

CHAPTER

1

An Overview of the Building Delivery Process

(How Buildings Come into Being)

CHAPTER OUTLINE

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Building construction is a complex, significant, and rewarding process. It begins with an idea and culminates in a structure that may serve its occupants for several decades, even centuries. Like the manufacturing of products, building construction requires an ordered and planned assembly of materials. It is, however, far more complicated than product manufacturing. Buildings are assembled outdoors by a large number of diverse constructors and artisans on all types of sites and are subject to all kinds of weather conditions.

Additionally, even a modest-sized building must satisfy many performance criteria and legal constraints, requires an immense variety of materials, and involves a large network of design and production firms. Building construction is further complicated by the fact that no two buildings are identical; each one must be custom built to serve a unique function and respond to its specific context and the preferences of its owner, user, and occupant.

Because of a building's uniqueness, we invoke first principles in each building project. Although it may seem that we are “reinventing the wheel”, we are in fact refining and improving the building delivery process. In so doing, we bring to the task the collective wisdom of the architects, engineers, and contractors who have done so before us. Although there are movements that promote the development of standardized, mass-produced buildings, these seldom meet the distinct needs of each user.

Regardless of the uniqueness of each building project, the flow of activities, events, and processes necessary for a project's realization is virtually the same in all buildings. This chapter presents an overview of the activities, events, and processes that bring about a building—from the inception of an idea or a concept in the owner's mind to the completed design by the architects and engineers and, finally, to the actual construction of the building by the contractor.

Design and construction are two independent but related and generally sequential functions in the realization of a building. The former function deals with the creation of the documents, and the latter function involves interpreting and transforming these documents into reality—a building or a complex of buildings.

The chapter begins with a discussion of various stakeholders (personnel involved in the design and construction of the project) and the relational framework among them. Subsequently, a description of the two major elements of design documentation—construction drawings and specifications—is provided. Finally, the chapter examines some of the methods used for bringing a building into being, referred to as the *project delivery methods*. From the owner's perspective, these methods are called *project acquisition methods*.

The purpose of this chapter, as its title suggests, is to provide an overall, yet distilled, view of the construction process and its relationship with design. Although several contractual and legal issues are discussed, they should be treated as introductory. A reader requiring additional information on these topics should refer to texts specially devoted to them.

1.1 PROJECT DELIVERY PHASES

The process by which a building project is delivered to its owner may be divided into the following five phases, referred to as the *project delivery phases*. Although there is usually some overlap between adjacent phases, they generally follow this order:

- Predesign phase
- Design phase
- Preconstruction phase
- Construction phase
- Postconstruction phase

1.2 PREDESIGN PHASE

During the predesign phase (also called the *planning* or *programming phase*), the project is defined in terms of its function, purpose, scope, size, and economics. This is the most crucial of the five phases, and is almost always managed by the owner and the owner's team. The success or failure of the project may depend on how well this phase is defined, detailed, and managed. Obviously, the clearer the project's definition is, the easier it is to proceed to the subsequent phases. Some of the important predesign tasks are:

- Details of the project's program.
- Economic feasibility assessment, including the project's overall budget and financing.
- Site assessment and selection, including the verification of the site's appropriateness, and determining its designated land use (see Chapter 2).
- Governmental constraints assessment, for example, building code and zoning constraints (see Chapter 2) and other legal aspects of the project.
- Sustainability rating—whether the owner would like the project to achieve sustainability rating, such as the U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design (LEED) certification at some level (see Chapter 10).
- Design team selection.

BUILDING (PROJECT) PROGRAM

This includes defining the activities, functions, and spaces required in the building, along with their approximate sizes and their relationships with each other. For a house or another small project, the program is usually simple and can be developed by the owner without external assistance. For a large project, however, where the owner may be an

NOTE

**Building (Project)
Program**

The American Institute of Architects (AIA) Document B141-1997, *Standard Form of Agreement Between Owner and Architect*, defines the building program: “A program is a written statement setting forth design objectives, constraints, and criteria for a project . . . A program includes space requirements and relationships, flexibility and expandability, special equipment and systems, and site requirements. If a comprehensive program is not available at the outset of the project, the owner may obtain the architect’s assistance in developing one as an expansion of services”.

institution (such as a corporation, school board, hospital, religious organization, or governmental entity), developing the program may be a complex exercise. This may be due to the size and complexity of the project or the need to involve several individuals—a corporation’s board of directors, for example—in decision making. These constituencies may have different views of the project, making it difficult to create a consensus.

Program development may also be complicated by situations in which the owner has a fuzzy idea of the project and is unable to define it clearly. By contrast, experienced owners tend to have a clear understanding of the project and generally provide a detailed, unambiguous program to the architect.

Although the owner must provide the program details to the architect, it is not unusual for the owner to involve the architect in preparing the program for some architecturally complex projects. In this instance, the architect may be hired early during the predesign phase. Note that the architect’s role in the preparation of the building program is not considered a part of the architect’s “basic” services, but as an “additional” service, compensated separately [Ref. 1.1].

Whatever the situation, preparing the program is the first step in the project delivery process. It should be spelled out in writing and in sufficient detail to guide the design, reduce the liability risk for the architect, and avoid its misinterpretation. If a revision is made during the progress of the project, the owner’s written approval is necessary.

1.3 DESIGN PHASE

The design phase begins after the selection of the architect. Because the architect (usually a firm) may have limited capabilities for handling the broad range of building-design activities, several different, more specialized consultants are usually required, depending on the size and scope of the project.

In most projects, the design team consists of the architect, landscape architect, civil and structural consultants, and mechanical, electrical, and plumbing (MEP) consultants. In complex projects, the design team may also include an acoustical consultant, roofing and waterproofing consultant, cost consultant, building code consultant, signage consultant, interior designer, and so on.

Some design firms have an entire design team (architects and specialized consultants) on staff, in which case, the owner will contract with a single firm. Generally, however, the design team comprises several different design firms. In such cases, the owner typically contracts the architect, who in turn contracts the remaining design team members, Figure 1.1.

Thus, the architect functions as the prime design professional and, to a limited degree, as the owner’s representative. The architect is liable to the owner for his or her own work and that of the consultants. For that reason, most architects ensure that their consultants carry adequate liability insurance.

ARCHITECT’S LIABILITY FOR WORK DONE BY OWNER-CONTRACTED CONSULTANT

In some projects, the owner may contract some consultants directly, particularly a civil consultant (for a survey of the site, site grading, slope stabilization, and the design of site drainage system), a geotechnical consultant (for investigation of the soil properties), and a landscape architect (for landscape and site design), Figure 1.2. These consultants may be engaged before or at the same time as the architect.

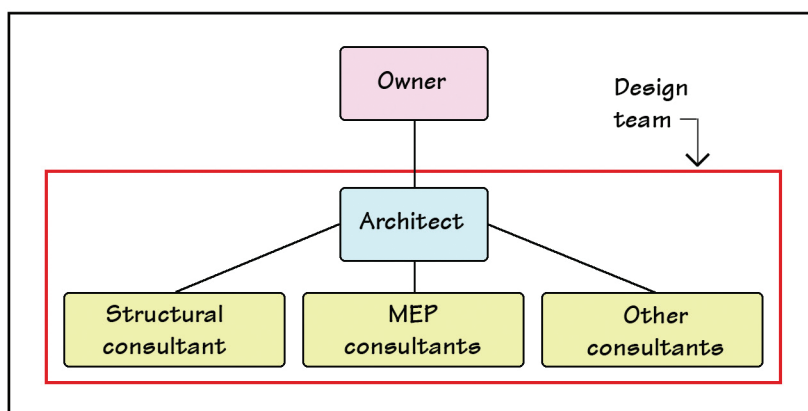


FIGURE 1.1 Members of a typical design team, and their interrelationships with each other and the owner in a traditional contractual set-up. A line in this illustration indicates a contractual relationship between parties. (“MEP consultants” is an acronym for mechanical, electrical, and plumbing consultants.)

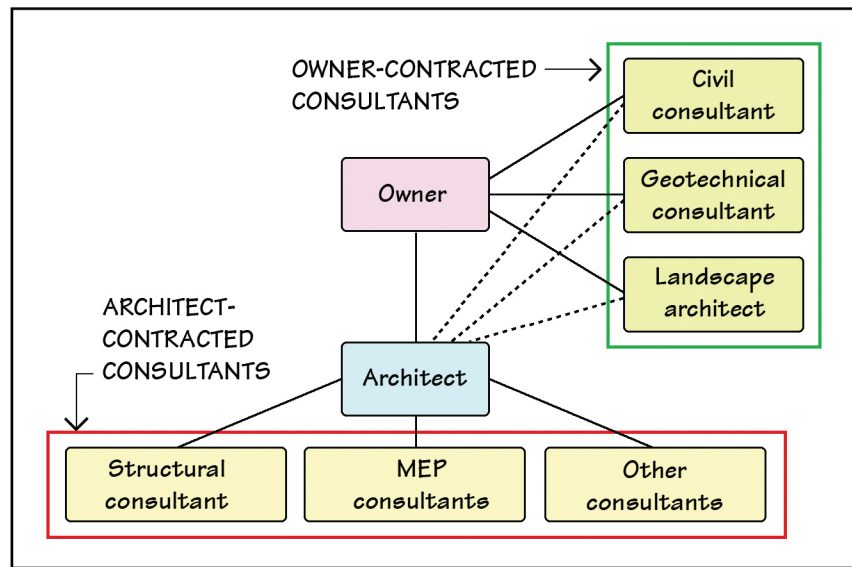


FIGURE 1.2 Members of a typical design team, and their interrelationships with each other and the owner in a project where some consultants are contracted directly by the owner. A solid line in this illustration indicates a contractual relationship between parties. A dashed line indicates a communication link, not a contract.

Even when a consultant is contracted directly by the owner, the architect retains some liability for the consultant's work. This liability occurs because the architect, being the prime design professional, coordinates the entire design effort, and the consultants' work is influenced a great deal by the architectural decisions. Therefore, the working relationship between the architect and an owner-contracted consultant remains essentially the same as if the consultant were chosen by the architect.

ENGINEER AS PRIME DESIGN PROFESSIONAL

In some cases, an engineer or another professional may coordinate the design process. This generally occurs where architectural design is a minor component of a large-scale project. For example, in a highly technical project such as a power plant, an electrical engineer may be the prime design professional.

1.4 THREE SEQUENTIAL STAGES IN DESIGN PHASE

In most building projects, the design phase consists of three stages, which occur in the following sequence:

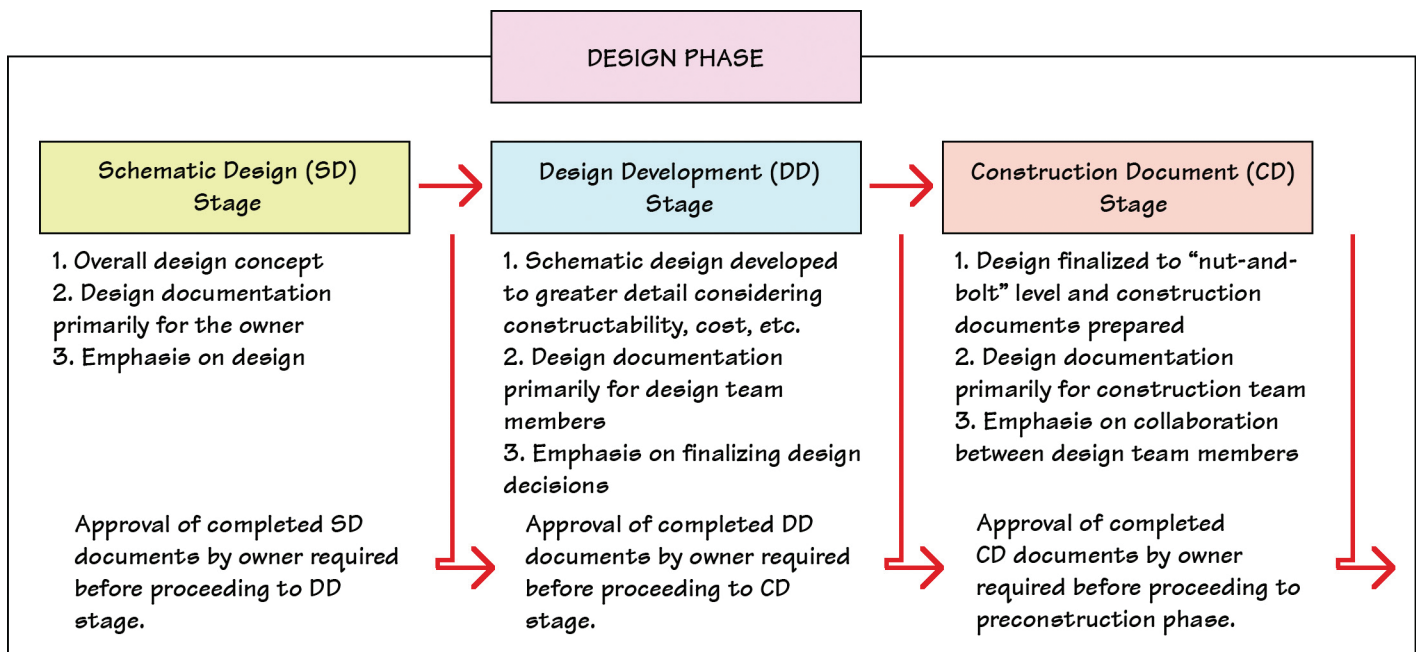


FIGURE 1.3 Three sequential stages (steps) of the design phase and the important tasks accomplished in each stage.

- Schematic design (SD) stage
- Design development (DD) stage
- Construction document (CD) stage

Figure 1.3 illustrates the sequence and the important tasks accomplished in each stage. Note that at the end of each stage, a written approval from the owner is required before proceeding to the next stage, or from the design phase to the preconstruction phase.

SCHEMATIC DESIGN STAGE—EMPHASIS ON DESIGN

The schematic design gives graphic shape to the project program. It is an overall concept that illustrates key ideas of the design solution. The major player in this stage is the architect, who develops the design scheme (or several design options), generally with limited help from the consultants. Because most projects have strict budgetary limitations, a rough estimate of the project's probable cost is generally produced at this stage.

The schematic design usually goes through several revisions, because the first design scheme prepared by the architect will rarely be approved by the owner. The architect communicates the design proposal(s) to the owner through various types of drawings—plans, elevations, sections, freehand sketches, and three-dimensional graphics (isometrics, axonometrics, and perspectives). For some projects, a three-dimensional scale model of the entire building or the complex of buildings, showing the context (neighboring buildings) within which the project is sited, may be needed.

With significant developments in electronic media technology, especially building information modeling (BIM), computer-generated imagery has become common in architecture and related engineering disciplines. Computer-generated walk-through and flyover simulations are becoming increasingly popular for communicating the architect's design intent to the owner at the SD stage.

It is important to note that the schematic design drawings, images, models, and simulations, regardless of how well they are produced, are not adequate to construct the building. Their objective is merely to communicate the design scheme to the owner (and to consultants, who may or may not be on board at this stage), not to the contractor.

DESIGN DEVELOPMENT STAGE—EMPHASIS ON DECISION MAKING

Once the schematic design is approved by the owner, the process of designing the building in greater detail begins. During this stage, the schematic design is developed further—hence the term *design development* (DD) stage.

While the emphasis in the SD stage is on the creative, conceptual, and innovative aspects of design, the DD stage focuses on developing practical, pragmatic, and constructible solutions for the exterior envelope, structure, fenestration, interior systems, MEP systems, and so forth. This development involves strategic consultations with all members of the design team.

