

Construction

Construction is the process of constructing a building or infrastructure. Construction differs from manufacturing in that manufacturing typically involves mass production of similar items without a designated purchaser, while construction typically takes place on location for a known client. Construction as an industry comprises six to nine percent of the gross domestic product of developed countries. Construction starts with planning,[citation needed] design, and financing and continues until the project is built and ready for use.

Large-scale construction requires collaboration across multiple disciplines. An architect normally manages the job, and a construction manager, design engineer, construction engineer or project manager supervises it. For the successful execution of a project, effective planning is essential. Those involved with the design and execution of the infrastructure in question must consider zoning requirements, the environmental impact of the job, the successful scheduling, budgeting, construction-site safety, availability and transportation of building materials, logistics, inconvenience to the public caused by construction delays and bidding, etc. The largest construction projects are referred to as megaprojects.

In general, there are three sectors of construction: buildings, infrastructure and industrial. Building construction is usually further divided into residential and non-residential (commercial/institutional). Infrastructure is often called heavy/highway, heavy civil or heavy engineering. It includes large public works, dams, bridges, highways, water/wastewater and utility distribution. Industrial includes refineries, process chemical, power generation, mills and manufacturing plants. There are other ways to break the industry into sectors or markets.

Engineering News-Record (ENR) is a trade magazine for the construction industry. Each year, ENR compiles and reports on data about the size of design and construction companies. They publish a list of the largest companies in the United States (Top-40) and also a list the largest global firms (Top-250, by amount of work they are doing outside their home country). In 2014, ENR compiled the data in nine market segments. It was divided as transportation, petroleum, buildings, power, industrial, water, manufacturing, sewer/waste, telecom, hazardous waste plus a tenth category for other projects. In their reporting on the Top 400, they used data on transportation, sewer, hazardous waste and water to rank firms as heavy contractors.

The Standard Industrial Classification and the newer North American Industry Classification System have a classification system for companies that perform or otherwise engage in construction. To recognize the differences of companies in this sector, it is divided into three subsectors: building construction, heavy and civil engineering construction, and specialty trade contractors. There are also categories for construction service firms (e.g., engineering, architecture) and construction managers (firms engaged in managing construction projects without assuming direct financial responsibility for completion of the construction project).

Building construction is the process of adding structure to real property or construction of buildings. The majority of building construction jobs are small renovations, such as addition of a room, or renovation of a bathroom. Often, the owner of the property acts as laborer, paymaster, and design team for the entire project. Although building construction projects typically include various common elements, such as design, financial, estimating and legal considerations, many projects of varying sizes reach undesirable end results, such as structural collapse, cost overruns, and/or litigation. For this reason, those with experience in the field make detailed plans and maintain careful oversight during the project to ensure a positive outcome.

Residential construction practices, technologies, and resources must conform to local building authority regulations and codes of practice. Materials readily available in the area generally dictate the construction materials used (e.g. brick versus stone, versus timber). Cost of construction on a per square meter (or per square foot) basis for houses can vary dramatically based on site conditions, local regulations, economies

of scale (custom designed homes are often more expensive to build) and the availability of skilled tradespeople. As residential construction (as well as all other types of construction) can generate a lot of waste, careful planning again is needed here.

New techniques of building construction are being researched, made possible by advances in 3D printing technology. In a form of additive building construction, similar to the additive manufacturing techniques for manufactured parts, building printing is making it possible to flexibly construct small commercial buildings and private habitations in around 20 hours, with built-in plumbing and electrical facilities, in one continuous build, using large 3D printers. Working versions of 3D-printing building technology are already printing 2 metres (6 ft 7 in) of building material per hour as of January 2013[update], with the next-generation printers capable of 3.5 metres (11 ft) per hour, sufficient to complete a building in a week. Dutch architect Janjaap Ruijsenaars's performative architecture 3D-printed building is scheduled to be built in 2014.

In the modern industrialized world, construction usually involves the translation of designs into reality. A formal design team may be assembled to plan the physical proceedings, and to integrate those proceedings with the other parts. The design usually consists of drawings and specifications, usually prepared by a design team including Architect, civil engineers, mechanical engineers, electrical engineers, structural engineers, fire protection engineers, planning consultants, architectural consultants, and archaeological consultants. The design team is most commonly employed by (i.e. in contract with) the property owner. Under this system, once the design is completed by the design team, a number of construction companies or construction management companies may then be asked to make a bid for the work, either based directly on the design, or on the basis of drawings and a bill of quantities provided by a quantity surveyor. Following evaluation of bids, the owner typically awards a contract to the most cost efficient bidder.

