

Lecture 3 – Geometric Innovations in Architecture

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Welcome to 3rd lecture within series Guastavino in Pittsburgh. Forgive me for canceling last week's class, I was in Columbus for father's passing.

Guastavino lived in the heart of the Industrial Revolution that developed **new materials and machinery for manufacturing**, saw a **maturing of Building Science**, the subject of last week's lecture and the **focus of today's architectural practice**. That lecture will be folded into next week's lecture on structural engineering.

Today, we will take a step back to the **periods before modern engineering**, to the **practice of architecture as geometry, proportion, scale, massing, perspective**... In particular, the revival of historical styles from antiquity: Gothic, Romanesque, Classical Greek, and a few new traditions popular at turn century: Arts & Crafts, Art Deco, ...



Columbian Exposition of 1893 in Chicago (Chicago World's Fair) was a **turning point for the Beaux-Arts movement in American architecture**. Many American architects in the late 19th century were trained at **Ecole des Beaux-Arts in Paris**, which emphasized the **study of historical precedents** and the principles of **symmetry** and **proportion** found in the **classical architecture of antiquity**.



Countries from around the world constructed national pavilions in the south side of Chicago's **Jackson Park**. Guastavino was selected as the principal architect for the **Spanish Pavilion** (he had built past pavilions: in **Vienna of 1873** and in **Philadelphia of 1876**). Selected for Chicago's Fair by a committee with two Valencians, hiring **one of their own** and he was **established within the United States** where the construction was going to occur.



Spanish Pavilion was a 3/4 scale reproduction of the Late Gothic **silk exchange building in Valencia (La Lonja de la Seda, 1482)**, built during the time period of **Christopher Columbus**' discovery of New World, the theme for World's Fair.

“Massive structure of buff sandstone, square tower at one end with a **circular stairway**, arched doorway, **pointed windows** terminating in a cross, fretwork ornamentation, **heavy cornices** solid as a fortress, warrior figures symbolic of commerce/finance.



Inside a hall of **cathedral-like columns** extending to the roof, composing a majestic interior space.” However, **constructed of lath and plaster**, rather than tile vaulting.

August 5, 1893, 8 weeks after opening of Spanish Pavilion, Guastavino gave a lecture on his **cohesive construction method of structural tile vaulting** to the **Congress of the American Institute of Architects (AIA)**. The Congress drew the leading architects to Chicago, described as the “**greatest meeting of artists since the 15th century**”.



He discussed great historical domes, like Roman **Pantheon (Emperor Hadrian, 126 AD, 142 ft. diameter and height: sphere within a cylinder)**, nearly 2K years old, **world's largest unreinforced concrete dome**. **Greek / Roman style**.

Modern concrete made from **Portland cement** (gypsum), same material sought out, importing **from England by Guastavino** for its **superior strength** to **lime mortars**. However, known to **deteriorate exposed to water, freeze / thaw cycle**, weathering.



Roman concrete used 10% less water, less lime, and added **volcanic ash**, containing fragments of glass crystals; **pozzolana dust rich in Aluminum Silicate**, that chemically reacts with seawater, making the lime denser and crystalline (aluminous tobermorite crystals); and **Potassium rich mineral Leucite**, that strengthened the mechanical binding between lime and other crystalline fragments in the mix. Roman structures underwater, remain unscathed by harsh salt water and currents.

Interesting parallel to **Valencia tile vaulting innovation in 1382**, using thin tiles as an **economic infill, “scrap materials”** as a substitute for time consuming cut stone. **Romans 2K years ago**, during the reign of **Caesar Augustus (27 BC – 14 AD)**, **innovated use of concrete (opus caementicium)** by adding “scrap materials” to the cement mix, **stone fragments from carvings, broken ceramic tiles, brick rubble**, resulting in a concrete revolution, structurally complicated arch, vaults, domes.



Another historical dome discussed in his lecture, **Hagia Sophia in Istanbul (Roman Emperor Justinian I, 537 AD, 170 ft. diameter and 2 ft. thick brick)**, largest pendentive dome in the world, until **Michelangelo’s St. Peter’s Basilica (1547 AD)**. **Byzantine style**.



