allows the owner's representative to contribute during the construction planning and design phases and offer feedback about construction site operations. Key qualifications for the owner's representative include a familiarity with the owner's organization and values, experience in relevant types of construction, and the ability to communicate project goals and objectives clearly.

The general responsibilities of the owner's resident project representative include the following:

- Representing the owner at the construction site;
- Supervising conduct of owner QA activities;
- Mediating conflicts at the construction site;
- Administering the owner's contracts with the constructor, design professional, and others;
- Reviewing and evaluating deviations from the schedule;
- Reviewing and approving invoices, and processing them for payment;
- Reviewing and approving construction contract change orders, and processing related documents;
- Supervising other owner personnel at the construction site;
- Communicating appropriately with regulatory agencies to ensure compliance with relevant laws;
- Conducting periodic progress meetings;
- Managing the communication process with the public and others as needed;
- Managing project financing.

13.3.2 Constructor's Construction Site Representative

The constructor's lead employee on the construction site is the construction site representative. Depending on the size and complexity of the project, this position may be held by a project manager, superintendent, or foreperson. The construction site representative works to achieve the project objectives, as specified in the contract with the owner, by carrying out general duties that include the following:

- Representing the constructor at the construction site;
- Managing the constructor's quality control program;
- Providing the owner's resident project representative with the submittals specified by the contract;
- Managing the execution of work per the terms of the construction contract (usually including activities such as scheduling, sequencing operations, expediting labor resources and materials, and coordinating the various trade contracts);
- Arranging for licensed professionals to design temporary facilities not included in the project drawings and project specifications, such as shoring, scaffolding, cofferdams, river diversions, traffic maintenance, or other facilities;
- Making appropriate submittals for temporary facilities to the owner, designer, and regulatory agencies;
- Managing subcontractors, suppliers, and construction workers;
- Arranging for timely payment of subcontractors, suppliers, and the constructor's employees;
- Managing construction site safety;
- Managing construction site security;
- Complying with legal, contractual, and regulatory obligations.

📖 ASCE Policy Statement 350, "Construction Site Safety"

13.3.3 Design Professional Construction Support Services

In addition to completing the project drawings and project specifications, the design professional is usually expected to provide support services on behalf of the owner during construction. Such services often include some on-site monitoring to verify progress toward project objectives. This support is usually specified in the design professional's agreement with the owner. Under design-bid-build, the design professional does not usually have a contractual relationship for construction-phase services with the constructor.

The design professional's construction representative may assist the construction team in resolving minor design-related concerns, though larger design matters may need to be resolved with the active participation of the owner and constructor team representatives—or even the principal members of the team. The design professional's experience is often valuable in resolving certain disputes concerning the meaning or intent of the project drawings and project specifications, as well as the quality of the constructor's work. The design professional also typically certifies the constructor's pay requests.

The portions of the design professional's contract with the owner that are related to construction support generally assign the design professional the following authorities and responsibilities:

- Clarifying and resolving technical questions about project drawings and project specifications in response to requests for information (RFIs);
- Reviewing contract change orders from a technical viewpoint;
- Reviewing and commenting on technical data, including shop drawings;
- Coordinating technical questions with regulatory agencies;
- Evaluating alternatives and proposed substitutions, and making recommendations to the owner;
- Observing construction when specified by contract or law;
- Reviewing and approving payment applications.

13.3.4 Regulatory Agencies

During the course of construction, representatives of federal, state, and local government agencies may inspect or be assigned to observe the construction site. These representatives and inspectors are responsible for assessing the construction team's compliance with applicable codes and standards, laws, rules, permits, and regulations to ensure safety, public health, and environmental protection. These agencies are responsible for enforcing compliance with a wide range of regulations, from construction site safety, to hazardous material disposal, to environmental protection and insurance.

The various agencies and individuals that may work with the construction team, depending on the size and scope of a project, include

- Various codes and standards inspectors;
- The Occupational Safety and Health Administration (OSHA);
- The U.S. Environmental Protection Agency (EPA);
- State and city departments of environmental protection;
- Water and wetlands agencies;
- Air quality agencies;
- State and local fire safety officials;
- Food and Drug Administration (FDA);
- Local and state health-care facilities approval agencies;
- Local and state boards of health.

The construction team can avoid delays and extra cost by submitting certificates and documentation required by the contract and the regulatory agencies in a timely manner and by maintaining records of compliance.

Other agency personnel may wish or need to visit the construction site to observe progress as a matter of public interest, especially if the project involves the expenditure of public funds under grant programs, nuisance abatement under court orders, or potential public health and safety concerns. Good communication with agency personnel and prompt compliance with regulations improve project quality and promote overall team cooperation.

13.3.5 Subcontractors and Suppliers

In addition to construction workers, who may be members of the constructor's staff, union craft laborers, or independent hires, the constructor typically engages subcontractors and suppliers to complete specific construction tasks. The constructor often relies on subcontractors to provide skilled construction craft labor to augment the project workforce. Suppliers provide the materials, from lumber and concrete to sophisticated electronics, that are used to assemble project facilities. Suppliers may provide limited construction site labor, usually to deliver materials or install equipment.

General responsibilities of subcontractors and suppliers include

- Supporting and complying with the constructor's quality control and construction site safety programs;
- Providing qualified labor and supervision;
- Preparing appropriate submittals relating to their work, products, or materials;
- Supplying materials that meet the project specifications of the contract documents;
- Coordinating work and deliveries with the construction schedule.

Though subcontractors and suppliers may not have direct contractual relationships with the owner, the performance of these participants directly affects the ability of the construction team to achieve the owner's objectives. Many construction teams now include subcontractors and suppliers in partnering programs and other quality assurance efforts to improve coordination among "second tier" construction team members.

➢ Chapter 24, "Partnering"

In many states, lien laws require that the constructor inform the project owner of the existence of subcontractors or suppliers. Contracts with the owner may also stipulate this disclosure.

13.4 CONSTRUCTION SPECIALTY ADVISERS

The construction team may benefit from the assistance of additional professionals with special expertise. The owner, design professional, and constructor may separately retain advisers or consultants on matters of law, insurance, laboratory and on-site testing, public relations, safety, and other specialties. The close contact of the owner's representative with specialty advisers may help the construction team resolve problems quickly and avoid constructor claims, litigation by outside parties, citations by regulatory agencies, labor disputes, or public misperceptions. Expert advice is often cost-effective, helping to speed contract completion and enhance overall project quality.

SUMMARY

The cohesiveness of the construction team affects project quality in many areas, from completing the project on schedule and within the established budget, to ensuring the safety and functionality of the facility, to protecting the environment and meeting regulatory obligations.

The owner is responsible for selecting the other members of the construction team and achieves a quality project by seeking participants with the skills and capabilities to meet the project objectives. In many cases, the owner benefits from working closely with the design professional and, if the size and scope of the project merit, seeking the advice of independent and trusted construction experts in assembling the construction team. The relationships established during the formation of the construction team endure throughout the life of the project. ❏

Chapter 13: The Construction Team

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor*	Design-Builder
Establish contractual arrangements	●	⦿	⦿	⦿
Designate construction site representatives	●	●	●	●
Monitor regulatory compliance	●	⦿	●	●
Coordinate subcontractor and supplier participation	○	○	●	●
Engage construction planning specialty advisers	●	⦿	⦿	⦿
Overall responsibility for selecting construction team	●	⦿	⦿	⦿

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

● = Primary Responsibility ⦿ = Assist or Advise ○ = Review

CHAPTER 14

PROCEDURES FOR SELECTING THE CONSTRUCTOR

The selection of a qualified constructor for a competitive price is an owner responsibility that significantly influences project quality. To choose a constructor, the owner formulates and uses selection procedures that determine the constructor's ability to produce the desired results. In some cases, this may include setting pre-qualification criteria for constructors.

The owner generally seeks assistance in constructor selection from the design professional, legal counsel, and other advisers. The role of the design professional in constructor selection centers on preparing, for the owner's approval, the bidding package. This package includes the contract documents that define the project, as well as the procedures for submitting price competitive bids or proposals. The design professional may also assist the owner in administering the bidding process, evaluating the bids or proposals received, and awarding the contract.

Many competitive bidding procedures are described in documents prepared by professional organizations, industry associations, and government agencies. These procedures, recommendations, laws, and regulations are usually structured for competitive bidding of public work. Using public works procedures as a base, other procedures, such as competitively priced proposals and competitive bidding by a select list of bidders are discussed in this chapter.

Constructors are motivated to bid projects, both public and private, if the risk allocation provisions in the bid documents are fair, clearly stated, and diligently followed.

In this chapter

14.1 SELECTION PROCEDURES AND QUALIFICATIONS

The owner, typically assisted by either a construction manager, the design professional or other advisers, formulates a procedure to attract and evaluate interested constructors. This procedure for selecting the constructor may be informal or highly structured, depending on the size and complexity of the project and the owner's organization. Private-sector owners may award construction contracts on the basis of prices offered informally, even orally, by constructors known to them. However, most public agencies are required by law to solicit for their requirements using either competitive bidding or competitive negotiated proposals for construction contracts.

➢ Chapter 3, "Project Delivery Systems"

The first step in the selection procedure, either public or private, may be to invite constructors to submit information about their qualifications in the form of a statement of qualifications (SOQ). The invitation can be either a public

➢ 3.3, "Construction Management"

notice or private invitation. The tailoring of the qualification appraisal varies, depending upon the construction site and complexity of the project and any special skills, experience, or equipment required.

In general, competitive bidding for public-sector projects requires the following qualifications of constructors submitting bids:

- Valid state and local license(s) to perform the work; and
- Proof of financial capability to enter into contract, as evidenced by the ability to supply bid and performance bonds.

However, public agency regulations may permit a more restrictive pre-qualification if the project requires specialized construction techniques, is on a critical schedule, or has special characteristics regarding protection of the environment and safety.

The following is a general checklist of pre-qualification information that may be requested by the owner:

- Constructor name, location, license, and corporate structure, if applicable.
- Commitment of constructor to not change key personnel.
- Business data: financial information, bonding capacity, bank references.
- Construction experience: projects constructed or under construction, size, type, performance on schedule, and budget.
- Workforce on constructor payroll versus subcontracting.
- Equipment owned versus rentals.
- Safety records: written program, actual experience.
- Quality control: written program.
- Resumes of key executive and supervisory staff.
- Current workload: remaining bonding capacity.
- Personnel to be assigned to key positions of management and field supervision.
- Performance of completed projects, specifically including information on project cost and completion relative to terms of the contract and references for each project's owner.
- Record of litigation, including arbitration, mediation, mini-trials, and other proceedings, i.e., with ILRB, EEOC, OSHA, IRS, etc.

The Associated General Contractors of America (AGC) has prepared a preprinted form, "Construction Contractor's Qualification Statement for Engineered Construction" (AGC Doc. 220), for use as a suggested generic pre-qualification statement or a contract-specific qualification statement. Guidance for the presentation of design-builder qualifications may be found in the Design-Build Institute of America's "Design-Build Contracting Guide" (Doc. 2215). The American Institute of Architects (AIA) has prepared a helpful document titled "Contractor's Qualification Statement" (AIA document A305). Another example is a form developed by the California Department of Industrial Relations in response to California law. This was developed as a guidance document, including model questionnaire, titled "Pre-Qualification of Contractors Seeking to Bid on Public Works Projects."

Associated General Contractors of America: http://www.agc.org

Design-Build Institute of America: http://www.dbia.org

American Institute of Architects: http://www.aia.org

California Department of Industrial Relations: http://www.dir.ca.gov/prequal.htm

In examining and evaluating the information submitted, the owner may, in addition to checking the references supplied by the constructor, make independent checks on the constructor's credit standing, visit projects completed and interview owners and operators, investigate safety and litigation records, and review other indicators of performance capability.

14.2 CONSTRUCTOR QUALIFICATIONS

After the submittal and confirmation of constructors' qualifications, the owner is ready to proceed with selection of a constructor. Private-sector owners may choose the constructor or design-builder that they consider the best qualified. Alternatively, the owner may use the qualification information to develop a short list of pre-qualified constructors who are asked to

- Bid competitively for the work on a unit-price or lump sum basis; and
- Present priced proposals for negotiation of a contract on mutually acceptable terms.

If the owner is a public agency, the analysis of the qualification information may be used to select a short list for submittal of priced proposals.

If pre-qualification information is not being requested from constructors, criteria may be set by the agency for qualifying bidders in terms of experience, size, licensing, workload, specialized expertise, financial status, and other qualifications appropriate for the construction of the project.

14.3 SELECTION BY COMPETITIVE BIDDING

Ingredients for true price competitive bidding include the following:

- A clear, concise set of project drawings, project specifications, and other proposed contract documents;
- A defined procedure for the bidding and award;
- An adequate industry capacity and interest.

Adequate industry interest and capacity ensure that a sufficient number of bidders are competing against each other to win the project.

The contract documents specify the product to be delivered by the constructor. The bidding procedure protects the owner as well as the bidders by providing a systematic approach to bidding and awarding the contract.

Competitive Bid Web Resources

- AIA: http://www.aia.org
- EJCDC: http://www.ejcdc.org
- ACEC: http://www.acec.org
- AGC: http://www.agc.org
- APWA: http://www.apwa.net

14.3.1 Role of Design Professional

The design professional's degree of involvement in the bidding process depends on the agreement for professional services with the owner. The nature and extent of this agreement are influenced by the owner's staff size and capability. In a typical arrangement, the design professional:

- Prepares project drawings, project specifications, bidding documents, and other contract documents, as well as estimates of probable con-

struction cost and duration for the review and approval of the owner, the owner's legal counsel, and other advisers;
- Assists the owner in obtaining bids for each separate contract to be awarded;
- Assists the owner in evaluating bids and in awarding contracts.

The general responsibilities of preparing documents for the bidding process and performing activities are outlined in standard procedures by a variety of professional organizations.

14.3.2 Competitive Bidding for Public-Sector Projects

Competitive bidding is a frequently used constructor selection method for federal, state, and local government projects. For these types of projects, the use of competitive bidding is usually mandated by law or agency regulations. This mandate reflects a legislative body's opinion that competitive bidding for construction contracts provides value to the taxpayers and fairness to the construction industry when spending major sums for capital programs. The goals of value and fairness are met when the integrity of the bidding process is preserved.

Beyond the general mandate for competitive bidding, there are numerous specific rules and criteria that may affect public owners during the constructor selection process. The information required for typical bidding and award of a public construction contract is defined by the set of documents issued to prospective bidders. These documents generally include

Management of Public Works Construction Projects, Section 16, "Bidding," James L. Martin, American Public Works Association, 1999.

- The invitation to bid (legal notice), instructions to bidders, information for bidders, and bid forms. Bidder qualification data may be a part of the bid submittal if proof of valid licensing and bonding capacity is all that is required. If constructor pre-qualification is used as a means of developing a list of qualified bidders, this activity occurs before the start of the conventional bidding procedure.
- Contract documents specify the constructor's performance on the project and generally include the owner/constructor agreement, performance and payment bonds, the bid or proposal, general conditions, supplementary conditions, project specifications, project drawings, and addenda issued during the bidding period.

14.3.3 Owner's Bidding Procedures for Public Works

The procedures required to solicit and inform bidders, to receive and analyze bids, and to award contracts under a competitive bidding system include the following actions prior to the bid opening, during the bid opening process, and after bid opening. These activities are conducted by the owner, assisted by the design professional, legal counsel, and other advisers.

14.3.3(a) Prior to Bid Opening

- Receive and evaluate constructor qualifications if a pre-qualification of bidders is part of the process.

- Invite qualified constructors to bid on the project through legal notices and other advertisements, direct mailings, and notices to trade publications and accredited plan rooms.
- Set bid-opening time and date to allow sufficient time for constructors to make accurate quantity take-offs, conduct project site investigations, obtain subcontractor prices, determine material and equipment costs, and take whatever action is necessary to prepare a unit price or lump sum bid.
- Arrange for distribution of bidding and contract documents to interested bidders, accredited plan rooms, and other viewing locations.
- Maintain a current list of document holders.
- Make appropriate arrangements so that prospective bidders may have access to the project site.
- When appropriate and practical, hold a pre-bid conference at the project site to answer inquiries on and clarify provisions of the bidding documents. The pre-bid conference is not used to convey information in addition to that contained in the bidding documents. The constructor and owner are held responsible for what is in the written documents, not the conversation at the pre-bid conference. If clarification is required, an addendum is issued to all document holders.
- Issue addenda to all document holders of record. If an addendum is required, and cannot with certainty reach all prospective bidders in time to permit adjustments in the bid to be submitted, the bid opening may be postponed.

14.3.3(b) Bid Opening

- Require that all bids be dated and time-stamped when received at the bid opening location. Late bids should be returned unopened.
- Open bids at a public meeting where they are read aloud.
- Check bid submittals for presence and amount of bid security, acknowledgment of receipt of all addenda, presence of required documentation.
- Make original bidding documents available for inspection in the presence of the bid-opening official.
- Safeguard bids for later evaluation.

14.3.3(c) After Bid Opening

- Prepare bid tabulations and make information available to interested parties.
- Verify and analyze qualification data submitted with the bids.
- Confirm compliance with other requirements of bidding documents.
- Take appropriate action with advice of legal counsel in rejecting non-conforming bids.
- Take appropriate action with advice of legal counsel in permitting withdrawal of bids by bidders claiming errors in bid preparation.
- Analyze bid prices (compare to estimate of probable cost), supporting information, and documentation, using criteria set forth in bidding instructions, and determine lowest responsive, responsible bidder.

- Reject all bids if constraints of budget, schedule, or other critical elements cannot be met.
- Take appropriate action to advise all bidders of the apparent low bid and release unsuccessful bidders in accordance with the instructions to bidders.

14.3.3(d) Contract Award

- When required, obtain approval of federal or state agencies administering grants and/or loans.
- Make award within the time specified in the bid documents (AGC recommends a maximum of 75 days after bid opening). If the time must be extended, a written approval from the selected bidder is required.
- Prepare a notice of award, forwarding multiple copies of the contract documents for the successful bidder's signature. The notice of award allows a certain period of time for the constructor to sign the documents and return them along with executed bonds, certificates of insurance, and other required documentation.
- Have owner sign and execute contracts, and issue notice to proceed with the work.
- Carefully observe procedures, rules, and regulations that protect the integrity of the bidding process, provide fair and equal treatment of bidders, and give the public agency owner fair prices from the competitive process.

14.3.4 Competitive Bidding for Private-Sector Work

The private-sector owner may elect to follow essentially the same procedures in securing competitive bids as have been outlined for the public sector. The owner may invite a broad spectrum of the construction industry to participate or may limit participation to a select bidders list chosen by pre-qualification.

In either case, the owner and bidders rely on defined bidding and contract documents, generally prepared by the design professional, to provide mutual understanding of the project and to set rules and procedures for competitive bidding and award of contract.

14.4 SELECTION PROCEDURES FOR COMPETITIVE NEGOTIATED CONTRACTS

Best Value Contracting:
Best value contracting is a process used in competitive negotiated contracting to select the most advantageous offer by evaluating and comparing factors in addition to cost or price.

Situations occur where requirements solicited using competitive sealed bidding and contract award based solely on lowest price may not be appropriate. In these situations, the owner first compares the qualifications submitted by interested constructors. The owner selects the constructor best qualified for the project, according to established criteria, and then negotiates a contract for project construction with that firm or person. This approach generally results in some form of reimbursable cost-plus-fee contract, although negotiated lump sum or unit-price arrangements are not precluded.

If competition more directly related to construction or design-build services is desired, the owner selects a list of constructors on the basis of qualification analysis. The owner then solicits proposals from constructors on the list to address certain topics defined by the owner. These topics typically include

- Project understanding with emphasis on the owner's goals and objectives;
- Approach to unique project ideas in the construction plan;
- Organization of project activities—services proposed;
- Proposed schedule, with milestones;
- Programs for safety, quality control, design, and use of temporary structures;
- Availability of construction crafts, use of subcontractors, minority involvement;
- Use of local resources;
- Business information—wage and salary costs, overhead costs, contracting policy, insurance, and other related items;
- Project budgets by components of the work;
- Proposed cost of work—unit-price, lump sum, reimbursable cost-plus-fee;
- Key management and supervisory personnel to be assigned to the project.

With this information available, the owner makes an evaluation of the organizational and cost elements of the project and negotiates a contract with the constructor judged to offer the overall best value to the owner.

14.5 SELECTION PROCEDURES FOR NONCOMPETITIVE NEGOTIATED CONTRACTS

Under certain circumstances the owner may select a specific constructor and negotiate the contract. Situations where this procedure applies include

- The owner may choose the constructor based on the constructor's satisfactory performance on projects previously done for the owner;
- The constructor may have unique qualifications for the planned project;
- The constructor is already working at the project site;
- The urgency of the situation requires immediate action. (For example, damage control, restoration of failed utilities, protection against flood or other natural disaster.)

In the case of sole source award of a contract by a public agency, the constructor may have unique characteristics, such as a record of successful business relations with the owner, specialized expertise not available elsewhere, or may be available immediately to handle an emergency.

SUMMARY

Project quality depends in large measure on the ability of the constructor to conscientiously follow the project drawings, plans, and project specifications to complete the construction of project facilities safely, on time, and within budget. With these responsibilities in mind, the owner formulates a selection procedure that emphasizes the evaluation of constructor qualifications. The owner evaluates these qualifications and makes a list of pre-qualified bidders or proposers who are most likely to be capable of completing the project successfully. The design professional generally assists in the constructor selection process.

Public-sector agencies typically use fair and impartial, though sometimes extensive, bidding procedures that focus on the requirement to obtain a competitively bid low price for construction from a responsible bidder. Private-sector owners may use less rigid selection procedures, often soliciting bids from a pre-selected list of constructors. The competitive bidding process usually results in the award of the contract to the most qualified bidder with the lowest unit-price or lump sum bid. Constructors may also be selected on the basis of competitively priced proposals or by a sole-source selection process.

Up-to-date versions of constructor selection recommendations and guidelines are available from many construction industry organizations. ❑

Chapter 14: Procedures for Selecting the Constructor
Typical Responsibilities

Responsibility ⇩	**Owner**	**Design Professional**	**Constructor***	**Design-Builder***
Adopt bidding procedures	●	⦿		
Request constructor's qualifications	●	⦿		
Prequalify bidders	●	⦿		
Prepare contract documents including project drawings and project specifications	○	●		
Request submittal of bids/proposals	○	●		
Prepare and submit bids			●	●
Receive and evaluate bids	●	○		
Evaluate bidders/proposers if pre-qualifications not used	●	○		
Select qualified constructor	●	⦿		
Select alternatives	●	⦿		
Execute construction contract	●	⦿	●	●

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

● = Primary Responsibility ⦿ = Assist or Advise ○ = Review

CHAPTER **15**

THE CONSTRUCTION CONTRACT

In this chapter

The construction contract, including all exhibits and attachments, defines the business agreement between the owner and the constructor. Under traditional design-bid-build (DBB) project delivery, the construction contract is a two-party agreement that does not include the design professional. However, the design professional may provide professional services related to construction at the owner's direction during construction.

In a design-build project, the design-build firm contracts to perform both construction and design services. However, the basic elements of the traditional DBB construction contract, as described in this chapter, remain at the core of design-build agreements. Other project delivery systems (described in Chapter 3) involve design-build variations. Therefore, it is important that the construction contract, whatever form it may take, accurately document a meeting of the minds; states clearly the roles and responsibilities of the parties without overlaps or voids; and aims squarely at achieving a quality project.

15.1 FUNCTIONS OF THE CONSTRUCTION CONTRACT RELATING TO QUALITY

The construction contract serves several important functions from the beginning to the end of a project. It defines the rights and responsibilities of the owner and the constructor, ranging from the specific quality requirements contained in the project specifications and project drawings to the owner's obligations to make decisions and payments in a timely manner. Additionally, the contract documents set forth procedures and requirements for management and administration of the contract, such as schedules, shop drawings, and inspections. In this context, the contract documents can be considered a procedures manual to help ensure quality.

Another important role of the construction contract is that of a planning tool for quality of construction. That is, the parties preparing the contract documents can look to the various components to help ensure that appropriate attention is given to quality of construction. This could range from requirements for materials or workmanship to procedural requirements such as submittals and inspections.

The construction contract documents also support a structured planning process in their role as a risk management plan and risk allocation device. Finally, of course, there is the legal function. Contract rights and responsibilities are legally enforceable. This provides certainty to both parties that the other party will perform in accordance with the terms of the contract, which if prepared with appropriate quality requirements will result in a quality project. In the event of disputes, the contract documents will be an agenda or road map for litigation or other dispute resolution procedure.

15.2 ROLE OF THE DESIGN PROFESSIONAL IN THE CONSTRUCTION CONTRACT

Under traditional DBB project delivery, the construction contract is a two-party agreement between the owner and the constructor. However, it may include a description of the various services and functions the design professional may provide during construction. The design professional may also have a major role in preparing many of the contract documents and compiling documents for use by bidders and the parties.

Other project delivery systems (see Chapter 3) may involve variations. For example, in projects where the owner has retained an agency construction manager (ACM), the ACM may prepare parts of the contract documents. In any case, it is important to carefully coordinate all parts of the contract documents to avoid conflicts or inconsistencies.

15.3 DEFINING AND PREPARING THE CONSTRUCTION CONTRACT DOCUMENTS

➢ Chapter 17, "Construction Contract Documentation and Submittals"

Typically there are several separate components to the construction contract documents. Each should be clearly listed in the agreement signed by the parties. These documents supersede any prior oral or written agreements (particularly if there is a contract clause stating this).

Construction contract documents generally include the following:

- The agreement (the document signed by the parties, which customarily identifies the parties; states the contract price, payment terms, and contract time; and lists the contract documents);
- General conditions;
- Supplementary conditions;
- Lien waivers;
- Confidentiality agreements;
- Project drawings;
- Project specifications;
- Addenda (if any) issued before bid submittal;
- Bid instructions;
- Bid forms;
- Contractor's bid;
- Notice to proceed;
- Performance and payment bonds (if any);
- Change orders or contract modifications (post-execution).

Preparation and assembly of the construction contract documents for review and approval by the owner and the owner's legal counsel may be done by the owner's staff, a third-party design professional, a construction management professional, or a combination of these parties. Sometimes the contractor or the design-builder may submit a contract to the owner. In any case, preferably a team of individuals knowledgeable about the project and contract documents work together to produce a construction contract that accurately reflects the intent of the parties. Regardless of who prepares the construction contract documents, the owner must make decisions on many subjects, such as insurance requirements, bonds, and bidding requirements.

Because the contract documents are the key to defining quality requirements, it is important to denote the preparation effort necessary to produce quality contract documents both individually and as an integrated "package." Quality contract documents help provide quality in constructed projects. It is essential that attention be given to a careful review of all of the documents to help ensure coordination and consistency, i.e., avoid gaps and conflicts, the source of many misunderstandings and disputes.

One of the functions of the contract documents is to allocate risks inherent in any construction project. Every risk has an associated, unavoidable cost that must be accounted for or assumed in the design and construction process. Risk should be allocated to the party best able to evaluate, control, bear the cost, and benefit from the assumption of risk. Some risks (weather, for example) may be shared, with each party accepting its own risk for the cost associated by that risk.

Improper allocation of risk is more likely to result in a poor quality project and lead to disputes. Owners benefit from fair and balanced allocation of risk because projects are more likely to be completed on time, with acceptable quality, and at a fair price without the inclusion of contingencies in the contractors' bids to account for some uncontrollable risk. Fair and balance allocation of risks also enhance working relationships between the parties throughout construction. Unfair provisions in the contract documents may not be enforceable and are more likely to distract the parties' attention away from the goals of the project and lead to expensive disputes and litigation. "The Guide to Uniform Location of Subject Matter and Information in Construction Documents," a joint publication of the American Institute of Architects (AIA Doc. 521) and the Engineers Joint Contract Documents Committee (EJCDC Doc. 1910-16), addresses the question of where to place or find a specific subject in contract documents, offering a uniform approach to the organization of contract documents. It also serves as a comprehensive checklist of items to be included in the construction contract.

15.4 STANDARD-FORM CONSTRUCTION CONTRACT DOCUMENTS

Several components of the construction contract documents may be available as standard forms, to be completed or edited to define the agreement for a particular project. These standard forms typically include the agreement form, general conditions, and surety bond forms. The benefits of standard forms include efficiency in both time and cost in their preparation and include efficiency in the bidding process because bidders are familiar with the terms and working arrangements set forth in the documents. Standard forms are

Organizations mentioned in this chapter

American Council of Engineering Companies: http://www.acec.org

Associated General Contractors of America: http://www.agc.org

American Institute of Architects: http://www.aia.org

American Society of Civil Engineers: http://www.asce.org

Construction Management Association of America: http://www.cmaanet.org

Construction Specifications Institute: http://www.csinet.org

Engineers Joint Contract Documents Committee: http://www.ejcdc.org

Design-Build Institute of America: http://www.dbia.org

National Society of Professional Engineers: http://www.nspe.org

➢ Chapter 23, "Risk, Liability, and Handling Conflict"

Users of standard forms should be cautioned, however, that standard forms can rarely be used without some modification or enhancement. Standard forms need to be carefully reviewed for each specific project and each place and time of construction.

➢ Chapter 7, "Agreement for Professional Services"

ENAA: http://www.enaa.or.jp/

FIDIC: http://www.fidic.org

http://www.ice.org.uk/

JCT: http://www.jctltd.co.uk/

more likely to include industry standard allocation of risks and include tested language in the event of disputes. Standard forms are also carefully prepared to coordinate provisions among the various contract documents, thereby avoiding inconsistencies. Large public and private owners, design professionals, and constructors may have their own individually drafted standard contract forms. However, such forms may not always document an appropriate allocation of risk. They may also include potentially unenforceable contract provisions, archaic terms and procedures, and internal conflicts.

Professional organizations and industry associations offer important advantages by promoting the broad use of standardized contract content, forms, definitions, and language. EJCDC (a joint committee of ASCE, ACEC, AGC, and NSPE), AIA, AGC, and DBIA have also developed high-quality standard forms, agreements, general conditions, and other documents, as well as commentaries on the use of these materials. Developed by practitioners with varying perspectives and experiences, and with extensive review by legal counsel, the EJCDC, AIA, and AGC standard forms are coordinated, reliable, "court tested" documents that offer significant advantages in most contracting situations. Descriptive information and purchase procedures may be obtained from the respective organizations (EJCDC documents are sold by ASCE, ACEC, NSPE, AGC, and CSI).

15.5 INTERNATIONAL CONSTRUCTION CONTRACTS

Construction contract documents for work outside the United States are also often based on industry-prepared standard forms. A number of organizations prepare recommended standard general conditions and associated forms. The organizations include the following:

- ENAA (Engineering Advancement Association of Japan);
- FIDIC (International Federation of Consulting Engineers);
- ICE (Institution of Civil Engineers, United Kingdom);
- JCT (Joint Contracts Tribunal).

For example, FIDIC has prepared a widely used standard form entitled "Conditions of Contract for Works of Civil Engineering Construction" in consultation with lending institutions and with constructor associations. This document (often referred to as the *Red Book,* after its color), currently in its fourth edition, is considered to have fairly balanced the contractual risks and responsibilities between owner and constructor. It is frequently the design professional's responsibility to adapt Part II of the *Red Book,* the "Conditions of Particular Application," to meet the needs of individual countries or projects. Guides to the use of FIDIC conditions of contract are also published by FIDIC. Some are available through ACEC; all may be obtained from FIDIC.

In 1995, FIDIC published "Conditions of Contract for Design-Build and Turnkey" Parts I and II. This document, informally known as the *Orange Book,* is structured much like the *Red Book* but is for design-build or turnkey applications. In 1999, FIDIC published the first edition of "Conditions of Contract for Plant and Design-Build," which is intended for electrical and mechanical plant and building and engineering work designed by the contractor. Also in 1999, FIDIC published "Conditions of Contract for EPC Turnkey Projects" and "Conditions of Contract for Construction for Building and Engineering Works Designed by the Owner." FIDIC's often-used "Conditions of Contract for Electrical and Mechanical Works" is usually known as the *Yellow Book.*

The ENAA has issued model forms for international contracts for both process plant and power plant construction. The ICE has published design and construction conditions of contract, as well as a standard "Conditions of Contract for Design and Construction Projects."

15.6 DESIGN-BUILD

The basic components of the traditional DBB construction contract, as described in this chapter, remain at the core of design-build agreements. The contract documents also include design criteria, performance specifications, or outline specifications (or a combination thereof) prepared by the owner or a firm specializing in the preparation of design-build procurement documents (often a design professional), as well as the design-builder's proposal.

In design-build projects, several of the contract documents that define specific quality requirements, particularly the project drawings and project specifications, have not yet been prepared or are not in their final form at the time of entering into an agreement. Consequently, it is important for the parties to come to a meeting of the minds concerning quality requirements prior to establishing the price and time for the work. This can be done in a variety of ways, such as including specific quality requirements or performance requirements in the request for proposal, requiring the design-builder to include quality requirements in its proposal, or by making reference to another specific similar project.

➢ Chapter 3, "Project Delivery Systems"

SUMMARY

The construction contract defines the relationship between the owner and constructor. The contract documents embody the agreement between these two parties for construction of the project. The construction contract assigns responsibility and authority for managing and administering situations that the parties expect to encounter, as well as procedures for addressing those that are unexpected.

