مدیریت پروژه‌های صنعت ساخت

(ساختمانی، زیرساختی و صنعتی)

معرفی دوره

ارائه دهنده:

سید محمدرضا علوی‌پور

(PhD, PMP, CMIT)

دانشگاه Illinois Tech آمریکا

۱. صنعت ساخت

» **تاریخچه، مبانی و مفاهیم اصلی صنعت ساخت:** تاریخچه صنعت ساخت، بخش‌های مختلف صنعت ساخت، انواع پروژه‌های ساخت، ذینفعان صنعت ساخت، تصویر کلی از صنعت ساخت، فرصت‌های شغلی صنعت ساخت، عبارات، لغات و مفاهیم کلیدی صنعت ساخت و...

۲. مدیریت ساخت

» **تاریخچه، ساختار و اصول مدیریت ساخت:** تاریخچه مدیریت ساخت، انجمن‌ها، تشکل‌ها و استانداردهای مدیریت ساخت، مهارت‌ها و وظایف مدیر ساخت، فازهای پروژه‌های ساخت، روش‌های اجرا و تحویل پروژه (Project Delivery Systems) و...

۳. قراردادهای ساخت

» **ساختار کلی مناقصات:** پروژه‌های دولتی و خصوصی، روش‌های برگزاری مناقصه، روش‌های انتخاب پیشنهاد مناقصه، چالش‌های مناقصات، نحوه تهیه و تصمیم‌گیری درباره پیشنهاد مناقصه، قاعده بازی در مناقصه و...

» **ساختار قراردادی و تفصیلی مناقصات:** اسناد قراردادی و مناقصه، انواع قراردادهای همسان (Standard Contract Forms)، شرایط عمومی قراردادها (General Conditions)، شرایط خصوصی قراردادها (Supplemental Conditions)، مشخصات فنی قراردادها (Technical Specs)، الحاقیه‌های قراردادی (Addenda)، انواع قراردادها از منظر پرداخت (Contract Pricing Methods)، قراردادهای پیمانکاری دست دوم و جزء (Subcontracts and Prime Contracts)، انواع ضمانت‌نامه‌ها، انواع بیمه و...

۴. مدیریت برنامه‌ریزی و زمان‌بندی پروژه

» **برنامه‌ریزی و زمان‌بندی پروژه:** معرفی روش‌های برنامه‌ریزی و زمان‌بندی پروژه، تدوین ساختار شکست کار (WBS)، تعیین بسته‌های کاری (Work Packages)، تعریف انواع فعالیت‌ها، تعیین اولویت اجرای کار (Sequence)، تعریف مراحل زمان‌بندی، تعیین میزان بهره‌وری، تخصیص منابع، تعریف تقویم، برآورد زمان اجرای فعالیت‌ها، تسطیح منابع، تعیین شناوری، تعیین مسیربحرانی و...

» **کنترل زمان پروژه، به‌روزرسانی و اصلاح برنامه:** چرخه کنترل پروژه، چرخه بازخورد از ذینفعان پروژه، هماهنگی فرآیند اجرای کار، بررسی پارامترهای تاثیرگذار در عملکرد پروژه، کنترل زمان پروژه، کنترل منابع پروژه، کنترل موادومصالح پروژه، به‌روزرسانی برنامه، تحلیل تاخیرات به منظور کنترل زمان پروژه، اخذ اقدامات اصلاحی به منظور کنترل زمان پروژه، تحلیل وضعیت کلی پروژه، مستندسازی عملکرد پروژه، ایجاد گزارشات مدیریتی و...

۵. مدیریت مالی و هزینه

» **ارزیابی اقتصادی:** تعریف ارزش زمانی پول، تعاریف سود، تعاریف شاخص‌های اقتصادی، تعریف شبکه جریان نقدینگی (Cash Flow)، تحلیل گزینه‌های سرمایه‌گذاری، تحلیل شرایط اقساط در پروژه‌ها و...

» **مدیریت هزینه:** معرفی چرخه حیات هزینه‌های پروژه، تعیین استراتژی و تعریف ساختار اصولی برای برآورد هزینه، بررسی شرایط سایت پروژه، زمان، کیفیت و بازار برای برآورد هزینه، دسته‌بندی هزینه‌های پروژه، تعریف سرفصل‌ها و سیستم کدینگ هزینه، معرفی انواع روش‌های برآورد هزینه، تعریف مراکز هزینه، متره و برآورد، نحوه اخذ پیشنهادات از پیمانکاران جزء و تامین‌کنندگان برای برآورد هزینه، جمع‌بندی برآوردها برای پیشنهاد مناقصه، سیستم کنترل هزینه پروژه، مدیریت ارزش کسب شده و...

» **مدیریت مالی:** پیش‌بینی شبکه جریان نقدینگی پروژه، تعیین الزامات مالی و الزامات برداشت از حساب، کنترل پرداخت‌ها و اثرات آن در نقدینگی و...

» **تامین مالی:** فرآیند تامین مالی پروژه، گزینه‌های تامین مالی بلندمدت، وام مسکن، وام ساخت، وام کارفرمایی با استفاده از ضمانت‌نامه، روش تامین مالی BOT و...

۶. مدیریت قرارداد

» **مدیریت اجرای قرارداد:** جلسات پیش از شروع اجرا، سازماندهی تیم پروژه برای مدیریت قرارداد، نحوه هماهنگی جزئیات قرارداد، بازه پذیرش یا رد پیشنهاد (Acceptance Period/Withdrawal)، اعطای قرارداد و دستور شروع به کار (Award of Contract و Notice to Proceed)، تجهیز کارگاه، مدیریت صورت وضعیت‌ها، مدیریت پرداخت‌ها، مدیریت مقادیر (SOV)، حسن انجام کار، گزارشات پیشرفت، تحویل موقت و نهایی و...

» **مدیریت اسناد و مدارک:** مدیریت نقشه‌ها، فایل‌ها، RFI، مدارک ارسالی (Submittals)، مدارک روزانه توسط سرپرست کارگاه، صورتجلسه‌ها، نحوه ثبت مدارک و...

» **مدیریت ادعا و اختلافات:** تمدید زمانی (Extension of Time)، دستور تغییر و مدیریت تغییرات (Change Order)، تغییر شرایط (Changed Condition)، تعلیق، تاخیر و تصدیع (Disruption)، خسارت تاخیر (Liquidated Damage)، دلایل بروز ادعا، اثرات حقوقی ادعا، روش‌های حل اختلاف و...

» **مدیریت اختتام پروژه:** برنامه‌ریزی اختتام، اجرای فرآیند اختتام پروژه، اختتام ساخت، اختتام قراردادی، اختتام مالی، اختتام تیم اجرایی و مدیر پروژه، مدیریت دوره ضمانت و...

۷. مدیریت ریسک

» **فرآیند مدیریت ریسک:** ساختار فرآیندی مدیریت ریسک، شناسایی ریسک، ریسک‌های طراحی، ریسک‌های اجرا، ریسک‌های سیاسی، ریسک‌های مالی، ریسک‌های محیطی، ارزیابی ریسک، کمی‌سازی ریسک، کنترل و کاهش ریسک، انتقال ریسک، ساختار قراردادی در مدیریت ریسک، قراردادهای پیمانکاری در مدیریت ریسک و...

۸. مدیریت کیفیت

» **ایجاد سیستم مدیریت کیفیت:** تعریف کیفیت، تعیین اهداف در برنامه کیفیت، ایجاد سیستم بهبود مستمر، ایجاد سیستم کنترل و تضمین کیفیت، بررسی نمونه‌های موردی کیفی، اجرای برنامه کنترل کیفیت، کنترل قراردادهای پیمانکاران جزء، نحوه اجرای عملیات تست و بازرسی، نحوه مستندسازی در سیستم مدیریت کیفیت، نحوه تدوین گزارشات کنترل کیفیت و...

۹. مدیریت ایمنی

» **ایجاد سیستم مدیریت ایمنی:** تحلیل میزان نیاز به ایمنی، نگرانی‌های انسانی در زمینه ایمنی، اثرات مالی و اقتصادی ایمنی، هزینه حوادث، الزامات مدیریت ایمنی، نقش مدیر ایمنی، تدوین برنامه مدیریت ایمنی، نگهداری مستندات ایمنی و...

۱۰. مدل‌سازی اطلاعات ساخت (BIM)

» **مبانی و مفاهیم BIM در مدیریت ساخت:** تعاریف، توسعه مدل، اجرای BIM، طراحی با BIM، تعریف LOD، برنامه اجرایی BEP، استفاده از BIM برای مدیریت اجرا/ساخت، نحوه مدیریت پروژه در BIM، تغییرات آینده مدیریت پروژه با BIM و...

۱۱. مدیریت پایداری

» **مبانی و مفاهیم پایداری در مدیریت ساخت:** تعریف چرخه حیات ساخت و هزینه، تعریف پایداری، محیط ساخت پایدار، نقش‌ها و مسئولیت‌های ذینفعان پروژه در پایداری، سیستم اندازه‌گیری و تایید صلاحیت در پایداری، استانداردهای پایداری، بررسی پروژه‌های مختلف ساختمانی و زیرساختی از منظر پایداری و...

۱۲. مهارت نرم

» **تیم‌سازی و مدیریت ارتباطات:** تعریف تیم پروژه، نحوه ایجاد اعتماد و احترام بین اعضای تیم پروژه، نحوه ایجاد ساختار مسئولیت‌پذیری و افزایش انگیزه در تیم پروژه، نحوه ایجاد ساختار ارتباط موثر بین اعضای تیم پروژه، نحوه ایجاد ساختار مشارکتی و یکپارچه‌سازی تیم پروژه، بررسی فرهنگ کاری در صنعت ساخت، بررسی ساختار نیروی انسانی چندنسلی در صنعت ساخت و...

» **رهبری:** تاریخچه تئوری رهبری، تفاوت مدیریت و رهبری، ظرفیت‌های رهبری در صنعت ساخت، الزامات رهبر صنعت ساخت، رازهای رهبری در صنعت ساخت و...

۱۳. مدیریت کسب‌وکار

» **کسب‌وکار در صنعت ساخت:** توسعه کسب‌وکار، مدیریت منابع مالی، مدیریت منابع انسانی، مدیریت بازار و...

معرفی سرفصلها

ACEMI

ویژگی‌ها و جزئیات

آنچه خواهید آموخت

در این دوره جامع، تعاریف، مبانی، ساختار، محدوده‌های دانشی، خدمات و جزئیات اجرایی مدیریت ساخت را فرا خواهید گرفت و خواهید آموخت که یک Construction Manager یا CM چه وظایف، آینده شغلی و محدوده‌هایی را باید مدیریت نماید. این دوره برای افراد و سازمان‌هایی که قصد دارند به مدیریت ساخت به چشم یک ساختار و خدمات یکپارچه نگاه کنند، حکمی حیاتی دارد. این دوره برای افرادی که قصد دارند شرکت‌های مدیریت ساخت (CM) را برای اولین‌بار در ایران ایجاد نمایند، بسیار مهم بوده و به افراد مبتدی نیز کمک می‌نماید تا در این زمینه به دانش مناسبی برای ادامه مسیر برسند. دوره‌ای که به علت تمرکز بر بروزترین مبانی تخصصی و اجرایی در دنیا، باعث وجه تمایز فراگیران این دوره می‌گردد. در واقع هدف این دوره آنست که:

۱. تاریخچه، مبانی، مفاهیم و ساختار مدیریت ساخت را به شما آموزش دهد.
۲. محدوده‌های دانشی مختلف مدیریت ساخت را با رویکرد تطبیق‌سازی به شما آموزش دهد.
۳. فرآیند یکپارچه‌ای را برای مدیریت پروژه‌های صنعت ساخت به شما ارائه نماید.
۴. شما را با ساختار شرکت‌های CM که درآمدهای بسیار زیادی در آمریکا دارند، آشنا نماید.
۵. شما را برای آموزش‌های پیشرفته‌تر و تخصصی در زمینه مدیریت ساخت آماده نماید.

