Chapter 1

The Construction Industry

In This Chapter

- The economic impact of construction
- How construction was transformed from a craft to an industry
- The five primary sectors of the construction industry
- The roles of the project participants
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- The advancement of technology in construction
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The construction industry is vast and varied. Just take a look around—from homes to highways to hospitals—and you see the results of this industry. Starting with the need for shelter, we first built primitive huts and houses. Then we constructed buildings for assembly and churches in which to worship. As our needs expanded, so did our building capabilities. We eventually built political capitals, great cities bustling with business and commerce. Though the means and the methods have changed over the centuries, the construction industry is still about building communities that serve people.

Construction is big business, totaling more than $3.9 trillion annually worldwide, and there is no slowdown in sight. The industry employs about 7 million people directly (plumbers, carpenters, welders, and so on) and hundreds of thousands more indirectly. It gives rise to the steel industry, the lumber industry, the carpet industry, the furniture industry, the paint industry, the concrete industry, the paving industry, and so on. It goes even further than that if you consider the trucking, shipping, manufacturing, and mining industries. Architects, engineers, draftspeople, building inspectors, code officials, and other professionals would not have jobs if it weren't for construction. As construction projects become increasingly more complex, the challenges associated with managing these projects become more complicated. The need for qualified construction managers is tremendous, and opportunities abound for those interested in the work.

Let's take a closer look at the construction industry and the position it has in our economy and our lives.

The Scope of the Industry

Let's first make sure that you understand what construction is really all about. I have found that most people, including many who are already engaged in construction, do not understand the significance of the industry. So, let's start by considering the scope and the magnitude of construction and take a look at its impact on our society and our economy.

"It's Just Construction"

In my experience, the average observer of construction regards the process as rather insignificant and inconsequential—nothing special, nothing unique, not an industry of any major importance—mostly filled with noninfluential blue-collar macho types. After all, when compared to medicine or law or even architecture, the common notion is "it's just construction." This is why our great buildings and structures are typically identified only with the designer, and not with who built them. The contractor is incidental. Let me give you a few recent examples to drive home my point.

The distinctive architectural designs of Frank Gehry are known all over the world. One of his newest creations, the Walt Disney Concert Hall in Los Angeles, is "the most challenging of all Frank's buildings … an enormously complicated structure because of the curved shapes and intricate joinery," according to Terry Bell, project architect for Gehry Partners, LLP, as quoted on the Walt Disney Concert Hall website. The website mentions that "extraordinary state-of-the-art construction techniques" were needed for the Concert Hall—"[o]ne of the most technically advanced structures in the world, [with] its lack of right angles and the overall sculptural quality." At any one time as many as 550 construction workers were on-site to transform the concrete and steel into one of the most acoustically sophisticated concert halls in the world. However, you would be hard-pressed to find one mention of the building contractor of this magnificent construction feat in the popular press or on the Concert Hall's website. Not one single mention! This incredible construction challenge was accomplished by the M.A. Mortenson Company.

base isolators
Large shock absorbers made of alternating layers of rubber and steel attached to a building's foundation to allow movement of the structure without causing damage.

Let's consider another example. In 2002, the third-largest cathedral in the world and the first cathedral to be built in the United States in more than a quarter of a century was constructed in downtown Los Angeles. Designed by the world-renowned Spanish architect Professor Jose Rafael Moneo, the Cathedral of Our Lady of the Angels stands 11 stories tall and weighs a whopping 151 million pounds. The cathedral rests on 198 *base isolators* so that it will float up to 27 inches in any direction during an 8-point magnitude earthquake. It has been stated that the design is so geometrically complex that none of the concrete forms could vary by more than $1/16$th of an inch. Having visited the cathedral several times during its construction and been witness to the extraordinary efforts made by the construction team to ensure the quality of the design along with the requirements for the budget and schedule, I was

very disappointed, again, not to find one mention of the contractor, Morley Builders, on the cathedral's website.

Consider any of our architectural jewels: the Willis Tower (formerly known as the Sears Tower) in Chicago, the Space Needle in Seattle, the Transamerica Pyramid in San Francisco, and the Empire State Building in New York. With a little research, you would find that each of these buildings is easily identified with their designers. However, it would be a real challenge for you to discover that Morse Diesel International, Inc., was the builder of the Sears Tower, that Howard S. Wright Construction built the Space Needle, that the general contractor for the Transamerica Pyramid was Dinwiddie Construction (now Hatheway-Dinwiddie), and finally that Starrett Brothers & Eken, Inc., was the builder of the Empire State Building.

To me, not recognizing and acknowledging the contractor along with the designers of these buildings is a grave injustice—but, unfortunately, indicative of how our society views the construction industry. Apparently, to some people it is not very important. Well, let me explain why it is *very* important. Drawing a pretty picture on paper or calculating a complex engineering formula does not make a building real—construction does, and that takes tremendous creativity, ingenuity, tenacity, skill, blood, sweat, and tears. So remember, no matter how outstanding the design, it is not architecture until somebody builds it! "Just" construction? I don't think so!

Construction's Contribution

Our society does not take the contributions of the construction industry very seriously. But it should, because without these contributions, this world would be a very bleak place. When you walk out of your office, home, or classroom today, just take a good look at the world around you. I want you to notice the houses, the churches, the hospitals, the shopping malls, the theaters, the baseball stadiums, the bridges, the streets, and even the cars driving around. None of these would exist without construction. There would be no cars or any other manufactured products because there would be no manufacturing plants—no Nike shoes, no McDonald's restaurants, and no iPhones. There would be no commerce, no transportation, and no manufacturing. Progress and construction go hand in hand—we can't have one without the other. Our society, our economy, and our culture are all dependent upon the construction industry. So, the next time you hear someone complaining about construction workers stirring up dust at the intersection or delaying their trip to work in the morning, I hope that you will take the time to point out what our world would be like without construction.

NOTE

When a building is notably impressive, people ask, "Who designed that wonderful building?" But when a building design is particularly unimpressive, people ask, "Who built that eyesore?" Why aren't people as curious about who builds the great structures as they are about who designed them?

Construction Statistics

Let's put it all in perspective. Construction is one of the nation's largest industries, accounting for approximately 9 percent of the gross national product. It is larger than the automobile and steel industries put together. Housing starts (which are identified by building permits issued) are one of the major economic indicators reflecting the overall health and direction of our economy.

According to the U.S. Census Bureau, the year 2008 ended with approximately $1 trillion worth of construction (all private and public sectors) put in place for the year. The U.S. Department of Labor estimates that there are at least 880,000 construction companies employing just under 7.7 million people in the United States. Construction offers more opportunities than most other industries for individuals who want to own and run their own businesses, and statistically an additional 1.6 million individuals do just that.

Construction impacts the quality of life for every human being and plays a major role in all of society and has for a very long time. Anyone who is involved in construction—from the grading laborer to the electrician to the estimator to the construction manager to the construction company executive—needs to understand that what they do makes a *big* difference in the world.

Construction has been around a very, very long time. Construction means, methods, and motivations have changed over the past 12,000 years or so, and the trek has been absolutely fascinating. Let's continue this adventure by taking a look at some of the factors that have influenced this very significant industry.

A Historical Perspective

The purpose of spending some time on the history of the construction industry is to further reveal the impact of construction on society. As you read this brief history, imagine the creativity, ingenuity, and tenacity that these early constructors must have possessed in order to achieve such extraordinary building achievements. What started as a craft motivated by necessity (shelter from the elements) gradually turned into building science motivated by curiosity, intrigue, and genius. The building challenges of today are just as complex as in the past and are even more sophisticated, inspiring the same attributes exhibited by the early master builders. Let's take a brief walk through time and visit some of the world's greatest construction accomplishments.

Ancient Times

Although agriculture is probably recognized as the oldest industry in history, construction is most likely a close second. The construction industry can trace its roots back to at least the Stone Age, as early as 12000 BC. Using materials readily available—mud, wood, and stone—early man began constructing simple

structures for protection from the rain, cold, heat, and snow. During this same period, the development of bronze and iron allowed man to make stronger tools that significantly expanded the possibilities in building construction, allowing builders to develop their skills.

As construction skills and tool development increased, real expertise in the building trades began to emerge. Simple shelter grew into planned settlements, villages, and cities. Soon, the need for common gathering places became part of the building challenge, and this period saw the start of public building for special events, religious ceremonies, manufacturing, and commerce. Small villages became large cities, and large cities grew into great civilizations, and at the heart of it all was construction.

Egypt and the Pyramids

Many of these early civilizations were building with one of the first manufactured building materials, dried mud bricks. However, the Egyptians began to use stone as their primary building material. Although the process of moving these very large masses of rock was difficult, to say the least, the ingenuity of these ancient builders conquered these challenges, resulting in some of the most fascinating building projects in all of history—the great pyramids.

At this time, there was really no distinction between architecture, engineering, or construction. All three disciplines were embodied in one person—the master builder. The master builder concept would survive for many years, until the complexity of structures and construction techniques warranted a separation of disciplines.

It was during the building of the pyramids that the first known building code was recorded, dating back to approximately 1792–1750 BC. These written rules and responsibilities were among the laws carved into stone tablets, collectively known as the Code of Hammurabi. The building code dictated acceptable workmanship standards for the master builder. Failure to meet these standards brought stiff penalties, in some cases including death.