The development of the construction contract is a crucial phase in the life of a project. The roles and responsibilities stated and assigned by the contract bear directly on the cost and quality of the project, as well as the safety of the people who will build and use it.

Therefore, while each party may approach the development and negotiation of the construction contract in good faith, it is important that the contract documents be reviewed and approved by qualified legal counsel—preferably a person or firm with construction experience. ❑

Typical Responsibilities—DBB

Responsibility ⇩	Owner	Design Professional
Prepare proposed construction contract documents	◉	●
Provide legal review of proposed construction contract documents	●	
Establish procedures for timely and effective contract administration	●	◉

● = Primary Responsibility ◉ = Assist or Advise

Typical Responsibilities—Design-Build

Responsibility ⇩	Owner	Design-Builder
Prepare proposed contract documents	◉	●
Provide legal review of proposed contract documents	●	
Establish procedures for timely and effective contract administration	●	◉

● = Primary Responsibility ◉ = Assist or Advise

CHAPTER 16

PLANNING AND MANAGING CONSTRUCTION

The planning and management of construction can vary dramatically depending on the type of project, its scope, and the relationships between the owner, design professional, and constructor.

This chapter discusses the principal activities involved in construction planning and management, including project organization, pre-construction meetings, the nature of the proposed construction activities, and project coordination and communication.

In this chapter

16.1 ORGANIZING FOR CONSTRUCTION

A project team's organizational structure strongly influences the construction planning and management activities of the owner, design professional, and constructor. Project team structure depends on the characteristics of the owner's organization—it may be a public agency or a private firm—as well as the type of contracts the owner holds with team members. For example, if the owner chooses a design-build approach, the design professional may contract with and report to the constructor, rather than the owner (as would be the case in a design-bid-build project). The requirements of funding agencies and financial institutions may also affect construction planning and management.

Given the large number of variables that influence project team organization, the owner can improve the quality of construction planning and management by establishing and monitoring clear lines of authority and team member responsibilities. This is especially true as owners adopt an increasing variety of project delivery methods. While contracts and laws remain the primary means for defining team member responsibilities, project participants may no longer assume that traditional owner–design professional and owner-constructor relationships are applicable to every project. As an example, owners of industrial projects often retain responsibility to separately contract for, or provide, process equipment. Owners may decide to contract with a project manager, enter into design-build agreements, or contract with a construction manager. All of these variations involve different construction planning and management considerations.

16.1.1 Owner Responsibilities

The primary responsibilities of the owner during construction generally include

- Providing clear expectations for the project;
- Providing quality assurance oversight for the duration of the project;

- Administering contracts and coordinating the activities of participants;
- Making prompt decisions on construction matters;
- Responding in a timely manner to documents and materials submitted for review;
- Making payment according to contract terms;
- Enforcing contracts;
- Performing other duties and responsibilities assigned by the contract and governing statutes;
- Maintaining communication with the public and/or affected parties.

Design-Build Institute of America: http://www.dbia.org

While the following activities may occur during the early phases of construction, they are most effective if implemented during pre-construction:

- Establishing responsibilities for quality assurance. This may be either in-house staff or contracted third party.
- Establishing value engineering responsibilities;
- Assigning overall responsibility for construction site safety (usually to the constructor).

16.1.2 Design Professional Responsibilities

The design professional's agreement, as well as any additional legal requirements, are the basis for the design professional's activities during construction. The design professional's construction phase responsibilities generally include the following:

- Interpreting and clarifying contract documents when questions arise;
- Reviewing and approving technical elements of contract change orders;
- Reviewing and evaluating proposed value engineering suggestions and/or proposed substitutions;
- Reviewing and commenting on technical elements of contract submittals;
- Providing advice to the owner's resident project representative (RPR) on technical elements of design and construction;
- Consulting with the RPR on project quality assurance measures.

The design professional's agreement with the owner may define further responsibilities and delegate authority that allows the design professional to

- Function as the owner's RPR and provide complete, accurate, and timely communications to all project team members;
- Review and approve change orders for the owner's signature;
- Review and approve progress payment applications for the owner;
- Review and take appropriate action on constructor's submittals specified by the contract;
- Observe the progress and quality of the constructor's work and report all observed deficiencies;
- Represent the owner with regulatory agencies;
- Provide other professional services specified by the contract.

16.1.3 Constructor Responsibilities

As the team member performing work at the project site, the constructor's principal responsibilities include the following:

📖 ASCE Policy Statement 350, "Construction Site Safety"

"ASCE believes that safety on construction sites can be improved... by (placing an) emphasis on safety at the project level, (and) the assignment of primary overall safety responsibility and authority to a single organization for the project..."

- Planning construction-related activities, including coordinating and sequencing of construction activities;
- Constructing the facility in accordance with the project drawings, project specifications, and approved change orders of the construction contract;
- Providing or causing others to provide the selection, planning, and implementation of the actual means and methods of construction;
- Notifying the owner and design professional of possible design problems during the construction process;
- Notifying the owner and design professional of unforeseen site conditions;
- Establishing and maintaining the project construction schedule and budget;
- Performing quality control for construction activities, with deficiencies tracked on a rolling completion list maintained by the constructor and shared with all parties;
- Developing and implementing the construction site safety plan (if delegated by the owner);
- Preparing (or causing to be prepared) and reviewing the required shop drawings and other submittals and monitoring the completion of the various necessary shop drawings throughout the project using a submittal schedule created prior to the start of a project;
- Managing and paying construction suppliers and subcontractors;
- Fulfilling the provisions of the owner-constructor contract;
- Complying with applicable laws and regulatory guidelines.

Variations in the contractual arrangements and participation of other project-related organizations (such as program, project, and construction managers) may involve modifications to the constructor's responsibilities as described above.

16.2 PRE-CONSTRUCTION MEETINGS

Upon selection of the constructor, the owner, design professional, and constructor usually hold pre-construction meetings. These meetings provide the participants with the opportunity to become acquainted with each other's organizations and key players, become familiar with the owner's schedule requirements, and agree on methods of communication. In addition to these meetings, many elements of the initial pre-construction meeting(s) may be addressed in partnering sessions moderated by an outside facilitator.

➢ Chapter 24, "Partnering"

16.2.1 Owner's Pre-Construction Meeting

The owner usually holds the first pre-construction meeting, inviting the key construction representatives from its organization, the design professional, and the constructor. The owner may also invite representatives of regulatory agencies and, through the constructor, various subcontractors.

The pre-construction meeting is a unique opportunity for members of the project team to familiarize themselves with project goals and objectives, other participating organizations, and key personnel. Therefore, the owner benefits from preparing and distributing the agenda in advance, as well as following up with accurate minutes distributed to the attendees (see Figure 16-1).

The agenda should also include other items that are unique to the project and/or the owner's requirements.

16.2.2 Constructor's Pre-Construction Meeting

After the owner's pre-construction meeting, the constructor may hold a similar meeting for participants involved in the construction effort, including representatives of subcontractors, material suppliers, and vendors. The RPR and design professional may attend to observe and provide information to the constructor as requested. If portions of design are to be lawfully delegated to

Figure 16-1 Typical Pre-Construction Meeting Agenda Items

1. Team member roles and responsibilities
2. Communication and correspondence procedures, including an e-mail distribution list
3. Procedures for issuing and revising design information and authorizing changes
4. Documentation, record-keeping, and reporting requirements
5. Project schedule
6. Project cost control program
7. Methods and schedules of payment
8. State and local laws or regulations
9. Subcontractor qualification
10. Insurance coverage, review of certificates, and verification of coverage
11. Critical provisions of project specifications
12. Submittal procedures
13. Overtime and shift work procedures
14. Safety and first aid
15. Survey information
16. Site rules and regulations
17. Project drug-free policy
18. Constructor's designated areas for staging and construction
19. Coordinating procedures
20. Constructor quality control and owner quality assurance
21. Testing procedures
22. Access, parking, and security
23. Project confidentiality requirements, if any
24. Responsibility for and details of environmental issues and procedures
25. Site and building cleanup
26. Temporary facilities and services
27. Site logistics
28. Contaminated material handling and disposal
29. Claims and dispute resolution procedures
30. Equal Employment Opportunity (EEO) compliance
31. Community relations
32. Record and as-built document requirements
33. Project closeout

subcontractors, the design professional, constructor, and other parties involved should review and confirm in writing the attendant responsibilities in accordance with applicable law as early as possible.

The agenda for the constructor's meeting is similar to the owner's pre-construction meeting, but the discussion focuses on the performance of the participants who support the constructor.

16.2.3 Specific Element Pre-Construction Meetings

The owner may require or the constructor may hold additional pre-construction meetings prior to the start on specific elements of the project, such as demolition, concrete operations, fabrication of pre-cast elements, roofing, exterior wall installation, or other discrete tasks that are critical to a project's overall success. These meetings may include representatives of the owner, design professional, constructor, subcontractors, suppliers, associated construction crafts, and other participants as may be needed.

Agenda items for these meetings may include performance expectations, project drawings, project specifications, deliveries, testing, anticipated results, schedule, logistics, necessary approvals, acceptable practices and procedures, safety, resources, and other related issues that need to be resolved before construction for the specific activity begins. Minutes of items discussed and decisions made should be prepared and distributed to all participants.

Also, scheduled progress meetings on these elements should be held to ensure that those items discussed at the preparatory (pre-construction) meetings are being adhered to and to address officially any changes necessitated during the execution of the work.

16.3 CONSTRUCTION ACTIVITIES

The planning and managing of construction focuses on the successful sequencing and performance of activities at the construction site. The owner and design professional begin planning construction even before the constructor is engaged, estimating the major schedule milestones for inclusion in the construction contract. After joining the project team, the constructor takes a lead role in revising construction plans to the level of detail necessary to actually begin construction activities. The RPR reviews and approves the planning and schedule refinements proposed by the constructor.

➢ Chapter 12, "Pre-Contract Planning for Construction"

The construction planning and management activities that the team addresses in pre-construction planning include the following:

- Construction scheduling to include schedule of submittals;
- Testing, inspection, and other QC activities;
- Estimates and cost control;
- Mobilization, logistic, temporary construction facilities, and utilities;
- Equipment and material management;
- Managing the construction workforce;

- Safety and first aid;
- Project close-out; and
- Other activities that may be specific to a particular project.

Projects benefit from these planning and management activities—projects with relatively short construction schedules generally benefit the most from aggressive efforts in these areas. The following sections address these topics.

16.3.1 Construction Scheduling

Usually 30 days after receiving notice to proceed, the constructor prepares and presents for the owner's review a schedule to be used as the baseline schedule. On larger projects this usually involves a computer-generated critical path method (CPM) schedule. This baseline schedule reflects the proposed construction sequence plan, includes the critical path, and is resource loaded. Later, schedule updates are compared to the baseline schedule to determine if the project is ahead or behind the constructor's original construction plan.

The submittal schedule is developed from the baseline schedule and is used to manage submittals and allow adequate time for review and approval to avoid project delays.

During a project's pre-construction phase, and continuing through construction, the project team regularly updates the schedule, incorporating increasingly greater levels of detail about the activities and schedules of subcontractors and other participants. On longer projects (those lasting a year or more), the team may use both a computer-generated CPM schedule updated monthly and a "rolling" schedule with an upcoming window of several weeks or months to display detailed and specific construction information. The constructor often prepares daily, weekly, and monthly schedules to aid in directing the construction site workforce.

Schedules reflect available resources and funds and the allocation of staff, construction workforce, materials, and equipment.

If the owner uses multiple construction contracts for a single project, a specific designee of the project team integrates the schedule of each constructor into the overall project schedule to ensure successful interfaces among the constructors.

The size and complexity of a project influence the team's selection of appropriate scheduling processes and technologies. The team establishes schedule milestones that reflect the individual needs of project participants, as well as the activities that involve cooperation and have interdependence among two or more participants. The schedule reflects available resources and funds, and the allocation of staff, construction workforce, material, and equipment.

➢ 17.2.2, "Schedule"

Construction schedules are "living" documents. They evolve with the project, providing the project team with a road map that shows a project's current status, its rate of progress, and the anticipated milestone and completion dates.

16.3.2 Estimates and Cost Control

During the planning stage and before construction starts, the constructor creates from the bid estimate a budget. The budget spreads the project estimate over a series of cost codes that are used to capture, track, and project the cost of the project. This budget is used as a baseline and later is compared to actual cost to determine if the project is under or over budget.

The constructor usually refines and updates cost estimates as construction proceeds. The actual progress of construction provides the constructor with the information necessary to track variations in cost and productivity from those forecast in estimates. This information often proves valuable in identifying potential problems and significant deviations from initial cost estimates, allowing the constructor to correct many problems early on that would otherwise create cost overruns and disputes.

Original bid packages may contain a “per-unit” price for furnishing and installing material. This unit price provides a defined value for additional work that may be necessary beyond that described in the construction contract documents owing to unforeseen conditions or a change order issued by the owner. Care must be exercised in obtaining and using unit prices as they are often evaluated and/or bid out of the context in which they will be used. As an example the provider of the price will not know if the pricing will be for 1 or 1,000 units, or if the item will be added before, during, or after the work related to the item is constructed.

It is also prudent to include contract provisions for mark-ups on changes for overhead and profit. Such provisions should also address the mark-up on multi-tier changes that involve subcontractors and possibly sub-subcontractors and/or vendors.

Cost control includes procedures for handling changes to the design and associated contracts. The procedures should address the processes for authorizing, documenting, pricing, and implementing project changes. These procedures also include steps to assess the potential schedule, budget, and quality impact of proposed changes.

Estimates and cost control also involve developing procedures for determining and disbursing payment. The owner and constructor usually address payment during contract negotiations, including such procedures as base contract work, changes in progress, unit cost items, and anticipated labor and material work.

16.3.3 Mobilization, Temporary Construction Facilities, and Utilities

During the design and perhaps bidding phases, the owner identifies facilities that will be provided to the constructor. The constructor typically acts on these identified facilities as soon as possible to ensure uninterrupted utility service and compliance with the terms of the contract with the owner.

Before mobilizing work crews and equipment for construction, the constructor finalizes plans for temporary construction facilities, based on analysis of the necessary construction access, lay-down areas, warehouses, dumping facilities, temporary utilities, communications systems, deliveries, and parking areas.

16.3.4 Material, Equipment, and Waste Management

During the submittal process, it is valuable for the constructor to obtain sample materials and products, as well as supporting documentation from suppliers and manufacturers. These aid the constructor in developing plans for managing the materials and equipment that are to be brought to the construction site. This planning may include determining purchasing needs, delivery considerations, special storage needs, and in-storage maintenance of materials and equipment. The constructor coordinates the materials and equipment management plan with the schedule and continues to synchronize material and equipment needs to the schedule as the project progresses. The availability of materials and equipment is a prime consideration whenever the schedule is revised. Shortages of materials or equipment can interrupt work routines and adversely affect quality and/or cost.

The materials and equipment management plan is a crucial aspect of the estimating process, as it impacts the determination of the size and number of necessary offices, warehouses, and lay-down yards, as well as staffing needs. Computerized material management systems can enhance the managing of materials significantly by assigning schedule item numbers to material records.

The need for a parallel waste management assessment or plan is directly related to materials management. A significant volume of waste, which must be recycled, reused, or disposed of, can accumulate during the construction phase of a project. Waste management programs vary significantly depending on available hauling and dumping facilities; local, state, and federal laws and guidelines; recycling opportunities; and contractual requirements. Creative solutions to waste management can save money and create a positive image for the project; the use of concrete demolition debris as road fill is an example. Projects should be assessed for the need of a hazardous waste management plan. If needed, a comprehensive plan that meets project, local, state, and federal requirements must be developed, documented, and properly distributed to appropriate project team members.

16.3.5 Managing the Construction Workforce

A qualified construction workforce is an essential ingredient in a successful project. The need for skilled trade workers varies with each project, and the assembling and managing of an appropriately sized workforce with the appropriate skills is a difficult yet crucial responsibility of the constructor.

The local availability of skilled construction workers is a key factor in the constructor's management of the workforce. The constructor may gain some flexibility in meeting skilled labor needs by allocating available trades workers, or by spreading out the anticipated workload, in such a manner that the ranks of workers with the necessary skill sets are not depleted during any given time period. The constructor may introduce employment incentives and on the job training to help alleviate shortages of qualified workers. The constructor may also consider prefabricating some project elements in another location where there are sufficient numbers of skilled workers to achieve the project objectives.

In addition to managing the skill levels and size of the construction workforce, the constructor is responsible for ensuring that the workforce meets applicable contractual and legal provisions. These typically include equal employment opportunity guidelines (including compliance with hiring goals for minorities and women), community hiring, relationships with labor unions, and safety training and compliance.

16.3.6 Construction Site Safety and First Aid

Construction site safety is the responsibility of all parties. However, because of the integral relationship of construction site safety to the constructor's means and methods of construction, on most projects the owner assigns to the constructor the responsibility for planning and implementing safety and first aid programs. Such programs are intended to ensure compliance with federal, state, and local laws and regulations and to address issues that are unique to the project or its method of execution.

ASCE Policy Statement 350, "Construction Site Safety"

The owner should support the constructor by following the plan themselves. If the whole project team cannot follow the safety rules, it is more difficult for the constructor to get the craftsperson to adhere to them.

Construction site safety plans may include the following:

- Clearly posted safety rules, inspection procedures, and enforcement actions;
- Safety training sessions;
- Safety certification of equipment, operators, and personnel entering the construction site;
- Personal safety equipment (hard hats, boots, safety vests) available at the construction site;
- Training for emergency first aid and fire fighting;
- Emergency telephone numbers posted for paramedics, fire fighters, and police;
- Designation of emergency escape routes and gathering areas;
- Safety drills; and
- The establishment of safety quotas (such as number of "safe days" at the site) and performance incentives to achieve them.

Occupational Safety and Health Administration: http://www.osha.gov

Associated General Contractors of America: http://www.agc.org

16.3.7 Project Close-Out

Final close-out requirements should be included in the contract documents and involve joint participation of the owner, design professional, and constructor. These include

➢ 9.1.4, "Design Close-Out"

- Preparing the punch list (which may be a monetized punch list, created at the outset from the constructor's rolling completion list, if additional

funds may need to be held in excess of the retainage) and enuring compliance;
- Submitting a complete package of warranty and standard materials to the owner;
- Demonstrating that installed equipment properly operates;
- Providing training on the use of equipment;
- Providing required maintenance checks of equipment during warranty periods;
- Submitting record project drawings of completed facilities in hard copy and electronic formats;
- Providing maintenance and operations manuals for installed equipment and systems;
- Providing maintenance stock and repair parts for installed equipment and systems; and
- Completing necessary certification for government agencies.

16.3.8 Other Activities

The planning and management of construction activities may involve a wide range of other concerns, depending on the size and scope of the project. These may include the following:

- Environmental controls, which often include "best management practices," or BMPs, such as fencing, hay bales, water treatment, and restricted work hours, to limit the environmental impact of construction activities;
- Hazardous waste handling and disposal, which include procedures for testing, storing, and disposing of materials such as asbestos, lead, or contaminated soil;
- Traffic control, including detours, parking, police details, and lane restrictions (these are typically noted in the bid package);
- Public outreach, including notification of work schedules and impacts to local residences and businesses;
- Making photographic, video, and electronic records of project progress.

Hazardous Materials are a unique and critical concern, as the responsibility for their handling and disposal often hinges on when they are discovered. Therefore, the project team benefits from an aggressive effort to identify possible hazardous materials during project development and design.

16.4 COORDINATION AND COMMUNICATION DURING CONSTRUCTION

➢ Chapter 5, "Coordination and Communication"

Coordination and communication during construction depends on well-defined lines of communication among the project team members, subcontractors, vendors, regulators, and other participants. The coordination and communication activities with direct bearing on planning and managing construction include

- Scheduling meetings for appropriate topics and intervals;
- Distributing correspondence in a timely fashion;
- Processing shop drawings efficiently;
- Reviewing and processing payments in a timely manner; and

- Initiating and maintaining relationships with relevant government agencies.

While these activities may involve any team member at any phase of the project, the constructor plays a larger role in coordination and communication during construction and is responsible for directing activity at the construction site and coordinating the participation of subcontractors. Therefore, it is vital to the coordination effort that the contract specify a single party, such as the owner's resident project representative, with the authority to direct the constructor's activities. Similarly, vendors and manufacturers should accept direction only from the constructor, as in the signing of a purchase order, unless the contract terms specify otherwise.

SUMMARY

Strategies for planning and managing construction are evolving as project delivery methods proliferate. New project organizational arrangements are emerging and transforming the traditional roles of the owner, design professional, and constructor. In some cases, design professionals are involved in program management, while in other situations, such as design-build, constructors are involved before the start of construction planning and management. Therefore, an understanding of the key project responsibilities of and by all project team members is an important aspect of project quality. ❑

Chapter 16: Planning and Managing Construction

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional**	Constructor**	Design-Builder
Assign contractual responsibilities	●	◉	◉	◉
Develop construction plan	○	○	●	●
Initiate reporting system	○	○	●	●
Provide and update construction schedule	○	○	●	●
Perform estimating and cost control	○	○	●	●
Provide construction facilities and services	○	○	●	●
Procure materials and manage waste	○	○	●	●
Manage the construction workforce			●	●
Provide safety programs and first aid*	●	○	●	●
Perform project close-out	○	○	●	●
Supervise construction			●	●
Maintain construction quality control	○	●	●	●
Interpret project drawings and project specifications	◉	●	●	●
Make design revisions	○	●	◉	●
Submit payment requests	◉	◉	●	●
Issue stop work order (non-emergency)	●	◉		◉

**As designated by the owner (see ASCE Policy Statement 350, "Construction Site Safety").*

***For DBB. For design-build delivery, the Design-Builder is the responsible party.*

● = Primary Responsibility ◉ = Assist or Advise ○ = Review

CHAPTER 17

CONSTRUCTION CONTRACT DOCUMENTATION AND SUBMITTALS

In this chapter

After the owner awards the construction contract, the constructor prepares and submits to the owner and/or, if designated, the design professional the information necessary to determine that the project will be constructed in accordance with the project objectives, as defined in the construction contract documents. This information from the constructor falls into two broad categories:

- **Contract documentation,** which demonstrates that the constructor is prepared to properly execute and manage the project;
- **Submittals,** which include reports, shop drawings, schedules, and other information showing that the constructor's proposed or completed work meets the intent of the design.

This chapter describes the nature of the documentation and submittals, as well as the roles and responsibilities of project team members in preparing and processing this information under traditional design-bid-build (DBB) contracting. In alternate forms of project delivery, the design professional or constructor may do internally many of the processes described; and a design professional or other consultant engaged by the owner may also have a review role in these processes.

17.1 ROLES AND COORDINATION

Contract documentation and submittals encompass a wide range of information that the constructor provides to the owner and/or, if designated, the design professional (see Figure 17-1). Generally, all communication from subcontractors to the owner or design professional is routed through the constructor. In cases where the nature of the project involves close coordination among parties to meet project specifications, the parties may direct subcontractors and suppliers to communicate directly with the design professional and to inform the constructor of their decisions.

The owner usually reviews non-technical contract documentation, while the design professional reviews most technical documentation and submittals for conformance with the project drawings and project specifications. The design professional does not usually review aspects of technical submittals pertaining to processes, such as the following:

- The means, methods, techniques, sequences, and procedures of construction;
- Detailing dimensions;

Figure 17-1 Contract Documentation and Submittal Process

1. Constructor consults support team
The constructor consults with fabricators, suppliers, subconsultants, and others with submittal responsibilities to determine schedule requirements.

↓

2. Constructor meets owner/design professional
The constructor and team members with submittal responsibilities meet with the owner and design professional to review design requirements, lines of communication, the schedule, and other criteria related to the development and processing of documentation and submittals.

↓

3. Constructor prepares documentation/submittal
The constructor's team prepares the documentation and submittals. If any team member needs further clarification of contract requirements, the constructor makes, or authorizes the team member to make, a written request for information from the owner or design professional. (If unusual circumstances or time constraints render a written request impractical, then oral communication is acceptable—as long as all parties agree.)

↓

4. Constructor transmits documentation/submittal
When the constructor has reviewed and is satisfied with the quality of the information prepared by the team, the documentation or submittal is transmitted to the owner or design professional.

↓

5. Owner/design professional review; request revisions
In general practice, the owner reviews documentation and submittals that are contractual or business-related in nature; the design professional reviews technical items. (Some items may be reviewed by both the owner and the design professional.) The owner and design professional advise the constructor if revisions are required.

↓

6. Constructor makes revisions (if required)
The constructor revises any documentation and submittals that are not approved and resubmits them. In some cases, more than one round of revisions may be required.

↓

7. Owner/design professional approve documentation/submittal
The owner and design professional provide the constructor with written notice of their approval of the documentation or submittal. In the case of technical submittals, the constructor then returns materials to the appropriate parties so that work may proceed.

↓

Construction of specified elements proceeds

- Fit or constructibility in the field;
- Safety precautions and programs.

The following sections describe the roles and responsibilities of the primary team members in promoting the smooth flow of this information, as well as the general coordination of the flow of documentation and submittals.

17.1.1 Owner

The preparation, coordination, review, and approval of contract documents and submittals are crucial in allowing sufficient time and funding for the design professional, constructor, subconsultants, and subcontractors to accomplish their respective contractual obligations. Project quality benefits from the use of tracking systems to manage contract documents and submittals, thereby expediting the completion of their review in a timely manner.

The owner's contracts with the constructor and design professional define the responsibilities of each party related to contract documentation and submittals, the nature of the information to be submitted, as well as the expected time schedule for completion and return of the submittal. The owner usually requests information in the following general categories:

- Non-technical contract documentation (insurance coverage, legal obligations, and schedules);
- Preliminary technical submittals as required by the project specifications.

17.1.2 Design Professional

As the creator of the project drawings and project specifications, the design professional is responsible for providing sufficient information to permit the preparation of shop drawings, placing drawings, and other technical submittals relating to work or materials that will be incorporated into the completed and permanent project.

At a minimum, the design professional is responsible for identifying the nature, magnitude, and location of all final design loads that will be imposed on the supporting completed and permanent structures. The design professional is also responsible for exercising professional care in preparing the design and in complying with applicable codes. The design professional should present the design information in a recognized format that allows the constructor and members of the construction team to understand the design objectives.

The design professional's review of submittals is typically for the limited purpose of evaluating whether the content of the submittal is consistent with the design intent and information contained in the contract documents. Information in a submittal relating to the constructor's proposed or actual means and methods of construction are beyond the scope of the design professional's review. The design professional should prepare and utilize a submittal stamp that defines the purpose, scope, and limitations of the review, and/or approval of submittals in a manner consistent with contractual obligations.

In addition to the review of submittals relating to technical issues, the design professional's agreement may outline responsibilities regarding other types of submittals. The review of change orders, requests for extra work, construction schedules, constructor requests for additional information, and the review of payment requests may be part of the design professional's construction-period services. The design professional may also be responsible for tracking contract documents and submittals.

As with the responsibilities of all members of the project team, the design professional is responsible for accomplishing these tasks in a timely manner.

17.1.3 Constructor

In the construction contract submittal process, the constructor is responsible for the following:

The constructor plays a central role in maintaining the smooth flow of this information.

- Producing or eliciting contract documentation and submittals from subcontractors and/or fabricators;
- Reviewing and concurring with the contract documentation and submittals;
- Submitting the documentation and submittals to the owner and/or design professional;
- Reissuing the submittals as required.

➢ 10.2, "Design Disciplines and Project Objectives"

The constructor's development of a system and schedule for preparing and tracking submittals is essential—and usually stipulated by the construction contract. This system must be realistic and workable to meet the requirements of the owner and design professional, as well as those of the constructor's subcontractors and suppliers. The documentation and submittal system must also include time and resources to accommodate the review and approval by regulatory agencies.

To improve the quality of technical submittals, especially shop drawings and placing drawings, some constructors have an engineer on staff or, more commonly, engage a subcontractor to perform specialty engineering or "detailing." In some cases, the constructor may aid the production of shop drawings by allowing direct communication between the staff person or subconsultant performing the engineering and those on the owner or design teams who are familiar with the related project objectives. However, it is important that the constructor maintain control of the shop drawing process and associated communication.

The constructor's detailer prepares the drawings in accordance with

- The design information in the construction contract documents;
- Instructions from the design professional (as specified in the contract documents or in a written request for additional information);
- Sound construction practices;
- Applicable regulatory laws and guidelines.

17.2 CONTRACT DOCUMENTATION

Construction contracts assign responsibility to the constructor for providing a body of information, known as contract documentation, to verify performance capability and actual performance and for providing necessary project delivery data. The primary areas of contract documentation are non-technical documents, the schedule, shop drawings, and constructor proposals. Some of this information is submitted shortly after the award of the construction contract. Other contract documentation is submitted and updated continually throughout the construction process to support and confirm the proper completion and management of the project itself.

17.2.1 Non-Technical Documentation

The constructor usually is required to submit a variety of non-technical information promptly after the award of the contract and prior to starting construction. These may include the following:

- Evidence of performance, payment, and material bonds;
- Proof of insurance coverage;
- Names of proposed subcontractors, suppliers, and manufacturers;
- Estimated cash flow needs;
- Schedule of payments;
- Quality control plan;
- Health and safety plans;
- Environmental plans and permits.

Regulatory agencies may also stipulate that the constructor provide non-technical documentation or information related to project safety, wages and hours, compliance with minority and women employee hiring goals, environmental impacts, and other regulatory concerns.

17.2.2 Schedule

The project schedule is developed with input from project participants, focuses on relevant responsibilities, and provides sufficient and appropriate detail. While schedules are often viewed as a tool of the constructor, they are most effective when used by the entire team. Some typical characteristics of project schedules are described below.

Level of Detail: From the constructor's perspective, the schedule should be sufficiently detailed to manage the work and resources needed to complete the project. The project team's scheduling needs, however, tend to focus on the flow of information, the interface of various responsibilities between team members, and the significant milestones that define the progress of the project.

Sources of Input: The initial schedule should have input from all levels of the project team—owner, design professionals, constructor, subcontractors, vendors, and manufacturers.

Regulatory agencies that enforce codes, environmental laws, safety, and zoning regulations should also be consulted for possible schedule impacts. Labor organizations and community action groups may also have concerns that could relate to schedule time and resources.

Flexibility: The schedule is a dynamic tool that is used daily to monitor and manage the project. Changes to the scope of work, site conditions, availability of labor and material, and the flow of information should be incorporated in the schedule as they are identified.

17.2.3 Submittal Schedule

The submittal schedule is normally derived from the constructor's project schedule and lists all required submittals and expected dates of submission to allow review, approval, procurement, and delivery of materials and equipment to meet activity dates established in the project schedule.

17.2.4 Quality Control Plan

The requirement for and content of the constructor's quality control plan is typically detailed in the project specifications. These details generally include the level of inspection and testing and whether they are to be performed by the constructor's own staff or by an approved independent agency.

➢ Chapter 20, "Quality Assurance and Quality Control"

The plan should detail management, inspection, testing, and documentation practices that are intended to ensure that project services and work meet contractual requirements.

17.3 TECHNICAL SUBMITTALS

Generally, submittals are documents of a technical nature developed by the constructor to describe elements of the permanent project work at a level of design detail that is sufficient to allow the construction, fabrication, or manufacture of the elements in accordance with the requirements of the contract documents. Submittals include the following:

- Preliminary technical submittals;
- Shop drawings for structural components;
- Shop drawings for manufactured structural components;
- Shop drawings for mechanical, electrical, and fire protection components;
- Coordination drawings showing interrelationships between mechanical systems and the structure rebar or steel framing;
- Shop drawings for temporary construction;
- Pre-engineered and prefabricated components;
- Placing drawings for concrete reinforcing steel;
- Test results;

- Samples and mock-ups;
- Constructor proposals.

The following sections describe these technical submittals. Note that some submittals must be signed and sealed by a licensed professional engineer, while others need only to be verified for compliance with applicable codes and standards.

17.3.1 Preliminary Technical Submittals

The owner and design professional (if assigned to do so under the terms of the professional services agreement) may call for the constructor to provide preliminary technical documentation before the bulk of a project's technical submittals are transmitted. Preliminary technical documentation may include the following:

- Manufacturer's and/or supplier's specifications of certain equipment and materials;
- A breakdown of any lump sum bid items for partial payments, sometimes known as a schedule of values.

In most cases, the approval by the owner and design professional of the preliminary technical documentation, which may call for the constructor to address structural and architectural considerations, is necessary before construction moves forward. The constructor may need to work closely with other members of the project team to satisfactorily address owner concerns.

17.3.2 Shop Drawings for Structural Components

Structural shop drawings depict structural or architectural components that will be part of a completed structure. These components are fabricated or constructed according to the requirements provided by the design professional in the construction contract documents.

Shop drawings are needed for a broad range of structural components and connections, including those made of steel, concrete, wood, plastic, and most other construction materials. The detailed design of connections and unique structural elements is often deferred until a fabricator is selected, which allows the design to be tailored to the particular capabilities and production procedures of the fabricator.

Shop drawings are needed for structural components and connections, including those made of steel, concrete, wood, plastic, and most other construction materials.

The design professional typically has the authority and responsibility for overall design, while the fabricator is responsible for designing and detailing the structural components and connections that meet the standards included by the project design professional.

In some cases, the owner may contract with the design professional to design the entire structure, including the connections.

