The Future of the 21st Century Architecture: Innovation and Technology

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Abstract: If we analyze the history on architecture it will be possible to observe that technology and innovation are inherent to architecture; every century architecture is defined by its contribution to society. The architect since ancient times has sought the integration of technologies and materials to provide the best result for his work. Steel, glass and concrete gave him new opportunities for the twentieth century architecture to develop and spread great landmarks of modern architecture. Currently thanks to the contributions of technology new ways of designing architecture are generated, providing solutions to architectural design and society; if the new contributions of technique, materials and technology are known, we can generate better solutions. Today the architecture is faced by new problems and challenges, thanks to the new materials, design methods, technologies that problems could be solved. The way of designing architecture seeks to understand and explain the needs that will be developed in the 21st century; this means seeking a balance between a humanistic, sustainable, technological and scientific vision. Due to the great advance and technological development the design process advances by leaps and bounds limiting the scope of the technology and the benefit it has to society.

Keywords: Innovation, architectural design, technology, history

Introduction

The 21st century is a crucial century for the thought and design of architecture, during the last two centuries technology, materials, theory and systematization created roots for the current architecture. Nowadays architects and engineers seek to understand and analyze the needs that architectural design will develop in the next decades of this century. Because of the economic, social and political development that encompasses the entire world, architecture must be adapted to the regional needs of each part of the world, this acceleration is revolutionizing the way of thinking and designing architecture and influences the creative process with a somewhat limited vision focused more on the product and leaving aside the inhabitant, sustainability and critical sense to design.

This article aims to show how new materials, new technologies and new innovations are generating new design perspectives for 21st century architecture. But it will first be explained precisely why it is essential to integrate technologies and how they can innovate architectural design. The future of architectural design is highly dependent on advances in materials, systems and construction processes and the development of new technologies applied to architecture. In the same way, it will be explained how in the 20th century materials and technological innovations gave rise to a new way of designing architecture and what were the technological processes necessary for Modern Architecture to mark a milestone in the history of architecture. We will explain in detail the relationship that materials had to give rise to Modern Architecture, learn a brief history of materials (iron, steel and glass) and explain the importance of a few architecture works.

Today we must take into account aspects in the 21st century such as: sustainability, society and economy; but why? Buildings are now more expensive than ever, and this means that large construction companies and real estate companies are demanding more for the investments they make. The 20th century showed us that architecture and engineering were capable of large skyscrapers, new technologies and materials were integrated into architectural design, but they put sustainability aside; the 21st century should seek to integrate technology and innovations to develop more and have a lower negative impact on the environment. Socially we must understand the needs that are required during the century to transport them to architectural design and how it influenced the 19th and 20th century.

The above invites researchers, architects, scientists and engineers to join forces to obtain a common good and for society; We must not think that our research will be carried out competitively individually taking advantage, on the contrary, we must share knowledge transparently in order to develop innovation and technologies that can improve the current situation of architecture during this 21st century.

Why is important to integrate innovation and technology in architecture?

Architects and engineers are currently facing problems that have never worried society in past centuries: population,ⁱ environmental effects, new materials and technologies, the rapid increase and development of new software, social needs. This leads to the need to develop new technologies and innovate to develop new tools to meet the challenges of the 21st century. There are several reasons to develop new technologies and integrate new innovations to be adopted to architectural design and construction technologies.

The general definition of innovation is that is the process of introducing changes to methods, services or products. These changes must be useful and meaningful, adding value to the established norms and contributing to our knowledge. (Aksamija, 2016, p12).

After the second half of the twentieth century great scientists, architects and researchers set out to generate new contributions to architecture such as the case of Fuller Buckminster.ⁱⁱ He claimed that this architectural revolution could only be carried out by architects, inventors and scientists/artists. Fuller saw the generalist figure of the architects uniquely inclined to “putting things together” across a wide range of expertise, and thus architecture as the leading discipline in what he coined “Comprehensive, Anticipatory Design Science.” In this construct, the term comprehensive pointed to the need of drawing transdisciplinary connections as a way to meet systemic global challenges: design emphasized the need of innovation rather than prescriptive technical problem; and science refereed to the need to establish a rigorous design-research methodology based on facts and performance goals (Lopez-Perez, 2020,p.126).

