We Love Building Green

By Dennis Hagen-Smith	5th Grade

Lesson Plan Background

Students will learn how architectural design intersects with global climate change to provide strategies to create energy-efficient structures. By designing buildings that reduce dependency upon non-renewable energy sources, students will learn that individuals can have a direct impact on creating a more sustainable future. These lessons can also be applied to the creation of structures on the moon or Mars.

The teacher initiates the unit with lessons derived from Climate Change (DK Eyewitness).

Learning about topics such as the greenhouse effect and the carbon cycle will provide scientific background for the unit. Subsequently, students will work in collaborative groups completing a variety of activities to build their understanding of climate change, the importance of individual initiative, and the manner in which design elements can contribute to more sustainable living.

Groups will start by comparing the adventures of a mythical eco-hero in Green Power Girl & The Green Power Heroes: No Cape Required with real-life youth activists in Girl Warriors: How 25 Young Activists Are Saving the Earth. Students will utilize experiments and activities from Catch the Wind, Harness the Sun: 22 Super-Charged Projects for Kids as they explore various pathways to reduce human contributions to climate change. Lessons and activities derived from Wild Buildings and Bridges: Architecture Inspired by Nature will demonstrate how architects "look to nature to solve structural problems, like creating an earthquake-proof bridge by mimicking the long roots of a type of grass known for stabilizing riverbanks," as well as showing how nature provides artistic inspiration for architects such as Frank Gehry and Jean Nouvel.

Finally, students will use SmartLab Archi-TECH Electronic Smart House 2020 to synthesize their learning in the creation of sustainable structures that incorporate green technologies.

Implementation

Throughout the course of their investigations, students will be utilizing the *Cornell Method of Note-taking* in which they use three sections: 1) note important facts and information, 2) make connections between and beyond the lessons, and 3) create ongoing summaries of lessons learned. These notes will be used by students as they create pamphlets promoting their designs for sustainable architecture. These pamphlets will be distributed to students in other classes, along with an invitation to a special Architecture Open House in which models and presentations are shared with other students and community members.

Standards & 21st Century Learning

Implementation of this grant aligns with 21st Century Learning by immersing students in holistic series of lessons that enhance their understanding of the causes and effects of climate change. In addition, it empowers students to actively design engineering solutions that reduce our carbon footprint, and work to mitigate the consequences of climate change upon our human built environment. This unit of study utilizes STEM principles and lessons to promote innovation and

collaboration as student groups work to design high-tech products, new jobs, and a healthier urban environment. By so doing, students will develop creative problem solving, communication, and critical thinking skills that will assist them throughout their education and professional careers. Aligned with Next Generation Science-Engineering Standards, this unit of study asks students to define a problem (impact of climate change), research and consider multiple possible solutions to that problem, and to create and test solutions to these problems in the creation of new, more effective designs.

Evaluation

Teacher observations will inform evaluation throughout this unit of study. Students will be assessed upon their collaborative efforts during group work, as well as their individual production. A persuasive essay culminating this unit will ask students to convince civic leaders to incorporate their designs into the future architectural plans for the city (a verbal component to this DBQ will enable those with learning challenges to express their understanding in a different format).

Materials

All products are found on Amazon. One copy of Climate Change (DK Eyewitness) will be utilized by teacher for direct and guided lessons. Eight copies of all other books for use in student collaborative groups.

- 3x Catch the Wind, Harness the Sun: 22 Super-Charged Projects for Kids
- 3x Wild Buildings and Bridges: Architecture Inspired by Nature
- 3x SmartLab Archi-TECH Electronic Smart House 2020
- 3x Thames & Kosmos Structural Engineering | Science Experiment & Model Building Kit|Build 26 Models of Structures & Structural Elements
- AAA Batteries (for SmartLab Archi-Tech)



We Love Building Green!!

Draw your Heart Hotel:

Your Challenge:

Work with your team to build the tallest tower. You will have 15 min. Bragging rights and 10 supernovas are reserved for the first place team and 5 supernovas for the second place team.

Requirements:

- Must be made out of only paper and tape.
-Must be able to stand with out help.
-The entire team must participate.
-Have fun!!

Good Luck!!

Take Note of Different Architecture Styles

Style	What Impresses	What Could Be Improved	Opinion	Sketch
Classical				
Gothic				
Victorian				
Neo-classical				
Modern				
Post-Modern				

The Engineering Design Process:

1.
2.
3.
4.
5.
6.

Let's straighten some stuff out:

Engineer:
A person who figures out _____ and finds _____ for _____.

Architect:
A person who _____ buildings. They focus on the _____ and _____ of structures and spend their time working with _____ to _____ and _____. An _____ is usually required.

Architectural Engineer:
A person who works with _____ to _____ by using _____ to ensure the _____ of structures while coming up with _____ to maintain the building's _____. They will also ensure that _____ such as ____, _____, and _____ are organized efficiently throughout structures. A _____ is usually required.

Green Buildings:

Cleaning the Air

Bosco Verticale (Milan, Italy)

Tao Zhu Yin Yuan (Taipei, Taiwan)

These buildings are designed to incorporate _____ which not only cleans _____ from the atmosphere but also has an _____.

Wind Energy

Bahrain World Trade Center (Manama, Bahrain)

This building is designed to transform ____ into _____ using carefully placed _____ that don't impair the _____ of the structure.

