

A key design role in tectonic architecture history essay



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The following thesis seeks to identify and examine the relationship between tectonic architecture and materials. Although materials are all around us; we often do not take the time to examine them; to truly reflect on their inclusion, and so their very presence is often taken for granted. In order to emphasise the importance of materials in architecture; this research question focused on discussing How do materials play a key design role in tectonic architecture?

The thesis used two main methodologies. The first was a literature review, which includes a comprehensive review of the literature that was instrumental in addressing the main topics, materials and tectonic architecture. The second was a model based study which focused on a particular building. It examines how a change in materials could affect the design of a building; and thus emphasises the key role materials play in tectonic architecture.

The findings of the research highlighted the fact that materials do indeed play a key role in the design of tectonic buildings; and in some cases they can be the main driver for the initial design. However it was also established that there are many other contributory factors which also affect the overall design. Factors such as the structure, the crafting of construction, innovation, the use of cutting edge technology, the collaboration of the design team as they work in synergy with the architect, and finally the methodologies of learning by doing or facilitating education through the teaching of others.

Definitions / Glossary

Tectonic Architecture – A non-monolithic structure, assembled using different materials, techniques and resources in the act of construction making and revealing[1].

Stereotomic Architecture – A self-supporting monolithic structure composed from articulated solid elements.

Atectonic – A combination of tectonic and stereotomic building techniques.

The crafting of construction – This is not just a joint or a construction detail; it is the crafting together of materials and surface through bespoke means.

Green design – Philosophy that treats environmental attributes as design objectives and not as constraints.

High-tech – Refers to technology that is at the cutting edge or the most advanced technology currently available.

Honesty – The notion that a structure shall display its “ true” purpose and not be decorative

Materials – “ The matter from which a thing is or can be made”[2]

Constructivist teaching methodologies – “ Constructivist teaching is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction rather than passively receiving information”[3].

“ All works of architecture involve a creative interplay between ideas and materials to which both makers and critics have repeatedly been willing to assign ethical value”[4]

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1. 0 Introduction

“ Materials are not trendy; they are a necessity for the realization of creativity”[5]

Looking around the built environment, one can see materials are everywhere; yet they are not often questioned; when were they invented? How are they picked? How are they used? Why were they put together in a particular way? Were the correct materials selected? In addition to these questions architects must also address issues around purpose and design; can materials be the driving force behind their designs or are they insignificant, merely an aesthetical feature of the building. Attempting to delve into and address some of these questions has led to the research of this thesis; namely ‘ How do materials play a key design role in tectonic architecture’?

This thesis aims to understand tectonic architecture and the role of materials in the design of a building. One has a basic understanding of what these words mean from the glossary however there is a need to explore where they have come from and how they have and will affect architecture. In exploring this idea there is a need to acknowledge, where tectonic architecture and materials began, how they have evolved over time, and going forward what direction are they headed in?

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The thesis shall discuss a number of these issues in order to address the research question. The paper shall examine the following main chapters; Joint / The crafting of construction, the tectonic innovation of large span, 20th century modern tectonic architects, 21st century tectonic environmental architecture and a model based study.

Research methods

This thesis is jointly done through two research methods. The first consists of the literature review, and was under taken to gain an in depth understanding of tectonic architecture and the complexity of materials. The second involves a model based research which was conducted through the analysis of drawings in order to understand the effect of a material change on a tectonic building.

The first five chapters will analyse the key role materials play on tectonic architecture. It will look at both the theory and the practical side of this subject; with analytical drawings to further develop this principle. This study will be carried out via secondary research, comprising of books, journals, newspaper articles, electrical journals, published conferences and websites. Research will be carried out on both subjects, starting with the design and building of the mere hut to the development of the contemporary tectonic architecture.

Chapters six will be an in-depth study in to a model based research, where the question will be asked if materials do play a key role in tectonic architecture and if there was variations in materials would the building

design and space changed. The analysis will aim to show how important materials are to the building design with 3 dimensional drawings.

2.0 Joint / The crafting of construction

“ Often it is the expressiveness of the jointing which humanizes structures and gives them their friendly feel.”[6]

In Greek, the term tectonic comes from the work tekton, which suggests carpenter or builder. In the fifth century, the meaning evolved into the role of the tekton. This led to the emergence of the master builder or architekton. Kenneth Frampton observed that Adolf Heinrich Borbein claimed this meaning would eventually change to an aesthetic rather than a technological category.