The modern trend in design is toward integration of previously separated specialties, especially among large firms. In the past, architects, interior designers, engineers, developers, construction managers, and general contractors were more likely to be entirely separate companies, even in the larger firms. Presently, a firm that is nominally an "architecture" or "construction management" firm may have experts from all related fields as employees, or to have an associated company that provides each necessary skill. Thus, each such firm may offer itself as "one-stop shopping" for a construction project, from beginning to end. This is designated as a "design build" contract where the contractor is given a performance specification and must undertake the project from design to construction, while adhering to the performance specifications.

Several project structures can assist the owner in this integration, including design-build, partnering and construction management. In general, each of these project structures allows the owner to integrate the services of architects, interior designers, engineers and constructors throughout design and construction. In response, many companies are growing beyond traditional offerings of design or construction services alone and are placing more emphasis on establishing relationships with other necessary participants through the design-build process.

Construction projects can suffer from preventable financial problems. Underbids happen when builders ask for too little money to complete the project. Cash flow problems exist when the present amount of funding cannot cover the current costs for labour and materials, and because they are a matter of having sufficient funds at a specific time, can arise even when the overall total is enough. Fraud is a problem in many fields, but is notoriously prevalent in the construction field. Financial planning for the project is intended to ensure that a solid plan with adequate safeguards and contingency plans are in place before the project is started and is required to ensure that the plan is properly executed over the life of the project.

Mortgage bankers, accountants, and cost engineers are likely participants in creating an overall plan for the financial management of the building construction project. The presence of the mortgage banker is highly likely, even in relatively small projects since the owner's equity in the property is the most obvious source of funding for a building project. Accountants act to study the expected monetary flow over the life of the project and to monitor the payouts throughout the process. Cost engineers and estimators apply

expertise to relate the work and materials involved to a proper valuation. Cost overruns with government projects have occurred when the contractor identified change orders or project changes that increased costs, which are not subject to competition from other firms as they have already been eliminated from consideration after the initial bid.

The project must adhere to zoning and building code requirements. Constructing a project that fails to adhere to codes does not benefit the owner. Some legal requirements come from *malum in se* considerations, or the desire to prevent things that are indisputably bad – bridge collapses or explosions. Other legal requirements come from *malum prohibitum* considerations, or things that are a matter of custom or expectation, such as isolating businesses to a business district and residences to a residential district. An attorney may seek changes or exemptions in the law that governs the land where the building will be built, either by arguing that a rule is inapplicable (the bridge design will not cause a collapse), or that the custom is no longer needed (acceptance of live-work spaces has grown in the community).

A construction project is a complex net of contracts and other legal obligations, each of which all parties must carefully consider. A contract is the exchange of a set of obligations between two or more parties, but it is not so simple a matter as trying to get the other side to agree to as much as possible in exchange for as little as possible. The time element in construction means that a delay costs money, and in cases of bottlenecks, the delay can be extremely expensive. Thus, the contracts must be designed to ensure that each side is capable of performing the obligations set out. Contracts that set out clear expectations and clear paths to accomplishing those expectations are far more likely to result in the project flowing smoothly, whereas poorly drafted contracts lead to confusion and collapse.

There is also a growing number of new forms of procurement that involve relationship contracting where the emphasis is on a co-operative relationship between the principal and contractor and other stakeholders within a construction project. New forms include partnering such as Public-Private Partnering (PPPs) aka private finance initiatives (PFIs) and alliances such as "pure" or "project" alliances and "impure" or "strategic" alliances. The focus on co-operation is to ameliorate the many problems that arise from the often highly competitive and adversarial practices within the construction industry.

This is the most common method of construction procurement and is well established and recognized. In this arrangement, the architect or engineer acts as the project coordinator. His or her role is to design the works, prepare the specifications and produce construction drawings, administer the contract, tender the works, and manage the works from inception to completion. There are direct contractual links between the architect's client and the main contractor. Any subcontractor has a direct contractual relationship with the main contractor. The procedure continues until the building is ready to occupy.

The owner produces a list of requirements for a project, giving an overall view of the project's goals. Several D&B contractors present different ideas about how to accomplish these goals. The owner selects the ideas he or she likes best and hires the appropriate contractor. Often, it is not just one contractor, but a consortium of several contractors working together. Once these have been hired, they begin building the first phase of the project. As they build phase 1, they design phase 2. This is in contrast to a design-bid-build contract, where the project is completely designed by the owner, then bid on, then completed.