Insulation

NBF Osaki Building (Tokyo, Japan)

This building has a ____ that absorbs ____ and _____ the building effectively. This is environmentally friendly because it _____ the need to use _____.

Station 1 (p.1) -

Sketch your team's completed structure:

What did your team to do well?

What could your team have done better?

What did you learn?

Station 2 (p.1) -

Look through this list and find your group along with its corresponding problem. First, read through the situation and discuss possible solutions with your group. Then, draw YOUR OWN design of a building that solves the problem on the next page. Take note of your solution and your design process as you go, and be ready to share what your group came up with at the end of the day.

Team Wright - Flooding -

Jen is a new mom living in New Orleans, Louisiana. She is looking for a home for her family, but is terrified of getting a house that can not protect her from flooding, a common concern in her area. Design a house for Jen that would address her concerns.

Team Gaudí - Wildfire -

Nate is a senior citizen who has been living in his home in the hills outside of Los Angeles for fifty years, and doesn't want to move, yet it is very important to him that his house is safe from wildfires. Design his house so that it is most likely to stand up against the fires.

Team Fuller - Drought -

Daron grew up in Isiolo, Kenya and wants to adjust his home so that it can withstand the drought that the town and its people go through. Help him redesign his home.

Team Gehry - Overcrowding -

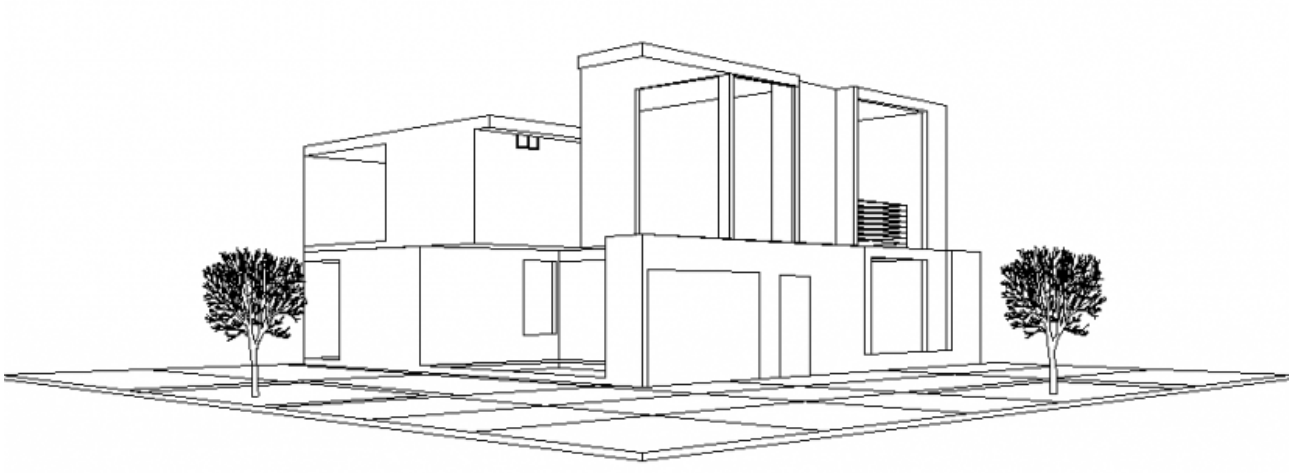
Jueles is a city planner in an up and coming city that has limited space, yet a growing population. Help her design buildings to help ensure that the citizens don't become overcrowded. Think outside of the box.

Team Safdie - Heat -

Delilah is an architectural engineering student studying the effects of heat on buildings in Death Valley, California. Help her design a building to withstand this severe heat.

Station 2 (p.2) -

Draw your house's adjustments.
(Think about both the house itself and the area surrounding the house)



Take note of your changes and your ideas here. What materials would you use and why?

Station 3 (p.1) -

At this station you will find a box full of stuff. Each thing has an original purpose, but right now that use isn't important. Take an object from the box and discuss with your group possible uses for it OTHER than its original purpose. Try to come up with at least 5 creative uses for each object, yet more is better. Record your ideas below.

Object	Original use	New and improved uses for the object (as many as you can!)

Station 3 (p.2) -

Object	Original use	New and improved uses for the object (as many as you can!)

Station 4 (p.1)-

All About Circuits

In this two page worksheet, you will learn about circuits, including what they look like, how they work, how to draw a diagram of them, and how to make one.

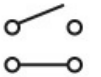
Circuits are all around us; they can be as simple as a battery connected to a lightbulb, and as complex as those found within computers. Circuits are like highways for electrons, which are particles that make up electricity. Electrons will always travel between positive and negative terminals of a power source, like a battery. Like people, electrons will never leave "home" unless they can get back; therefore, electrons will only flow through a circuit that has a complete path between positive and negative terminals. If the electrons dont flow, then power won't flow, and anything connected to the circuit will not turn on. In addition, electrons are lazy: they will always take the path of least resistance, or the easiest route between terminals. For example, if given the choice between a path with a lightbulb or a path without, they will take the path without the lightbulb.

