



# Construction Project Management

An Online Continuing Education Course for Engineers

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# Construction Project Management

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## I. INTRODUCTION

Construction is principally defined by the concept of assembling materials and products. The highways we drive on, the bridges we cross, the water we drink, the fuel we burn all are made possible by the activities of the construction industry. Likewise, where we shop, where we work, where we worship and learn, and where we live all exist because of the construction industry. Until the late 1800s, most buildings were four or five stories high. The limitation to height was because people could practically climb up only four or five stories. The invention of elevators made construction of taller buildings possible and in turn spurred construction activities. Innovation in robotics and computer modeling had also improved the construction industry. Construction is big business in the United States and is the single largest employer. The total gross value of construction represents nine percent of the gross domestic product (GDP). Construction employment has risen steadily over the years and construction professionals work with several more disciplines than do most other professionals. Its success or failure depends on the qualities of its people rather than on its technology or product. Government funding, demographics, and market trends largely determine demand. Any extreme weather conditions can affect productivity level, damage materials and work-in-place, create unsafe conditions, and even shut down the site entirely. The risk factor is much higher in construction than in other industries. However, anyone with motivation, technical skills, and a sufficient cash flow can start the construction business and be successful.

At one time, general contractors constructed almost the entire project with their own work force. But as buildings become more technically complex and the business of building them more sophisticated, the industry has increasingly turned to specialty trades.

### I.1. Industry Sectors

The following four categories constitute the industry sector:

- Residential
- Commercial
- Infrastructure and Heavy engineering
- Industrial

The residential construction sector is comprised of individual homes, small condominiums, and apartment complexes. These projects tend to be privately funded by individual owners for their own use or for speculation. They are typically designed by architects.

Commercial building sector includes office buildings, large apartment complexes, shopping malls, schools, universities and hospitals. These are also mostly funded by private persons. But some public funding is available for schools and hospitals. These are typically designed by architects with support from engineers and are built by general contractors.

Infrastructure and Heavy engineering sector includes roadways, bridges, canals, dams, and tunnels. These are principally designed by civil engineers and built by heavy construction contractors with engineering background. Most projects of this type are publicly funded because they serve the public needs.

Industrial sector projects include steel mills, petroleum refineries, chemical processing plants, and automobile production facilities etc. Most of these facilities are privately funded.

Project is defined as an interrelated and non-repetitive set of activities which are intended to meet certain objectives. Many tasks in a project such as collecting data, estimating costs, and regulatory considerations etc. are not new and are common to all projects. The uniqueness of a project lies in the context of clients, team members, physical conditions, and constraints etc. Construction projects are born from ideas. For an idea to be realized, it must be translated first to graphic form, which in turn, must be transformed into a finished product by the constructor.

Project management is the process of applying human and other resources as required to produce a complete project design or construction activity within the stipulated goals of time, budget and quality. By careful project management, all these expectations can be realized. Creating policies, planning, organizing, and committing resources are all aspects of project management. All projects, regardless of size, need to be carefully managed. Success of project management spreads throughout an organization and thus contributes to its profitability. Improper management of projects results in negative impact on an organization. The individual who is entrusted with the responsibility to carry out the project from beginning to end is the project manager. He organizes a team to help him in his duties.

## **II. PROJECT PARTICIPANTS**

The main participants in a construction project are as follows:

**II.1. Owner** – Owner can be an individual seeking a home for his family, a large organization, a municipality, or a developer. Owner is the originator of the project. The owner’s most important function is to establish the project objective and to financially back the project. Owners are classified as public and private.

**II.1.1. Public Owner** – One quarter of the construction in the United States is done with public money. The money can be from local, state or federal sources, but in all cases, the owner is the tax payer. Because the public is the owner, public agency requirements must be complied with and certain specific methods of managing the project must be followed. Public approval processes must be figured into any schedule or budget. How the designer and contractor are selected is carefully spelled out. Negotiation of claims is well defined, as well as how payments are issued. Some public-funded projects are managed by private organizations such as universities or hospitals. The funding of these projects often combines public funding with private money for some or all the construction. During design, there can be multiple reviews of the project by various agencies. Bidding requirements may affect how a specific contractor is selected.

**II.1.2. Private Owner** – Most construction is financed through private ownership. A private owner may be an individual, a developer, or a multinational company. A developer is a special type of private owner who owns the project only for the duration of construction.

**II.2. Owner Representative** – Facility managers are the most common representatives of the owner. Facility managers are a diverse and professional group. Their job is to understand the goals and objectives of the owner and ensure that the facilities are planned to support them. Owners without large in-house departments to manage construction projects often hire outside consultants. A building committee is another form of owner representation. Owners are concerned about the durability of the design, storage and availability of materials, simplicity of operation, and ease of maintenance.

**II.3. Design Professionals** – Architects and engineers are the principal designers of construction projects. On most building and residential sector projects, the architect is the lead designer who lays out the concept on paper with the owner. The engineer is brought in later after the basic concept is worked out to design systems like structures, mechanical, electrical, and plumbing. On infrastructure and industrial projects, the lead designer is usually an engineer; the architect is brought in to work on the aesthetics. Both the architect and engineer must think mechanically, technically, and creatively, but the architect works in the

artistic realm to solve a specific set of problems, while the engineer works in the technical realm.

