

CE303 Introduction to Construction Engineering

THE CONSTRUCTION INDUSTRY

Learning Objectives

- The student should be able to:

- Describe the nature of the Construction Industry in the US.
- List the segments of the Construction Industry and explain their similarities and differences.
- Define a Construction Contract and what responsibilities it imposes on the Owner and the Contractor.

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Learning Objectives

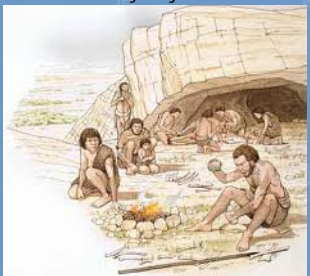
- The student should be able to:

- List the types of Construction Contracts and explain how each can be appropriately applied as a Delivery System.
- Challenges of the Construction Industry

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Construction Industry History


- Dates back to the early days of civilization



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Construction Industry History



Stonehenge in England




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Construction Industry History

- Maya and Inca Constructions



- Pyramids of Egypt



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Construction Industry History

- The history of the construction industry over the past 200 years has been rapidly changing, in large part due to the technological advances starting with the Industrial Revolution and the explosive growth of the global population

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Highways



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Bridges



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Dams



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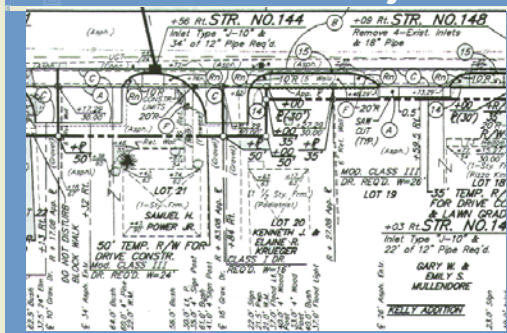
Myriad of Buildings



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The Construction Project



U.S. Construction Industry

- Construction is considered the largest single production industry in the United States
 - ~10% of the Gross Domestic Product (GDP).
- This includes new construction, design, equipment & materials manufacturing, and supply.
- The GDP measures output generated through production by labor and property that is physically located within the confines of a country.
- Times of national prosperity are accompanied by a high national level of construction expenditure.

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Economic Importance of the Construction Industry

- Every \$1 Billion of new construction
 - ≈ 13,000 jobs in the construction industry
 - ≈ 34,000 jobs in supplies & services
- Every \$1 spent on new construction generates \$3.60 in economic activity in other industries.
- Construction Project Financing
 - 80% of construction is privately financed,
 - 20% is paid by various public agencies.

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Construction Industry Statistics

- Industry is fragmented:
 - 884,300 construction establishments in the United States (BLS,2008)
 - 91% were small businesses employing fewer than 20 workers.
 - Only 1% had 100 or more employees in 2008
- Construction is an easy entry industry

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More Construction Industry Statistics

- Employment peaked at 7.7 million in mid-2006, seasonally adjusted, and fell to 5.6 million (down 27%) by November 2010.
- KY Population 4.3 mil
- The industry's unemployment rate in November 2010 was 18.8%, not seasonally adjusted, roughly double the all-industry rate.
- Expected Job growth is 19% through 2018 (BLS)

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Years Construction Businesses were Established

Year Range	Percentage
Before 1980	14%
1980 to 1989	20%
1990 to 1996	22%
1997 to 1999	16%
2000 to 2002	28%

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The Participants in the Construction Industry

- The Owner
 - The Public Owner
 - The Private Owner
- The Architect/Engineer (A/E)
- The Prime Contractor (General Contractor)
- The Sub Contractor (Specialty Contractor)
- The Vendors - Materials & Equipment
- The Regulators

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The Public Owner

- Agencies of the federal government, state, county and municipal entities
- Local boards, commissions and authorities.
- Must proceed in accordance with applicable statutes and administrative directives, pertaining to the
 - advertising for bids, bidding procedures, construction contracts, contract administration, and other matters relating to the design and construction process.

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The Private Owner

- Individuals, partnerships, corporations.
- Some play an active role in the design and construction phases of their projects.
- Negotiated contracts much more common.

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The Architect-Engineer

- The architect-engineer is the design professional that is the party, organization, or firm that designs the project.



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The Prime Contractor (AKA General Contractor)

- Firm with direct contract with the owner for the construction of the project.
- The party that brings together the diverse inputs of the construction process into a single, coordinated effort.
- Provides control of construction.
- Complete charge of field operations.