وجه تمایز این دوره

۱. اولین برگزارکننده دوره اختصاصی مدیریت ساخت (پروژه‌های ساختمانی، زیرساختی و عمرانی و صنعتی) در کشور با رویکرد و تعاریف بین‌المللی
۲. بررسی ساختار و تاریخچه حقیقی صنعت و سازمان‌های مدیریت ساخت (CM) در آمریکا و دنیا، با بررسی مبانی ناشناخته در کشور
۳. تطبیق‌سازی محدوده‌های دانشی مختلف برنامه‌ریزی، زمان‌بندی، مالی، هزینه، قرارداد، ریسک، کیفیت، ایمنی، BIM، پایداری، مهارت نرم و مدیریت کسب‌وکار بر اساس ساختار صنعت ساخت
۴. یکپارچه‌سازی محدوده‌های دانشی مختلف در یک ساختار به نام "مدیریت ساخت"
۵. متمایزسازی فراگیران به دلیل آموزش به‌روزترین منابع، استانداردها، سندها و مراجع مدیریت ساخت در دنیا که بعضا دسترسی به برخی از آنها در کشور سخت و یا ناممکن است
۶. ارائه ویدئوها و جزوات به صورت کامل
۷. گروه پشتیبانی ۶۰ روزه از زمان شروع دوره
۸. ارائه محتوا به صورت جامع، ساختار یافته و هدفمند در راستای نقشه راه CM

جزئیات دوره

نوع دوره	مهارت سخت
سطح دوره	کارشناسی و اجرایی
دپارتمان	مدیریت پروژه
مدرس	دکتر سید محمدرضا علوی‌پور
گواهینامه‌ها	گواهینامه حضور ـ گواهینامه حرفه‌ای
پیش‌نیاز	-----

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مدیریت پروژه‌های صنعت ساخت (ساختمانی، زیرساختی و صنعتی)

مقدمه: معرفی دوره

مهارت‌های سخت (Hard Skills) - سطح کارشناسی و اجرایی

دپارتمان‌ها	سطح ۱	سطح ۲	سطح ۳	سطح ۴	سطح ۵
مدیریت پروژه	مدیریت پروژه‌های صنعت ساخت	راهنمای PMBOK	متدولوژی Prince2	استاندارد مدیریت ساخت CMAA	
مدیریت مالی و هزینه	مدیریت مالی و هزینه پروژه ارزیابی اقتصادی پروژه			تامین مالی پروژه	
مدیریت برنامه‌ریزی و زمان‌بندی	برنامه‌ریزی و کنترل پروژه نرم‌افزار MSP نرم‌افزار P6				
مدیریت کیفیت			مدیریت کیفیت پروژه		
مدیریت قرارداد	آنالیز تاخیرات پروژه	مدیریت ادعاء و اختلافات			اجرای پروژه به روش CM
مدیریت ایمنی			مدیریت ایمنی پروژه		
مدیریت طرح و برنامه		مدیریت پروژه به روش Lean دفتر مدیریت پروژه (PMO)	مدیریت چابک Agile		مدیریت طرح
مدیریت پایداری			مدیریت پایداری پروژه		
مدیریت ریسک		مدیریت ریسک پروژه			
مدیریت اطلاعات	مدیریت اسناد و مدارک پروژه	نرم‌افزار Power BI			
مدیریت مدل‌سازی اطلاعات ساختمان (BIM)		نرم‌افزارهای BIM		مدیریت BIM در پروژه	

مهارت‌های سخت (Hard Skills) - سطح ارشد استراتژی

دپارتمان‌ها	سطح ۱	سطح ۲	سطح ۳	سطح ۴	سطح ۵
مدیریت پروژه			منشور اخلاق در مدیریت پروژه		
مدیریت مالی و هزینه		استراتژی مدیریت هزینه و مهندسی ارزش			
مدیریت برنامه‌ریزی و زمان‌بندی		استراتژی مدیریت برنامه‌ریزی و زمان‌بندی			
مدیریت کیفیت				استراتژی مدیریت کیفیت	
مدیریت قرارداد	اصول مدیریت ساخت		استراتژی مدیریت قرارداد		
مدیریت ایمنی				استراتژی مدیریت ایمنی	
مدیریت طرح و برنامه					استراتژی مدیریت طرح و برنامه
مدیریت پایداری				استراتژی مدیریت پایداری	
مدیریت ریسک			استراتژی مدیریت ریسک		
مدیریت اطلاعات			استراتژی مدیریت اطلاعات		
مدیریت مدل‌سازی اطلاعات ساختمان (BIM)					استراتژی مدیریت BIM

References Used in This Course

Primary resources

- **Construction Management**, Halpin, Senior, and Lucko, *Wiley*, **2017**
- **Construction Management Jumpstart**, Jackson, *Wiley*, **2020**
- **Construction Project Management (Aa practical guide to field construction management)**, Sears, Sears, Clough, Rounds, Segner, *Wiley*, **2015**
- **Introduction to Construction Project Engineering**, Migliaccio and Holm, *Routledge*, **2018**
- **Management of Construction Projects (A constructor's Perspective)**, Schaufelberger and Holm, *Routledge*, **2017**
- **Successful Construction Project Management (The practical guide)**, Netscher, *Panet*, **2014**

Other resources

- **Construction Management Standards of Practice**, Construction Management Association of America, *CMAA*, **2021**
- **Contract strategies for major projects**, Merrow, *Wiley*, **2023**
- **CACM Application Handbook**, Construction Management Association of America, *CMAA*, **2022**
- **CCM Renewal Handbook**, Construction Management Association of America, *CMAA*, **2018**

مدیریت پروژه‌های صنعت ساخت

(ساختمانی، زیرساختی و صنعتی)

فصل اول: صنعت ساخت

تاریخچه، مبانی و مفاهیم اصلی صنعت ساخت

ارائه دهنده:

سید محمدرضا علوی‌پور

(PhD, PMP, CMIT)

دانشگاه Illinois Tech آمریکا

What we will learn?

- History
- Definition
- Scale of construction industry
- Industry sectors
- Construction project format
- Construction project players
- Career opportunities

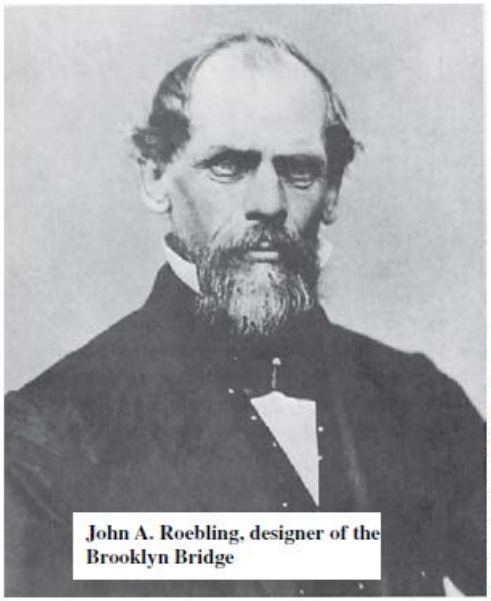
HISTORY

History of construction industry

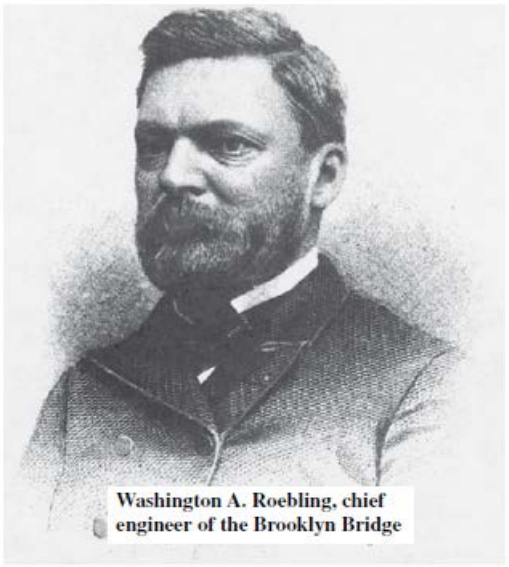
- Construction and the ability to build things is one of the **most ancient of human skills**.
- As society became **more organized**.
- The pyramids and Greek temples, such as the Parthenon, are **impressive testimony** to the **building skills** of the civilizations of antiquity.

The Parthenon in Athens

History of construction industry


John A. Roebling, designer of the Brooklyn Bridge

American Society of Civil Engineers


Washington A. Roebling, chief engineer of the Brooklyn Bridge

Special Collections and University Archives, Rutgers University Libraries


Emily Warren Roebling, wife of Washington Roebling

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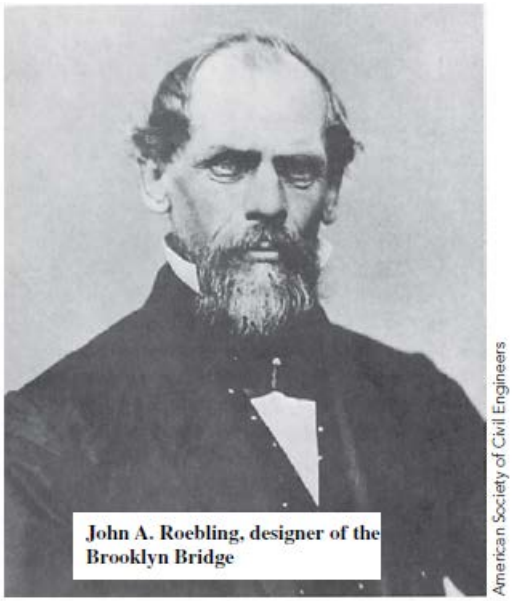
- The **Roebling family** as a group can be **credited** with building the **Brooklyn Bridge** during the period 1869 to 1883. It was the **greatest project of its time** and required the use of technology at a scale never before tried. The concept of a **cable-supported suspension bridge** was perfected by John A. Roebling. Roebling was born in **Germany** and was the **favorite student** of the famous philosopher Hegel.
- Upon his death (**precipitated** by an **accident** that occurred during the **initial survey of the centerline of the bridge**) his son, Washington, took charge.

History of construction industry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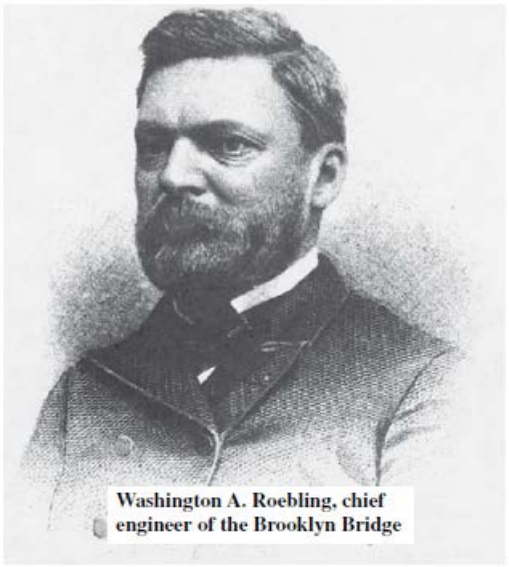
Washington A. Roebling, chief engineer of the Brooklyn Bridge

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Emily Warren Roebling, wife of Washington Roebling

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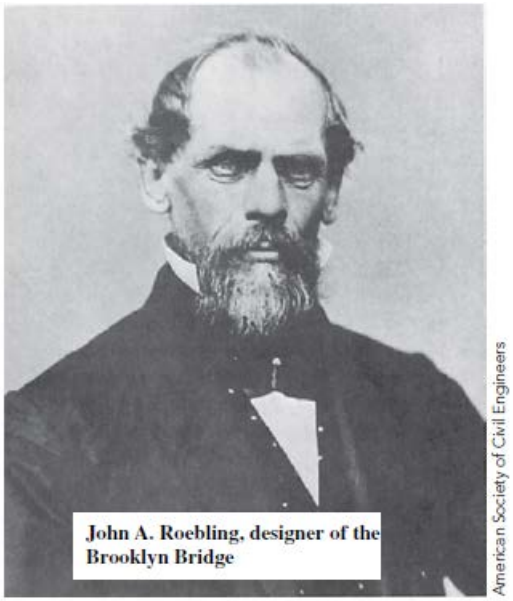
- **Washington Roebling** received his training in civil engineering at **Rensselaer Polytechnic Institute**.
- **Like his father**, he was a man of great vision and courage.
- He solved numerous problems as the great towers of the bridge rose above **New York City**.
- He ultimately suffered from a mysterious illness

History of construction industry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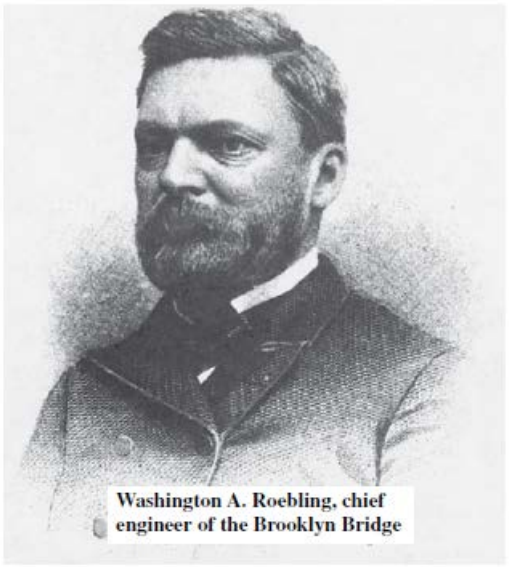
Washington A. Roebling, chief engineer of the Brooklyn Bridge

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Emily Warren Roebling, wife of Washington Roebling

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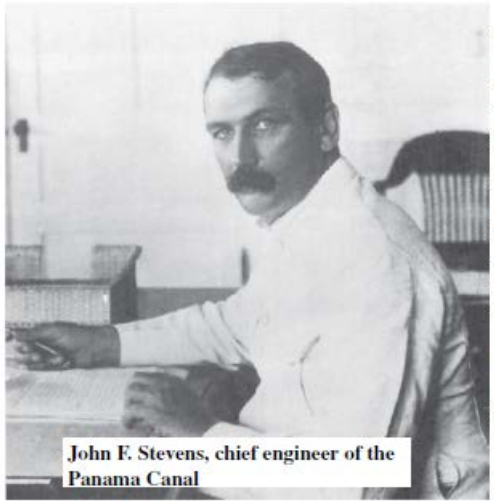
- **Although incapacitated**, Washington continued to **supervise the work from an apartment** that overlooked the site.
- At this point, Emily, **Washington's wife**, entered the picture.
- She was able to gain the **confidence and respect** of the site engineers.