When structures involve simple components and connections, the design professional, if permitted by the construction contract documents, may analyze and approve structural systems designed by the fabricator based on accepted industry standards.

For more complex structures with nonstandard components and complex connections, the construction contract documents should clearly specify one of two general design approaches:

1. **The design professional** performs complete engineering design.
2. **The fabricator** provides the services of a qualified licensed professional engineer to design or supervise the design of components and connections that are not completely designed in the construction contract documents.

Under the second approach, the construction contract documents include the necessary loading information, as well as performance data and other requirements not defined in the codes and standards governing the project. The fabricator provides the design professional with shop drawings that have been certified by a professional engineer as meeting the component and connections requirements in the contract documents. In this case, the design professional is still responsible for the design of the completed structure, the review and approval of the design of structural systems, and the review and approval of shop drawings.

Under either alternative, the design of structural systems is completed by, or under the supervision of, a qualified professional engineer. The design professional is responsible for including sufficient information in the construction contract documents to permit the preparation of shop drawings. The review and approval of shop drawings, calculations, and associated documentation generated by the design professional provide confirmation that the design concept of the project and information given in the construction contract documents conform to and are compatible with primary structural systems.

The constructor and the subcontracted fabricator are responsible for meeting the project specifications for materials and fabrication processes. Activities to meet this goal include maintaining the specified fabrication and construction tolerances, developing detailed dimensions, and establishing that the fit and erection of the structure in the field can be accomplished in an acceptable manner in accordance with the contract documents, approved shop drawings, and industry standards.

17.3.3 Shop Drawings for Manufactured Structural Components

The constructor is responsible for ensuring that the manufacturer-supplied components meet the level of quality specified by the design professional in the contract documents with respect to performance and material selection.

Manufactured structural components that may be part of a completed structure may include

- Skylights
- Elevator structural supports
- Curtain walls
- Proprietary space truss systems
- Steel stairs
- Pre-cast concrete stairs
- Steel joists
- Wood floor or roof trusses
- Cellular floors
- Decks
- Pre-cast concrete components
- Other pre-cast and miscellaneous components
- Other pre-engineered components involving design and fabrication

The design professional's activities for manufactured structural items include specifying performance requirements in the contract documents and reviewing the documentation provided by the manufacturer to ensure compliance with the project objectives for the completed structure. The design professional may specify that the manufacturer's submittals bear the signature and seal of a professional engineer in order to be approved.

17.3.4 Shop Drawings for Mechanical, Electrical, and Fire Protection Components

Many projects call for uniquely engineered mechanical, electrical, and fire protection components. Examples of components that can vary widely from project to project include the following:

- Components to meet access regulations for people with disabilities
- Electrical distribution systems
- Fire suppression and smoke detection systems
- Fireproofing materials and assemblies
- Heating, ventilation, and air conditioning (HVAC) ducts
- Lighting components or systems
- Piping
- Water, fuel, and coolant tanks

Shop drawings or other technical documentation (including test results) for these components are considered in a manner similar to those specified for structural components by the particular engineering discipline involved.

17.3.5 Coordination Drawings

Coordination drawings are used to show that planned installation by the constructor does not contain interference with underground components, structural framing, ceilings, partitions, equipment, lights, mechanical, electrical, conveying systems, and other services. Examples include

- Underground electrical, storm drains, chill water piping, etc.;
- In and above ceilings;
- Within walls;
- Within chases;
- In mechanical spaces;
- In electrical spaces.

17.3.6 Shop Drawings for Temporary Construction

Shop drawings for temporary construction depict components that exist only during construction, such as equipment slabs, temporary lifts, temporary buildings, shoring, re-shoring, formwork, bracing, scaffolding, de-watering facilities, and temporary power systems. As the party responsible for carrying out the construction plan, the constructor has full authority and responsibility for these shop drawings, including their design, preparation, review, and approval. However, shop drawings for any construction element that involves engineering analysis or design services, such as shoring, bracing for excavations, or temporary construction, require the seal of a qualified licensed engineer who, typically, is engaged by the constructor.

➢ 10.2, "Design Disciplines and Project Objectives"

Procedures for submitting shop drawings for temporary construction facilities vary in several respects from those for other types of submittals, since the constructor retains full control and responsibility for temporary work. The design professional does not usually review shop drawings for temporary construction, except when it is necessary to determine compatibility with the design of a safe and properly completed structure. The design professional may specify in the construction contract documents the duration that is acceptable for the placement and use of items such as temporary bracing, shoring, re-shoring, and similar temporary structures.

The design professional may specify the use of structures that may need special treatment or safeguards during construction, such as non-self-supporting frames, and indicate the impact that the design concept may have on the construction sequence or performance of the permanent structure. In cases where temporary structures may have an impact on the design concept or completed structure, the constructor may be required to submit the relevant shop drawings for review and approval by the design professional consistent with limitations set forth in the contract documents.

17.3.7 Pre-engineered and Prefabricated Components

The design professional may define the general nature and quality of certain manufactured or shop-fabricated components by including a particular brand name and model or its approved equal in the project specifications. The design professional may also define the requirements referring to trade industry codes or operational characteristics, such as operating efficiency, capacities, power needs, or energy output. Examples of components for which such references are generally acceptable are the following:

- Pumps;
- Boilers, chillers, heat exchangers, and air handlers;
- Emergency power systems;
- Water and sewerage treatment equipment;
- Exhaust systems;
- Elevators, escalators, lifts, and conveyors.

Compliance with the performance responsibilities of the construction contract documents may be demonstrated by a manufacturer's warranty and certification or by the owner's representative (often the design professional) witnessing tests in the manufacturer's laboratory and confirming the validity of the manufacturer's claims.

In reviewing the constructor's shop drawings for factory-assembled materials and equipment, the design professional determines compliance with the design concept and compatibility with other elements of the project, such as

- Anchor bolt layout;
- Foundation designs;
- Pipe fittings, flanges, and welds;
- Routing of utilities;
- Drainage for water and other liquids;
- Wiring for power supply;
- Interfacing of instrumentation and controls.

Although the design professional may review and comment on interface data, it is the constructor's responsibility to complete the installation in accordance with the provisions of the contract documents.

Some pre-engineered, prefabricated and stand-alone specialty components, such as office equipment, computers, or other items may be too complex to be included in shop drawings. In such cases, the design professional and constructor (and supplier, if appropriate) may review the related component technical specifications and determine whether the manufacturer's or supplier's certification of the components satisfies the construction contract documents.

17.3.8 Placing Drawings for Concrete Reinforcing Steel

Concrete placing drawings illustrate the reinforcing steel components that will be part of a completed structure. These components are crucial to the safety and performance of a completed facility.

Reinforcing steel components are furnished and placed according to the design professional's project specifications in the construction contract documents. Examples of components for which placing drawings are prepared include cast-in-place concrete and post-tensioned, pre-stressed concrete structural elements.

The design professional has authority and responsibility for overall design of the completed structure and for the review and approval of the placing drawings for conformance with the project design concept and the information in the construction contract documents.

The constructor and subcontractors have responsibility for preparing the placing drawings, providing the materials specified, and completing the fabrication and construction processes. This work is carried out in accordance with the construction contract documents, approved placing drawings, and accepted industry standards.

In most cases, placing drawings for reinforcing steel in cast-in-place concrete do not need design services and it is not necessary or appropriate for the contract documents to call for certification by a licensed engineer. For post-tensioned, pre-stressed, cast-in-place concrete structures, the design professional may delegate certain design activities to a specialty engineer employed or retained by others and provide criteria for the loading conditions and other design parameters in the contract documents. In such cases, the design professional retains responsibility for the overall safety and performance of the completed structure. The specialty engineer is responsible only for the design work delegated and certifies with signature and seal that the related calculations and drawings conform with the requirements of the contract documents.

Concrete Links

- Precast/Prestressed Concrete Institute: http://www.pci.org
- National Precast Concrete Association: http://www.precast.org
- Concrete Reinforcing Steel Institute: http://www.crsi.org
- Occupational Safety and Health Administration: http://www.osha.gov

To ensure the quality of concrete elements, construction contract documents usually call for the submittal of evidence that manufacturers of pre-cast, pre-tensioned, pre-stressed concrete components and related items are certified to function according to the standards of the relevant industry association. These include the following:

- Precast/Prestressed Concrete Institute (PCI);
- National Precast Concrete Association (NPCA);
- Concrete Reinforcing Steel Institute (CRSI);
- National Ready-Mix Concrete Association (NRMCA);
- Post-Tensioning Institute (PTI).

Concrete-related submittals may also include verification of certification for the necessary work in accordance with a governmental agency, such as the federal Occupational Safety and Health Administration (OSHA) and applicable codes and standards.

17.3.9 Test Results

For some projects, the construction contract documents may call for the testing of certain materials by an independent testing agency or laboratory to determine if they meet the project specifications. Examples are

- Soils testing;
- Concrete testing;
- Materials testing;
- Chemical or biochemical testing of water;
- Shop inspection testing;
- Pipe fabrication testing;
- Welding.

Manufactured equipment and operating systems may also need independent testing. The owner typically engages the services of an independent testing agency or laboratory or directs the constructor to do so. Test results are usually submitted to the party contractually responsible for conducting the test who reviews the results for adequacy and conformance prior to submitting to the other parties for information and in some cases, approval.

17.3.10 Samples and Mock-Ups

The main use of samples and mock-ups is to assure the project team that the material, piece of equipment, or building element being provided by or through the constructor is consistent in terms of aesthetics and/or function with the contract documents.

Examples of building components in three general categories include

Manufactured	Custom-Produced	Natural Materials
• Door hardware • Light fixtures • Manhole covers	• Pre-cast concrete panels • Built-up structural steel members • Terrazzo	• Wood panels • Naturally finished stone (slate or processed stone)

Meeting the quality provisions of the contract documents can be ensured only if the measured criteria are embodied in one sample. Having one sample with the desired functionality, another with the correct color, and a third with the approved texture often results in a delivered product that is not acceptable.

Samples for custom or natural materials should include ranges to properly identify the allowable variation of color, texture, imperfections, or other anticipated variables. All such samples should be viewed from a specified distance for acceptance in an environment identical to the final location of the materials.

Mock-ups can range in complexity from aesthetic samples to full-scale elements of the constructed project to be tested against various performance criteria set forth in the contract documents. Generally, mock-ups are used to answer the question: "What is it going to look like?" While aesthetics are certainly an important issue, mock-ups can also serve a number of other useful functions:

- Testing of items, such as curtain wall mock-ups;
- Checking the interfaces of building components;
- Determining the functional capabilities of constructed and furnished elements in a variety of use scenarios;
- Verifying the constructability of complex and/or repetitive elements.

Care must be exercised to ensure that the mock-ups (and samples) are constructed in a manner consistent with the practices that will be used in the construction of the actual project. Laboratory technicians working in a near clean room environment should not be used to install caulking that will actually be installed by construction site workers on a scaffold in less than optimum conditions. In addition, mock-ups and samples should be retained until all work has been completed and accepted.

17.3.11 Constructor Proposals

Constructor proposals constitute a unique form of submittal, as they cannot by their nature be specified in the contract documents (though procedures for submitting them should be). Constructor proposals are technical submittals requesting modifications to the construction contract documents that the constructor has determined are either necessary or desirable to achieve the specified material selection, fabrication, erection, or placement results.

To initiate such a change, the constructor makes a written request to the design professional incorporating as much information and relevant supporting documentation as possible from supporting fabricators, specialty engineers, detailers, and suppliers. If the proposal involves a revision to a custom-designed project component, the constructor supplies drawings certified by a licensed engineer.

The design professional reviews the proposal and makes a recommendation to the owner as to whether or not the proposal is appropriate. The owner makes the final decision on any deviations from the construction contract provisions.

SUMMARY

The smooth flow of contract documentation and submittals from the constructor to the design professional and owner is a crucial activity, as it allows construction site work to proceed efficiently. Delays in generating, reviewing, or approving documentation and submittals can compound the already challenging task of faithfully transforming the contract documents into the desired completed structure.

The constructor takes the lead in the documentation and submittal process, holding primary responsibility for transmitting the information called for by the construction contract. The constructor coordinates the documentation and submittals of subcontractors, material and equipment suppliers, fabricators, and testing laboratories. The design professional and owner are responsible for the timely and appropriate level of review of information submitted by the constructor to keep the contract documentation and submittal process on schedule. ❑

Chapter 17: Construction Contract Documentation and Submittals

Responsibility Matrix

Responsibility ⇩	Owner	Design Professional*	Constructor*	Design-Builder
Establish contract documentation and submittal responsibilities and procedures	●	⦿	⦿	⦿
Provide sufficient technical information in contract documents to produce documentation and submittals		●	⦿	●
Specify shop drawing submittal procedures	○	●	⦿	●
Comply with applicable codes and regulations	⦿	●	⦿	●
Ensure shop drawings comply with construction contract documents		⦿	●	●
Produce shop drawings for permanent components		⦿	●	●
Produce shop drawings for temporary components		○ **	●	●
Produce concrete placing drawings		○	●	●
Review and approve most non-technical contract documentation	●	⦿	⦿	●
Review and approve most technical documents and submittals	○	●	○	● ***
Track documentation and submittals		●	●	●
Incorporate test results	○	○	●	●
Review documentation and submittals in a timely fashion	●	●	⦿	●

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*
***If components affect permanent facility.*
****Design-build team reviews internally information that would typically be submitted.*

● = Primary Responsibility ⦿ = Assist or Advise ○ = Review

CHAPTER **18**

CONSTRUCTION CONTRACT ADMINISTRATION

The effective administration of the contract between the owner and constructor is crucial to project quality. This chapter discusses the practices and procedures that the owner may use to establish and maintain a productive and positive contractual relationship with the constructor.

At the heart of this relationship is the construction contract between the owner and the constructor, which includes the contract itself, and the project drawings, project specifications, and special provisions. The resident project representative (RPR), a person or entity appointed by the owner, administers the construction contract in accordance with the owner's project goals and objectives.

In this chapter

18.1 OWNER'S RESIDENT PROJECT REPRESENTATIVE

The owner may designate a staff member or engage a person or firm with construction administration expertise (often a design professional or a construction manager) to serve as the RPR. The RPR's primary responsibility is the administration of the construction contract. Depending on the size of the project and the decision of the owner, the RPR may or may not actually have a full-time office at the project site. The duties of the RPR begin with the development of construction administration procedures that call for monitoring construction progress and maintaining appropriate records of the constructor's performance and compliance with the terms of the contract documents. On larger projects, the RPR may delegate responsibilities to individual inspectors.

The owner's contract with the RPR assigns to the RPR a range of responsibilities that may include the following:

- Pursuing the attainment of quality goals by performing or directing quality assurance functions;
- Collecting and monitoring current construction expenditures and facilitating timely progress payments under the terms of the contract;
- Payment estimating and processing;
- Pursuing the timely review and approval of contract documentation and submittals by the design professional;
- Evaluating and making decisions related to unforeseen conditions;
- Coordinating owner-related construction site activities such as safety monitoring and testing;

- Promoting good project communication;
- Building the project record by organizing and maintaining all of the various documents that the owner and constructor exchange;
- Negotiating construction change orders.

Contracting for Business Success, Andrew Cox and Ian Thompson, Telford, 1998.

18.2 QUALITY OBJECTIVES

The RPR is responsible for implementing the procedures specified in the contract documents for recording the review and evaluation of quality objectives. In general, construction quality involves two broad areas: materials and workmanship. Typical contract procedures for these two areas of project quality are discussed below.

Construction Project Administration, 9th Edition, Edward Fisk and Wayne Reynolds, Prentice Hall, 2010.

18.2.1 Materials

Materials fall into two broad categories: those that are already in place (in situ) and those that must be procured. The RPR is responsible for monitoring the materials used by the constructor and reporting instances where they do not meet the contract documents, which typically require conformance to accepted standards. Table 18-1 provides references to many sources for typical acceptance standards and information.

Journal of Construction Engineering and Management (print and online), ASCE.

18.2.1(a) In Situ Materials

In situ (natural or original) materials typically include native soils and rocks. Contract documents often call for laboratory testing and engineering evaluation of the properties of in situ materials to determine their suitability for project uses. Such laboratory reports and engineering evaluations become part of the project file. Any re-testing or other follow-up analysis also becomes part of the file.

18.2.1(b) Procured Materials

➢ 17.3, "Technical Submittals"

Procured materials are natural material such as earth fill, aggregates, topsoil, and manufactured items. These manufactured items include materials such as structural steel, asphalt, concrete, paint, glazing, or mechanical and electrical equipment. Contract documents usually provide minimum quality standards, as well as the manner of qualification, for procured materials. For example, manufactured products, such as an electric motor, may be accepted based on the verification of a brand name and catalog number. However, the contract documents may require that other types of materials, such as concrete or paint, undergo physical and chemical analysis to verify their quality.

Procured materials or products are documented in a file listing the qualification procedure and the minimum acceptable criteria as detailed in the contract documents. This includes the type of tests performed, the date a test is performed, the signature of the person performing a test, test results, any nonconformance reports, and, if specified, the location in the structure where the tested material or product is incorporated. Many products, on the other hand, are purchased with performance warranties and certification instead of specific qualification or testing.

18.2.2 Substitutions

Requests for substitutions of materials are common during construction. Thus, most contracts (usually located in the general conditions section) establish procedures for members of the project team to follow in such cases. Substitution

Table 18-1 Sources of Acceptance Standards and Information

Element	Source	Web Address
General	American Society for Testing and Materials	www.astm.org
Earthwork	American Society of Civil Engineers, Geo-Institute	www.content.geoinstitute.org
	ASFE: The Geoprofessional Business Association	www.asfe.org
Concrete	American Concrete Institute	www.concrete.org
	Portland Cement Association	www.cement.org
	Precast/Prestressed Concrete Institute	www.pci.org
	American Society for Testing and Materials	www.astm.org
	American Association of State Highway and Transportation Officials	www.transportation.org
Masonry	American Society for Testing and Materials	www.astm.org
	American National Standards Institute	www.ansi.org
	National Institute of Standards and Technology	www.nist.gov
	Masonry Society	www.masonrysociety.org
	Brick Industry Association	www.bia.org
	National Concrete Masonry Association	www.ncma.org
Timber	American Institute of Timber Construction	www.aitc-glulam.org
	Forest Products Society	www.forestprod.org
Structural Metals	American Institute of Steel Construction	www.aisc.org
	American Iron and Steel Institute	www.steel.org
	Concrete Reinforcing Steel Institute	www.crsi.org
	Wire Reinforcement Institute	www.wirereinforcementinstitute.org
Asphalt	American Association of State Highway and Transportation Officials	www.transportation.org
	Asphalt Institute	www.asphaltinstitute.org
Painting	The Society of Protective Coatings	www.sspc.org
Electrical	IEEE	www.ieee.org
	NEMA	www.nema.org
	National Fire Protection Association	www.nfpa.org
Mechanical	ASME	www.asme.org
	American Society of Heating, Refrigerating and Air-Conditioning Engineers	www.ashrae.org
	American Petroleum Institute	www.api.org
	American Water Works Association	www.awwa.org
Welding	American Welding Society	www.aws.org
	James F. Lincoln Arc Welding Foundation	www.jflf.org
Skid Resistance	American Society for Testing and Materials	www.astm.org

procedures usually allow the constructor to propose alternate materials that offer savings in construction time or money or improvements in quality. Quality substitution procedures call for the design professional to determine if the proposed substitution will achieve the project objectives, as well as who will be responsible for the adequacy compatibility, and quality of the substitute, if approved.

Following the design professional's approval of a substitution, the RPR initiates a formal change order signed by both the owner and constructor incorporating the substitute material into the contract. The change order delineates the original item, the item substituted, the reason for substitution, who is responsible for this substitution, date of action, and the price adjustment, if any, negotiated as a result of the change.

18.2.3 Construction Workforce Performance

The quality of the construction workforce performance is usually determined by minimum acceptable standards in the contract documents. Standards of measurement have been developed for most physical construction tasks. For structural considerations, such as with bearing value of piles, soil compaction, or the tightness of bolts, minimum standards of acceptance are obtained from leading industry associations (see Table 18-1). When quality assessments involve a high degree of subjectivity, as with the quality of a concrete wall finish, the RPR relies on observation, experience, and accepted industry practices.

Where the quality of workforce performance may be critically important, the constructor may be responsible for building a mock-up to demonstrate that the specified level of quality can be achieved by the installer of a portion of the project. After acceptance, the mock-up becomes the quality standard for related tasks.

18.3 CONSTRUCTION SITE SAFETY

ASCE Policy Statement 350, "Construction Site Safety"

Safety on the construction site is a critical responsibility of the owner. Because safety is inextricably linked to the constructor's selection, planning, and implementation of construction means and methods, the owner often delegates this responsibility to the constructor, who implements a plan for compliance with applicable safety practices and regulations.

U.S. Occupational Safety and Health Administration: http://www.osha.gov

The safety program does not replace the constructor's responsibility for means and methods of construction. Rather, the program emphasizes with the constructor that safety is a primary concern in those means and methods.

A coordinated program of safety education and certification for construction site personnel, as well as members of the project team, regulators, media, and other visitors, is an effective strategy for reducing the number and severity of accidents. Such programs typically address construction site personal protective equipment, restricted areas, personnel monitoring procedures, emergency notification procedures, equipment operation, construction practices, and other issues.

18.4 PAYMENT

The owner's timely and appropriate payment for work accomplished is an important aspect of a good relationship among project participants. The owner depends on accurate estimates by the RPR of the project's cash flow projections to provide adequate funding to support construction progress.

Payments are divided into two broad categories: those to the constructor and those to others. Payments to constructors include regular or periodic payments for originally contemplated work, as well as payment for work completed to address unforeseen conditions.

Payments to other participants include those made to the design professional, property owners for real estate and right-of-way acquisition, utility companies, consultants performing laboratory testing, specialty consultants, equipment vendors, and other firms or persons performing construction-related tasks that are not the responsibility (according to the contract documents) of the constructor.

18.4.1 Payments for Originally Contemplated Work

On most projects, periodic payments for originally contemplated work are made on a monthly schedule, based on the value of work accomplished. On projects with large cash flow needs, the owner and constructor may contract for a more frequent payment schedule, such as weekly or biweekly.

In some instances, payment for originally contemplated work is made only once, and in full, when the project is completed. In other cases, the owner may make payments when construction progress reaches predetermined percentages of completion. While the timing of payments varies with each project and the agreement between the two parties, monthly payment is the general industry practice.

The construction contract establishes responsibility for initiating payment. The constructor is usually responsible for preparing a periodic payment application that is reviewed and approved by the RPR. On some public-works projects, however, the reverse is true.

The method used for preparing the periodic payment application depends on the type of contract involved. Payment under the three principal types of contracts—unit-price, lump sum, and cost-plus—are described in the following sections.

18.4.1(a) Unit-Price

Unit-price contracts are common in public-works projects where the quantities of various kinds of materials and work segments are estimated and cannot be known with great precision. Therefore, contracts may be awarded with language that describes the type and approximate quantity of work to be performed, such as cubic yards of excavation or backfill or square feet of pavement involved. The actual value of the work is based on a unit price for each item that is included in the constructor's bid or is negotiated.

Under unit-price contracts, pay items are structured so that the measured quantities involved for each item determine the amount of payment.

If the contract documents specify, it may be necessary for the owner to pay for materials that have been delivered but not yet incorporated in the project. For example, the contract may include the cost of reinforcing steel in the price per cubic yard of concrete. The delivery of the reinforcing steel, however, is expensive and therefore a bulk delivery may reduce total costs, even if the steel is incorporated into structures only periodically. (The steel also represents a valuable future asset to the owner.) In such situations, the value of the reinforcing steel is included in payments to the constructor before the steel is actually placed in forms and covered with cast-in-place concrete. The RPR generally approves the value of the material after obtaining copies of invoices for the materials from the constructor. Owners often pay a portion of the pay item value for materials delivered but not yet incorporated into the construction.

Measures of value of partially completed work include not only the effort or funds expended to date but also the cost to complete. The effective transfer of control of the materials and matters of security also influence the value of partially completed work. The RPR is responsible for recommending payment for only the stated value of a completed item, less the cost to complete it.

Although not encouraged, it may be necessary to change or renegotiate a unit price. Unforeseen circumstances, such as unknown soil conditions or changes in the materials to be used, may alter original quantity estimates. The new unit price may be more or less than the original price but generally reflects such cost factors as restocking, overhead amortization, and supplier's discounts. Unit-price changes may also involve a revision of the contract duration.

It is common for the owner to make partial payments for uncompleted unit-price items as the work proceeds, even though it is not yet complete. In such cases, the RPR is responsible for estimating and recommending payment to the constructor for the value of the completed portion of the unit-price item. Accurate record-keeping and a familiarity with the materials involved are essential in unit-price contracts. The RPR and constructor work together on this effort, developing a periodic assessment of the value of completed work through joint review.

18.4.1(b) Lump Sum

In lump sum contracts, the constructor determines the quantities of materials and work hours and submits to the owner a single lump sum price for the completed project. Typically, it is the constructor's responsibility to divide the contract into various components (known as a schedule of values) that are similar to the categories in unit-price contracts. Mobilization or contract initiation costs are paid as a separate item, if permitted under the contract.

The RPR has the responsibility to determine if the various items of work included in the lump sum breakdown are properly balanced to avoid over-payment for completion of early items, a practice known as "front-loading." For example, on a project where foundation excavation preceded roofing, a constructor could overstate the costs to complete the foundation excavation and understate the cost of the roofing, thereby generating greater cash flow at the beginning of a project. Even though the total final amount of the contract is the same, the payment schedule would be unfair to the owner because payment would be made for work that had not yet been completed.

18.4.1(c) Cost-Plus

In cost-plus contracts, the constructor is reimbursed for actual costs plus an agreed-upon rate for overhead and profit. Because the constructor is compensated for costs rather than completed work, the emphasis on record-keeping shifts from the amount of work completed to the costs for the completed work. Under this type of contract, documentation is very important and usually involves submitting a work-hour record for each employee (including direct, indirect, and supervisory staff as may be allowed by the construction contract), hours worked, the type of work, and the wages paid. Equipment usage and costs are also submitted. Cost-plus contracts also involve methods to record and file the large quantity of material invoices, delivery slips, and other records that are necessary to verify the costs borne by the constructor.

Cost-plus work may be completed within a unit-price or lump sum contract, such as when extra or unexpected work is encountered for which no unit price has been established. This mix of contracting approaches involves complex record-keeping and reporting. In such situations, the mixed use of personnel and equipment can be reimbursed to the appropriate pay item on a cost-plus basis.

18.4.2 Retainage

Owners may use retainage for leverage to help ensure constructor performance. Retainage is the withholding of an agreed-upon percentage of the constructor's earned payment. This percentage is usually based on the work completed to date to minimize the potential impact of any error in quantity estimating, a lapse in meeting quality standards, or construction errors.

Retainage is neither a penalty nor a provision to alter the contract. In many cases, retainage is an inducement to encourage timely completion; in others, it provides a means for the owner to ensure that work is completed according to the contract documents. In either case, retainage is a temporary assessment against earned funds that should be released promptly after the cause or term of the assessment has been addressed satisfactorily.

The releasing of earned funds fully and promptly, while withholding unearned funds, can pose a challenge to contract administrators. In some cases, the posting of securities or other items of value in lieu of retainage, which may be placed in escrow under the owner's control, or procedures that allow the constructor to earn interest on retained funds, are acceptable forms of retainage. Such escrow account payments are not released until the project is accepted and final payment made.

18.4.3 Liquidated Damages

Liquidated damages are intended to compensate the owner for anticipated costs incurred and potential loss of income if the project is not substantially complete within the time specified in the contract documents. Some courts have ruled that liquidated damages should be in effect until the project is fully complete.

Liquidated damages are based upon an estimated monetary loss to the owner given the information known at the time of contract agreement and are usually expressed in dollars per day. Liquidated damages are incorporated in contracts if the parties recognize that a precise determination of the owner's delay damages is not possible. This is why it is desirable to "liquidate" the damages; that is, consolidate them to a specific sum. Once established in the contract, the liquidated damages clause is enforceable regardless of the actual delay damages that the owner may incur.

Liquidated damages can also work to the constructor's advantage. If the owner's actual delay damages exceed the liquidated damages amount, the owner cannot recover the difference, as the liquidated amount has established how much the owner can recover. Liquidated damage provisions are sometimes offset by bonus clauses for early project completion.

Liquidated damages can be assessed only when the cause for the delay can be attributed to acts or omissions by the constructor. If a project is delayed for reasons beyond the control of the constructor, then sufficient extensions of time are granted under a change order. In any case, because of variations in state laws regarding liquidated damages, it is recommended that knowledgeable counsel be consulted with regard to their application and enforceability.

18.4.4 Bonus Clauses

Bonus clauses (incentive clauses) are categories of cost incentives. Bonuses may be prescribed for progress determinants as well as for quality determinants.

Unlike liquidated damages, a bonus used as a progress incentive is not necessarily related to actual benefits as a result of finishing the project early or late. They are a predetermined sum defined by the contract and are proposed solely as an inducement.

Bonuses for quality determinants usually are based on some statistical evaluation of a measurable quality attribute (the smoothness of pavement, the strength of concrete, or the density of compaction). Such clauses are an excellent means of rewarding constructors for high-quality work.

18.4.5 Payments for Work Related to Unforeseen Conditions

Payment for work related to unforeseen conditions on the site is generally made when the work is completed. Some contracts call for timely notification of changes or unforeseen conditions. The RPR and constructor work together to determine the payment, using the complete record of change orders as a basis for negotiation. Unforeseen work may involve the need for additional rights-of-way, differing soil conditions, unidentified or differing utility location or size, and additional surveying, inspection, or investigation related costs.

18.4.6 Non-Constructor Invoices

The certification and recommendation for payment of vendors' invoices are important steps in managing project costs. All such non-constructor invoices—whether for utility relocations, purchase of equipment by the construction organization, or the testing of construction components—should show

- The date that the purchase was made or the work was performed;
- The unit prices or costs involved;
- A copy of, or reference to, the approved purchase order or service agreement;
- The quality criteria used in the work.

18.5 CONSTRUCTOR SUBMITTALS

The RPR receives, reviews, and processes the constructor's construction documentation and submittals specified in the construction contract.

Contract documentation typically includes payment and performance bonds; proof of insurance coverage; the names of proposed subcontractors, suppliers, and manufacturers; and estimated cash flow needs. Submittals may include shop drawings, catalog cuts, material certifications, test reports, requests for substitution, requests for partial payment, safety-related documentation, schedules, and progress reports.

➢ 17.2, "Contract Documentation"

The RPR tracks the date the documentation or submittal is received, the date any action is due, the person with the responsibility to act on the submittal, and the status of the submittal at any given time.

➢ 17.3, "Technical Submittals"

18.6 CHANGE ORDERS

By its nature, construction involves responding to changing conditions and circumstances. Even under the most ideal circumstances, contract documents cannot provide complete information about every possible condition or circumstance that the construction team may encounter. Variations will occur in sub-surface conditions, the nature of materials, design, fabrication, and erection. Quality construction is better served when the project team has the flexibility to revise the original project design as construction proceeds. These changes help to produce a facility that is consistent with the project objectives. The formal amendments to the contract to address unanticipated conditions or circumstances (i.e., owner-initiated changes) are known as change orders, extra work orders, or work change directives.

➢ Chapter 23, "Risk, Liability, and Handling Conflict"

➢ Chapter 24, "Partnering"

📖 *Construction Claims, Changes and Dispute Resolution*, 2nd Edition, Paul Levin, ASCE, 1998.

The prompt identification of the need for a change order helps both the owner and constructor avoid unnecessary disputes, associated work disruption, cost increases, and schedule delays. In many cases, it is more cost-effective for construction to proceed before the details and costs of implementing the change can be negotiated and formalized. Typical project changes involve differing site conditions; severe weather conditions; or revisions of original materials, design, or fabrication. Extra construction workforce or equipment time may also be necessary.

Change orders may also do the following:

- Acknowledge changes to the contract's required completion date(s) due to any of the changes incorporated into the project;
- Make adjustments when a project team member does not fulfill one or more responsibilities.

Therefore, the judgment and skill of the RPR are crucial to the change order process. While the RPR works to obtain formal approval of change orders as soon as possible, a preliminary written order may be acceptable until the change documents are formally approved (though this is not recommended). In other cases, the contract documents may not call for formal change orders if the modification will result in the expenditure of less than a certain dollar amount.

In general, it is a benefit to project quality to document change orders as completely and as quickly as possible. The owner and constructor sign each change order (after appropriate review by the design professional). Change orders are usually numbered and dated and may include revised project drawing sheets, sketches, project specifications, and quotations. When appropriate, the change order should also address the impact of the changed work on the project schedule. Some changes may not be within the scope of the original contract; in such cases, the constructor has the right to reject a change order.

On projects with a high potential of encountering unforeseen conditions, such as building renovations, environmental remediation, or underground work, the owner benefits from budgeting for change orders as part of contingency costs. Change order contingencies provide a more realistic picture of project costs and reduce the potential for disagreement among team members.

18.7 DOCUMENTATION

While verbal communication and an ability to work with a variety of people are essential skills for the RPR's administration of the construction contract, the documentation of communication and decisions is essential. Such important items as safety, payment, and overall quality depend on documentation. This section describes two broad categories of project documentation: written communication and project records.