Frampton noted in his book ‘ Studies in Tectonic Culture’ that Karl Otfried Muller, in his third edition of ‘ Handbuch der Archäologie der Kunst’, that tektones was specialized, in reference to people in construction or cabinet makers which used a specifically functional or dry joint, though this did not include clay and metal working in the meaning. This gave the definition of tectonic as the joint or the joining through the construction process.

In 1851 Gottfried Semper, published his book, ‘ The Four Elements of Architecture’ (Die vier Elemente der Baukunst). He based some of his elements on a Caribbean hut (see figure 1) that he saw at the great exhibition of 1851 and he divided the dwelling into four elements, “ 1 the earthwork, 2 the hearth, 3 the framework (including the roof) and 4 the lightweight skin or membrane”[7]. On the base of these four elements,

Semper classed the building crafts into two fundamental different

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procedures: the tectonics of the lightweight frame work and the stereotomic of the base.

Semper illustrated the use of the stereotomic base where mud-brick and stone were placed on the ground, on to which the lightweight framed structure sat. Frampton considered the stereotomic base to be load bearing masonry, weather stone and mud brick. He noted the importance of the lightweight framed structure, where he saw the creation of the knot as a fundamental element in enabling the tying together of the lightweight components. The knot led to the securing of the frame and was perceived by Semper as a complex jointing of construction. Around the world, this technique can be visibly seen, where rope is used to knot lightweight structures together; highlighting how locally available materials were utilized to build huts. African tribal cultures used a wide range of vertical screen walls where the rope knot was the key construction element. The Gogo house in Tanzania was built from tree branches where a rope knot was employed to hold the structure together while mud was built around the structure. In comparison to this, the Kuba hut found in the southeast of the Congo was erected using woven mats, again with all joints being knotted together with rope.

Semper highlighted the development of knots into a weaving process, which subsequently led to the creation of buildings fabric. Buildings such as the Bedouin tribal huts were assembled using locally sourced materials in a weaving manner in order to build strong huts; as oppose to those which were built with knots. Woven walls were a form of “ wattle construction”[8], which was described by Allen Noble as “ vertical stakes, each fitted into a hole or <https://assignbuster.com/a-key-design-role-in-tectonic-architecture-history-essay/>

slot in one horizontal and sponge into a groove or another hole in the other member of the framework. Materials such as osiers, reeds or thin strips of oak were most common"[9]. This style of wattle construction is still in use today in the building of fences; however it did lead to the advancement in wattle and daub construction, which can be seen in many vernacular buildings around the world today.

Cherie Wendelken in his article on The Tectonics of Japanese Style: Architect and Carpenter in the Late Meiji Period noted that Japanese architecture had great symbolical structures which were primarily tectonic, whereby locally sourced material such as grasses and bamboo pillars were being knotted together. The 15th century Japanese house was constructed with a woven façade. These houses were built in a post and beam framed manner with woven infilling walls which allowed for flexible sliding screens. Semper's, The Four Elements of Architecture, can be seen clearly in these houses as the stereotomic base which was built of boulder footings, a lightweight timber structure sat on these foundations and finally a lightweight skin was applied. Some of these structures would be built every 20 years as there time cycle only lasted this length. The most celebrated of these structures being the monumental Naiku and Geku.

Pre 1800 tectonic architecture illustrates that the joint or the crafting of construction was the most important and innovative aspect of tectonic architecture with materials playing a key role in the design of the building. This can be seen from the reed-built houses of the Marsh Arabs in Iraq (Materials, Form and Architecture for images p13). These materials were normally locally sourced and the construction methods were tried and tested <https://assignbuster.com/a-key-design-role-in-tectonic-architecture-history-essay/>

over long periods of time, as was the case with most vernacular architecture of that era.

3.0 The tectonic innovation of large spans

Gothic churches and cathedrals were noted by Frampton as having “ the idea that with the combining vaulted and trabeated structural forms in a new spatial unity; on the other, it stretched the art of reinforced masonry construction to its technological limits”[10]. This led to the innovation of large non-load bearing façades in gothic architecture. This innovation in structure went on to influence many architects of the 19th century, including Augustus, Welby, Northmore, Pugin and Viollet Le Duc.