Symbols used to represent circuit parts:

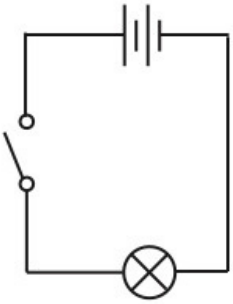
BATTERY: 

WIRE:

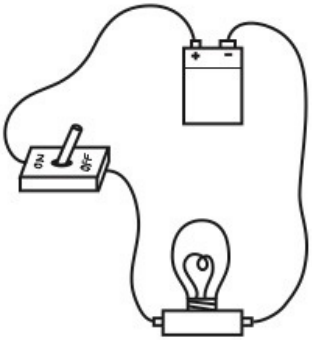
LIGHTBULB: 

SWITCH: 

Circuit Diagram:



Drawing of Circuit:



Station 5 (p.1) -

At this station you will use biomimicry and your own critical thinking skills to solve a problem. Make sure you read all the instructions carefully. They will help you.

Start by reviewing the definition of biomimicry:

Biomimicry: The design and production of materials, structures, and systems that are modeled after biological structures, entities, and processes.

Your materials:

2 Blue Boxes
Construction paper
1 deck of cards

Your Challenge:

Take the two blue boxes in front of you and place them a few inches apart. Your challenge is to manipulate the construction paper (aka: folding, twisting, stacking) so that when laid across from one box to the other, it can support the deck of cards. Try to get the boxes as far apart as possible while using as few papers as possible. You MAY NOT attach any of the materials together or to anything else.

Step #1:

Lay a single sheet of paper over the space between the two boxes to create a bridge. What do you notice? Now try putting the deck of cards on this bridge. Can it support the cards? What problems occur? Now try using multiple peices of paper. Do any changes occur?

Step #2:

This bridge clearly needs improvements. Take a hint from nature to create a more structurally sound and stronger bridge! Look over the structure of a bird bone and a truss bridge on the next page. What do you notice? Use this as an example and reattempt to make your paper bridge to support the cards following the original criteria. Don't forget that your group should try to get the boxes as far apart as possible. Record your findings below. ("Hint" try folding you paper like a fan to resemble the bird bone. Experiment with the thickness of folds to see what gives the best support. Does the way you lay down the paper make a difference?)

Reflection -

Which station did you enjoy the most and why?

What was the most interesting idea you learned about today?

Why do Architects need to adapt?

What did you learn and why is it important?

Always Trust a Truss

A team of architects in Japan had a major challenge. They were asked to design a bridge that would take traffic from the mainland to the island where the Kansai International Airport was located. The bridge would have to be about 5 km (3 mi.) long. Normally, a suspension bridge would be used to span such a long distance. But being so close to an airport with all the planes taking off and landing, the tall towers and high roadway of a suspension bridge could be a disaster.

The Sky Gate Bridge R in Osaka, Japan, uses a truss pattern for support, similar to the metacarpal bones in a vulture's wing (below).

The solution? Build a truss bridge — a bridge that uses a triangular pattern for support. A truss bridge is low enough not to be in the way of low-flying airplanes. It's strong because of its use of triangles and it uses less material than other bridges, making it cheaper to build.

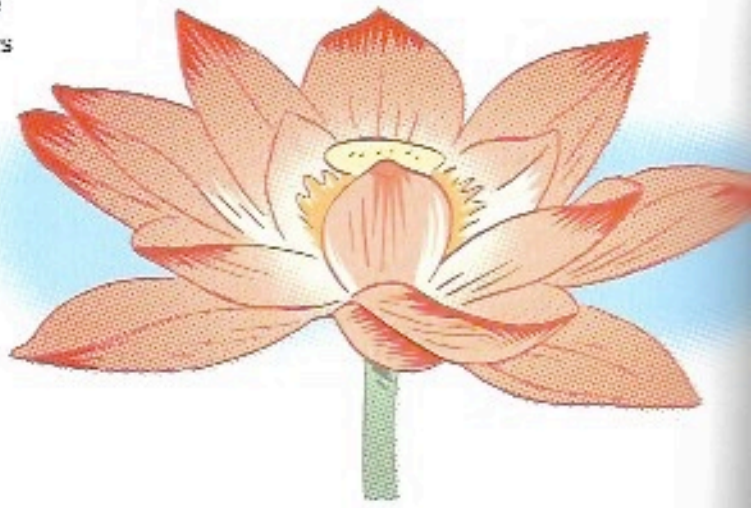
The result was the Sky Gate Bridge R, a double-decker truss bridge with lanes for cars on the upper level and tracks for trains on the lower level. The truss pattern used for this bridge is made of equilateral triangles (all three sides are the same length) with vertical supports.

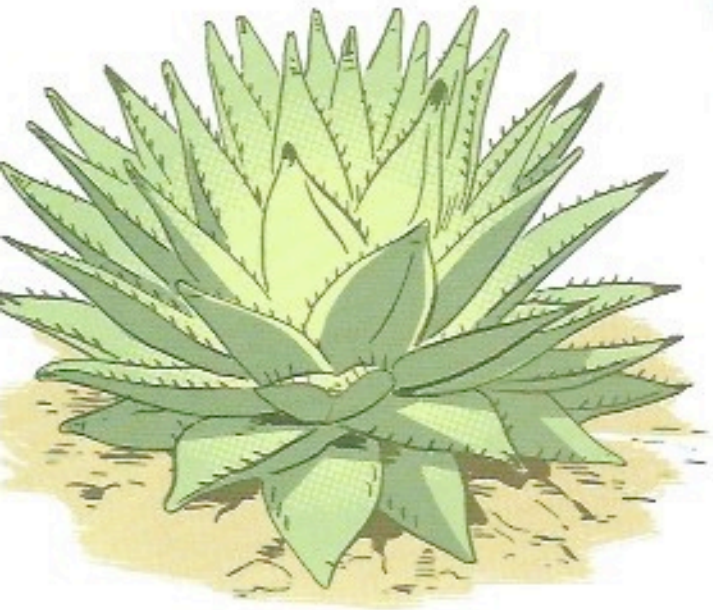
BUT ... nature was there first. Vultures have a pattern of equilateral triangles in their metacarpals. Your metacarpals are the bones in your hand from your knuckles to your wrist. A vulture's metacarpals are much longer than yours and are in their wings. Much like how triangles are used in a truss bridge, the pattern of bony triangles in a vulture's wings makes the wings strong, but still light, for flying.