Panama Canal

- The **end of the 19th century** was a time of visionaries who conceived of projects that would **change the history of humankind**.
- Since the time Balboa crossed **Panama** and discovered the **Pacific**, planners had conceived of the idea of a water link between the **Atlantic and the Pacific oceans**.
- Having successfully **connected** the Mediterranean with the Red Sea at Suez, in **1882** the **French** began work on a canal across the narrow Isthmus of Panama, which at that time was **part of Colombia**.
- After struggling for **nine years**, the French were ultimately **defeated** by the formidable **technical difficulties** as well as the **hostile climate** and the scourge of **yellow fever**.


John F. Stevens, chief engineer of the Panama Canal

Courtesy of Georgetown University Library, Booth family Center for Special Collections

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Panama Canal

- **Stevens** understood the **organizational aspects** of large projects.
- He immediately realized that the **working conditions** of the laborers had to be improved.
- He also understood that **measures** had to be taken to **eradicate the fear of yellow fever.**
  - To address the first problem, he constructed **large and functional camps** for the workers in which **good food was available**.
  - To deal with the problem of yellow fever he enlisted the **help of an army doctor** named William C. Gorgas.
    - ✓ **Prior to being assigned** to Panama, Dr. Gorgas had worked with Dr. Walter Reed to **wipe out yellow fever in Havana**, Cuba.

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Panama Canal

- He had come to **understand** that the key to **controlling and eliminating** this disease was, as Dr. Reed had shown,

  the **control of the mosquitoes** that carried the dreaded infection.

- **Dr. Gorgas** was successful in **effectively controlling** the threat of yellow fever,

  but his success **would not have been possible** without the total commitment and support of **John Stevens**.

Panama Canal

- Having established an
  1. **Organizational framework** for the project
  2. Provided a **safe and reasonably comfortable environment** for the workers,
- Stevens addressed the **technical problems** presented by the project.
- The **French** had **initially conceived of a canal built** at sea level and similar to the Suez Canal.
  - Due to the **high ground and low mountains** of the **interior portion** of the isthmus,

    it became apparent that this approach **would not work**.


Hulton Archive/Getty Images, Inc.
Construction of a lock at the Panama Canal

Panama Canal

- **To solve the problem** of moving ships over the interior,

  it was decided that a set of water steps, or locks, would be needed

  to **lift the ships** transiting the canal up and over the high ground of **Central Panama and down to the elevation** of the opposite side.

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Panama Canal

- Stevens **abruptly resigned**. It is **not clear** why he decided not to carry the project through to completion.
- **President Roosevelt** reacted to his resignation by **appointing a man** who, as Roosevelt would say, **"could not resign."**
- Roosevelt selected an **army colonel** named George Washington Goethals to **succeed Stevens.**
- Goethals had the **managerial and organizational skills** needed to push the job to successful completion.

Panama Canal

- Rightfully so, **General Goethals** received a great deal of credit for the construction of the Panama Canal.
  - However, primary credit for pulling the **job "out of the mud,"** getting it on track, and **developing the technical concept** of the canal that ultimately led to success must be **given to Stevens**—a great engineer and great construction manager.

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The 20th century

- Although **only a few advances** in materials or technologies took place during the 20th century,

  new challenges were being imposed on 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.

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The 20th century

- 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.

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The 20th century

- The industry began to recognize that the **correlation** between
  1. Sound **management** techniques
  2. Successful **building** practices

- The **ability** to measure and monitor
  1. Progress
  2. 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.

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The 20th century

- 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**
  1. Management principles,
  2. Methodologies, and
  3. 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.

The 20th century

- 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.

The 20th century

Welcome to The Associated Schools of Construction

The professional association for the development and advancement of construction education, where the sharing of ideas and knowledge inspires, guides and promotes excellence in curricula, teaching, research and service.

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The 20th century

- **Today**, there are **more than 160 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.**

You will learn this history in next session

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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.

The age of technology

- **Technologies** such as
  - Global positioning systems (GPS),
  - Building information modeling (BIM), and
  - Virtual and augmented reality
  - Artificial intelligence

  are allowing **construction managers** to enter and interact with structures that exist only in cyberspace.

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The age of technology

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.

DEFINITION

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Built environment

- Developing the **built environment**—

  adding or changing functions

  in the underlying natural, economic, and social environments—

  means imagining **facilities** and **physical infrastructures**.

- These **facilities and infrastructures** have residential, commercial, governmental, industrial, recreational, transportation, and utility uses.

Built environment

- In **categorizing these businesses** by industry, this course refers to the North American Industry Classification System (NAICS),

  which "is the **standard** used by federal statistical agencies in classifying **business establishments** for

  purpose of collecting, analyzing, and publishing **statistical data** related to the U.S. business economy" (NAICS 2017).

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Built environment

- An **essential BE industry** includes companies within the
  - Architectural,
  - Engineering, and
  - Related Services NAICS category,

  which provide planning, design, and other consulting services.

- The **title** of this course includes the word **"construction,"**

  because **companies** within the **Construction category** are those physically translating design into facilities and infrastructures.

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Built environment

- Given their **built environment-centered focus**, these companies are sometimes referred to as a **single industry**:

  the architecture– engineering– construction industry (AEC).

- The **following sections** provide a **current overview** of these industries through **critical statistics** from the
  - United States (U.S.) Bureau of Labor Statistics (BLS) and
  - U.S. Bureau of Economic Analysis(BEA)

SCALE OF CONSTRUCTION INDUSTRY

Architectural, engineering, and related services(AE)

- **AE** businesses provide a large number of services that are needed to develop the built environment, including

  architectural, engineering, drafting, surveying, and testing services.

- According to the BEA data, the gross output of the AE industry **peaked in 2008** at $285 billion.

- Though the **AE industry** was hit by the Great Recession, its economic performance has slowly recovered since 2011.

- In 2015, its gross output was **equal to $280 billion**, nearing its **2008 peak.**

Construction

- Construction businesses provide **many services** that are needed to develop the built environment,

  including the construction of buildings, infrastructures and industrials.

- **Construction services** may contribute to the
  - Development of **new facilities/ infrastructures**,
  - As well as additions, alterations, repairs, or maintenance to existing facilities/ infrastructures.

Construction

- According to the **BEA data**,

  the **dollar value** of the construction industry reached a **peak in 2006** when it added $698 billion to the U.S. economy,

  which was equal to 5.0% of the gross domestic product (GDP) of the United States.

- While the industry was **hit hard** by the Great Recession between 2007 and 2010,

  its economic performance has **improved again since 2011**.

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Construction

- In 2016, its dollar value added **$784 billion** to the U.S. economy, which was equal to **4.2% of the GDP**.

  - Whereas these **economic statistics** are massive in absolute numbers, the **contribution of the construction industry** to the GDP has been actuating from 3.5% to 5% since 1947.

Let's look at the whole industry!

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Construction industry statistics

- Construction is big, **big business**—reaching **$10.6 trillion** in spending worldwide in **2017**, and

  projected to reach $12.7 trillion by 2022, and

  $15.5 trillion by 2030,

  according to the *Construction Intelligence Center, Orbis Research, and other sources.*

  - And there appears to be **no slowdown** in sight.

- The industry employs **more than 7 million people** directly (plumbers, carpenters, welders, and so on) and

  hundreds of thousands more indirectly.

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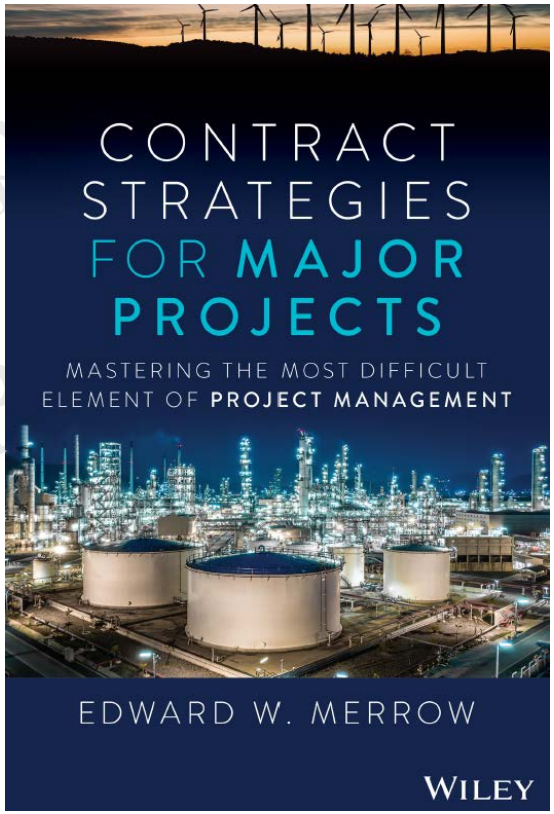
Construction industry statistics

- It is **larger than** the automobile and steel industries **put together**.
- According to the U.S. Census Bureau, **2017** ended with **approximately $1.257** 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 791,772 **private construction companies** employing approximately 6.7 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

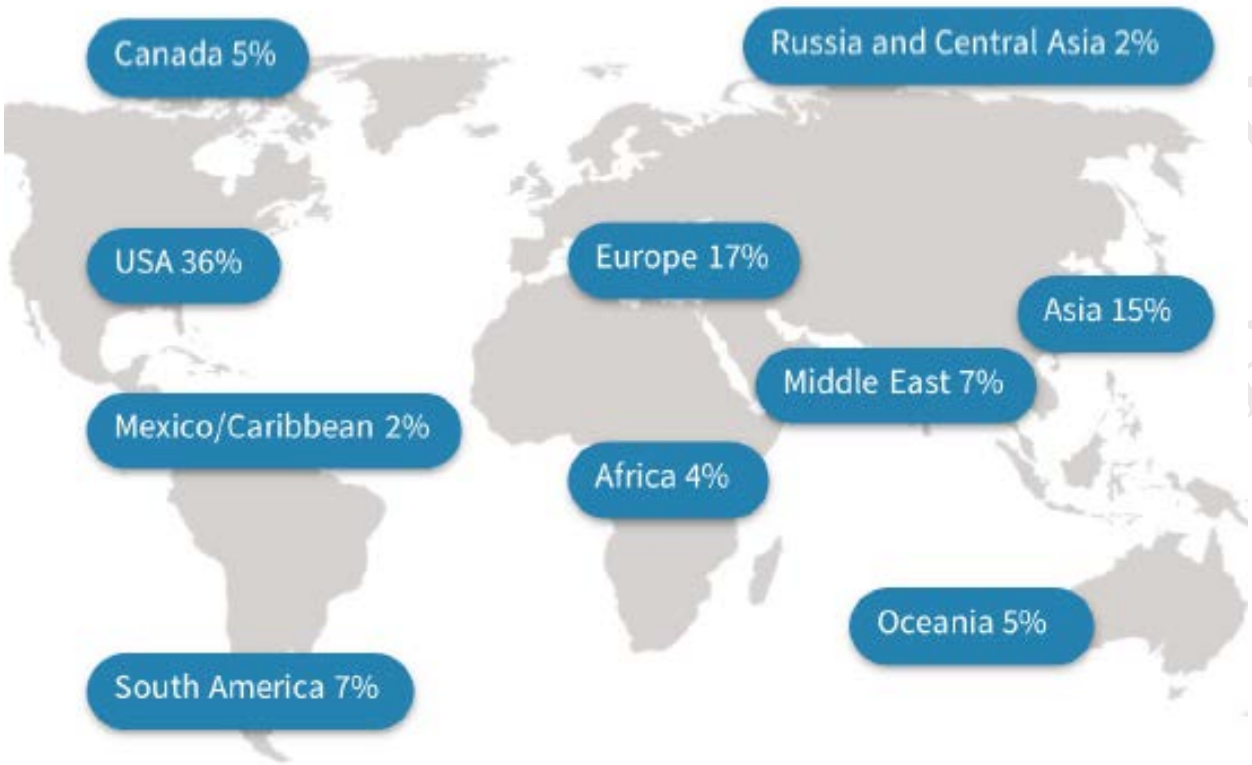
  statistically an **additional 1.6 million individuals** do just that.