Technology and innovation are complementary to architectural design, both go hand in hand to obtain the same result; innovation completely needs science and technology to be able to develop. However, the concept of innovation is not new in architecture or engineering. If we analyze history, we will be able to analyze great cases where innovation and technology played a very important role; as examples we have the Roman Colosseum (70 A.D.) in Rome that was one of the most important structures developed by the Roman Empire; the church of Saint Sofia (535 A.D.) in Turkey, its great dome was one of the great contributions of Byzantine architecture and broke paradigms of architectural design by the use of geometry and materials; Paxton's Crystal Palace (1851 A.D.) in London, this work integrated steel and glass (Picture 1) to generate a new architectural language thanks to the technological contributions of the Industrial Revolution. As explained above, we can see how technology and innovation have always been inherent in architecture and here the importance of being able to develop new research and new ways of integrating technology to meet the needs of the 21st century.

Picture 1 The Crystal Palace was an example of the development of the new architecture, a new conception of technique and material, something similar had never been built before this work. Apart it was the first building that had such dimensions that was built with iron and glass.

After the Industrial Revolution, the technological changes generated a great change in the thought of architecture and the development of a new language that would mark the 19-20th century. Thanks to steel and glass, many great works were developed generating a great impact, through research and implementation of these new construction techniques. The result of the Industrial Revolution was the creation of new construction techniques and materials that in the mid-eighteenth century and during the nineteenth century, developed new ways of designing.

The importance of integrating innovation and technology to architecture and engineering requires applying new materials, design processes, new software, construction systems, sustainable designs and social methods according to the needs of society. Thanks to the development of new materials and new technologies we will be able to design more appropriately

The results of technology and innovation in past centuries

The Industrial Revolution gave great technological advances that influenced architecture, this change was due to scientific advances that went hand in hand with the way of thinking of the late 18th century, through the industrialization and technological/scientific advances that were developed in the middle of the 19th century. It becomes evident that the architect sought to develop a new architecture.

The acceptance of these materials was given thanks to the new needs that were emerging in this century, their integration into the design was trial and error under design margins that did not exist before, and therefore it is worth asking what the needs were. A good question to make it's : What did architecture demand during the 19th century and what relationship did it have with materials?; A great example of the new needs were the railway stations, a new means of communication was emerging, this required new forms and large spaces with few structural supports to accommodate the needs of the project, which would be solved through iron and glass. If we analyze the works prior to the eighteenth century we will see that there were only three materials to build:

wood, stone and brick. These were the only main building materials, as there was no current technology or knowledge. The emergence of these new materials was due to the industrial and technological growth that was being experienced in the middle of the 18th century, this led to the creation of new constructions and the new material that would give rise to these works would be iron. The development of architecture is linked to the social, political and technological events of the time, design is responsible for satisfying those needs and defining them through architecture. The new possibilities helped the construction of the first skyscrapers in Europe and the United States that emerged to take advantage of the land and obtain a greater height, the needs that design demanded during the 19th century and take advantage of all the technological and material developments to create a new architecture.

The production and needs that arose after the Industrial Revolution were and gave rise to iron, steel and glass that would be a new tool for the designer, the effects not only of designing but of thinking and understanding architecture were so profound and impressive for the human being, who currently continue to exercise our way of thinking and designing. The Industrial Revolution was commissioned to innovate and employ new techniques and materials, serial production changed understanding to architecture.

The forms and designs that formed the works that will be the germ of future modern architecture were influenced by new materials, technologies and techniques that thanks to them could be created and built. Through iron, steel and glass, the works of the 20th century benefited in order to give greater spatiality and way of building, through the dissemination of these works in magazines, newspapers and cinema, the world would be in charge of knowing the new potential of these materials and innovations.