18.7.1 Written Communication

➢ Chapter 5, "Coordination and Communication"

Written communication includes memos and correspondence among project participants, letters to and from outside parties, reports, meeting minutes, memoranda to the project file, and written summaries of telephone calls. E-mail, while often viewed as informal communication, is a form of documentation.

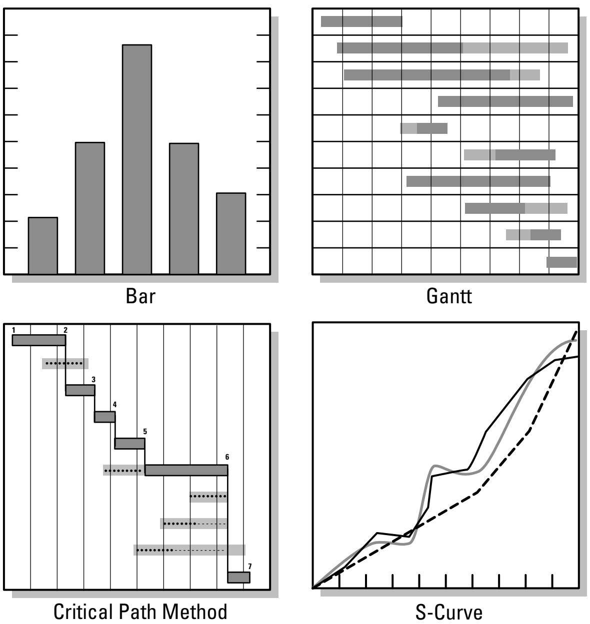
The RPR is responsible for maintaining subject matter and chronological files of relevant correspondence and other written material. The following sections describe these types of written communication.

18.7.1(a) Construction Progress

Contract documents generally call for the constructor to submit a progress schedule before construction commences. The schedule aids the RPR in establishing cash flow needs, assessing personnel demands, and coordinating contract work with adjoining work activities by other contractors.

The constructor may communicate intended progress in several formats (see Figure 18-1). The most common schedule formats are Gantt charts; critical path method (CPM) schedules, or "Pert" schedules; and "S" curve charts that relate progress to cumulative cost. The presentation of information in CPM or Pert schedule format is known as network analysis.

Figure 18-1 Sample Schedule Formats

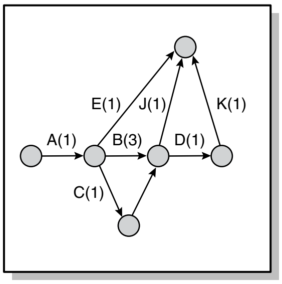


The contract documents normally specify the degree of schedule detail.

Bar charts are the simplest schedules to prepare and evaluate, because they show time on the horizontal axis and the various items of work on the vertical axis. Bar charts can become more detailed and complex simply by refining the time scale. The use of weeks rather than months, or days rather than weeks, improves detail.

"S" curves are prepared by combining the values (e.g., cost, time, or quantity) of the elements of a schedule for the period shown on the schedule. These periodic totals are accumulated to show a rising "S" pattern curve to predict

Figure 18-2 Network Schedule Analysis



project progress. Although such curves usually are prepared by accumulating dollars, they also can be created by accumulating working hours or any other items of the project such as cast-in-place concrete.

In addition to time, schedules can present interrelationships among various construction elements. These elements are represented by one-dimensional arrows. The nodes, representing the tail and head of the arrow, can be tabulated for early or late start, or early or late finish, to present a realistic picture of the variability that is common to construction (see Figure 18-2). As with bar charts, network analysis is not inherently simple or complex. The complexity is actually derived from the complexity of the project and the level of detail desired or dictated. The information developed through network analysis can be effectively displayed in bar chart form.

On larger projects, the owner may wish to consider a periodic independent review of the progress schedule so that an impartial assessment of any delays can be made while the project is ongoing.

18.7.1(b) Progress Reports

Progress reports communicate construction status. This involves the comparison of actual progress to that forecast in the submitted schedule. There are three common types of construction progress reports—detailed reports, summary reports, and subjective reports.

Detailed reports are prepared on a regular basis (usually daily), and involve the tabulation of each work item accomplished during the defined period. Detailed reports form the substance of the contract administration file and are an important resource for payment requisitions, dispute resolution, and project history.

Summary reports contain information from each of the detailed reports and relate that information to project objectives. Summary reports may be prepared for any period of time, but are usually completed on a monthly basis.

Subjective reports, also known as exception reports, are filed when unusual or significant events occur. For example, a summary report may omit a detailed explanation of why some anticipated work was not completed. A subjective report may be prepared to explain why such deviation from schedule was necessary. Subjective reports are usually filed in the form of a letter that the RPR transmits to parties that are likely to have an interest in the event.

18.7.2 Project Records

The project record includes other documents and written materials. The project record includes design and shop-drawing logs, photographs (which may be filed with the progress reports), and certified payroll records required by a federal or other government agency. Additional project record information includes non-conformance reports on discrepancies between "as designed" and "record" or "as-constructed" project drawings, as well as change orders. The logging of this information is beneficial in the event of a legal challenge to accuracy of the completed design.

Shop Drawing Log:	The shop drawing log shows a number identifying the individual drawing, drawing title, date it was received, to whom it was forwarded for review, date it was returned, and approval status.
Project Photograph Log:	Project photographs should have an identifying date and number photographically developed as part of the print, showing when the picture was taken. That number provides a reference to information in the project photography log about the photographer, direction the camera was pointed, and activity shown.
Bid Documents:	Bid documents generally become part of the project record. These documents include project drawings, project specifications, bonds, and other similar affidavits that may have been requested when the contract was awarded. Record documents showing revisions and additions to the original project drawings and project specifications are maintained as a part of a project record.
Certificates of Completion:	Upon project completion, many agencies require a release or affidavit (or sometimes both) certifying that work has been completed in accordance with the contract documents and no payment is outstanding. Certificates of completion may include information about the location or completeness of record drawings, as well as lien or bond releases or additional guarantees that all project payments are appropriate. It is the responsibility of the RPR (and in some cases, the constructor) to collect and present releases, certifications, and affidavits.

SUMMARY

The effective administration of the construction contract is a key aspect of achieving quality in the constructed project, and the RPR is the central figure in this effort. The RPR acts on the owner's behalf, performing the duties and responsibilities assigned to the owner in the construction contract.

The RPR may oversee quality concerns related to materials, the quality of work competed by the construction workforce, construction site safety, payment and retainage, unforeseen conditions, non-constructor invoices, constructor submittals, documentation, change orders, and construction site coordination.

The RPR builds and maintains the project record on which most decisions are based. The RPR works hand in hand with the constructor and design professional to generate and process the wide array of information that is necessary to document compliance with the construction contract documents.

The RPR depends on the cooperation and support of each project participant to successfully administer the construction contract. ❑

Chapter 18: Construction Contract Administration
Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor*	Design-Builder
Designate resident project representative (RPR)	●	◉		◉
Overall administration of the construction contract	◉	◉	●	◉
Ensure quality of materials and completed work		◉	●	●
Maintain construction site safety	●	◉	● **	● **
Make payments according to contract	●	◉		◉
Process constructor submittals	●	◉		◉
Process change orders	●	◉	◉	◉
Coordinate construction activities	●		●	●
Generate, review, and approve contract documentation	◉	◉	●	●
Archive contract documents	●	◉	◉	◉

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*
***As designated by owner.*

● = Primary Responsibility ◉ = Assist or Advise

CHAPTER 19

OPERATION AND MAINTENANCE

In this chapter

Successful operation and maintenance of a completed project is closely associated with its level of quality. Even if design and construction proceed smoothly, overall quality may suffer if the project owner or users find the project too costly or cumbersome to operate and maintain. Operation and maintenance (O&M) characteristics affect a project's reliability, durability, efficiency, and life-cycle costs. O&M can also affect the environment, public health, user safety, and other external aspects of the completed project. Therefore, the project team benefits by giving careful considerations to O&M objectives during the project's planning, design, construction, and commissioning (start-up) phases.

In most cases, the owner operates and maintains the project upon completion and so may wish to consult experienced operators of similar projects during the planning, design, and construction phases. The owner may designate a special O&M representative to advise the project team on how to complete the project in a manner that best achieves the owners's goals and objectives for O&M.

The level of effort to achieve quality O&M performance depends on the size and complexity of the project. On larger projects, the owner often benefits from including operating staff and maintenance experts in all phases of the project. The owner's internal O&M staff can often provide the design professional with crucial input regarding equipment, operating and control systems, manufacturers, and other information. On smaller or less complex projects, the design professional, constructor, equipment manufacturer, suppliers, or others often have sufficient experience with O&M issues.

On larger projects, the owner often benefits from including operation staff and maintenance experts in all phases of the project.

When making contractual and staffing arrangements, the owner's options for ensuring consideration of O&M objectives during appropriate project phases include the following:

- Assign an internal O&M staff person as the project O&M coordinator. This person advises the project team on O&M issues related to planning, design, construction, and commissioning. Ideally, the O&M coordinator has practical experience with similar projects.
- Contract with the design professional, design-builder, constructor, or an independent consultant to provide a qualified O&M coordinator.
- Delegate internal O&M staff, preferably the people who will ultimately be responsible for O&M on the completed project, to assist project team members in observing and/or inspecting construction. This arrangement

- provides an opportunity for O&M personnel to become familiar with the project before commissioning and operation.
- Delegate internal O&M staff to assist during project commissioning.
- Contract with the design professional, design-builder, constructor, or independent consultant to review and advise on O&M activities for a specified period after the project begins operating.

Under any of these options, the owner benefits by specifying the roles and responsibilities of all project participants during the planning and design, construction, and commissioning phases of the project in their respective contracts.

This chapter discusses activities that contribute to quality in O&M during four project phases:

1. Planning and Design	Reviewing project configuration, functions, and processes.
2. Construction	Observing construction activities related to O&M to ensure consistency with design requirements and intent as expressed in the project drawings and project specifications.
3. Commissioning	Verifying, testing, and accepting functions. Training owner's operating staff.
4. Operation	Operating and maintaining the completed project, including fine tuning, operational enhancements, and scheduling maintenance activities.

This chapter also discusses organizational arrangements that the owner may wish to make to help ensure that O&M concerns receive appropriate consideration throughout the project phases noted above.

19.1 O&M DURING PLANNING AND DESIGN

In early stages of project planning, and sometimes during preliminary design, the owner and design professional make decisions that have a lasting impact on O&M. These include selecting the site, defining the type of construction to be incorporated, determining access points, choosing equipment, and many other decisions about individual project elements. Given the potential long-term impacts of these decisions, the project team can enhance project quality greatly by consulting with the project O&M coordinator during the design phase.

As design proceeds, the project team benefits from one or more reviews focusing on O&M. The number and frequency of these reviews may vary with the size, complexity, and function of the project. The review(s) may be simple, informal discussions between the owner and design professional. On more complex projects, it may be necessary to set up special review teams that include the O&M coordinator, operations specialists, design professional, constructor (or design-builder, if applicable), construction specialists, and others. Such comprehensive reviews are typically incorporated in broader project reviews, such as value engineering studies.

➢ Chapter 25, "Value Engineering"

Operations and maintenance review considerations include

Physical Plant:	Size and layout of project components; special accommodations for people and equipment; safety and security considerations; maintenance needs; specialized services, such as laboratory and chemicals; amenities for personnel such as dining, meeting, and shower facilities; lighting; heating, ventilation, and air conditioning (HVAC); future expansion; land utilization; equipment layout and control systems; access for deliveries and shipments; system flexibility and redundancy; the owner's O&M requirements at other facilities; and manufacturer-supplied materials, training, and spare parts.
Control Strategies:	Manual backup controls, as well as supervisory control and data acquisition (SCADA) systems.
Cost:	Annual costs for project component and equipment maintenance, labor, energy, supplies, utilities, annual permits, site maintenance, and landscaping.
Environmental:	Odor control, noise abatement, air and water quality protection, hazardous waste disposal, and other closely monitored impacts to facility users and abutters.
Safety:	Equipment, chemicals, protective devices, sprinklers, clothing, staff training, and risk management.
Budget and Staffing:	Revenue sources, expenses, hours of operation, number of employees, professional qualifications, and prevailing market conditions.

During the project planning and design phases, the project team determines needs, constraints, and criteria related to the performance, operation, and maintenance of the proposed project. The project team also develops draft O&M budget and staffing plans. These O&M needs are incorporated into the project drawings and project specifications, which typically include equipment performance criteria, repair and replacement warranties and manuals, spare parts information, operator training, and equipment commissioning needs.

An O&M manual created by the project team can be of special value for complex projects. Such manuals usually include process descriptions, design criteria and equipment specifications, equipment purpose, operating parameters, potential problems and solutions, emergency procedures, safety, and other information. The O&M manual is often a regulatory requirement for a project.

19.2 O&M DURING CONSTRUCTION

As construction gets under way, more information becomes available for the O&M staffing plan and budget. The project team and O&M coordinator have the opportunity to inspect and witness the installation and testing of materials and equipment, observe project elements that may not be accessible after completion, such as underground utilities, electrical conduit routings, and structural support elements. Providing the flexibility to adapt the design during construction to meet evolving O&M objectives is an important aspect of project quality, as is the constructor's experience with relevant O&M issues.

Providing the flexibility to adapt the design during construction to meet evolving O&M objectives is an important aspect of project quality.

In most cases, owners strive to have their O&M staff members in place before project commissioning begins, often before construction is complete. To meet this goal, the O&M coordinator may begin, assisting the owner in planning, budgeting, and training for O&M during the project construction phase. Project team members and future O&M staff also review information from manufacturers for inclusion in the O&M manual, develop O&M training plans, and prepare for commissioning. The project O&M coordinator and O&M staff typically begin to take more active roles in project decision making during the construction phase.

Typical O&M-related activities during construction include

- Assembling equipment information, including warranties, operating instructions, and maintenance needs;
- Maintaining up-to-date project drawings and project specifications that reflect change orders, actual conditions, and other information pertinent to O&M;
- Coordinating and preparing for the delivery and storage of spare parts, tools, and equipment;
- Conducting training for O&M staff members;
- Preparing a work plan for project commissioning.

As construction nears completion, appropriate project team members (as defined in the construction contract) conduct acceptance tests of various elements and begin maintaining them until project commissioning begins.

19.3 O&M DURING COMMISSIONING

Project commissioning involves activities to demonstrate that the completed facility performs according to the contract documents. Commissioning gives the O&M staff the unique opportunity of becoming familiar with the project and its components with the support of the project team, in particular the design professional, design-builder (if applicable), and constructor. During this phase, the O&M staff continues to take on increasing responsibility as the project progresses toward full operation. However, it is usually the case that certain contractual responsibilities, including the responsibility for security, operations, safety, maintenance, heat, utilities, and insurance coverage are not transferred to the owner until the date of substantial completion of the project as set forth in the contract documents.

Project commissioning can be as simple as cutting the ribbon at the dedication ceremony for a new pedestrian bridge in a park. The commissioning of complex projects, such as power plants, petrochemical facilities, rail transportation facilities, airport terminals, or wastewater treatment plants, may require the preparation of an extensive commissioning plan. Such plans typically address procedures, sequencing, and responsible personnel for commencing operation, and may include extensive organization and training of representatives from the owner, other project team members, and specialty vendors.

19.3.1 Organizing for Commissioning

The commissioning plan assigns responsibilities to project participants for organizing and leading related activities. Commissioning responsibilities are often specified in contractual agreements among project team members. The specific project objectives dictate in large measure the project team member most likely to lead the commissioning process:

Owner	Design Professional	Constructor
Leads commissioning on projects where major equipment is furnished or specified; on projects that require multiple constructor and design professional assignments; and on projects where joint construction site occupation requires coordination of construction and O&M.	Usually leads commissioning on projects where the design team is responsible for the O&M manual and training.	Leads commissioning in all other cases in accordance with requirements established by the contract.

When the responsibility for commissioning has been established, the commissioning team is formed with representatives from the O&M staff, specialty vendors, and project team, including the design professional, the constructor (or design-builder), and the owner.

The commissioning plan may outline the interaction and exchange of information among the principal parties, as well as planning, scheduling, testing, and other activities. The commissioning plan is geared to meet the needs of the particular project, and it benefits from a simple and direct style that makes use of standard forms, checklists, and tabulations.

19.3.2 Commissioning Activities

Commissioning involves a range of activities, including preparing and reviewing commissioning plans and procedures, determining construction completion status, scheduling, system testing, making corrections, reviewing final inspection reports, and submitting closeouts.

Commissioning and related activities are intended to demonstrate the functional integration of the project's constructed systems, which include

Structural: Foundations, slabs, bearing walls, and frames.

Envelope:	Roofs, curtain walls, and ceilings.
Mechanical/Electrical:	Systems for water, waste disposal, heating, ventilating, air conditioning, conveyances (elevators), fire safety, and electrical systems (which may power mechanical systems).
Process Systems:	Specialized equipment supported by the mechanical and electrical systems for manufacturing, refining, or treating products.
Interior or Architectural:	Habitable components, such as partitions, suspended ceilings, floors, furnishings, and wall coverings.
Exterior:	Parking lots, pedestrian access, landscaping, storm water drainage, utilities, and transportation systems.
Control and Communications:	Specialized hardware or computer software for SCADA systems, digital/analog systems, voice and data systems, and wire/wireless/optical fiber systems.

Commissioning activities are generally based on the premise that elements of the project systems meet the requirements detailed in the contract documents. Therefore, the specific commissioning activities are designed to do the following:

- Determine that each individual component is fully operational;
- Determine that individual components operate collectively together as specified and in accordance with project objectives;
- Provide a means of training O&M personnel to safely operate each component and the entire project;
- Validate the O&M manuals, including manufacturer's instructions and project-specific procedures;
- Check to ensure up-to-date documents are readily available for reference, such as project drawings and project specifications;
- Serve as the milestone marking the completion of construction and the start of operations.

19.4 O&M DURING OPERATION

Project operation is the primary responsibility of the O&M staff, although the project team may be obligated to make appropriate staff available to support and assist for an initial operating period.

➢ 3.5, "Design-Build Variations"

Depending on the size and complexity of the project, the O&M staff may work with project team members for the first few months or years of operation, often on enforcing equipment warranties and correcting defects. In particular, the O&M staff may wish to consult the design professional to help clarify operating and maintenance manuals, fine-tune operations, and evaluate performance with respect to design criteria and project goals. The O&M staff may also wish to work with the constructor and manufacturers on warranty issues, minor improvements, or revisions.

SUMMARY

Project quality in O&M depends on the active participation of the people who will be involved with O&M activities long after the project team has disbanded. Designating a project O&M coordinator early on, as well as establishing organizational responsibilities for O&M tasks during commissioning, are effective strategies for ensuring that the project team addresses O&M goals in a timely and cost-effective manner during all phases of project development. ❑

Chapter 19: Operation and Maintenance
Typical Responsibilities

Responsibility ⇩	**Owner**	**Design Professional***	**Constructor***	**Design-Builder**
Assign O&M coordinator and staff	●	⦿	⦿	⦿
Develop O&M program	●	⦿	⦿	⦿
O&M design review(s)	○	●	⦿	●
Handle construction phase information gathering and coordination; prepare start-up plan	○	●	●	●
Prepare O&M manuals	○	● **	● **	●
Designate commissioning leader	●	⦿	●	●
Oversee commissioning activities	⦿	⦿	●	●
Perform operations	●	⦿	⦿	⦿

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*
***May be assigned to either design professional or constructor.*

● = Primary Responsibility ⦿ = Assist or Advise ○ = Review

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CHAPTER 20

QUALITY ASSURANCE AND QUALITY CONTROL

The term "QA/QC," abbreviation for quality assurance and quality control, is a buzzword on construction projects. Yet this acronym is often uttered by people who are not quite sure what it means. In fact, QA and QC are two separate functions. For the purposes of this Guide, QA refers to quality assurance activities that are the responsibility of the owner or its agent. QC refers to quality control activities that are the responsibility of the design professional and constructor.

Quality means different things to different members of the project team. Owners, design professionals, and constructors place different value on the durability, operational features, configurational flexibility, initial capital investment, life-cycle costs, and other characteristics of projects.

In this Guide, quality is defined as the delivery of products and services in a manner that meets the reasonable requirements and expectations of the owner, design professional, and constructor, including conformance with contract requirements, prevailing industry standards, and applicable codes, laws, and licensing requirements. This chapter discusses some of the key activities and initiatives that the owner, design professional, and constructor may undertake to ensure that project design and construction meet the quality goals and objectives of the project team under traditional design-bid-build project delivery. Where appropriate, this chapter also notes how the use of alternative project delivery systems may affect the application of QA and QC measures.

Quality Assurance: Planned and systematic actions established by the owner or its agent to establish a level of confidence that project design documents comply with applicable codes, standards, and criteria and that the resulting construction complies with the contract documents. Quality assurance substantiates the effectiveness of the design professional's and constructor's quality control responsibilities.

Quality Control: Plans, procedures, resources, and organization performed by the design professional necessary to control the quality of the contract documents to ensure consistency with applicable codes, standards, and criteria, or by the construction professional necessary to control the quality of its construction to ensure compliance with the contract documents. Quality control includes observations, calculations, inspections, tests, and documentation that either confirm quality processes and

In this chapter

➢ 1.4, "Defining Key Terms"

systems are effective in ensuring the achievement of quality or are ineffective and therefore need to be changed to achieve the required level of quality.

20.1 THE OWNER'S ROLE

The owner is the central figure in promoting initiatives and activities to achieve project quality. The owner must take a leadership role in promoting initiatives and activities to achieve project quality. It is the owner who makes a value decision respecting quality and what is an acceptable level of investment to achieve it. In the case of large or complex projects, owners often benefit from the assistance of other team members in specifying project quality objectives.

20.1.1 Options

Owners have several options respecting implementation of project-specific quality assurance and quality control plans. Owners may use standing generic QA plans, create project-specific QA plans, or tailor generic plans for the specific design or construction effort. The owner may require the design professional or constructor to furnish a project-specific design quality control plan or construction quality control plan, respectively, by prescriptively describing the processes and systems they must follow, or the owner may describe the quality control plans in performance terms.

📖 *Construction Inspection Handbook: Total Quality Management,* 4th Edition, James J. O'Brien, Chapman & Hall, 1997

20.1.2 Design Phase

For most design-bid-build projects, the owner engages the design professional or design team before the constructor joins the team. The owner's pre-construction involvement with the design professional includes defining the project services required, negotiating the agreement for professional services, and defining project quality objectives. The owner and design professional typically discuss the elements of the design quality control plan during this phase. This initial development of a design quality control plan directly affects the construction process. Effective design quality control plans should result in less ambiguity in the design documents and fewer instances of errors and omissions that give rise to change orders during construction.

In some cases, the owner and design professional produce a quality manual. A written manual is recommended for major projects.

20.1.3 Construction Phase

➢ 18.1, "Owner's Resident Project Representative"

The owner may designate a resident project representative (RPR), see 18.1, Owner's Resident Project Representative, to implement and conduct oversight of QC activities of the constructor.

The owner as part of project planning must determine and adopt an inspection alternative. These alternatives include performance by

- Owner;
- Design Professional;
- Independent Agency;
- Code Compliance Official;
- Constructor.

Each of these alternatives is viable, and, for any given set of project parameters, there may be a clear, rational argument for one being the best. Whatever the choice, it is important to know that there are choices, and that the best choice will most likely require deliberate and careful consideration in order to balance cost, safety, schedule, and quality requirements.

There is no single "best choice" inspection alternative for a given field of construction. The inspector decision should be based on a combination of both objective and subjective criteria, and it could be that there is no latitude for consideration of alternatives, as in the case of many U.S. government projects that require the contractor to provide the inspection.

20.2 THE DESIGN PROFESSIONAL'S QC PROCESS

The design professional is responsible for implementing a project-specific QC plan for the design phase that meets the terms of the agreement for professional services. The owner reviews and approves the plan and receives appropriate documentation of the design professional's QC activities as the design phase proceeds. Design QA by the owner at agreed intervals provides the owner with the opportunity to make timely requests for clarification of design information or for supplemental design information before the design professional submits the final contract documents for approval.

Who Provides Inspection, Abdol R. Chini, editor, ASCE, 1999

20.2.1 General Elements

QC activities for design professionals typically include measures to enhance creative processes, clarify communication among team members, and develop project concepts to a level of design detail sufficient for the constructor to effectively transform the design into physical completion.

Most design professionals already have QC plans for typical design activities in place. The design professional usually adapts and expands the existing plan to meet the unique objectives of the specific project at hand.

The International Organization for Standardization (ISO) provides quality guidelines and certification currently known as ISO 9000.

http://www.iso.org

Typical Design Professional Project-Specific QC Plan Items

- A sufficient number of staff members with appropriate experience.
- Communication and review opportunities with the owner to allow the design team to fully understand the owner's project priorities.
- Communication among design team members.
- Confirmation of field, regulatory codes, standards, and safety conditions that may affect design.
- Confirmation of the owner's satisfaction with design activities during the design process.
- Preparation, review, and coordination of the interdisciplinary design, project drawings, cost estimates, and project specifications, including mock-ups, field testing, and documentation.
- The scheduling of design reviews, audits, and progress reporting as appropriate for internal control within the design team.
- The inclusion of specialty advisers on construction, operation and maintenance, and design who are not part of the day-to-day design effort.

Typical design professional project-specific QC plans call for the submission of reports and supporting documentation at specified intervals, such as weekly summaries, or at the completion of a major design milestone.

20.2.2 Evolution of Design QC Activities

The design professional and the owner benefit from a project-specific design QC plan that provides the flexibility to focus on meeting the owner's quality goals during different phases of a project.

The design professional's project-specific QC activities evolve with the advance of project design. Therefore, the design professional and owner benefit from a QC plan that provides the flexibility to focus on meeting the owner's project quality goals during different phases of a project. These phases and associated activities are discussed below.

20.2.2(a) Pre-Design

Pre-design consists of the initial actions of the owner and the design professional. During this phase, the two parties define their relationship, establish project parameters, and negotiate the agreement for professional services. In addition, the owner and design professional agree on a project-specific QC plan.

20.2.2(b) Schematic Design

During this phase, the owner and design professional develop a written project plan based upon the executed agreement to guide design during subsequent phases. The project plan establishes design parameters, constraints, space and regulatory guidelines, and procedures for communicating with the owner. The design professional makes schematic studies to define project outlines and develops a preliminary opinion of probable construction costs. QC activities during this phase include the investigation of design alternatives that satisfy the project plan. These investigations involve in-house project concept reviews, as well as reviews with the owner. An important element of QC is owner acceptance of a schematic design report prepared by the design professional. This phase, in some cases, may have been completed during the alternative studies and project impacts discussed in Chapter 8.

20.2.2(c) Design Development

After the owner approves the schematic design report, the design professional prepares design development project drawings and outlines project specifications. During this phase, the owner and design professional seek review and comment on the design from key stakeholders, such as regulatory agencies. QC activities during this phase include the refinement of design alternatives and cost estimates to confirm that they satisfy the project plan. An important element of QC is the approval of the design development report prepared by the design professional. Following this approval, the design is "frozen," after which no more significant changes are allowed so that the contract documents focus on a single design.

20.2.2(d) Contract Documents

With the design frozen, the design team maintains control over changes so that they may produce consistent project specifications, take-offs, document coordination, review implementation, and other construction documents. These activities usually require further reviews, design and cost refinements, and the filing of contract documents with appropriate authorities. Elements of the constructor's project-specific QC plan are mandated in the contract documents as they define standards and testing of the materials of construction, mock-ups, sample construction, performance and testing of equipment, project start-up, and, if required, details of commissioning and training.

Design QC activities in this phase include detailed checking of computations, project drawings, and quantity take-offs and a review of pay items and project specifications. They will also involve reviews to assess constructability. The owner and the owner's legal counsel should review and approve the language in the contract documents.

20.2.2(e) Bidding or Negotiating

Bidding is a relatively short phase in the pre-construction process but one that requires active involvement on the part of the design professional to ensure proper documentation and quality control procedures. QC activities in this phase include responding to questions from the bidders. It is extremely important that ambiguities, errors, and omissions in the documents identified by potential bidders or offerors are corrected by the design professional before bids or offers are due. After bids have been submitted, they are reviewed for conformance with the requirements of the bidding documents and overall evaluation of the bid tabulations.

20.2.2(f) Construction

During the construction phase, the design professional may assume a quality assurance role on behalf of the owner. This role may include some or all of the following typical quality assurance activities: technical review and approval of construction submittals; site visits; responding to the construction professional's questions respecting the interpretation of plans and specifications; correction of errors and omissions in the contract documents; review of daily quality control reports; review of test reports; visual observation of work in process; review and approval of mock-ups; check tests or companion testing to confirm the results of quality control testing; and documentation of quality assurance activities.

➢ 18.1, "Owner's Resident Project Representative"

Alternatively, the owner may designate a resident project representative (RPR) to administer the construction contract. The design professional has varying degrees of responsibility, similar to those described above, according to whether the design professional will be acting as the RPR and the terms of the owner–design professional agreement.

Design reviews, either as independent technical reviews or as external peer reviews, allow the owner to make timely requests for clarification of design information before the design professional submits final contract documents for approval.

20.2.3 Design Reviews and Audits

The owner's project-specific QA plan and the design professional's project-specific QC plan should include design reviews or audits during the preparation of the contract documents. These do not replace the design team's regular ongoing checking to identify and correct discrepancies in dimensions, incorrect notes and references to details on project drawings, conflicts between project drawings and project specifications, or other similar problems. Rather, design reviews or audits ensure appropriate design quality by identifying

Additional design development phase reviews may benefit project quality as design proceeds. At a minimum, owners and designers usually hold a final review when design completion reaches approximately 90 percent.

unsound concepts, analyzing constructability, eliminating redundant activities, providing benchmarks for cost and schedule, and aiding interdisciplinary coordination.

The design review is an internal quality control procedure usually carried out by members of the design team and a review board with relevant experience. Design audits, if implemented, are performed by individuals who are not members of the design team.

Design audits are often referred to as independent technical reviews when performed by other members of the design professional's organization, or external peer reviews when performed by independent experts from an organization or multiple organizations completely independent of the design professional's organization. External peer reviews are recommended for highly complex controversial projects or projects with significant technical or cost risk.

Prior to convening for the design team, the review or audit team usually receives design information from the design team leader. The review or audit team and the design team then meet to discuss the project's relevant design concepts. While the documentation of these reviews is important, detailed records or audio recording of conversations is usually limited to encourage candor among participants.

20.2.4 Quality Control During Bidding or Negotiation

The design professional's QC responsibilities during the bidding or negotiation phase are determined by the professional services agreement with the owner. These responsibilities may affect the quality and integrity of the bidding process and typically include conducting a pre-bid conference, responding to questions from the bidders, and evaluating bids.

20.2.4(a) Pre-Bid Conference and Bidder Questions

The pre-bid conference, along with a tour of the project site, is an important introduction to the project for potential bidders. The primary emphasis of the quality control program during pre-bid activities is to provide accurate and forthright information about project conditions and the bidding documents. The pre-bid conference is an opportunity for bidders to ask questions about project site conditions and the bid documents. To ensure fairness to all bidders, the owner and design professional issue clarifications or supplementary information in addenda to the bid documents distributed to all bidders. Addenda are issued with receipt acknowledged by document holders and with sufficient time allowed to permit incorporation in the bidder's submittal.

20.2.4(b) Bid Evaluation

➢ 14.3.1, "Role of Design Professional"

The owner's evaluation and analysis of construction bids requires careful review to ensure that each bidder has complied with the bid requirements. The owner may find it useful to enter the bid amounts from each bidder (and for each project element, if appropriate) in a spreadsheet to simplify evaluation. This systematic approach to evaluation also helps reveal errors in the bids. The design team may be involved in this process, as the owner may require.

20.3 THE CONSTRUCTOR'S QC PROCESS

The constructor is responsible for preparing and implementing a project-specific QC plan as specified in the contract documents during the construction phase. Additional QC elements may be added in the constructor's own interest to avoid cost overruns and schedule delays.

The constructor's project-specific QC plan can be quite complex, as it involves subcontractors, suppliers, vendors, and others.

In some respects, the constructor's project-specific QC requirements are easier to formulate and implement, as most contract quality provisions focus on readily measurable physical properties or quantities. However, the constructor's QC plan is often quite complex because the constructor is responsible for the activities of subcontractors, material suppliers, manufacturers, fabricators, and vendors—as well as the constructor's own activities. The constructor must also take into account the interest and participation of public agencies that enforce applicable codes, oversee the handling of toxic and hazardous materials, enforce storage and disposal regulations, grant permits, and enforce other regulations that affect construction.

20.3.1 General Elements

The constructor usually adapts and enhances a generic QC plan to meet the specific project requirements. The plan is intended to ensure conformance with project specifications and project drawings with respect to materials, quality of workmanship, construction, finish, functional performance, mock-ups, sample construction, inspection, field testing and documentation, reporting, and resolution of non-conformances.

📖 *Implementing Total Quality Management in a Construction Company*, Associated General Contractors of America, 1993

The quality management procedures in this generic plan focus on improving thought processes, clarifying communications among subcontractors, and translating the project drawings and project specifications that define the project into physical completion and commissioning of the project.