Greek Influence

During the pyramid-building era, the Egyptians used large numbers of unskilled workers to construct their massive undertakings. However, the Greek master builders, who were building many beautiful temples made of marble and limestone (such as the Parthenon in Athens), started to organize and utilize small groups of skilled stonemasons. This idea of congregating workmen around a particular craft represents the beginning of the building trades concept, in which a particular building skill is honed to a level of expertise associated with a master craftsman. Although much of the work was still performed by an unskilled workforce, the use of skilled artisans allowed for a finer detail and design to be applied to the architecture. This is clearly a turning point in construction history.

The Roman Empire

The Roman Empire represents one of the most influential periods of time for architecture, engineering, and building science. During the Roman Empire, significant strides were made in construction techniques. An early form of concrete, a staple in every present-day building project, was invented by the Romans. This early version consisted of a pasty, hydrated lime and pozzolan ash mixture made from rock. In addition to utilizing concrete in the foundations of their structures, the Romans began adding domes and arches to their buildings, achieving engineering and construction feats that were astounding. During this time, some of the world's most impressive structures were built, including the Colosseum and the Pantheon. The first glass was also incorporated in the first century AD and decorated many Roman structures. Road construction was another highlight of the Roman Empire, and many of these ancient pathways are still carrying travelers today.

Around 40 BC, a Roman writer, engineer, and architect named Marcus Vitruvius Pollio wrote the first design and construction handbook. His writings included topics on building materials, construction processes, building styles, road and bridge design, water-heating techniques, acoustics, and other building physics. With Vitruvius' writings, the concept of master builder or architect took on even greater distinction. The master builder was responsible for both the design and the supervision of the construction. Surprisingly, Vitruvius' work was recognized as the authority on building and design for centuries.

The Middle Ages

With the downfall of the Roman Empire came a real decline in building activity and technology. Then around 900 AD, the powerful Roman Catholic Church revitalized stone construction as it intensely pursued church and cathedral building throughout Europe. Even during this somewhat stagnant period, great building efforts were taking place. Glorious Gothic cathedrals highlighted the European landscape, and many other impressive structures were being designed and built all over the world.

Craft training and education became a major focus, and craft guilds were organized, even forming special brotherhoods around specific trades. Building construction became a major industry in and of itself. The two most important building trades were carpenters and stonemasons. Three distinct stages of ability were recognized—master, journeyman, and apprentice. These three stages of organized labor are still widely recognized today among the trade unions.

The Renaissance

Toward the end of the Middle Ages, a renewed interest in architecture, building, and science took place, continuing the transformation and evolution of construction

and building design. It was during this time that the concept of the master builder began to be questioned as the most efficient way to build. Leone Battista Alberti, considered by some to be the precursor to the modern-day architect, argued that he could create drawings and models as a way to direct master craftsmen without actually being involved in the building process. Alberti was a theoretical architect rather than a practical hands-on architect-builder. He furnished plans of his buildings but never participated in the actual construction. This was the first application of a new philosophy that would eventually separate design and construction as distinct functions. Interestingly, there is a real push today to return to the master builder concept—but with the recognition that the modern master builder is a collaborative team.

The Industrial Revolution

The Industrial Revolution had a major influence on all of society. The construction industry was no exception. As construction became recognized as separate and unique from design, more theoretical concepts involving physics, mathematics, chemistry, and thermodynamics were being applied, and building science as a discipline began to emerge. The various building professions took on increasingly defined roles—the art of architecture, the science of engineering, and the craft of building became even more distinct. As architecture moved further away from the building process, the engineering disciplines took on a greater role for overall technical coordination, while general contractors were left to assemble, organize, and manage the labor force, equipment, and materials on a project. Cast iron and wrought iron became the building materials of choice. These materials were being used to build bridges, railways, great exhibition halls, and various other buildings. New machinery and equipment such as steam shovels, steam hammers, and pile drivers were being invented to support building. The transformation of construction into a modern industry began during this period of time.

The Age of the Skyscraper

During the late 1800s, the production of steel and electricity really took center stage as factors that would influence the construction industry in a big way. It was a time of immense growth in building technology. Steel framing replaced iron framing and allowed for high-rise building. Portland cement and reinforced concrete were invented. Glass was now being mass-produced and was used to clad many of these new building frames. The dream of constructing tall buildings reaching to the sky became a reality when E.G. Otis invented the first passenger elevator. Building skyscrapers was seen as a way to conserve land as the pace of growth in American cities became a concern. Technological advancements in building science continued, electric power became commonplace in all structures, and advancements in heating and cooling systems made life easier for people in all climates of the world.

Construction started showing up as big business during this time. Although most building was still being performed by small and medium-sized companies, much larger organizations were forming, and the globalization of the construction industry had begun. Opportunities for extensive projects in housing, industry, transportation, and city development were popping up all over the world. The construction industry developed into a major economic sector.

The 20th Century

infrastructure
The basic roadways, bridges, and railroad networks that support a community or society.

specifications
The written instructions from an architect or engineer accompanying the project plans pertaining to the quality of materials and workmanship required for the project.

Although only a few advances in materials or technologies took place during the 20th century, new challenges were being imposed upon the construction industry. After World War II, there was a construction boom in the United States and around the world. The demand for housing, industry, and *infrastructure* was enormous. Time, cost, and quality became critical concerns for those needing new facilities. The construction industry responded. Mechanized tools, panelized construction, and prefabrication inspired a whole new way to view the building process. New techniques emerged to help regulate and standardize building materials and methods. Building codes, standards, and *specifications* were established to help regulate and control the quality of materials and methods. Over time, as more residential, commercial, and industrial development started to spring up, new issues such as the environment, energy conservation, sustainability, safety, and workforce diversity started to add to the complexity of the building process in a way that had never been seen before.

The industry began to recognize that the correlation between sound management techniques and successful building practices was very important to the success of a project. The ability to measure and monitor progress and economic effectiveness of the construction process became more important as projects became increasingly complex. Although the discipline of engineering had been tapped to provide the management function for years, a new distinction was being drawn.

As early as 1935, a new educational program that focused specifically on construction was popping up at a few universities across the country. These early programs eventually evolved into what is now recognized as construction management. The idea was to merge management principles, methodologies, and techniques with the art, science, and craft of building and create a unique educational experience. In addition to teaching building science, the program introduced estimating, scheduling, project controls, and project administration techniques.

In 1965, representatives from nine universities met in Florida to form the Associated Schools of Construction (ASC). This organization's distinct mission was to promote construction management as a legitimate and unique area of study at the university. The organization's goal was to establish a four-year degree program that clearly identified construction management as a recognized discipline among allied disciplines such as engineering and architecture.

Today, there are approximately 120 four-year colleges and universities listed with ASC offering construction management curricula. The programs are typically identified as construction management, construction engineering, engineering technology, building science, or construction science, and they are often affiliated with colleges or schools of engineering, architecture, or technology. The educational opportunities available today are discussed in greater detail later in this chapter; see the "Educational Offerings" section.

The Age of Technology

New technologies are impacting every aspect of our lives. The construction industry is no exception. There are computer applications across all aspects of the construction management function: programs for estimating, scheduling, project administration, building design, cost accounting, project controls, quality control, and information transfer. Computers are available on every job site, and increasingly we are seeing all kinds of field mobility software and tablet computers being applied to every aspect of the construction management process that can be used to initiate a schedule or purchase order change in an instant. But the technology doesn't stop there. Technologies such as global positioning systems (GPS), computer-aided earth-moving systems, and building information modeling (BIM) are allowing construction managers to enter and interact with buildings that exist only in cyberspace. These virtual mock-ups are real enough to evaluate things as simple as whether welders have enough room to work in a confined space and more serious issues such as the impact of a powerful hurricane on an entire facility. (You'll learn more about BIM in Chapter 13, "Building Information Modeling.")

The technological opportunities in construction methods, materials, and management are endless. In the future, we can look forward to the use of nanotechnology, metallic polymers, and micro-electromechanical systems that will allow for embedded intelligence in building materials and produce products such as interactive, "talking" doors, windows, walls, and even kitchen countertops.

NOTE

If you want to learn more about the history of construction, look for Gyula Sebestyén's *Construction: Craft to Industry* (Spon Press, 1998). It is a fascinating read and takes a very comprehensive look at the many factors that influenced the growth of the construction industry from the collapse of the Roman Empire to planning for the global frontiers of the future.