Construction industry statistics

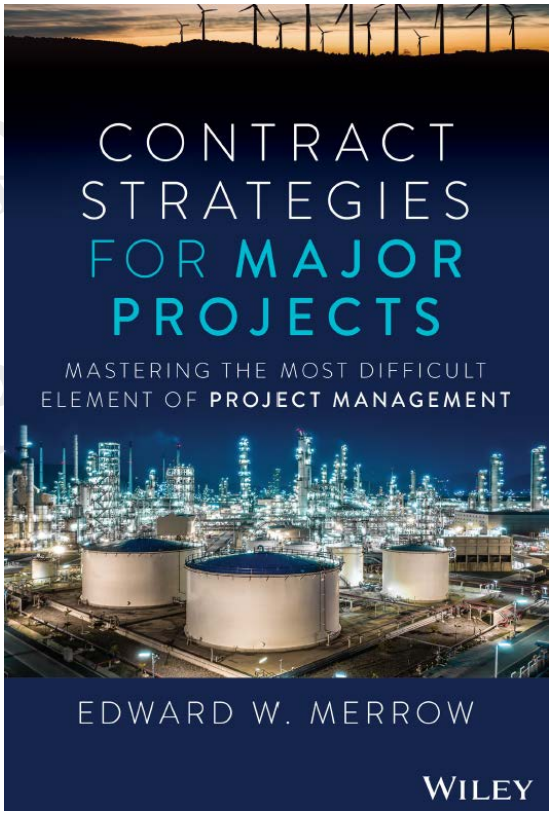
Contracting Database	
Project Characteristics	
Number	1,148
Average project cost (2022 USD)	$460 million
Range of project costs (2011 USD)	$15.5 million to $15.8 billion
Average execution duration	27 months
Average cycle time duration	46 months
Number of owners represented	109
Mean authorization year	2Q 2009
Projects with any new technology	7.5%



Construction industry statistics

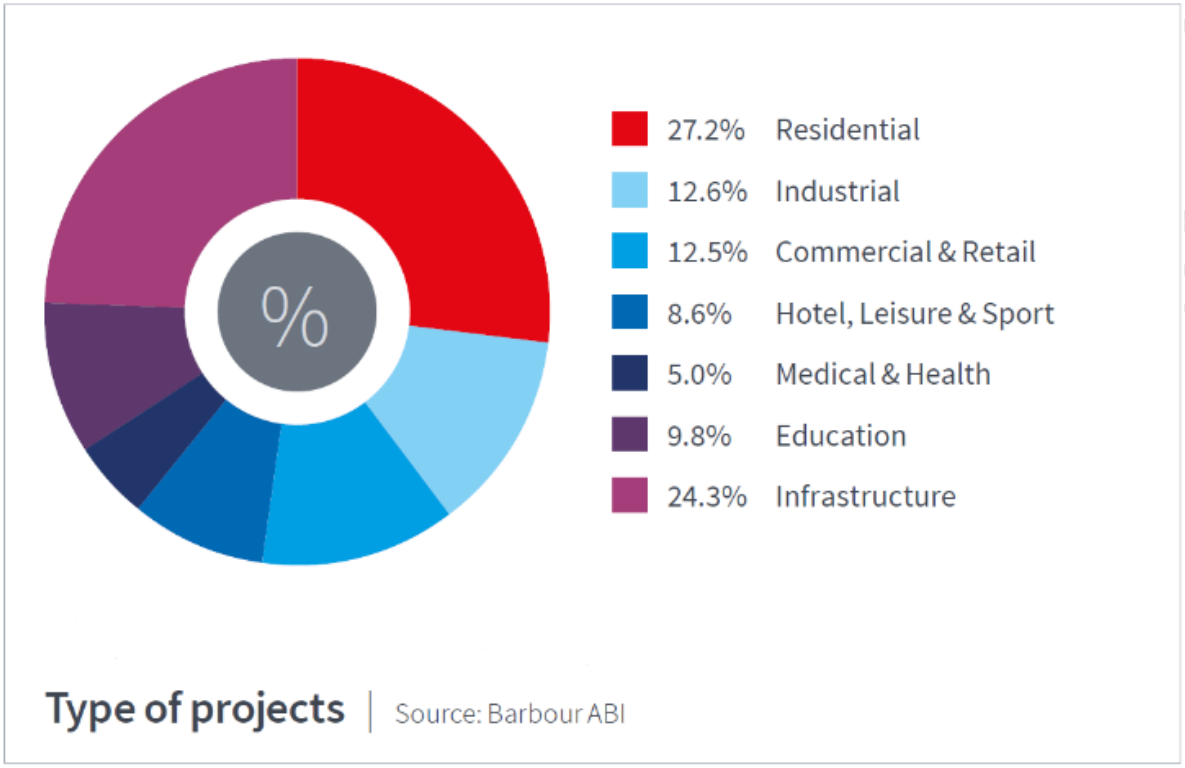


Project sample geographical distribution.



Construction industry statistics

The latest edition of the **Economic & Construction Market Review** from industry analysts Barbour ABI, highlights levels of construction contract values awarded across **Great Britain.**



Download the full report here: http://ubm.io/2FRLrwm

Construction industry statistics

- 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.

Construction industry statistics

- 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.

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Construction industry statistics

- Architects, engineers, 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.

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**.

INDUSTRY SECTORS

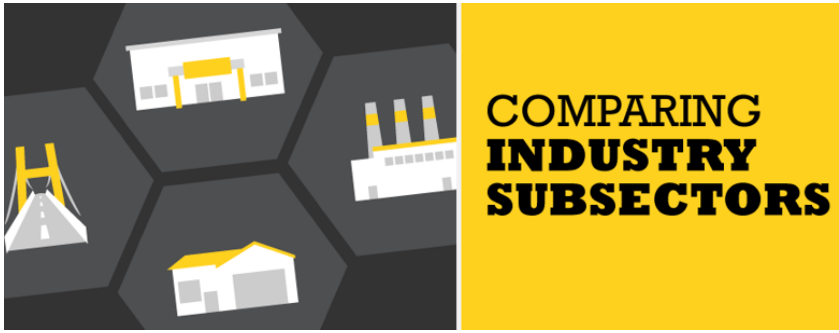
Industry sectors

See Videos 1 and 2

Industry sectors

- Each of these different facility needs is **depicted 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



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Industry sectors

- **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.*

Industry sectors

- **Each sector** requires specific expertise and familiarity in order to **optimize** the **construction operations and management** efforts.
  - Therefore, the **majority of experts** 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:
  1. Individual homes,
  2. Apartments,
  3. Condominiums,
  4. Townhouses, and
  5. Prefabricated units such as modular and manufactured homes

*Residential construction is typically **funded by private** individuals or developers for **their own use or for sale**.*

NOTE

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

Residential building

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.

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Residential building – Characteristics

- Whether the **residential construction** firm is
  1. A small mom-and-pop operation or
  2. 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.

Residential building – Characteristics

- 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.

Residential building – Characteristics

- **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.

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Commercial building

- This sector of the industry primarily addresses the needs of commerce 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.

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Commercial building

- 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
  1. The project duration is **much longer**.
  2. It is **not uncommon** for a commercial project to **last three years or more**.

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Commercial building

- **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**.*

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Commercial building

- **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**.*

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Commercial building

- **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**.*

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Commercial building – Characteristics

- 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 course.

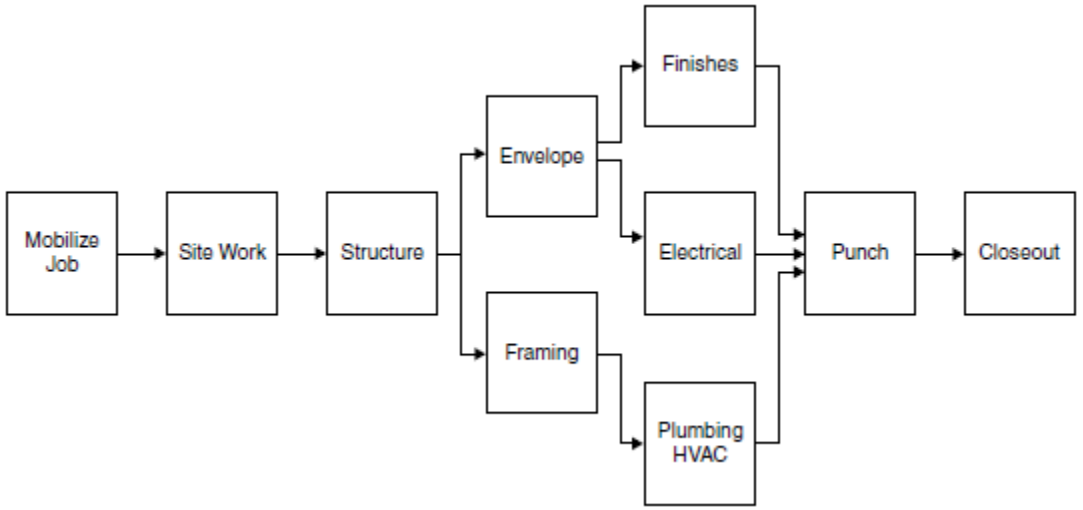
project delivery
A comprehensive process by which a building, facility, or structure is designed and constructed.

Commercial building – Characteristics

- 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.

Heavy civil construction

- **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**.

Heavy civil construction

- These projects are **typically designed** by civil engineers, and often the **construction management team** has a strong background in **civil engineering** as well.

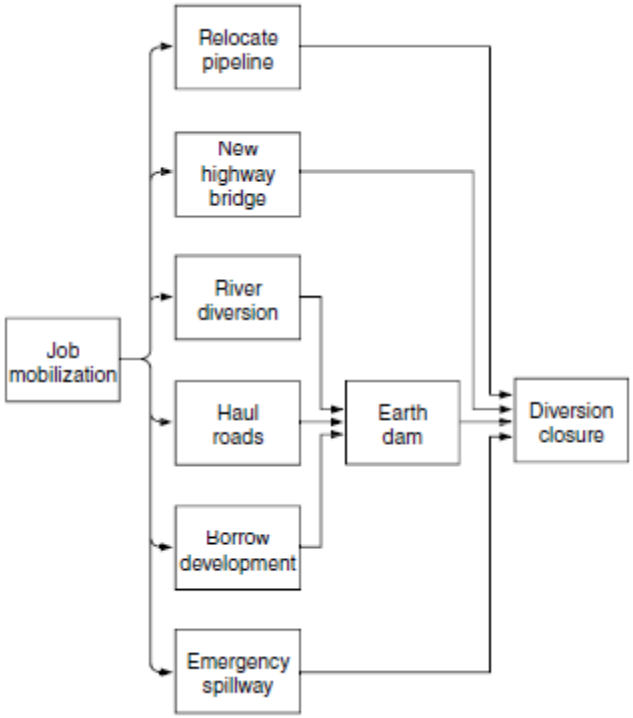
- Heavy civil construction firms are generally **very large operations** that can offer opportunities nationally and internationally.

  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.

Heavy civil construction – Characteristics

- These projects are **usually publicly funded** and tend to **last for a long time**.
- It is **not unusual** for **individuals involved** in this sector of the market to **move temporarily** to where the project is **located**.
- This sector of the market is the **least affected by economic fluctuations** and, therefore, can offer a **reasonable measure** of job stability.



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Industrial construction

- This sector of the industry is
  1. **Highly specialized** and
  2. Requires firms with
     - Vast **resources**
     - 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.*

Industrial construction – 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.

Industrial construction – Characteristics

- 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.

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Environmental construction

- Although some people may lump **environmental construction** under the **heavy civil category**,
  - ✓ some people believe 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.

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Environmental construction

- 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**.

Environmental construction

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!

Environmental construction – 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.

Environmental construction – Characteristics

- **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.

Environmental construction – Characteristics

- 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.

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Industry sectors

- A **slightly different approach provided by North American Industry Classification System (NAICS)** that subdivides construction businesses into three sectors:

  (a) Construction of Buildings

  (b) Heavy and Civil Engineering Construction, and

  (c) Specialty Trade Contractors

Industry breakdown

- A **slightly different approach** to project classification is used by the Construction Market Trends Section of the **Engineering News Record (ENR) magazine**, which reflects the weekly dynamics of the construction industry in the **United States**.