**II.3.1. Architects** – Architects are the stars of the building industry. They are the industry’s image makers. For some architects the physical context is the guiding feature, others are guided by activities that will occur in the building, and still others focus on creating a unique image. Very good architecture responds to all these three aspects. Often, they influence the choice of contractor and delivery method and act as owner’s representative throughout the construction phase of the project. In addition to understanding the requirements of the owner, the architect must have enough skill and expertise to choose appropriate systems and materials. He should have the talent to formulate a decision that is mathematically proportioned and aesthetically pleasing. Though architects are usually designers on a building project, many other professionals, as shown below, contribute to their work:

**II.3.1.1 Drafters/CAD Operators** – Until recently, drafting was done manually. Of late, companies use computer-aided software packages extensively, and all drafting is done with the aid of a computer.

**II.3.1.2. Specification Writers** - A specification writer prepares a written document called specifications. It spells out specific products and methods to be used. A specification writer must meet with manufacturer’s representatives and use sources such as the Construction Specification Institute (CSI). He should be able to write clearly and concisely, be organized and methodical about material and have an extensive understanding of construction processes.

**II.3.1.3. Interior Designers** – These professionals work on a project’s nonstructural interior spaces. They work out interior finishes such as painting, window treatment, flooring, ceiling, furniture, and signs etc. Interior designers require expertise in space planning, acoustics, lighting, and telecommunications, and must have good understanding of the latest products on the market.

**II.3.1.4. Landscape Architects** – The work of a landscape architect includes identification of plant species and location of trees and shrubs. They set grades, establish walkways, walls and fences, and specify paving types etc.

**II.3.2. Engineers** – Engineers play an important role on projects. When engineers are the lead designers, the functional aspects of the work take center stage. An engineer’s responsibility on projects is varied depending upon their discipline. They should understand the owner’s requirements such as budget, operations, durability, and intended use of space. Engineering tasks include specifying large equipment such as air-handler units, and electrical switch gear etc. Although engineers have many career options, the following are the most common:

**II.3.2.1. Structural Engineers** – They calculate strengths and deflections, foundation sizes, beam thickness, and strength of floor slabs etc. They ensure that a building can withstand the forces of wind, gravity, and seismic activity.

**II.3.2.2. Mechanical Engineers** – They design heating, ventilating and cooling systems. They make sure enough room is provided for ducts and fans. They share information about equipment weight with structural engineers and power requirements with electrical engineers.

**II.3.2.3. Electrical Engineers** – They calculate the overall electrical load required and size equipment accordingly. They supply drawings that show power lines, motors, transformers, switch gear, and telecommunications etc. They determine the amount of lighting required for the owner’s intended use and design lighting layout to meet an architect’s criteria.

**II.3.2.4. Civil Engineers** – They determine the location of the project on a site by studying the subsurface soil conditions and the topography of the land. They design roads, bridges, tunnels, parking lots, storm drainage systems, and sewage & water treatment plants.

**II.3.2.5. Surveyors** – They measure distances and elevations of land surfaces. They locate natural features such as hills, valleys, vegetation, rock-outcroppings, and water bodies etc. They also measure built features such as curbs, paved areas, utilities, structures, and property boundaries.

**II.4. Constructors** – This is the term used to define the professional responsible for all construction activities. Their knowledge of the details of construction is supported by the expertise of specialty subcontractors. In olden days, constructors were brought to the site after the design was complete, but now they may be brought along with the designer to advise an owner during the design process. In large companies, many distinct career paths have evolved to meet the needs of specialized projects. Some examples of such career paths are as follows:

**II.4.1. Estimators** – They work with design drawings and prepare a complete list of materials and prepare project costs. They need to understand the construction process, be detail-oriented and well organized and have a thorough knowledge of costs for labor, material, and equipment.

**II.4.2. Schedulers** – They work between the home office and the field office of a construction company. Schedulers should have a thorough understanding of the construction process as well as the ability to define distinct construction activities. They should also understand the relationship among different activities. They monitor job progress, coordinate subcontractors, analyze changes and their impact and solve problems, if any.

**II.4.3. Purchasing Agents** – They select subcontracts once the job is won. They negotiate to get the best price while ensuring that all contract requirements are met. They should understand building materials, their prices, and the construction process; have broad business sense and be persuasive.

**II.4.4. Specialty Contractors** – They are generally known as subcontractors and include mechanical, electrical, excavation, and demolition contractors etc.

**II.4.5. The Trades** – The people who do the work on the job is ‘trades people’. On a complex building site, as many as 15 different trades may be working on a given day. The US Department of Labor Statistics lists the following job categories for construction trade:

- Boiler makers
- Brick mason, block mason, and stone mason
- Carpet, floor, and tile installers and finishers
- Cement masons, concrete finishers, segmental pavers, and terrazzo workers
- Construction and building inspectors
- Construction laborers
- Drywall installers, ceiling tile installers, and tapers
- Electricians
- Elevator installers and repairers
- Glaziers
- Hazardous waste abatement workers
- Insulation workers
- Painters and paperhangers
- Pipe layers, steamfitters, and boilerfitters
- Plasterers and stucco masons
- Roofers
- Sheet metal workers
- Structural and fabricating ironworkers

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**II.4.6. Material Suppliers** – Some materials and building components may be installed by the manufacturer or fabricated materials may be installed by the manufacturer. Some materials have formed trade associations that establish standards and specifications for standardize certain characteristics. Some examples include the American Plywood Association (APA), American Concrete Institute (ACI), and the National Electrical Manufacturers Association (NEMA).