DESIGN TIME

It's your turn to design your own building or bridge. For some inspiration, you might want to check out the list of some of nature's creations below. Use a pencil and paper to draw your design or ask your parents for permission to use a free online design program, such as Google SketchUp. Then let your imagination go wild!

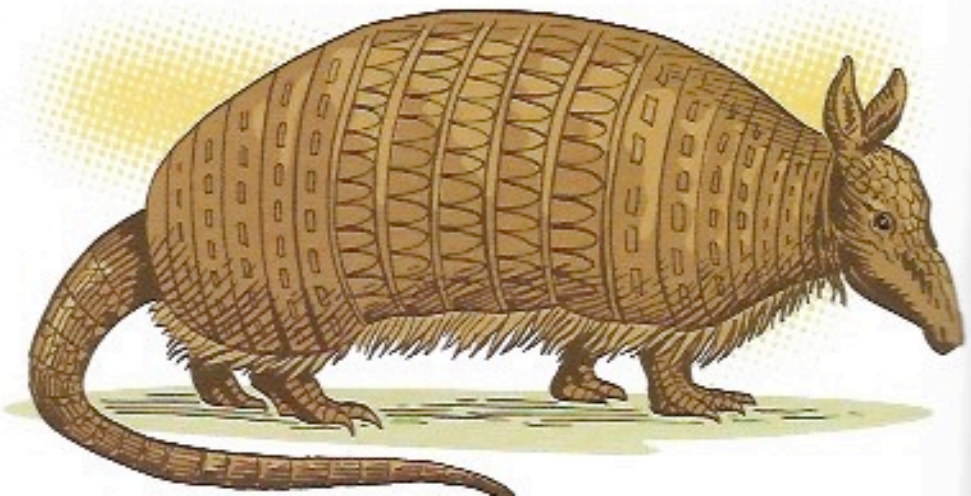
Lotus flower: This beautiful flower comes in five colors: white, pink, red, blue and purple. It grows from the bottom of a muddy pond and yet blossoms on the surface of the water perfectly clean.

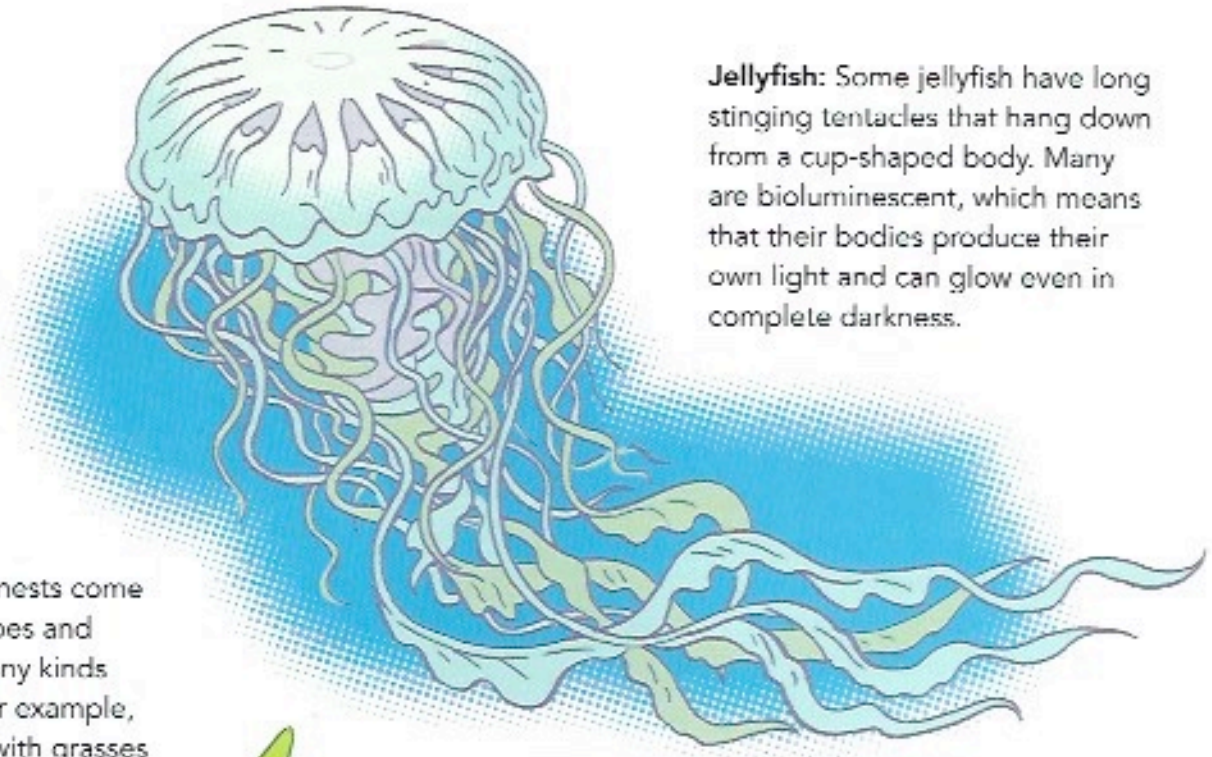




Agave desert plant: Because they grow in an arid (extremely dry) environment, agave plants need to collect as much water as possible. Channel-shaped leaves (that look something like a paper-towel roll cut in half lengthwise) catch and funnel any rain directly to the heart of the plant and its roots.