Industry Sectors

The facility needs of a society are vast and varied. People need places to live, worship, work, receive medical care, shop, be educated, exercise, vacation, and generally engage life. From a facilities standpoint, all of these needs taken together are

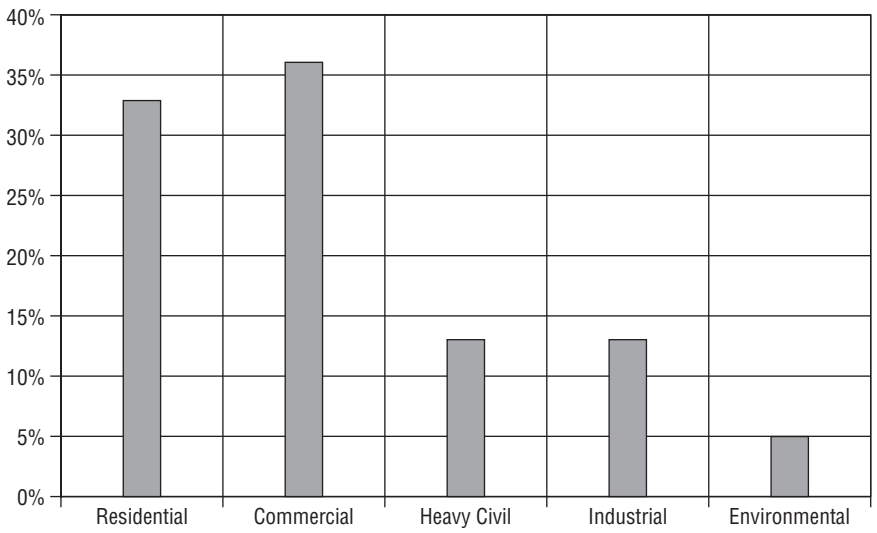
often referred to as the *built environment*. Although many other industries assist in creating the built environment, construction ultimately delivers it.

Each of these different facility needs is manifested as a different market or sector of the construction industry. There are five basic sectors of the industry:

- Residential building
- Commercial building
- Heavy civil construction
- Industrial construction
- Environmental construction

Each sector is characterized by different means, methods, and materials of construction. The types of equipment, the type of structural framework, the manufacturers, the suppliers, the specialty contractors, and even the sources of funding vary with each sector. For example, structural steel frames, steel erection, and steel fabrication are all common components of the commercial, but not residential, sector. On the other hand, wood frame structures, rough carpentry, and lumber are common components of the residential, but not commercial, sector of the industry.

Each sector requires specific expertise and familiarity in order to optimize the construction operations and management efforts. Therefore, the majority of builders focus their attention on only one sector or market of the industry. Furthermore, each sector has a particular "personality" or character. Everyone interested in pursuing a career in construction management will ultimately have to choose which sector they are most attracted to. So, let's take a closer look at each of these sectors.



Residential Building

Residential construction addresses the housing needs of a society. Housing construction takes many forms: individual homes, apartments, condominiums, townhouses, and prefabricated units such as modular and manufactured homes.

NOTE

Individual homes are classified as *single-family* dwellings. Apartments, condominiums, and townhouses are all referred to as *multi-family* dwellings.

Residential construction is typically funded by private individuals or developers for their own use or for sale. Builders of individual homes generally fall within one of three categories: they are *custom builders* constructing one-of-a-kind homes for specific customers on specific lots, they are single-family *small-volume builders* who build 25 or fewer homes a year, or they are single-family *production builders* who build more than 25 homes a year.

Although custom and small-volume builders account for approximately 70 to 80 percent of all residential builders, they produce only about 20 percent of the homes. On the other hand, production builders construct almost 80 percent of the homes in the United States.

Although some custom homes may be designed by an architect, many house plans are available from catalogs and plan books. In some cases, the contractor may provide the design for the customer. Engineering services are rarely required, and construction techniques are relatively simple. The project duration for a typical single-family home is in the three- to six-month range. Even high-end custom homes can be built in one year or less. Large production builders focus their efforts by creating communities of 50 to 400 houses in one location. These large projects will build out over several years.

NOTE

Production builders used to be called *tract builders*. Tract builders gained a reputation in the 1940s, 1950s, and 1960s for producing "cookie-cutter" homes—homes that all looked alike. Today's production builders offer numerous custom options and upgrades while still utilizing standard designs and floor plans.

Means and Methods

Residential construction is relatively low-tech in terms of the means and methods needed to produce its product. Hammers, nails, drills, and saws still make up the primary tools and equipment needed to perform the construction tasks, although the hammers are now pneumatic nailing guns. Many contractors joke that any two guys with a pickup truck, a cell phone, and a dog can start a residential construction company. This exaggeration is not far from the truth. The residential construction market is relatively easy to get into; however, because so many of

the companies are very small, they are also at high risk for failure. One bad job can put the contractor out of business in a hurry. However, the large production builders are big business, generating annual revenues and profits surpassing those of many large commercial construction companies. They are engaged in every aspect of home building, from land acquisition to financing, and are often publicly owned and traded on the stock market.

Primary Materials

Residential construction is often referred to as *wood frame construction* or *light framing*. The building materials utilized in this sector are typically wood products such as lumber and plywood. Over the past 25 to 30 years, attempts have been made to replace traditional wood framing with light gauge steel framing in an effort to conserve natural resources. The use of light gauge steel is still quite limited in residential framing; however, great strides have been made in better utilizing every piece of a harvested tree: the branches, the wood chips, and even the sawdust. Numerous engineered wood products have emerged, such as roof and floor trusses, laminated beams, oriented strand board, and wood I-beams. These products are now commonplace.

Exterior finishes for residential buildings are usually limited to siding, brick, or stucco. Single-family dwellings are most often designed with pitched roofs utilizing various types of shingles or tiles made of asphalt, clay, concrete, or slate. Interior finishes typically include drywall partitions and ceilings with paint or wall coverings and carpet, tile, hardwood, laminate, or sheet vinyl floors.

Characteristics

Whether the residential construction firm is a small mom-and-pop operation or a huge publicly owned enterprise, there are certain characteristics of this market that anyone contemplating a career in building should understand. Home building is personal. Your client is usually an individual family with individual personalities. This is probably not the sector for you if you are not a people person. Home buyers are spending their personal funds on these projects, and usually it is the single largest amount of money they have ever spent.

As a construction manager, you will be directly involved with the owner on a regular basis. You will get to experience the full range of emotions and temperaments associated with the home-buying public. There is a great deal of personal service and hand-holding that will be required of you. Many construction professionals delight in this aspect of the business, anxious to address every detail and concern that an owner might have regarding the building process, while others cringe at the thought of having to deal with someone at such an intimate level.

Residential construction companies come in all sizes. Some limit their service area to a local market, others might expand operations regionally or nationally,

and a few are even building overseas in Europe and South America. Of all the construction industry sectors, the residential sector probably requires the broadest scope of knowledge. Construction is only one facet of the home-building business. An understanding of sales, marketing, financing, land development, entitlement, building codes, purchasing, construction operations, customer service, and warranty are all needed to participate in this sector of the industry.

Commercial Building

This sector of the industry primarily addresses the needs of commerce, trade, and government and makes up about a third of the total construction market. This is the category that includes banks, schools, office buildings, hotels, shopping malls, religious facilities, baseball stadiums, theaters, universities, amusement parks, hospitals, courthouses, government buildings, and other facilities where people gather. These projects may range in size from a small medical office to large high-rise office buildings to state-of-the-art biotechnology facilities. The building costs are significantly higher than with residential construction, and the project duration is much longer. It is not uncommon for a commercial project to last three years or more.

Funding for these types of building projects may be private, public, or combined in a special private-public partnership. Commercial construction companies are usually categorized by their dollar volume per year. For example, a company that does less than $10 million per year might be classified as a small commercial contractor, whereas a large commercial contractor completes more than $250 million of work annually. Of course, everything is relative to a given market. What might be considered a large company in Nebraska could easily be classified as a small company in California.

Commercial projects are very wide-ranging in scope, and it's difficult to develop expertise in all areas. For example, hospitals and clean rooms, which have very specialized systems, require contractors who possess the special knowledge needed to successfully perform the construction. Therefore, it is not unusual for a commercial contractor to focus their attention on only a few building types.

Commercial projects are typically designed by architects. The building systems can be complex, and various specialty engineers are engaged to support the architect with the electrical, mechanical, and structural design. Additional consultants may also be brought in for unique requirements of the project. For example, a sound and acoustics engineer is a likely participant on a concert hall project but would not be called in for a retail facility. And given the interest in sustainability, a LEED consultant would be a "must-have" member on the construction team. (LEED is discussed in more detail later in the chapter; see the "Sustainability" section.)

Means and Methods

cofferdams
Temporary watertight enclosures erected to prevent water from seeping into an area, allowing construction to take place in the water-free space.

slip forms
Concrete forms that rise up the wall as construction progresses.

Commercial construction tends to be far more technically complex than residential construction. Special construction processes are utilized in the building of commercial buildings, and specially trained technicians are required. The use of concrete casting beds, *cofferdams*, and *slip forms* are common techniques in commercial construction but would seldom ever be utilized in residential construction. Although plumbers, electricians, and painters are some of the trades required in both the commercial and residential sectors, ironworkers, pipefitters, and glaziers are more likely to be exclusive to the commercial (and industrial) sectors. The equipment needs in commercial construction are much more extensive as well. Cranes are a common sight on most commercial projects, as well as pile drivers, welding machines, and concrete pumps.

As a construction manager involved in commercial building, you will be required to work with numerous specialty contractors and union workers employed in various trades. The labor management aspect of commercial construction can be complex and requires special knowledge of labor laws and collective bargaining.

Primary Materials

curtain wall
An exterior cladding system that is supported entirely by the frame of the building, rather than being self-supporting or load-bearing.

Just take a look at any downtown city area, and you will see a variety of combinations of the three basic building materials associated with commercial building: steel, concrete, and glass. These three materials compose the primary materials utilized in commercial construction. Commercial buildings consist of some type of building frame or structure and an exterior cladding to cover the frame. The cladding material is usually applied as a *curtain wall* of brick, stone, concrete, aluminum, steel, or glass or as an exterior insulation panel. In some cases, reinforced concrete masonry (RCM) is the material of choice for commercial buildings of limited height.

