Architecture
Three-Dimensional Art

Sculpture

Architecture

Craft & Design
The mother art is architecture. Without an architecture of our own, we have no soul of our own civilization.

–Frank Lloyd Wright
Introduction

• What is architecture?
• Why is architecture important to us?
• Why does architecture, of all the arts, have the greatest impact on our lives?
• Why does architecture determine the quality of the environments in which we work, play, live, meditate, and rest?
Introduction

- Architecture—design that surrounds and influences us—represents the safety of home, the strength of government, the energy of commercial enterprise, and the power of human innovation.

- Architecture suggests feelings of permanence and place.

- Architectural space is the result of thoughtful design by an artist, or by a team of artists working to a common idea.
Architecture

- **Architecture** - The art and science of designing buildings, bridges, and other structures to meet our personal and communal needs.
- It is also a vehicle for artistic expression in three-dimensions.
- The architect mediates between the client and the selected site
The Context of Architecture

- Although buildings can be some of the largest and most complicated man-made objects, they usually begin from the simplicity of a drawing.

- Before drawing a picture, an architect collects information about the planned location of the building and its place in the community, selects the appropriate building techniques, and decides which materials are needed to construct it.

- Artists must consider the availability and cost of building materials when they plan their projects.

- The engineering of the building, or its structural integrity, dictates some of the design decisions.
2.165 Fumihiko Maki, Sketch of Four World Trade Center, 2006
Fumihiko Maki, Sketch of Four World Trade Center

- Preliminary design for the New World Trade Center in New York City

- Shows how his building will fit in with other buildings by continuing a spiral design
The Engineering and Science of Architecture

- Engineers must understand and control the forces pushing or pulling the structure of the building
  - When stresses pull, they create tension, which lengthens and stretches the materials of the building
  - When stresses push, they create compression, which can squash and shorten the same materials

- Architectural engineers work to create balances between tension and compression so that the amount of push equals the amount of pull

- They measure the strength of the material so that they can anticipate and control the balance of the forces at work
Traditional Construction in Natural Materials

- Ancient cultures derived their building materials from the earth

- Stone, wood, and clay are plentiful and easily available, but they must be modified for use in architecture

- When shaped and used with great care and skill, these raw materials can result in architecture that transcends time
Figure 11.1, p.214: Cliff Dwellings, Mesa Verde, Colorado. Native American, Pre-Columbian.
Cliff Dwellings, Mesa Verde, Colorado. Native American, Pre-Columbian

- Could be considered an earthwork high relief
- The cliff itself becomes the back wall and support
- Kivas served as community centers
Dry Masonry

Figure 11.4, p.216: Walls of Fortress of Machu Picchu, Urubamba Valley, Peru. Incan, 1490–1530.
Macchu Picchu

- Dry masonry relied on masterly carving of blocks, strategic placement, and weight for durability
- Made of granite, constructed by the Incas
- Pieced together so perfectly, not even a knife blade can pass between the blocks
Basic Load-Bearing Construction

- Probably the most direct way to build something is simply to make a pile

- The ancient Egyptians’ ability to move and place such large stones, with the few tools available at the time, has always been a cause of wonder
Post-and-Lintel Construction

Figure 11.3a, p.215: Post-and-lintel construction.
Post and Lintel Construction

- Two elements set upright, and third placed across them, creating an opening beneath
- Stonehenge is an example
Arches

- Arches span distances.
- They support other structures, such as roofs.
- They can serve as an actual symbolic gateway, such as in the Arch of Triumph in Paris, France.
Rounded and Pointed Arches

Figure 11.3b, p.215: Rounded arches enclosing square bay.
Figure 11.3c, p.217: Pointed arches enclosing rectangular bay.
Figure 11.7, p.217: EERO SAARINEN. Jefferson National Expansion Memorial, Gateway Arch, St. Louis, MO (1966).
• Completed in St Louis in 1966
• Stands 630 ft tall
• Commemorates the westward push of the United States after the Louisiana Purchase of 1803
Terminology

- Bricks
- Voussiors - wedge shaped blocks of stone
- Centering (wooden scaffolding)
- Keystone (the center of this)
- Compressive strength (allows the builder to place additional weight above the arch)
- Tiers
Vaults Terminology