Voorthuis highlights how Pugin claimed “ You can decorate construction...but you cannot construct decoration”[11]and thereby hides the true construction of a building. Pugin had a great understanding of material’s and craftsmanship. He himself used innovative and experimental techniques when it came to craftsmanship and designing building such as the Church of St. Augustine, Ramsgate or St. Aidan’s Cathedral in Enniscorthy. However Voorthuis emphasised how Pugin would insist that if mouldings were to appear on a building, they need to do so for a reason, such as to stop weathering of an area rather than for aesthetic reasons; and this was his use of tectonic architecture. Frampton pointed this out in the fabric build-up of St. Pauls in London (167-1710). Where he commented on Pugin’s proposed drawings of the church “ a section through a pointed church compared to the hidden buttresses built into the fabric”[12](fig ??) or ornamented mediaeval truss roof compared to that of the concealed truss hidden by a suspended ceiling (fig ??). While Pugin worked on the innovation in craft and his idea, <https://assignbuster.com/a-key-design-role-in-tectonic-architecture-history-essay/>

that mouldings were to appear for reasoning, Eugene Emmanuel Viollet le Duc worked on the advancement in materials.

Viollet Le Duc was a French architect and theorist famous for his interpretive restorations of medieval buildings and also for his writing advocating that materials should be used honestly. He began his career with twelve commissions for the restoration of medieval monuments. He encouraged the use of different materials with new techniques and resources, in contrast to the work of William Morris and his art and crafts movement, which promoted traditional crafts. Henry Van Brunt in his book Discourse on architecture noted that Viollet Le Duc was more concerned with the “ economy of structure than the theorists of the Ecole des Beaux-Arts. Viollet-le-Duc pursues lightweight hollow or reticulated metal construction as an agent for transforming every conceivable tectonic element, from window shutters to metal roofs”[13]. This interest in metal construction led to Viollet le Duc using wrought and cast iron which promoted lightweight tectonic framed structures and was a unique resource from which 19th century architecture would developed from.

His experimentation with metal led to the development of an iron network of vaulting and can be seen in his octagonal hall design. Frampton stated that the “ octagonal hall is organized with its polygonal roof structure and statically determinate iron members displayed the principles of structural rationalism for the first time in construction”[14]. The octagonal hall was to be a 3000 seat hall spanning 140 feet, illustrating iron works and innovative techniques, which tended to pushed the boundaries of architecture and materials to their limits. His idea of cast iron framed structures was to be <https://assignbuster.com/a-key-design-role-in-tectonic-architecture-history-essay/>

firstly realized by the English landscape architect Joseph Paxton and Anatole de Baudot.

Paxton won the design competition for the Great Exhibition of 1851 (fig ??) designing a building measuring over 92, 000m². He was assisted in his work by two engineers, Fox and Herderson, who came up with a system of structural elements. The building was completed in nine months due to its innovative modular design and construction techniques which used the largest glass panels available and the most up to date technology in order to forge and connect elements. Another major factor that contributed to the fast building time was the collaboration of each person involved, from the architect down to the craftsman.

De Baudot was seen as Viollet Le Duc's predecessor. Frampton noted that he worked in a similar style to that of Viollet le Duc, using cast iron columns to equally express his tectonic architecture in the world exhibitions held in Paris in 1878 and 1889. These two significant projects, "one circular, the other rectangular, were attempts to realize Viollet-le-Duc's iron network vaulting on a grand scale"[15]. However they never lived up to the grand scale of Galerie des Machines 1889 designed by Ferdinand Dute which had a 180 foot span. The building was a controversial design for steel construction however iron was used as Robert Thorne notes that John W. Stamper emphasised "The principal material of the building's structure was to have been steel, but the decision was made at the last minute to use iron instead. Steel was abandoned on the two-fold ground of expense and the necessity of hastening the execution of work"[16].

Georg Heuser, and Otto Wagner were both great writers in the promotion of architectural realism as a matter of principle in the late 1800's. Heuser saw the development of architecture innovation rather than decorative style. Frampton indicated that Heuser “ seems to have been among the first to acclaim the riveted steel frame as the new industrial vernacular of the machine age”[17]. To the contrary Richard Weston wrights “ For Ruskin, industrial production was the work of the Devil, and cast or machine work that imitated craft (hand) production – what he called operative deceit”[18].

4. 0 Tectonic reinforced concrete

“ Bring out the nature of the materials; let their nature intimately into your scheme”[19]

The latter half of the 19th century, also saw the development in structural framing concrete. In 1890, engineer Paul Cottancin came up with his reinforced masonry system known as ciment arme. This system was noted to be labour intensive and became obsolete 17 years later due to Francois Hennebique's patent and his reinforced concrete design known as beton arme. This outcome reversed tectonic principles allowing the transgression of a stereotomic material to a tectonic frame.