Before the foundation can be dug, contractors are typically required to verify and have existing utility lines marked, either by the utilities themselves or through a company specializing in such services. This lessens the likelihood of damage to the existing electrical, water, sewage, phone, and cable facilities, which could cause outages and potentially hazardous situations. During the construction of a building, the municipal building inspector inspects the building periodically to ensure that the construction adheres to the approved plans and the local building code. Once construction is complete and a final inspection has been passed, an occupancy permit may be issued.

In the United States, the industry in 2014 has around \$960 billion in annual revenue according to statistics tracked by the Census Bureau, of which \$680 billion is private (split evenly between residential and nonresidential) and the remainder is government. As of 2005, there were about 667,000 firms employing 1 million contractors (200,000 general contractors, 38,000 heavy, and 432,000 specialty); the average

contractor employed fewer than 10 employees. As a whole, the industry employed an estimated 5.8 million as of April 2013, with a 13.2% unemployment rate. In the United States, approximately 828,000 women were employed in the construction industry as of 2011.

In 2010 a salary survey revealed the differences in remuneration between different roles, sectors and locations in the construction and built environment industry. The results showed that areas of particularly strong growth in the construction industry, such as the Middle East, yield higher average salaries than in the UK for example. The average earning for a professional in the construction industry in the Middle East, across all sectors, job types and levels of experience, is £42,090, compared to £26,719 in the UK. This trend is not necessarily due to the fact that more affluent roles are available, however, as architects with 14 or more years experience working in the Middle East earn on average £43,389 per annum, compared to £40,000 in the UK. Some construction workers in the US/Canada have made more than \$100,000 annually, depending on their trade.

Construction is one of the most dangerous occupations in the world, incurring more occupational fatalities than any other sector in both the United States and in the European Union. In 2009, the fatal occupational injury rate among construction workers in the United States was nearly three times that for all workers. Falls are one of the most common causes of fatal and non-fatal injuries among construction workers. Proper safety equipment such as harnesses and guardrails and procedures such as securing ladders and inspecting scaffolding can curtail the risk of occupational injuries in the construction industry. Other major causes of fatalities in the construction industry include electrocution, transportation accidents, and trench cave-ins.

What is the process of constructing a building or infrastructure

Construction

What typically involves mass production of similar items without a designated purchaser

manufacturing

What percentile of gross domestic product is construction comprised of

six to nine percent

What three things are needed for construction to take place

planning,[citation needed] design, and financing

Construction takes place on location for who

a known client

Who normally manages a construction job

An architect

Who normally supervises a construction job

a construction manager, design engineer, construction engineer or project manager

What is essential for the successful execution of a project

effective planning

The largest construction projects are known as what

megaprojects

Zoning requirements, environmental impact, budgeting, and logistics are things who should consider

Those involved with the design and execution of the infrastructure

What are the three sectors of construction

buildings, infrastructure and industrial

Building construction is usually further divided into what categories

residential and non-residential

Infrastructure is often called what

heavy/highway, heavy civil or heavy engineering

Large public works, dams, bridges, highways, water/wastewater and utility distribution are under what construction sector

Infrastructure

Refineries, process chemical, power generation, mills and manufacturing plants are under what sector of construction

Industrial

What is Engineering News-Record

a trade magazine for the construction industry

What compiles and reports on data about the size of design and construction companies

ENR

In what year did ENR compile data in nine market segments

2014

ENR used data on what to rank Top 400 firms as heavy contractors

transportation, sewer, hazardous waste and water

What are the three construction subsectors

building construction, heavy and civil engineering construction, and specialty trade contractors

There are other categories for what

construction service firms (e.g., engineering, architecture) and construction managers

What has a classification system for construction companies

The Standard Industrial Classification and the newer North American Industry Classification System

What are construction managers

firms engaged in managing construction projects without assuming direct financial responsibility for completion of the construction project

What is the process of adding structure to real property or construction of buildings

Building construction

The majority of building construction jobs are what

small renovations

Who acts as laborer, paymaster, and design team for a renovation project

the owner of the property

What are some examples of undesirable end results of a project

structural collapse, cost overruns, and/or litigation

What do those in the field do to ensure a positive outcome

make detailed plans and maintain careful oversight

Residential construction practices, technologies, and resources must conform to what

local building authority regulations and codes of practice

What generally dictates the construction materials used

Materials readily available in the area

Residential construction can generate what is not carefully planned

a lot of waste

Site conditions, local regulations, economies of scale and the availability of skilled tradespeople all affect what

Cost of construction

New techniques of building construction are being researched, made possible by advances in

what

3D printing technology

Building printing is making it possible to flexibly construct small commercial buildings and private habitations in what amount of time

around 20 hours

Dutch architect Janjaap Ruijssenaars's performative architecture 3D-printed building is scheduled to be built when