Therefore, the most critical feature of the DD stage is decision making, which ranges from broad design aspects to finer details. At this stage, the vast majority of decisions about products, materials, and equipment are made. Efficient execution of the construction documents depends directly on how well the DD is managed. A more detailed version of the specifications and probable cost of the project is also prepared at this stage.

CONSTRUCTION DOCUMENTS STAGE—EMPHASIS ON DOCUMENTATION

The purpose of the *construction documents* (CD) stage is to prepare all documents required by the contractor to construct the building. During this stage, the consultants and architect collaborate intensively to work out the “nuts and bolts” of the building and develop the required documentation, referred to as *construction documents*. All of the consultants advise the architect, but they also collaborate with each other (generally through the architect) so that the work of one consultant agrees with that of the others.

The construction documents consist of the following items:

- Construction drawings
- Specifications

CONSTRUCTION DRAWINGS

During the CD stage, the architect and consultants prepare their own sets of drawings, referred to as *construction drawings*. Thus, a project has architectural construction drawings, civil and structural construction drawings, MEP construction drawings, landscape construction drawings, and so on.

NOTE

Working Drawings and Construction Drawings

The term working drawings was used until the end of the twentieth century for what are now commonly referred to as *construction drawings*.

Construction drawings are dimensioned drawings (usually computer generated) that fully delineate the building. They consist of floor plans, elevations, sections, schedules, and various large-scale details. The details depict a small portion of the building that cannot be adequately described on smaller-scale plans, elevations, or sections.

Construction drawings are the drawings that the construction team uses to build the building. Therefore, they must indicate the geometry, layout, dimensions, types of materials, details of assembling the components, colors and textures, and so on. Construction drawings are generally two-dimensional drawings, but three-dimensional isometrics are sometimes used for complex details. Construction drawings are also used by the contractor to prepare a detailed cost estimate of the project at the time of bidding.

Construction drawings are not a sequence of assembly instructions, such as for a bicycle. Instead, they indicate what every component is and where it will be located when the building is completed. In other words, the design team decides the “what” and “where” of the building. The “how” and “when” (means, methods, and sequencing) of construction are entirely in the contractor’s domain.

SPECIFICATIONS

Buildings cannot be constructed from drawings alone, because there is a great deal of information that cannot be included in the drawings. For instance, the drawings will give the locations of columns, their dimensions, and the material used (such as reinforced concrete), but the quality of materials, their properties (the strength of concrete, for example), and the test methods required to confirm compliance cannot be furnished on the drawings. This information is included in the document called *specifications*.

Specifications are written technical descriptions of the design intent, whereas the drawings provide the graphic description. The two components of the construction documents—the specifications and the construction drawings—complement each other and generally deal with different aspects of the project. Because they are complementary, they are supposed to be used in conjunction with each other. There is no order of precedence between the construction drawings and the specifications. Thus, if an item is described in only one place—either the specification or the drawings—it is part of the project, as if described in the other.

For instance, if the construction drawings do not show the door hardware (hinges, locks, handles, and other components) but the hardware is described in the specifications, the owner will get the doors with the stated hardware. If the drawings had precedence over the specifications, the owner would receive doors without hinges and handles.

Generally, there is little overlap between the drawings and the specifications. More importantly, there should be no conflict between them. If a conflict between the two documents is identified, the contractor must bring it to the attention of the architect promptly. In fact, construction contracts generally require that before starting any portion of the project, the contractor must carefully study and compare the drawings and the specifications and report inconsistencies to the architect.

If the conflict between the specifications and the construction drawings goes unnoticed initially but later results in a dispute, the courts have in most cases resolved it in favor of the specifications—implying that the specifications, not the drawings, govern the project. However, if the owner or the design team wishes to reverse the order, it can be so stated in the owner-contractor agreement.

EXPAND YOUR KNOWLEDGE

Relationship Between Construction Drawings and Specifications

Construction Drawings	Specifications
Design intent represented graphically	Design intent represented with words
Product/material may be shown many times	Product/material described only once
Product/material shown generically	Product/material identified specifically, sometimes proprietary to a manufacturer
Quantity indicated	Quality indicated
Location of elements established	Installation requirements of elements established
Size, shape, and relationship of building elements provided	Description, properties, characteristics, and finishes of building elements provided

THE CONSTRUCTION DOCUMENT SET

Just as the construction drawings are prepared separately by the architect and each consultant for their respective portions of the work, so are the specifications. The specifications from various design team members are assembled by the architect in a single document. Because the specifications are in text format (not as drawings), they are bound in book format. A few other items are also included in this document at a later stage, and the entire bound document is called the *project manual*, described in Section 1.7. The construction drawings plus the specifications constitute the construction document set, Figure 1.4 (see also Figure 1.11). Although hardcopy drawings and specification are common, their digital versions are being increasingly used.

OWNER'S ROLE DURING DESIGN PHASE

The owner's role in the design phase of the project may not appear as active as in the predesign phase, but it is important all the same. In fact, a conscientious owner will be fully involved throughout the entire project delivery process—from the predesign phase through the project closeout phase.

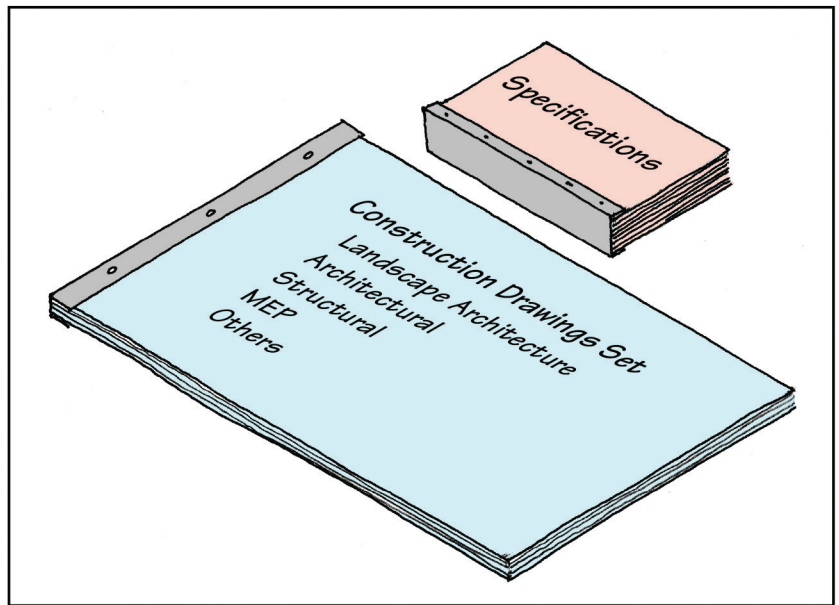


FIGURE 1.4 A construction document set consists of a set of architectural and consultants' construction drawings plus the specifications prepared by the architect and the consultants. The specifications are bound in book format along with other items.

PRACTICE QUIZ

Each question has only one correct answer. Select the choice that best answers the question.

- The delivery of a typical building project, as described in this text, may be divided into
 - two phases.
 - three phases.
 - four phases.
 - five phases.
 - six phases.
- Establishing the project's economic feasibility and its overall budget is part of the design phase of the project.
 - True
 - False
- The term MEP is an acronym for
 - municipal emergency plan.
 - mechanical, electrical, and plumbing.
 - mechanical, electrical, and piping.
 - mechanical and electrical plans.
 - mechanical and electrical plant.
- The program for a building project is prepared by the
 - owner.
 - general contractor.
 - building official of the city.
 - architect.
 - all of the above collectively.
- In a typical building project, the coordination of the building's design is done by the
 - owner.
 - general contractor.
 - building official of the city.
 - architect.
 - any one of the above, depending on the type of building.
- The construction drawings of a building project are prepared during the
 - SD stage of the project.
 - DD stage of the project.
 - CD stage of the project.
 - preconstruction phase of the project.
 - construction phase of the project.
- The construction drawings of a building project are drawings that the architect uses to explain the design to the owner.
 - True
 - False
- The construction drawings of a building project are generally in the form of
 - freehand sketches.
 - two-dimensional plans, elevations, sections, and details.
 - three-dimensional drawings.
 - photographs of three-dimensional scale model(s).
 - all of the above.
- The construction drawings for a building project generally consist of
 - architectural drawings and structural drawings.
 - architectural drawings, structural drawings, and MEP drawings.
 - architectural drawings, structural drawings, MEP, and QSA drawings.
 - architectural drawings, structural drawings, and QSA drawings.
 - none of the above.
- The construction document set consists of
 - construction drawings.
 - construction drawings and construction schedule.
 - construction drawings, construction schedule, and owner-contractor agreement.
 - construction drawings, construction schedule, and specifications.
 - construction drawings and specifications.
- The specifications of a typical building project are prepared by the
 - architect.
 - architect in collaboration with the GC.
 - architect in collaboration with the GC and the architect's consultants.
 - architect and the architect's consultants.
 - none of the above.

1.5 CSI MASTERFORMAT AND SPECIFICATIONS

The specification document for even a modest-sized project can run into hundreds of pages. It is used not only by the contractor and the subcontractors, but also by the owner, the material suppliers, and in fact, the entire construction team. With so many different people using it, it is necessary that the specifications be organized in a standard format so that each user can go to the section of particular interest without having to wade through the entire document.

The standard organizational format for specifications, referred to as *MasterFormat*, has been developed by the Construction Specifications Institute (CSI) and is the format most commonly used in the United States and Canada. MasterFormat is divided into two groups—(i) *Procurement and Contracting Requirements* group and (ii) *Specifications* group, Figure 1.5. The Specifications group is further divided into five subgroups, and each subgroup consists of divisions. The subgroup *General Requirements* comprises one division; *Facilities Construction* subgroup has 18 divisions; and the following three subgroups have 10 divisions each.

The total number of divisions in MasterFormat is 50, which are identified using six-digit numbers. The first two digits of the numbering system (referred to as *Level 1* digits) identify the division number. The 50 division numbers are 00, 01, 02, 03, . . . , 48, and 49. A division identifies the broadest collection of related products and assemblies, such as Division 03—Concrete.

The next two digits of the numbering system (*Level 2* digits) refer to various sections within the division, and the last two digits (*Level 3* digits) refer to the subsections within a section. In other words, Level 2 and Level 3 digits classify products and assemblies into progressively closer affiliations. Thus, Level 1 digits in MasterFormat may be compared to chapter numbers in a book, Level 2 digits to section numbers of a chapter, and Level 3 digits to subsection numbers of a section.

A complete list of MasterFormat titles is voluminous. Figure 1.6 provides a bird's-eye view of MasterFormat, showing groups, subgroups, and divisions in each subgroup. It also provides additional details of one of the divisions, Division 04—Masonry—as brief illustration of the numbering system. Note that the *Procurement and Contracting Requirements* group is Division 00 and the *Specifications* group consists of Divisions 01 to 49.

Also note that MasterFormat deals with all types of construction (new buildings, renovations, and maintenance). Construction work and products, not directly related with buildings (services, urban infrastructural construction, equipment, etc.) are also included—in Divisions 30 to 49.

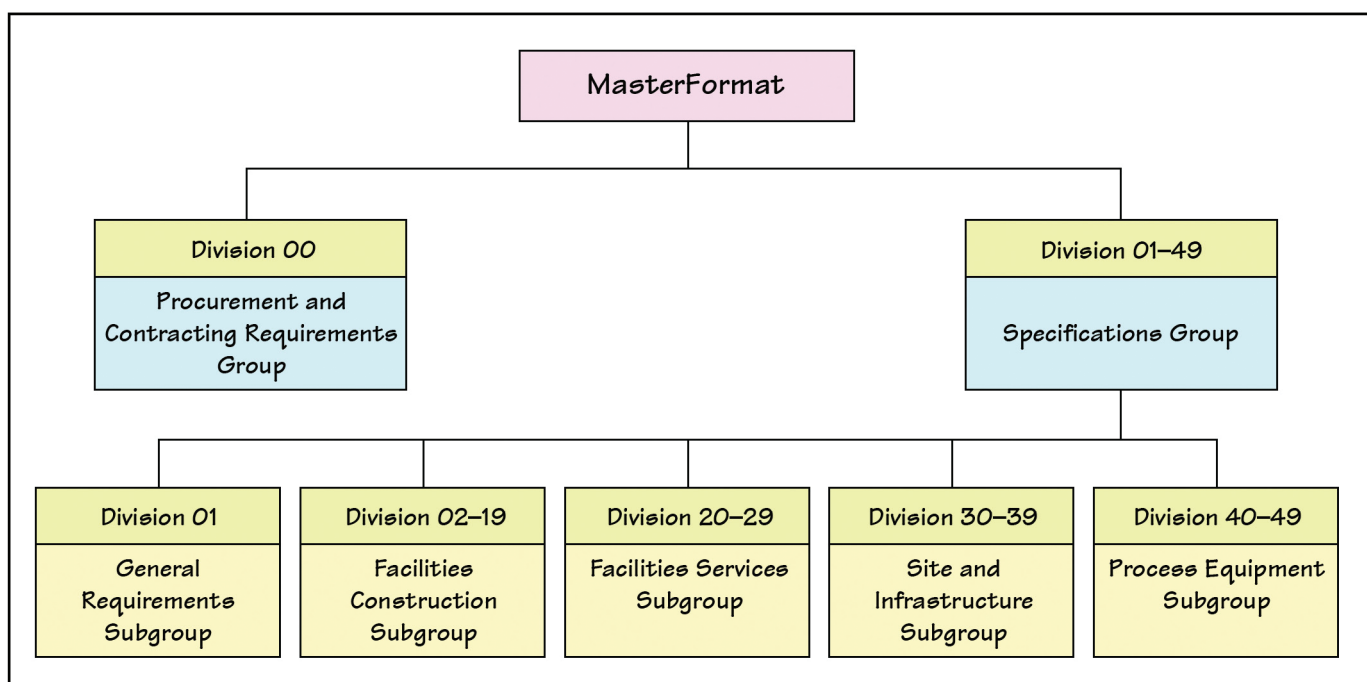


FIGURE 1.5 Structure of the MasterFormat, showing its separation into two groups—(i) Procurement and Contracting Requirements group and (ii) Specifications group. The Specifications group is further divided into five subgroups. Each subgroup is divided into a number of divisions.