Typical Constructor Project-Specific QC Plan Items

- Recruiting and assigning a skilled workforce
- Quality control organization
- Submittal schedule
- Inspections
- Preparation and review of mock-ups and sample construction
- Quality control testing plan to include special inspections
- Documentation of quality control activities
- Procedures for corrective action when quality control and/or acceptance criteria are not met

The RPR typically, if specified in the project documents, reviews the constructor's QC plan before the start of any production, construction, or off-site fabrication.

20.3.2 Meeting Contractual Provisions

The contract documents represent the minimum level of quality to be achieved by the constructor. They define standards and materials of construction, expectations for the execution of the work, performance criteria and testing of equipment assemblies and systems, and the documentation necessary to demonstrate that these contract provisions have been met.

The constructor's organization and execution of quality control activities in the preparation and processing of submittals required under the contract and the approved constructor project-specific QC plan are essential to achieving a smooth workflow. QC measures are intended to avoid delays by subcontractors, the constructor, the design professional, the RPR, or the owner during the contract submittal, review, and approval processes. The constructor, supported by subcontractors, suppliers, and vendors, is responsible for submitting complete and technically accurate documentation as required by the contract documents. Attention to these responsibilities on initial submittals is an essential aspect of the constructor's ability to maintain the schedules and procedures agreed upon with the owner. The design professional also plays a key role in this process, typically reviewing the constructor's submittals.

➢ 17.3, "Technical Submittals"

20.3.3 Project-Specific Needs

The constructor's project-specific QC plan to meet project objectives usually includes the following:

- Measures to ensure that subcontractors are qualified, certified, and/or licensed as required;
- Procedures for the inspection, control, and timely delivery of materials, equipment, and services to include owner-furnished equipment/materials;
- Provisions for required mock-ups and sample construction;
- Procedures for start-up, or commissioning;
- Identification, inventory, and storage of materials, parts, and components pending incorporation into the project;
- Control of measuring and test equipment;
- Segregation and disposition of nonconforming materials, equipment, or components;
- Maintenance of records specified by contract and required by the constructor's project-specific QC plan to furnish documents of the achievement of the specified performance of the work;
- Procedures for certification to support occupancy approval.

SUMMARY

The owner is responsible for specifying and funding project-specific QA and QC activities. The owner specifies the design quality control requirements in prescriptive or performance terms which the design professional must follow in the preparation of the design and construction documents. The owner implements QA activities during design and construction in accordance with its quality assurance plan to establish a level of confidence that the project design documents comply with applicable standards and criteria and that the resulting construction complies with the design. The construction professional is responsible for QC activities during the construction phase to ensure the quality of its construction and compliance with the contract documents.

The design professional is responsible for formulating, implementing, and administering the design project specific QC plan, which is separate from the constructor's plan. The constructor develops and implements the construction project specific QC plan, which the owner and RPR review and approve. In most cases, the design professional also reviews technical elements of contract documentation submitted by the constructor.

Project-specific QA and QC plans involve many details, measures, and submittals—all of which serve the goal of attaining expected project quality. To make QA and QC measures work, participants must communicate regularly. QA and QC processes involve collaboration and a mutual understanding of the entire project team—owner, design professional, constructors—of their respective concerns and accomplishments, as well as an active commitment to resolve issues equitably and quickly. ❑

Chapter 20: Quality Assurance and Quality Control

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor*	Design-Builder
Establish QA program and set overall approach and attitude to quality	●	◉	◉	◉
Develop and implement design phase QC plan	◉	●	◉	●
Conduct design audits** or reviews	●	● ***	◉	● ***
Incorporate QC measures in construction contract bid documents	◉	●	◉	●
Evaluate construction bids	●	◉	○	◉
Develop and implement construction phase QC plan****	◉	◉	●	●
Set measurable goals or standards for construction quality****	◉	◉	●	●
Provide documentation of progress toward construction QC goals****	○	◉	●	●
Communicate regularly with team members regarding quality concerns****	●	●	●	●

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

***Owner has primary responsibility for audit.*

****May engage qualified consultant or other design staff not assigned to project for design reviews or audits.*

*****Resident project representative (RPR) may act as approved by the Owner.*

● = Primary Responsibility ◉ = Assist or Advise ○ = Review

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CHAPTER 21

COMPUTER TECHNOLOGY AND PROJECT QUALITY

In this chapter

Computer technology offers a wide range of benefits to the project team. Current and evolving hardware, software, and application technology have improved staff productivity by increasing efficiency and accuracy of individual tasks, as well as improving integration and coordination for the entire team. Computers and the Internet are helping the team improve the speed and accuracy of communication, especially when members are spread over several offices or large geographic areas. Computers significantly expand opportunities for improving compliance with project quality requirements incorporated in the contract documents.

Since the Second Edition of this Guide was published in 2000, significant advances in computer technology and widespread access to the Internet have added significant transformation to each project team member's workplace. This chapter describes some of the benefits that today's computer systems offer owners, design professionals, and constructors. The continuing rapid development of computer technology requires that team members seek out the latest information about systems and software. Therefore, this chapter offers general suggestions about the use of computers to enhance project quality.

21.1 COMMON COMPUTER USES

Computers assist with office tasks that are common to the owner, design professional, and constructor. Commercially available "office suite" software is now used by virtually every organization or business in the construction industry.

Following are brief descriptions of the types of software packages that are typically used in the offices of project team members. The types of programs listed below enable employees to produce documents and information more quickly. However, without an understanding of the tasks being automated or the software programs, users can just as quickly create misunderstandings or repeated errors. For example, pre-formatted templates help create documents that look professional—even if they are wrong. Despite advanced "spell check" features, no word processing program has yet been developed that finds factual errors. Therefore, software training courses and self-tutorials are valuable in helping employees get the most out of computer applications.

Following are types of software packages and typical uses by project team members.

Word Processing:	Manage text and automate the composing, editing, and formatting of documents. Users can easily incorporate material from older documents into new ones and use "mail merge" features to address an identical document to many recipients. A "track changes" function can be used when a revised document is to be collaborated with or reviewed by others.
Spreadsheets:	Plan and perform repetitive calculations, summarize data graphically, and organize information in tabular formats.
E-mail:	Exchange messages and transfer most types of files over computer networks and the Internet.
Databases:	Assist in organizing, storing, and retrieving large amounts of information, such as personnel and project records, mailing lists, client project histories, and correspondence.
Project Management and Collaboration:	Provide planning tools, schedules, and budget templates to automate many project management tasks.
Computer-Aided Design and Drafting (CADD):	Automate many tasks in the preparation of project drawings, shop drawings, and record drawings.
Accounting:	Automate project accounting, assist with financial planning, and prepare taxes.
Presentation:	Assist in preparing slide shows, illustrations, overhead view foils, handouts, and computer images to accompany presentations.
Desktop Publishing:	Assemble text and graphics for a variety of publications, from newsletters to books. Desktop publishing software can also be used to prepare files for professional printing.
Project Extranets:	Web-based platforms that allow all team members to track to-do lists and exchange files.

21.1.1 E-Mail

E-mail deserves a special mention because of its widespread use. In many cases, people now prefer e-mail to phone calls. E-mail offers convenience in business communication, but it is not as confidential as the phone. E-mail messages can be saved for months, even years; therefore, e-mail is a form of written correspondence and should be treated as such. A good rule of thumb regarding e-mail content is if you wouldn't want to see what you wrote, with your name attached, on the front page of the local paper, don't put it in an e-mail. Think twice, click once.

With the convenience of e-mail, it may also become burdensome. Care should be taken with the use of the "reply all" function. Limit e-mails to those who really need to be informed of the subject information. Also limit the attachment of large electronic files whenever possible. When possible, save the electronic file to the network and provide the location or link to the file within your e-mail.

Another useful function of e-mail is to greatly reduce document distribution costs. E-mail notifications can replace distribution of hard copies by notifying the e-mail recipient about the availability of a document and its location on the network.

The growth and ease with which e-mail and electronic files can be exchanged also raise concerns about computer viruses—programs that deliberately damage data or a computer's operation. Software for detecting and removing viruses is available commercially and should be mandatory on project networks and shared data environments. Virus detecting software should be updated regularly as needed, especially on systems handling data crucial to the success of the project. Due to the prolific exchange of data electronically, it is extremely important to detect and eliminate viruses as soon as they enter a system. Quick action substantially reduces the effort needed to eliminate the virus and prevents the loss of important data.

21.1.2 Project Extranets

Available and developing project extranet technology provides unique and efficient means for improving communications among project team members regardless of their location. Careful consideration for the selection or development of a project extranet should include the following:

- Understanding all the various electronic platforms used by project team members;
- Experience and reliability of source firm for commercially available extranet programs;
- Resources required to operate and maintain selected system.

21.1.3 Backup and Storage

Frequent backup and safe storage of electronic files is essential for all computer users and systems. Daily backups are recommended to ensure that equipment failure, theft, fire, viruses, or other events do not result in the loss of the most valuable part of a computer system—the data.

21.2 COMPUTERS AND THE OWNER

Computer technology can provide project owners with project-specific tools to aid in planning, soliciting bids, construction management, developing and performing quality assurance tasks, and operation and maintenance. Many computer systems now offer intuitive graphical user interface (GUI) technology that can greatly enhance the owner's ability to understand complex or voluminous project information quickly.

One common interface involves a three-dimensional electronic project model that is linked to alphanumeric databases of project information. This type of interface provides owners with easy, "point-and-click" access to information.

Typical GUI computer applications for the owner include

Project Operation:	Planning, scheduling, and administering maintenance and repair operations; and managing inventories of maintenance supplies and spare parts.
Financial Management:	Tracking and managing project assets; maintaining inventory information on installed assets; assigning assets to entities within the project; and calculating asset depreciation.
Facility Space Management:	Tracking the assignment of project space to departments and managing backcharges for its use.
Communications Management:	Managing communication system information, such as telecommunications cables and Internet connections.
Human Resources:	Locating staff, managing electronic communications, organizing mail delivery, and linking to a larger human resources database.

Three-dimensional CADD models can assist the owner in preparing to expand, retrofit, or remodel an existing facility. Such computer models require that the owner coordinate with the design professional and constructor to ensure hardware and software compatibility. Computer modeling to enhance owner access to information is a significant benefit on large and complex projects. However, such modeling requires additional effort over and above that needed to prepare project drawings and project specifications; therefore it may not be cost-effective for small projects. To realize its full value, the model must accurately reflect the project as work actually progresses, not as it was proposed.

21.3 COMPUTERS AND THE DESIGN PROFESSIONAL

An increasing number of specialized software applications, and the powerful computer systems to run them, are available to the design professional for various design tasks. The following sections discuss general considerations and computer capabilities in drafting, designing, exchanging information electronically, and enhancing project coordination and communication.

21.3.1 CADD Software

CADD (computer-aided design and drafting) is of special interest to designers as this software automates many tasks related to the preparation of project drawings, including the following:

- Revising project drawings as design progresses to completion;
- Extracting frequently used graphics from electronic archives and inserting them in new project drawings;
- Copying repetitive information, such as identifying markings or baseline conditions, on multiple project drawings;
- Sharing project drawings among disciplines and departments.

CADD systems allow users to create detailed three-dimensional project models and conveniently generate different perspectives for design documents and other uses. Some enhanced versions allow the user to perform a virtual walk-through of the designed project.

The Project Manager's CADD Survival Guide, Stephen M. Benz, ASCE Press, 1997

Some CADD systems allow users to link graphic models with related non-graphic information, such as material descriptions, product names and identifying numbers, prices, and information on ordering, delivery, and installation. Sophisticated CADD systems also allow the user to query the model and develop complex qualitative and quantitative reports.

Though these powerful CADD features speed up many aspects of the design and drafting process, their use requires care. Automated CADD tools can allow drafters and technicians to produce complex drawings with little supervisory oversight. These drawings may look right, but the information or calculations supporting them may be wrong. In addition, while it may be possible to create a design concept in CADD, the designer must verify the appropriateness of the design to the project at hand and its constructability. It is tempting to promise very short turnaround times, relying on "the computer" to somehow ensure that the drawings will be correct. Designers still need time to check their work carefully before, during, and after the use of a CADD system.

Common CADD errors include using library materials and information from other projects without verifying their relevance to the project at hand, sharing drawings with other team members without verifying their accuracy, and failing to document the exchange of electronic files.

The type of CADD software to be used needs to be considered at the beginning of the project. Where CADD files need to be shared between organizations, compatibility becomes an issue when input into the CADD file is required by several organizations. Converting CADD files from one format to another may cause the file to lose some of the file's information. For large projects it is critical that the full set of all software that will participate in the electronic exchanges be identified and tested to ensure that the transfer will perform as expected.

21.3.2 Building Information Modeling

Building information modeling (BIM) extends the simple visualization functionality provided by 3-D CADD by adding conceptual and physical properties of objects in the model and relationships between the 3-D objects. BIM technologies are being aggressively implemented in many projects. The transition from CADD to BIM technologies in engineering disciplines is also under way.

21.3.3 Specification-Writing Software

Professional designers often use standard specification software to create the baseline project specifications, which are then reviewed and revised as necessary to conform to project-specific requirements. These software packages are typically standard word processors linked to a library of commonly accepted specifications to provide current product, material, and construction methods. Standard specification libraries must be kept current. Most government agencies and vendors provide subscription services at a nominal cost to ensure that subscribers keep their specifications current.

21.3.4 Design Software

Design software performs tasks related to calculation-based design work, such as structural loadings or roadway geometry.

Many design programs interact directly with the user's CADD graphic files. Some design programs evaluate the work as it is drawn, and some include features that feed calculations directly into CADD software and produce significant portions of the project drawings automatically. The general benefits of design software include the following:

- Consistency in design tasks;
- Ease in checking work;
- Greater convenience in sharing calculations with clients and other team members.

As with CADD software, design programs can provide misleading or incorrect information if used by inexperienced staff. Project quality depends on the review of critical work products by experienced design team members even when using sophisticated CADD software. Many design firms continue the time-honored practice of formalizing the review process with routing slips or stamps with the familiar boxes: "Designed By," "Checked By," and "Approved By" as part of their quality control responsibilities.

21.3.5 Electronic Information Exchange

Computer networks allow design professionals to submit and receive a variety of information electronically. They may send and receive information over computers connected to a company-wide network or linked to the Internet.

These links allow design professionals to receive information not only from colleagues within their own firms but also from owners, subcontractors, constructors, and government agencies. This information may include surveys, reports on existing site conditions, drawings for adjacent properties, preliminary design studies, documents from previous project phases, government codes and regulations, and more. In many cases, exchanging project drawings electronically is more convenient and less expensive than producing and shipping actual blueprints.

CADD and design software may allow the designer to import or link information directly to a project model or file so that it can be easily recalled. Such features can save time and effort, compared to the manual recording and filing of information from paper documents but can also raise quality concerns. These concerns include the following:

- Reliability or trustworthiness of the party that prepared the files;
- Availability of the person or agency who prepared the information to answer questions during the project;
- Accuracy, completeness, and relevance of the material. Extraneous material may hamper progress if the designer must locate or verify relevant materials;
- Compatibility between software systems.

21.3.6 Coordination and Communication

Automated tools help the design professional better communicate with other team members and coordinate project work with them.

Project coordination requires communication among many people. Beyond e-mail and electronic file transfers, computers can further assist in project coordination by allowing team members to

➢ Chapter 5, "Coordination and Communication"

- Exchange or work simultaneously on large text documents, spreadsheets and other calculations, drawings, red-line mark-ups, catalog cuts, 3-D electronic models, and other files;
- Conduct online meetings with video images of participants in remote geographic locations;
- Share and evaluate ideas with other people on the computer network;
- Operate a program on a computer in another location.

However, computer-based communication poses its own challenges. The equipment and rental of any extra network lines can be expensive, and operating the systems requires staff and ongoing support. Such systems can make communication so convenient, even fun, that people communicate too much. Instantaneous communication can allow individual team members to make decisions and act without pausing to reflect or consult others.

21.4 COMPUTERS AND THE CONSTRUCTOR

In addition to assisting with day-to-day office operations, computers offer important benefits in automating many of the tasks performed by the constructor.

These include quantity calculations, project management, quality control management and documentation, document control, submittal tracking, layout, and information management.

21.4.1 Quantity Calculations

Electronic project drawing files are a great benefit to the constructor in estimating the quantities of bulk materials, such as concrete and steel, as well as the number of individual components, such as electrical outlets, that will be necessary to complete the project as designed. Computer files that include three-dimensional project models linked to non-graphic databases are especially helpful for estimating purposes. However, these models may not allow for waste, breakage, settling of materials, or other factors that affect the actual quantity of material needed.

21.4.2 Project Management

Project management software assists constructors and other users in breaking down a large project into a sequence of individual tasks. Such software often includes features that allow the user to

- Assign people, equipment, and materials to each task;
- Assign duration to each task;
- Develop a project flow diagram that shows the tasks and the sequence in which they are to be performed;
- Identify critical path items;
- Investigate alternate project task scenarios that allow the critical path to be shortened.

Project management software can be valuable to the constructor, as long as the information entered is accurate and reliable. This necessitates that the relationships and time frames assumed in the model are consistent with actual conditions and that information is current. Regular tracking and comparison of actual progress with that forecast by the software allows further adjustments to the model and helps increase accuracy.

21.4.3 Quality Control

Quality control tasks, document production, and communication are as described in this subsection. In addition, computer-based applications are widely available for quality control activities to include (but are not limited to):

- Wireless access to project contract documents;
- Location verification by GPS;
- Movement sensors;
- Soil moisture and density;
- Concrete strength;
- Pavement smoothness;
- Temperature monitoring;
- Digital camera images.

21.4.4 Document Control

Computer systems are an enormous benefit to the constructor in organizing, archiving, and controlling the flow of project documents. In particular, the use of central file servers (computers with large storage capacities that are accessible via a network) can electronically consolidate documents that may have previously been scattered throughout the company.

Documents that may typically be included on file server systems include

- The owner's original request for proposal and the constructor's submitted proposal;
- Contracts and amendments;
- Correspondence;
- Project schedules;
- Meeting minutes and notes;
- Quality control reports;
- Project drawings and project specifications;
- Catalog information;
- Shop drawings and submittals;
- Miscellaneous project reports;
- Operations and maintenance data;
- Punch lists;
- Technical library.

Documents that are not received in electronic format may be easily scanned and saved in an appropriate format that can be viewed by others. These documents can be made searchable to facilitate locating relevant information in a large document. This same format should be used when sharing documents that the originator does not want changed.

Computer operating systems provide a variety of options for organizing these documents and providing convenient access to them. Wireless access by pocket or tablet computers permit access from "wireless hot spots" established within the project site. The constructor's team benefits from investing time in determining what type of file organization will be most effective for the project at hand. Like a library, an organized and maintained project document repository helps everyone perform more efficiently.

21.4.5 Submittal Tracking

Computer systems can help the constructor manage project submittals received from subcontractors, suppliers, fabricators, and other project participants. Once received, submittals are typically distributed and reviewed by multiple parties, marked with corrections and changes, returned to the originator for updating, re-submittal, review, and final approval.

Many word processing, database management, and project management programs provide the constructor with automated capabilities to determine the status of any submittal. These programs may record the arrival of submittals and track them through the subsequent steps of the review and approval process. Submittal tracking systems require active staff participation to be reliable and useful.

21.4.6 Layout

Surveying instruments integrated with computer-based CADD and BIM information provide a means for efficient transfer of construction plan information in the layout stage.

21.4.7 Information Management

Computer information and management communications capabilities are assets to the constructor. One example is real-time video communication, which not only brings together project participants—of which there are usually a greater number during the construction phase of a project—but can also allow the constructor to view construction sites remotely. Akin to older, more expensive closed-circuit television systems, affordable web-cam technology can be useful at construction sites involving unusual automobile traffic or security concerns.

21.5 INTERNET RESOURCES

In addition to e-mail, computer technology used in conjunction with the Internet offers opportunities to enhance productivity for project participants. Computer technology can streamline the exchange of information among team members, provide quick and convenient access to reference materials or other professionals in the industry, provide information to the public, and improve overall project coordination. Two examples are highlighted below.

21.5.1 File Transfer Protocol

FTP programs let team members post drawings and other large files on secure Internet sites from which other team members can download them. Use of an FTP site requires file transfer software that is inexpensive or even free. FTP sites are valuable as online electronic libraries for large project files. FTP sites allow team members to reduce costs for long-distance telephone services, printing expenses, and shipping. However, the management of FTP sites requires care, as files must be current, approved for use, and properly identified.

21.5.2 Project-Enabled Websites

Secure websites help provide project team members with rapid, secure, and easy access to critical project information through Web browsers. Such websites, which are generally easier to use than FTP sites, require a level of Web page expertise on the part of the person maintaining the site. Project-enabled websites can include a variety of project information, including correspondence, reports, drawings, specifications, product information, budgets, schedules, tracking data, and more. Authorized team members can view the postings online or download them. A project-enabled website can act as a "home office" for team members spread out over many geographic locations.

SUMMARY

Computer systems and software are indispensable support elements for planning, designing, and constructing projects. Computers support the various processes, from conceptual planning to operation of the completed project. Computers can increase productivity, automate routine tasks, improve the integration of related tasks, and enhance communication among team members.

However, computers are not magic. They contribute to project quality only when they are selected and used appropriately to achieve accuracy and completeness. The impact and contribution of computer technology to constructed projects will continue to grow, and project owners, design professionals, and constructors will benefit by investing the time and funds to remain in the forefront of this rapidly changing field. ❑

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CHAPTER **22**

PEER REVIEW

Peer review is an independent assessment of a business organization, project, or technical process. This chapter discusses two types of peer reviews: organizational peer reviews and project peer reviews. In some professions, peer reviews carry a negative connotation, but not in design and construction, where a peer review is an affirmative tool available to the project team for improving efficiency and effectiveness and enhancing quality.

Organizational peer reviews address the typical workings of a firm or agency as a whole, including policies, procedures, and practices. Organizations include project owners, design professionals, and constructors; they can be privately owned or a governmental entity.

Project peer reviews, in contrast, focus on a single project and usually focus primarily on either design or management. Project design peer reviews (sometimes called project performance peer reviews to broaden their scope beyond design) examine in detail the technical results or recommendations for all or part of the project at its current stage of development.

Peer reviewers are design or construction professionals who have experience with similar organizations or projects and who are typically managers or senior technical persons from another organization. Reviewers thus have a fresh perspective that allows them to act independently.

The scope of the peer review is specified by the organization's manager or project team member who commissions the review. The review might cover issues of technical design, project management, or the overall management of team member organizations. The peer review processes described in this chapter are typical for traditional design-bid-build project delivery, but in most cases, they are applicable to design-build and other forms of project delivery.

22.1 GENERAL FEATURES

Organizational and project peer reviews have the following general features:

- The purpose, scope, format, and duration of the review are well defined to help distinguish it from other, less systematic reviews;
- The technical or managerial expertise of the reviewers—industry peers of the owner, design professional, or constructor—is usually similar to or greater than that of the professionals being reviewed;
- The organization or project reviewed by an independent peer or team of peers benefits from the broader range of experience brought to bear;

In this chapter

Types of Peer Reviews

1. Organizational
2. Project
   - Design (or performance)
   - Management

Wonder, rather than doubt, is the root of all knowledge.

Abraham Heschel

- The parties involved give the review special attention in acknowledgment of its potential benefits;
- Peer review observations are disseminated in a timely fashion to appropriate individuals, especially those whose activities are the subject of the review;
- The peer reviewers serve in an advisory capacity; they do not have the authority to recommend solutions to the problems or issues that surface, unless clearly requested to do so.

Peer reviews differ from other reviews in several respects:

- Peer reviews do not signal that an organization or member of a project team is incompetent or suspect; rather, observations of or participation in a peer review demonstrates a commitment to improve quality, efficiency, and/or organizational effectiveness;
- Peer reviews are conducted only by people who have not been involved with the organization or project;
- Peer reviews are not required by a regulatory agency;
- Peer reviews are more than a constructability review, although reviewers often inquire about assumptions affecting construction.

To succeed, a peer review requires adequate resources, including budget, time, and effort. Advance planning can keep peer reviews from being disruptive. The benefits of a peer review usually outweigh the costs, often by orders of magnitude.

22.2 TYPES AND BENEFITS OF PEER REVIEW

The following sections discuss the two types of reviews that are most frequently encountered in the construction industry: organizational reviews and project reviews.

Peer reviews deliver many benefits that enhance quality for individual projects, as well as for the organizations involved. Benefits occur even before the review begins: a peer review signals that managers care enough about quality and efficiency to ask their peers to point out possible improvements in their work, or participants acknowledge that a project or organization is important enough to warrant outside opinions. Therefore, the preparation for a peer review is also a benefit, as it requires participants to bring a new level of focus on their work and procedures.

The leverage gained from just one project or organizational “shortfall” can be immense. In either case, for example, it is not uncommon to find that there is a significant contract or legal liability that is exposed. Project peer-reviewers might discover that QA or QC procedures are not being followed according to either company policy or the project requirements. While nothing dire might have followed from these discovered “gaps,” something dire could have, equaling one potential benefit. And, by discovering them before they became dire, the processes and procedures needed to correct them can be put in place sooner. This latter benefit has long-lasting application.

Experience shows that more than one discovery is normally made during any peer review; in fact, many may be. Hence, the potential benefits of peer review can be significant.

22.2.1 Organizational Peer Review

Organizational peer reviews independently assess the operations of a design or construction organization (private or public) in light of how faithfully the organization's stated overall policies and practices are actually practiced.

These reviews can focus on an entire organization, on portions of it (e.g., certain locations), and/or on certain operations. For example, an organization composed of five office locations might choose to have its main office and one branch office reviewed and have the reviewers cover project management, quality management, financial management, human resources, and the organization's IT infrastructure. This would mean that the reviewers would not review the organization's sales and marketing functions, executive leadership, strategic planning, and ownership transition, to name but a few other options. Peer reviews of this type can span from one to four days, involving from one to four peer-reviewers, depending on scope.

Organizational peer-reviewers are looking to find both what is and what is not operating according to the stated objectives of the organization. Generally, they need to obtain material that describes the organization's plans, policies, and procedures, and they often survey a sampling of the organization's population prior to the actual, on-site review. Upon completion of their review, they brief a pre-selected group from the organization on their findings. While they overview what is working well, they focus more intently on gaps, issues, and problems that they have uncovered and offer their observations for consideration. They refrain from making specific recommendations on how to solve the problems they uncover, since there could be many suitable and unsuitable solutions that only further study by the organization can determine. They may also be requested to submit a written report which summarizes their findings.

22.2.2 Project Peer Review for Design

Project design peer reviews—both design reviews and the less frequent project design management reviews—involve a separate, structured, focused, and thorough fact-finding process conducted by one or more senior professionals who are independent from the project team. Before either type of review begins, the reviewer(s) work with the owner, design professional, or constructor to develop a detailed scope of the review. This scope includes the functions to be reviewed, the process to be followed, the schedule, and the form of reporting.

A project management peer review is essentially an organizational peer review applied to a single project, rather than to the entire organization, and can be carried out by adapting procedures of organizational peer reviews (see section 22.2.1). Hence, the discussion of project peer reviews in this chapter refers to project design peer reviews only.

The discussion of project peer reviews in this chapter refers to project design peer reviews only.

A distinguishing feature of a project design peer review is that its scope goes beyond routine standard procedures and daily quality control checks. For instance, a critical structural connection might be peer-reviewed using an independent method of analysis or for the effects of cumulative dimensional tolerances, the sequence of fabrication or erection, or loads other than those assumed by the designer.

One or more of the following circumstances might suggest that a project peer review would prove useful:

- The project is larger or more complex than is usual for the team;
- Technological innovations are involved;
- Previous similar projects have experienced difficulties;
- Project objectives have changed during design, or disputes have arisen;
- The project team includes several offices or many different organizations;
- The project involves a rapid or fast-track schedule;
- Budgets for developing or implementing recommendations are limited;
- The number or qualifications of staff personnel are a concern, including apparent over-commitment or the recent departure of key persons;
- The project involves large potential liabilities to the owner, design professional, or constructor or poses unusual risks to the public;
- The status of work performed to date is in question;
- The project involves special environmental concerns.

Project design peer reviews can examine an entire project but usually are more limited in scope. They often occur at the completion of design, but there are advantages to holding a review at the earlier key milestones. Project peer reviews can also be performed during construction, or even upon project completion (as a benefit to subsequent projects). Therefore, the scope of a project peer review is defined when the review is authorized and necessarily reflects the current state of project completion. Typical scopes include inquiries into the following:

- Design assumptions or criteria;
- Applicable codes and regulations;
- Accuracy of calculations (in designated areas or by spot check);
- Clarity and completeness of reports or design documents;
- Appropriateness of selected actions compared to alternatives identified;
- Application of good judgment;
- Constructability of the design;
- Construction means, methods, and techniques proposed or employed;
- Prospects of meeting project objectives.

➢ 11.3.5, "Constructability Reviews"

Despite certain similarities, the project design peer review is not a value engineering study. Value engineering assumes an adequate design and attempts to match the effectiveness of the design while reducing cost, whereas a project peer review focuses on the quality of the design in meeting the project objectives (while still being cognizant of cost). Value engineering focuses more upon whether the right overall solution is being pursued, while design peer review examines whether the selected solution is being engineered correctly.

➢ Chapter 25, "Value Engineering"

22.3 PROCEDURAL ELEMENTS OF PEER REVIEW

Peer reviews of either organizations or projects follow six general steps: commissioning the review, developing the scope, selecting the reviewer(s), examining documents, conducting on-site interviews, and reporting. Subsequent follow-up actions may be advisable for the clarification and acceptance of findings and assurances, where appropriate, that corrective actions will be taken. The following sections discuss these procedures in more detail, highlighting similarities and differences in organizational and project design peer reviews.

➢ See 22.5.2, "Project Design Peer Reviews," for the *Agreement Between Owner's Designer and Project Peer Reviewers for the Professional Services for Independent Project Peer Review*

22.3.1 Request for Peer Review

A peer review begins when one of the parties involved formally requests that a review be conducted. In the case of organizational reviews, this request often comes from management as part of an organization-wide quality enhancement process. Reviews are especially effective for large organizations seeking to improve the performance of individual operating units. Organizational peer reviews might also be mandated by an owner or required by a regulatory agency as part of an approval process.

Project design peer reviews can be requested by any member of the project team (owner, design professional, or constructor) or by one or more regulatory agencies having jurisdiction over the project. In most circumstances, unless the review is requested by the designer or constructor, the owner authorizes the review and pays the associated costs.

22.3.2 Establishing Scope of the Peer Review

The scope for a peer review should be focused and well defined, distinguishing it from other, more general reviews.

22.3.2(a) Organizational Peer Review

An organizational peer review can focus on procedures for carrying out projects or address all aspects of management of an organization. The organizational peer review begins with an agreement or authorization and proceeds typically through the following steps:

- Defining scope of the review, including resources and time required;
- Selecting reviewers;
- Collecting documentation defining organizational processes, policies, and procedures;
- Organizing and implementing surveys of stakeholders;
- Interviewing stakeholders and conducting on-site visit(s);
- Collating and organizing findings;
- Reporting on findings.

The organizational peer review may verify the adequacy of office facilities, libraries, support for field services, and the management of "low-tech" or nontechnical equipment. The review team may critique personnel policies and professional development programs, or lack thereof, as well as procedures or opportunities for sharing professional experiences. As a rule, a review includes all facets of an organization's practice, from line activities, to distinctive staff functions, to looking at marketing activities and relationships with external organizations.

The scope of organizational peer reviews is often standardized by recognized programs.

22.3.2(b) Project Design Peer Review

The scopes of project design peer reviews vary widely. While reviewers might be asked to look only at a project's final design documents, the process generally delivers more benefit when conducted at earlier points in a project's design phase, as well as, occasionally, during construction. All parties should be apprised in a timely manner of the proposed use of the review.

Project design peer reviews can be commissioned as early as the planning for design phase of a project. A review at this point provides the owner with an independent assessment of the proposed design, presumed construction processes, and design schedule. Irrespective of project phase, however, a project design peer review scope calls for a report to be delivered immediately upon completion of the review. The scope might state that the delivery of the report signals the end of the peer review for the project or for that phase; or the scope might involve the review team in evaluating follow-up activities. Because of the many variables involved in setting the scope of a project design peer review, all participants benefit from investing ample time in the scoping process.

22.3.3 Selecting Reviewers

Accomplished peer reviewers are independent thinkers, good communicators, and contributors to excellence in their professions, regardless of the type of review.

The independence of the review team starts with the selection of members from outside the organization or office being reviewed. Peer reviewers rarely come from within the same organization, and then only if they are sufficiently removed in authority and geographic location from those whose work is being reviewed.

Peer reviewers should be qualified, well-regarded senior professionals, experienced with similar organizations or projects, familiar with governing regulations, and widely accepted as being ethical, objective, and thorough. The team could include reviewers from varied disciplines, including environmental scientists, economists, estimators, and experts from other construction fields. Several professional associations offer formal organizational peer review programs with training and certification.

➢ 22.5, "Peer Review Programs and Resources"

The size of the review team depends upon the scope and complexity of the peer review. A team normally consists of two or more reviewers, although single-person reviews are possible for smaller organizations or projects.

22.3.4 Preliminary Document Review

All peer reviews begin with an examination of documents provided to the review team before they meet as a team. These documents serve to introduce the organization or project. Preliminary peer review information might include confidential questionnaires completed by appropriate staff.