During the 19th century the main materials will be iron in the first instance, and then glass and steel will be incorporated, the technical evolution of which paralleled the development of the industry. The architects, however, with few exceptions, remained quite aloof from technological innovations and remained basically bottled up in academic formulas with different degrees of historicism and eclecticism. Materials have great influence within architectural design and architecture, concrete, steel and glass are materials that in western culture have been identified as elements of progress within modern architecture. Through technology, knowledge and theories, new materials give the designer new possibilities.

Industrialization and technology were responsible for producing not only new ways of designing, but also the new way of innovating and designing architecture. For its part, industry and technology were not only an invention, it was the sample of the ingenuity that the industrialization process produced, generating greater production in greater quantities, repetition and unity. The production was in series of elements and products of the construction, engineering and this would give rise to the prefabrication of pieces and parts of the architecture. With these innovations, new needs and ways of designing with new materials such as iron began to arise, which would give rise to large spaces such as railway stations, industrial buildings, factories, markets and docks.

The glass

The first appearances of glass are very uncertain but the artisan production of this material could be located with the discovery of fire, since it gave humans access to the high temperatures generated by fire, one of its origins according to Pliny the Elder, talks about the chance discovery by the Phoenician sailors, when making the bonfires near the shores of the beaches, they found that it formed vitreous residues, which was formed thanks to the natron. The merchants were in charge of selling this material on the banks of the Nile River, since there were no stones to place their utensils to hold their pots and they used some pieces of natron. They would heat their food and leave the natron stones on overnight. At dawn and thanks to the combustion that had been carried out, a hard and shiny material was produced, these were the first beginnings of glass.

For the beginning of the 20th century, the technical contributions and technologies that existed regarding this material gave a very significant change to architecture, granting a new tool to be able to enclose a building; thanks to the theories and contributions of Paul Scherrbart and Bruno Taut; they gave rise to new expressions in architecture. Stained glass destroys hatred, said Bruno Taut, this phrase could be read in the glass pavilion at the Werkbund Exhibition held in Cologne in 1914. This pavilion had been designed by Bruno Taut, it contained a polygonal shape with concrete pillars armed, covered with glass brick and covered by a glass dome: it was a building for the glass industry. This work caught the attention of many critics and architects, but it would soon be considered the new expressionist trend in German architecture. (Picture 2)

Picture 2 The structure made by Bruno Taut demonstrated the many ways in which glass could be used in construction, but also hinted how material could be used to organize human emotions and as a new way to integrate new materials.

During the seventeenth century the glass industry began to generate its first contributions, producing workshops and furnaces in various parts of the world. During the 17th century was characterized by the innovation of techniques that would help the improvement of this material, technological and manufacturing processes, such as the one produced in England in 1611 where coal began to be used as material for furnaces, this technological innovation it occurred because Queen Elizabeth I prohibited the use of wood as fuel because the English Navy needed more wood to build their ships. Before the 19th century, many workshops developed new techniques for the development of glass but without any relation to architecture (only stained glass and mirrors were developed during the Baroque period), their contribution was completely minimal to design; It was not until the Industrial Revolution that it created the production of greater quantities and dimensions of glass, forcing the creation of new and larger furnaces; This generated a new technique that was the mechanical production of glass bottles; for his part, the invention of the incandescent lamp that was created by the American inventor Thomas Alva Edison, reason for the creation and commercialization of large quantities of lamps that began in New York in 1870. As the industry progressed and production techniques improved, the use of iron and glass increased, generating

new glazed surfaces that allowed new technological contributions. The union between iron and glass produced new solutions for design in the 19th century, the conjunction of these materials occurred in France thanks to the French of Pierre-François-Léonard Fontaine, together with his colleague the French architect Charles Percier, who they developed the Empire Style.* Despite being very familiar with neoclassical architecture; They were commissioned to build a glass roof for the Galerie d'Orléans (1829), which was part of the Palais Royal in Paris. This was the first gallery that counted on having a glazed barrel vault. The innovation of this cover was that, thanks to the prefabrication materials, it guaranteed the speed of its manufacture and assembly; also, be able to cover large spaces allowing less saturation of structural elements; This meant the implementation of the new structural systems that were the result of the Industrial Revolution. Without a doubt, glass is one of the materials that has been most used in modern architecture, giving the possibility of giving more light to the interior and also using it more dynamically on facades. The relationship between glass and architecture is a of the premises of Modern Architecture based on the incorporation of new materials.