Frampton stated that after “ Louis Vicat's perfection of hydraulic cement around 1800, concrete began to be used in a new way”[20]. However he mentions how Joseph Moniers began building prefabricated flower pots and sewer pipes from reinforced wire and cement. It was not until Francois Hennebique, a French engineer and self-educated builder, began using perfected reinforced concrete in his construction that it became popular.

Douglas McBeth, in his book Francois Hennebique-Reinforced concrete pioneer, emphasised that Hennebique's system started out as fireproofing to protect iron beams. However he soon realised that the floor system would be more economical if the iron was used only where the slab was in tension, while it could rely on the concrete in compression. The Hennebique system was a simple erection of timber formwork around steel, after which concrete could be poured.

While Hennebique was perfecting his methods, De Baudot whom was Viollet Le Duc's predecessor was working on St. Jean de Montmartre. Frampton observed that De Baudot wanted to exploit a method that could combine light construction with bonded brickwork, as he pointed out, " the result was a somewhat oriental, diagonally ordered system of vaults rising from thin brick walls and piers enclosing narrow channels of interior spaces"[21]. This would bring Viollet Le Duc's idea of cast iron vaulting to a new innovative method of brick vaulting. However Hennebique system began to be widely used and was further developed by architects such as Auguste Perret.

Auguste Perret's architectural career was bound around the principle of reinforced concrete and Karla Britton, in her book Auguste Perret noted that Perret claimed " reinforced concrete frame construction is the ultimate structural material"[22]. Perret's went to the Ecole des Beaux arts school where he argued between practical and theory in architectural education. However as Frampton highlighted, he chose the practical as he left abruptly before submitting a final project. He started to design and build one of the first apartment blocks from reinforced concrete construction. Nonetheless, Perret was concerned for a building to be structurally honest and with this, <https://assignbuster.com/a-key-design-role-in-tectonic-architecture-history-essay/>

used a visible framework as can be seen in his Garage Marboeuf. His work was noted for establishing concrete as an acceptable architectural material in the 20th century. It was noted by Britton that Perret and Frank Lloyd Wright attempted fair faced reinforced concrete at virtually the same time and both had similar results.

5. 0 20th Century Modern Tectonic Architects

“ Construction is the means; architecture is the result”[23]

Frank Lloyd Wright left school in 1887 without finishing his degree, and moved soon afterwards to Chicago where he found work with Adler and Sullivan. Wright was impressed with Sullivan’s ornamental design. Louis Sullivan was influenced by the idea ‘ form and function’. However his statement was “ form ever follows function”[24]. Sullivan took Wright under his wing and acted as a mentor to him in his early career. Frampton stated; “ Wright’s early domestic architecture, executed in wood, is invariably conceived and machined according to a repetitive modular order and framed”[25]. Sullivan also introduced Wright to Celtic iconography and Celtic textiles. Following on from this induction, Wright became heavily influenced by textiles. He visited the Columbian exhibition of 1893, ‘ the Ho-o-den’, and began turning his attentions to Japanese architecture. He visited Japan in 1917 and worked there until 1922. While working in Japan, Frampton noted that Wright studied tea houses, religious Japanese architecture, and the Horyu-ji shrine. Upon his return in 1922, Wright brought back many ideas, such as heated floors and modular part construction. However it was woven façade and concrete that mostly inspired him as he stated “ Aesthetically, concrete has neither song nor any story”[26]. In 1921 Wright finally looked <https://assignbuster.com/a-key-design-role-in-tectonic-architecture-history-essay/>

at the idea of wire-reinforced concrete blocks that were pre-cast with a pattern on the outer face. He would later call this the textile block. He first used this system in the Aliace Millard house in Pasadena California. Terry Patterson in his book Frank Lloyd Wright noted that he would make a double coursed wall, one internally and one externally for the cooling and heating of the house. After the accomplishment of both system and house, Wright refers to himself as a “ weaver”[27]stating his textile blocks were a woven skin/façade. Wright follows this up with a statement in his book Frank Lloyd Wright Writings and Buildings “ I finally had found simple mechanical means to produce a complete building that looks the way the machine made it, as much at least as any fabric need look...Standardisation as the soul of the machine, here for the first time may be seen in the hand of the architecture”[28].

Semper, in ‘ The Four Elements of Architecture’, spoke about the textile and its comparison to the art of enclosures or the woven façade. This can be seen from the wattle construction, or Japanese vernacular houses, but now can also be seen in the development and the influence in Frank Lloyd Wright’s architecture. There was also the development in the joint or crafting of construction. This came from the pre 1800’s work and the great iron works of the 19th century which was advanced by architects such as Mies van der Rohe and Carlo Scarpa.