Working versions of 3D-printing building technology are already printing

Working versions of 3D-printing building technology are already printing how much building material per hour

2 metres (6 ft 7 in)

Construction involves the translation of what

designs into reality

A formal design team may be assembled to do what

plan the physical proceedings, and to integrate those proceedings with the other parts

The design team is most commonly employed by who

the property owner

Who provides the bill of quantities

a quantity surveyor

The owner typically awards a contract to who

the most cost efficient bidder

The modern trend in design is toward integration of what

previously separated specialties

Even in large firms, architects, interior designers, engineers, developers, construction managers, and general contractors were more likely to be what

entirely separate companies

In modern times, firms may offer themselves as what for a construction project

"one-stop shopping"

What kind of contract is given when the contractor is given a performance specification and must undertake the project from design to construction, while adhering to the performance specifications

"design build" contract

What project structures assist the owner in integration

design-build, partnering and construction management

These project structures allow the owner to integrate the services of who throughout the design and construction

architects, interior designers, engineers and constructors

Many construction companies are now placing more emphasis on what

establishing relationships with other necessary participants through the design-build process

What can construction projects suffer from

preventable financial problems

What is an underbid

when builders ask for too little money to complete the project

When do cash flow problems exist

when the present amount of funding cannot cover the current costs for labour and materials

What financial issue is notoriously prevalent in the construction field

Fraud

Who are likely participants in creating an overall plan for the financial management of the building construction project

Mortgage bankers, accountants, and cost engineers

The presence of who is highly likely even in small projects

the mortgage banker

Who studies the expected monetary flow over the life of the project and to monitor the payouts throughout the process

Accountants

Who applies expertise to relate the work and materials involved to a proper valuation

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Cost overruns with government projects have occurred when the contractor did what

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What must a project adhere to

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the owner

What is malum in se considerations

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What are malum prohibitum considerations

things that are a matter of custom or expectation

Who may seek changes or exemptions in the law that governs the land where the building will be built

An attorney

What is a complex net of contracts and other legal obligations

A construction project

What is the exchange of a set of obligations between two or more parties

A contract

What does the time element in construction mean

that a delay costs money, and in cases of bottlenecks, the delay can be extremely expensive

Contracts must be designed to ensure what

that each side is capable of performing the obligations set out

What leads to confusion and collapse

poorly drafted contracts

A growing number of new forms of procurement involves what

relationship contracting where the emphasis is on a co-operative relationship

What is PPP

Public-Private Partnering

What is a PPP also known as

private finance initiatives (PFIs)

Focus on what is to ameliorate the many problems that arise from the often highly competitive and adversarial practices within the construction industry.

co-operation

In the most common construction procurement, who acts as the project coordinator

the architect or engineer

Whose role is to design the works, prepare the specifications and produce construction drawings, administer the contract, tender the works, and manage the works from inception to completion

the project coordinator

There are direct contractual links between who

the architect's client and the main contractor

Any subcontractor has a direct contractual relationship with who

the main contractor

The procedure continues until what

the building is ready to occupy.

Who produces a list of requirements for a project, giving an overall view of the project's goals

The owner

Who presents different ideas about how to accomplish goals

D&B contractors

Who selects and hires the best ideas and appropriate contractors

The owner

Who is usually working together

a consortium of several contractors

What happens as they build phase 1

they design phase 2

Who is required to verify and have existing utility lines marked

contractors

Having existing utility lines marked lessens the likelihood of what

damage

What are some existing facilities

electrical, water, sewage, phone, and cable facilities

Who inspects the building periodically to ensure that the construction adheres to the approved plans and the local building code

the municipal building inspector

What is issued once construction is complete and a final inspection has been passed

an occupancy permit

What is the annual construction industry revenue in 2014

\$960 billion

How much revenue is private

\$680 billion

How many firms were existing in 2005

667,000 firms

The average contractor hired how many employees

fewer than 10 employees

How many women were employed in construction in 2011

828,000

What is the average construction salary in the Middle East

£42,090

What is the average construction salary in the UK

£26,719

Where have some workers made more than \$100,000

US/Canada

What is one of the most dangerous occupations in the world

Construction

What is the most common cause of injury on site

Falls

What are other major fatality causes

electrocution, transportation accidents, and trench cave-ins

What can curtail the risk of occupational injuries in the construction industry

Proper safety equipment such as harnesses and guardrails and procedures such as securing ladders and inspecting scaffolding