The frame of a commercial building is designed to withstand certain loads and conditions. Architects and engineers will determine whether a steel frame or reinforced concrete frame is best suited for the building. Glass is a common cladding material for commercial buildings, although other materials are available for this purpose. In some cases, the entire building frame and cladding are concrete. There is very little wood used in commercial buildings because of the higher fire-resistive design standards required by building codes.

Interior partitions are most often constructed of light gauge steel studs covered with drywall. Interior finishes include paint, wall coverings, carpet, tile, marble, granite, and acoustic ceilings.

Most commercial buildings have flat roofs covered with a bituminous membrane with gravel ballast or some type of a vinyl or rubber covering. Commercial buildings with sloped roofs are often covered with prefinished metal roofing.

Characteristics

project delivery
A comprehensive process by which a building, facility, or structure is designed and constructed.

Unlike the residential sector, commercial buildings are typically funded by corporations, agencies, or the government. Personal dollars are not involved, and the owners are typically not as concerned with the day-to-day operations of construction. However, they are concerned with meeting the schedule and getting their operations up and running as quickly as possible. This need for speed to market has prompted many changes in *project delivery* that will be discussed later in this book.

The primary focus in commercial building is actually the construction itself. If you are fascinated with tall buildings, towering cranes, and complex construction details, then commercial construction may be your niche. Depending on the size of the company, opportunities exist at the local, regional, national, or international levels.

Whereas residential construction requires an across-the-board understanding of the home building business, commercial construction requires a deep understanding of construction processes and techniques. Commercial contractors are rarely involved in the sales or marketing or land acquisition components of the project.

Heavy Civil Construction

This sector of the industry impacts all of society in a very big way. Often referred to as *horizontal construction*, the heavy civil sector includes roadways, bridges, tunnels, dams, airports, and railways. Basically, any work that is associated with infrastructure, transportation, and how we move about involves the heavy civil construction market. Similar to the industrial sector, heavy civil projects are complex, usually high-dollar endeavors that take special engineering know-how. This market is huge and growing larger every day. The need for building and rebuilding of our nation's roadways, airports, sewage plants, and bridges is great.

These projects are typically designed by civil engineers, and often the construction management team has a strong background in civil engineering as well. Heavy civil construction firms are generally very large operations that can offer opportunities nationally and internationally. However, the heavy civil sector of the industry is difficult to enter because of the huge capital outlay required for entry, not to mention the specialized knowledge required to be successful.

Means and Methods

Only a few trades are engaged in heavy civil construction compared to the other three sectors. There is no need for carpet layers or drywall finishers in this sector of the market. On the other hand, equipment and equipment operators play a huge role in the work of a heavy civil project. Heavy civil contractors make huge investments in equipment. Keeping the earth movers, excavators, scrappers, and trucks rolling is the name of the game for this sector of the industry.

Primary Materials

Asphalt, gravel, concrete, steel, and dirt make up the primary materials used in heavy civil construction. Most of us have witnessed highway road crews as they lay down new asphalt on our highways and streets. We watch as they bring in loads of gravel and rock dust before they place the hot asphalt and roll out the roadway.

Other heavy civil projects such as bridges and dams make use of large amounts of concrete and steel. For example, a dam project may require that a concrete-batching plant be constructed right on the building site in order to accommodate the quantities of concrete needed.

Characteristics

These projects are usually publicly funded and tend to last for a long time. Building miles of roads can take many years. It is not unusual for individuals involved in this sector of the market to move temporarily to where the project is located. There are also occasions when your work might require that you be located in isolated areas for long stretches of time. However, anyone intrigued by big machines, tractors, and excavators will be attracted to this sector. This sector of the market is the least affected by economic fluctuations and, therefore, can offer a reasonable measure of job stability.

Industrial Construction

This sector of the industry is highly specialized and requires firms with vast resources and significant construction and engineering expertise. The number of contractors qualified to work within the industrial sector is limited. The project types included in this category are defined primarily by the production activities that occur within the facility. Manufacturing plants, electrical generating facilities, oil refineries, pipelines, steel mills, and chemical processing plants are all examples of industrial construction projects.

Means and Methods

Industrial buildings are often very basic in their exterior design. The building shell does not need to be very fancy for its intended purpose. The success of an industrial project is usually determined by how well the facility is able to perform relative to its production goals. In industrial construction, the processes that go on inside the shell constitute the real construction challenge. Unlike residential or commercial construction, the installation of equipment makes up a big piece of the industrial construction process. Massive boilers, reactors, and processors that need to be installed under strict quality standards and regulatory guidelines are what really count here.

Because of the complex process considerations, engineers are typically the lead designers on these types of projects. The means and methods associated with the construction of the building shell are quite simplistic; however, the installation of the equipment and process systems require technological savvy, sophisticated knowledge, and great attention to detail.

Primary Materials

The building materials utilized in industrial construction are very similar to those used in commercial construction. Steel, concrete, and reinforced concrete masonry make up the primary components. These buildings often house specialized equipment, machinery, or process piping, and the interior finishes are usually quite stark for ease of maintenance. Often the concrete or block walls are simply painted, concrete floors are left unfinished, and no ceiling finish is applied, thus leaving exposed piping and ductwork in full view. In some cases, special materials, such as glass piping or heat-sensitive tiles, may be utilized in the construction of industrial buildings.

Characteristics

This sector of the industry deals with building huge facilities that take many years to complete. In some cases, a project may be under construction for as long as 5 to 10 years, and the possibility of the construction management team having to relocate is quite high. The funding for these projects is usually provided by private sources, and the contract amounts are generally large. There are many international opportunities in industrial construction, and anyone seeking a chance to travel abroad will most likely find it within this sector. Having an interest in international business, international law, or even world politics could be an asset for anyone considering this sector. And, of course, fluency in a foreign language is always a plus.

Sometimes industrial projects are located in remote areas, even to the point where modern conveniences are in short supply. Depending on the facility type, there may be requirements for high security clearance and government oversight. It is very important that the engineers and construction managers on these projects work closely together because the consequences of poor communication can be serious.

Environmental Construction

Although some people may lump environmental construction under the heavy civil category, it is unique enough to have its own classification, especially considering the increase in market share that this sector is currently experiencing and probably will for some time to come. Generally, this sector of the industry is comprised of

projects that improve the environment, maintain public health, and contribute to a community's quality of life. Think clean water, sanitary sewers, and waste management. And although these projects may not seem very glamorous at first glance, in reality they represent one of the most vital sectors of the industry and one that demands a significant investment in order to sustain our communities.

brownfield sites
A property that is abandoned or underused because of historic environmental contamination.

In the United States, we don't give much thought to what happens to the water that we release down the drain after taking a bath or what happens once we flush a toilet. Most people don't even consider where our drinking water comes from, especially with many of us buying a bottle from the local convenience store. And then there's what happens to the plastic bottle that the water we purchased came in. But the fact is that each one of these daily occurrences is directly tied to the environmental construction sector. This sector builds the conveyance systems, treatment plants, and operations facilities necessary to collect, treat, reclaim, and distribute water. It works to build desalination plants, clean up hazardous sites, and handle other ecological endeavors such as managing and restoring watersheds and wetlands. It is also the sector of the industry that deals with landfill remediation and the redevelopment of the *brownfield sites* left behind. Often these sites become golf courses, parks, or other recreational areas, and the contractors who mitigated the hazards are often the same contractors who get to complete the restoration work as well. Quite rewarding work, wouldn't you say? If you are one of those individuals who is particularly interested in improving the environment and sustaining the planet, then environmental construction may be the perfect opportunity for you to get your feet wet—literally!

Means and Methods

There is a great deal of earth moving and site work that usually takes place with any environmental project along with trenching and pipe laying, asphalt removal and installation, tunneling, blasting, and other means of excavation. However, many environmental projects still require a building or structure to house the specialized instrumentation, monitoring equipment, incinerators, and process piping to operate the system. Therefore, the same means and methods associated with typical industrial or commercial construction also come into play in this sector. These facilities still need foundations, exterior cladding, windows, doors, roofing, and finishes, as well as mechanical and electrical systems. These support buildings may not be as fancy as a bank or a museum, but they still need to provide a proper work environment for the people who operate the facilities.

Primary Materials

Environmental projects are often comprised of a combination of commercial, industrial, and heavy civil building materials. However, in addition to dirt, gravel, asphalt, concrete, rebar, steel, and piping, we also need specialized materials such as pumps, valves, filters, membranes, and aerators, just to name a few. Special

electronic equipment and controls are also part of the mix on these projects, and a vital one at that. Because the facility isn't really of much use unless it can operate and perform as designed, these elements become a critical part of the equation. The construction manager, who often has an engineering background, must be familiar with these items and their operation so they can manage their procurement, delivery, installation, and sometimes even performance after installation.