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The Subcontractor (Specialty Contractor)

- Construction firm that contracts with prime contractor to perform some specialized portion of the prime's scope of work.
- The sub-contractual relationship is limited to the prime and the sub, without the owner's involvement.
- The prime contractor maintains contractual responsibility to the owner for the work performed by the subcontractor.

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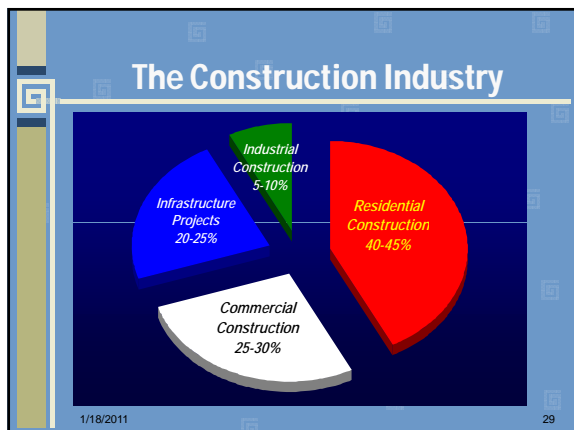
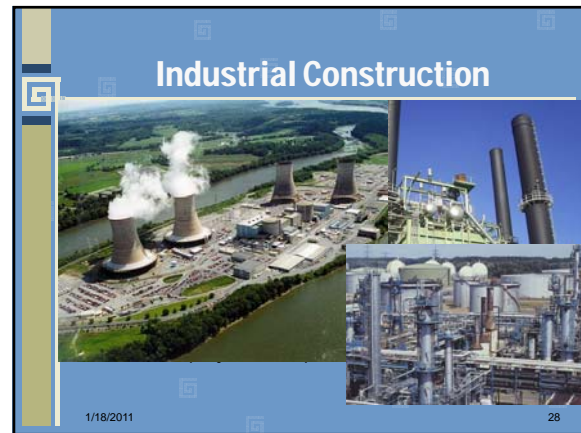
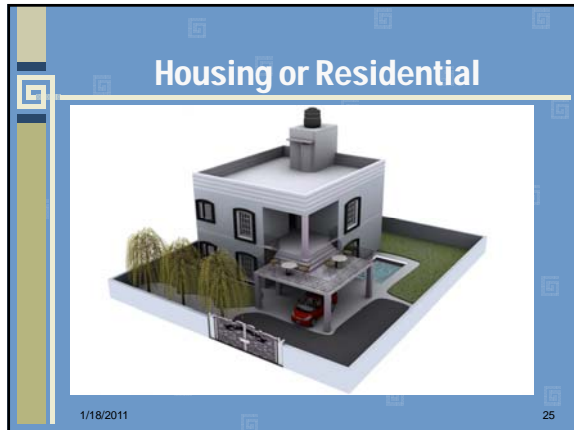
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Segments Of The Industry

- Housing or Residential Building
- Commercial or Building
- Engineering or Heavy Construction or Infrastructure Project Building
- Industrial Construction Project Building

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- ### The Contract System
- What is a Contract?
 - A legal agreement between two or more parties to perform a legal action.
 - Competitive Bidding – Open and Closed
 - Negotiated Contract
 - Payment Options
 - Lump Sum Contract
 - Unit Price Contract
 - Cost Plus Fee Contract
 - Guaranteed Max
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Lump Sum Contracts

- The design is totally complete.
- The plans and specs are prepared in detail.
- The Project Scope is accurately defined.
- Invitation or advertisement to bid is issued.
- The Bidders are asked to:
 - Perform quantity takeoff,
 - Estimate their costs
 - Submit a single price bid (lump sum).

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Unit Price Contract

- The design is totally complete, but there may be some quantities unable to be exactly determined
- These are then identified as Unit Price Pay Items, as few as possible.
- The bidding documents include the Engineer's Estimate giving the best information available on these quantities.
- The contractor estimates his costs and submits unit prices for each pay items

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Unit Price Contract

- Payments will be made on actual work performed, the actual quantities times the unit prices.
- Contractor's Profit is difference between amount paid by the owner and the contractor's actual cost.
- The owner does not know the exact cost until the work is complete.