- Vault - an extended arc
- Barrel (or tunnel) Vault
- Groin vault
- Buttressing
- Bay
- Ribs
- Webbing
- Gothic
- Pointed arcs
- Ottonian
- Romanesque
- Clerestory
- Fenestration
Figure 11.3d, p.215: Tunnel or barrel vault.
Figure 11.3e, p.215: Groin vault.
Figure 11.3f, p.215: Groin vault showing ribs that carry greatest loads.
Figure 11.3g, p.215: Flying buttress.
Stone is an elegant Gothic structural element for examples of vaults see:

- The lacy buttressing and ample fenestration of
  - Laon Cathedral,
  - Cathedral of Notre-Dame,
  - and Chartres Cathedral (ch. 14)
**Domes**

*Domes* are hemispherical forms
- They are rounded when viewed from underneath
- They are extensions of the principle of the arch
- They are capable of enclosing a vast amount of space

- *Pendentives* - triangular surfaces used to support the dome on a square base
- *Piers* - structures under the pendentives that the load of the dome is transferred onto
- *Veneers* - thin facades
Anthemius of Tralles and Isodorus of Miletus, Interior of Hagia Sophia, Istanbul, Turkey
The dome is 108 feet in diameter
Architects used four triangular surfaces called pendentives to support the dome on a square base
Pendentives transfer the load from the base of the dome to the piers at the corners of the square beneath
Post-and-Beam Construction

• Similar to post-and-lintel construction
• Vertical and horizontal timbers are cut and pieced together with wooden pegs
• The beams allow for windows, doors, and interior supports
• Supports another story or roofs
Figure 11.10a, p.222: Post-and-beam construction.
**Trusses**

*Trusses* - Lengths of wood, iron, or steel pieced together in a triangular shape.
- Trusses span large distances.
- Trusses are used as design and engineering elements.
Figure 11.10b, p.220: Trusses.
Balloon Framing

- An American construction building technique.
- A product of the Industrial Revolution (early 20th century).
- Mass production and assembly of materials
- Originally “balloon framing” was an insulting term due to the fact that people were skeptical that it would work.
Figure 11.10c, p.220: Balloon framing.
A Family in front of their new Levitt home
• This house is more than a home, it is a socioaesthetic comment on the need for mass suburban housing that impacted many metropolitan regions during the marriage and baby boom following World War II

• This house, and 17,000 others were built just like it
Architectural Materials

- Stone, Wood, Cast Iron, Steel Cage
- Reinforced Concrete, Steel Cable, Shell
STONE ARCHITECTURE

- Massive and virtually indestructible.
- Symbol of strength and permanence.
- Expresses warmth

Terms:
- **Kivas** - Circular underground community centers created by the native American Cliff dwellers.
- **Adobe** - Dried mud used in architectural construction.
Stone as a favored material

Figure 11.5, p.216: Temple of Amen-Re, Karnak. Egyptian, XVIII dynasty, 1570–1342 BCE.
• Stone became the favored material for the public buildings of Egyptians and the Greeks
• Amen-Re Temple speaks of the elegance and massiveness that can be made from stone
Other Uses of Stone in Construction

- Stone is rarely used today as a structural material.
- Expensive to quarry and transport
- Mostly stone veneers are used
  - Decorative stone used on façades
- Stone slabs are used for entry halls, patios, and gardens.
WOOD ARCHITECTURE

Advantages:
• Attractive
• Versatile
• Abundant
• Renewable
• Light
• Can be worked onsite with portable hand tools
• Variety of colors and grains
• Weathers well
• Can be painted
• Can be used on the façade or as a structural material

Disadvantage:
• Warps
• Cracks
• Highly flammable
• Termites
CAST-IRON ARCHITECTURE

Cast-Iron
- Was also a product of the 19th century’s Industrial Revolution
- Changed the realm of architecture
- It was a welcome alternative to stone and wood.
- Allowed for the erection of taller buildings with thinner walls
- Has great strength but is heavy

Prefabrigration
Steel-cage construction
Figure 11.14, p.222: Engraving of Sir Joseph Paxton’s Crystal Palace, London (1851).
• The Crystal Palace was prefabricated, iron parts were cast at the factory, not on site

• The new railroads made it easy to transport the parts, and it was simple to bolt them together at the exhibition

• It was also simple to dismantle the structure and reassemble at another location
Figure 11.15, p.222: GUSTAVE EIFFEL. Eiffel Tower, Paris (1889).
• Built in Paris in 1889
• The pieces of the 1,000 ft tower were prefabricated, and the tower was assembled in 17 months by 150 workers on site
• Gustave Eiffel was criticized at the time for building an open structure lacking the standard masonry façade
• Structures such as these encouraged steel-cage construction and the development of the skyscraper
Steel-Cage Architecture