- This breakdown of construction identifies **three major construction categories**:
  1. Heavy and highway
  2. Nonresidential building
  3. Multiunit housing

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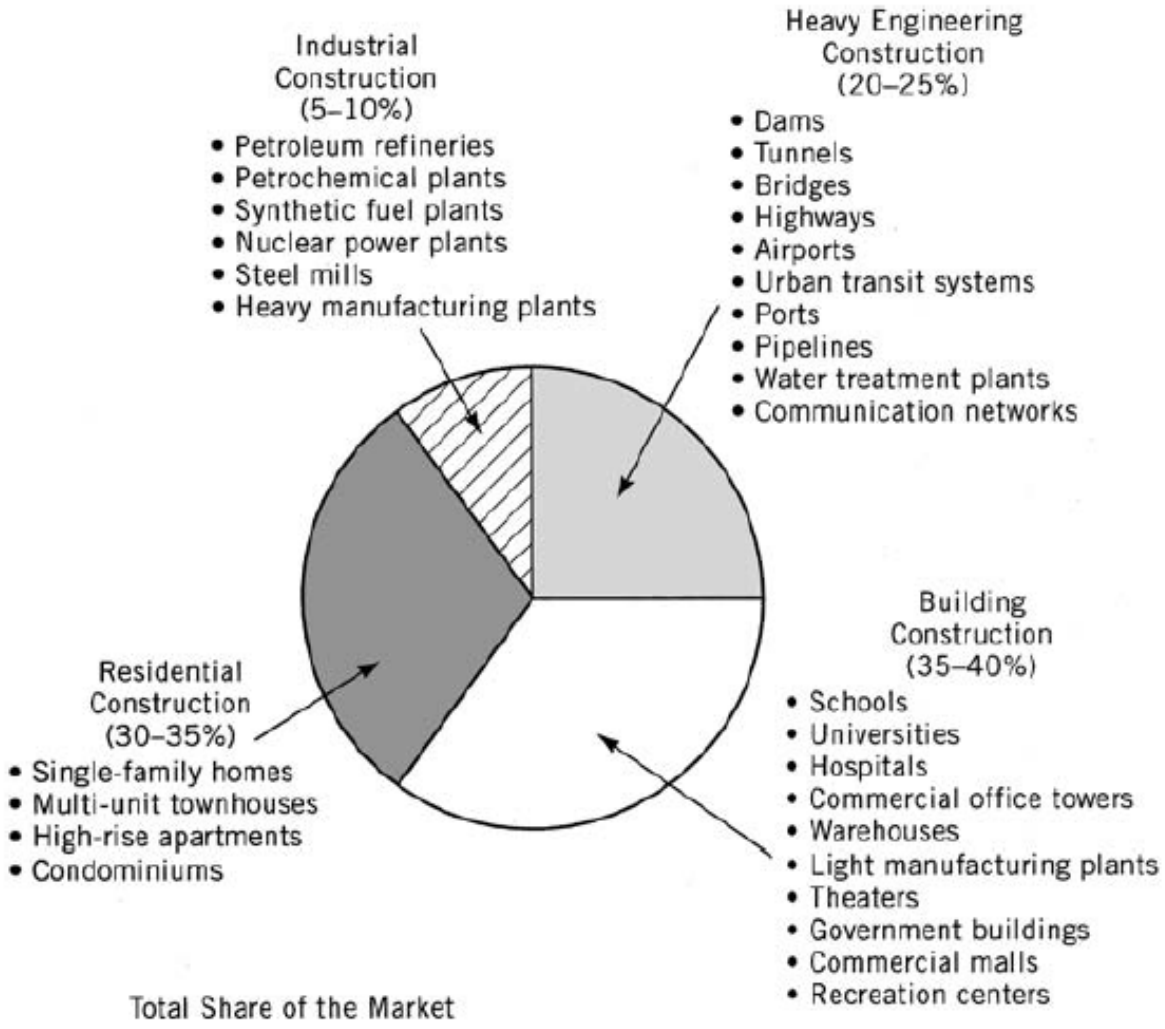
Industry breakdown

- The **nonresidential building** category includes building and industrial construction as defined.
- ENR publishes an **update of information** based on this set of construction categories **each week**.
- In addition to this information regarding individual project categories, the ENR indexes derived from a **20-city base** are also reported.
- These indexes indicate **industry trends** and provide the **construction manager** with a nationwide view of the construction industry.

Industry breakdown



CONSTRUCTION PROJECT FORMAT

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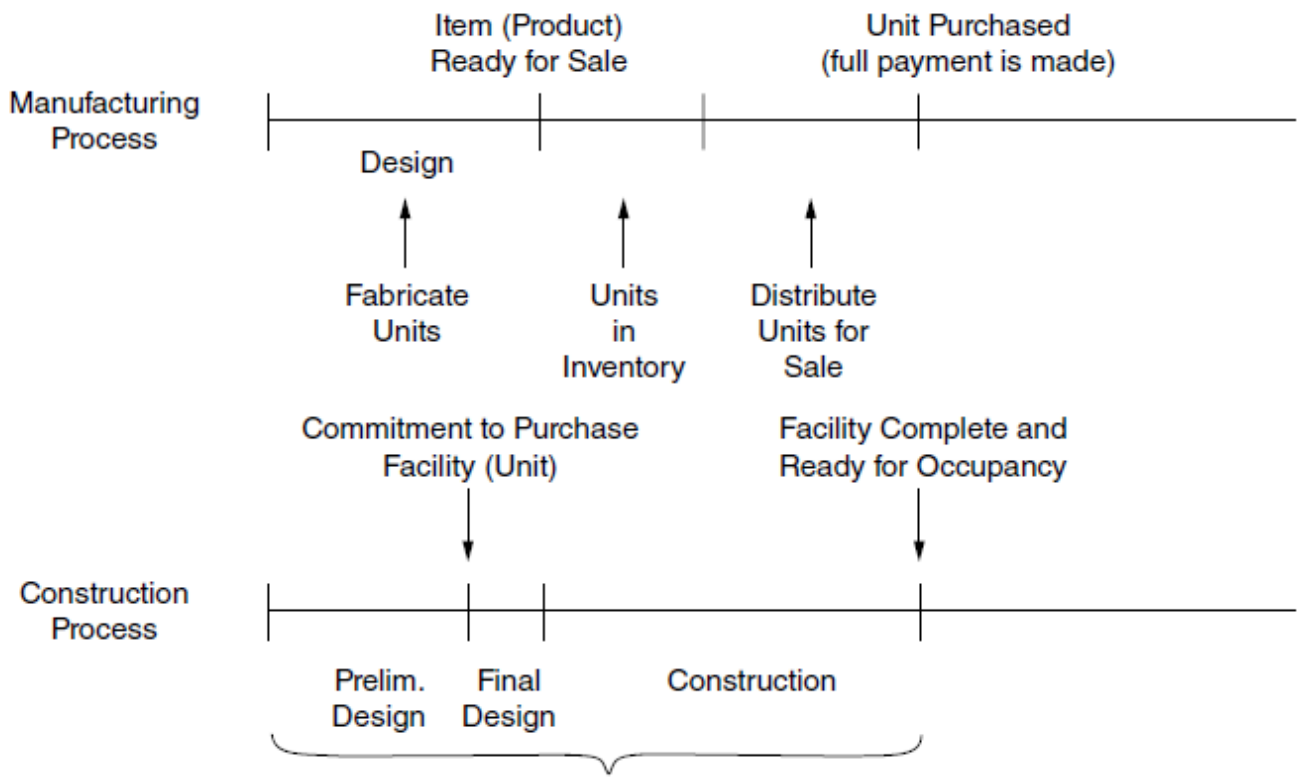
Introduction

- In **contrast** to other manufacturing industries
  that fabricate **large numbers of units** such as automobiles or computers,
  the construction industry is **generally focused** on the **production of a single and unique end product**.

- That is, the product of the construction industry is a facility that is usually **unique** in design and method of fabrication.

- It is a single "one-off" item that is stylized in terms of its function, appearance, and location.

Construction vs. Manufacturing processes



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Construction vs. Manufacturing processes

- **Mass production** and **batch production** are not typical of the construction industry.

  Because the industry is oriented to the production of single unique units, the **format** in which these **one-off units** are achieved is called the **project format**.

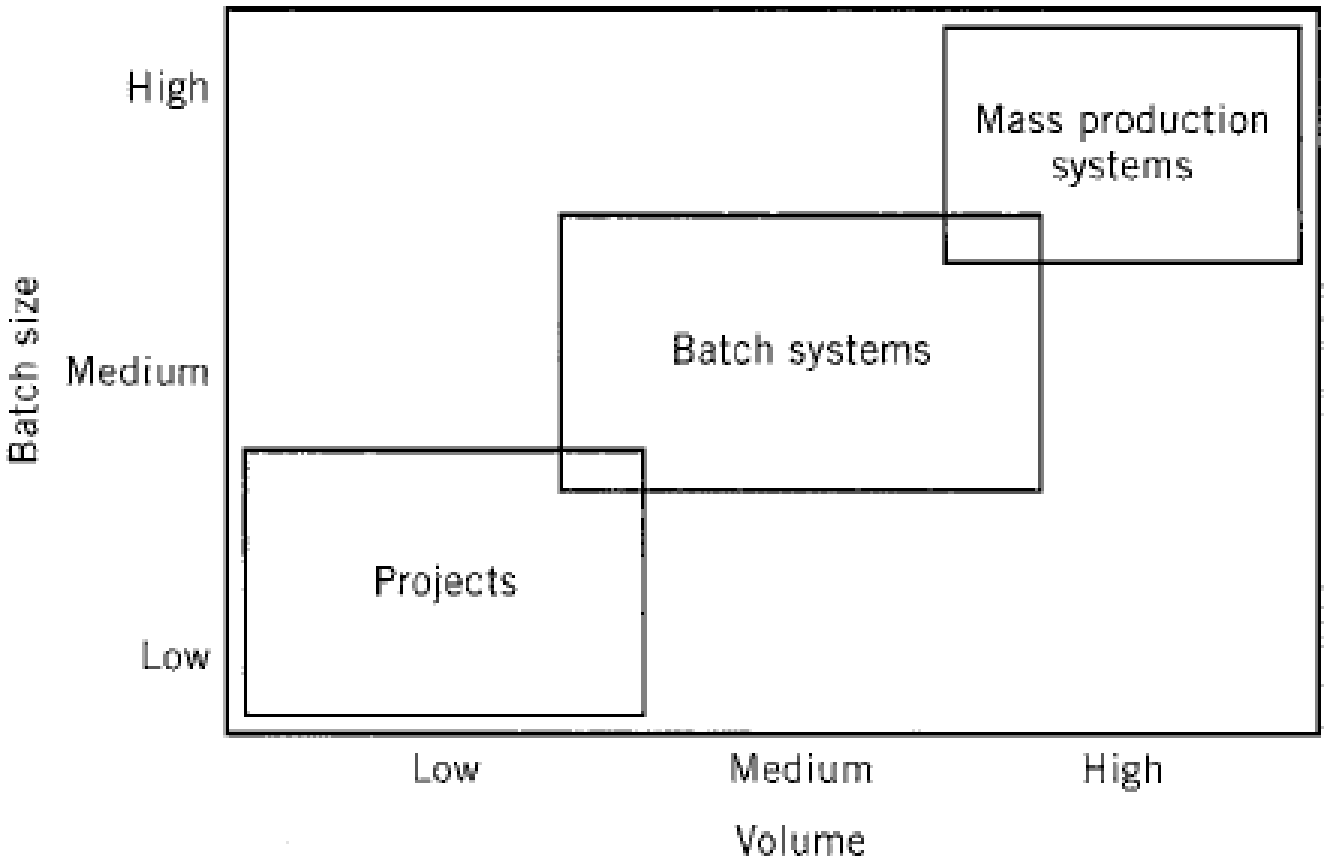
Both the design and production of constructed facilities are realized in the framework of a project.

Construction vs. Manufacturing processes

- The **focus of construction management** is the planning and control of resources within the **framework of a project**.

- This is in **contrast** to other manufacturing sectors that are interested in the **application of resources** over the **life of an extended production run** of many units.

Construction vs. Manufacturing processes



Comparison of production systems

CONSTRUCTION PROJECT PLAYERS

Introduction

- 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**.

It is very important to understand the various roles and responsibilities of these many players as they influence the construction management process.

Introduction

- In addition to getting to know the **primary players** in the game,

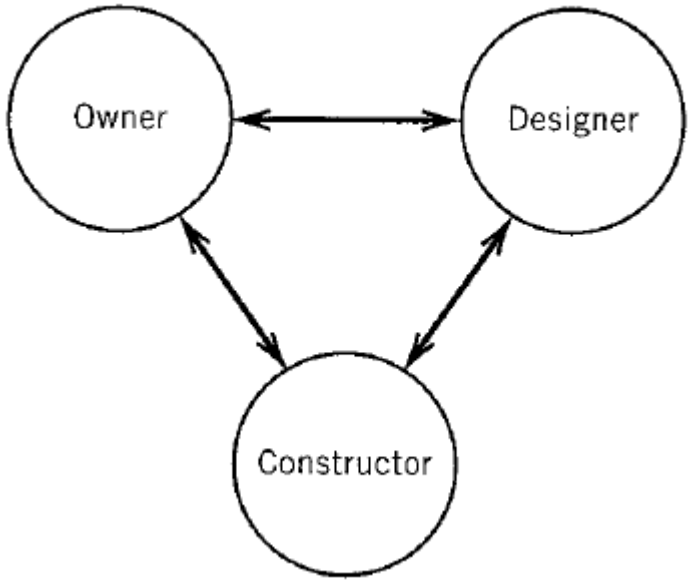
  you need to know the **secondary players** involved and the various layers of **influence and risks** associated with their involvement.