50 Divisions of the MasterFormat

PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP

Division 00 Procurement and Contracting Requirements

SPECIFICATIONS GROUP

Div. 01 General Requirements

FACILITIES CONSTRUCTION SUBGROUP

Div. 02 Existing Conditions

Div. 03 Concrete

Div. 04 Masonry

Div. 05 Metals

Div. 06 Wood, Plastics, and Composites

Div. 07 Thermal and Moisture Protection

Div. 08 Openings

Div. 09 Finishes

Div. 10 Specialties

Div. 11 Equipment

Div. 12 Furnishings

Div. 13 Special Construction

Div. 14 Conveying Equipment

Div. 15 Reserved for Future Expansion

Div. 16 Reserved for Future Expansion

Div. 17 Reserved for Future Expansion

Div. 18 Reserved for Future Expansion

Div. 19 Reserved for Future Expansion

FACILITIES SERVICES SUBGROUP

Div. 20 Reserved for Future Expansion

Div. 21 Fire Suppression

Div. 22 Plumbing

Div. 23 Heating, Ventilating, and Air Conditioning

Div. 24 Reserved for Future Expansion

Div. 25 Integrated Automation

Div. 26 Electrical

Div. 27 Communications

Div. 28 Electronic Safety and Security

Div. 29 Reserved for Future Expansion

SITE AND INFRASTRUCTURE SUBGROUP

Div. 30 Reserved for Future Expansion

Div. 31 Earthwork

Div. 32 Exterior Improvements

Div. 33 Utilities

Div. 34 Transportation

Div. 35 Waterway and Marine Construction

Div. 36 Reserved for Future Expansion

Level 1 digits
Level 2 digits
Level 3 digits

04 00 00 MASONRY

04 01 00 Maintenance of Masonry

04 03 00 Conservation Treatment for Period
Masonry

04 05 00 Common Work Results for Masonry

04 06 00 Schedules for Masonry

04 08 00 Commissioning of Masonry

04 20 00 Unit Masonry

04 21 00 Clay Unit Masonry

04 22 00 Concrete Unit Masonry

04 23 00 Glass Unit Masonry

04 24 00 Adobe Unit Masonry

04 25 00 Unit Masonry Panels

04 26 00 Single-Wythe Unit Masonry

04 27 00 Multiple-Wythe Unit Masonry

04 28 00 Concrete Form Masonry Units

04 29 00 Engineered Unit Masonry

04 40 00 Stone Assemblies

04 41 00 Dry-Placed Stone

04 42 00 Exterior Stone Cladding

04 43 00 Stone Masonry

04 50 00 Refractory Masonry

Div. 37 Reserved for Future Expansion

Div. 38 Reserved for Future Expansion

Div. 39 Reserved for Future Expansion

PROCESS EQUIPMENT SUBGROUP

Div. 40 Process Interconnections

Div. 41 Material Processing and Handling
Equipment

Div. 42 Process Heating, Cooling, and Drying
Equipment

Div. 43 Process Gas and Liquid Handling,
Purification, and Storage Equipment

Div. 44 Pollution and Waste Control Equipment

Div. 45 Industry-Specific Manufacturing Equipment

Div. 46 Water and Wastewater Equipment

Div. 47 Reserved for Future Expansion

Div. 48 Electrical Power Generation

Div. 49 Reserved for Future Expansion

FIGURE 1.6 MasterFormat divisions. The first few sections (Level 2 details) of Masonry division have been highlighted in a box. Level 3 details would show further divisions of a section. For example, 04 23 13 covers the specifications of vertical glass unit masonry, 04 23 16 covers glass unit masonry floors, and 04 23 19 covers glass unit masonry skylights.

RECOLLECTING MASTERFORMAT DIVISION SEQUENCE

Architectural design typically involves Divisions 02 to 14 of the Facilities Construction subgroup. Although the basis for sequencing the Divisions in this subgroup is far more complicated, the first few divisions (that are used in virtually all buildings) may be deduced by visualizing the sequence of operations required in constructing the simple building shown in Figure 1.7. The building consists of load-bearing masonry walls, steel roof joists, and wood roof deck.

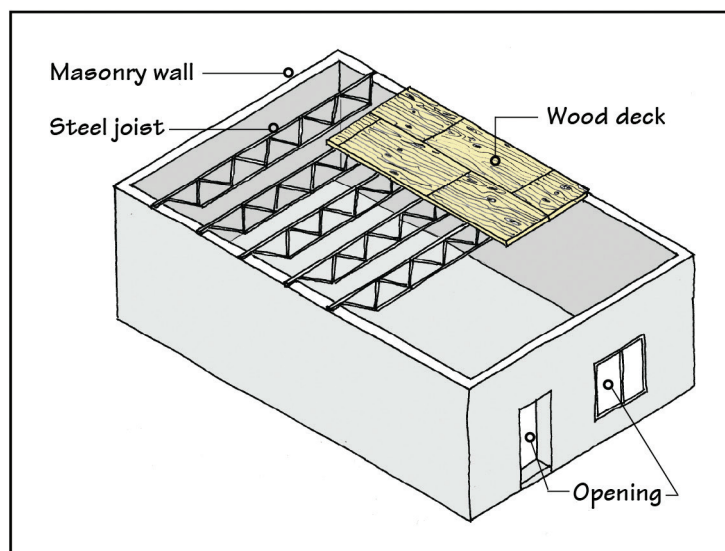


FIGURE 1.7 A simple load-bearing masonry wall building with steel roof joists and wood roof deck, used as an aid to recalling the sequence of first few divisions of the MasterFormat.

NOTE

Difference Between Specialties (Division 10) and Special Construction (Division 13)

Specialties (Division 10) includes prefabricated items such as marker boards, chalkboards, tackboards, lockers, shelves, grilles and screens, louvers and vents, flagpoles, manufactured fireplaces, and demountable partitions.

Special Construction (Division 13) includes items that are generally site fabricated but are not covered in other divisions, such as air-supported fabric structures, swimming pools, ice rinks, aquariums, planetariums, geodesic structures, and sound and vibration control.

Obviously, the first operation in constructing such a building is to excavate for foundations and lay below-ground utility lines (water supply, sewage, electrical and telecommunication lines, etc.). Because excavation deals with earthwork, MasterFormat includes it in Division 31 (Site and Infrastructure subgroup). After earthwork, the next operation is to construct foundations. Because foundations are typically made of concrete, *Concrete* is Division 03. After the foundations have been completed, masonry work for the walls can begin. Thus, *Masonry* is Division 04. After the walls are completed, steel roof joists can be placed. Thus, Division 05 is *Metals*. The installation of wood roof deck follows that of the steel joists. Hence, *Wood, Plastics, and Composites* constitute Division 06.

After the roof deck is erected, it must be insulated and protected against weather. Therefore, *Thermal and Moisture Protection* is Division 07. Roofing and waterproofing (of basements) are part of this division, as are insulating materials and joint sealants. The next step is to protect the rest of the envelope; hence, Division 08 is *Openings*. All doors and windows are part of this division, regardless of whether they are made of steel, aluminum, or wood.

With the envelope protected, finish operations, such as those involving the interior dry-wall, flooring, and ceiling, can begin. Thus, Division 09 is *Finishes*. Division 10 is *Specialties*, which consists of several items that cannot be included in the previous divisions, such as toilet partitions, lockers, storage shelving, and movable partitions.

Obviously, the building must now receive all the necessary office, kitchen, laboratory, or other equipment. Thus, Division 11 is *Equipment*. Division 12 is *Furnishings*, followed by *Special Construction* (Division 13) and *Conveying Equipment* (Division 14).

DIVISION 01 AND DIVISION 02

Before beginning with the coverage of individual materials and products, the MasterFormat covers items that apply to all of them, such as price and payment procedure, product substitution procedure, and contract modification procedure. These items are included in Division 01, titled as *General Requirements*, and illustrated in Figure 1.8. This illustration also provides items covered in Division 02—*Existing Conditions*.

Division 01 comes into effect during the construction phase, but all parties involved in the project (particularly the owner and the contractor) must know of their respective roles and obligations, detailed in this division, before signing the construction contract. By contrast Division 00, discussed in Section 1.7, comes into effect when the project is ready for soliciting bids for construction, that is, during the preconstruction phase.

MASTERFORMAT AND CONSTRUCTION-RELATED INFORMATION

Familiarity with MasterFormat is required to prepare the project manual and write the specifications for the project. It is also helpful in filing and storing construction information in an office. Material manufacturers also use MasterFormat division numbers in catalogs and publications provided to design and construction professionals. MasterFormat is also helpful when seeking information about a construction material or system, as any serious student of construction (architect, engineer, or builder) must frequently do.

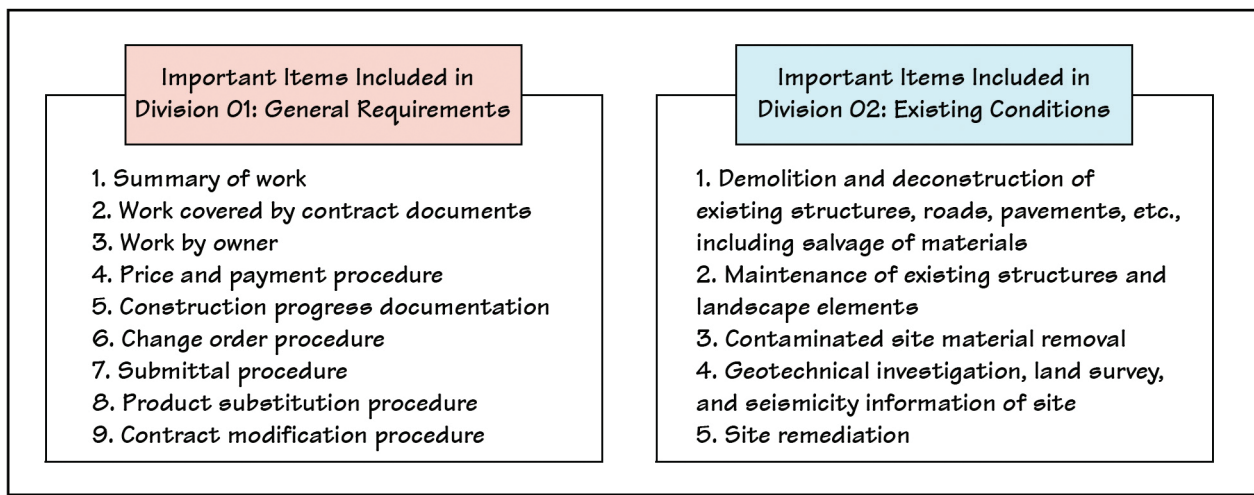


FIGURE 1.8 Important items included in MasterFormat Division 01 and Division 02.

1.6 THE CONSTRUCTION TEAM

The construction of even a small building involves so many specialized skills and trades that the work cannot normally be undertaken by a single construction firm. Instead, the work is generally done by a team consisting of the general contractor (GC) and a number of specialty subcontractors, Figure 1.9. Thus, a project may have roofing, window and curtain wall, plumbing, and heating, ventilation, and air-conditioning (HVAC) subcontractors among others, in addition to the general contractor. The general contractor's own work may be limited to certain components of the building (such as the structural components—load-bearing walls, reinforced concrete beams and columns, and roof and floor slabs), with all the remaining work subcontracted.

In contemporary projects, however, the trend is toward the general contractors not performing any actual construction work but subcontracting the work entirely to various subcontractors. Because the subcontractors are contracted by the general contractor, only the GC is responsible and liable to the owner.

In some cases, a subcontractor will, in turn, subcontract a portion of his or her work to another subcontractor, referred to as a *second-tier subcontractor*. In that case, the GC deals only with the subcontractor, not the second-tier subcontractor.

Whether the GC performs part of the construction work or subcontracts the entire work, the key function of the GC is the overall management of construction. This includes coordinating the work of all subcontractors, ensuring that the work done by them is completed in accordance with the contract documents, and ensuring the safety of all workers on the site. A GC with a good record of site safety not only demonstrates respect for the workers but also improves the profit margin by lowering the cost of construction insurance.

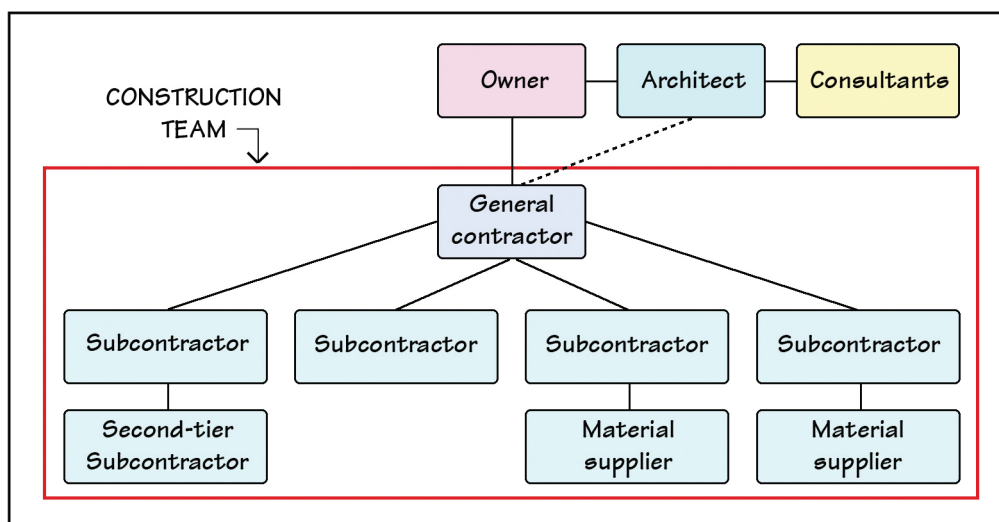


FIGURE 1.9 The construction team and their interrelationships with each other and the owner. A solid line in this illustration indicates a contractual relationship between parties. A dashed line indicates a communication link. The relationships shown here are not absolute and may change somewhat with the nature of the project.

DESIGN AND CONSTRUCTION CONTRACTS AS TWO-PARTY CONTRACTS

It is important to note at this stage that all design and construction contracts are two-party contracts, such as owner-architect contract, owner-GC contract, architect-consultant contracts, and GC-subcontractor contracts. Multiparty design or construction contracts do not exist (except in the integrated project delivery method, described in Section 1.17).

1.7 PRECONSTRUCTION PHASE: THE BIDDING DOCUMENTS

The preconstruction phase comprises two important activities: preparation of bidding documents (also called *bid package*) and the selection of the GC. The bidding documents are prepared by the architect with the help of the entire design team. They are documents that are used by the GC to bid for the construction of the project. They include (i) construction documents, which comprises construction drawings and specifications (Divisions 01 to 49) and (ii) Division 00.

Division 00, titled as *Procurement and Contracting Requirements*, contains legal and contractual information that the GC must be aware of before preparing the bids. For the ease of grasping its contents, Division 00 may be divided into four parts: (a) bid procurement requirements, (b) contract requirements, (c) contract administration, and (d) available project information, Figure 1.10.

As shown in Figure 1.10, the *bid procurement* part of Division 00 refers to items that a GC will typically not deal with after signing the contract, such as instruction to bidders, prebid meetings, and bid bond information. The *contract requirements* part contains owner-GC agreement, conditions of contract, etc. *Contract administration* includes performance and payment bond details, and requirements for certificates of substantial and final completion. *Available project information* relates to land survey, geotechnical information, geophysical information, etc. An important component of geophysical information is the degree of seismicity of the site.

The bidding documents may also contain addenda. An addendum refers to a document that is added to the original construction documents during the bidding period because of the errors or omissions observed after the bidding documents have been released to the bidders. An addendum may also become necessary in response to questions raised during a prebid meeting by the prospective bidders.

After the contract has been awarded to the successful bidder, the bidding documents (with owner's and GC's signatures on documents where needed, and blank forms in Division 00 completed) become the contract documents. The contract documents may also include modifications to owner-GC contract after the execution of the original contract. These modifications must be mutually agreed to between the owner and the GC per contract modification procedure described in Division 01. The items included in contract documents are shown in Figure 1.11, which also illustrates the differences between construction documents, bidding documents, and contract documents.

