Since the dawn of human existence, people have sought to create shelter to protect themselves from constant weather fluctuations and predators. To do so, humans have had to use tools and build structures by relying on architecture, “The art or practice of designing and building structures and especially habitable ones” (Webster, 1995). Dating back to the original architectural structures, anthropologists and architects, from around the world have noticed key similarities in human buildings. The first “Homo” species made the first tools to build basic structures and even decorated the inside walls with pictures, just as humans today use more advance tools and material to build more advanced structures and decorate the walls of their homes. However, there are also key differences in architecture around the world.

Sumer

Archeologists found the first architectural evidence in the present day nation of Iraq, dating back to 3,500 BC. During that time, the region now known as Iraq was called Sumer. The Sumerian people built these early structures with mud-bricks. Since these mud-bricks were large and solid, the Sumerians did not know how to make the structures hollow, so they created large, solid structures that ascended diagonally to form large staircase-like structures called ziggurats. Such ziggurats were built for each different Sumerian city, and was the most important building in every city. Atop the ziggurat was a shrine used for religious worship (Kirkpatrick, 2003).

Can Architecture define a nation?

Architecture is the practice of designing and buildings structures, most commonly buildings. This very specific definition, however, does not address that the “art of architecture” differs from place to place. As if it could speak, architecture can reveal the time, place, economic status, and preferences of one geographic region. Different nations, or cultures, have very distinct architectural differences. Understanding these key differences when researching architecture helps expand knowledge on different cultures and areas of the world.
Similarly, the Egyptians built massive structures that, just like ziggurats, were triangular in shape, and built in layers of large steps. These structures were called Step Pyramids; the first one was built at Saqqara, Egypt, for Pharaoh Djoser in 2,650 BC. Just like ziggurats, these architectural structures were not built for habitual use, but rather were built for pharaoh’s burial tombs. These Step Pyramids were more advanced than the Samarian ziggurats due to the fact that the Egyptian builders used large stone instead of mud-brick to create the tombs. Each step, or mastabas, must fit proper dimensions perfectly so the layer above it will create a triangular shape. Distinct economic status is also seen through the use of Step Pyramids, and later better crafted Pyramids, because instead of burying wealthy pharaohs in the ground, thousands of slaves would build large pyramids for their burial sites. The inside of the Step Pyramids and Pyramids are like intricate mazes. In the middle of the maze, the pharaoh, along with his prized possessions, were buried in the king chamber (Forest, 2012). The Egyptians, in particular, were very advanced for their time. James Fergusson, a 19th Century author, in particular, raved about the Pyramids in his book A History of Architecture in all Countries. Referring to the pyramids, he states “No language can convey an idea of its beauty, and no artist has yet been able to reproduce its form so as to convey to those who have not seen it an idea of its grandeur” (Fergusson, 1865).

Though the ziggurats, Step Pyramids and Pyramids are examples of the first intricate architectural styles designed to show economic dominance (whether for a city or ruler), the first recorded habitable architectural structures were found in Anatolia, present day Turkey. This civilization, called Catalhoyuk, dates back to 6300-5500 BC. Just like the Sumerians, the people who lived in Catalhoyuk made their homes out of mud-brick, but also used plaster. These original homes were very utilitarian, but also contained non-utilitarian rooms that were built into shrines, designed for worshipping the gods. All of these early architectural structures, along with other succeeding structures, were lined with limestone. This is because limestone is maintainable, stable and long lasting, and also beautiful, great for aesthetic purposes (Hirsk, 2012).

Though the first architectural structures were less concerned with aesthetic beauty, architects can really notice differences in nation’s architecture once humans begin to focus not just on survival, but more on creating an environment which their nation considers beautiful and aesthetically pleasing.

Since beauty is “In the eye of the beholder,” architects gain a good understanding of how the people of different nations define beauty based on the evolution of their architecture. Since the majority of the world’s nations are religious, one way many nations apply aesthetics in architecture is through religious symbolism, such as decorative shrines, temples or churches. Each nation or culture takes a lot of pride in their religion and, just as the Sumerians and Egyptians showed their respect to their rulers, god-kings, with colossal ziggurats and pyramids, we today show respect to the gods or God we worship with large, intricately designed buildings.
Islam

Muslims follow a very specific form of aesthetics, according to the Islamic Decorative Canon. This Canon defines three types of architecture:

1. **Calligraphy**
   
   Calligraphy is the form of writing used in sacred Muslim text, such as the Al-Quran. Therefore, this is the most sacred form of decoration in the Canon. Different styles and types of calligraphy are used to decorate mosques to show their importance.

2. **Geometric Patterns**
   
   Geometric patterns are more vague decorative styles in the Canon. This appeals to Muslim designers and architects because it allows them to have more freedom in their symbolic interpretations of the design. It also gives the architects the opportunity to show their skills and amaze worshipers at the mosque.