The contribution and theories of the German Paul Scheerbart to the glass architecture were transcendental and important since they were the theoretical support of the next generations of architects; This is explained in his book *Glasarchitektur*:

“The pyramids are monumental, the Cologne Cathedral is also (...) this name is often applied today to the Eiffel tower. In the same way, the concept of monumentality will change with glass architecture. Glass towers will also be built in the depths of the sea, this will be an architecture of particular luxury, where freshness and calm will reign. It seems as if the recent fad for aquariums with glass tunnels under water is anticipated. The light seeks to penetrate the entire space and is alive in the glass.”(Scheerbart, Strasbourg, 1995 pp. 145)

In the same way, he explains the design thinking at that time:

“If we want to raise our cultural level, we are obliged, whether we like it or not, to transform our architecture. And this will only be possible if we end the closed character of the rooms where we live. But we can only achieve this by introducing a glass architecture, which allows sunlight, moonlight and stars to enter the rooms, not only through the windows, but through all the possible walls, which will be completely glass, colored glass.”.(Scheerbart, Strasbourg, 1995 pp. 178)

Before the advances and contributions of the Industrial Revolution, glass was manufactured through the casting or casting system; the process consisted of joining glassy mass (sand and limestone) that obtained its liquid state through the melting of this mass and later cuvettes were filled with this material with copper spoons (to avoid impurities at the right temperature), it was emptied this material on a copper table that was previously heated and after this a roller was passed and slid on the surface of the dough; After this, it was placed in an annealing oven where it would gradually cool down in an approximate process of 10 days. After this, it was passed to the polishing room (where the imperfections of the sheet such as sand or stones were removed)

The iron

This mineral is present in almost all of the Earth's crust with approximately 6% of the total minerals and metals in the crust; Its first uses did not have to do directly with architecture or construction, its applications were used for weapons of war and household utensils, because there were no current processes to process large amounts of iron and its production was of manual and artisanal way. During antiquity its use was minimal and punctual, the Greeks and the Romans preferred copper for its resistance to rust on the exteriors, it was until the 17th century that it was found as a complementary material to architectural details such as wooden girders and floors, where the iron served as ironwork and nails to join the pieces. During the Renaissance the use of this material cannot be observed in the works, writers such as Leon Battista Alberti, recommend materials that can be used in their natural state and not those that are prepared by human hands. The Florentine Michelangelo used iron as belts to

be able to lock the dome of Saint Peter (1546), that is, a function to sustain the thrust of the loads. Its use was very limited in times prior to the 19th century, not only because of its low resistance to weathering, but also because it could not be obtained in large quantities and it was obtained by hand. For its part, cast iron can be seen in the columns that support the kitchen bells of the Monastery of Santa María de Alcobaza (1752) in Portugal. All the uses that were had of the iron were for ornament or details, the material was not used for any structural use.

Iron was a material that was beginning to be manufactured industrially, it had the advantages that it was much cheaper than stone, it could withstand high temperatures, fire resistance, but above all one of its great contributions was that it allowed the construction of much more spaces spacious and could be illuminated by glass. The steam engine and iron frame appeared around the same time thanks to the interdependent efforts of three men: James Watt, Abraham Darby, and John Wilkinson. Of these, the last was the master blacksmith of his time, and his invention in 1775 of the cylinder reamer was essential to Watt's further development of the steam engine in 1789. Wilkinson's experience in ironwork was going to reveal equally indispensable for the first structural use of this material since it helped Darby, to design and to raise in the first foundry bridge, the Coalbrookdale bridge. As England's steel industry developed; More than in other countries, due to the high consumption of natural resources (wood and coal), coke began to be used, which, thanks to its calorific power, could better facilitate the fusion of iron, thus starting the production of iron in larger quantities. England has been established as the country where the Industrial Revolution was generated, this happened in order to move from artisanal production to industrialized production, countries like France and Germany shared the same vision. One of the great uses of the technique and iron arose in 1777, the Coalbrookdale Bridge (Picture 3) was built in England, thus designing the first iron bridge, influenced by technology. Through cast iron, a new design and the calculation of new materials, it was possible to build this work that would give rise to a way of developing architecture.