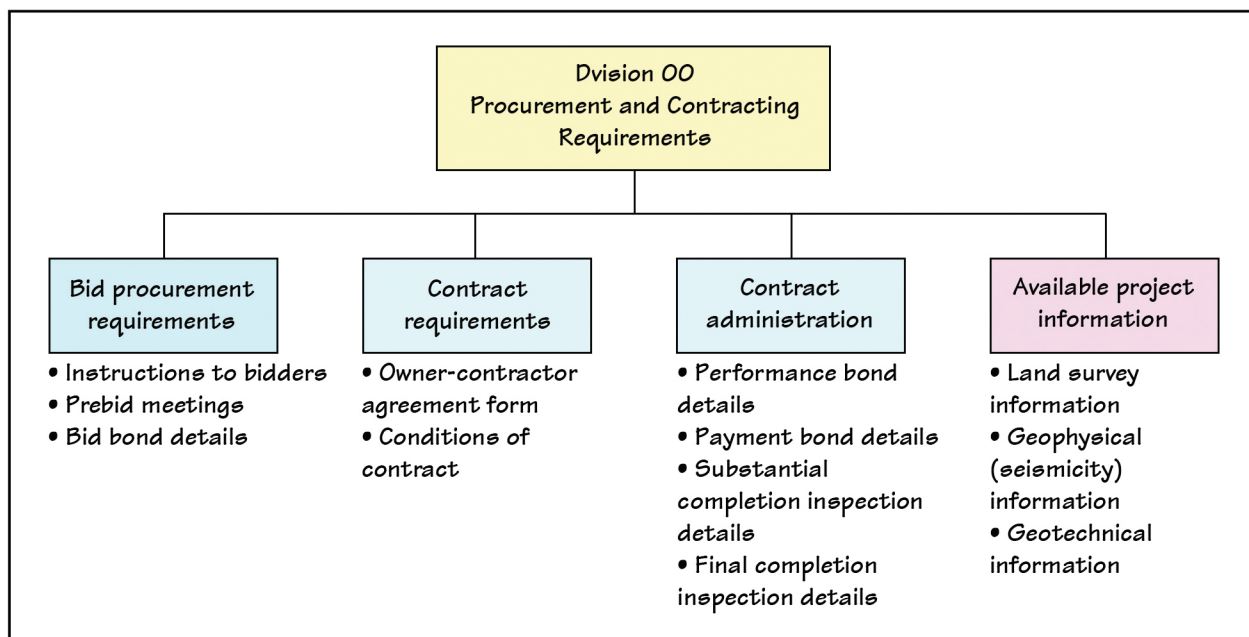


FIGURE 1.10 Important contents of MasterFormat Division 00.

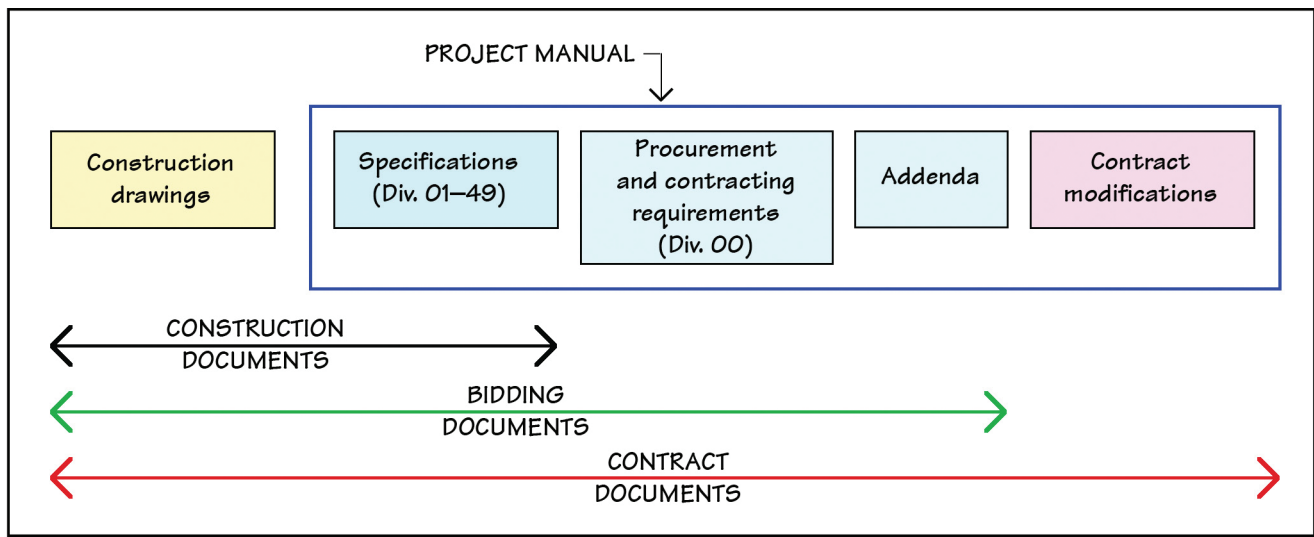


FIGURE 1.11 Differences among construction documents, bidding documents (also called “bid package”), and contract documents.

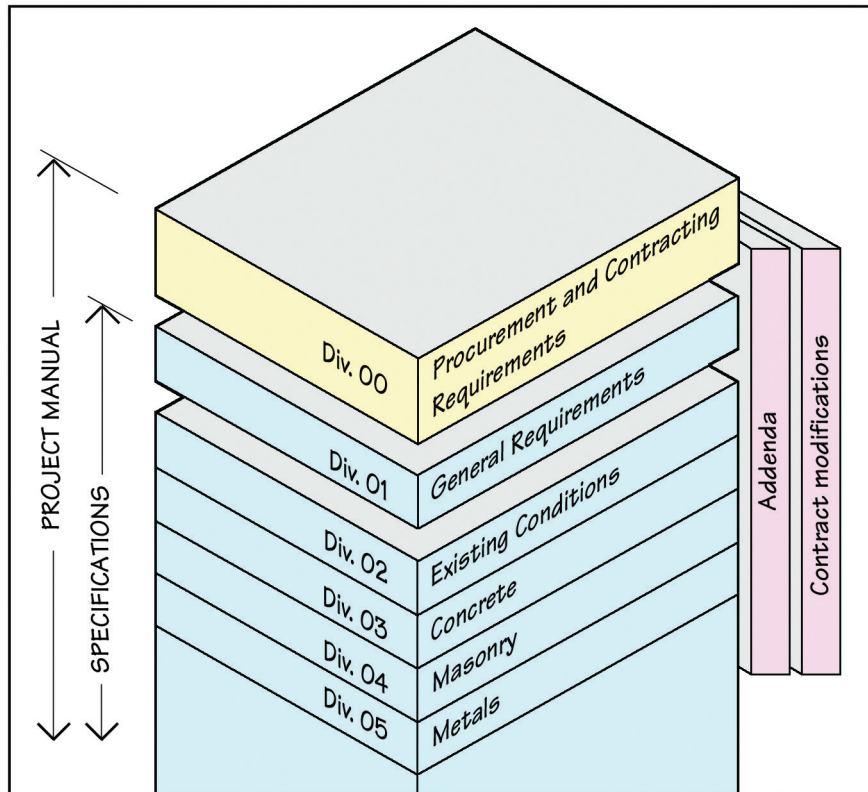


FIGURE 1.12 Contents of a typical project manual.

Although no owner would like to modify the contract, contract modifications are not uncommon. The reason, as stated in the introduction to this chapter, is that the construction of a typical building, unlike a manufactured product, is one-off entity, which may be subjected to unforeseen situations. Causes such as significant change in project scope (additive or deductive), design error or omission, nonavailability of materials due to national emergency, and extreme weather conditions may require contract modification.

PROJECT MANUAL

Project specifications (Division 01 to 49), Division 00, addenda, and contract modifications are bound together into a document called the *project manual*, Figure 1.12. In other words, the project manual comprises the contract documents minus the construction drawings.

1.8 PRECONSTRUCTION PHASE: THE SURETY BONDS

It is essential that the GCs bidding for the project are qualified by virtue of their financial resources and a successful record of contracting experience to undertake the project of the size and complexity of the owner’s project. Therefore, a reliable and just process of screening the GCs must be used, which is achieved by requiring the GCs to provide bonds to the owner.

A bond is a form of surety, which ensures that if the GC fails to fulfill contractual obligations, there will be a financially sound third party—referred to as the *surety* (also called the *guarantor* or *bonding company*)—available to take over those unfulfilled obligations of the GC. The bond is, therefore, a form of insurance that the GC buys from a surety—a bonding company.

There are three types of surety bonds in most building projects. A few others may be required in some special projects. The three types of bonds are: (i) bid bond, (ii) performance bond, and (iii) payment bond, each with a unique purpose, as described hereunder, and illustrated in Figure 1.13.

BID BOND

The purpose of the bid bond (also called the *bid security bond*) is to exclude frivolous bidders. It ensures that, if selected by the owner, the bidder (GC) will be able to enter into a contract with the owner based on the bidding requirements, and that the bidder will be able to obtain performance and payment bonds from an acceptable bonding company.

A bid bond is required at the time the GC submits the bid for the project. If the GC refuses to enter into an agreement or is unable to provide the required performance and payment bonds, the bonding company is obliged to pay a penalty (bid security amount) to the owner—usually between 5% and 10% of the project’s anticipated cost.

PERFORMANCE BOND

The performance bond is required by the owner before entering into an agreement with the successful GC. The performance bond ensures that if, after the award of the contract, the GC is unable to perform the work as required by the contract documents, the bonding company will provide sufficient funds for the completion of the project.

A performance bond protects the owner against default by the GC or by those for whose work the GC is responsible, such as the subcontractors. For that reason, the GC will generally require a performance bond from all major subcontractors.

PAYMENT BOND

A payment bond (also referred to as a *labor and materials bond*) ensures that those providing labor, services, and materials for the project—such as the subcontractors and material suppliers—will be paid by the GC. In the absence of the payment bond, the owner may be held liable to those subcontractors and material suppliers whose services and materials have been invested in the project. This liability exists even if the owner has paid the GC for the work of these subcontractors and material suppliers.

PROS AND CONS OF BONDS

The bonds are generally mandated for a publicly funded project. In a private project, the owner may waive the bonds, particularly the bid bond. This saves the owner some money because although the cost of a bond (the premium) is paid by the GC, it is in reality paid by the owner since the GC adds the cost of the bond to the bid amount.

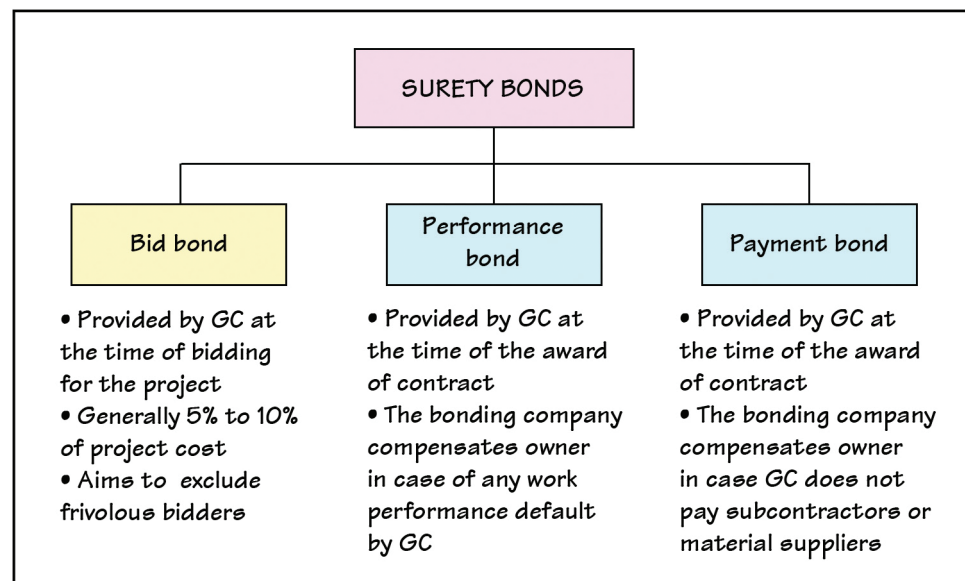


FIGURE 1.13 Details of three surety bonds used in construction projects.

Despite their cost, most owners consider the bonds (particularly the performance and payment bonds) a good value because they eliminate the financial risks of construction. The bid bond is unnecessary in an invitational bidding method where the owner knows the GC's financial standing and the ability to perform. However, where uncertainty exists, a bid bond provides an excellent prequalification screening of the GC. Responsible GCs and subcontractors generally maintain a close and continuous relationship with their bonding companies. Therefore, the bonding company's knowledge of a contractor's financial and contracting capabilities far exceeds that of most owners or architects (as the owner's representative).

1.9 PRECONSTRUCTION PHASE: SELECTING THE GENERAL CONTRACTOR AND PROJECT DELIVERY

After the bidding documents are ready, the selection of the GC is next obvious and a significant step forward. A number of selection methods exist. They differ from each other depending on:

- the basis of selection—open competition, limited competition, or negotiation with selected GCs,
- the timing of selection—stage of the project at which the selection is made—pre-design phase, design phase, or preconstruction phase,
- the GC's role during the design phase, and
- the level of coordination between the design and construction teams through all phases of the project.

These methods are called the *project delivery methods*. Some of the most commonly used project delivery methods are:

- Design-bid-build (DBB) method
- Design-negotiate-build (DNB) method
- Construction manager at risk (CMAR) method
- Design-build (DB) method
- Integrated project delivery (IPD) method

The DBB is the oldest and most familiar method of project delivery. It has stood the test of time and enjoys the largest market share. The IPD is the latest method and still evolving in details with limited amount of industry consensus. Figure 1.14 gives the current approximate market shares of various methods [Refs. 1.2, 1.3], and the table “Project Delivery Methods at a Glance”, at the end of this chapter, provides a synopsis of their pros and cons. The reader is urged to go through this table to obtain a bird's-eye view of various methods.

Regardless of the method selected, the essential features of construction and postconstruction phases are almost identical in all methods. Therefore, the activities involved in these two phases are covered first. In this coverage, we will assume that the GC has been selected and the construction has commenced. After the discussion of construction and postconstruction phases, the project delivery methods are covered in Sections 1.13 through 1.17.

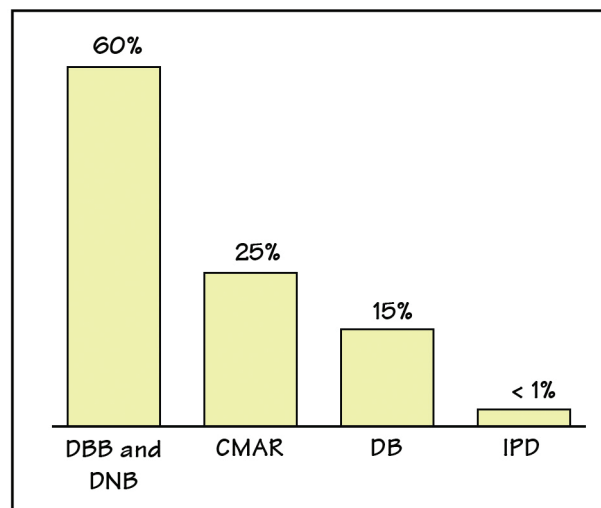


FIGURE 1.14 The current approximate market shares of various project delivery methods [Refs. 1.2, 1.3].

PRACTICE QUIZ

Each question has only one correct answer. Select the choice that best answers the question.