Characteristics

Because construction managers are often involved with public health issues in environmental construction, you can expect to spend a significant amount of your time dealing with governmental and regulatory agencies such as the Environmental Protection Agency (EPA) and the Center for Disease Control (CDC), not to mention the myriad of state and local authorities. For this reason, individuals involved in this sector of the industry not only need to be familiar with construction means, methods, and management but also need to be familiar with the law, particularly those laws and regulations dealing with public health and the environment. As a matter of fact, many construction management graduates who go on to work in the environmental sector often get graduate degrees in environmental engineering or environmental law.

NOTE

I once asked the president of an international environmental construction firm why he left the commercial building side of the industry to dedicate his life to building water systems and sewage treatment plants. He told me he got bored with commercial construction. He admitted that it may seem "sexier" to build high-rises, but in reality, when you spend your day building facilities that ensure a clean and fresh water supply, safe and sanitary wastewater treatment, and a healthy environment for communities, then you go home at night knowing you made a difference, whether anyone notices or not.

Furthermore, you will find yourself working with individuals beyond the usual group of construction colleagues. In environmental construction it is not unusual to be collaborating with chemists, biologists, ecologists, and other scientists who deal with the actual quality of the water, soil, and other materials that flow through or interact with the systems that you build. As you can see, there are many opportunities to expand your knowledge and learning beyond construction in this sector of the industry.

Similar to the heavy civil industry, environmental construction projects are usually not a luxury item—they are necessities. And given the current state of our existing municipal water and waste water systems in the United States (most are more than 50 years old—the life expectancy of a typical system) and the fact that most projects are publicly funded, we will see a great deal of work in this area and, therefore, the need for construction managers who have a propensity toward projects that support the environment.

The Project Players

As our brief walk through construction history revealed earlier, the days of the individual master builder are long gone. No longer is it practical to expect one person to design, engineer, and build construction projects. Today's master builder is a collaborative team with diverse skills and expertise. Many, many players are involved, and they all make a valuable contribution to the effort while at the same time adding to the complexity of the process. It is very important to understand the various roles and responsibilities of these many players as they influence the construction management process.

In addition to getting to know the primary players in the game, you need to know the secondary players involved and the various layers of influence and risks associated with their involvement. Understanding the intricacy of these relationships will help you appreciate the management function in construction.

Primary Players

The three principal players in any construction project are the owner, the designers (architects and engineers), and the contractor. Although these three parties are always involved in a project, the alignment and contractual relationships among them will vary depending upon the project delivery system utilized to deliver the project. Project delivery will be discussed in Chapter 2, "What Is Construction Management?" Each of these parties provides distinct services and has specific accountabilities necessary to fulfill the building objectives.

Owners

program
A written statement that identifies and describes an owner or end user's needs and requirements for a facility. Every design starts with a program.

No construction would ever be accomplished without owners. They are the driving force behind the construction industry. Their demands for housing, commercial facilities, industrial products, and infrastructure are the chief motivation to build. After determining need and deciding to build, the owner is accountable for four primary duties:

- Developing the *program* and outlining the needs and requirements of the end users
- Determining the quantity, extent, and character of the project by defining the scope of work
- Creating the overall budget for the project, including land acquisition (if necessary), development, design, and construction costs
- Providing the funding for the project and making periodic payments to the designers and the contractor

How an owner accomplishes these tasks is often determined by what type of owner they are. There are basically two types of owners—public owners and private owners. Public owners are typically government agencies such as the General Services Administration, the Army Corps of Engineers, or the state departments of transportation. These agencies represent the public and spend tax dollars to build courthouses, military bases, and federal highways. Private owners make up the bulk of construction spending and may take the form of an individual building a single home, a developer who builds speculatively, a small manufacturer enlarging operations, or a national firm that owns numerous facilities. Funding comes from private sources such as banks, investment brokers, and venture capitalists.

Design Professionals

Two types of professional designers are engaged in the construction process, and each deals with different parts of the project design. Architects deal with the function, life safety issues, and aesthetics of the building, and engineers deal with the systems. They typically work together to complete the design function with one or the other taking the lead, depending on the type of facility being constructed.

I will use the term *designer* throughout the text to imply either an architect or an engineer.

NOTE

The construction manager works with both the architect and the engineer on a regular basis throughout the construction process. The following are the primary responsibilities of the designers:

- Assisting the owner in developing the facility program and determining end user needs and requirements
- Advising the owner regarding the image and character of the facility and establishing broad design goals
- Assisting the owner in selecting products to fit the program and the budget
- Advising the owner on special and aesthetic issues and generating graphic solutions to problems
- Developing the final building plans, construction details, and specifications

To better understand the distinctions between architectural design and engineering design, consider the human body. Just as a body has a particular functional design with arms, legs, and a head, as well as skin and hair to protect it from the elements, so does a building with various rooms, porches, stairs, an exterior cladding of brick or siding, and shingles or asphalt on the roof to keep it dry. The body has a

skeletal system to keep it straight and upright, and a building has a structural frame to keep it straight and upright. The body has a circulation system to move blood and nutrients. A building has a plumbing and mechanical system to move water, waste, heat, and air conditioning. The body has a central nervous system to send energy to our legs and arms. A building has an electrical and communications system to send messages and deliver power to our offices and living spaces. Basically, architects deal with the arms, legs, hair, and skin, and engineers deal with the bones, blood, and nerves.

Architects

Architects are licensed professionals trained in the art and science of building design. They transform the owner's program into concepts and then develop the concepts into building images and plans that can be constructed by others. In addition to completing a four- or five-year college program, architects are also required to have a number of years of experience and pass an exam before they can become licensed.

Architects design the overall aesthetic and functional look of buildings and other structures. The design of a building involves far more than its appearance. Buildings also must be functional, safe, and economical, and they must suit the needs of the people who use them. Architects also specify the building materials and, in some cases, the interior furnishings. In developing designs, architects follow building codes, zoning laws, fire regulations, and other ordinances, such as those requiring easy access by people who are disabled. Several specific roles within the typical architect's office support the architectural design function:

Design architects Design architects are the creators of the aesthetic solution—they are the concept and idea people. Although most design architects can only hope to achieve celebrity status, some become quite famous. As previously mentioned, we often recognize their names in association with their creations—Frank Lloyd Wright, Aalvar Alto, I.M. Pei, Julia Morgan, and Frank O. Gehry, to name a few. They are sometimes referred to as *signature architects*. Owners often seek them out because of their reputations. They are typically the senior associates or principal partners within the architectural firm. Their function first and foremost is to come up with the creative expression. They convey their ideas to their design staffs through sketches and schematic renderings. They do not typically engage in the actual production of the construction drawings. They are supported by architectural technicians and specification writers in the preparation of the final construction documents.

Architectural technicians Architectural technicians are typically the drafters of the building plans. They are the ones who actually produce the drawings that are used for construction. They work from preliminary sketches and concept drawings provided by the design architects. However, the days of

sitting at a drawing board with a mechanical pencil in hand using a T square and a triangle are all but gone. Today drafters have become computer operators and produce their drawings electronically using computer-aided design (CAD) software. Some CAD operators have expanded their skills to include 3D building information modeling (BIM) as well. As the trend toward information modeling continues, these technicians will become more and more valuable in the marketplace.

Specification writers Accompanying the plans for a new building is a written project manual that contains the specifications for the project. The plans and specifications compose two parts of the legal contract for construction. (A third component is the contract forms themselves.) The specification writer is responsible for spelling out the specific products and methods that are to be used on a project in order to ensure a particular level of performance and quality.

Engineers

Engineers are usually the lead designers for heavy civil and industrial projects. Engineers are regulated by professional licensing requirements that include a four- or five-year college program, a specific number of years of experience, and the passing of a professional licensing exam. However, in building design, they are most often hired as consultants by the architects. In this scenario, they have no direct contact with the owner.

There are many different engineering specialties; the most common ones associated with construction activities are described next:

Structural engineers Structural engineers design the timber, concrete, or steel structural systems that support a building and basically hold it up to withstand the forces of wind, gravity, and seismic activity. They design the foundations, beams, girders, and columns that make up the skeleton of the structure.

Mechanical engineers Mechanical engineers design the heating, cooling, ventilating, plumbing, and fire suppression systems within a building. They coordinate their efforts with the architectural design, the structural design, and the electrical design.

Electrical engineers Electrical engineers design and calculate electrical loads and determine the circuitry, lighting, motors, transformers, and telecommunications needed for a building. They typically work closely with the architect to ensure that the owner's expectations are met and often coordinate their efforts with the mechanical engineer.

Civil engineers Civil engineers design roads, bridges, tunnels, dams, site drainage, parking lots, runways, and water supply and sewage systems. Civil engineering, considered one of the oldest engineering disciplines, encompasses

many specialties. Civil engineers are the ones who take the bare land and excavate it, move it, drill it, and shape it to meet the needs of the architectural design and the construction. Site work is one of the most unpredictable and expensive aspects of any construction project, and good design makes all the difference in the world.

Landscape Architects

I am including landscape architects as a separate design professional because they are. Many people do not understand the distinction, but landscape architects are professionals licensed and regulated by an entity separate from building architects. Landscape architects deal with the building site and outside environmental issues surrounding the structure. They are involved with such things as plantings, sidewalks, retaining walls, and water features to enhance the project. Large architectural firms may employ landscape architects on staff and utilize their services in the overall design. Or the landscape professional may be hired directly by the owner or work under a separate contract with the builder.