22.3.5 On-Site Document Review and Personal Interviews

When the peer review team arrives at the sponsoring organization's office, reviewers go over additional documents and conduct confidential interviews with key personnel and a cross section of other employees or team members.

In an organizational peer review, personal interviews provide reviewers with first-hand information about the organization and its goals. The managers and staff interviewed have the opportunity to share their perspectives on how the organization is performing in key areas, including administration, quality assurance, quality control, user satisfaction, project controls, field activities, and overall direction. The confidential nature of these interviews aids in eliciting candid observations.

Project design peer reviewers generally develop preliminary conclusions about the project's status or technical quality based upon an on-site evaluation of relevant documents and then augment the results of this document review with personal interviews of managers and staff. This consideration of both written and oral information helps the review team determine the extent to which project design assumptions and goals are understood and are being implemented.

In both kinds of reviews, the primary task of the peer reviewers is to compare their findings to the stated objectives of the project or to the processes and procedures that are specified by the organization for conducting its business. They are, therefore, first called upon to, in effect, perform a gap analysis. Unless specifically requested otherwise, they are not asked, nor should they volunteer, to recommend specific solutions to problems or issues identified. It is up to the organization or project team to decide how to address any issues or problems addressed in the peer review report or findings.

22.3.6 Reporting

Peer review reports are of great interest to those being reviewed. In addition to the impact on the industry reputation or public perception of an organization or project, the influence of peer review reports can affect the professional status of the people involved. Therefore, the structure, tone, and delivery of reports for both organizational and project design peer reviews are crucial. The report should be distributed according to the parameters established in the agreed-to scope for the review.

Organizational peer reviews are confidential. These peer review reports are often informal and delivered orally. Reports should remain within the established scope, noting areas of compliance and patterns or instances of unmet responsibilities, contract problems, inappropriate behaviors, or authorization issues. The report might also provide insight or identify areas or items for improvement.

If an organization is large or has multiple offices, the organizational peer review report might be delivered to either the top managers of the office that commissioned the review, or only to the office reviewed. Following the delivery of the report, the review team usually destroys the notes and documents created during the review to ensure the confidentiality of the process. At this time, they also return all documents that were provided to them by the organization.

In the case of a project design peer review, many issues can be resolved informally by direct communication between the designer and the reviewers. Unresolved or major issues concerning the owner's requirements, as set forth in the scope of the inquiry, are included in the written report.

Unlike typical organizational peer review reports, reports of project design peer reviews are generally detailed, not confidential, and submitted in writing to communicate accurately the review team's technical conclusions. Typical reports include the following sections:

- Scope of the review, including limitations;
- Current schedule and the status of the project;
- Phase being reviewed;
- Identification of needed corrective actions;
- Issues for further evaluation and consideration.

For both organizational and project design peer reviews, balance is an important aspect of the report; favorable comments, as well as critical ones, are helpful in assessing performance. Peer-reviewers should avoid imposing their own personal preferences without appreciating other acceptable practices. Further, peer review reports do not in themselves call for required actions but are intended to guide decisions by pointing out potential items and areas for improvement. In many cases, informality is an asset in achieving this goal.

22.3.7 Follow-Up Actions

Without clearly defined follow-up or action items after the delivery of the report, the full benefit of any peer review to the organization or project can be lost. In some cases, the authority commissioning the review can simply order that the findings be addressed, through reconciliation or corrective action. In other cases, those being reviewed should accept the responsibility to address the findings.

Offices that voluntarily seek either type of peer review tend to take the findings seriously and work to implement them in a constructive spirit. Establishing measurable goals and a realistic schedule are key aspects of successful implementation of the findings.

Upon the conclusion of the review, the authority commissioning the review acknowledges completion and releases the team. At that point, the parties complete any remaining administrative actions, including compensation, certificates of completion, and any other appropriate documentation.

22.4 RESPONSIBILITY

While the goal of the peer review process is to enhance project or organizational quality by soliciting the input and advice of external parties, the responsibilities of the organization or the professionals reviewed remains the same. Organizational peer reviews lead to the organizations themselves adopting or rejecting findings. Project peer-reviewers are not authorized to make changes or direct others to make changes in project documents; they have no authority over organization or project personnel, and the original professionals retain their legal responsibilities.

22.5 PEER REVIEW PROGRAMS AND RESOURCES

The following two sections offer additional resources for organizational and project peer reviews.

22.5.1 Organizational Peer Reviews

Some professional associations offering standardized organizational peer review programs for design professionals, generally costing only reimbursement of direct expenses plus a modest honorarium for the reviewers, are

Organizational Peer Review Resources:
http://www.asfe.org
http://www.acec.org
http://www.asce.org
http://www.aia.org
http://www.agc.org

- ASFE, an organization of professional firms practicing in the geosciences, which developed the first organizational peer review process in 1978;
- The American Council of Engineering Companies (ACEC), which expanded the ASFE program and adapted it for all private engineering and architectural design firms in the United States, Canada, and Mexico. The ACEC-sponsored program has been endorsed by ASCE, the National Society of Professional Engineers (NSPE), and the American Institute of Architects (AIA) for all engineering and architectural firms. Peer reviews have been conducted by ACEC in English, French, and Spanish;
- The American Society of Civil Engineers (ASCE), which administers an organizational peer review program for governmental agencies that is similar to the ACEC program;
- The Associated General Contractors of America (AGC), which has a voluntary program that can be implemented by groups of interested firms.

22.5.2 Project Design Peer Reviews

Several large project owners, designers, and constructors have also established in-house project design peer review programs. The Engineers Joint Contract Documents Committee (EJCDC) has developed a *Standard Form of Agreement Between Owner's Designer and Project Peer Reviewers for Professional Services for Independent Project Peer Review.* Since EJCDJ is made up of representatives of ACEC, ASCE, AGC, and NSPE, this guideline offers a standard to help make the framework for project peer reviews more consistent, cost-effective, and successful.

EJCDC Doc. E-581, *Agreement Between Owner, Design Engineer and Peer Reviewers for Professional Services for Independent Project Peer Review,* 2011

SUMMARY

A project peer review is a high-level action taken to improve the efficiency, effectiveness, and quality of projects that organizations undertake. An organizational peer review goes further and examines the policies and practices of an organization across many of its projects and activities. A project peer review focuses intensely on a single project, perhaps even on a single phase at a time or a single component of the entire project.

Peer reviews are requested as an added measure to improve quality. Many leaders familiar with peer reviews have encouraged their use by large or small organizations and on large or small projects. A fresh, unbiased, and diplomatic review by one or more professionals can be a highly cost-effective management initiative measure that may help avoid unnecessary and even costly mistakes, close unrealized gaps in an operation or process, and reduce costs and overall time required to complete a project. ❑

Chapter 22: Peer Review

*Typical Responsibilities**

Responsibility ⇩	Owner	Design Professional**	Constructor**†	Design-Builder
Commission the review	● ***	◉ ††		◉ ††
Establish scope	●	◉ ††	◉	◉
Provide sufficient budget and schedule resources	●	◉ ††	◉	●
Select reviewers	●	◉ ††	◉	●
Participate in interviews, document reviews, and other activities	◉	●	●	●
Adopt report	●	●	●	●
Implement recommendations	◉	●	●	●

* *Responsibilities apply to project design peer reviews. For organizational peer reviews, the organization itself holds primary responsibility for the general tasks above.*

** *For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

*** *A regulatory agency, acting on its own or enforcing a regulation, could require a project peer review as a condition of permitting.*

† *The Constructor is generally not involved unless invited at the time a project peer review is initiated and is specifically invited to participate, or unless a design-build delivery system is being used.*

†† *The Design Professional (or Design-Builder) can initiate a project peer review of his or her own work at any stage of a project, in which case the designer is responsible for carrying out all responsibilities alone.*

● = Primary Responsibility ◉ = Assist or Advise

CHAPTER 23

RISK, LIABILITY, AND HANDLING CONFLICT

In this chapter

Construction projects involve risks. All participants—the owner, design professional, and constructor—face varying degrees and types of risks, which are present during every phase of a project.

Risks normally determine many of the financial, contractual, and practical relationships among the participants. Some risks may involve more than one of these relationships; some may involve all of them. Because significant risks are present on almost every project, each participant must have a plan to manage these risks before making any commitment to the project and other parties. As a part of the plan, all projects should include a dispute resolution process.

This chapter identifies some of the risks that are common to construction projects and outlines practical and contractual techniques to manage those risks. Topics include the use of risk management tools such as insurance, warranties, and bonds; an overview of contractual and legal liabilities that can result when a risk materializes into a loss; and a discussion of conflict avoidance, options for conflict resolution, and litigation.

Because many methods of managing risk (e.g., clauses involving indemnity, limitation of liability, contribution, and other technical risk transfer techniques) involve specialized legal and/or insurance knowledge, it is critical that an appropriate consultant be engaged as soon as possible to offer the needed expertise.

23.1 CONSTRUCTION PROJECT RISKS

Risks, by definition, are uncertain. It is impossible, therefore, to predict and account for every adverse occurrence on any project. However, historic experience has helped identify the nature of most risks on most projects. These types of risks are summarized below.

Safety: Construction work has a potential for construction site injuries to workers and others, including the general public.

Difficulty: Construction work is performed under (somewhat) uncontrolled field conditions, often using designs that incorporate unique or new ideas by a workforce with varying degrees of training, skill, and experience.

Unforeseen Conditions: During construction, previously unforeseen or changed conditions may be encountered, requiring modifications to design and construction activities that may increase cost or delay completion.

Environmental: Discovery of hazardous and/or contaminated materials during construction is a risk to all project participants and may require the intervention by regulatory and law enforcement agencies vis-à-vis the proper identification, handling, and disposition of such materials.

Diversity of Interests: The owner, design professional, and constructor may have different interests with respect to the allocation of project resources and financial risk.

Force Majeure (Control): Project participants lack the ability to control a variety of factors, such as weather, fire, earthquake, labor needs, civil disorder, market conditions for materials, and the actions of third parties (including regulatory agencies).

Labor: Quantity and skills required of labor force may not match needs of the project.

Materials: Availability and cost of materials may change significantly.

Professional: Participants may risk damage to their reputations or industry standing.

Legal: Participants and third parties risk exposure to litigation and legal liability.

Financial: A participant's lack of sufficient funding to meet obligations may increase risk.

Community Expectations: The failure to meet community expectations, communicate project objectives, and/or be a good neighbor may increase risk.

23.2 MANAGING RISK

Risk management requires that the project owner, design professional, and constructor carefully identify and examine several aspects of the project at hand. They accomplish this by evaluating the potential risks of the project itself, the roles and qualifications of the other team members, the method of project delivery, contractual provisions for allocating risk, and the means of establishing and providing incentives for performance. All participants must evaluate their particular exposure to risk presented by the project. The owner is in the best position to properly allocate risk through fair contract provisions. Frequently, the owner seeks the advice of the design professional regarding risk. In fact, one of the most important considerations in using the standardized contracts is that risk is allocated fairly and to the party in the best position to manage and, therefore, accept it. The following sections address these aspects of risk management.

➢ Chapter 7, "Agreement for Professional Services"
➢ Chapter 15, "The Construction Contract"

23.2.1 Evaluating the Project

Before an owner, design professional, constructor, or other entity undertakes any particular project, questions relating to feasibility and risk associated with that project must be addressed. Some of these questions include

- Will the project meet the owner's needs?
- Is the project adequately funded?
- Is the project schedule realistic?
- What is the potential financial loss to the team members?
- What is the potential for personal injury or property damage?
- What is the potential for uninsurable losses, such as environmental conditions that are generally excluded under standard general liability insurance policies?
- Does the project have significant environmental impacts?
- Does the project involve novel or unfamiliar delivery techniques?
- Is the public profile of the project such that professional reputations are at risk?
- Are the project risks allocated fairly?
- Are the risks allocated to the party best able to manage them?

23.2.2 Evaluating Other Team Members

The quality and reputation of the other members of the team are important considerations in the management of project risk. Characteristics to consider include the following:

- Reputation and record for honesty and integrity in business relationships;
- Financial strength and funding capability;
- Performance on similar projects;
- Capability and experience of the personnel assigned to the project;
- Previous relationships among team members;
- History of litigation on previous projects;
- Limits and quality of bonding and insurance coverage;
- Safety history and worker's compensation rating;
- Capacity to complete the work proposed within the proposed schedule.

The qualifications of each participant directly affect the degree of risk assumed by the others. For example, if the constructor or the owner has limited financial resources, parties making claims against the project are more likely to pursue the design professional to recover losses. Parties also benefit from evaluating the types of legal entities that parties may deploy to participate on a project. The formation of a joint venture, limited liability company (LLC), or a limited liability partnership (LLP) for the purpose of working on a particular project is a common strategy for limiting risk. Recovery against these types of entities is usually limited to the resources of the LLC or partnership, which may be significantly less than needed to cover major losses or liabilities.

23.2.3 Project Delivery Systems

A number of hybrid and legally complex project delivery systems are available to owners. In addition to traditional design-bid-build contracting, owners can choose from delivery systems such as design-build, construction management, turnkey, and other variations to meet the needs of a particular project. Therefore, it is essential that participants carefully consider the risks associated with their roles under the proposed delivery system. For example, design-build-operate-maintain (DBOM) projects often require that the design professional and constructor contribute equity or financing to the project. While this arrangement may reduce the burden on the owner, it requires that the other parties carefully evaluate the allocation of risk, particularly the economic risk of recovering that equity.

23.2.4 Contractual Provisions

After the project and participants are evaluated, each party focuses on the contractual arrangements that are available to manage risk. The advice of experienced construction attorneys and insurance professionals is essential in drafting and negotiating specific contract terms and conditions. Such advice should be sought early in the contract negotiation process because the different manners in which risk is transferred, assumed, avoided, or reduced will have significant impacts on the project cost, method of delivery, and other important characteristics.

Contractual provisions must address dispute resolution procedures.

23.2.4(a) Owner–Design Professional Agreement

➢ Chapter 6, "Selecting the Design Professional"

In the professional agreement between the owner and design professional, provisions relating to risk management include the following:

- A well-defined scope of services, including a statement of the services to be provided by the designer and those excluded;
- A statement of actions, information, or services to be provided by the owner;
- A statement of the standard of care by which the design professional's performance will be judged;
- Definition of expected level of detail in design work products, such as conceptual, diagrammatic, working drawing, issued for construction, etc.;
- Constructability of design;
- Quality assurance of design work products;

- Definition of project specifications as being "design" or "performance" in nature;
- The extent to which design responsibility for systems or components may be delegated to the constructor;
- The approval of the contractor's design of temporary structures when they are integrated with the permanent structure;
- Definition of each party's responsibilities regarding obtaining permits and licenses;
- Disclaimers of liability for certain responsibility of others, such as the constructor's safety program, the design of temporary structures, and means and methods of construction;
- Indemnification for appropriate risks, including third-party claims;
- Waiver of consequential damages;
- Limitations of liability;
- Necessary professional liability insurance coverage, including errors and omissions;
- Dispute resolution provisions;
- Establishment of methodologies for measuring progress and payment;
- Establishment of target schedule for design work products that connect to construction milestones.

When appropriate, the design professional may incorporate similar provisions in agreements with subconsultants.

23.2.4(b) Owner-Constructor Agreement

In the agreement between the owner and constructor, the typical provisions related to risk management include the following:

➢ Chapter 14, "Procedures for Selecting the Constructor"

- A well-defined scope of work for the constructor, including project drawings, project specifications, and other contract documents;
- Establishment of order of precedence for technical documents, i.e., Do project drawings supersede project specifications?;
- A statement of actions, information, or services to be performed by the owner;
- The extent to which design responsibility for systems or components may be delegated to the constructor;
- Quality control requirements;
- Responsibility for construction means, methods, techniques, procedures, and for construction site safety programs and temporary structures, if applicable;
- Definition of who is responsible for subsurface conditions and environmental impacts;
- Definition of each party's responsibilities regarding obtaining permits and licenses;
- Definition of schedule requirements, such as resource and cost loading, update frequency, and required report formats and level of detail;
- Definition of methodologies for measuring progress and payment;

- Definition of methodologies to be used for incorporating schedule impact events into the schedule updates;
- Indemnification clauses providing protection for the design professional and owner;
- Waiver of consequential damages (between and among the parties, including design professional);
- Limitation of liability and/or liquidated damages (when appropriate);
- Insurance and bonding requirements;
- Granting additional insured status to both owner and design professional and waiver of subrogation by all insurers;
- Warranties and guarantees;
- Dispute resolution provisions.

When appropriate, the constructor may incorporate similar provisions in agreements with subcontractors.

23.2.4(c) Design-Build Risk Contractual Considerations

➢ Chapter 3, "Project Delivery Systems"

In the United States, the popularity of design-build project delivery is increasing. To manage risk, the design-builder considers the risks that face both the design professional and constructor, as outlined in the two previous sections. The members of the design-build team address risk management internally and incorporate provisions to allocate the risks among the various team members in one or more separate contracts. In addition, the design-build team and the owner must address risk management issues. Some of the risks to be considered in either, or both, of these types of agreements include

- Design deficiencies;
- Design changes;
- Differing site conditions;
- Delays;
- Warranties;
- Liquidated damages;
- Waiver of consequential damages;
- Limitation of liability;
- Indemnification;
- Insurance and bonding;
- Constructability.

Under some forms of project delivery, such as turnkey or one of its variations, the design professional or constructor may be required to contribute equity or financing to the project, thereby assuming all or a portion of the owner's financial risk. In such a case, parties benefit from the careful consideration of the risk and contractual issues noted above.

23.2.5 Project Performance

After agreeing on contract terms that minimize and properly allocate risk, the team members can continue to manage risk by performing in a manner that is faithful to the letter and spirit of those terms. Attention to detail and completing tasks on time improves overall project quality and reduces the likelihood of conflict. Adherence to the owner's or constructor's job-site safety program, regardless of the terms of contract, is often the most important means of reducing the risk of injuries to workers. Taking affirmative steps to meet schedule milestones is an important strategy for minimizing delay-related conflict.

For performance-related activities, regular and honest communication is the cornerstone of the effort to minimize risk, especially during periods of adversity and conflict. Communication is necessary for defining problems, resolving misunderstandings, and facilitating solutions in a manner that is productive and non-confrontational.

23.3 RISK MANAGEMENT TOOLS

The owner, design professional, and constructor all have certain tools at their disposal that are specifically designed to manage risk. The most important of these are insurance, bonds, warranties, and an equitable distribution of risk through the contract language.

23.3.1 Insurance

Because of the dangers inherent with construction and the potentially large number of participants, construction projects can require several types of insurance arrangements. Team members typically carry insurance for general liability and property damage, motor vehicle operation, and workers' compensation. Certain project-specific and wrap-up owner or contractor controlled insurance programs (OCIP and CCIP) may also be required. The contract documents specify the type and amount of insurance coverage required for each project and the parties who are to provide and pay for it.

23.3.1(a) Insurance Needs of the Owner

An owner uses insurance to protect against the risks posed by physical loss or damage to the work in progress at the construction site. To cover these risks, an owner may purchase or require the constructor to provide builder's risk insurance. Because the interests of the owner, design professional, and constructor may be at risk throughout construction, each party is named on the builder's risk policy. It is typical that either the owner or the constructor is designated to be responsible for obtaining builder's risk insurance for the benefit of all participants. In addition, to make sure that losses are shifted to the insurance company or companies, the builder's risk insurance should include a waiver of subrogation.

23.3.1(b) Insurance Needs of the Design Professional

Design professionals typically carry insurance for professional liability (or "errors and omissions") insurance. These policies are often written on a claims made form (that is, the policy must be in force at the time of the claim) and usually are renewable annually. The policy limit has annual aggregate feature and does not apply on an each and every claim. In some instances, policy limits may need to be increased according to the provisions of the owner–design professional agreement.

Alternatively, because the design professional's practice policy covers claims made during the policy period that may, in turn, relate to services actually completed many years ago on unrelated projects, the aggregate limit of liability may not be adequate to indemnify the injured party on claims arising from the instant project. Accordingly, some owners may require the design professional to obtain project-specific insurance, the limits of which are totally dedicated to the claims arising from the project. Typically, the premiums for this insurance are paid by the owner, consistent with the principle that the owner pays for the contractor's bonds.

The design professional also considers specific project needs for insurance in reaching agreements with subconsultants on a project. Design professionals must often deal with situations over which they have no direct responsibility, such as injuries on the site, fire, or other physical damage to the construction. Therefore, as mentioned above, it is crucial that the design professional be named as an additional insured on the builder's risk and liability insurance policies carried by the constructor and that the policies include the appropriate waivers of subrogation.

23.3.1(c) Insurance Needs of the Constructor

Because the constructor controls and supervises the construction site while work is under way, the constructor is normally required to indemnify and hold harmless other parties who do not control the site, usually the owner and the design professional. In order to fulfill this obligation, a constructor is typically required to provide insurance to support this indemnification obligation in an amount specified by the contract with the owner. Insurance carried by the constructor typically includes commercial general liability (CGL) that covers bodily injury and property damage; workers' compensation and employer's liability insurance to cover injuries to workers; and builder's risk insurance (if not provided by the owner). Insurance certificates evidencing the required coverages and limits are usually a condition of the contract with the owner.

23.3.1(d) Insurance Needs of the Design-Builder

On design-build projects, the design-build entity should obtain the insurance policies that would be required of the constructor, plus professional liability insurance to cover design responsibilities. Because the risks to design-builders are greater, they should consult with insurance professionals about coverage needs for particular projects, as standard construction and/or professional liability insurance policies may not be adequate for one or more of the design-build team members. The legal structure of the design-build organization will also affect insurance needs.

23.3.2 Bonds

Bonds are another means of managing certain construction project risks. Bonds are not insurance policies; rather they are financial guarantees provided by a third party (a surety company). Bonds are backed by assets of the personal or corporate pledges of the parties whose actions or performance is being bonded. Typically, there are three types of bonds used on a construction project: bid bonds, performance bonds, and payment bonds.

Bid bonds protect the owner from the risk of increased costs in the event that the constructor fails to enter into an agreement with the owner at the bid price. The bond typically states that the surety will compensate the owner for the difference between the lowest and second lowest bids if the low bidder does not enter into a contract after award.

A performance bond guarantees the performance of the constructor's contractual obligations in the event the constructor is unable or unwilling to complete them. If the constructor defaults, the surety is liable under the performance bond to the owner for the completion of the contract. Typically in the event of a default (though not always), the surety hires a replacement constructor to complete the work.

Payment bonds guarantee that persons providing labor and materials to the project will be paid the amounts due under their contracts. Payment bonds traditionally have been used as a means of reducing mechanic's liens on a project and often provide the only security for subcontractors and suppliers on public projects where liens are prohibited.

23.3.3 Warranties

Warranties provide another means of reducing risk. Warranties can be expressly provided for under a contract, and in some cases may arise by law. The purpose of a warranty is to guarantee the quality of the materials or services provided by a construction contractor, supplier, or manufacturer in accordance with the specified requirements. Warranty obligations may be general in nature, such as a general warranty that the project will function properly for a period of time, or may be specific, as is the case of warranties that equipment or systems will produce specific results. Like other risk management techniques, parties must evaluate the costs of providing a particular warranty against the benefits that the warranty would provide.

23.4 LIABILITY

When risks become actual losses, the resulting liabilities must be evaluated. Often, these liabilities are allocated in the contract documents. In this circumstance, the contractual liability of one or more parties arises. If the particular loss is not provided for under the contract, the law will generally allocate responsibility for the loss. Similarly, an owner may be responsible for claims by subcontractors through mechanic's lien statutes, despite contractual language that attempts to limit such liability. Project participants benefit from sensitivity to the potential liabilities arising from their role on a project, including professional liability, property damage, and bodily injury, and should seek legal counsel concerning legal liabilities to which they may be subjected.

23.5 AVOIDING CONFLICT

Conflict is an inevitable aspect of any working relationships. The degree to which parties to a construction project are able to acknowledge and manage conflict is an indicator of potential project success. The first step in managing conflict involves taking action to avoid it. Actions that can help stop conflicts from becoming actual disputes include the following:

- Select team members who are professionally and financially capable of performing responsibly;
- To the extent possible, balance the interests of team members with regard to schedule, payments, decision making, and performance;
- Structure contracts to allocate risks clearly and fairly so that all parties understand their responsibilities from the outset;
- Perform contract obligations on time and maintain appropriate records;
- Provide clear, accurate, and complete plans and specifications;
- Conduct appropriate peer and constructibility reviews;
- When unforeseen or changed conditions arise, define problems quickly and work diligently to contain the condition and minimize impacts;
- Make a conscious and continuing effort to look ahead to identify potential sources of project conflict and then work with appropriate parties to resolve or reduce them;
- Cooperate with other team members and remain flexible;
- Consider participating in a partnering exercise with team members to outline and establish common goals and expectations on the project;
- Discuss areas of impact or dispute in regular meetings and include them in the meeting minutes.

Selecting project team members who are experienced, knowledgeable, motivated, and prepared to resolve their differences fairly and quickly is essential to project success and quality. Maintaining a team approach to the job is the best means of achieving this end.

23.6 CONFLICT RESOLUTION

Effective conflict resolution strategies are often intended to resolve disputes at the lowest possible organizational level. This approach is based on the premise that as conflict moves up a chain of command and away from the construction site and the people who have day-to-day knowledge of the facts involved, delay can result and the quality of the solution may deteriorate.

If a conflict makes its way up the organizational ladder and still cannot be resolved through negotiation between the principals of the respective team member organizations, then the parties often benefit from a more structured conflict resolution procedure. A well-drafted contract provides procedures for conflict resolution without involving the courts, including

Dispute Resolution Board Foundation (DRBF): http://www.drb.org

- A dispute resolution procedure requiring a dispute resolution board (DRB);

- Mediation attended by relevant parties using a third-party mediator to help participants structure negotiations, provide neutral evaluation, and encourage fair settlement;
- The use of hearing officers, dispute review board judges, or standing neutrals to resolve disputes and provide binding decisions (when available on public projects);
- Binding arbitration (mandatory or voluntary), usually under rules adopted by the National Construction Dispute Resolution Committee of the American Arbitration Association (AAA);
- Other alternative dispute resolution (ADR) processes, preferably binding, including mini-trials and neutral fact-findings.

The costs associated with these options vary but can often be controlled by narrowing issues and limiting discovery and the time involved in reaching a resolution. For example, the AAA Construction Industry Arbitration Rules and Mediation Procedures are designed to expedite the dispute resolution process.

AAA Construction Industry Arbitration Rules and Mediation Procedures, 2009.

23.7 LITIGATION

Although most conflicts can be resolved through processes similar to those outlined in Section 23.6 above, litigation becomes unavoidable at times. Litigation of construction disputes is usually complex, expensive, and time consuming. Perhaps most significantly, litigation can be unpredictable and may place the outcome of a dispute in the hands of persons with no experience and little knowledge of the construction industry. This uncertainty can be magnified if a jury is assigned to hear the case. Therefore, parties may consider agreeing by contract to mutually waive their rights to a court proceeding and agree to utilize alternative dispute resolution techniques. Because of the perceived risks of litigation involving the particular facts and issues, it may be advisable for certain construction contracts to permit resolution of disputes by voluntary, binding arbitration.

If litigation remains an option, each participant carefully evaluates not only the merits of his or her case but also the likelihood of how well the facts can be presented in a formal judicial proceeding. This analysis will involve, among other things, questions of witness availability and credibility and whether the case lends itself to a concise presentation to lay persons with little or no construction experience.

It is important to recognize that in the pursuit of legal remedies, whether in litigation or arbitration, substantial direct and indirect costs are involved, including, but not limited to the following:

- Direct external costs, such as attorneys' fees, court costs or arbitrators' fees, deposition costs, expert fees, and costs of various investigations, such as soils, geology, hydrology, and materials testing;
- Direct internal costs, such as the costs of key personnel working with attorneys and experts to prepare for arbitration or depositions and trial, attending forum proceedings, and other incidental costs;

- Indirect costs, including the interruption of management and key personnel duties, impacts on professional and business reputation, reduction in bonding capacity for the constructor, interruption of cash flow, and other costs. While many of these costs may be hidden in overhead accounts, they can be significant;
- Loss of client relationship, either temporarily or permanently;
- The disruption to an organization that always occurs when a project is completed and demobilized. Most project personnel have been reassigned, memories may fade with time, and records may get misplaced or lost.

In most cases, litigation is the last resort and least preferable way to resolve a dispute. In such instances, the parties are wise to conduct a thorough and dispassionate review of the costs and benefits of litigation throughout the conflict. Even after litigation is initiated, such a review will assist in settlement negotiations before trial.

While binding arbitration may be a viable manner in which to settle construction disputes, one must realize that no two construction projects are alike and special consideration should be taken when drafting the ADR clause for a particular project. The parties should always consider other methods of dispute resolution. Reliance on mediation, partnering, DRBs, etc., will in most cases lead to resolution, thereby avoiding the complexity and cost of arbitration and/or litigation.

In summary, the greater the potential risk of loss and desire to appeal an adverse result, the more questionable it becomes whether any party should agree by contract to waive his or her right to litigate the issues in a court of law.

SUMMARY

Construction presents a variety of risks to the project participants. The risks range from personal injury and property damage to loss of profits and loss of reputation. These risks can be minimized through prudent risk management techniques, which include the evaluation of the project objectives, other team members, the selected delivery system, contractual provisions, and performance expectations. Specific risk management tools such as insurance, bonding, indemnities, and warranties are helpful in this regard.

When a risk becomes a loss, liability to some project members may ensue. This liability may be contractual or may be imposed by law. When a party is perceived to have liability to another, conflicts between project participants often arise. These conflicts may, in some instances, be minimized by maintaining an atmosphere of cooperation and open communication. If a conflict cannot be resolved, the parties may attempt to reach a solution through informal means or by a more structured settlement procedure. These conflict resolution techniques are often described in the dispute resolution provisions of the contract.

Whether arbitration or litigation is the final option for the dispute resolution process, the parties should consider conditions precedent to these approaches such as partnering, dispute resolution boards (DRBs), on-site neutrals, and mediation. Whether disputes are subject to ADR techniques, arbitration, or litigation, the parties should be aware of the potential trade-offs associated with each venue. Reliance on DRBs will in most cases lead to resolution via the recommendations of the board, thereby avoiding the complexity and cost of arbitration and/or litigation. ❏

Chapter 23: Risk, Liability, and Handling Conflict

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor*	Design-Builder
Evaluate project risks	●	●	●	●
Evaluate other team members	●	●	●	●
Address risk in contractual agreements	●	●	●	●
Reduce risk by ensuring contract performance	●	●	●	●
Assess insurance requirements	●	●	●	●
Use bonds and warranties when appropriate to ensure performance	●	●	●	
Evaluate liability	●	●	●	●
Establish conflict resolution procedures (contracts, partnering agreements, ADR)	●	⦿	⦿	⦿

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

● = Primary Responsibility ⦿ = Assist or Advise

CHAPTER 24

PARTNERING

Partnering is a process that enables project team members to work together as partners and establish good communication, develop common understanding of project goals and objectives, reduce conflict, and solve problems in ways that deliver mutual benefits. At its core, partnering is geared toward developing good working relationships among project participants by creating an atmosphere of respect and trust. Since its inception on U.S. Army Corps of Engineers projects in the 1980s, partnering has been implemented successfully on thousands of projects and has come to be regarded as an important means of avoiding disputes and contributing to quality in the constructed project.

When partnering is practiced according to the suggestions contained in this chapter, significant cost and time savings are probable. Evidence suggests that cost savings may run between 4% and 30% of constructed cost, after considering all the ways projects get into trouble (changes, delays, disputes, litigation, etc.). These are huge numbers that should interest all stakeholders in the project.

Partnering may begin at any point in the life of a project, from the conceptual planning phase, to design, construction, and even post-construction phases. In most cases, project participants begin formal partnering activities at the beginning of construction; however, an increasing number of owners are initiating partnering during earlier phases. Partnering is most often initiated by owners, construction managers, and contractors. It is a voluntary process that requires commitment, especially of senior management, to succeed.

Partnering can even be successfully extended to be used to facilitate cooperation and collaboration of any disparate parties within an organization—for example, the same processes work well between engineering disciplines needing to work together or between functions and/or departments with seemingly competing agendas.

The goal of partnering can quite simply be expressed as "designing and implementing an effective problem finding/problem solving management system, using teamwork," whereby the design is part of the process of establishing the partnership.

This chapter describes the potential benefits of partnering on constructed projects and provides an overview of the partnering process, key steps in the partnering process, and special applications of partnering.

In this chapter

24.1 BENEFITS OF PARTNERING

Partnering can enhance project quality by improving relationships among project team members and result in improved management of risk, greater financial control (fewer claims and cost overruns), more timely completion, increased job satisfaction and camaraderie among project participants, and reduced litigation.

Partnering is voluntary; it requires the commitment of the project participants—especially senior management.

24.1.1 "Win-Win" Solutions

Construction projects bring together a diverse group of people, with different backgrounds, experiences, abilities, agendas, interests, and styles of communication. It is in the interest of project quality to enhance the relationships among these people. The more common "win-lose" approach to design and construction, which is modeled on the adversarial precepts of the judicial system, tends to undermine effective working relationships, and the bias toward "winners and losers" reduces incentives to innovate and solve contemporary construction problems. On construction projects, where the interests of participants tend to overlap, an adversarial approach can undermine sound business decision making and cause everyone to lose.