Original dome collapsed after earthquake in 558. Original walls built with more mortar than **brick, laid without mortar setting up**, causing the **walls to lean outward** from the lateral thrust of the dome on wet mortar. Rebuilt new walls on interior to make plumb vertical and **raised the dome 20 ft., to be more circular**, transferring loads more vertically to the base. New dome built with **40 ribs, like scalloped shell or umbrella**, transferring loads uninterrupted between the windows to the ground.

Guastavino’s lecture also cited examples of his **current work which included many buildings by architects present** at the lecture, of which he said such buildings would form “**a page in the American history of constructive art, ...impossible to be built in concrete**, with such dimensions, strength, thickness, and short time”.

He was **connecting his tile vaulting system to the great domes in the history** of architecture. Domes considered the crowning feature of architectural monuments.

And, his comments on the **inferior qualities of concrete construction**, speak to the growing interest in reinforced concrete, seen as the biggest competition to tile vaulting’s greatest strengths: **load capacity** and **fire resistance**. Also seeing advancements in **steel frame buildings**, Guastavino described such structures as “a human skeleton only enveloped with a skin, **without ...artistic life and soul.**”



One of the buildings under construction by Guastavino at the time of the lecture was **Central Congregational Church (1893)** in Providence, Rhode Island (architects John Carrere & Thomas Hastings, formerly w/ McKim, Mead & White).



Central Congregational Church was **Guastavino's first large central dome in the United States**, spanning **54 ft. in diameter**, supporting **24 ton lantern**, using adjacent **barrel vaulting to buttress the dome**, pierced with **ocular windows**. Interior with **exposed tile throughout**.



+2

Local example of pendentive dome in **St. Boniface Roman Catholic Church** (A.F. Link architect, **1926**).



+3

Ads in **Sweets Catalog (1931)**



In **1907**, **Henry Hornbostel** stretched the capabilities of Guastavino's tile vaulting with the **Rodef Shalom Synagogue**. [Martha Berg, archivist] **Square plan dome** spanning **90 ft. diameter**. Guastavino Jr. stating, "it is the **largest dome of this kind in existence**, most other large domes usually being octagon or round".

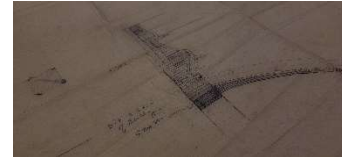


Exterior of cream colored **Kittanning brick** in two tones, laid in Flemish bond. Polychromed in intricate ornament of **terra cotta trimming green pantiles roof**.



+2

Guastavino and Hornbostel developed quite a friendship, collaborating on many buildings, with Guastavino saying, “**New materials possess a certain fascination** for Mr. Hornbostel beyond what they have for the less imaginative mind of the average architect, and in the use of **Guastavino tile among new materials** he has led the way as he has in **steel work.**”



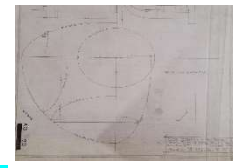
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Dome originally designed for steel. Guastavino sketch on trace (**March 2, 1906**).

The **high construction cost of ‘true’ masonry construction**, domes **made of stone**, and the required **expertise not available**, architects **opted for steel** (later concrete). “A true masonry dome has apparently been beyond the abilities of our architects or the purses”. **Guastavino’s success** following the World’s Fair was due in part to the **economy of material and labor in tile vaulting offering an alternative.**



+2



Another oculus window in a dome, **elliptical** in **Baker Hall** (**Hornbostel, 1914**)
Profile of vault determined by the architect, calculated **on paper, in drawing.**

Guastavino’s **versatility adapting the tile vaulting to any style.**



+9

First Baptist Church of Pittsburgh (**Bertram Goodhue** architect, **1911**)
Gothic Revival Style

Painted clay tile to imitate stone??? Machined limestone exterior



+1



Also known for **Gothic Revival Style** religious buildings, located in Homewood
Holy Rosary Church (Ralph Adams Cram architect, **1929**)

Plaster finish



+15



East Liberty Presbyterian Church (Ralph Adams Cram architect, **1934**)

[Thomas Morton, historical architect]

Cram's masterpiece for **Mellon**, despite design for NY St. John the Devine (1911).
 "Seldom in the case of great churches are the architects permitted to see their highest ideals carried out after a complete and definitive fashion. Here the donors had a vision of adequacy and completeness...it is doubtful if there is anywhere in this country a church of similar magnitude where every detail of utility and artistic quality has been achieved in so full a degree."