- Very strong metal with some carbon and other metals
- Harder than cast iron and very expensive; however, less of the material needs to be used
- Skeletal forms of steel result in “steel cages”
- Façades and inner walls are hung from the skeleton
Terms

• **Steel** - strong metal of iron alloyed with small amounts of carbon and a variety of other metals.
• **Steel cages** - skeletal forms on to which I-beams can be riveted or welded.
• **Pilasters**
• **Cornice**
Figure 11.16, p.223: Steel-cage construction.
Figure 11.17, p.223: Louis Sullivan. Wainwright Building, St. Louis, MO (1890).
• Early example of steel-cage construction
• Sullivan emphasized the verticality of the structure by running pilasters between the windows through the upper stories
• Also emphasized horizontal features with the ornamented horizontal bands
• Early skyscraper was a precursor for the 20th century skyscrapers we are familiar with
REINFORCED CONCRETE ARCHITECTURE

Reinforced Concrete - (or ferroconcrete)

- Invented by gardener Jacques Monier in 1860s
- Steel rods and/or steel mesh are inserted into wet concrete.
- Steel is inserted at points of greatest stress before hardening.

**Advantages:**
- Less susceptible to pulling apart at stress points.
- The concrete prevents the steal from rusting.
- Can span greater distances then stone.
- Supports more weight then steel.
- Can take on more natural shapes.
Figure 11.22 p. 226 FRANK LLOYD WRIGHT. Kaufmann House ("Fallingwater"), Bear Run, PA (1936).
• Shows different approach to reinforced concrete
• Naturalistic style integrates the building with its location site
• Concrete and stone walls reference the rock of the Pennsylvania countryside
STEEL-CABLE ARCHITECTURE

Steel-cable bridges are not new. The Asian culture has made suspension bridges for thousands of years.

Steel Cable - many parallel wires are intertwined so that they share the stress of the load.

Advantages:
- Strong
- Flexible
- Can sway during weather and traffic conditions
Figure 11.24, p.227: JOHN A. ROEBLING. Brooklyn Bridge, New York (1869–1883).
• Many parallel wires share the stress, and steel cable is flexible, allowing the roadway beneath to sway in response to changing weather and traffic conditions
SHELL ARCHITECTURE

- Modern materials and engineering methods now enclose spaces with inexpensive shell structures.
- Shells are capable of spanning greater spaces.
- Constructed from reinforced concrete, wood, steel, paper, etc.
- Concepts as old as the tent, or new as a geodesic dome
Figure 11.25, p.227: BUCKMINSTER FULLER. United States Pavilion, Expo 67, Montreal (1967).
• An assemblage of lightweight metal trusses
• The trusses compose six-sided units that give the organic impression of a honeycomb
NEW MATERIALS, NEW VISIONS

• New idea in architecture: “If you can think it, we can build it.”
• Global architects now adopt high-tech metals and methods.
• Different visions concerning assembling designs and buildings have created new and interesting buildings.
• Architects are also using unorthodox building materials.
New Materials, New Visions in Architecture

- Frank Gehry’s Ray and Maria Stata Center for Computer, Information and Intelligence Science, MIT, Cambridge, MA

- Peter Testa and Devyn Weisner, Testa Architecture and Design’s Carbon Tower

- Shigeru Ban’s Nomadic Museum
Discussion Questions:

• Why is architecture so important to us as humans?
• What are the materials used in building construction?
• What are some of the building techniques used in architecture?
• Why is architecture an art form and a science (engineering)?
What to Study

• Definition of post and lintel construction and that Stonehenge is an example
• Definition of Dry Masonry technique and that Machu Picchu is an example
• How groin vaults are created, and what the square space it covers is called (bay)
• Definition of pendentive, and know that Hagia Sophia in Constantinople is an example of dome and pendentives
• Definition of trusses, and that they are primarily used for covering roofs of structures
• Definition of Balloon Framing and that it was originally a derisive and insulting term
• Know about cast iron and that it came about because of industrial revolution, and was the first material that made it possible to have tall buildings with slender walls
• Know that the Eiffel tower’s trusses were prefabricated
• Know about the Brooklyn Bridge, steel cable construction, and the fact that it allows for spanning great distances