NOTE

Great landscape design can make an ordinary building look extraordinary. Likewise, an ill-conceived landscape design can make an extraordinary building look ordinary. Unfortunately, many owners fail to see the significance of this design element and shortchange the budget for landscape design.

Interior Designers

Not all projects will engage the services of an interior designer. They may be hired directly by the owner or be a consultant to the architect. They deal with the building's interior finishes or schemes and make decisions regarding furniture selection and placement, paint colors and accessories, light fixtures, window treatments, floor finishes, and ceiling treatments. The contractor may or may not have direct dealings with the interior designer.

Construction Professionals

According to the American Institute of Constructors, the term *constructor* is generally used to define the professional responsible for all construction activities whether they work as a general contractor, a construction manager, or a specialty contractor. The profession of constructor includes job titles such as, but not limited to, project manager, general superintendent, project executive, operations manager, construction manager, and chief executive officer. The constructor's job is to do the following:

- Interpret the plans and specifications and prepare cost estimates and time schedules to meet the requirements of the owner.

- Determine and implement the best construction practices, means, and methods to satisfy the owner's requirements for time, cost, and quality.
- Oversee and manage all of the construction operations into a single, safe coordinated effort.

General Contractors

The general contractor, also known as the *prime contractor*, enters into a contract with the owner to deliver the construction project in accordance with the plans and specifications that have been prepared by the architects and engineers. They may or may not actually perform any of the actual construction work with their own forces. When they do, they are said to be doing *self-performed work*. When they don't, they arrange for subcontractors or trade contractors to perform the specialized craftwork such as excavation, concrete placement, painting, or plumbing. Today, more often than not, the general contractor maintains only a management staff and a field staff as permanent employees. The construction management staff includes estimators, schedulers, and purchasing agents, while the field management staff consists of superintendents, foremen, field engineers, and lead workers. The work of the trades is performed under separate subcontracts with various specialty contractors.

self-performed work
Construction work that is performed with the general contractor's own forces or labor. This is work that is not subcontracted.

Construction Managers

Construction managers may be employed by construction management firms, general contractors, architects, engineers, owners, or specialty contractors. The primary responsibility of the construction manager is to organize the project team to perform the construction management function that is the topic of this entire book.

Specialty Contractors

Specialty contractors are often referred to as *subcontractors* because they perform their work under a contract with another contractor (typically the general contractor) to do a portion of the contractor's work, as opposed to contracting directly with an owner. These subcontractors, in turn, may engage other subcontractors. Thus, there can be several levels of subcontracting to a general contractor.

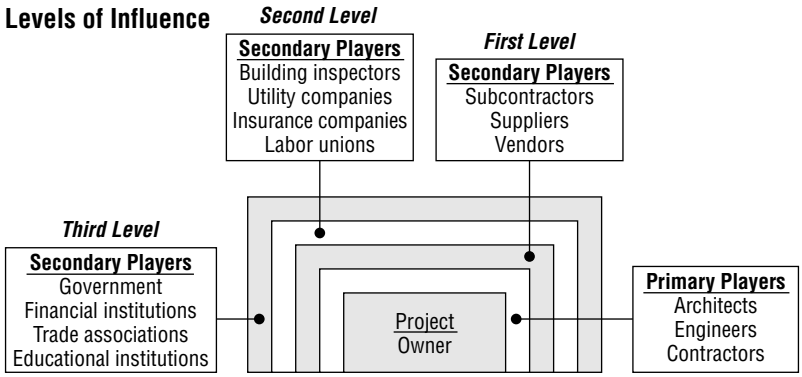
The Building Trades

It is important to include the trade workers as part of the construction professionals' discussion because, without them, there would be no construction at all. These are the men and women (plumbers, electricians, ironworkers, and so on) who actually perform the work. These skilled and semi-skilled workers are the construction industry's most valuable asset, although they are rarely recognized for their immense contribution. Unfortunately, too, their ranks are dwindling to crisis proportions, despite relatively high compensation, because of decreased

training opportunities, traditionally provided by labor unions and vocational schools. However, various trade associations such as the Associated General Contractors, Associated Builders and Contractors, and the National Association of Women in Construction have tried to pick up the slack by introducing educational opportunities through special initiative programs.

Secondary Players

Construction is second only to the restaurant business when it comes to high-risk business endeavors. Four out of five construction companies will go out of business during their first year. There are many factors for this. One of them is the power that outside parties have over the entire construction process and outcome. These secondary players, or what I call *layers of influence*, are beyond the immediate control of any of the primary players. I have divided these layers of influence into three levels.



First-Level Players

This level of influence includes subcontractors, material suppliers, and equipment vendors. This layer directly influences the outcome of a job in a serious way. Although this group is often directly connected to the primary players via a subcontract agreement or a purchase order agreement, they are primarily independent operators and not under the immediate control of the owner, the architect, or the contractor. And because they are not under direct control and yet provide vital services, they always add risks to the project. For example, a subcontractor is scheduled to start their portion of the work on a certain date but instead shows up three weeks later, delaying the startup of other related work and, therefore, delaying the completion of the overall project. Or a material supplier promises to deliver the concrete block for a commercial building on a Monday, and your masonry subcontractor has a full crew waiting to start the work at 7 a.m. The delivery doesn't arrive, and the subcontractor goes off to start another job.

The block delivery then shows up on Tuesday, but the subcontractor is unwilling to return to your job until he finishes the one that he has already started.

Second-Level Players

This level of influence includes insurance companies, utility companies, bonding companies, building code officials, zoning, labor unions, and manufacturers. Although this level has no contractual connection or obligation to any of the three primary parties, they hold great influence over your project. For instance, a building inspector can shut down operations on a job for even the slightest code infringement, causing work stoppage for trades not even involved in the infringement. Or an insurance agent who fails to issue certificates of insurance on subcontractors in a timely fashion can put a monkey wrench in the administrative requirements and ultimately put the project schedule at risk. Or a strike at a manufacturing plant thousands of miles away can delay the delivery of your air conditioning units for a new retail store, delaying the completion of the job, delaying the opening of the store, and, therefore, costing the owner thousands of dollars in lost revenue for each day of delay.

Third-Level Players

This layer of influence includes the courts and attorneys, local government, state and federal government, trade associations, education and training, bankers, and others. Like the second level mentioned previously, these parties do not have a direct link to the primary players but do influence construction projects on a regular basis. Although the effects are not always immediate, actions and decisions by this group of players can have a significant impact on the whole industry, which eventually trickles down to the project level. For instance, government agencies that adopt policies or create new laws relative to such things as growth, wetlands, or endangered species are constantly having an impact on the construction industry. With the stroke of a pen, a project can be stopped dead in its tracks, and millions of dollars can be at stake for the owner, the contractor, and even the architect, not to mention the eventual end users. Decisions to eliminate craft training and educational opportunities at vocational high schools and the decrease in labor union training have greatly affected the industry. The shortage of skilled workers immediately impacts the ability of the construction manager to deliver a quality product on time and within budget to the owner. It is the single most important issue facing the industry today.

The Industry Image

In my estimation, construction is one of the most honorable professions that a person can pursue. However, the image of the construction industry is admittedly not always a positive one. As so often is the case, the negative aspects of

this industry get the most coverage in the media and through word-of-mouth. The positive aspects—and there are many—are less often communicated, leaving us with the stereotypical images of construction. Practitioners who are all brawn and no brains, an unreliable workforce, a dangerous and dirty work environment, unscrupulous con artists posing as professional contractors, and entrenched discriminatory and sexist attitudes are some of the imagery conjured up regarding the construction industry. Don't get me wrong, the industry has its challenges; however, I find the industry to be filled with principled, hardworking, dedicated individuals, committed to building better communities. The industry may not have done the best job projecting its image in a positive light over the years, but that is changing. And as a teacher of the next generation of construction professionals, I can tell you that the future is looking very bright.

An Industry in Transition

Turning the image of the construction industry around is no easy task. Millions of dollars have been invested by several construction associations over the past several years in an effort to change the public's perception, and it appears to be paying off. The Associated General Contractors (AGC) has developed an exciting campaign called *Construction Futures*, an initiative designed to alter the current perception of the construction industry and to inform and educate youngsters, their parents, and teachers about the career opportunities that the construction industry has to offer.

The National Association of Home Builders (NAHB) created a public service campaign called *Home Builders Care* to recognize contractors who have contributed millions of dollars in cash, building materials, supplies, and countless volunteer hours to community charities through local community service projects.

Another effort, *ABCares*, is another national community service initiative undertaken by the Associated Builders and Contractors (ABC) to recognize chapters that contribute significantly to their communities.

NOTE

Even the toy industry appears to be contributing to the rebuilding of the industry's image, although unintentionally, I'm sure. The *Bob the Builder* television franchise has sold millions of dolls, storybooks, and assorted toys in recent years.

It is hard to tell whether the efforts by the various construction associations have paid off, but it seems that the industry is clearly in transition, and there are clear signs that a new respect for construction is emerging. The days of the individual master builder are long gone, but the new master builder, the collaborative team, is taking on challenges the likes of which have never been seen before, and the world is watching. The rebuilding of the Pentagon after September 11, 2001, is a good example. A project that was slated to take five years by federal government estimates was completed by September 11, 2002, in only 364 days by men and women determined to show what the American construction industry can do.