- Understanding the **intricacy of these relationships**

  will help you **appreciate the management function** in construction.

Primary players

1. Owners
2. Design professionals
   - ❖ Architects
   - ❖ Engineers
   - ❖ Landscape architects
   - ❖ Interior designers
3. Construction professionals
   - ❖ General contractors
   - ❖ Construction managers
   - ❖ Specialty contractors
   - ❖ The building trades



Primary players

- Although these **three parties** are **always involved** in a project,

  the alignment and contractual relationships among them

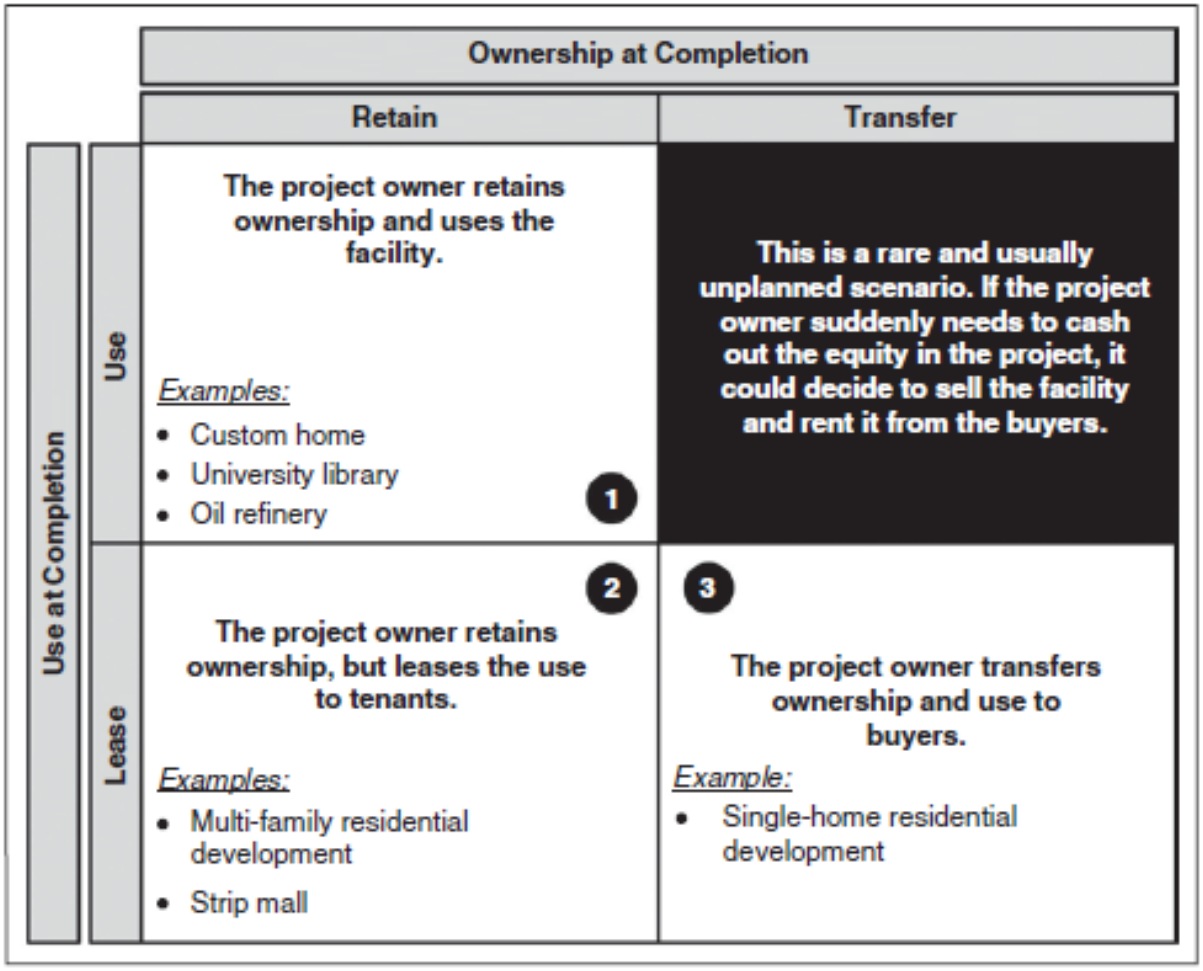
  will **vary depending** on the project delivery system utilized to deliver the project.

  - Project delivery will be discussed later.

- ***"What Is Construction Management?"***

  - *Each of these parties provides **distinct services** and has **specific accountabilities** necessary to fulfill the building objectives.*

Primary players



Ownership and Use at Completion

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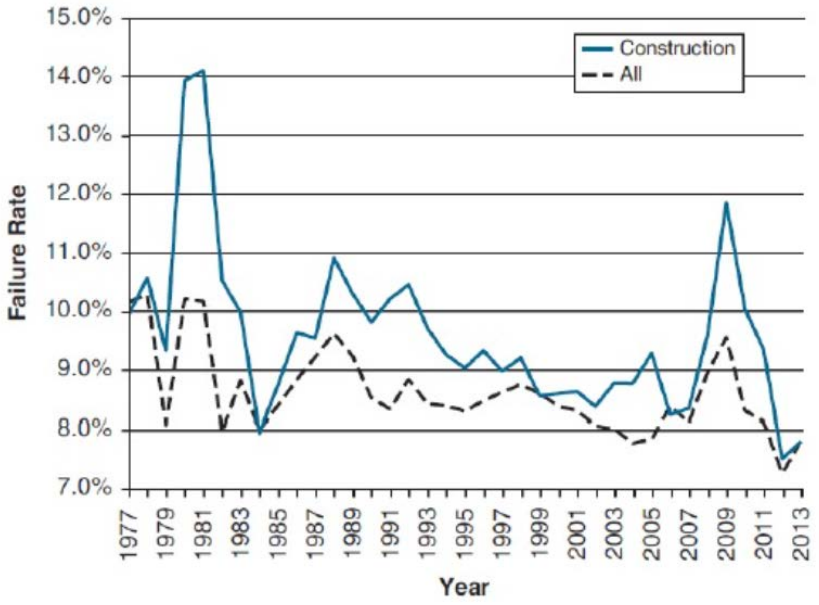
Secondary players

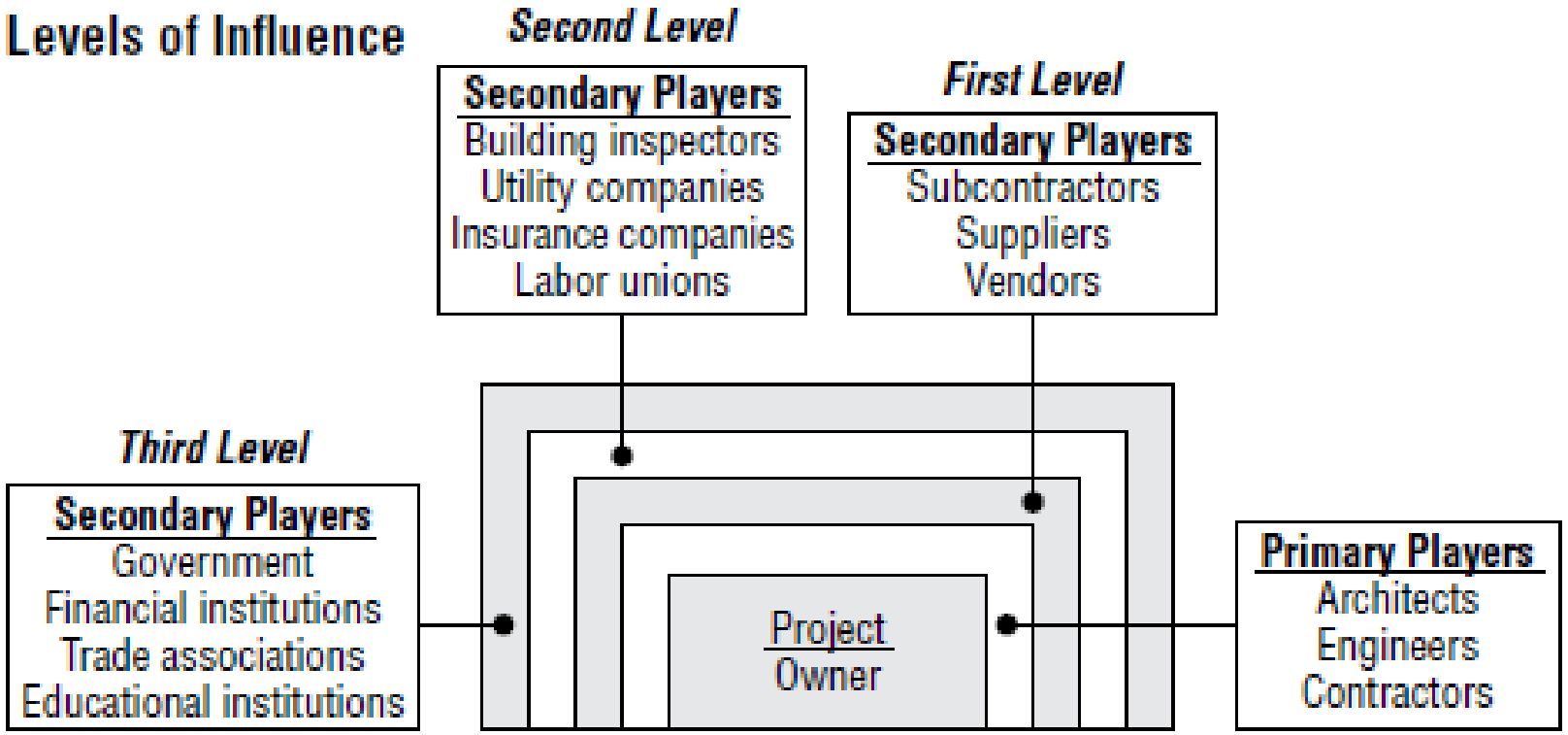
- Construction is **second only** to the restaurant business when it comes to **high-risk business endeavors.**
- **Four out of five construction companies** will go out of business during **their first year.** *There are many factors for this.*
- These **secondary players**, or what we call layers of influence, are **beyond the immediate control** of any of the primary players.

- ***We have divided these layers of influence into three levels.***



شکل ۱. نرخ ورشکستگی در صنعت ساخت نسبت به سایر صنایع

Secondary players



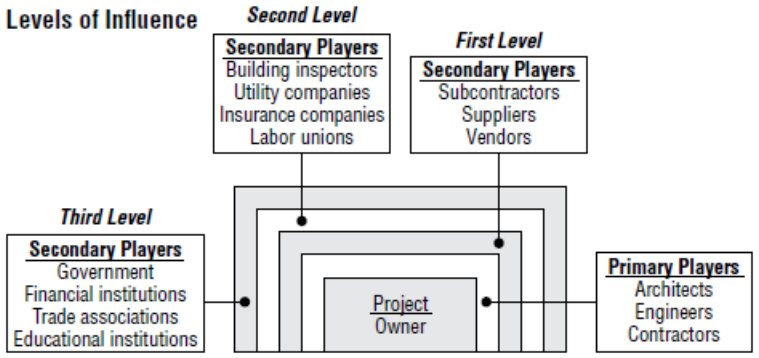
Secondary players – First level players

- 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.



Secondary players – First level players: Example

- 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.

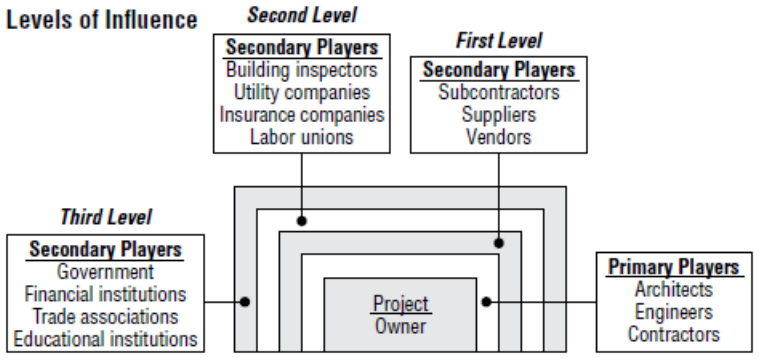
  - The **delivery doesn't arrive**, and the **subcontractor goes off to start another job**.
  - The **block delivery then shows up** on Tuesday,

    but the **subcontractor is unwilling to return** to your job **until he finishes** the one that he **has already started**.