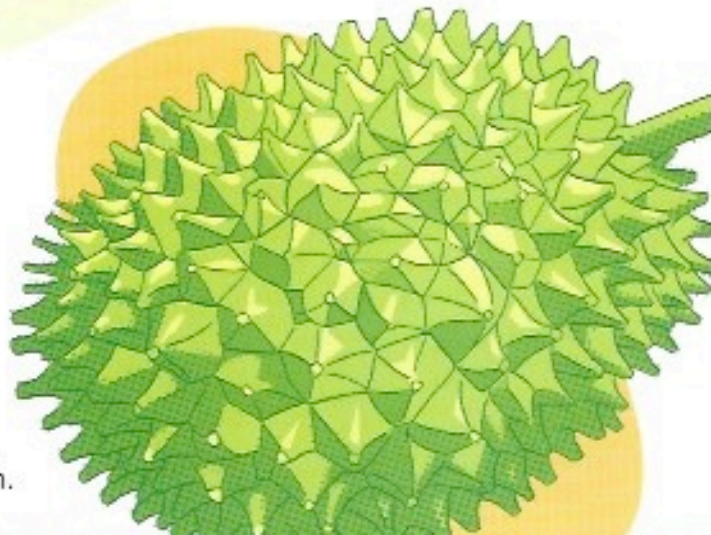
Armadillo: Armadillos are small mammals that have a protective bony shell made of keratin, the same material your fingernails are made of. The shell is made up of a number of bands that operate like hinges across its back. These bands allow the armadillo to curl up into a ball when threatened.





Jellyfish: Some jellyfish have long stinging tentacles that hang down from a cup-shaped body. Many are bioluminescent, which means that their bodies produce their own light and can glow even in complete darkness.

Bird nest: Bird nests come in different shapes and are made of many kinds of materials. For example, some are built with grasses and strips of bark woven through softer materials and small twigs.



Durian fruit: Sharp spikes on the outside of this large, round fruit protect the one to seven large seeds inside its white flesh. Many people think the durian fruit is the smelliest fruit in the world, claiming it smells like old gym socks or rotting flesh.


We Love Building Green!!

Classical Architecture

- Architecture of ancient Greece and Rome
- 5th century ad in Greece to the 3rd century ce in Rome
- Based on the post-and-beam systems
  - Columns!!
- Small variations rather than big differences between buildings
- Consists mainly of ancient buildings
- Qualities of Classical Architecture are seen in every type of architecture since.

Roman Forum, Rome, Italy

Pantheon, Rome, Italy

Parthenon, Athens, Greece

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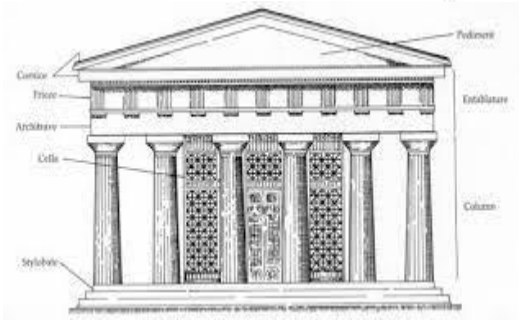

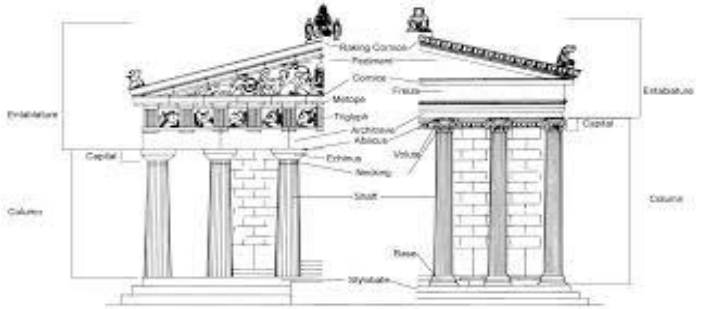

Gothic Architecture

- Architecture of middle age (and Renaissance) Europe
- Lasted mid-12th century to the 16th century
- Based on ornate, geometric, and religious designs
- Easy to spot, yet a lots of variation
- Consists mainly of churches
- Not as widespread in modern day design

Wells Cathedral, Wells, Somerset, England

Westminster Palace, London, England

Cathedral of Santa Maria del Fiore, FLorence, Italy

Gothic Architecture

Gothic Architecture

Victorian Architecture

- The mid-to-late 19th century (1800s)
- Refers to the reign of Queen Victoria (England)
- Revival of Gothic styles
  - Gothic but Modern
- Ornate
- One of the most versatile styles
  - Seen from palaces to houses to colleges