3. **Arabesque**
   
   The Islamic Decorative Canon says the last architectural design should be arabesque in style and, just like geometric patterns, is found across a wide range of Muslim designs (Broug, 2008).

Greece

Just as the Islamic Canon’s followed specific architectural designs, the Greeks built their temples following three different orders. However, these orders were not classified by religious hierarchy. Rather, the different structures marked different time periods in Greece. All the Greek temples follow the same structure. Each part of the temple and columns is named:

1. **Doric**
   
   The first order, the Doric style was very sturdy with a plain capital. This style was used in mainland Greece and was adopted by colonies in southern Italy and Sicily.

2. **Ionic**
   
   As the 5th century B.C. continued, the Greeks wanted to show more intricacy, and created the Ionic order. The Ionic style is thinner and more elegant than the Doric style. Its capital has a scroll-like design and is found in eastern Greece and on the Greek islands.

3. **Corinthian**
   
   Lastly, as the years continued, the Greeks became even more complex in their architecture and created the Corinthian order. This new style is rarely seen in Greece, but is more prominent on Roman temples (the Romans marveled at the Greek Corinthian style). The Corinthian capital is very elaborate and decorated with acanthus leaves (University Press, 2008).
The order the Greeks used for their temples did not matter; rather, what did matter was that each structure had to follow a specific proportion. For example, Doryphoros, the sculptor of the Parthenon, believed that “beautiful proportions resulted from strict adherence to harmonious numerical rations, whether [he was] designing a temples more than 200 feet long or a life-sized statue of a nude man” (Kleiner, 2010). Therefore, architects today can observe mathematical proportions represented in Greek architecture.

Greece was not the only nation that used columns in their temple design. As noted earlier, Romans architectural design was based heavily on what they observed in Greek architecture. Thus, a lot of the Roman temples of worship are very similar in nature to the Greeks. However, major differences can be observed.

**Differences between Greek architecture and Roman architecture:**

<table>
<thead>
<tr>
<th><strong>Greek</strong></th>
<th><strong>Roman</strong></th>
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<tr>
<td>• Temples were built on a platform called a stylobate, with three steps under it called crepidoma (Gonzalez-Longo, 2009).</td>
<td>• Created own order of architecture, the Composite Column, which contains a mixture of Ionic and Corinthian elements.</td>
</tr>
<tr>
<td>• Temples are built with vague entrances.</td>
<td>• Temples were built on an elevated plateau.</td>
</tr>
<tr>
<td>• Statues are placed in the cela, the room of the temple which no one was allowed to enter.</td>
<td>• Temples had very definite entrances.</td>
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<tr>
<td></td>
<td>• Roman statues were placed in the center of the temple.</td>
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Asia: When observing Asian culture, one can compare it to Egyptian and European because they all add detail to show grandeur; however, they all express grandeur differently. Since the Tang Dynasty in the 600s, Asia’s biggest nation, China, has kept its architectural style largely constant, and has even influenced the architectural styles of Japan, Korea, Taiwan and Vietnam (Weston, 2002). Asia, as a continent, is geographically large, home to 1,400 different languages, contains 18 million square miles of land and has more than 30,000 islands. It is therefore hard to pinpoint one specific Asian architectural style. Yet even though it seems impossible to find a specific architectural detail that represents Asia’s unique population, Weston states in his article “The Arts” that there are some similar features that architects can observe, regardless of the region they are in.

1. One key characteristic are Asia’s rooftops, which are flat, to emphasize the width of the building rather than emphasize height with pointed roofs like Western roofs. All the roofs are made out of gables, similar to shingles. Interestingly, Asia follows a strict classification order, such as those in the Islamic Canon.

2. Asian architecture also stresses the importance of symmetry. Asian symmetry applies to all economic statuses, such as palaces and farmhouses; not just nobility. However, their gardens are mostly asymmetrical to give the sense that one is walking through nature (as opposed to Europe’s freshly manicured, symmetrical gardens to show artistry) (Weston, 2002).

3. Observing a region’s architecture can also help one learn about the geographical area. Since Asia experiences many earthquakes, they build most of their buildings from wooden structures.
4. Just as the Egyptians, Greeks and Romans built large, elaborate buildings in honor of their royalty, the Chinese also reserved certain architectural features for their Emperors. Color holds a lot of meaning in Asian culture and is used to show different status.
   a. The Emperor’s home had yellow roof tiles, because yellow is the Imperial color.
   b. Blue roofs were used for religious buildings because blue symbolized the sky, or heavens. Wealthy, Imperial architecture also contains numerology, the use of numbers in construction.