Akoustolith acoustical tile.



+1

Following the deaths of Richard Beatty and Jennie King Mellon in 1942, the Church Session voted to construct a memorial which became Trinity Chapel. The doors are Siamese teak. The interior carvings are inspired by Peter Paul Rubens and the windows by Wilbur H. Burnham. The chapel, designed as well by Cram, was erected at a cost of \$120,000 and dedicated January 15, 1944.



+2

Last Guastavino vault laid in Pittsburgh (1942):

Stone lined crypt with bronze casket; walls of carved stone crest and ribs with Guastavino tile vault 'fill' (just as in 1st lecture. 1382 Monastery in Valencia, by master mason Juan Franch filling btwn. stone ribs with tile vaults, 560 yrs. later); yet, roof made of 4x12@2'o.c. long leaf dense grade pressure treated southern pine, 1 1/8" roof boarding, 5 ply roofing, 1 1/2" mortar bed, 1" quarry tile on top.



Heinz Memorial Chapel (Charles Z. Klauder architect, **1934**) Campus architect.



+11



Stephan Foster Memorial (steel frame; Charles Z. Klauder; Pittsburgh; **1937**)

Tile infill, between stone ribs, just as with Valencia vaults in 1362.



The success of the Chicago World's Fair led to historicist styles dominating public buildings at the turn of the century. The popularity of this American Beaux-Arts movement was criticized by **Louis Sullivan**, who had just completed one of the **first skyscrapers in Chicago** (**Wainwright Building, 1891**) and stated, “**the virus** of the World's Fair, **after a period of incubation** ...began to show unmistakable signs of **the nature of contagion**. There came a **violent outbreak of the Classic and the Renaissance in the East**, which **slowly spread Westward, contaminating all** that it touched, both at its source and outward. By the time the market had been saturated, **all sense of reality was gone**. In its place, had come **deep seated illusions, hallucinations**, absence of pupillary reaction to light, absence of knee-reaction symptoms all of progressive **cerebral meningitis**; the **blanketing of the brain**. This

Architecture died in the land of the free and the home of the brave. The damage wrought by the World's Fair will last for half a century from its date, if not longer.”
3:50

A half century later would be 1943, World War II, Guastavino's last tile vault in Pittsburgh was laid in 1942. By the time the historic Modern Architecture: International Exhibition opened at the Museum of Modern Art (NY) in 1932, establishing the foothold of Modernism made of concrete and steel, Guastavino's structural tile vaulting projects were declining, relegated to decorative tiles.

By the 1930s, young architects and engineers were being trained to design using the calculated properties of structural steel and reinforced concrete. The unknown building practices of traditional masonry vaulting made them nervous.

And, as the older architects, Guastavino had built a relationship of trust in his methods of vaulting, began to retire, there were fewer and fewer commissions. The postwar construction boom was fueled by concrete and steel. 1940s, Guastavino's tile factory was making 1/20 the number of tiles produced during the 1910s. The New York and Boston offices were forced to close and in 1943, a half century after the Chicago World's Fair, Guastavino Jr. sold the family company (to the son of the company's financial manager, until finally closing in 1962 after 75 years).

However, in that half century, the Guastavinos built over 1K buildings across the United States, the greatest public buildings of the American Beaux-Arts, his tile vaults creating the permanence and solidity found in masonry construction.

Despite the Guastavino Company decline, Louis Sullivan was correct, foretelling the impact of this Neo- and Revivalist virus lasting longer than a half century...

To this day, well over a century later, the Beaux-Arts influence of the 1893 Chicago World's Fair is found in our government, civic, and religious architecture. Largely due to sentimentality developed from experiencing the beauty and grandeur of spaces built but Guastavino's tile vaults and domes.