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Cost Plus Fee Or Percentage

- Owner reimburses contractor for all of his out-of-pocket expenses.
 - Contractor's Fee is to cover Project O/H, plus profit.
 - There is no risk on his part.
 - The contract may have a stipulated Guaranteed Maximum Price (GMP).
 - If so, the contractor may have input in the design.
- Construction may be started before the design is totally complete.

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Construction Project Delivery Methods

- Linear Construction
- Phased Construction

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Linear Construction

"The Traditional Approach"

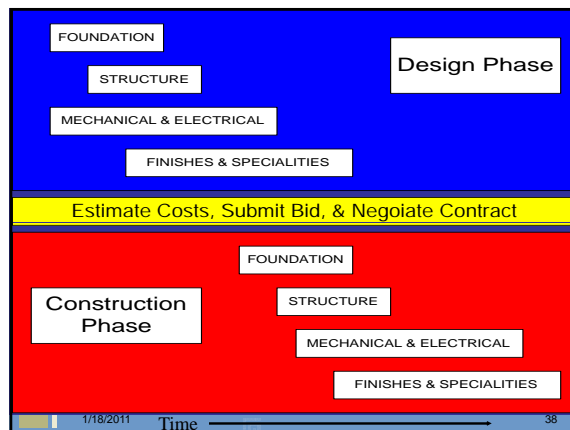
- DESIGN, BID, BUILD.
- Ample time is available for selection of the architect-engineer, to perform a complete design, preparation of plans and specifications, competitive bidding and contractor selection, and performance of the construction process in the order to deliver the best building product.

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Phased Construction *"Fast Track"*

- Design work proceeds in an order required by Design Logic or Order of Construction.
- As design segments become complete, a scope of work segment can be used to prepare a construction package.

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Construction Contract Types

- The Single Prime Contract
- Separate Prime Contract
- Design Build
- Construction Management
- Construction by Force Account

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The Single Prime Contractor

- The GC has entered into a contractual agreement with the Owner and is responsible for all construction work.
- The GC may, in turn, contract other contractors, subcontractors, to perform some of his work.
- The GC is still responsible for:
 - all of his work he performs and the coordination of subcontracted work

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Separate Prime Contractors

- The Owner may contract directly with several Contractors at one time.
- Each contractor may perform a specialty portion of the scope of work.
- Specialty Contractors may include:
 - Mechanical: Heating & Plumbing, Electrical, Steel Erection, Concrete, Landscaping, Painting, Tunnel boring, Pile driving, Excavation, Underpinning, Etc.

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Design Build

- Includes "Turn-key"
- Owner purchases design and construction services in a single package from one entity.
 - One contract for both design work and construction work.
 - Close interaction between designer and constructor

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Construction Management (CM)

- CM is a Professional Service similar to a design contract, typically separate party
- CM Key Services
 - Provides constructibility input during design
 - CM does scheduling, coordination and cost control, inspection, safety, and payments to subs and material suppliers
 - CM does general conditions construction and supervision
 - Orders long-lead materials
- The CM will have the responsibility for effective coordination and control of multiple contractors on the site

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Construction By Force Account

- Owner acts as GC to builds his own project, not a project for later re-sale.
- Hires and uses his own labor force and makes his own Subcontracts.
- Unless the owner is as good as a GC
 - Costs are typically higher and
 - Quality of work not as good
- Contractors are against this practice and have tried to induce the passing of legislation to prevent public owners from construction by force account.

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Challenges For The Industry

- Economic Recovery
- Aging Infrastructure and declining tax revenues (\$1-3 Trillion over 20 years)
- Housing bust
- Sustainability

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Synchronized Sinking

Real GDP of World Economies

Region	2006	2007	2008	2009	2010	2011
United States	2.8	3.0	1.9	-2.8	2.3	1.5
Canada	2.5	2.8	1.5	-1.5	1.5	1.0
Eurozone	2.5	2.8	1.5	-1.5	1.5	1.0
U.K.	2.5	2.8	1.5	-1.5	1.5	1.0
Japan	2.5	2.8	1.5	-1.5	1.5	1.0
Eastern Europe	2.5	2.8	1.5	-1.5	1.5	1.0
Other Asia-Pac	2.5	2.8	1.5	-1.5	1.5	1.0
Latin America	2.5	2.8	1.5	-1.5	1.5	1.0
Mid East & N Africa	2.5	2.8	1.5	-1.5	1.5	1.0
Sub-Saharan Africa	2.5	2.8	1.5	-1.5	1.5	1.0