5. The greatest number in Asia was nine, thus the reason why imperial city, The Forbidden City in Beijing, is believed to have 9,999.5 rooms.

6. Even the placement of Asian buildings sheds light on their cultural beliefs. The East, the direction of the rising sun, was the direction most Imperial buildings faced, as a form of solar worship found in many ancient cultures, because Imperial rulers worshiped the sun (Weston, 2002).

America

After observing many cultures and their differences, as well as similarities in architectural styles, one can look at American architecture and see all the different architectural styles represented from different nations. America, or the melting pot, contains all types of nationalities and was created by immigrants from other nations. Thus, these immigrants took their home-architectural styles and implemented them in America. When the English came over, they built many of their Colonial homes with brick, because that was the common element of English buildings (Essential Architecture, 2004). When the Spanish explored the Southwest region of America in the 1500’s, the Pueblo people built cubic homes from adobe, known today as Pueblo Style homes. New England styled homes became popular in the 18th Century when constructing plantations. In the 19th Century, many Cathedrals were architecturally influenced by the Medieval, Gothic era from Europe…

... Then, in the late 1800’s and early 1900’s, our nation’s capital, Washington D.C., designed the Capitol building and many monuments based on the Greek architecture. Just as Rome modeled their architectural columns off of Greek’s columns, political figures in America, such as Thomas Jefferson, also worked in architectural buildings modeled from Greece, yet lived in large, Federal style homes, built similar to Roman style buildings (Essential Architecture, 2004).

America has many architectural influences from all different nations. However, the most innovative architectural design, built originally in America, is the skyscraper. In 1885, Chicago built the world’s first steel framed skyscraper. America’s quickly growing population also created the first suburbs, which emerged in San Jose, California in 1944 (Essential Architecture, 2004).
Throughout history, each nation has revealed individual taste through their architecture. “Until the invention of the printing press, architecture was the primary means of the expression and communication of the ideas, values, and beliefs of a culture.” (Hendrix, 2010). Hendrix’s quote makes it clear that just by observing different nations’ architecture, you can learn about their evolution as a country, their beliefs and values, economic statuses, and much more. Yet, after researching, it seems as though all nations get architectural ideas from one another and apply the styles to their own environment. However, each nation adds its own uniqueness to old designs, to create new ones. Thus, architects can learn many different things about a specific nation and its region just based on its architecture.


The importance of math and science in architecture

Inspirationfeed explains that “Mathematics and architecture have always been close, not only because architecture depends on developments in mathematics, but also their shared search for order and beauty” (Tate, 2012).

http://www.storyofmathematics.com/greek_pythagoras.html

Ancient Greek philosophers and mathematicians, the Pythagoreans, believed that “number took on a religious significance” and “all things are numbers” (O’Conner & Robertson, 2012). Therefore, mathematics was clearly heavily used in that time. Pythagoras applied mathematics to everything, particularly music. Because of his experiments with stretched strings on a music scale, he discovered the significance of dividing it into ratios determined by small integers. By dividing the ratios, harmonious sounds were created. This discovery “led to architects designing buildings using ratios of small integers. This led to the use of a module, a basic unit of length of the building, where the dimensions were now small integer multiples of the basic length” (O’Conner & Robertson, 2012).

Geometry was also heavily used because geometry is the study of shapes and “shapes were determined by numbers”. But even more fascinating, Pythagoreans created the aesthetics of a building with proportion. They used symmetry to create beauty and harmony in their architecture. “The word symmetry comes from the Greek architectural term “symmetria” which indicated the repetition of shapes and ratios from the smallest parts of a building to the whole structure” (O’Conner & Robertson, 2012).


Continuing through history:

- A mathematician from the Renaissance period, Bombelli, became an engineer and architect; he applied both these skills in his work and his thorough investigation of complex numbers.
- Bramer followed in Bombelli’s footsteps and combined mathematical and architectural skills to construct fortifications and castles. Bramer also published a work on the calculation of sines, and in 1630 he constructed a mechanical device which enabled one to draw accurate geometric perspectives (such as a protractor or ruler) (O’Conner & Robertson, 2012).
- O’Conner and Robertson make it clear that throughout the early history of architecture, mathematics, science and architecture played a large role together. However, they also explain that in the 19th century, people began to separate scientific and artistic notions. Though the connections between mathematics and architecture did not vanish during this time, people just mentally separated these aspects. “Scientific and artistic aspects were seen as complementary skills not to be found in the same person” (O’Conner & Robertson, 2012). This was much different than the classical view that great mathematicians were great artists, such as Di Vinci.