St Pancras Train Station, London, England

The Rialto (Hotel), Melbourne, Australia

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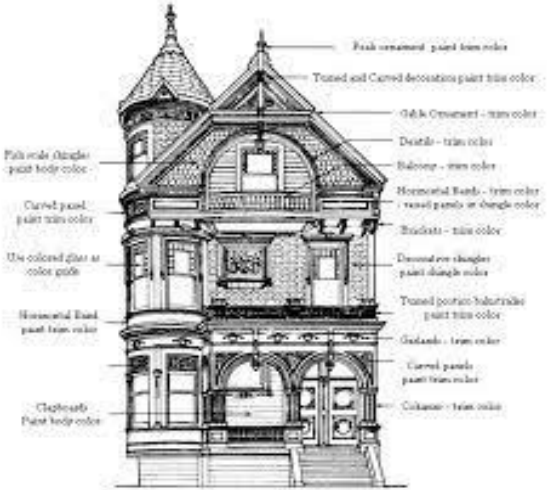

Neoclassical Architecture

- Characterized by scale and simplicity of geometric forms
- Revival of Greek styles
  - Columns and Domes
  - BIG buildings
- 18th and early 19th centuries (1700s-1800s)
  - The time period when the US became a Nation
- Seen in many government buildings

University of Virginia, Charlottesville, Virginia, USA

Lincoln memorial, District of Columbia, USA

The Capital, District of Columbia, USA

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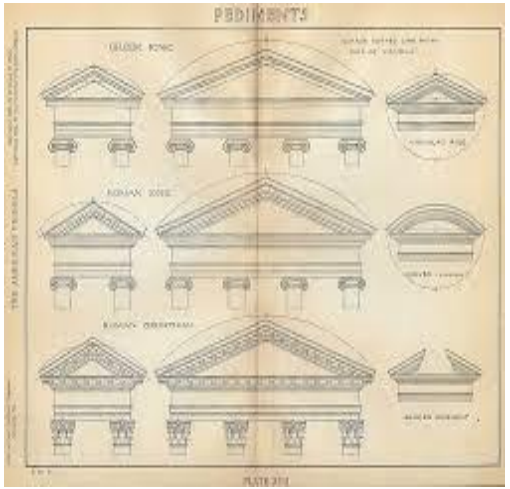
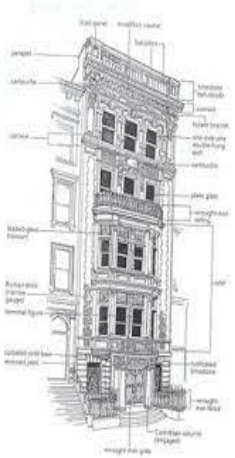
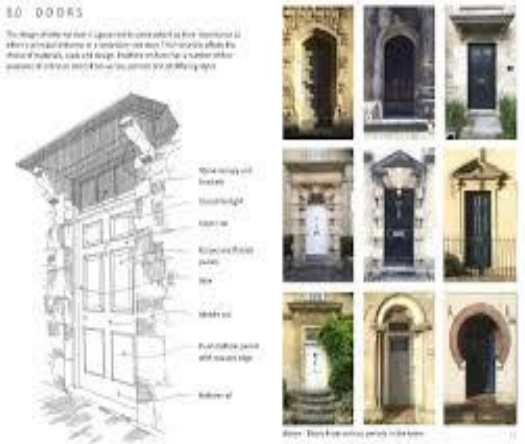


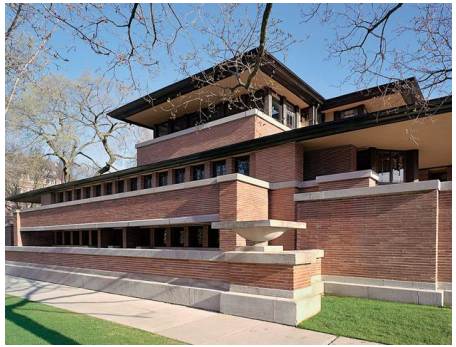




Modern Architecture

- Clean lines
- Minimalist aesthetic
- BIG windows
  - Bringing the outdoors in
- Long and flat buildings
- Most present in the 1900s (in the middle of the century!)
- Most present in homes
  - Palm spring style homes

Villa Savoye, (outside of Paris), France



Frederick C. Robie House, Chicago, Illinois, USA

White Gates, Phoenix, Arizona, USA

Eames House, Pacific Palisades, California

Modern Architecture

Modern Architecture

Post-Modern Architecture

- Emerged in the 1960s (still around today)
- Mostly big buildings
  - Museums and Concert halls
- Abstract and creative designs
- A reaction against the lack of variety of modern architecture
- Ment to fight expectations and limitations physics
  - Crazy, gravity defying buildings
  - A result of modern materials and technologies

Stata Center (MIT), Cambridge, Massachusetts, USA

Wave, Vejle, Denmark

The Centre Pompidou, Paris, France

Inntel Hotels, Amsterdam, Netherlands

Post-Modern Architecture

Post-Modern Architecture

Engineer Design Process

1. **Ask** - What problem do you want to solve?
2. **Brainstorm** - How can you solve this problem?
3. **Design** - How can you make you solution feasible?
4. **Build** - How can you make your design reality?
5. **Test** - How does you design work? Are there any flaws?
6. **Improve** - How could I make this better and fix any flaws?

Engineer

A person who figures out how things work and finds practical uses for scientific discoveries.