Getting to Yes: Negotiating Agreement without Giving In, 3rd Edition, Roger Fisher and William Ury, with Bruce Patton, ed., Penguin, 2011

Partnering rejects the "win-lose" paradigm in favor of "win-win" strategies. A simple but often misunderstood catch phrase, "win-win" actually requires that project team members redouble their efforts to cooperate and solve problems together. Partnering encourages the team to be creative in solving problems and managing conflicting interests to achieve outcomes that are fair.

Harvard Mediation Project: http://www.pon.harvard.edu

24.1.2 Improved Relationships (High-Performance Teams)

Partnering provides a forum for project participants to meet and agree on their approach to the project with an emphasis on procedures for resolving disagreements and disputes. One of the reasons partnering is so effective in resolving conflict is that the respect and trust established in the early, formative stages of a project help to carry participants through any disputes that do arise.

Partnering provides participants with a greater degree of understanding of their relationships with fellow team members. Partnering encourages participants to work together to determine the most effective strategies for communicating, cooperating, coordinating the work, and resolving conflicts within the framework of the contract documents.

24.1.3 Improved Risk Management

Construction projects generally involve significant risks, primarily in the areas of finance and safety. Therefore, enhanced efforts to deal effectively and fairly with risk reduce the potential impacts of disputes. Many, if not most, disputes involving litigation have their roots in poor relationships and communication. Partnering focuses on reducing risk in five common areas, to include

- Cost of changes;
- Duration for changes;

- Change order costs;
- Claim costs; and
- Value engineering.

Generally, risk reduction is achieved through partnering in two ways:

- Establishing preventative maintenance processes; and
- Facilitating attitudinal shifts.

Examples of the first are

- Defining a process in advance for solving problems that come before the group; for example, how will RFIs be handled on this project;
- Establishing proactive monitoring processes to alert all parties to potential changes or delays, before they happen or progress too far.

Examples of attitudinal shifts that can be achieved through partnering include

- Establishing an atmosphere of honesty and openness that promotes early and proactive discussions of real and potential problems;
- Acknowledging and respecting each participant's role, scope, schedule, and personal agenda;
- Basing decisions on equity and fairness rather than power and intimidation;
- Acknowledging that professional reputations are closely tied to project success.

24.1.4 Greater Financial Control

Partnering has come to be recognized as an effective strategy for controlling project costs. Partnering helps lower administrative costs and reduce the number and frequency of cost overruns, offering the project greater opportunity for financial success.

24.1.5 Improved Productivity, Timeliness, and Job Satisfaction

At the personal level, partnering helps the members of the project team focus on the tasks that they do best: designing and building projects. Disputes and litigation tend to distract team members from their jobs. By reducing conflict and valuing innovative solutions, partnering can help boost the job satisfaction of participants and help them to be more productive and innovative.

Construction professionals at the worksite are generally more knowledgeable and better able to resolve most disputes than judges and lawyers in courtrooms.

24.1.6 Reduced Litigation

Like many other industries, engineering and construction have witnessed an increase in litigation. Partnering achieves consistent and dramatic results in reducing claims and litigation—to the point where some insurance providers may reduce premiums or cover a portion of partnering fees for projects that utilize partnering in acknowledgment of the likelihood of substantially limited financial risks from litigation and disputes.

24.2 PRINCIPLES OF PARTNERING

Most partnering advocates agree on a basic concept: partnering is about people. The human relationships involved in developing and building a constructed project are often more complex than the project itself. Partnering takes human relationships seriously and strives to manage them according to a set of fundamental principles, as described in the three subsections which follow.

24.2.1 Prerequisites for Partnering

Partnering is more likely to succeed when stakeholders share several basic philosophies when approaching problem solving:

- Common "ownership" of projects—the joint acceptance of the responsibility to identify and resolve problems;
- A commitment to fully disclose information that will aid the project team in reaching the best decisions possible;
- The delegation of authority to empower participants to resolve conflict and make appropriate decisions at the project level;
- A focus on attacking problems (not people) based on the best interests of the project as a whole;
- A commitment to the partnering process as well as the willingness to accept its outcomes.

24.2.2 From Conflict to Coherence

Depending on the trust level, existing or developable, partnering offers a variety of benefits.

The following four categories describe general project conditions and the value that partnering may bring to each.

Team Situation	Description	Partnering Benefits
High Performance	• Trust among members is high; creativity drives a coherent, unified effort.	• Provides opportunities to fine-tune performance and achieve project objectives as completely as possible.
Function	• Participants have a history of working together successfully.	• Directs team activities toward successful project planning and processes.
Disarray	• Participants are suspicious of or unfamiliar with each other.	• Builds relationships and trust to allow members to begin to function as one team.
Open Conflict	• Participants are distrustful; conflict has erupted.	• Helps control chaos and lays groundwork for resolving differences.

The partnering facilitator should make every effort to determine where the stakeholders are, approximately, in this continuum, in order to design the partnering exercises and discussions for maximum effect. With time, it is quite possible for the stakeholders to move up this continuum from whence they started.

24.2.3 Misperceptions

As a still evolving practice, partnering endures some misperceptions within and outside the construction industry. This section addresses some of the more common ones.

Partnering is not legally binding. The partnering agreement (see 24.3.4(a)) is not a contract. Rather, it is a personal commitment by the participants to pursue the project's mission, goals, dispute resolution process, evaluation procedures, and partnering values. The agreement also represents an organization's commitment to achieving the partnering objectives.

Partnering does not give one party an unfair advantage. If one of the parties to the partnering carries this belief strongly, the partnering will ultimately fail. Partnering exercises and agreements should serve to benefit all stakeholders and should be viewed truly as win-win endeavors.

Partnering is not a substitute for the construction contract or for the laws and regulations under which the contract was issued. Partnering is not a waiver of rights—legal, political, and other avenues of dispute resolution remain open to the parties.

Partnering is not an excuse to compromise one's level of effort. In fact, partnering requires that project participants make extra efforts, above and beyond those that might be expected with conventional project relationships, to resolve problems. Partnering does not force an owner to accept poor quality.

Partnering does not eliminate disputes, disagreements, or problems. It is natural for problems to arise and for dedicated, qualified professionals to disagree on occasion. Partnering provides team members with the opportunity for constructive debate and the airing of potential solutions, as well as a process that leads to the resolution of problems in a timely manner.

Partnering does not involve compromising one's better judgment. Project partners are empowered to communicate, explore problems, develop solutions, assess the merits of solutions, and play a role in the decision to implement them.

24.3 ELEMENTS OF PARTNERING

➢ Resources at the end of this chapter.

To achieve the values and benefits described above, partnering employs a structured approach that is geared toward creating teamwork and shared values. The elements of this approach include the identification of project stakeholders; getting them to "buy in" to the partnering program; planning the pre-partnering phase; holding the partnering session itself, including the development of the partnering charter and issue resolution strategies; and following through with partnering commitments and implementation. The following subsections describe these elements of the partnering process.

24.3.1 Identifying Stakeholders

Partnering acknowledges that there are many people and organizations with a vested interest in the success of a given project. These project stakeholders include those who are participating directly in the project, as well as those people and organizations who may be affected or have an interest in the process or outcome. The roles, interests, and objectives of stakeholders provide insight into potential opportunities and problems associated with the project. Stakeholders may include the following:

- The end-user*
- The owner*
- The funder
- The design professional*
- The construction manager*
- The constructor*
- Subcontractors
- The construction workforce
- Suppliers and vendors
- Regulatory agencies
- Members of the community

*Considered to be the core group of stakeholders. Others participate as deemed necessary by the nature of the project and agreement of the stakeholders.

The situation should help indicate which of these stakeholders need to be represented at formal partnering exercises (workshops). Any stakeholder who may be able to influence the success of the project should be considered. Other stakeholders can be represented in other ways, for example, through communiqués, closed meetings, or town hall type meetings, the need for which should be addressed by the formal partnering participants.

24.3.2 Participant and Stakeholder Buy-In

Partnering succeeds, in large measure, because it is voluntary. Team members must obtain the concurrence of the other participants before partnering can proceed.

The owner is typically the first participant to signal an interest in initiating partnering by incorporating appropriate language in the bid documents that announces the owner's desire to partner and encourages the design professional, constructor, and/or design-builder to participate. The owner also addresses how partnering expenses will be paid (usually shared equally). If the owner does not incorporate such language in the bid documents, the design professional, design-builder, or constructor may express an interest in partnering during negotiations or after the award of the contract, though it is preferable to indicate such an interest as early as possible.

The commitment of senior management and project leaders to partnering is essential to the success of any partnering program. It is critical that at least one key senior manager serve as a visible "champion," or advocate, of the partnering effort. Ideally, a champion should eventually be identified in each major stakeholder organization. The champion helps educate and introduce team members to the key values of partnering, including

- Cooperation
- Respect
- Trust
- Open and honest communication
- Teamwork
- Fairness (win-win environment)
- Joint problem solving
- Working for mutual gain
- Rapid dispute resolution at the lowest possible level

24.3.2(a) Sharing Program Costs

One of the first tasks of a newly formed partnering team is deciding who will pay for the program. The responsibility for partnering costs is often addressed in the contract documents. If not, fairness is the principal concern, as each participant faces varying financial constraints.

Practically speaking, the project will be paying for the partnering cost. The largest component of cost is people's time, which is accounted for differently in different types of organizations. The owners won't be donating their time; it will be part and parcel of their participation as owners. The contractors won't be donating their peoples' time; it should be reflected in their bid. The design professional should include the costs in his or her negotiated fee. If partnering is introduced after all financial and contractual arrangements have been set, then there is probably a basis for supplemental negotiations, which should take into consideration that partnering may actually lower each stakeholder's costs.

The additional costs of partnering are for the out-of-pocket costs for travel of each individual, again probably to be borne as their times are borne. Finally there is the cost of a facilitator or facilitators, possibly rental of meeting facilities, and provision of food and drink, not just for an initial workshop, but over the life of the project. Although these costs may be substantial, they should be mostly offset by the potential benefits. Accordingly, the funder or owner should think of these as investments in the ultimate success of the project.

Nevertheless, in the spirit of partnering, it is not uncommon for the major stakeholders to offer to cover, on a rotating basis, out-of-pocket costs for holding the workshops (meetings).

24.3.2(b) Selecting a Facilitator

Most partnering programs benefit from the services of a professional facilitator. Experienced facilitators have background and training in the techniques of partnering, as well as in construction. Facilitators determine the degree of readiness of proposed partnering participants. Facilitators also prepare materials for workshops, suggest communication techniques, aid in establishing goals, serve as negotiators, and perform other tasks. The presence of a facilitator is also a benefit in diffusing tension among stakeholders. Desirable qualities in a facilitator include the following:

- Knowledge of the design and construction industry;
- Skill in facilitation;
- Experience in delivering training;
- Neutrality;
- Background in strategy development and negotiations;
- Familiarity with organizational development concepts and practices.

Various facilitators may be found by searching the World Wide Web for "partnering facilitator." In some cases, if all partnering participants agree, a facilitator may come from one of the stakeholder organizations.

24.3.3 Pre-Partnering Process

The pre-partnering process involves gathering information about the project and assessing the motivations and challenges of the stakeholders. These activities are typically conducted or managed by the facilitator, who uses the information to design a partnering process geared toward aiding the stakeholders in achieving their goals for the project. This process may be conducted by conference calls or other electronic means. Pre-partnering activities may include

- Giving guidance to the stakeholder organizations for identifying partnering session participants;
- Issuing participants an overview on partnering process, generic agenda for session, and advance questionnaire to be returned before session;
- Meetings or interviews between the facilitator and representatives of each organization to identify issues that are critical to project success and to plan the session.

Based upon an evaluation of needs, the facilitator recommends or negotiates the length of the initial partnering session. This determination depends on the complexity of the project and the need for developing relationships among the participants. One and a half to two-day sessions are usually optimal for developing positive, productive relationships and exploring potential project problems in depth. One-day sessions may not provide enough time for a desirable level of team building activity but usually do provide participants with enough time to address problem solving and at least set the stage for additional partnering sessions as needed. For multi-day sessions, it is usually worthwhile to plan a social event or group dinner.

In preparation for the workshop, the facilitator reviews the information yielded by these activities, uses it to develop the partnering program or agenda, and may prepare it in summary form for reference at the partnering session. The facilitator should, either through the stakeholder champions or on their own, arrange for meeting facilities, clearly spelling out needs for comfort, communications, and training aids.

24.3.4 The Partnering Session

The central element of the partnering process is the initial partnering workshop—the face-to-face meeting of stakeholder representatives. While the goals and stakeholders of any given project are unique, every partnering session addresses a basic set of topics:

- Team-building;
- Development of a vision or mission statement;
- Problem-solving procedures;
- Dispute resolution procedures;
- Evaluation procedures;
- The follow-through process;
- The signing of the partnering agreement or charter;
- Producing a summary of the partnering session.

24.3.4(a) The Partnering Agreement (or Charter)

At the partnering session, the participants usually develop a partnering agreement, or charter, usually on a single sheet of paper, that is signed by project participants at the conclusion of the session. The agreement simply affirms the commitment of the participants to conduct themselves according to the mission, objectives, and/or values that the group has decided are valuable to improve the outcome of the project.

Partnering agreements are not binding contracts, and the decision to sign is entirely voluntary. Although some participants initially may reserve the right not to sign ("I don't have the authority to commit my organization"), it is rare that a participant chooses not to sign at the conclusion of a session because they discover that what they are signing usually makes sense and is something they want to commit to.

The charter is a valuable tool, and most participants usually post it for all to see. Participants can then easily refer to it when issues come up, reminding each other of their commitment. It also serves as a review tool that the partnering champions and/or the facilitator can use as a checklist for "how are we doing?"

Sample language for partnering agreements is available from a variety of sources, including ASCE, the U.S. Army Corps of Engineers (USACE), the American Institute of Architects (AIA), and the Associated General Contractors of America (AGC). Partnering facilitators are also often able to provide sample language for such an agreement. However, participants should recognize that agreements are most effective when created to be unique to the project. They are best developed under the guidance of the facilitator during the partnering session.

24.3.4(b) Issue/Conflict Resolution

One of the hallmarks of partnering is the emphasis on resolving disputes as close to their source as possible. The partnering process for resolving disputes generally involves a series of steps and associated time frames within which to elevate an issue or problem. The time frame is critical in ensuring prompt resolution and eliminating the frustration that comes from indecision and often damages team relations.

➢ 23.5, "Avoiding Conflict"

24.3.5 Follow-Through and Evaluation

To ensure that it is a living program it is important to review the status of partnering on a routine basis during construction. This review can be easily incorporated in normal on-site weekly progress meetings.

Additional full periodic progress reviews are critical to the success of partnering, and by extension, the healthiness of the project. Getting the partnering participants back together forces addressing those issues that participants recognized initially as important but that may have been overshadowed by real events. Meeting under the banner of "partnering" can be effective in bringing a project back on track. When follow-up is put off too long, partnering may fail.

Follow-through evaluation of the partnering process should be based on real data—not hunches.

Follow-through often includes written surveys filled out by team members to assess progress toward goals, the effectiveness of relationships, and the value of partnering activities. To encourage participants to provide feedback, evaluation tools, such as surveys, should be concise and solicit quantitative and qualitative information. These surveys should be reviewed at the follow-up partnering meetings.

Another, though less quantitative, form of follow-through is a regular review or "check-in." With a desired frequency of once every one to two months, partnering check-ins can often be accomplished during normal project business, such as the inclusion of partnering on the agenda of a regular project progress meeting. Other types of check-ins include separate meetings for partnering issues only or informal team events.

Sample Follow-Through Questionnaire Items

1. Is communication satisfactory?
2. Has the team established reasonable goals?
3. Is the team reaching those goals?
4. Are there opportunities to improve communication among the team?
5. Are there obstacles to achieving the goals the team has set?

The partnering champion(s) plays a key role in follow-through, taking the initiative for such activities as

- Setting aside a regular time to review project accomplishments;
- Keeping a list of achievements and positive developments;
- Keeping a list of concerns and issues for improvement;
- Reviewing the mission statement daily;
- Meeting with other partnering champions;
- Soliciting opinions from people at all levels of the project;
- Preparing new information and ideas for meetings.

Finally, follow-through involves the acknowledgment of successes—at intermediate stages of the process and at its conclusion. Spontaneous celebrations make an invaluable contribution to positive working relationships and help diffuse the tensions that normally crop up when people work together.

24.4 SPECIAL APPLICATIONS OF PARTNERING

As with many other processes in constructed projects, the key to success in partnering depends on tailoring activities and tasks to meet the needs of the project at hand. This section discusses partnering variations structured to meet the needs of different types of projects.

24.4.1 Smaller Projects

While partnering is used on many larger projects, the process offers benefits to smaller and mid-size projects as well. Smaller projects tend to be shorter in duration, which increases the urgency of activity and interaction. There is less time to develop the project team, establish honest open communication, develop trust, and co-create solutions. The schedule and budget of small projects are also less forgiving of any errors.

Projects also need not be limited to construction projects. Much success has been noted with partnering on study and design projects that lead up to a construction phase. In fact, getting started with partnering earlier in the project cycle can be a great benefit to partnering efforts during construction.

In such cases, one-day or half-day partnering sessions can be valuable, with an abridged agenda including the following:

- Introductions
- Partnering overview
- Drafting a mission statement
- Key project issues
- Creative problem solving
- Goals and actions
- Dispute resolution procedures
- Evaluation
- Signing the partnering agreement

A professional facilitator is an extremely valuable resource in abbreviated partnering sessions, helping participants become familiar with the basics of the program within a very limited time frame. The value of a facilitator is directly related to his or her ability to be neutral, Therefore, the use of an in-house facilitator is discouraged.

24.4.2 Issue-Focused Partnering

The success of partnering in improving the quality of constructed projects has prompted project leaders to focus partnering efforts on single issues or areas of specialized concern. In these issue-focused forms of partnering, the project team may benefit from the participation of an independent expert with related experience.

Types of issue-focused partnering include

Turn-Around: A process geared toward quickly resolving, or "turning around," a significant dispute and promoting the healing of relationships. Turn-around partnering is often attempted when participants have left the negotiation table and communication needs to be re-established.

Program: A series of partnering sessions designed to address the separate stages of a large project or of several smaller, related projects. Program partnering works well on projects with multiple constructors. The series of sessions would be likely to include a kick-off session, site partnering, shell partnering, interior partnering, finishing partnering, and turnover/activation partnering.

Inter-Agency: A valuable approach when two or more public agencies are involved in the same project or have a similar mission, as is often the case when federal and state agencies share management or oversight responsibilities. Typical goals for this type of partnering include identifying and agreeing to the roles of each agency, as well as defining a process for completing the project.

Environmental: A benefit during the planning stage and preparation of environmental documentation. Environmental partnering brings together regulatory agencies, environmental groups and stakeholders, and project participants to work toward agreements on the interpretation of regulations, the use of data, permitting, and other related activities.

Design Intent: An opportunity for the design professional to communicate the intent of the design to the owner, constructor, and subcontractors.

SUMMARY

Partnering is one of the most effective non-technical strategies for improving the quality of constructed projects. Professionals throughout the construction industry recognize how partnering helps manage project risks and improve quality, reduce cost and schedule overruns, eliminate litigation, and improve the working environment.

Partnering is not a magic bullet, and it is not a substitute for contract compliance. It requires that participants make an extra effort and reach out to each other in difficult circumstances—at the very time that it may be most difficult to do so. It also requires follow-up and nurturing.

Successful projects do not just happen. They are made to happen.

USACE Col. (retired) C.E. Cowan

Partnering offers an effective strategy for managing and enhancing the relationships among the owner, design professional, constructor, subcontractors, specialty personnel, agency participants, and other stakeholders that places emphasis on positive, proactive relationships and focuses on quality. ❑

ADDITIONAL PARTNERING RESOURCES

American Arbitration Association. http://www.adr.org/

American Council of Engineering Companies. http://www.acec.org/

Arizona Department of Transportation. http://www.azdot.gov/CCPartnerships/Partnering/Index.asp

Associated General Contractors of America. http://www.agc.org/

International Partnering Institute. http://www.partneringinstitute.org/

Partner Your Project, Sue Dyer, Pendulum Publishing, 1997.

Partnering in Design and Construction, Kneeland A. Godfrey Jr., McGraw-Hill, 1995.

Project Partnering for the Design and Construction Industry, Ralph J. Stephenson, John Wiley & Sons, 1996.

U.S. Army Corps of Engineers Publication, *Partnering: A Tool for USACE, Engineering, Construction, and Operations*, http://www.iwr.usace.army.mil/docs/iwrreports/91-ADR-P-4.pdf

U.S. General Services Administration. www.gsa.gov/pbsintro.htm

CHAPTER 25

VALUE ENGINEERING

Value engineering (VE) is a systematic approach to identify a project's functional objectives with the goal of optimizing design, construction, and future operations. Value engineering studies are conducted by a multidisciplinary team that focuses on a clearly defined scope. While each member of the project team is free to recommend that a value engineering study be undertaken, it is the owner's responsibility to authorize and formally initiate a VE effort.

The VE process originated at the General Electric Company in the 1940s in response to materials shortages during World War II. VE has since grown from a strategy for optimizing product procurement to a powerful tool with the capability to enhance the value of constructed projects, as well as industrial processes and manufactured products. Some form of VE is now stipulated on many government projects.

In this chapter

25.1 THE CONCEPT OF VALUE

In its broadest sense, project value is determined by the relationship of the worth of the project and its elements to their cost. The following expression summarizes the relationship:

$$\text{Value} \approx \frac{\text{Function} + \text{Performance} + \text{Quality}}{\text{Cost}}$$

The goal of the VE process is to identify alternatives that maximize this value relationship. The owner's requirements are the basis for establishing values for the items in the numerator. For example, an owner who intends to sell a facility within five years of its completion may place less value in long-term maintenance characteristics than an owner who intends to keep a facility for decades.

Owner requirements directly affect the relative value of aesthetics, reliability, sustainable development, maintainability, operability, construction duration, and other characteristics.

Improving the quality of elements related to these characteristics usually increases cost. The goal of VE is to achieve a ratio of quality to cost that is acceptable to, and in the best interest of, the owner.

25.2 THE BENEFITS OF VE

The benefits of VE usually come from improvements in the efficiency of the project delivery system, refinements to specific features, or the development of new approaches to achieving the owner's requirements. The first item most owners look at when they consider value engineering is the potential cost savings. However, VE focuses on improving the relationship of function, performance, and quality to cost—not merely cutting cost.

As examples, in addition to financial benefits, VE provides the following benefits to project quality:

- More complete definition and fulfillment of the owner's goals and objectives;
- Development of a complete spectrum of alternatives;
- Timelier assessment of alternatives and costs;
- Confirmation of scope;
- Better project configuration, operation, and durability;
- Enhanced sustainable development input;
- Improved communication and consensus among project participants;
- More desirable impacts to outside entities;
- Reduced life-cycle costs;
- More effective deployment of staff.

25.2.1 Size and Complexity of Project and VE Benefit

In general, the larger and more complex a project, the greater benefits that a VE program can provide. The appropriate number and frequency of VE reviews varies with the objectives of each project. The following are offered as guidelines:

Project Size or Complexity	VE Application
Small (less than $3 million construction cost)	VE studies tend to offer the most benefit during the conceptual stage, when design is approximately 10 to 20 percent complete.
Medium ($3 to $30 million construction cost), uncomplicated	One VE study when design is approximately 20 to 30 percent complete usually offers the most benefit.
Large (more than $30 million construction cost) or highly complex	Two VE studies usually provide the most benefit: one at the concept phase (10 to 20 percent design complete) and the second when design is approximately 65–75 percent complete.

25.2.2 Rehabilitation Projects

A rehabilitation project requires special VE consideration. In these projects, the key often lies in identifying the need for the project, and thus a conceptual study often provides the most benefit. However, once the need for a rehabilitation project is established, such efforts require close attention to detail. Therefore, the ideal time to convene a VE study for a rehabilitation project is when sufficient details have been developed to allow a unit quantity cost estimate.

25.3 THE TIMING OF VE STUDIES

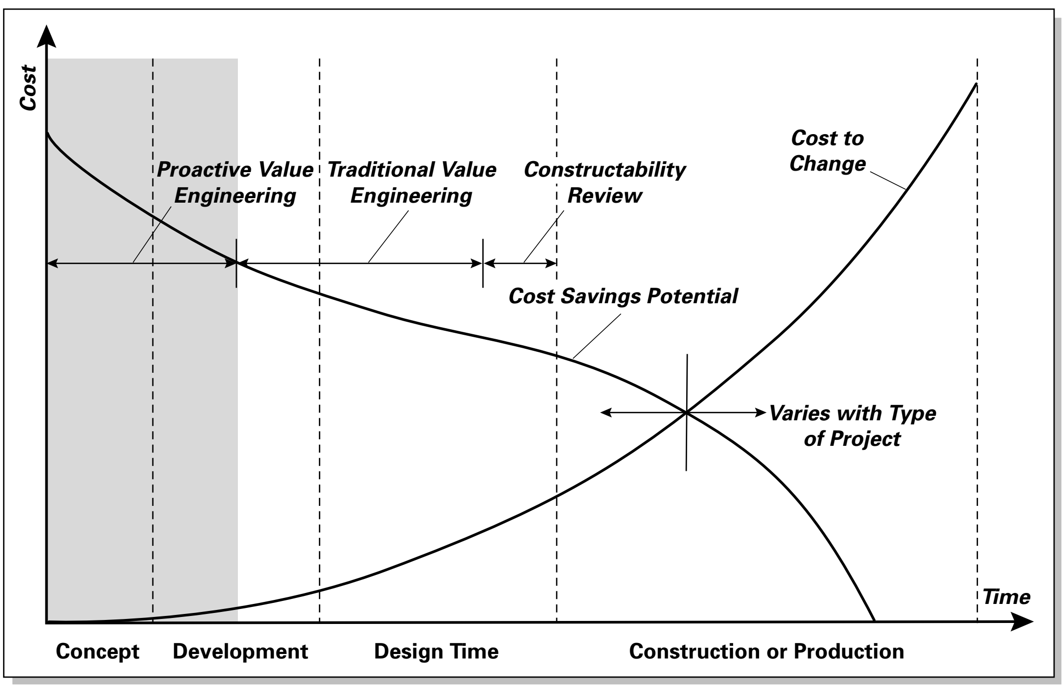
While VE studies can benefit project quality at most stages of development, VE studies conducted in the early stages of a project tend to provide the greatest benefit (Figure 25-1). In fact, in recent years VE has become an aid to owners in the formulation of goals and objectives—before most design work begins.

Traditionally, VE studies are undertaken at one or more of the following project stages:

- Conclusion of concept or project planning;
- 30 percent design completion;
- 60 percent design completion;
- 90 or 100 percent design completion.

VE studies performed during the early stages of a project tend to address broad project concerns related to the selection of the right design concepts and elements to achieve the owner's goals and objectives. The identification of effective solutions during conceptual planning tends to provide greater savings in

Figure 25-1 Effectiveness of Value Engineering



life-cycle costs than efforts to fine-tune a less-than-optimal approach that has progressed into design. This proactive strategy also saves on additional design fees. VE studies performed in the latter stages of a project tend to focus on getting the best value from the project elements that have been selected.

While controlling cost and addressing budgetary constraints can be important aspects of value engineering, VE is not merely a cost cutting exercise. VE studies focus on improving the relationship of function, performance, and quality to cost, whereas cost cutting typically involves reducing project function or scope. This distinction can be crucial to the effectiveness of VE studies, as participants who misunderstand VE's purpose may not trust the process or offer their full participation, both of which are necessary for success.

VE studies can also provide an agency or organization with information to determine if a project is consistent with a new organizational mission or policy.

25.3.1 When to Apply VE

VE can enhance project quality at every stage of project development. The following sections discuss VE's application and potential benefits during various phases of design.

25.3.1(a) Conceptual Design (Study and Report Phase)

Increasingly, VE is being performed at the conceptual design phase to improve the quality of project design. In this phase, VE involves the investigation of alternative design concepts with the owner, design professional, project or construction manager, design-builder, and any other conceptual design participants. The project team works to identify the owner's requirements and to design concepts with the potential to achieve them. This process offers an array of benefits, including the following:

➢ 11.3.2, "Sustainable Development"

- Team consensus;
- Shorter design schedule;
- Realistic budgets;
- Early evaluation of construction sequencing and contracts;
- Early user input;
- Improved communication among the project participants.

25.3.1(b) Schematic and Design Development (Preliminary Design)

VE may be applied during the schematic and design development phase. At this point, preliminary project drawings have been prepared, but the members of the project team—particularly the design professional—still have considerable flexibility. Major changes resulting from VE studies can be implemented without significant impacts to the project schedule or design budget. The potential for VE-related cost savings is quite substantial during this period. Among the benefits of VE studies during this phase are confirmation of the owner's goals and objectives, validation of the design approach, and overall optimization of the design.

25.3.1(c) Contract Documents (Final Design)

VE studies that are undertaken in the contract documents phase (60 percent completion or more) yield the most benefit when the focus is on constructability and design details. In this phase, VE does not reconsider fundamental project goals and design concepts, as the costs of making such revisions usually outweigh the savings.

25.3.1(d) Construction

VE recommendations made during the construction phase are called value engineering change proposals (VECPs). They commonly follow a format that shares the adopted savings between the owner and the constructor, after deducting expenses related to engineering development and review of the proposed change.

VECPs usually relate to the construction methods, materials, and equipment; they often result from the fact that one constructor may build things differently than another. Unless the constructor is involved in the design phase of the project, the contract documents are based on a "generically" constructable design. This design may or may not fit the method of operation for the constructor eventually selected by the owner.

25.3.2 Duration of VE Workshops

The period when the VE team works together in a workshop varies with the size, nature, schedule, cost, and complexity of each project. When VE is performed, traditionally at 30 percent design completion or later, workshops typically last three to five consecutive days.

However, when VE methodology is used to develop a project concept, the entire study may last weeks or months, a period that is typical for conventional conceptual project development. The initial VE workshop for project development may last two to three days. For complex projects, the team may disband to continue developing concepts on their own and reconvene as necessary for follow-up workshops of two to three days to re-evaluate and refine the scope and mission of their effort.

VE on the Web

SAVE International: http://www.value-eng.org

Federal Highway Administration: http://www.fhwa.dot.gov

General Services Administration: http://www.gsa.gov

American Association of State Highway and Transportation Officials: http://www.transportation.org

Generally, project cost is a contributing factor in determining the appropriate level of VE effort, though by no means the only factor. Projects with similar scopes but different scales may have VE workshops of similar duration. The complexity of the project and amount of information available are also factors in determining the appropriate VE effort. Workshops held during the early stages of a project can often be completed more quickly, as there are relatively few details to review, whereas a workshop at the 30 or 100 percent design completion level likely involves many documents and constraints.

25.4 VE TEAM COMPOSITION AND QUALIFICATIONS

The success of a VE effort is strongly linked to the experience of the team members. The number and qualifications of VE team members depend on the project objectives and stage of development. VE studies typically involve multiple disciplines. Therefore, VE teams benefit from members with diverse backgrounds who have a range of expertise with the project's key issues. Positive attitude, technical knowledge, education, certification, and professional experience are also desirable qualities for each member of the team.

The VE team leader plays a crucial role in the success of a study, as this person is responsible for managing all aspects of the effort. A good VE team leader has training and experience as a facilitator, team leader, or team member on previous VE studies. Strong leadership, management, and communications skills are important qualities in a VE leader. SAVE International, the professional association for value engineers, manages the Certified Value Specialist (CVS) program to certify VE team leaders.

VE teams working on conceptual development benefit from the participation of members with planning and technical experience within the organizations responsible for producing the concept. All project participants are represented or participate in this process, including the owner, operator, construction manager, program manager, and, if possible or appropriate, future users of the facility or the public. Team members with experience in finance and procurement may also be valuable.

For VE studies conducted during the concept and design stages, the study team mirrors the project team, with a study member representing each technical discipline on the project team. A more experienced VE team is needed when VE is performed during the concept design phase because participants must be able to visualize the project with limited information. In some cases, the VE team's work is independent of the design professional; in other cases, the VE team may work closely with the designer. Members of the design professional's staff may even be members of the VE team in cases where the project concept has been established by an entity other than the design professional. In general, the best VE teams provide a fresh, objective look at design issues.