In 2004 and 2006 the Construction Users Round Table (CURT) published two white papers. The 2004 paper was entitled "Collaboration, Integrated Information, and the Project Lifecycle in Building Design, Construction and Operation." The 2006 paper was entitled "Optimizing the Construction Process: An Implementation Strategy." (You can access both papers on the CURT website at www.curt.org. The papers are free for members and available for a small fee to nonmembers.) These white papers stress the need for more collaboration and teamwork among project players in the design and construction process and the implementation and use of advanced technology to address design and construction integration issues. The Construction Users Round Table represents owners—our clients, stakeholders, and end users in the construction business—and it is very important that we listen to what the organization is saying. These white papers articulate a clear message about the direction owners want the industry to take, and it appears that contractors and construction managers are responding.

Technology

As with most industries, advancements in technology have revolutionized the way that we do business in construction. Software programs are available to assist with almost every management function in construction. Programs for estimating, scheduling, cost control, and project administration are common. Projects are managed using web-based "project integration" programs that allow all members of the team to exchange information, access building plans and specifications, process change orders, and even view construction activities and progress via a webcam from thousands of miles away. Building foundations and layouts are pinpointed using laser levels and GPS on a regular basis. Just as CAD revolutionized architecture practice in the early 1980s, architects, engineers, and constructors can now develop three-dimensional visual models that simulate the building process right on their computer screens. Now the project team can conduct *constructability reviews* and anticipate and address construction problems before the first shovel of dirt is ever turned on the job site.

constructability reviews
A design review process in which experienced contractors and construction managers work with designers to ensure that the details of the design actually can be built in an efficient and cost-effective manner. The process entails review of materials, application, installation techniques, field execution, and building systems.

The construction environment is becoming more and more complicated, and the need for innovation is paramount. Not only has technology changed the way that we manage projects, but building materials, construction methods, and the projects themselves have become more sophisticated. Buildings are becoming "smart." Automated homes, offices, plants, and other facilities are using computers, networks, and programs to control specific operations such as temperature, airflow, lighting levels, and access.

Simply knowing how to swing a hammer or wield a power drill will not cut it anymore. It is not uncommon for even the smallest of construction firms to have laptop computers in the job trailer and personal digital assistants (PDAs) in every job foreman's pocket. Anyone who perceives the construction industry to be all brawn and no brains certainly has not visited a job site lately. "Toto, we are not in Kansas anymore!"

Globalization

In the 1970s, 80 percent of the world's construction was being built in the United States, and 20 percent was being built overseas. According to the U.S. Department of Commerce's *Construction Review* published in 1997, those numbers had reversed. By that time, 80 percent of the world's construction was occurring on foreign soil, and only 20 percent was occurring in the United States. This drastic shift is undoubtedly still having an impact on the U.S. construction industry and those who are involved in it. With annual revenues in the $4 trillion range worldwide, more and more U.S. companies are pursuing international opportunities.

Each year, the weekly construction magazine *Engineering News Record* (ENR) publishes a list of the top 225 international construction firms. By 2008, a total of 63 American firms made the list, accounting for 11.9 percent of total international construction revenue. No doubt that number will continue to grow.

Today anyone working in the construction industry should anticipate a future involving an international experience. The world is getting smaller, and the demand for infrastructure and building programs for roads, dams, power plants, water and sewer facilities, mass transit, and even housing in emerging and third-world countries is immense. Individuals pursuing careers in construction management who are interested in the international market will undoubtedly have the opportunity to track that venture.

Sustainability

Today, a much greater emphasis is being placed on the environment and the relationship between our buildings and the communities in which they are constructed. In recent years, a voluntary, market-driven building-rating system called the Leadership on Energy and Environmental Design (LEED) program, developed by the U.S. Green Building Council (USGBC), has been making its way into segments of the construction industry. This program, which evaluates environmental performance from a "whole building" perspective over a building's life cycle, is becoming so popular that many states are requiring LEED certification of its public buildings. The Leadership in Energy and Environmental Design (LEED) Green Building Rating System is a third-party certification program and the nationally accepted benchmark for the design, construction, and operation of high-performance green buildings. LEED provides building owners and operators with the tools they need to have an immediate and measureable impact on their buildings' performance.

Green building and green building technologies are being applied to every sector of the industry, and construction practitioners are playing a vital role in carrying out and implementing sustainable goals and objectives on projects.

Not only are buildings being certified LEED but so are the individuals who design and construct them. Today it is quite common to see the initials "LEED AP" (for LEED Accredited Professional) printed on a business card after the name of a construction manager. As a matter of fact, there are many construction management

students who have already achieved their LEED AP designation by the time they graduate. This is a testament to the dedication and commitment that has been expressed by the construction community toward building sustainable communities. It is clear evidence that sustainability is not some passing fancy—rather, it's an accepted and standard way of doing business in the construction industry.

Efficiency

lean principles
Stemming from the Toyota Production System, principles that focus on creating more value for customers with less work and the elimination of waste. These principles are now being applied to the construction industry.

Historically the design and construction industry has had the notorious reputation of being one of the most wasteful and inefficient industries in the United States. However, in 1993 a group of contractors started to apply *lean principles*, typically associated with manufacturing, to the construction industry. Basically, lean principles, originally derived from the management philosophy known as the Toyota Production System (TPS), are centered on creating more value with less work. In other words, it's the elimination of waste in all forms—wasted materials, wasted time, wasted movement, wasted manpower, and so on. Today, the Lean Construction Institute (LCI) has developed a number of processes and procedures specifically focused on the construction industry that support the lean philosophy. One such technique is called the Last Planner System, which focuses on stabilizing workflows in the construction process, thereby adding reliability to the schedule.

With such innovations, along with the ever-increasing use of advanced technologies such as BIM making their way into construction firms, it is indeed a very exciting time to be in construction. (To find out more about the last planner approach, go to `www.leanconstruction.org/lastplanner.htm`.)

Diversity

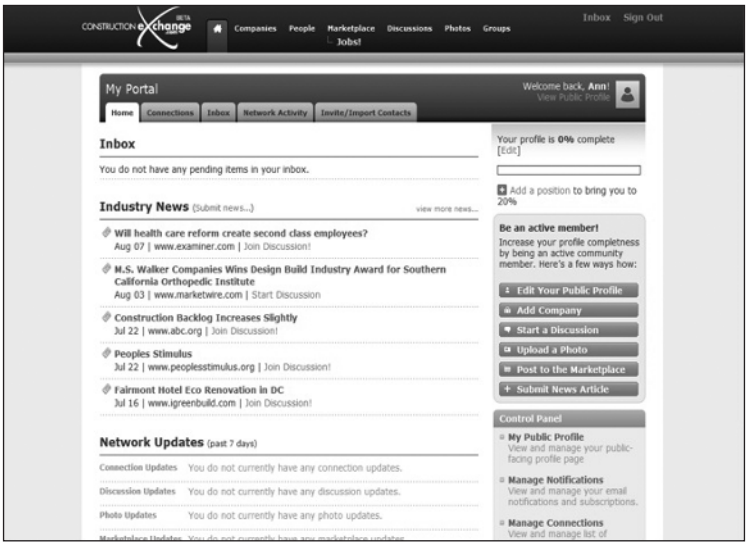
There is no doubt that the construction industry in the United States is still a white- and male-dominated industry. However, the demand for construction managers is so significant that the only way the need can be met is by opening the doors to attract the best and the brightest to join in the effort to take on the building challenges around the world. And just as in other traditionally male industries, the face of construction is changing. As a professor of construction management, I have a chance to talk with recruiters from every sector of the industry and from all over the country. There is a conscious effort being made to bring diversity to the forefront of the profession, and tremendous opportunities for women and minorities in the construction industry exist today.

Collaboration

Anyone reading this book is well aware of the impact that the Internet has had on society. The Web is no longer a passive place where people idly surf, read, listen, or watch without engaging. Today we use the Web to network together,

participate in dialogue, and collaborate. Facebook, MySpace, Flickr, LinkedIn, and Twitter are just a few of the networks people are using to interact socially and professionally.

Although the construction business has been slow to take advantage of these mass collaboration opportunities, a group of young professionals at Western Water Constructors in Santa Rosa, California, launched a new networking site in 2009 specifically dedicated to the construction industry. The website, `www.constructionexchange.com`, provides a simple environment with powerful tools for sharing ideas, disseminating information, and promoting growth through networking.



Construction Exchange provides for the collaborative efforts of its users. People are invited to engage in discussions, participate on projects, and join problem-solving endeavors associated with any type of construction topic. It is a great place for construction professionals and students alike to share ideas and get to know each other.

Making a Difference

The contributions of the construction industry relative to the changing needs and demands of our society are becoming more apparent. Construction management holds the promise to help close the gap between design and end user satisfaction by offering team leadership, project feasibility reviews, constructability analysis, value engineering, and life-cycle cost evaluation.

There are not many professions where you can look around and actually see the difference that you are making in the world. In construction, the results of

your work are right there for the whole universe to see. This became very apparent to me just as I was about to leave the construction industry and return to the university to complete a master's degree and doctorate.