12. MasterFormat has been developed by the
 - a. Construction Specifications Institute.
 - b. American Society for Testing and Materials.
 - c. American National Standards Institute.
 - d. American Institute of Architects.
 - e. Associated General Contractors of America.
13. MasterFormat consists of
 - a. 20 divisions.
 - b. 30 divisions.
 - c. 40 divisions.
 - d. 50 divisions.
 - e. none of the above.
14. In MasterFormat, Division 02 refers to
 - a. Procurement and Contracting Requirements.
 - b. General Requirements.
 - c. Masonry.
 - d. Metals.
 - e. none of the above.
15. In MasterFormat, Division 04 refers to
 - a. General Requirements.
 - b. Existing Conditions.
 - c. Masonry.
 - d. Metals.
 - e. none of the above.
16. In MasterFormat, windows are part of
 - a. Division 04.
 - b. Division 05.
 - c. Division 06.
 - d. Division 07.
 - e. none of the above.
17. In MasterFormat, roofing is part of
 - a. Division 07.
 - b. Division 08.
 - c. Division 09.
 - d. Division 10.
 - e. Division 11.
18. In MasterFormat, flooring is part of
 - a. Division 05.
 - b. Division 06.
 - c. Division 07.
 - d. Division 08.
 - e. Division 09.
19. Who is responsible for ensuring the safety of workers on the construction site of a typical building project?
 - a. The architect
 - b. The structural engineer
 - c. The general contractor
 - d. Occupation Safety and Health Administration of the U.S. Government
 - e. All of the above collectively
20. The bidding documents include
 - a. construction drawings.
 - b. construction drawings and specifications.
 - c. construction drawings, specifications, and addenda.
 - d. construction drawings, specifications, addenda, and contract modifications.
 - e. none of the above.
21. A contract document set consists of
 - a. construction drawings.
 - b. construction drawings and specifications.
 - c. construction drawings, specifications, and addenda.
 - d. construction drawings, specifications, addenda, and contract modifications.
 - e. none of the above.
22. The project manual includes the project's construction drawings.
 - a. True
 - b. False
23. The surety bonds used in a typical construction contract are
 - a. bid bond, contract award bond, and completion bond.
 - b. prescreening bond, award bond, and completion bond.
 - c. bid bond, performance bond, and completion bond.
 - d. bid bond, performance bond, and payment bond.
 - e. none of the above.
24. All required surety bonds must be provided by the GCs, who are bidding for the project, along with their bids, that is, at the time of bidding.
 - a. True
 - b. False
25. The owner is required to provide payment bond to GC whose bid has been accepted
 - a. at the time of executing the owner-GC agreement.
 - b. when the owner gives the notice to GC to proceed with the work.
 - c. within one week of the GC commencing construction.
 - d. when the GC provides performance bond to the owner.
 - e. none of the above.
26. A GC would usually require performance bond from
 - a. the owner.
 - b. the architect.
 - c. the owner and the architect.
 - d. the owner, architect, and the consultants.
 - e. each major subcontractor.
27. Where the owner is sufficiently familiar and confident of the financial and contractual capabilities of the GCs bidding for the project, the owner may not require the bid bond. This reduces the total cost of construction.
 - a. True
 - b. False
28. Of the various project delivery methods described in the text, the oldest method is
 - a. integrated project delivery (IPD) method.
 - b. construction manager at risk (CMAR) method.
 - c. design-build method (DB) method.
 - d. design-negotiate-build (DNB) method.
 - e. design-bid-build (DBB) method.

1.10 CONSTRUCTION PHASE: SUBMITTALS AND CONSTRUCTION PROGRESS DOCUMENTATION

The construction phase begins after the GC has been selected, contract awarded, and “notice to proceed” has been issued. The selection of a GC is a function of the chosen project delivery method. Regardless of the chosen project delivery method, the role of GC in the construction phase remains essentially the same in all of them, and the GC must conform to the work described in the contract documents.

In preparing the contract documents, the design team's aim is to communicate the design intent effectively in order to minimize missing pieces of information. However, in almost

every project, there are a few items that cannot be described to absolute finality in contract documents. For these items, the design team makes its final decision based on the information sought from the GC. The entities from which the required information is obtained are called *submittals*. Typical submittals include material and product samples, product performance data, shop drawings, and mockups.

SHOP DRAWINGS

Shop drawings are required for components and products that must typically be made off-site (in a fabrication “workshop”). The need for shop drawings for certain items arises because the construction drawings do not describe them to a level of detail that makes their fabrication possible. Therefore, the fabricators generate their own drawings, referred to as *shop drawings*, to provide the higher level of detail necessary to fabricate and assemble the components.

Shop drawings are not generic, consisting of manufacturers’ or suppliers’ catalogs, but are exclusively prepared for the project by the manufacturer, fabricator, erector, or subcontractors. Shop drawings are a big item for structural members, such as steel columns, steel beams, and reinforcement details in reinforced concrete members. They are also required for nonstructural components. For example, an aluminum window manufacturer must produce shop drawings to show that the required windows conform with the construction drawings and the specifications. Similarly, precast concrete panels, stone cladding, and marble or granite floor coverings require shop drawings before they are fabricated and installed.

Before commencing fabrication, the subcontractors and suppliers submit the shop drawings to the GC. The GC reviews them, marks them “approved”, if appropriate, and then submits them to the architect for review and approval. Subcontractors or suppliers cannot submit shop drawings directly to the architect.

The review of all shop drawings is coordinated through the architect, even though they may actually be reviewed in detail by the appropriate consultant. Thus, the shop drawings pertaining to structural components are sent to the architect and then to the structural consultant for review and approval. The subcontractor or supplier generally begins fabrication only after receiving the architect’s review of the shop drawings.

The review of shop drawings by the architect is limited to checking that the work indicated therein conforms with the overall design intent shown in the contract documents, Figure 1.15. Approval of shop drawings that are later discovered to deviate from the contract documents

XYZ

Architects
Any City

Review is only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. Review is not conducted for the purpose of determining the accuracy or completeness of other details such as dimensions or quantities or for substantiating instructions for installation or performance of equipment or systems designed by the Contractor, all of which remain the responsibility of the Contractor. Review or acceptance of a specific item shall not indicate approval of an assembly of which the item is a component. Review neither extends nor alters any contractual obligations of the Architect or Contractor and review shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents.

<input type="checkbox"/> Accepted as Noted <input type="checkbox"/> Revise, Resubmit <input type="checkbox"/> Product Substitution, Submit in accordance with Section 01630 <input type="checkbox"/> Value Engineering, Submit in accordance with Section 01630	<input type="checkbox"/> Not Reviewed; Submittal not required by contract documents <input type="checkbox"/> Reviewed for Architectural Issues Only <input type="checkbox"/> Reviewed for Project Close Out Requirements Only
--	---

By: _____
Date: _____

FIGURE 1.15 A typical stamp used by architects to indicate the result of review of shop drawings and other submittals.

FIGURE 1.16 A typical mockup showing various finishes on the exterior facade of a building under construction. The workmanship in the finished building will be evaluated to match that of the approved mockup.

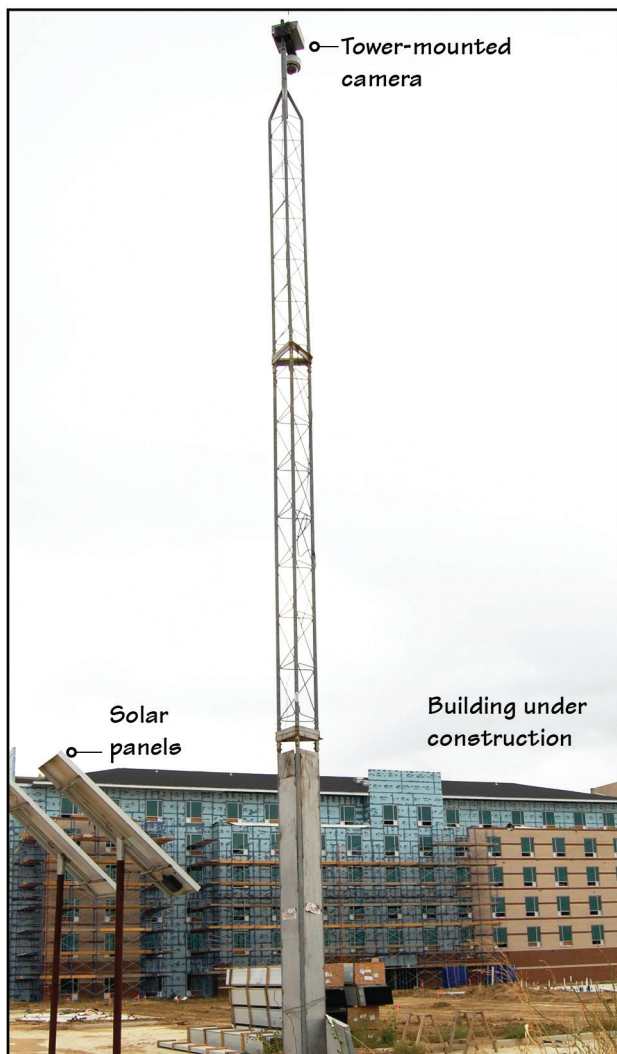


FIGURE 1.17 A tower-mounted camera takes regular photographs of the construction of the building shown. The solar panels power an array of batteries that, in turn, power the camera. The batteries are housed in a box below the panels, not visible in the photograph.

does not absolve the GC of the responsibility to comply with the contract documents for quality of materials, workmanship, or the dimensions of the fabricated components.

MOCKUPS

In addition to shop drawings, full-size mockups of one or more critical elements of the building may be required in some projects. This is done to establish the quality of materials and workmanship by which the completed work will be judged. For example, it is quite common for the architect to ask for the construction of a mockup that shows various exterior façade materials before undertaking the construction of the actual façade. Figure 1.16 shows a typical mockup of a building under construction. In some cases, the architect may require mockups of the same façade utilizing different materials, different colors, or different features to make the final design decision (see Figure 29.20).

CONSTRUCTION PROGRESS DOCUMENTATION

Keeping a complete and continuous documentation of construction is an essential part of a GC's work. Important documentation includes project correspondence, minutes of meetings, verbal conversations, weather conditions, change order logs, critical materials brought to the site, and site visits by third party (design team members, building inspection personnel from the city, OSHA staff, etc.). (OSHA is an acronym for Occupational Safety and Health Administration of the U.S. Government.)

In many contemporary projects, the owner requires the GC to install web-based cameras (webcam) on the site for a continuous, photographic documentation of construction progress, Figure 1.17. This digital imagery provides real-time (24 × 7) and remote access of construction progress to the owner and the design team, in addition to time-lapse videos if needed. Modern webcam technology provides high-resolution images that help detect breach of site safety conditions, theft of materials, and such other activities. Images of construction obtained through drones and helicopters are also common, but they do not provide continuous documentation.

The GC will normally have an inspection process to ensure that the work of all subcontractors is progressing as indicated in the contract documents and that the work meets the standards of quality and workmanship. On smaller projects, this may be done by the project superintendent. On large projects, a team of quality-assurance inspectors generally assists the contractor's project superintendent. These inspectors are individuals who, by training and experience, are specialized in their own areas of construction—for example, concrete, steel, or masonry.

Additional quality control is required by the contract through the use of independent testing laboratories. For instance, structural concrete brought to the site must be verified for strength and other properties by independent concrete-testing laboratories.

Leaving quality control of materials and performance entirely in the hands of the GC is considered inappropriate. It can render the owner vulnerable to omissions and errors in the work, and it places an additional legal burden on the GC. Therefore, the owner usually retains the services of the project architect to provide a third-party level of scrutiny to administer the construction contract. If not, the owner will retain another independent architect, engineer, or inspector to provide construction contract administration services.

ARCHITECT'S OBSERVATION OF CONSTRUCTION

The architect's role during the construction phase has evolved over the years. There was a time when architects provided regular supervision of their projects during construction, but the liability exposure resulting from the supervisory role became so adverse for the architects that they have been forced to relinquish this responsibility. Instead, the operative term for the architect's role during construction is referred to as *field observation* of the work.

The observational role still allows the architects to verify that their drawings and specifications are transformed into reality just as they had conceived. It also provides a sufficient safeguard against the errors caused by the contractors' misinterpretation of contract documents in the absence of the architects' clarification and interpretation.

The shift in the architect's role to observer of construction also recognizes the important and entirely independent role that the GC must play during construction. This recognition provides full authority to the GC to proceed with the work in the manner that the GC deems appropriate. This reinforces the earlier statements that:

- The architect determines the *what* and *where*.
- The GC determines the *how* (means and methods) and *when* (sequence) of construction.

In other words, daily supervision or superintendence of construction is the function of the GC—the most competent person to fulfill this role. The architect provides periodic observation and evaluation of the GC's work and notifies the owner if the work is not in compliance with the intent of the contract documents. This underscores the division between the responsibilities of the architect and the GC during construction.

Note that by providing observation, the architect does not certify the GC's work. Nor does the observation relieve the GC of his or her responsibilities under the contract. The GC remains fully liable for any error that has not been discovered through the architect's observation. However, the architect may be held liable for all or part of the work observed, should the architect fail to detect or provide timely notification of work not conforming with the contract documents. This omission is known as *failure to detect*.

Because many components can be covered up by other items over days or hours, the architect should visit the construction site at regular intervals, as appropriate to the progress of construction. For example, earthwork covers foundations and underground plumbing, and gypsum board covers ceiling and wall framing. Observing the work after the components are hidden defeats the purpose of observation.

On some projects, a resident project architect or engineer may be engaged by the architect, at an additional cost to the owner, to observe the work of the GC. Under the conditions of the contract, the GC is generally required to provide this person with an on-site office, water, electricity, a telephone, and other necessary facilities.

INSPECTION OF WORK

There are only two times during the construction of a project that the architect makes an exception to being an observer of construction. At these times, the architect inspects the work. These inspections are meant to verify the GC's claim that the work is: (a) substantially

NOTE

Summary of the Architect's Functions as Construction Contract Administrator

- Observe construction
- Inform the owner of the progress of work
- Guard the owner against defects and deficiencies
- Review and approve shop drawings, mockups, and other submittals
- Prepare change orders, if required
- Review correspondence between the owner and the contractor and take action if required
- Prepare certificates of payment
- Make the substantial completion inspection
- Make the final completion inspection
- Review manufacturers' and suppliers' warranties and other project closeout documentation and forward them to the owner
- Make a judicious interpretation of the contract between the owner and the contractor when needed

NOTE

Value Engineering

Value engineering (VE) is the science of obtaining balance among cost, reliability, and performance of a product or project. VE is commonly used in building projects when the project's cost begins to exceed its budget. It relates to the substitution for a product or assembly that is part of the original design with an alternative that provides acceptable performance, reliability, and aesthetics at a lower cost. Some change orders in a project may be driven by VE.

complete and (b) fully complete, and hence is ready for the final payment. These inspections, explained in Section 1.12, are referred to as:

- Substantial completion inspection
- Final completion inspection

PAYMENT CERTIFICATIONS

In addition to construction observation and inspection, there are several other duties the architect must discharge in administering the contract between the owner and the GC. These are outlined in the box "Summary of Architect's Functions as Construction Contract Administrator". Certifying (validating) the GC's periodic requests for payment against the work done and the materials stored at the construction site is perhaps the most critical of these functions.

An application for payment (typically made once a month unless stated differently in the contract) is followed by the architect's evaluation of the work and necessary documentation to verify the GC's claim. Because the architect is not involved in day-to-day supervision, the issuance of the certificate of payment by the architect does not imply acceptance of the quality or quantity of the GC's work. However, the architect has to be judicious and impartial to both the owner and the GC, and perform within the bounds of the contract.

CHANGE ORDERS

There is hardly a construction project that does not require changes after construction has begun. The contract between the owner and the GC recognizes this fact and includes provisions for the owner's right to order a change and the GC's obligation to accept the change order in return for an equitable price adjustment. Here again, the architect performs a quasi-judicial role to arrive at a suitable agreement and price between the owner and the GC.

Note that the change orders refer to minor changes in the project and are unilaterally made by the owner. Where the project requires significant modifications, the contract must be modified and the modifications are to be mutually agreed upon between the owner and the GC. Thus, a construction contract differentiates between "changes" and "modifications".