25.5 STAGES OF VE STUDY

As shown in Figure 25-2, VE studies typically consist of three sequential stages:

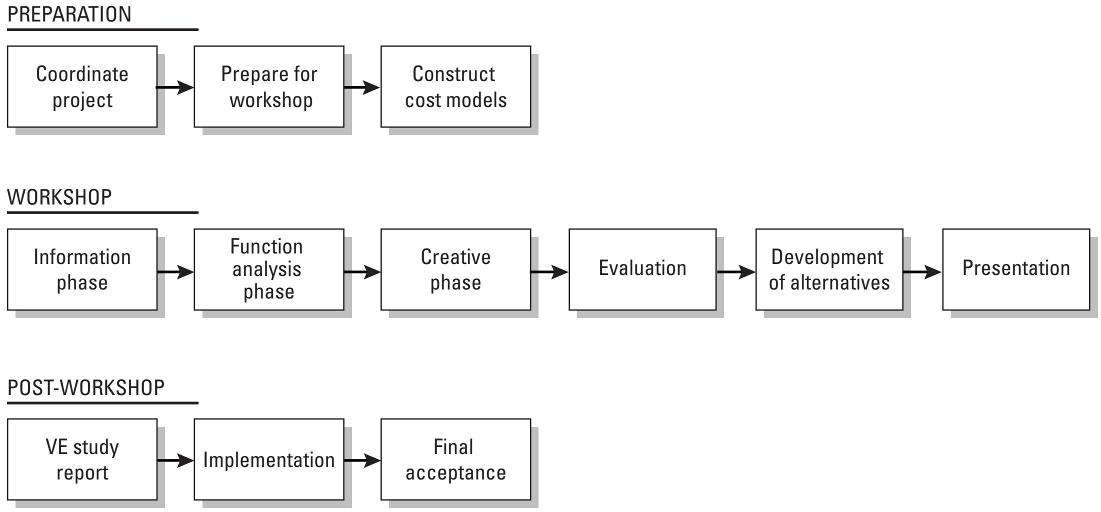
1. Preparation
2. Workshop (execution of the VE performance plan)
3. Post-workshop

25.5.1 Preparation (Cost Models)

Preparation is considered by many to be the most important step of a VE study. The tasks during this phase are summarized as follows:

- Defining user needs;
- Recruiting VE team members with appropriate experience and qualifications;
- Gathering and disseminating information to the members of the VE team;
- Determining evaluation factors;

Figure 25-2 VE Process Summary



- Establishing the scope of the study;
- Building appropriate models;
- Arranging for the presentation of relevant information at the workshop by appropriate members of the project staff.

The VE team has a relatively short amount of time to develop a thorough understanding of the project and its status. Therefore, project leaders (including the owner, construction manager, design professional, and, if applicable, the operator) benefit by making sufficient and relevant information available to the VE team during the preparation period.

Also during the preparation phase, the VE team leader uses the most current cost information from the project team leaders to prepare cost models. These models typically depict the distribution of costs in one or more of four contexts, which are described below.

Capital Cost: The initial cost to build the project is itemized, providing a breakdown for element and construction workforce labor. This form of analysis allows the VE team to identify high costs and make comparisons with costs on similar projects.

Life-Cycle Cost: All the costs of owning and operating the facility over its expected life span are totaled, including materials, labor, maintenance, energy, replacement parts, disposal or reuse of materials, and decommissioning. These costs may be provided for each element to aid in identifying high-cost items. The time value of money is also considered.

Energy Cost: Energy costs are itemized by system, subsystem, or functional area to identify high consumption and cost.

Pareto Distribution or Cost Histogram: Costs are displayed graphically according to order of magnitude of project elements considered, aiding in the identification of high-cost elements.

The use of accurate and comprehensive cost data in the development of cost models is critical, as subsequent VE analysis is based on this information.

25.5.2 Workshops and the Six-Phase VE Performance Plan

The VE team convenes to execute the formal, six-phase VE performance plan. The six phases of the workshop effort and performance plan are described in the following sections.

25.5.2(a) Phase 1: Gathering Information

➢ 25.5.1, "Preparation (Cost Models)"

During the information phase, members of the project team make oral presentations to augment the information already provided to VE team members. These oral presentations are a forum for the presentation and discussion of undocumented additional information that is typically encountered on constructed projects, such as local history, political considerations, opportunities for sustainable development enhancements, or personal preference. These presentations provide the VE team with personal accounts of the rationale for the current project approach and the difficulties encountered in achieving the project objectives. These meetings foster trust and understanding among the project staff and the VE team.

The information phase also includes the review of the cost models and a project site visit for first-hand knowledge of field conditions.

25.5.2(b) Phase 2: Function Analysis

The heart of VE methodology is function analysis. This is the primary activity that separates VE from other improvement programs and cost reduction techniques. During function analysis, the VE team defines the basic purpose of project elements and determines whether they are necessary to achieve the project objectives. Because function analysis is often misunderstood by those outside the VE process, an in-depth discussion is warranted.

The team identifies functions using just two words: an action verb and a noun with a measurable quality to it. For example, the function of a highway guide rail might be "redirect vehicle." Other examples include "kill bacteria," "contain water," "support load," and so on. In some cases, the team may use one or two adjectives to modify the noun for clarity.

After the team has identified the functions of the relevant project elements in this manner, they classify each function as either "basic" or "secondary." Basic functions are those that are essential to meet the project goals; these must be fulfilled by any VE alternative proposed. Secondary functions support or enhance basic functions and may be modified or eliminated by VE alternatives. Function analysis proceeds sequentially, from the whole project down to its various subsystems and components.

A systems approach can be valuable in classifying functions, allowing the VE team to visually relate a group of random functions within a project to better describe the entire system. The function analysis system technique (FAST) diagram (Figure 25-3) is a helpful diagnostic tool, asking questions that generate basic information about project functions. For example, "Why redirect vehicle?" The team answers these questions using logic and intuitive responses, and the answers form links between the functions. The FAST diagram is especially helpful if the VE team is uncertain of project goals.

After classifying functions, the VE team relates each function to cost. The cost models and the project team's cost data provide the basis for accomplishing this task. The establishment of costs for each function allows the team to develop a comparison value for the function's worth. Worth is defined as the lowest cost required to perform the function.

➢ 25.5.1, "Preparation (Cost Models)"

Establishing worth can be the most difficult part of function analysis. Worth is simply an indicator of the value of performing a given function, and a high degree of accuracy in estimating worth is not critical. Instead, worth is a mechanism to identify areas of high potential savings. The team generates estimates of worth, or the target cost, of a function based on their experience on similar projects. Subsystems that perform secondary functions may have little or no worth because they are not directly related to the basic function. For example, an access road to a wastewater treatment plant does not provide the basic functions of "remove solids" or "kill bacteria," and, therefore, represents a savings opportunity.

Finally, the team calculates a cost-to-worth ratio for the facility as a whole and for the systems and subsystems that compose it. Cost-to-worth ratios significantly higher than 1 indicate areas of large potential cost savings and identify systems or subsystems that are the object for further VE study.

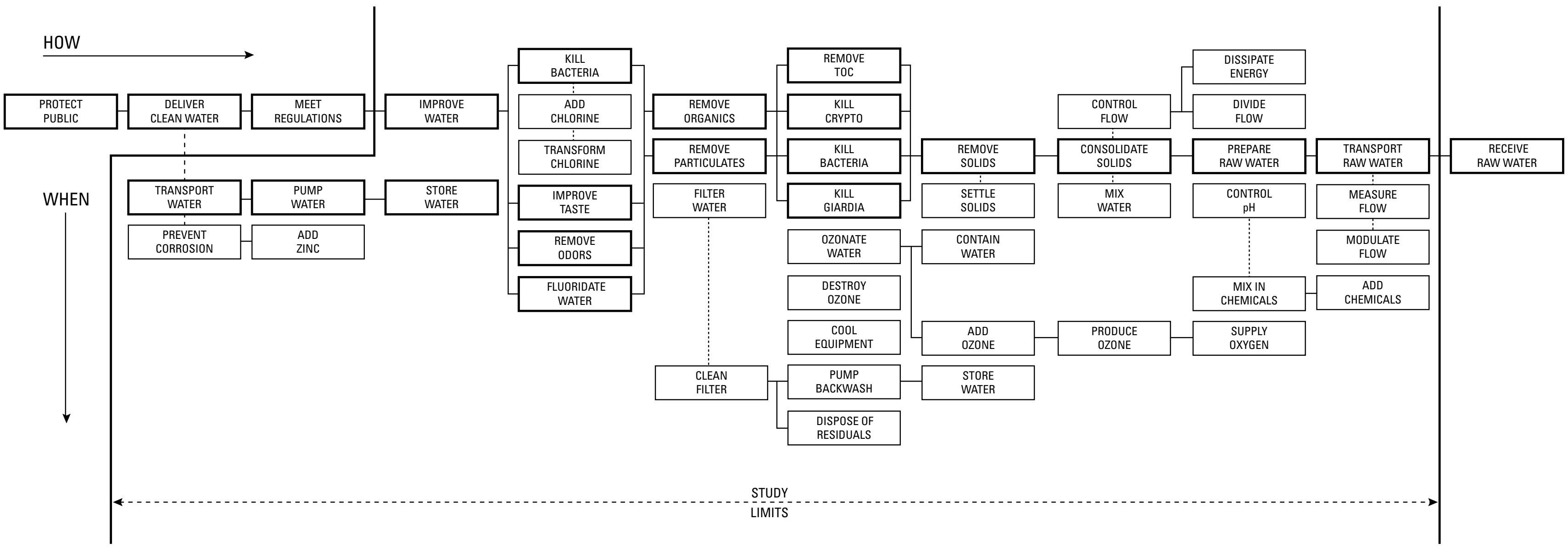
25.5.2(c) Phase 3: Creative Alternatives

The function analysis phase identifies project areas with a high potential for value improvement, setting the stage for the creative phase. The objective of the creative phase is to develop a broad spectrum of approaches for performing each function selected for study. The VE team approaches this phase unconstrained by habit, tradition, negative attitudes, assumed restrictions, and specific criteria. The team leader uses one or more methods to stimulate the group's creativity and generate lists of possible alternatives. To promote creative thinking, the team suspends all analysis, evaluation, or judgment of ideas until the phase is completed.

25.5.2(d) Phase 4: Evaluation

The goal of the evaluation phase is to identify the creative ideas that are feasible and worthy of further investigation. First, the team reviews the criteria for evaluation that were established during preparation. The team then discusses the advantages and disadvantages of each idea. Using a predetermined

Figure 25-3 Function Analysis System Technique (FAST) Sample for Water Treatment



scale, the team, as a whole, ranks each idea on how well it meets the criteria and on how well it performs the required function(s). The team continues the process until a consensus on the ranking of ideas is reached.

The team groups ideas addressing a common function or discipline together. If none of the alternatives meets every criterion satisfactorily, it may be necessary to return to the creative phase, and using the knowledge gained during the evaluation process, create additional solutions. Competing alternatives for a particular function may be comparatively evaluated using a matrix analysis.

The completed matrices, along with team judgment, can be used to determine the design that offers the best solution. In some instances, the original design may offer the best solution, in which case the team recommends no action.

25.5.2(e) Phase 5: Development

In the development phase, the team develops the high-ranking ideas into viable alternatives. Starting with the highest ranked ideas, the team selects "champions" for each idea. Drawing on the expertise of the team as necessary, the champions research and develop the ideas and provide preliminary designs and life-cycle cost comparisons. VE team members often consult outside experts, vendors, and reference sources to obtain additional evaluation information before developing—and if necessary revising—the design alternative.

Typical information that the champion provides in support of an alternative includes the following:

- Written descriptions of the original concept and proposed alternative;
- Sketches of the original and alternative designs;
- Technical back-up data, including calculations, information sources, and literature;
- Lists of advantages and disadvantages;
- Costs (initial and life-cycle estimates; performance data on the original and alternative);
- A concise argument in favor of the alternative that includes information on implementation, schedule (and potential conflicts), and other instances of successful implementations of the alternative.

25.5.2(f) Phase 6: Presentation

During the presentation phase, the VE team reports the results of the workshop to the decision-making body. One or more members of the VE team make an initial oral presentation, followed by a written report (prepared during the post-workshop activity).

25.5.3 Post-Workshop Activities

After the workshop, the VE team prepares a report to support the implementation process. At a minimum, the report includes the project description and objectives, the scope of the VE effort, VE procedures, and VE-recommended alternatives and supporting documentation.

Implementation of the VE team's recommended alternative(s) requires thorough evaluation by the project owner and the design professional. A typical implementation process for a VE alternative is as follows:

1. The VE team's report is circulated to the decision-making authority and the design professional so that the proposed alternatives may be reviewed in detail.
2. Each person reviewing the VE team's alternatives generates an initial opinion as to whether each alternative should be implemented, modified before implementation, or rejected.
3. The owner and design professional decide if the VE alternatives will be implemented. Alternatives requiring further modification or which fail to achieve a consensus among those responsible for reviewing them may be sent back to the design professional or VE team for revision.

25.6 ADDITIONAL VE CONSIDERATIONS

📖 Federal VE Guidelines, 23 CFR, Part 627

📖 Federal Acquisition Regulations, Parts 48 and 52.248-1

While government agencies and other organizations regularly involved in construction often have well-defined VE programs, extra care is advised when implementing a VE study with an owner who may be unfamiliar with the concept. VE is more than a cost-cutting tool, and during implementation, any cost savings that are estimated to result from VE recommendations should be carefully weighed against the costs of additional design, construction, and operations and maintenance.

This is especially true when VE is used near or at the end of the design process, when budget problems can emerge. In general, the further along a project is in the design process, the more difficult it is to save money without affecting function. Therefore, if VE is applied late in the design process, it is most valuable for reviewing issues of constructability and enhancing the coordination of construction documentation.

Finally, VE study recommendations should be implemented after they have been reviewed by affected disciplines. Without such review, unforeseen additional costs or impacts may reduce function, increase costs, or diminish quality to unacceptable levels.

SUMMARY

Value engineering is a powerful project improvement tool that establishes the lowest cost to achieve the project objectives without sacrificing quality. It can be applied to construction projects, processes, and manufactured products to develop an efficient concept or to significantly improve the value by improving quality and/or reducing cost.

It is a well-developed, structured, and utilitarian methodology that has been proven effective on countless projects for more than 50 years. The use of detailed function analysis sets VE apart from all other project improvement techniques. The involvement of a qualified value professional to lead the process avoids simple cost cutting and ensures a highly productive effort with a payback that is worth many times the initial investment. ❑

Chapter 25: Value Engineering

Typical Responsibilities

Responsibility ⇩	Owner	Design Professional*	Constructor*	Design-Builder
Initiate VE study	●	⦿	●	
Establish scope of VE study	●	⦿	●	
Provide personnel for VE study team	⦿	●	⦿	●
Provide information to VE team	●	⦿	⦿	●
Make oral presentation to VE team	⦿	●	⦿	●
Conduct VE study	● **	⦿	⦿	● **
Review VE recommendations	○	●	⦿	●
Implement VE recommendations	○	●	⦿	●

**For design-bid-build situation. In a design-build situation, the Design Professional and Constructor are part of the Design-Builder team.*

***Under the leadership of a certified value specialist (CVS) or other qualified VE facilitator.*

● = Primary Responsibility ⦿ = Assist or Advise ○ = Review

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GLOSSARY

ADVERTISEMENT FOR BIDS: Published public notice soliciting bids for a construction project or designated portion of a project; also included as part of the bidding documents.

ALTERNATIVES ANALYSIS: Analysis of different alternatives in project layout, scope, sequencing, and other variables to determine their validity and impact on project cost, appearance, schedule, and socioeconomic and environmental conditions.

ARBITRATION: A method of settling claims or disputes between parties to a contract, used as an alternative to litigation, under which an arbitrator or a panel of arbitrators, selected for specific knowledge in the field in question, hears the evidence and renders a decision.

ARCHITECT: See *Design Professional.*

ARCHITECT-ENGINEER: See *Design Professional.*

BID: A complete and properly signed proposal to perform the construction required by the contract documents, or designated portion of the documents, for an amount or amounts stipulated in the documents. A bid is submitted in accordance with the bidding documents.

BID BOND: A form of bid security executed by the bidder as principal and by a surety to protect the owner if the low bidder does not accept the award of contract.

BID DOCUMENTS: The advertisement for bids, the instruction to bidders, the bid form, other sample bidding and contract forms, and the contract documents, including any addenda issued prior to receipt of bids.

BID FORM: A form furnished to a bidder to be completed, signed, and submitted as the bidder's bid.

BID OPENING: The opening and tabulation of bids that have been submitted before the prescribed bid opening time and in conformity with the prescribed procedures.

BID SECURITY: The deposit of cash, certified check, cashier's check, bank draft, stocks/bonds, money order, or bid bond submitted with a bid. Also see *Bid Bond.*

BIDDER QUALIFICATION DATA: Information sometimes required by the owner, and sometimes required by law, about the bidder's financial and physical capability to perform the completed construction required by the contract documents, or designated portion of the documents.

BONUS CLAUSE: A provision in the construction contract for payment of a bonus to the constructor for satisfactorily completing the work before a certain date.

CERTIFICATE OF COMPLETION: A statement prepared by the responsible design professional on the basis of an inspection stating that the work or a designated portion of the work is, to the best of his or her knowledge, substantially complete.

CHANGE ORDER: A written order to the constructor signed by the owner and/or the owner's representative, issued after execution of a contract, that authorizes a change in the work or an adjustment in the contract sum or the construction schedule.

CODE COMPLIANCE OFFICIAL: The officer or other designated authority charged with the administration and enforcement of the applicable code within the jurisdiction where a project is located.

CODES AND STANDARDS: Regulations, ordinances, or statutory requirements of federal, state, and local governments related to building construction and occupancy that are intended to protect public health, safety, and welfare.

CODES OF ETHICS: Official statements prepared by organizations representing members of a profession that establish fundamental principles, canons, and guidelines of practice for the members of that profession.

COMMISSIONING: Preparing the project or facility for occupancy or use, including the testing of systems operation.

COMPETITIVE BIDDING: A method, often mandated by law, of selecting constructors for construction projects by price competition between qualified bidders subjected to various rules and procedures.

CONDITIONS OF THE CONTRACT: The portions of the contract documents that define the roles and responsibilities of the contracting parties and other participants.

CONSTRUCTABILITY ANALYSIS: A review of the practical ability to construct a project, covering economics, availability of materials, site restrictions, and local conditions that may affect construction.

CONSTRUCTION CONTRACT: The agreement, or contract, between the owner and constructor for construction of a project, or portions thereof, in accordance with contract documents.

CONSTRUCTION COST ESTIMATE: Cost estimates prepared during design for the purpose of budgeting, evaluating bids, serving as guides in conducting negotiations, and establishing a schedule of payments during the construction phase. (Derived and reused from USACE Engineering Regulation 1110-1-12.)

CONSTRUCTION MANAGEMENT: Management services provided to an owner during the construction phase of a project by an individual or entity possessing requisite training and experience.

CONSTRUCTION PLAN: Developed by or for the owner prior to the initiation of actual construction, the plan addresses roles, functions, contracting strategy, construction phasing, etc., for the pre-construction, construction, and post-construction portions of a project.

CONSTRUCTION SUPERVISOR: The constructor's representative at the site who is responsible for continuous field supervision, coordination, and completion of construction.

CONSTRUCTOR: The individual or entity responsible for performing and completing the construction of a project as required by the contract documents. The term constructor throughout the Guide includes all of the constructor's subcontractors.

CONSULTANT: A person or entity providing specialized advice or services to an owner, design professional, or constructor.

CONTRACT DOCUMENTS: The owner/constructor agreement, the conditions of the contract (general, supplementary, and other conditions), project drawings, project specifications, and all addenda issued prior to and all change orders issued after execution of the contract, and any other items that may be specifically stipulated as being included.

CONTRACTOR: See *Constructor.*

COST-BENEFIT RATIO: The ratio of costs expended to benefits received, in terms of present worth.

DELIVERABLES: Documents such as studies, cost estimates, calculations, project drawings, project specifications, and other submittals detailed in contract agreements between owner, design professional, and constructor.

DESIGN: The process of (1) developing the analyses that define the required technical systems (e.g., geotechnical, hydraulic, architectural, structural, electrical, mechanical, fire protection) which will be utilized, (2) producing the technical portions of the construction contract documents (i.e., the drawings and specifications), and (3) preparing the construction cost estimate.

DESIGN-BID-BUILD: The predominant form of contracting in the United States, in which the owner separately engages a design professional to provide design services and a constructor to build the project. Also see *Traditional Project Delivery.*

DESIGN-BUILD: A form of contracting where one entity, either a constructor or design professional, is responsible for both project design and construction.

DESIGN DISCIPLINE: A category of related professional services, such as structural engineering, architecture, mechanical engineering, civil engineering, and electrical engineering, requiring licensure or regulation in the state in which services are performed.

DESIGN DISCIPLINE DELEGATION: The delegation of design services for a portion of the permanent project work to the constructor or specialty subcontractor.

DESIGN PROFESSIONAL: A designation reserved, usually by law, for a person or organization professionally qualified and licensed to perform architectural or engineering services. These services may include, but are not limited to, the development of project requirements; the creation and development of project design documents; the preparation of project drawings, project specifications, and bidding requirements; and the delivery of design services during the construction and start-up phases of a project. The term design professional throughout the Guide includes all of the design professional's subconsultants.

DESIGN TEAM: The group of individuals or entities representing the design disciplines to be performed.

DESIGN TEAM LEADER: The individual responsible for the coordination of design activities on a project. The design team leader is responsible for monitoring progress and reporting to the owner.

DEVELOPER: A private individual or organization that arranges for the financing, design, and construction of a project. Private project owners are often developers.

DRAWINGS: Graphic and pictorial documents drawn to scale that show the design, location, and dimensions of project elements.

EJCDC CONSTRUCTION DOCUMENTS: Sample agreements and contracts prepared by the Engineers Joint Contract Documents Committee (EJCDC).

ENGINEER: See *Design Professional.*

ENGINEER-ARCHITECT: See *Design Professional.*

ENGINEER OF RECORD (EOR): The prime design professional, engineering firm, or organization that is legally responsible for the engineering design.

ENVIRONMENTAL ASSESSMENT (EA): A report on the anticipated impact of a proposed project on surrounding conditions. An EA typically includes environmental, engineering, aesthetic, and economic impacts.

ENVIRONMENTAL IMPACT STATEMENT (EIS): A detailed document meeting the requirements of the National Environmental Policy Act that discusses the benefits and impacts of project alternatives with respect to specified environmental issues. Some projects may require draft (DEIS) and final (FEIS) versions of this document.

FACILITY: The constructed elements of a project.

FAST-TRACK CONSTRUCTION: The practice of starting construction and/or site work as soon as drawings and specifications are available for some portions of a project, even though design may not be complete for others.

GOALS: Broad project aims, usually expressed by the owner. Also see *Objectives.*

INDEMNIFICATION: A collateral contract or assurance in which one party agrees to secure or "hold harmless" another against unanticipated losses or prevent the other party from being damaged by the legal consequences of an act of forbearance by one of the parties or a third party.

INSTRUCTION TO BIDDERS: The instructions contained in the bidding documents for preparing and submitting bids for a construction project or designated portion of a project.

INVITATION TO BIDDERS: See *Advertisement for Bids.* (For private owners, invitations are sent to pre-qualified contractors.)

LIFE-CYCLE COST: The total cost of developing, designing, constructing, owning, operating, and maintaining a constructed project for its design life, including energy, maintenance, and staffing. Life-cycle costs also include decommissioning, salvage (if appropriate), and other non-capital costs.

LIQUIDATED DAMAGES: A dollar amount established in a construction contract, usually a fixed daily sum, as the measure of damages incurred by the owner due to the failure of the constructor to complete the work as scheduled.

LOSS PREVENTION: The use of safety programs and insurance to mitigate financial losses resulting from loss of life and personal injuries and property damage on a construction project.

OBJECTIVES: Specific descriptions of the project location, function, size, performance characteristics, schedule needs, financial matters, and other items as established by the owner, often with the assistance of the design professional. Also see *Goals.*

OBSERVATION: A function of a design professional involving required visits to a project site during construction to observe the progress and quality of work and determine if it is proceeding according to the contract documents.

OFFICE PRACTICE: A standardized program for a design or construction firm that covers general management, the organization of projects, owner relationships, office procedures, filing and storing materials, and operating procedures.

OWNER: The individual or organization that initiates a construction project and is responsible for financing it.

PARTNERING: A voluntary effort among project participants to implement processes that enhance communication, reduce conflict, develop common goals, and solve problems in ways that deliver mutual benefits.

PLACING DRAWINGS: Detailed working drawings for reinforcing bars in site-cast reinforced concrete prepared by detailers showing placement and tying reinforcement bars within the formwork. Placing drawings also include lists of reinforcing bars containing quantities, sizes, lengths, and bending dimensions.

PLANS: See *Drawings.*

PRE-BID CONFERENCE: A meeting arranged by the owner for prospective constructors prior to the submission of construction bids to introduce the project, outline its goals and objectives, describe the design professional's intent (the design professional is usually present), and address bidders' questions.

PRE-CONSTRUCTION MEETING: A meeting arranged by the owner after the construction contract has been awarded, but before construction begins, to provide the owner, design professional, constructor, and subcontractors with the opportunity to establish procedures and working relationships for construction operations.

PRESENT-WORTH ANALYSIS: An analysis of project cost over a prescribed evaluation period with an emphasis on time-sensitive financial factors, such as inflation and amortization often used to establish life-cycle costs.

PROGRAM MANAGER: A person or entity who manages all phases of project development (conceptual, design, and construction) and reports to the owner.

PROJECT: (1) The facilities or elements to be constructed, as defined by contract documents; (2) the people and processes that create a completed facility.

PROJECT COST: The total capital cost associated with design and construction, including design fees, construction labor and materials, and financing costs for borrowed funds. Project costs do not include operating and maintenance expenses. Also see *Life-Cycle Cost*.

PROJECT EVALUATION: A critical evaluation of a project by the project team members during both design and construction to assess design, schedule, objectives, costs, legal ramifications, and trends that impact cost, quality, and schedule.

PROJECT MANAGEMENT: The planning, organizing, staffing, directing, controlling, and coordination of design and construction activities for a constructed project.

PROJECT MANAGER: The person who heads either the program management or construction management entity and who has a direct contractual responsibility to the owner.

PROJECT PLAN: A work activity diagram and other documents depicting features of a project's objectives.

PROJECT SCHEDULE: The chronological order of project events, usually depicted by a diagram, graph, or written listing showing proposed and actual times for the start and completion of tasks.

PROJECT TEAM: The people and organizations primarily responsible for completing a constructed project: the owner, design professional, and constructor (or design-builder).

QUALIFICATIONS: The information about an individual or organization submitted during the bidding or design agreement negotiation process in response to predetermined standards and requirements.

QUALIFICATIONS-BASED SELECTION (QBS): A process for selecting the design professional or design-builder based on his or her relevant qualifications for the project, rather than the price of his or her services.

QUALITY: The delivery of products and services in a manner that meets the reasonable requirements and expectations of the owner, design professional, and constructor, including conformance with contract requirements, prevailing industry standards, and applicable codes, laws, and licensing requirements.

QUALITY ASSURANCE: Planned and systematic actions established by the owner or its agent to establish a level of confidence that project design documents comply with applicable codes, standards, and criteria and that the resulting construction complies with the contract documents. Quality assurance substantiates the effectiveness of the design professional's and constructor's Quality control responsibilities.

QUALITY CONTROL: Plans, procedures, and organization performed by the design professional necessary to control the quality of the contract documents to ensure consistency with applicable codes, standards, and criteria, or by the construction professional necessary to control the quality of its construction to ensure compliance with the contract documents. Quality control includes observations, calculations, inspections, tests, and documentation that either confirm quality processes and systems are effective in ensuring the achievement of quality or are ineffective and therefore need to be changed to achieve the required level of quality.

REASONABLE CARE: A degree of care, precaution, or diligence as may fairly and properly be expected or required, having regard to the nature of the action, or of the subject matter and the surrounding circumstances of the action.

RECORD DOCUMENTS: A compilation of drawings, specifications, addenda, written amendments, change orders, work directive changes, field orders, and written interpretations and clarifications, maintained in good order and annotated to show all changes made during construction. These record documents, together with all approved samples and a counterpart of all approved shop drawings, are available to the design professional for reference while the project is under way and are delivered to the owner upon project completion.

RECORDS: Documents that contain project data, activities, transactions, and memoranda of oral communications, as well as specified electronic files. Records usually include the contract documents.

REQUIREMENTS: What each team members expects to achieve or needs to receive during and after their participation in a project.

RESIDENT PROJECT REPRESENTATIVE (RPR): The person who represents the owner during construction, managing the day-to-day administration of the construction contract, monitoring progress, and maintaining working relationships among project site personnel.

RESPONSIBILITIES: Tasks that a participant is expected to perform to accomplish the project objectives as specified by contractual agreement and applicable laws, codes, standards, and regulatory guidelines.

RESPONSIVE BID: A bid by a qualified bidder that meets the project specifications, as stated in the bidding documents.

RETAINAGE: A sum withheld from progress payments to the design professional or constructor according to terms of owner-designer or owner-constructor agreements.

RISK TRANSFER: Contractual clauses that transfer the risk of project team members to other parties by means of bonds or insurance. Sometimes risk transfer refers to the allocation of risk among members of the project team.

SELECTION COMMITTEE: A committee of qualified professionals established by the owner and guided by pre-established criteria and administrative policy, that makes recommendations on the selection of the design professional or design-builder after conducting investigations, interviews, and inquiries.

SHOP DRAWINGS: Drawings, diagrams, schedules, and other data required for manufacture, fabrication, and erection of project components. These can be prepared by the constructor, subcontractor, or manufacturer. See also *Placing Drawings*.

SPECIAL CONDITIONS: A section of the conditions of the contract, separate from general conditions and supplementary conditions, that describes relevant unique project conditions.

SPECIFICATIONS: A part of the contract documents, usually contained in the project manual, consisting of written requirements for materials, equipment, construction systems, standards, and quality of construction tradecraft.

SUBCONSULTANT: A person or entity providing design-related services to the design professional, design-builder, or owner.

SUBCONTRACTOR: A person or entity contracting with the constructor, design-builder, or owner (if project delivery is self-provided) to provide equipment or construction services.

SUBROGATION: The assumption by a third party of another's legal right to collect a debt or damages.

SUBSTANTIAL COMPLETION: The point in the progress of a project at which the work is sufficiently complete, in accordance with the contract documents, so that all or part of the facility can be used as intended.

SUPPLEMENTARY CONDITIONS: A part of the contract documents that supplements and may also modify, change, add to, or delete from provisions of the general conditions.

SUPPLIER: A person or firm supplying materials or equipment for construction, including materials fabricated for a special design.

SUSTAINABLE DEVELOPMENT: Meeting human needs for natural resources, industrial products, energy, food, transportation, shelter, and effective waste management while conserving and protecting environmental quality and the natural resource base essential for future development.

TASK MANAGER: An individual who manages a specific assignment of the design.

TRADECRAFT: The work performed by construction trade workers, including carpenters, masons, electricians, ironworkers, equipment operators, and other craftspersons.

TRADITIONAL PROJECT DELIVERY: A contractual arrangement or project delivery system, known as design-bid-build, or DBB, that involves three principal participants: the owner, design professional, and constructor. Also see *Design-Bid-Build.*

TURNKEY: An extension of design-build contracting in which the design-builder carries out most major project responsibilities, including land acquisition, financing, purchase and installation of equipment, and other tasks; the design-builder then operates the completed facility for a specified period and then "turns over the keys" to the owner.

UNBALANCED BID: A bid in which some of the unit prices do not reflect the true estimated cost of the services or materials being provided; the costs of some unit prices are overstated and others understated.

VALUE ENGINEERING: A limited independent engineering exercise with the goal of identifying or verifying engineering alternatives that maximize the relationship of the value of the function, performance, and quality of specific project elements to cost.

VENDOR: See *Supplier.*

ACRONYMS

AAA	American Arbitration Association
AASHTO	American Association of State Highway and Transportation Officials
ACEC	American Consulting Engineers Council
ACI	American Concrete Institute
ACM	Agency construction manager
ADR	Alternate dispute resolution
AGC	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
ASFE	ASFE: The Geoprofessional Business Association
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BMP	Best management practices
CADD	Computer-aided design and drafting
CCIP	Contractor-controlled insurance program
CFR	Code of Federal Regulations
CGL	Commercial general liability
CII	Construction Industry Institute
CM	Construction manager
CMAA	Construction Management Association of America
CPM	Critical path method
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
CVS	Certified value specialist
DBB	Design-bid-build
DBIA	Design-Build Institute of America
DBOM	Design-build-operate-maintain
DBOOT	Design-build-own-operate-transfer
DBOT	Design-build-operate-transfer
EA	Environmental assessment
EEO	Equal employment opportunity

EIS	Environmental impact statement
EJCDC	Engineers Joint Contract Documents Committee
EPA	Environmental Protection Agency
FAR	Federal acquisition regulations
FAST	Function analysis system technique
FHWA	Federal Highway Administration
FIDIC	International Federation of Consulting Engineers
FTA	Federal Transit Administration
GMP	Guaranteed maximum price
GSA	General Services Administration
ICE	Institute of Civil Engineers (U.K.)
IEEE	Institute of Electrical and Electronics Engineers, Inc.
LLC	Limited liability company
LLP	Limited liability partnership
NAS	Network analysis systems
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology (formerly NBS)
NPCA	National Precast Concrete Association
NRMCA	National Ready-Mix Concrete Association
NSPE	National Society of Professional Engineers
O&M	Operations and maintenance
OCIP	Owner-controlled insurance program
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Prestressed/Precast Concrete Institute
PDM	Precedence diagramming method
PSA	Professional services agreement
PTI	Post-Tensioning Institute
QA/QC	Quality assurance/quality control
QBS	Qualifications-based selection
RCRA	Resource Conservation and Recovery Act
RFI	Request for information
RFP	Request for proposals
RFQ	Request for qualifications
RPR	Resident project representative
SCADA	Supervisory control and data acquisition
SOQ	Statement of qualifications
USACE	United States Army Corps of Engineers
VECP	Value engineering change proposal

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