Architect

A person who designs buildings. They focus on the aesthetic and organization of structures and spend their time working with clients to create designs and efficient floor plans. An art degree is usually required.

Architectural Engineer

A person who works with architects to make their designs possible by using physics to ensure the stability of structures while coming up with creative solutions to maintain the building's aesthetic. They will also ensure that utilities such as gas, water, and electricity lines are organized efficiently throughout structures. A bachelor in science is usually required.

Cleaning the Air

These buildings are designed to incorporate plants which not only cleans CO2 (Carbon Dioxide) from the atmosphere but also has an aesthetic design.

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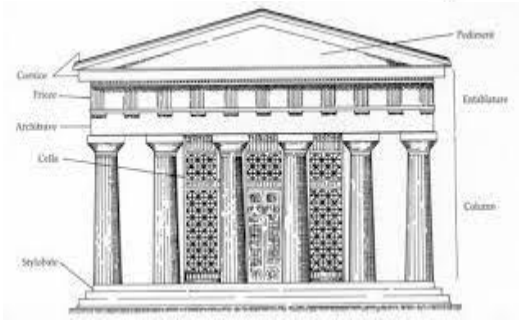

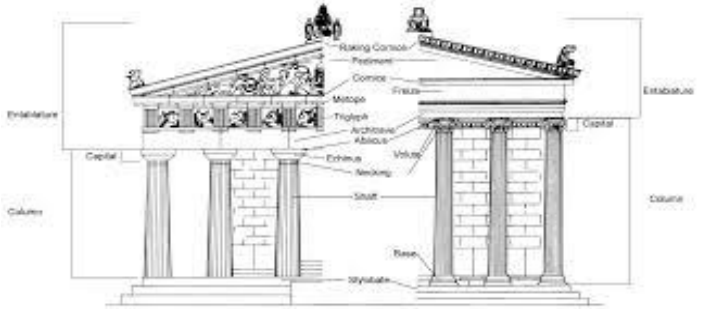

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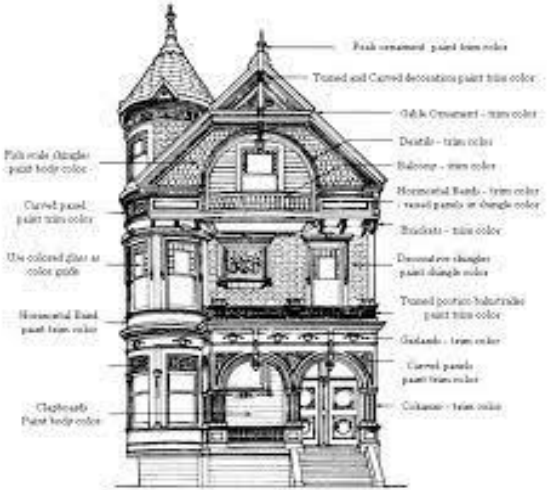

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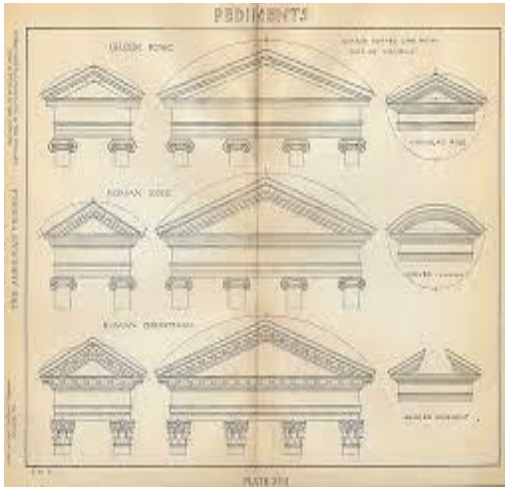

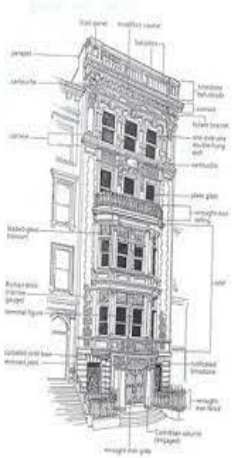

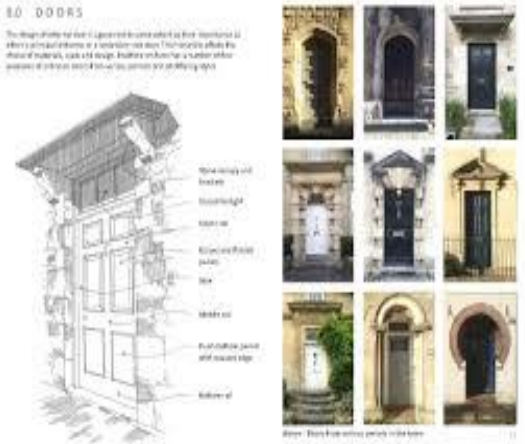

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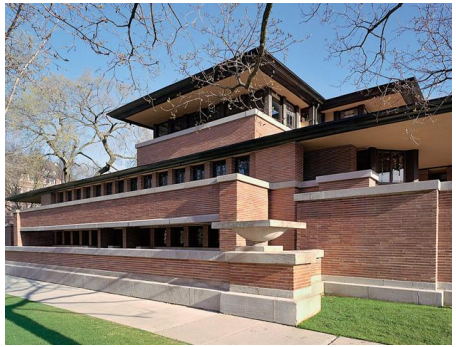
- Most present in homes
  - Palm spring style homes