1.12 POSTCONSTRUCTION PHASE: PROJECT CLOSEOUT

Once the project is sufficiently complete, the GC will ask the architect to conduct a substantial completion inspection to confirm that the work is complete in most respects. By doing so, the GC implies that the work is complete enough for the owner to occupy the facility and start using it, even though there might be cosmetic and minor work yet to be completed.

The GC's request for substantial completion inspection by the architect should include a list of incomplete portions of the work (to be completed), referred to as the *punch list*. The punch list, which is prepared by the GC, is used by the architect as a checklist to review all work, not merely the incomplete portions of the work. If the architect's inspection discloses incomplete items not included in the GC's punch list, they are added to the list by the architect.

The substantial completion inspection is also conducted by the architect's consultants, either with the architect or separately. Incomplete items discovered by them are also added to the punch list. If the additional items are excessive, the architect may ask the GC to complete the selected items before rescheduling the substantial completion inspection.

CERTIFICATE OF OCCUPANCY AND GC'S REQUEST FOR SUBSTANTIAL COMPLETION INSPECTION

The GC is required to secure a certificate of occupancy before requesting substantial completion inspection by the architect and the design team. The certificate of occupancy is provided by the authority having municipal jurisdiction over the project—usually the city where the project is permitted and built. The certificate of occupancy confirms that all appropriate inspections and approvals, required by the authority having jurisdiction, have taken place, the project is safe to use and occupy, and that the site has been cleared of the GC's temporary facilities so that the owner can occupy the building without obligations to any authority.

SUBSTANTIAL COMPLETION—THE MOST IMPORTANT PROJECT DATE

In addition to the certificate of occupancy, the GC must submit all required guaranties and warranties from the manufacturers of equipment and materials and the specialty subcontractors and installers used in the building. For instance, the manufacturers of roofing materials,

windows, curtain walls, mechanical equipment, etc. warrant their products for specified time periods. These warranties are in addition to the standard one-year correction period between the owner and the GC.

The warranties are to be given to the architect at the time of substantial completion for review and transmission to the owner. Because the obligatory one-year correction period between the owner and the GC, as well as other extended-time warranties, begins from the date of substantial completion of the project, the substantial completion date is an important project closeout event. That is why the GC is allowed a brief time interval to complete the work fully after the successful substantial completion inspection.

A successful substantial completion inspection results in the GC receiving the certificate of substantial completion from the architect. An important part of this certificate is the date of substantial completion, which implies that the GC is no longer liable for the maintenance (cleaning and upkeep), utility costs, insurance, and security of the project. These responsibilities and liabilities are transferred to the owner.

FINAL COMPLETION INSPECTION

After the GC carries out all the corrective work identified during the substantial completion inspection and so informs the architect, the architect (with the assistance of the consultants) carries out the final inspection of the project. If the final inspection passes, certification for final payment is issued by the architect, which entitles the GC to receive the final payment from the owner.

Before the certification for final completion is executed by the architect, and finally by the owner, the owner receives the record documents, keys and key schedule, equipment manuals, and other specified necessities. Additionally, the owner receives all legal documentation to indicate that the GC will be responsible for claims made by any subcontractor, manufacturer, or other party with respect to the project.

RECORD DOCUMENTS (AS-BUILT DOCUMENTS)

As previously stated, minor design changes are often made during the construction of a project. These changes must be recorded for the benefit of the owner should the owner wish to alter or expand the building in the future. Therefore, after the building has been completed, the GC is required to provide a set of record drawings (previously known as *as-built drawings*). These drawings reflect the changes that were made during the course of construction by the GC.

In addition to record drawings, record specifications, as well as a set of approved shop drawings, are usually required to complete the record document package delivered to the owner.

1.13 PROJECT DELIVERY METHOD: DESIGN-BID-BUILD METHOD

In the design-bid-build method, the GC is selected through competition. The owner obtains multiple bids for the project from which the GC, who provides the “best value for money”, is selected. Within this overall approach, several versions are available to suit the requirements of the project and the particular needs of the owner. Collectively, these delivery versions are referred to as the *design-bid-build* (DBB) method because in this version, the design, bid, and construction phases of a project are sequential, and one phase does not begin until the previous phase has been completed, as graphically shown in Figure 1.18. Following are three commonly used versions of the DBB method of delivery.

- DBB Method—competitive sealed bidding (open bidding)
- DBB Method—competitive sealed proposal
- DBB Method—invitational bidding (closed bidding)

DBB METHOD—COMPETITIVE SEALED BIDDING

The award of a construction contract to the GC is based on open bidding process, commonly called *competitive sealed bidding*. This refers to the process by which “qualified” GCs are invited to bid on the project; the “qualification” comes from the requirement of the bid bond. The invitation can be issued through advertisements in newspapers and trade publications, but web-based construction project bidding platforms, also called *construction project procurement opportunities*, are commonly used. The GCs regularly access these Web sites to keep abreast of the opportunities.

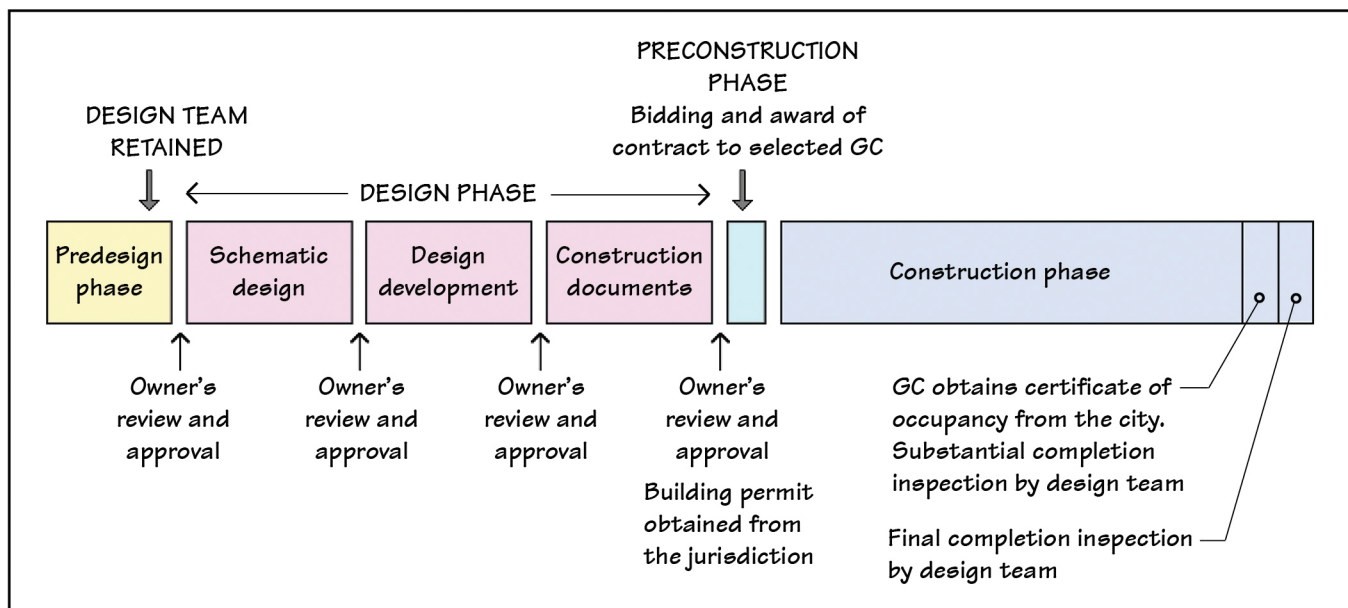


FIGURE 1.18 Sequence of operations in design-bid-build (DBB) method of project delivery. Note that design and construction phases are in sequence, and GC is selected only after the construction documents have been completed by the design team.

Because of the prequalification established through bid bond, all bidders are similarly qualified with respect to financial ability, experience, and technical expertise. Because all bidders receive the same information and are of the same standing, the competition is fair. Therefore, the contract is generally awarded to a qualified bidder with the lowest bid amount.

DBB METHOD—COMPETITIVE SEALED PROPOSAL

This method is similar to competitive sealed bidding and is commonly used for publicly funded projects. The difference between competitive sealed bidding and competitive sealed proposal methods is that the owner's selection of the GC is not based on price alone but also on other criteria such as the GC's past experience, safety record, proposed personnel, and project schedule. To ensure fairness, the advertisement and bidding documents must provide the details of the selection criteria, with relative weightings assigned to each criterion.

DBB METHOD—INVITATIONAL BIDDING

Invitational bidding, also called *closed bidding*, is another variation of the DBB method that is generally used for quasi-public and some private projects. In this method, the owner pre-selects the GCs who have demonstrated, based on their experience, resources, and financial standing, their qualifications to perform the work. The selected GCs are then invited to bid for the project, and the GC with the lowest bid is then awarded the contract. The architect (as the owner's representative) may be involved in preselection process.

ADVANTAGES OF DBB METHOD

As stated in Section 1.9 and shown in Figure 1.14, the DBB method is the most popular method. In addition to being simple and well understood because of its long history, it has following advantages: (a) there is a single point of responsibility for construction, (b) the GC is selected through aggressive and open competition, and (c) the project's scope and cost are fully defined before construction starts.

1.14 PROJECT DELIVERY METHOD: DESIGN-NEGOTIATE-BUILD METHOD

A major disadvantage of the DBB method is the absence of the GC's preconstruction (design-phase) services. A delivery method that addresses this concern uses a negotiated contract and is called the *design-negotiate-build* (DNB) project delivery method.

The DNB method is used where the owner knows of one or more reputable, competent, and trusted GCs. The owner simply negotiates with them concerning the overall contract price, time required for completion, and other important details of the project. The negotiations are generally conducted with one GC at a time, and after negotiations with all selected GCs are complete, the owner analyzes the bids, selects a GC, and awards the contract.

A major advantage of the negotiated contract is that the GC can be on board during the design (or predesign) phase. This helps the owner ensure that the architect's design is realistically constructible. In many situations, the GC may advise the architect of simpler, less expensive, or more sophisticated building systems to realize the architect's design intentions.

Additionally, because the GC is the one who is most knowledgeable about construction costs, budget estimates can be obtained at various stages during the design phase. This means that value engineering can proceed throughout the design phase instead of being undertaken at the end of this phase or during construction, as in the DBB method of project delivery.

Because the vast majority of owners have to work within a limited budget, the DNB method is fairly popular for private projects. The services offered by the GC during the design phase of a negotiated contract are referred to as the GC's *preconstruction services*.

The negotiated contract is not devoid of competition, because the GC obtains competitive bids from numerous subcontractors and material suppliers. Because the GC is selected during the SD or DD stage, the bids from some or all subcontractors can be obtained earlier, which generally shortens the project delivery time.

1.15 PROJECT DELIVERY METHOD: CONSTRUCTION MANAGEMENT-RELATED METHODS

In the delivery methods so far discussed (DBB and DNB), the role of the architect remains essentially the same: the architect designs the project, helps the owner select the GC, and provides construction administration services during the construction phase as the owner's representative. In the 1970s, in response to cost overruns and time delays caused by lack of realism in the design of several projects, owners began to seek the assistance of the contracting community during the design phase of the project. This approach became more common as project complexities grew, giving birth to an entirely new profession called *construction management*.

CONSTRUCTION MANAGER AS THE OWNER'S AGENT—(CMAA) METHOD

The project delivery method, in which a construction manager (CM) is included, is referred to as the *construction manager as agent (CMAA) method*. In this method, the owner retains a CM as the owner's agent to advise on such issues as cost, scheduling, site supervision, site safety, construction finance administration, and overall building construction.

Note that the CM is not a GC, but a manager who plays no entrepreneurial role in the project (unlike the GC, who assumes financial risks in the project). In most CMAA projects, the owner hires the CM as the first step. The CM may advise the owner in the selection of the architect and other members of the design team as well as the contracting team.

The birth of the CMAA delivery method does not mean that there is no construction management in DBB, or the negotiated contract method. It exists but it is done informally and shared by the design team and the GC.

The introduction of a CM on the project transfers various functions of the GC (in a traditional method) to the CM. Thus, in the CMAA method, the GC becomes redundant. Therefore, there is no GC in this method, and the owner awards multiple contracts to various trade and specialty contractors, whose work is coordinated by the CM. Thus, the structural framework of the building may be erected by one contractor, masonry work done by another, interior drywall work by yet another, and so on.

Each contractor is referred to as a *prime contractor*, who may have one or more subcontractors, Figure 1.19. The task of scheduling and coordinating the work of all prime contractors and ensuring site safety—undertaken by the GC in the DBB and DNB methods—is done by the CM in the CMAA method. Additionally, the CM administers the contracts between the prime contractors and the owner. Note, however, that because the CM is only an agent (employed to administer the contract on behalf of the owner), all the financial risks and other liabilities in the project are assumed by the owner.

Thus, the owner, by assuming part of the role of the GC, eliminates the GC's markup on the work of the subcontractors. The owner may also receive a reduction in the fee charged by the architect for contract administration. Although these savings are partially offset by the fee that the owner pays to the CM, there can still be substantial savings in large but technically simple projects.

The CMAA project delivery method is particularly attractive to owners who are knowledgeable about the construction process and can participate fully in all of its aspects, from bidding and bid evaluation to the closeout phase.

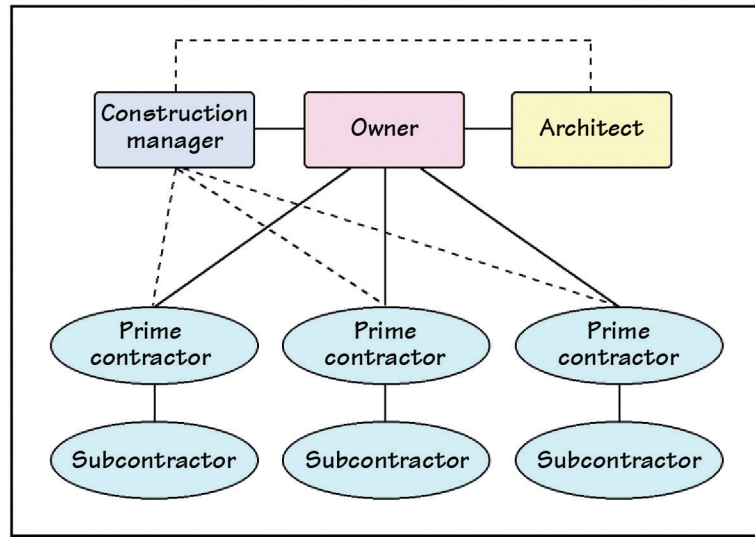


FIGURE 1.19 Contractual relationships between various parties in the CMAA method of project delivery. A solid line in this illustration indicates a contractual relationship between parties. A dashed line indicates a communication link, not a contract.

CONSTRUCTION MANAGER AT RISK (CMAR) METHOD

A disadvantage of the CMAA method lies in the liability risk that the owner assumes, which in the DBB method is held by the GC. This means that there is not the same incentive for the CM to optimize efficiency as when the CM carries financial risks.

Additionally, in the CMAA method, there is no single point of responsibility among the various prime contractors. Each prime contractor has a direct contract with the owner. Consequently, the CM has little leverage to ensure timely performance. The owner must therefore exercise care in selecting the CM because the cost, timeliness, and quality of the ultimate product are heavily dependent on the expertise of the CM.

In response to the preceding concerns, the CMAA method has evolved into what is known as the *construction manager at risk* (CMAR) method. In this method, the roles of the CM and GC are performed by one entity, but the compensation for these roles is paid separately by the owner.