Mies van der Rohe saw details and joints as one of the foremost important elements in his architecture, as his famously states, “ God is in the details”.

Mies started his career by using brick on such projects as his Brick Country house Project going to great lengths in this endeavor. Philip Johnson in his <https://assignbuster.com/a-key-design-role-in-tectonic-architecture-history-essay/>

book ' Mies van der Rohe' noted this as he states; " he calculated all dimensions in brick lengths and occasionally went so far as to separate the under-fired long bricks from the over-fired short ones, using the long in one direction and the short in the other"[29]. Mies gradually started to use other materials, such as steel, marble and large sheets of glass. The qualities of different materials became a leading idea in how Mies designed his buildings, from a stereotomic mass to a skeleton tectonic frame. When one looks carefully at the detail in Mies's buildings, he had a great understanding and respect for the qualities of materials. As while he was looking for stone for the Barcelona Pavilion, he knew that one could not move marble from a quarry in winter because it is wet inside and freezing conditions could cause it to break. With this in mind, he had to find a dry material and eventually found onyx blocks of a certain size and proportion, and from this he designed the pavilion to be twice the height as it was originally considered and developed the plan from there. Frampton acknowledged that from 1926 to 1933, Mies had " three main considerations; firstly, in the underlying aesthetic intention, secondly, in the essence of materials to hand, and thirdly, in the institutional status of the work"[30]. A change in Mies work can be seen when he shifted the column from circular to I or H. He began to express the joint in the column and beams more often. This transformation brought him back to a shift to more traditional tectonics. This expression can be clearly seen in the Farnsworth House and the Neue Nationalgalerie Berlin. Frampton states, " Within these parameters, the art of building for Mies meant the embodiment of the spirit in the banality of the real; the spiritualization of technique through tectonic form"[31].

6. 0 21st century Tectonic Environmental Architecture

“ Materials are not trendy; they are a necessity for the realization of creativity”[32]

Materials loom largely as one of the most discussed ideas of contemporary architecture. Victoria Ballard Bell, in her book *Materials for Design* explains that “ Materials should inspire designers to think of materials as a palette from which to imagine an idea or concept that can be realised with the use of materials”[33]. This idea can be seen in such building as the Laminata Glass house in Leerdam, The Netherlands, the horse stable (Ghost 9) in Nova Scotia Canada or Frank Gehry Guggenheim Museum Bilbao. However how are these materials chosen?

Bell outlines that material selection is one of the utmost important decisions an architect must undertake. She notes more often than not, materials are not addressed till the end of the design process or even during the creation of a construction document for a building design as if there are sometimes mere afterthoughts in various projects. Lisa Wastiels has the view that every material selection should aim to fulfil a simple need, to identify the best material for a particular application. However in order to identify the best materials, it is important to first understand the criteria used to select those materials in the first instance. Wastiels research broke material selection consideration into four identified categories, context, manufacturing process, material aspect and experience (see figure). However from interviews in Wastiels research, some interesting information appeared. It was highlighted that building codes, regulations and standards are major factors in the choosing of materials today. Further to this Richard Weston in his book <https://assignbuster.com/a-key-design-role-in-tectonic-architecture-history-essay/>

Materials, Form, and Architecture states, “ in addition to their traditional interest in the structural/constructional and aesthetic qualities of materials, designers must now also consider their embodied energy (in production, transportation, and on site), potential for recycling, and renewability as a resource”[34]. Bell remarks that materials are now being chosen for their green credentials to be sustainable and sensitive to our environment. This idea has been used by many tectonic architects such as Glenn Murcutt and Renzo Piano.

Australian architect Murcutt is world renowned for his energy efficient architecture; although he does not work outside the country, using his motto “ touch the earth lightly”[35]. Murcutt is an advocate of using locally sourced manufactured materials such as glass, timber and steel where he developed an appreciation for simple vernacular architecture which pays attention to the environment. Murcutt takes into account the origins of the material, the energy consumed to process them and reusing them to avoid the loss of energy. The Marika-Alderton House in Yirrkala Community is a prime example of Murcutt’s energy efficient ideas where he adapts his materials to the hot tropical climate where a skeleton skin like building emphasises ventilation. Nevertheless he also uses agricultural tin sheets to cover the building in an innovative way.

Murcutt uses Simper’s principle id