Secondary players – 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.



Secondary players – Second level players: Example

- 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,

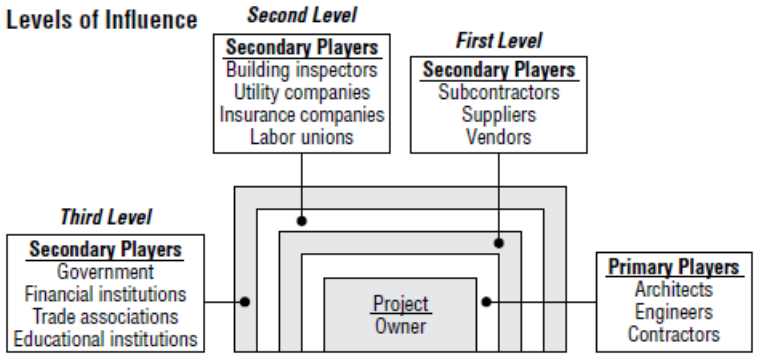
  delaying the completion of the job, delaying the opening of the store, and, therefore, costing the owner thousands of dollars

  in lost revenue for each day of delay.

Secondary players – 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**.



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Secondary players – Second level players

- For instance, **government agencies** that adopt policies or create n**ew 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
    - **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 a**bility of the construction manager** to deliver a quality product on time and within budget to the owner.

CAREER OPPORTUNITIES

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Career opportunities

- According to the **U.S. Bureau of Labor Statistics**,

  *"employment of **construction managers** is projected to **grow 10 percent** from **2016 to 2026**,*

  ***faster than** the **average for all occupations**."*

- Those with a **bachelor's degree** in
  1. Construction science,
  2. Construction management, or
  3. Civil engineering,

  coupled with **construction experience**, will have the best job prospects.

  - The **bottom line** is that the industry **needs more construction managers** than the **universities can turn out**.
    - ✓ As the **level and complexity of construction activity** continues to grow, so will the **demand** for qualified construction managers.

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Distinguishing construction companies

- One of the things that makes a **career in construction** so appealing is that the **firms that perform construction services** come in all shapes and sizes, across all sectors of the industry.
- One of the ways we distinguish construction companies is by their **geographical reach.**
- Construction companies may be identified as local, regional, national, and even international.
- You can find
  - **Sector-specific companies**
  - Within each **type of geographical distinction**

    —residential, commercial, civil, industrial, and environmental.

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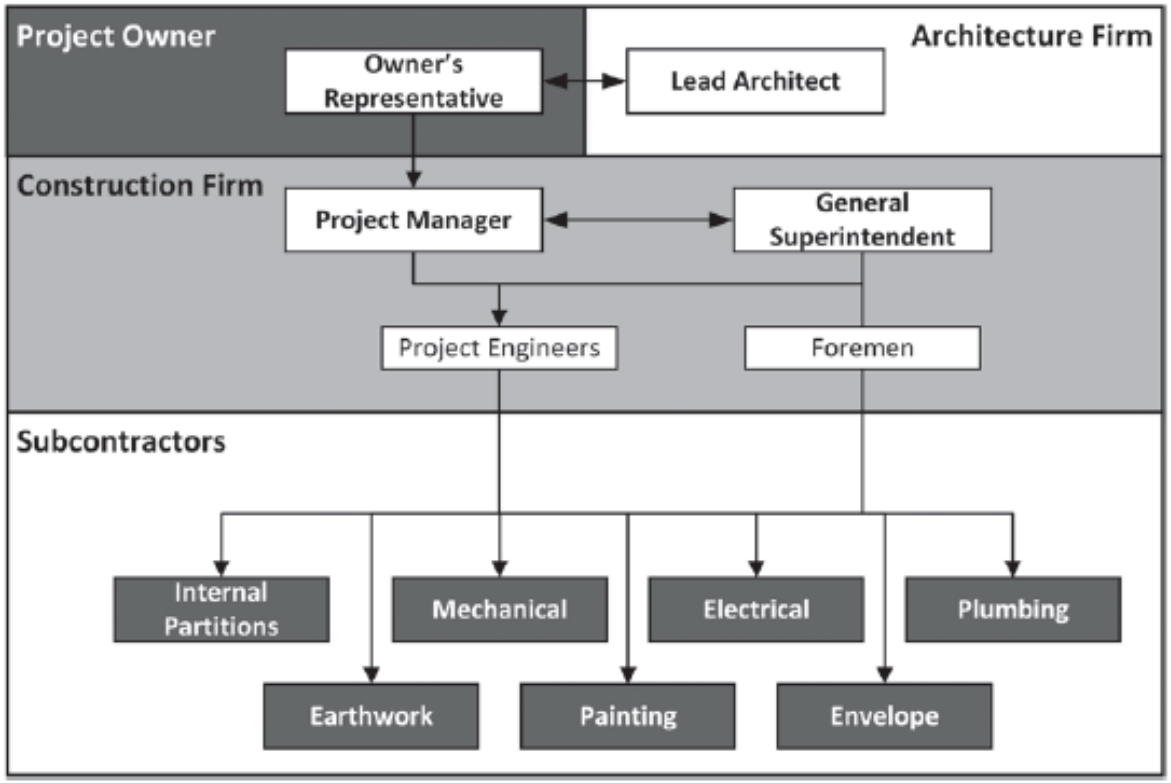
Distinguishing construction companies

Sample of Types and Sizes of Companies				
Company Name	**Scope**	**Primary Sector**	**Employees**	**Headquarters**
Vertix Builders	Local	Commercial	14	Frederick, CO
Thrive Home Builders	Local	Residential	21	Denver, CO
Texas Cordia Construction	Local	Civil	45	Edinburg, TX
Haselden Construction	Regional	Commercial	302	Centennial, CO
Pahlisch Homes	Regional	Residential	111	Bend, OR
Wollam Construction	Regional	Civil	32	Sandy, UT
Hensel Phelps Construction	National	Commercial	3167	Greeley, CO
Lennar Homes	National	Residential	9111	Miami, FL
Granite Construction	National	Civil	3600	Watsonville, CA
Skanska	International	Commercial, Civil, Residential	42,903	Stockholm, Sweden
Balfour Beatty	International	Commercial, Civil, Industrial	26,000	London, UK
Bechtel Group Inc.	International	Commercial, Civil, Environmental	55,000	Reston, VA

*Employee numbers are approximate for 2017–2019.

The built environment by functional role and occupation



Project Organizational Chart

The built environment by functional role and occupation

Project Owner

- The **project owner**, also simply referred to as the owner or the client, is the company or individual at the **top of the organization chart**.
- The **project owner** will have in-house representatives who contractors and designers **communicate** with and report to.
- Some **larger owner companies** may also have in-house design and construction capabilities.
- The **owner's facility manager** and **maintenance personnel** take over operations of the building once the construction is complete.

The built environment by functional role and occupation

Design Team

- The **design team** is headed by
  1. An architectural firm for **commercial projects** and
  2. A civil engineering firm for **heavy-civil projects**
- These firms will have a **contact person**, who may carry the **title of Project Manager** (PM) of construction projects,

  similar to that of a **contractor**.
- The **lead design firm** also employs a variety of other design disciplines, such as
  - Landscape architecture,
  - Structural engineering,
  - Mechanical engineering, and
  - Electrical engineering.

The built environment by functional role and occupation

Consulting Firms

- There are a **variety of other firms** involved in the development of built environment projects that may **contract directly with the owner**
  1. As **consultants** or
  2. Serve the lead design firm as **sub-consultants**

     in various specialties, including estimating, scheduling, lighting, and waterproofing.
- Each of **these consulting firms** will have a variety of **individuals working** for them in **addition to their PM**,

  including the architect, lead designer, engineers, draftsmen, computer-aided design (CAD) or building information modeling (BIM) technicians, specification writers, and shop drawing checkers.

The built environment by functional role and occupation

- Employees in the architecture and engineering disciplines are a significant portion of the **AEC industry**,

  as shown by its **employment data**.

- Next Table shows the **2016 employment and wage estimates**

  for some of the architecture and engineering occupations that support the AEC industry.

The built environment by functional role and occupation

2016 Employment and Wage Estimates for Selected Architecture and Engineering Occupations

Occupation Title	*Employment*	*Mean Hourly Wage*	*Annual Mean Wage*
All Occupations	**140,400,040**	**$23.86**	**$49,630**
Architecture and Engineering Occupations (All)	***2,499,050***	***$40.53***	***$84,300***
Architects, Surveyors, and Cartographers	*174,720*	*$36.66*	*$76,260*
Licensed Architects (*)	99,860	$40.61	$84,470
Landscape Architects	19,420	$33.08	$68,820
Surveyors	43,340	$30.52	$63,480
Engineers (All)	*1,635,420*	*$46.37*	*$96,440*
Civil Engineers	287,800	$43.14	$89,730
Electrical Engineers	183,770	$47.41	$98,620
Environmental Engineers	52,280	$42.56	$88,530
Health and Safety Engineers (**)	25,410	$43.36	$90,190
Mechanical Engineers	285,790	$43.17	$89,800
Drafters and Technicians (***)	*688,900*	*$27.66*	*$57,530*
Architectural and Civil Drafters	96,810	$26.10	$54,290
Civil Engineering Technicians	72,150	$25.06	$52,120
Environmental Engineering Technicians	16,550	$25.24	$52,500
Surveying and Mapping Technicians	53,920	$21.87	$45,490

(*) Except Landscape and Naval Architects
(**) Except Mining Safety Engineers and Inspectors
(***) Drafters, Engineering Technicians, and Mapping Technicians

Adapted from U.S. Bureau of Labor Statistics, May 2016 National Occupational Employment and Wage Estimates, United States (BLS 2017)

The built environment by functional role and occupation

- Based on these estimates, architecture and engineering occupations
  employ **nearly 2.5 million individuals**,
  equal to 2% of the **domestic workforce**.
  - However, a **large number of these individuals**
    work for owner organizations or other entities
    that **support** the development of the built environment,
    such as governmental regulatory agencies.

The built environment by functional role and occupation

Contractors

- There are a **variety of firms** that fit under the title of contractors.
- The prime contractor is typically the firm that **contracts with the owner** and, in turn, **employs** subcontractors and suppliers.
- A construction manager (CM) or a general contractor (GC) usually serves as the **prime contractor** on a project.

The built environment by functional role and occupation

Specialty Contractors

- Specialty contractors are firms that focus on **one type of work**, such as electrical, whereas the GC is responsible for all of the work.

- Specialty contractors **usually**, but not necessarily, participate in a project as **subcontractors**.

The built environment by functional role and occupation

General or specialty contractor

- Every **general or specialty contractor** customarily employs PMs, superintendents, project engineers, foremen, and craftsmen.

- **Construction management firms** **usually** do not employ foremen or craftsmen, but they will have PMs, superintendents, and project engineers.

- **Every large construction firm** will have hundreds, if not thousands, of employees who **fit these and other titles**.
  - However, a **smaller construction firm** is often led by its proprietor, who needs to multi-task.

The built environment by functional role and occupation

- **Employees of construction firms** are the largest portion of the AEC industry, as shown by its **employment data**.
- **Next Table** shows the **2016 employment** and **wage estimates** for some of the construction occupations that support the **BE industry**.
  - Based on these estimates, **construction occupations** employ nearly 5 million individuals, **equal to 4% of the domestic workforce**.

The built environment by functional role and occupation

2016 Employment and Wage Estimates for Selected Construction Occupations

Occupation Title	*Employment*	*Mean Hourly Wage*	*Annual Mean Wage*
All Occupations	**140,400,040**	**$23.86**	**$49,630**
Construction Managers (*)(**)	249,650	$47.84	$99,510
First-Line Supervisors of Construction Trades and Extraction Workers (***)	538,220	$32.71	$68,040
Construction Trades Workers (**)	4,216,890	$22.88	$47,580
Helpers, Construction Trades	228,590	$14.86	$30,900
Other Construction and Related Workers	403,940	$22.92	$47,670

(*) Including all individuals who "Plan, direct, or coordinate, usually through subordinate supervisory personnel, activities concerned with the construction and maintenance of structures, facilities, and systems." This is a broad description that could include project managers, project superintendents, and project engineers.
(**) Excluding first-line supervisors.
(***) Including all individuals who "Directly supervise and coordinate activities of construction or extraction workers." This statistic is cumulative and the data do not allow the segregation of supervisors of construction trades from supervisors of extraction workers.