In the CMAR method, the owner contracts with a CMAR company to (a) provide preconstruction services during the design phase of the project for a professional fee and (b) work as the GC of the project. Thus, the CMAR company works with the architect during the design phase to develop construction documents that will meet the owner's budget and schedule. In doing so, the CMAR company functions as the owner's representative. The relationships between the various parties in a CMAR project delivery method are shown in Figure 1.20.

After the drawings are completed, all the work is competitively bid by subcontractors and the bids are opened in the owner's presence. The work is normally awarded to subcontractors with the lowest bids. In working as the GC, the CMAR company assumes all responsibilities for subcontractors' work and site safety. The CMAR method is being increasingly used for publicly funded projects such as schools, university residence halls, and apartment buildings.

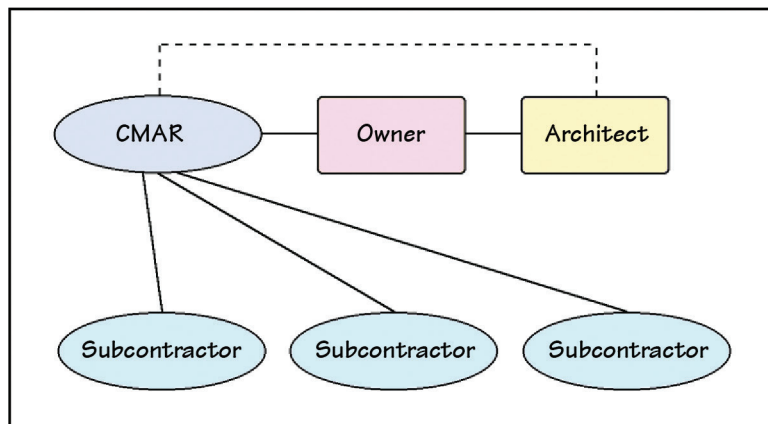


FIGURE 1.20 Contractual relationships between various parties in the CMAR method of project delivery. A solid line in this illustration indicates a contractual relationship between parties. A dashed line indicates a communication link, not a contract.

1.16 PROJECT DELIVERY METHOD: DESIGN-BUILD METHOD

A project delivery method that integrates design and construction activities into a single entity is called the *design-build (DB) method*. In this method, the owner awards the contract to one firm, which designs the project and also builds it, either on a cost-plus-profit basis or on a lump-sum basis. In many ways, this method resurrects the historic master-builder method, in which there was no separation between the architect and the contractor. The design-build firm is usually a GC, which in addition to providing construction capabilities, has a design team (of architects and engineers) within the organization, or a closely allied separate design firm.

The DB method has the advantage of integrating design and construction, thus fostering teamwork between the design team and the contracting team throughout the project. It can provide a reduction in change orders for the owner, faster project completion, and a single source of responsibility. The major disadvantage is that the owner does not receive the protection provided by the checks and balances inherent in delivery methods with separate design and construction responsibilities. Consequently, once the contract has been awarded to a DB firm, the owner loses much of the control over the project. Additionally, the architect does not represent the owner, as in other delivery methods. Therefore, for the DB method of delivery to succeed, the end result must be meticulously defined prior to the award of the contract.

The DB method has been in existence for decades in single-family residential construction. It is now being increasingly accepted in commercial construction—for both private and publicly funded projects. The establishment of the Design-Build Institute of America (DBIA) has further promoted the method.

A special version of DB method, referred to as the *turnkey method*, consists of the DB firm arranging for the land and financing for the project in addition to designing and constructing it.

1.17 INTEGRATED PROJECT DELIVERY METHOD

The integrated project delivery (IPD) method is the ultimate in promoting harmony, collaboration, and integration among all team members who contribute to the project. While the members of the triad (owner, architect-engineer team, and contracting team) are separated into three distinct entities in the DBB or CMAR method, and into two distinct entities in the DB method, they are integrated fully into one entity in the IPD method, Figure 1.21.

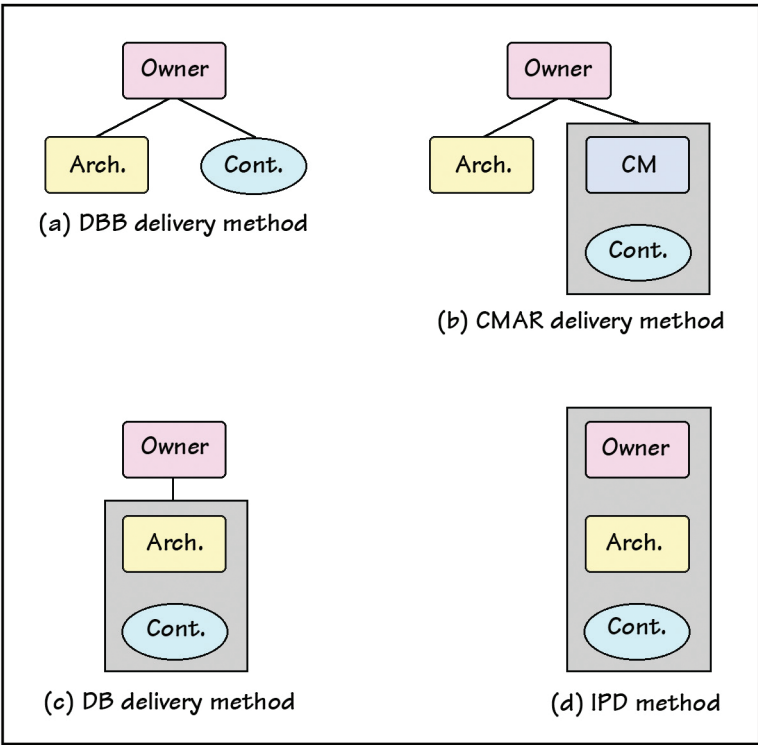


FIGURE 1.21 This illustration shows the relative integration among three major entities—owner, architect (Arch.), and contractor (Cont.)—in four major project delivery methods. Note that there is limited integration among the three entities in the DBB or CMAR method, partial integration in the DB method, and (supposedly) full integration in the IPD method. (The term *architect* implies the entire design team, which includes the architect and the architect’s consultants.)

In fact, the IPD method involves not simply the integration of the three major entities but of all those who contribute to the project (owner, architect, engineers, GC, subcontractors, fabricators, material suppliers, etc.). All participants come on board during the design phase or as soon as their expertise is needed. The entire delivery process, from inception to completion, is open across participants, with continuous sharing of knowledge.

The central underlying philosophy of IPD is across-the-board, trust-based collaboration in a zero-blame and zero-litigation environment. Differences and disputes are resolved without delay, as in any well-run organization under a single command authority comprising a group of individuals representing different interests and expertise in the project. Therefore, the project's management is shared, and so are the responsibilities, risks, and rewards.

INTEGRATED PROJECT DELIVERY (IPD) AND BUILDING INFORMATION MODELING (BIM)

IPD can be used with traditional computer-aided design (CAD) technologies for design, preparation of construction documents, and actual construction and its management, but it is best suited for use with the latest technology known as *building information modeling* (BIM). Simply explained, BIM technology produces a virtual, three-dimensional model of the proposed building so that a complete digital version of the building is completed before its actual construction begins.

The virtual model is constructed through the participation and coordination of all members of the triad representing the owner, the architect-engineer team, and the contracting team, Figure 1.22. The model is built over a period of time in the same way that a real building is constructed. That is why the process using BIM is commonly referred to as *virtual construction*.

A virtual, three-dimensional model of the building is just one important feature of BIM. Another important feature is that the model contains information about the physical and performance characteristics of various components of the model—walls, floors, roofs, openings, finishes, and so on. Therefore, the model comprises intelligent, data-rich three-dimensional objects rather than mere two-dimensional graphics (lines, rectangles, curves, etc.).

BIM AND DETECTION OF CLASHES AMONG BUILDING COMPONENTS

The virtual construction feature of BIM ensures that the clashes between various building systems or components are discovered during the design phase and can be eliminated as the model is constructed. For example, because of the two-dimensional nature of conventional drafting technology, unintended but serious errors, such as an HVAC duct passing through a floor beam or an underground utility pipe crossing a column footing, are not uncommon

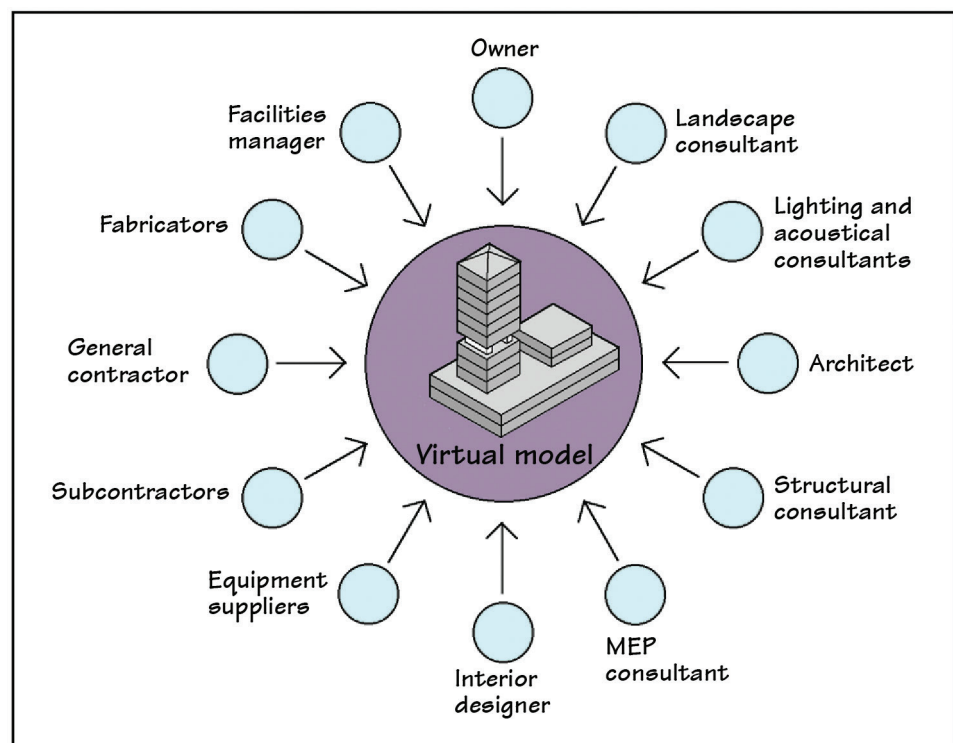


FIGURE 1.22 In an IPD method, all stakeholders in the project, such as the owner, architect, architect's consultants, general contractor, and subcontractors, contribute in constructing the virtual model.

in conventional projects. When discovered during construction, such errors result in a blame game, request for information (RFI) from the GC, change orders, increased project costs, and delayed project completion. In extreme cases, litigation is a possibility. BIM eliminates such possibilities. Figures 1.23(a) and 1.23(b) illustrate the capability of BIM for detecting clashes, such as between an HVAC duct and a column, and between a duct and two beams.

Error checking and ensuring compatibility among the works of various design and fabrication teams are revolutionizing project delivery because of BIM. Consequently, in some projects, there may be zero (or almost zero) change orders, providing substantial savings in project costs. Because the construction of the virtual model is comprehensive, the time needed to complete the sketch design (SD) and design development (DD) stages using BIM technology is greater than that using the conventional drafting technology. However, it is more than compensated by substantial reduction in the time needed for construction documentation because the model allows the extraction of two-dimensional construction documents (plans, elevations, sections, and specifications) with the press of a button, Figure 1.24.

The shift of time and effort toward design stages (SD and DD) from the documentation (CD) stage in BIM technology provides greater control over design. It also makes it easier to make design changes as compared with conventional technology because the cost of design changes during the CD stage is far greater than during SD and DD stages.

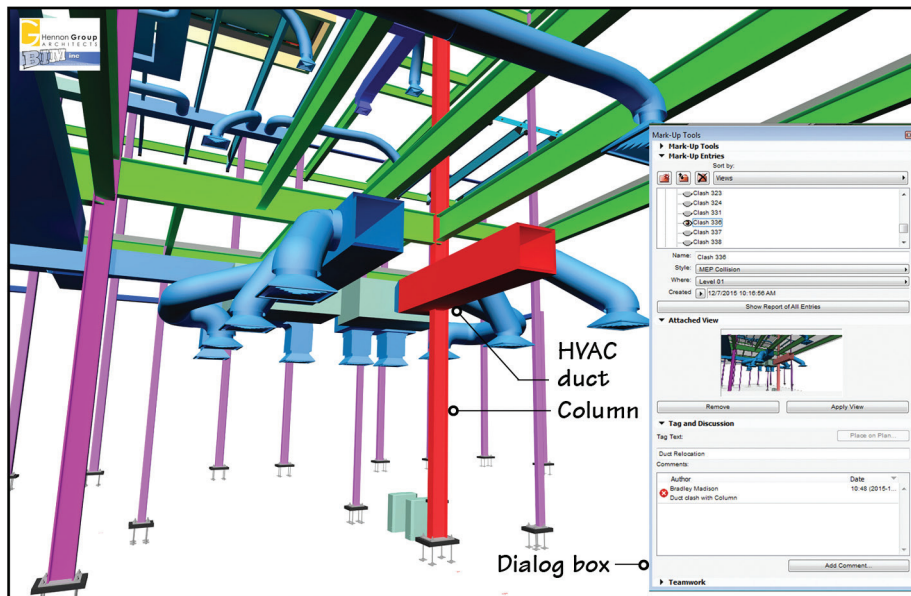


FIGURE 1.23(a) A screenshot from BIM model of a building showing the clash between a column and an HVAC duct. (Image courtesy of Hennon Group Architects and Graphisoft—the producer of ARCHICAD BIM software)

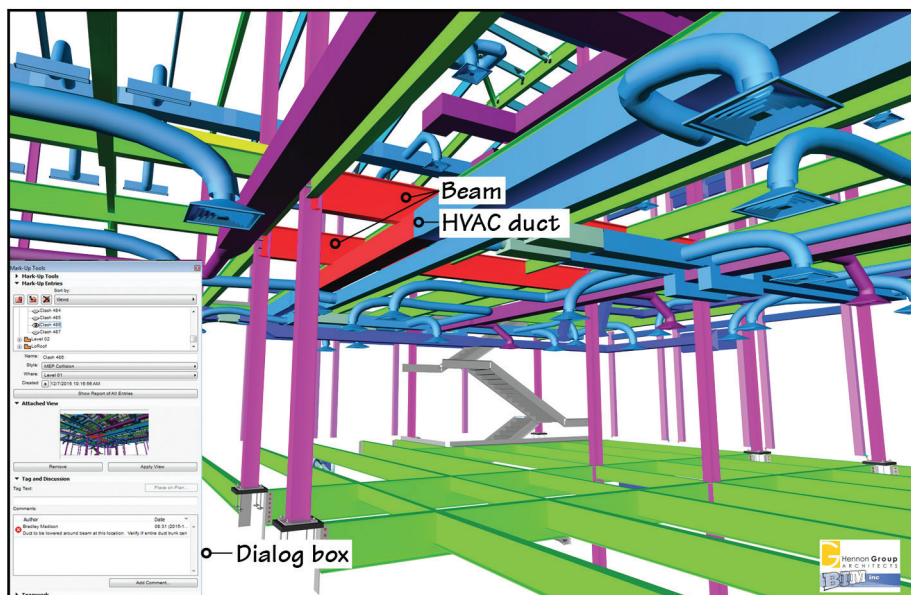


FIGURE 1.23(b) A screenshot showing the clashes between an HVAC duct and two beams. Note that the model for this image and that of Figure 1.23(a) highlights the clashing elements in red color. The dialog box in each image shows the image in miniature, the floor level where the clash occurs, and the identification mark of the clash to distinguish it from other clashes in the building. (Image courtesy of Hennon Group Architects and Graphisoft - the producer of ARCHICAD BIM software.)