Villa Savoye, (outside of Paris), France



Frederick C. Robie House, Chicago, Illinois, USA

White Gates, Phoenix, Arizona, USA

Eames House, Pacific Palisades, California

Modern Architecture

Modern Architecture

Post-Modern Architecture

- Emerged in the 1960s (still around today)
- Mostly big buildings
  - Museums and Concert halls
- Abstract and creative designs
- A reaction against the lack of variety of modern architecture
- Ment to fight expectations and limitations physics
  - Crazy, gravity defying buildings
  - A result of modern materials and technologies

Stata Center (MIT), Cambridge, Massachusetts, USA

Wave, Vejle, Denmark

The Centre Pompidou, Paris, France

Inntel Hotels, Amsterdam, Netherlands

Post-Modern Architecture

Post-Modern Architecture

Engineer Design Process

1. **Ask** - What problem do you want to solve?
2. **Brainstorm** - How can you solve this problem?
3. **Design** - How can you make you solution feasible?
4. **Build** - How can you make your design reality?
5. **Test** - How does you design work? Are there any flaws?
6. **Improve** - How could I make this better and fix any flaws?

Definitions:

Engineer

A person who figures out how things work and finds practical uses for scientific discoveries.

Architect

A person who designs buildings. They focus on the aesthetic and organization of structures and spend their time working with clients to create designs and efficient floor plans. An art degree is usually required.

Architectural Engineer

A person who works with architects to make their designs possible by using physics to ensure the stability of structures while coming up with creative solutions to maintain the building's aesthetic. They will also ensure that utilities such as gas, water, and electricity lines are organized efficiently throughout structures. A bachelor in science is usually required.

Green Buildings:

Cleaning the Air

These buildings are designed to incorporate plants which not only cleans CO2 (Carbon Dioxide) from the atmosphere but also has an aesthetic design.

Bosco Verticale (Milan, Italy)

Tao Zhu Yin Yuan
(Taipei, Taiwan)

Wind Energy

This building is designed to transform wind into renewable energy using carefully placed turbines that don't impair the function of the structure.

Bahrain World Trade Center
(Manama, Bahrain)

Insulation

This building has a facade that absorbs heat and insulates the building effectively. This is environmentally friendly because it reduces the need to use air conditioning or heaters.

NBF Osaki Building
(Tokyo, Japan)

Let’s talk about
today’s stations!

Antoni Gaudí
(1852-1926)

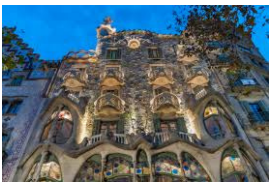
Theory and Style

- Gothic Revival Style
-Modernisme

"Nothing is art if it does not come from nature"

La Sagrada Familia

Casa Milà



Casa Batlló

Buckminster Fuller
(1895-1983)

Theory and Style

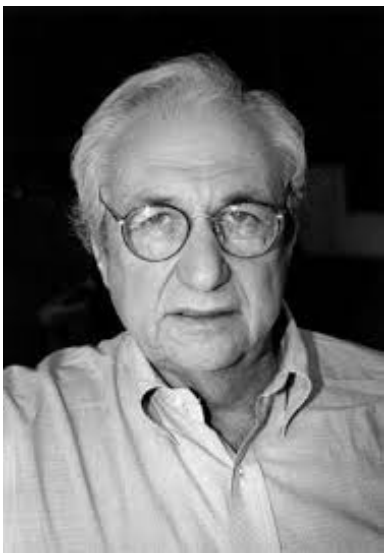
- Futurist style
- Geometric domes

"You never change things by fighting the existing reality."

Spaceship Earth

Fly's Eye Dome

The Biosphere,
Environment Museum



Frank Gehry
(1929-)

Theory and Style

- Post-Modern style
- Complicated designs

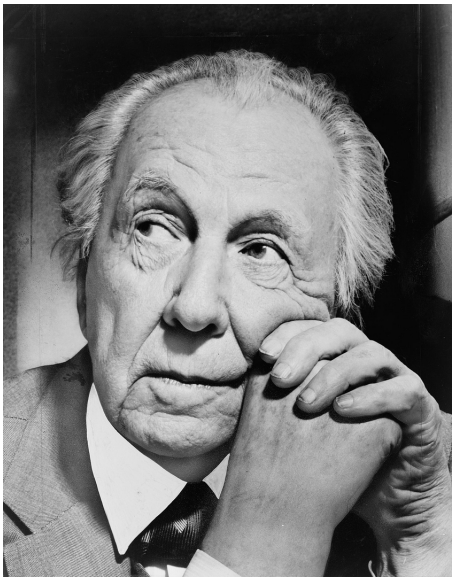
"Architecture should speak of its time and place, but yearn for timelessness."

The Lou Ruvo Center for Brain Health

New York

The Cleveland Clinic

Gehry Tower



Frank Lloyd Wright
(1867-1959)

Theory and Style

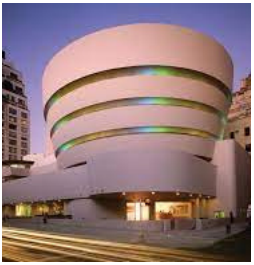
- Prairie Style
- Organic Architecture

"The city man's country home on the prairie"

Falling Waters

Lykes House

David and Gladys
Wright House



Solomon R. Guggenheim
Museum

Martin House