In 1995, I left Virginia, where I had had my design and construction business for 10 years. On my last Sunday there, a woman from my church whom I did not know came up to me. She took my hand and, with tears in her eyes, thanked me for the wonderful contribution that I had made to the community. Her husband had worked for me as a subcontractor before his passing, and she spoke of how proud he'd been to be working on some of my buildings. Well, I too began to get teary-eyed, and when I left church, I rode around that town and looked at the many homes, restaurants, and office buildings that I had designed and built. Until that day, I had never realized the impact that I and others make every day we go to work in construction. Knowing that I can return to that community 50 years from now and still view the fruits of my labor is a pretty awesome thing. The truth is that my work will still be standing long after I am gone—if not quite as long as the pyramids have lasted, at least long enough to impress my grandchildren's grandchildren.

Career Opportunities

According to the U.S. Bureau of Labor Statistics, excellent employment opportunities for construction managers are expected through 2016 because the number of job openings arising from job growth and replacement needs is expected to exceed the number of qualified managers seeking to enter the occupation. Employment of construction managers is expected to increase about as fast as the average for all occupations over the next six or seven years. The number of construction management jobs in the construction industry is expected to grow about 16 percent, compared with 11 percent projected for all industries combined. The bottom line is that the industry needs more construction managers than the universities can turn out. This is the case across the nation. As the level and complexity of construction activity continues to grow, so will the demand for qualified construction managers.

Advancement Opportunities

Construction managers may go to work for a number of different organizations. On the private side, general contractors, construction management firms, architectural or engineering firms, developers, financial institutions, and large corporations may all hire construction managers. On the public side, various state and federal agencies, public schools and universities, departments of transportation, federal prison systems, and others may seek their skills as well.

As in any profession, advancement opportunities for construction managers vary depending upon an individual's performance, ability, and the size of the company they work for. The customary progression for a new construction

management recruit is to start as a field engineer and then move to an assistant superintendent position, superintendent, estimator, assistant project manager, and then project manager. Within larger firms, highly qualified construction managers may eventually become top-level managers and executives, often moving to the vice president level or higher. Many construction managers will opt to branch out and start their own businesses.

Educational Offerings

The ideal construction management candidate is typically an individual who has a bachelor's degree or higher in construction management, construction engineering, or construction science, as well as practical experience working in construction. The work experience and hands-on knowledge of construction are as valuable as the degree. For this reason, many construction management students combine their formal university educations with paid internships while attending school. It is also not uncommon to find experienced field personnel pursuing their degrees in construction management as nontraditional older students.

Opportunities for education and training in construction management are numerous. As previously mentioned, the Associated Schools of Construction (ASC) lists about 120 colleges and universities offering four-year accredited degree programs in construction management or construction science. There are also a number of two-year colleges that offer construction management or construction technology courses as well as approximately 20 universities that offer a master's degree. In addition, several of the construction, engineering, and architecture trade and professional associations regularly host educational seminars on various construction management topics.

Typical course offerings in construction management include construction methods and materials, site surveying and layout, contract administration, construction documents, value analysis, cost estimating, scheduling, cost controls, accounting, business and financial management, building codes and standards, inspection procedures, engineering and architectural sciences, mathematics, statistics, computer applications, and information technology. Several of these topics will be discussed throughout this book.

Professional Affiliation and Certification

One of the easiest ways to get acquainted with the construction management profession is to become familiar with the various professional organizations affiliated with the industry. At least 250 organizations are associated with construction and its practitioners. Two of these organizations offer voluntary certification programs for construction managers. Requirements combine a written examination with verification of professional experience.

The American Institute of Constructors

The American Institute of Constructors (AIC) helps individual contractors who meet the requirements to achieve professional status through an examination and certification program. AIC is the certifying body for the designation of Certified Professional Constructor (CPC) and Associate Constructor (AC). The organization was formed in 1971 and serves the industry in a professional capacity similar to the professional organizations for architecture and engineering. You can learn more about the AIC at `www.aicnet.org`.

The Construction Management Association of America

The Construction Management Association of America (CMAA) is dedicated to promoting the professional practice of construction management. The organization welcomes members from all construction and design disciplines as well as owners and various service providers to the industry. The CMAA offers professional designations through its Certified Construction Manager (CCM) program for individuals who complete its self-study course, pass the certification exam, and meet other requirements set forth by the organization. To learn more about the CMAA, go to its website at `http://cmaanet.org`.

Other Associations

Several other recognized professional associations warrant mentioning. Each of them offers training courses and seminars on various construction and construction management topics on a regular basis.

The Associated General Contractors of America Formed in 1918, the Associated General Contractors of America (AGC) is the oldest major organization serving the interests of general contractors. Its membership includes general contractors and specialty contractors as well as suppliers and service vendors such as insurance agencies, bonding companies, and technology merchants. You can learn more about the AGC at `www.agc.org`.

Associated Builders and Contractors Associated Builders and Contractors (ABC) is a national trade association comprising contractor and subcontractor members who support a merit job philosophy. As such, members adhere to the belief that construction contracts should be awarded on the sole basis of merit regardless of labor or union affiliation. Their membership also includes material suppliers, vendors, and industry service providers. If you want to learn more about the ABC and the merit shop philosophy, visit its website at `http://abc.org`.

The National Association of Women in Construction The National Association of Women in Construction (NAWIC) was formed in 1955 in the state of Texas. It now has members in 49 U.S. states and 3 Canadian

provinces. NAWIC is dedicated to advancing career opportunities for women who are engaged in the construction industry. Its membership includes women working on the management and administrative side of the business as well as women who are working in the trades, such as electricians, carpenters, and welders. To learn more about NAWIC, check out its website at `http://nawic.org`.

The National Association of Minority Contractors The National Association of Minority Contractors (NAMC) is a nonprofit trade association that was established in 1969. In addition to providing training and networking opportunities, the organization's primary mission is to address the needs and concerns of minority contractors. Although membership is open to people of all races and ethnic backgrounds, the group focuses on construction industry concerns common to African Americans, Asian Americans, Hispanic Americans, and Native Americans. To learn more, go to `www.namcnational.org`.

The National Association of Home Builders The National Association of Home Builders (NAHB) is the largest of the construction associations with 211,000 members nationwide. Among its ranks are individuals from home building and remodeling companies of every size. A large percentage of the organization's members come from related business venues such as building supplies, manufacturing, mortgage banking, real estate, and insurance. You can learn more about NAHB by going to its website at `www.nahb.org`.

The Design-Build Institute of America The Design-Build Institute of America (DBIA) is one of the newest professional organizations serving the design and construction industries. Founded in 1993, DBIA is dedicated to the practice of integrated project delivery, representing members of the entire project team: contractors, architects, engineers, and owners. In 2001, DBIA initiated a professional designation program recognizing design-builders as unique service providers in the industry. Individual practitioners, who complete a required educational program, successfully complete the designation exam, and meet the experience requirements of the program are recognized as Designated Design-Build Professionals, displaying "DBIA" after their names. In 2009 the DBIA added an entry-level category to its designation program. The Associate DBIA certification is now available to college graduates who complete the education and testing requirements but who have not yet met the experience requirement. To learn more about design-build, visit the DBIA website at `www.dbia.org`.

The Project Management Institute The Project Management Institute (PMI) serves individual members from around the world who are dedicated to advancing the practices and methods associated with professional project management. PMI has members from a wide variety of industries, such as information technology, business, engineering, pharmaceuticals,

financial services, telecommunications, and construction. It offers a Project Management Professional (PMP) certification program that is recognized around the world. If you want to learn more about PMI, go to its website at `http://pmi.org`.

The United States Green Building Council In 1993, the United States Green Building Council (USGBC) was formed as a nonprofit, nongovernmental organization with a diverse membership of architects, contractors, owners, product manufacturers, environmentalists, and others who are interested in the promotion of green building in the United States. In 1998, the organization launched a nationally recognized rating system for benchmarking the design, construction, and operation of "green buildings." The system, referred to as LEED, is a voluntary rating system that identifies a definitive standard for what constitutes "green building." The goal of LEED is to evaluate the environmental performance of a building from a holistic perspective and measure that performance over the building's life cycle.

Individuals can become accredited as LEED AP professionals by passing an exam administered by the Green Building Certification Institute (GBCI).You can learn more about the USGBC by going to its website at `www.usgbc.org`.

The Lean Construction Institute The Lean Construction Institute (LCI) was founded in August 1997 and is now a nonprofit corporation. The institute is involved in research to develop knowledge regarding project-based production management in the design, engineering, and construction of capital facilities. To learn more about the LCI, visit its website at `www.leanconstruction.org`.

Terms to Know

base isolators
brownfield sites
constructability review
cofferdams
curtain wall
infrastructure
lean principles
program
project delivery
self-performed work
slip forms
specifications

Review Questions

1. What is the name of the stone carvings dating back to the pyramids that contained the first written regulations pertaining to construction, commonly referred to as the first known building code?
2. By what specific measurement is construction used as an economic indicator for the U.S. economy?
3. What are the five primary sectors of the construction industry?
4. What is the name of the organization credited with promoting construction management as a legitimate and unique area of study at four-year universities?
5. What is the role of the owner on a construction project?
6. What is the name of the weekly magazine dedicated solely to the construction industry?
7. Name three associations affiliated with the construction industry.
8. What does LEED stand for, and what is its purpose?
9. What two construction associations offer voluntary certification programs for construction managers?
10. What is lean construction, and from what industry does its concepts stem?