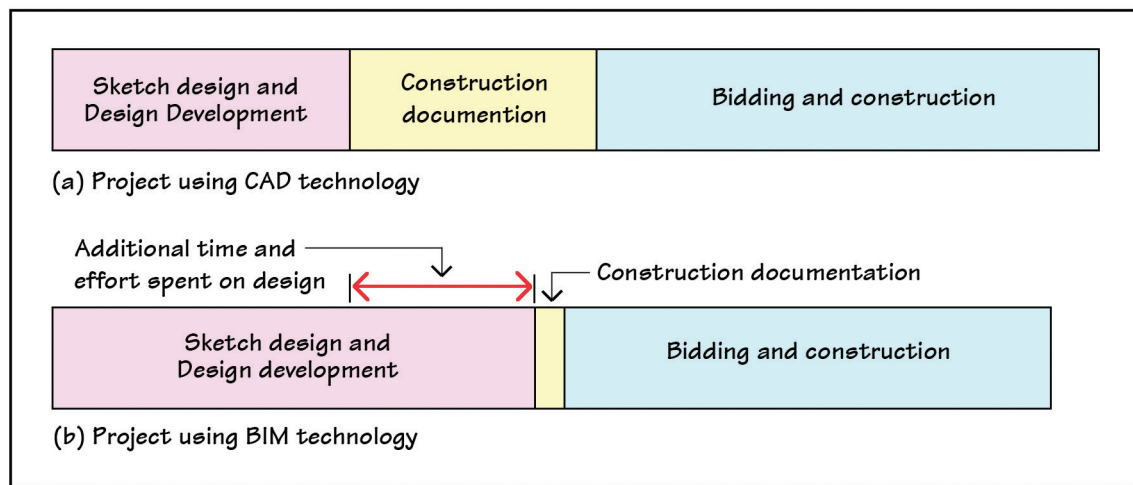


FIGURE 1.24 A comparison of the approximate overall time and effort spent in various activities in a project using CAD technology versus BIM technology.

BIM TOOLS AND INTEROPERABILITY

Various team members (shown in Figure 1.22) who contribute to the construction of the virtual model must use different software that are specific to their specialty. Thus, an architect uses architectural design BIM software to construct the model (e.g., Autodesk's Revit Architecture or Graphisoft's ArchiCAD BIM), a structural engineer uses structural analysis and design software (e.g., Autodesk's Revit Structure), and so on. These software tools are known as *BIM tools*. In order for a BIM tool to extract, process, and insert the information into the virtual model to update or modify it, it must be capable of providing seamless two-way communication with the model and other BIM tools.

The ability to exchange information between the virtual model and BIM tools is called *interoperability*. Interoperability implies that a software developed by a vendor as a BIM tool (say, a code analysis tool) is considered interoperable provided that it can be used correctly, completely, and easily with other BIM tools (such as BIM software for architectural design and for structural design).

LIFE-CYCLE NATURE OF BIM

The dynamic nature of BIM precludes the need to require record documents, as all changes made to the project during the design or construction phases are recorded in the model in real time. For the same reason, the model also serves as a maintenance tool for building users and facilities managers, providing a tool for record keeping throughout the life of the building, concerning factors such as life-cycle cost, energy use, and sustainability assessment.

Because BIM can track building performance, repairs, maintenance, and changes made to the building over its entire life, the owner's knowledge of and participation in virtual construction are critical. The same applies to architects and engineers, who will need to be more knowledgeable about building construction—how building assemblies go together—because they will be fully involved in the building's construction, albeit in the virtual environment.

BIM AND PRE-IPD DELIVERY METHODS

Although the development of BIM technology has helped the adoption of IPD, it should be noted that BIM is not limited to IPD but can be used with any project delivery method. Increasingly, a larger number of architecture and engineering firms are using BIM software with all types of delivery methods.

1.18 FAST-TRACK PROJECT SCHEDULING

A scheduling technique that can be used to save project delivery time with most project delivery methods is known as the *fast-track scheduling technique*. In this technique, the project is divided into multiple segments, and each segment of construction is awarded to different contractors through negotiations. The division of construction into segments is such that the segments are sequential. Thus, the first segment of the project may be site construction (site development, excavations, and foundations), the second segment may be structural framing (columns, beams, and floor and roof slabs), and the third segment may be the exterior enclosure, interior finishes, and project closeout that takes the project to completion.

Sequential segmenting of the project saves time because the earlier segments of the project can be constructed while the construction documents for the later segments are still in progress, resulting in overlapping design and construction processes, Figure 1.25.

Fast-track sequencing requires a great deal of coordination between segments. It also requires a commitment from the owner that the decisions will not be delayed and, once made, will not be changed.

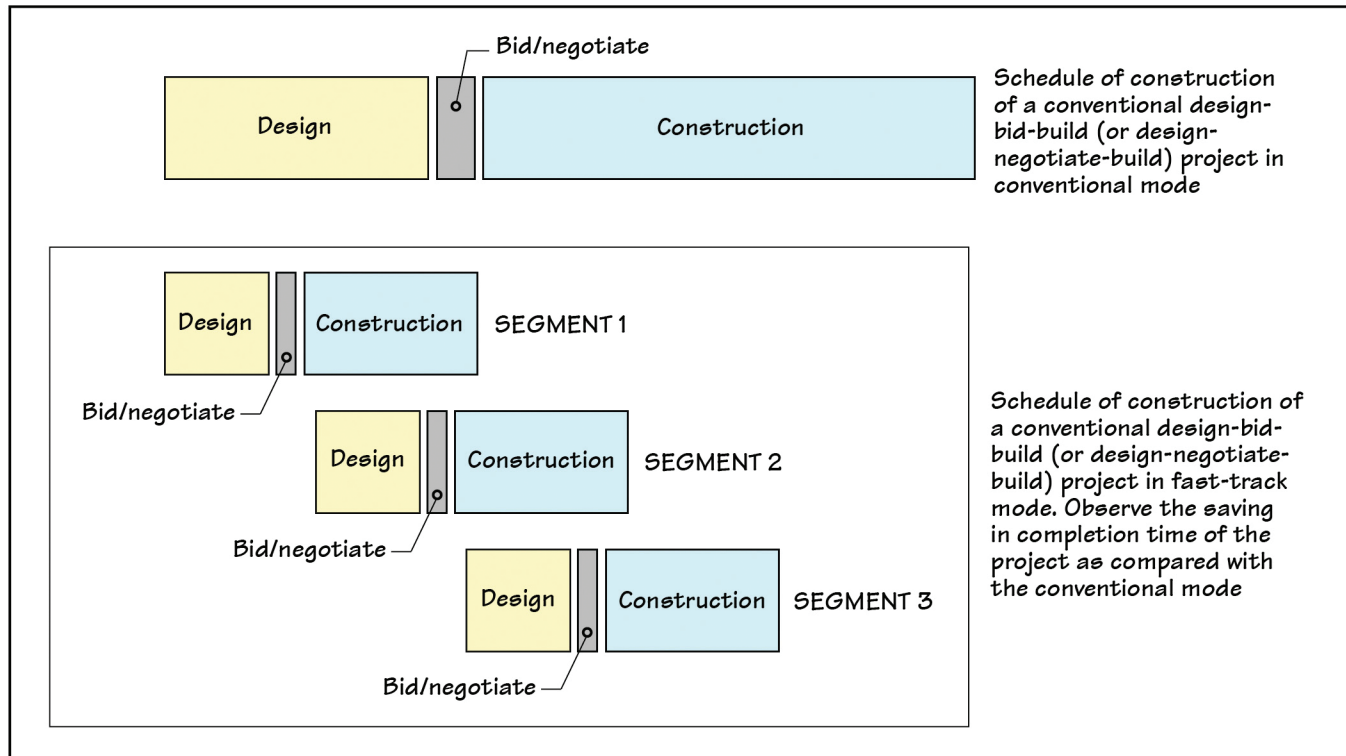


FIGURE 1.25 In fast-track scheduling, a project is segmented into parts, which overlap in time. As shown in this illustration, segmentation shortens project delivery in comparison with unsegmented scheduling. Fast-track scheduling is particularly suitable with DNB and CMAR project delivery methods because the GC is on board during the design phase.

PRACTICE QUIZ

Each question has only one correct answer. Select the choice that best answers the question.

29. The shop drawings are prepared by the
 - a. architect.
 - b. structural engineer.
 - c. MEP engineer.
 - d. all of the above.
 - e. none of the above.
30. Shop drawings are prepared during the design phase of the project.
 - a. True
 - b. False
31. The primary purpose of a mockup is to establish the quality of materials and workmanship involved in constructing important components of the building by which the completed components will be judged.
 - a. True
 - b. False
32. The day-to-day supervision of construction is the responsibility of the
 - a. architect.
 - b. architect's consultants.
 - c. GC.
 - d. collectively of all the above.
33. Who is typically responsible for obtaining the certificate of occupancy from the local jurisdiction?
 - a. Architect
 - b. Owner
 - c. GC
34. The certificate of occupancy predates substantial completion inspection of the project.
 - a. True
 - b. False
35. The certificate of substantial completion is issued by the local jurisdiction.
 - a. True
 - b. False
36. The final completion inspection of the project is conducted by the
 - a. architect.
 - b. owner with the help of the architect.
 - c. architect with the help of consultants.
 - d. building official of the city.
 - e. architect and the building official of the city.
37. The primary purpose of the contract modification procedure in the agreement between the owner and the GC is to allow change orders.
 - a. True
 - b. False
38. A record document set includes
 - a. a record of all communications between the owner and the GC.
 - b. a record of all communications among the owner, architect, and the GC.
 - c. as-built construction drawings.
 - d. as-built construction drawings, as-built specifications, as-built shop drawings, etc.
 - e. none of the above.
39. When does the owner receive manufacturers' warranties from the GC?
 - a. At substantial completion inspection
 - b. At final completion inspection

(Continued)

PRACTICE QUIZ (Continued)

- c. Within one week of the GC receiving warranties from the respective manufacturer or subcontractor
 - d. None of the above
40. In which of the following project delivery methods, the GC provides preconstruction services?
- a. DBB Method: Competitive Sealed Bidding
 - b. DBB Method: Competitive Sealed Proposal
 - c. DBB Method: Invitational Bidding
 - d. All of the above
 - e. None of the above
41. In the CMAR method of project delivery, the CM
- a. advises the owner in the selection of the architect and the design team members.
 - b. advises the design team with respect to the constructability of design decisions and their cost implications.
 - c. works as the general contractor for the project.
 - d. only (a) and (b).
 - e. only (b) and (c).
42. The project delivery method in which only one firm is contracted for both design and construction of the building is called the
- a. design-bid-build method.
 - b. design-build method.
 - c. CMAA method.
 - d. CMAR method.
 - e. IPD method.
43. The project delivery method that should ensure the least amount of litigation among parties contributing to the project is the
- a. design-bid-build method.
 - b. design-build method.
 - c. CMAA method.
 - d. CMAR method.
 - e. IPD method.
44. BIM is the most recently developed project delivery method.
- a. True
 - b. False

REVIEW QUESTIONS

1. List the phases into which the work on a building project is divided, including the three subdivisions (stages) of the design phase. Then, briefly explain what is accomplished in each stage.
2. Using a diagram, show the contractual relationships among the owner, architect, consultants, GC, and the subcontractors in a conventional (design-bid-build) building project.
3. Sketch in three dimensions the hypothetical building given in the text, which may be used to recollect the first 10 divisions of the MasterFormat. Then, list these 10 divisions.
4. List the important items contained in a project manual. At what stage are addenda and contract modifications added to the document that will finally become the project manual?
5. Using a sketch, explain the difference among construction documents, bidding documents, and contract documents.
6. Explain the difference between change orders and contract modifications.
7. Explain what is included in record documents and why they are required.
8. What are shop drawings, why are they required, and for which items? Who prepares them and do they require any approval? If so, by whom? Explain.
9. Explain the purposes of the three surety bonds used in a typical building project, and the stages at which they are provided.
10. Provide the spelled-out versions of the acronyms "CMAA" and "CMAR". Then, explain the differences between the two project delivery methods. Use sketches to illustrate the contractual relationships between various parties involved in both methods.
11. Explain the benefits of the GC's preconstruction services. In which project delivery methods are GC's preconstruction services available?
12. Explain what is integrated project delivery and how it differs from the other methods of project delivery.
13. Using a sketch, explain what fast-track scheduling is, and then, list its advantages and disadvantages.

PROJECT DELIVERY METHODS AT A GLANCE

Project Delivery Method	Description
Design-Bid-Build (DBB) Delivery (Competitive Sealed Bids)	The oldest and most familiar project delivery method. Construction work is awarded to the general contractor (GC) with the lowest bid through open aggressive bidding. There is no design-phase assistance from the GC, and hence a lack of coordination between the design and construction processes. The exact price is unknown until bidding process is complete. Commonly used for public projects.
Design-Bid-Build (DBB) Delivery (Competitive Sealed Proposals)	Same as the DBB (competitive sealed bid) method, except that the owner's selection of the GC is based not only on cost but also on several other criteria such as the project schedule, safety record, and qualifications of the GC's personnel. Commonly used for public projects.

(continued)

Project Delivery Method	Description
Design-Bid-Build (DBB) Delivery (Invitational Bidding)	Same as the above two methods, except that the competition is not open, but limited to those GCs who are preselected by the owner and invited to bid. The GC with the lowest bid is generally awarded the contract. Commonly used for private or quasi-private projects.
Design-Negotiate-Build (DNB) Delivery	Same as the DBB (invitational bidding) method, except that the competition among GCs is limited to those who are preselected by the owner. Negotiations are conducted early during the design phase with one GC at a time. The GC who provides the best value for money is awarded the contract, who also provides design-phase assistance. Commonly used for private or quasi-private projects.
Construction Manager as Agent (CMAA) Delivery	The owner hires a construction manager (CM) as his or her agent (instead of the architect), who provides design-phase assistance to the architect and also performs several functions of the GC, such as construction scheduling, coordination, and site safety. There is no GC in this method, and the work is awarded to several subcontractors (called prime contractors) under contracts with the owner. The CM is paid a fee and carries no financial risk or legal responsibility for the prime contractors' work. Commonly used for projects when the owner is experienced in contract administration.
Construction Manager at Risk (CMAR) Delivery	In this method, which has largely replaced the CMAA method, the CM performs two sequential roles. In the first role, the CM works as the owner's representative and provides design-phase assistance to the architect. For this role, the CM is paid a fee. In the second role, the CM functions as the GC after the completion of the design phase, and is compensated under a conventional owner-contractor agreement with all attendant risk and liability; hence, the CM is called CMAR. The CMAR obtains competitive bids from subcontractors, as in a DBB method. Used for both private and public projects.
Design-Build (DB) Delivery	In all previous methods, there is a lack of collaborative relationship between the design and construction teams—a lack that is addressed in this method because both design and construction work are awarded to one firm, called a design-build firm. The method generally saves time and cost to the owner, but to be successful, the owner's program must be precisely defined at the beginning of the project. Used for both private and public projects.
Integrated Project Delivery (IPD)	This method, which is still evolving, differs substantially from all other methods. It requires complete collaboration among the owner, architect, and GC in a zero-blame and zero-litigation environment. For successful integrated delivery, a virtual model of the project is constructed (using building information modeling, BIM) during the design phase with collaboration from all parties—owner, architect, consultants, GC, subcontractors, fabricators, material suppliers, so on.