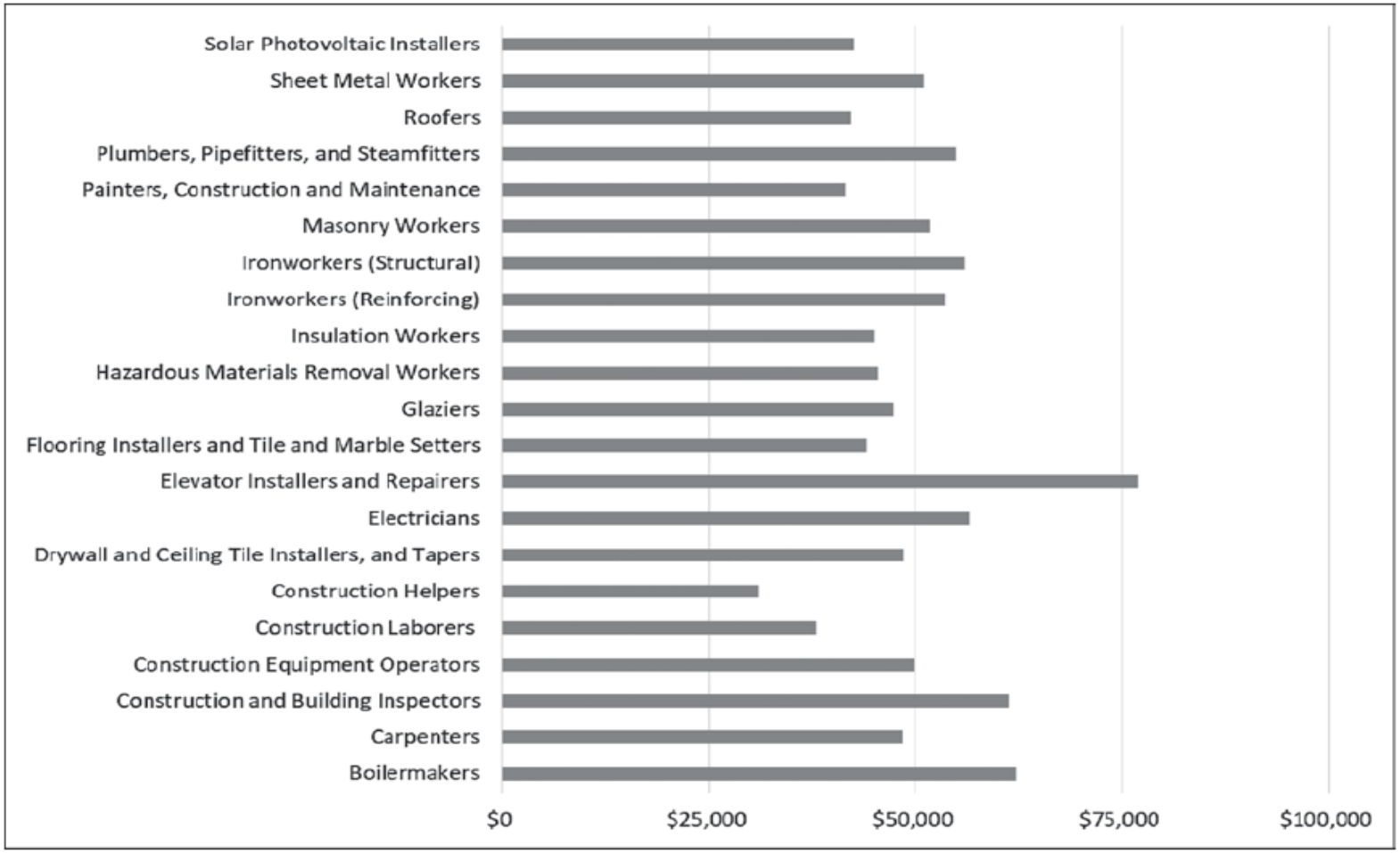
Adapted from U.S. Bureau of Labor Statistics, May 2016 National Occupational Employment and Wage Estimates, United States (BLS 2017)

The built environment by functional role and occupation

Specialty Trades

- There are **many different specialized trades** or **crafts** involved in construction, from plumbers to ironworkers to electricians, among others.
  - Some of these trades are included in the categories listed in the **previous Table**.
- They are all experts in their focus area and it is a gross misrepresentation to call them all "laborers" or simply "workers."
  - Instead, their mastery in a construction trade should be recognized by correctly identifying and distinguishing one trade from another.
- **Next Figures** show **employment and wage estimates** by construction trade.
- **Next Table** lists and describes major construction occupations by trade and provides **employment and wage estimates as of May 2016.**

The built environment by functional role and occupation



Construction Annual Average Wages by Trade (May 2016)
Adapted from U.S. Bureau of Labor Statistics, May 2016 National Occupational Employment and Wage Estimates, United States (BLS 2017)

The built environment by functional role and occupation

Major Construction Occupations by Trade

Occupation	*Job Summary*	*Employees*	*2016 Mean Annual Pay*
Boilermakers	Boilermakers assemble, install, and repair boilers, closed vats, and other large vessels or containers that hold liquids and gases.	16,600	$62,200
Carpenters	Carpenters construct and repair building frameworks and structures—such as stairways, doorframes, partitions, rafters, and bridge supports—made from wood and other materials. They also may install kitchen cabinets, siding, and drywall.	676,980	$48,340
Construction and Building Inspectors	Construction and building inspectors ensure that construction meets local and national building codes and ordinances, zoning regulations, and contract specifications.	94,960	$61,250
Construction Equipment Operators	Construction equipment operators drive, maneuver, or control the heavy machinery used to construct roads, bridges, buildings, and other structures.	412,190	$49,810
Construction Laborers and Helpers	Construction laborers and helpers perform many tasks that require physical labor on construction sites.	Laborers: 912,100 Helpers: 228,590	$37,890 $30,900
Drywall and Ceiling Tile Installers, and Tapers	Drywall and ceiling tile installers hang wallboard and install ceiling tile inside buildings. Tapers prepare the wallboard for painting, using tape and other materials. Many workers both install and tape wallboard.	111,650	$48,460
Electricians	Electricians install, maintain, and repair electrical power, communications, lighting, and control systems in homes, businesses, and factories.	607,120	$56,650
Elevator Installers and Repairers	Elevator installers and repairers install, fix, and maintain elevators, escalators, moving walkways, and other lifts.	22,240	$76,860
Flooring Installers and Tile and Marble Setters	Flooring installers and tile and marble setters lay and finish carpet, wood, vinyl, and tile.	77,410	$43,950
Glaziers	Glaziers install glass in windows, skylights, and other fixtures in storefronts and buildings.	47,140	$47,260
Hazardous Materials Removal Workers	Hazardous materials (hazmat) removal workers identify and dispose of asbestos, lead, radioactive waste, and other hazardous materials. They also neutralize and clean up materials that are flammable, corrosive, or toxic.	44,280	$45,500

The built environment by functional role and occupation

Construction Managers

- Construction managers may go to work for a **number of different organizations**.

1. **On the private side,**
   - General contractors,
   - Construction management firms,
   - Architectural or engineering firms,
   - Developers,
   - Financial institutions, and
   - Large corporations

   may **all hire construction managers**.

The built environment by functional role and occupation

Construction Managers

- Construction managers may go to work for a **number of different organizations**.

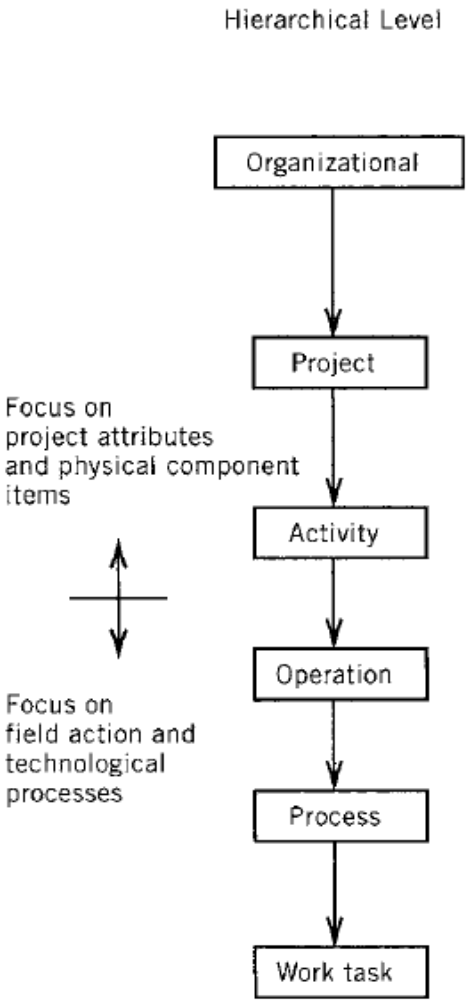
2. On the public side,

- Various state and federal agencies,
- Public schools and universities,
- Departments of transportation,
- Federal prison systems, and
- Others

may seek their skills as well.

Management levels of construction

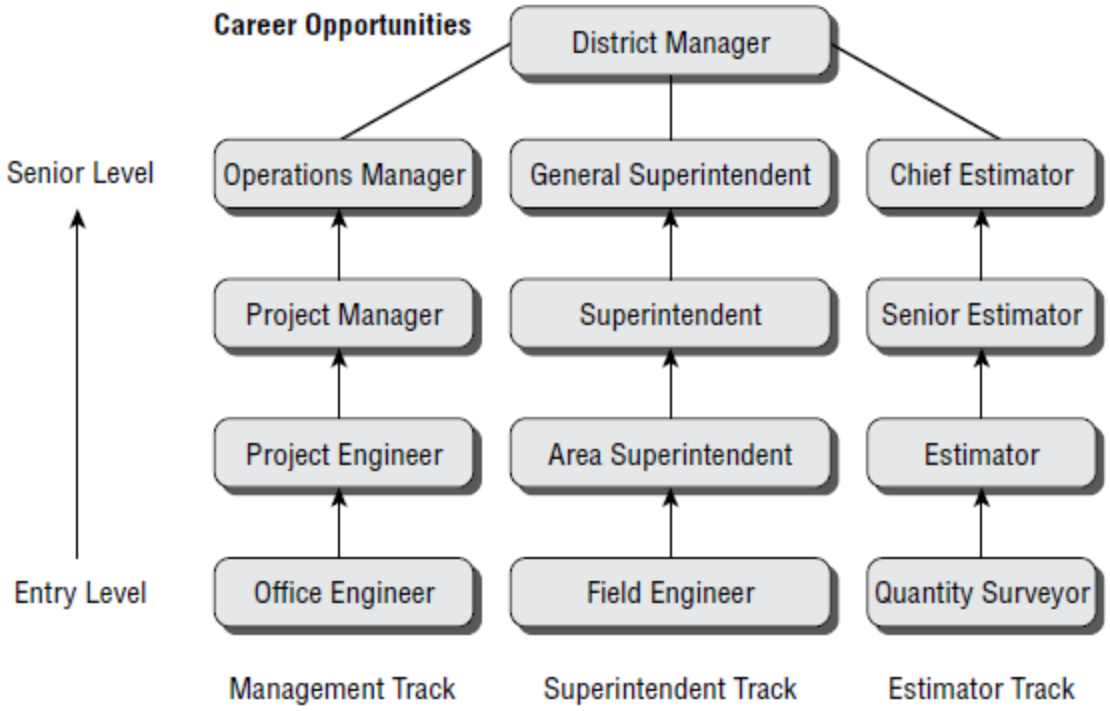
- **Organizational considerations** lead to a number of hierarchical levels that can be identified in **construction**.
  - This derives from the project format.



Description and Basic Focus
Company structure and business focus Head office and field functions Portfolio of projects Gross project attributes: total cost, duration, profit, cash flow, percent complete
Project definition, contract, drawings, specifications Product definition and breakdown into project activities Cost, time, and resource control focus
Attainment of physical segment of project equated to time and cost control Current cost, time, resource use Status focus
Construction method focus Means of achieving construction Complete itemized resource list Synthesis of work processes
Basic technological sequence focus Logical collection of work tasks Individual and mixed trade actions Recognizable portion of construction operation
Fundamental field action and work unit focus Intrinsic knowledge and skill at crew member level Basis of work assignment to labor

A typical career track

- A typical career track for an **entry-level construction manager** might look something like this:



Advancement opportunities

- As in any profession, **advancement opportunities** for construction managers vary depending on
  1. An individual's performance,
  2. Ability, and
  3. Size of the company they work for.

Advancement opportunities

- 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.

موسسه مهندسی و مدیریت ساخت علوی پور (ACEMI)

دفتر آموزش

تهران، بلوار فردوس شرق، مجتمع آبگینه، طبقه سوم اداری، واحد C42

+۹۸ ۲۱ ۴۶ ۱۰۰ ۴۵۰

+۹۸ ۲۱ ۴۶ ۱۰۰ ۴۴۵

info@dralavipour.com

www.dralavipour.com

@alavipour_pm

@acemi_social

@alavipour_pm

@IRANACEMI