Picture 3 Detail of the Coalbrookdale Bridge, in these it could see the details of the construction as the gaps between one point and another. This was the first bridge done with iron and a great innovation for the architecture

It was the first bridge of this material with a length of 60 meters, by means of 5 semicircular cast iron arches that are in charge of supporting an iron platform that is 7 meters wide. This bridge is supported on foundations and stone; with a total of 850 castings weighing approximately 380 tons. The technique can be seen reflected in this work, iron gave rise to the new production of new works in architecture, currently it is an architectural heritage because it made great contributions to the iron and steel industry, this work is the It is a clear example of the innovative thinking that sought to apply new techniques and materials to architecture and is a faithful witness of the advances that industry and engineering had in the 18th century. This bridge represents one of the experiments that of iron as a structural element, consists of a single arch with a distance of 31 meters and a height of 14 meters, the arch is shaped like a semicircle; This arch was built in the workshops of the English engineer Abraham Darby, a work that denotes two very important ideas.

The first was that it gave rise to a new construction technique and the other was that Darby's workshops would be precursors to the start of the Industrial Revolution. Darby's legacy was to leave the knowledge to undertake a new way of producing iron in ways that had never been produced before, since the method he had produced for the melting of iron, provided the theories and supplies necessary to do it. The iron manufactured in its furnaces were used for steam engines, train stations, railways and bridges. His contribution was that the foundry had never been able to respond to the large quantity that the industry was demanding at that time.

Since iron began to be produced industrially and in greater quantities, this began to give a new way of applying this material, but in order to develop more products of this material it was necessary to know its mechanical and physical properties, in order to produce and better understand this material. Before the eighteenth century, you had the least idea about the properties of this material, much less your knowledge of how to apply this material in construction.

Thanks to the economic and technological development that was emerging during the 19th century regarding the construction of iron works, Giedion refers to the following:

“The demand for the introduction of iron has existed before the machine made the manufacture of metal profiles possible. Before the means were found to theoretically calculate dimensions, vision and reason recognized iron as the material of the future (...) As industry has been recognized as the fulcrum of the century before the development of mechanical engineering, so on a smaller scale, a way of building is emerging before the social structure is ready for it.” (Giedion, 1956,p.35)

During the first three decades of the 19th century, the economic situation in Europe led to the incorporation of new materials and construction techniques into architecture. Bridges were the first uses of this material, later train stations and industrial warehouses. The use of these materials were a great example for the development of new spaces; thinking that new places were needed for the booming economic activities. Iron was a very ingenious material and gave an answer to the design of that time, its resistance to fire, low cost of production and assembly, great capacity to withstand loads and create larger spaces to make better use of the terrain.

In 1849 the French engineer Johard commented that:

“The new architecture is architecture in iron. Architectural revolutions always follow social revolutions. In the transition periods few changes appear, it does not matter how long these periods can be. Men insist on reproducing the old ways, until in radical change they make a clean sweep of all schools and of all banal theories. There are great periods in architecture, as we have seen great geological periods; a new breed of animal or plant appears only after the old one has disappeared. In architecture the same happens. The old dynasty of authority in architecture has been replaced in the same way that mastodons were replaced so that it can provide space for a new type of artist who has not wanted to preserve the traditional prejudices of the old schools.”(Caesar, 1901,p256)

When talking about the production of this material and its history, it is essential to understand that it goes hand in hand with the development of the sciences (physics and chemistry). Understanding the history of iron is not only understanding architecture, it is knowing the development of science to shed and produce new knowledge, and everything goes hand in hand to achieve a common goal. Take advantage of the knowledge and theories of the time to translate it into architecture

The production of this material took place on a large scale in England during the first decades of the 18th century and was introduced to construction until the year of 1770, its first works being train stations where the potential to design new shapes and show would be shown its potential as a structural element. This material was especially indicated to manufacture industries and large structures, such as factories, warehouses where it was combined with partition and brick elements (walls) and large gaps between columns could be obtained, which meant greater productivity for the development that existed in that moment.