Architecture Today

As we move towards the present day, people are beginning to see that mathematics and science, as well as technology and engineering, go hand-in-hand with the application of architecture. The 21st century company, Nexus, has a philosophy centered around determining mathematical connections in architecture (since the definition of nexus is “connections”). Specifically, the Nexus Design Company dedicates its time to “problem seeking and problem solving” (Nexus, 2012). Their large, diverse firm is able to collaboratively put together creative design solutions to create strong buildings. Constructing a building is not the only thing architects need to consider. Along with creating the blueprint, Nexus explains that architects need to consider building “sustainability, landscape design, and interior design” as well as research “the latest technologies [to] sensibly adapt into our projects” (Nexus, 2012). To help bring the architects creative, mathematic based ideas, to life, a civil engineer needs to bring science into play. A civil engineer’s job is to determine if the area where the architect wants to build can support buildings, as well as research the history of the land to see if erosion, earthquakes, or other natural disasters are common in the area. Without a civil engineer’s pragmatic thinking and science background to help advise the architect, buildings would not be as structurally sound as they are now.
Currently, architects and engineers are collaborating like never before. The journal, “Nexus Network Journal, 2011” explains that these professions will now need to be knowledgeable in computer technology as well. An important, up and coming program called CAAD (computer-aided architectural design), is a powerful tool for architects to use that will allow them to “manipulate geometric and algebraic formulas, recursions, random functions, statistics, splines, the fourth dimension and other complex mathematical concepts” (Williams, 2006). Through CAAD, the science of computer technology will allow architects to shift from paper and pencil blueprints to computer generated ones.

A huge shift in the 21st Century has been towards constructing ecofriendly, energy sufficient homes. The U.S. Energy Information Administration (EIA) reported that “in coming years, Building Sector energy consumption will grow faster than that of industry and transportation. Between 2010 and 2030…total Building Sector energy consumption will increase by 5.85 QBtu…1 QBtu is equal to the delivered energy of 37 1000-MW nuclear power plants” (Architecture 2030, 2011). Architecture 2030’s website explains that a 2030 Challenge has been created that provides strict, ecofriendly guidelines for builders to follow. In 2007, the Senate and the House of Representatives made the Energy Independence and Security Act a law that required all “new federal buildings and major renovations to meet the energy performance standards of the 2030 Challenge beginning in 2010” (Architecture, 2030, 2011). Architecture 2030 provides a diagram of what the 2030 Challenge expects energy consumption to look like by 2030:

![The 2030 Challenge](http://architecture2030.org/the_solution/solution_energy)

Civil Engineers are not the only people who work alongside architects. Many other jobs need to have architectural backgrounds:

- Landscape Architecture
- Carpentry
- Industrial Design
- Interior Design
- Building/Private home Inspection
- Renovation
- Historic preservation
- Technical architecture
- Construction worker

It is vital for STEM to be integrated in education with real world applications so our future can be prepared. Based on the list to the right, such integrations will not only prepare students to become architects, but will help create the foundation for many job avenues. Administrators who don’t know how this could be done in schools, here are just a few subjects that would benefit from real world application in architecture:

- Algebra
- Geometry
- Proportions
- Ratios
- Physics
- Calculus
- Art/Drawing
- Computer Graphics
Throughout the millions of years that humans have been on this earth, our ways of living have drastically changed. This change can be observed in the evolution of each nation’s architectural designs. Though some cultures are more minimalists and others value intricacy, each nation’s architectural tools have been able to evolve to help create more stable, economically secure buildings. It is important for a society to understand the similarities as well as staunch differences in every country’s building configurations. Though there are many visible differences, every architect, no matter where in the world, must use mathematics and science (and in today’s leading countries, technology) to create such aesthetically pleasing buildings.

Architects, engineers, urban engineers, and others in the field need to adopt the 2030 Challenge and to do this, they need to be good problem solvers. One major problem addressed in the 2030 Challenge is how to provide electricity for buildings without burning fossil fuel. Architecture 2030 states that “In 2010, 75.5% of all electricity produced at power plats in the U.S. was used to just operate buildings” (Architecture 2030, 2011). Too much fossil fuel emission over the years has put a huge strain on our earth’s climate, and has even been a huge factor in climate change. Therefore, it will not only be important for architects to keep this in mind when creating a floor plan, but in the upcoming years, it will be mandatory to build solely carbon-neutral buildings. To start this in the future, architects can look at current examples. The first carbon-neutral home was completed in September 2012 in D.C. It met the carbon-neutral classifications, as well as other standards being pushed for future use, because it had cutting-edge mechanical systems including:

- Ground source heating and cooling
- Solar hot water
- LED lights
- Energy Star appliances to produce a home that will use 60-80% less energy
- Local utility providers provide the rest of the homes “clean” power
- Ethanol fireplace

Homes, such as the one built in D.C., will act as the forerunners for our future sustainable and environmentally integrated buildings!

http://arifkhan1.blogspot.com/

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