1/18/2011 Ref: Standard and Poors, 2009 46

Risks to the U.S. Economy

The Unemployment Rate

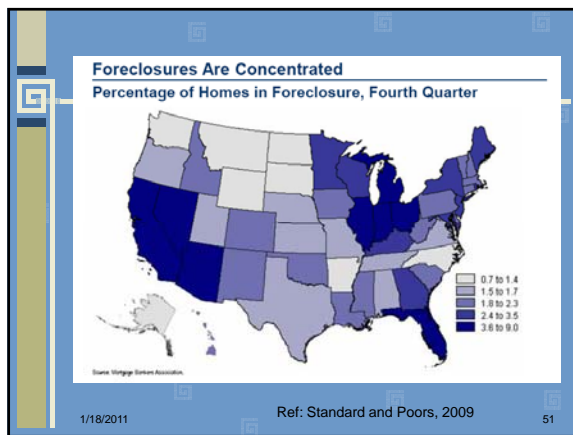
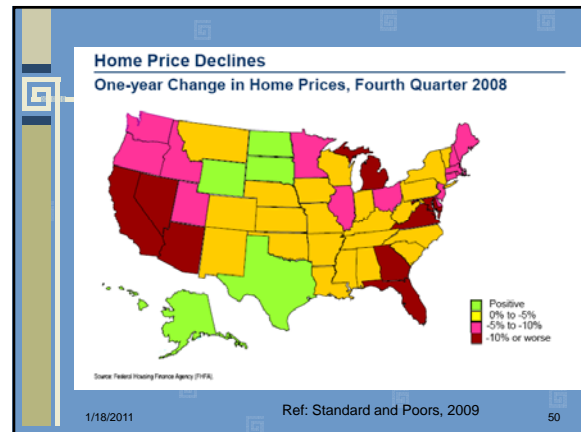
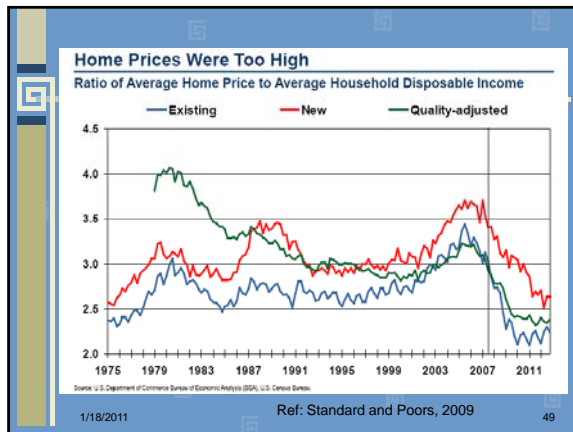
Year	Baseline (%)	Pessimism (%)	Optimism (%)
2000	4.0	4.0	4.0
2001	4.5	4.5	4.5
2002	5.0	5.0	5.0
2003	5.5	5.5	5.5
2004	6.0	6.0	6.0
2005	6.5	6.5	6.5
2006	7.0	7.0	7.0
2007	7.5	7.5	7.5
2008	8.0	8.0	8.0
2009	9.0	9.0	9.0
2010	10.0	12.0	9.0
2011	10.5	11.5	8.5
2012	11.0	11.0	8.0

1/18/2011 Ref: Standard and Poors, 2009 47

Industry Challenges

- Aging Infrastructures

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Challenges For The Industry

- Sustainability and energy efficiency
- The primary benefit of sustainable construction is through reduced energy costs and a reduction of raw materials used,
- building a more comfortable and far healthier living environment, reduced overall living expenses, fewer repairs and maintenance, higher resale values

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Some Examples

- Owner: Adobe Systems
- Year Built: 1996-2006
- Size: 1 mill Sq. Ft
- LEED: Platinum
- Features:
 - 35% less electricity usage
 - 16% CO2 emissions cut
 - 295,000 gal of water savings

<http://www.filtersfast.com/Greenest-Buildings-in-the-US.asp>

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IDEA HOUSE

- Builder: The EcoBuilders Inc.
- Developer: Whisper Mountain, Ltd.
- Architecture: Allison Ramsey Architects, Inc.
- 3,085-square-foot, three-bedroom dream home
- drought-tolerant landscaping
- "living roof"
- high-efficiency tankless water heater
- A zoned heating and cooling system

LEED Platinum
43%
80%
50%

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