The steel

This material is made of an alloy of iron and carbon, to which small amounts of other components are added, in order to improve its qualities. But for it to be considered steel and not cast iron (which is also an alloy of iron and carbon), this alloy must not contain more than 2% carbon.

The history of steel is very similar to that of iron, it was used for the manufacture of tools, weapons, utensils and jewelry from the 12th century, the first obtaining of iron occurred in China in 550 B.C. In the Middle Ages and until the end of the 19th century, many European countries were in charge of using the steel process called the Catalan Farga. The steel manufacturing process begins with the extraction of iron ore from the crust and deposits, it is rare to find it in a pure and natural way since it is always found from numerous minerals in which

hematite, magnetite, siderite and pyrite. Steel can be obtained from iron and many of the oxides with impurities, in order to obtain iron in the elemental state, in blast furnaces the oxides are reduced with carbon and later the remaining mineral is subjected to a process where refines to be able to remove impurities.

In 1850 the French poet Théophile Gautier warns that iron architecture was giving rise to the new architecture:

“Humanity must create a totally new architecture, born of its time, precisely at that moment when the new systems created for the industry are used. The application of cast iron allows and requires the use of many new forms, as can be seen at railway stations, on suspension bridges and in the arcades of greenhouses.”(Giedion,1959,p.45)

In the year of 1855 the English engineer Henry Bessemer patented a simple process but one that would mark the evolution of this material that bears the name of the Bessemer process (Picture 4) this would benefit the industry of the construction of the first skyscrapers, inventing a converter that transforms iron in steel this through the regulation of the amount of carbon. Bessemer managed to convince the big iron industry entrepreneurs to apply his process within their industries. The investments that were made to the different industries were a failure, and there was still a long way to go to produce the steel in a purer state.

Picture 4 The Bessemer process was the first chemical manufacturing process that served for the mass production of steel, cast in ingots, of good quality and with little cost from pig iron. The procedure was independently discovered in 1851 by William Kelly .It had also been used outside of Europe for hundreds of years, but not on an industrial scale. The key principle is the removal of impurities from iron by oxidation produced by blowing air into the cast iron. Oxidation causes the temperature of the iron mass to rise and keeps it molten

The resistance that steel has gave rise to the first skyscrapers in Chicago, the first building to be built with this material was in charge of the American architect William Le Baron Jenney,ⁱⁱⁱ the Home Insurance Building,^{iv} the large spaces that were in this work was Reflecting the power of steel, its structural system was a steel skeleton in which it could gain much more space inside the building thanks to the distances between columns and gain greater height between floors.

Steel has two major drawbacks: its low resistance to fire and its corrosion through rust, in order to solve the latter, an alloy between iron and chrome has to be put in order to create stainless steel or by a galvanizing

process to cover weathering steel. For its part, fire resistance is solved by integrating the steel directly to the facades or to the concrete and coatings are used to be able to retard the fire.

For several years England had been the world producer of this material, but it was during the 19th century, when in 1890 the United States took away the role of the largest steel producer in the world and it was until 1972 that the then Soviet Union generated an economic and industrial boom.

The introduction of these materials to modern architecture was a great advance for new works; iron, steel and glass are not new materials; It was thanks to the technological contributions of the Industrial Revolution that new techniques and innovative processes were developed to be able to implement them in architecture. These materials are a clear example of the thought of technological progress that was sought in the century. That it had the purpose of order and progress as an end, it is important to highlight that architecture reflects the thought of each era during the 19th and 20th centuries; the materials had a very important role, making many contributions to architecture

Integrating technology and innovation into the 21st century architecture

Today one of the great problems that construction and architecture must face is generating proposals and designs that do the least harm to the environment, this means that the research and proposals developed during this century must do “more with less”. Environmental problems and climate change are a reality that contemporary society must face and this requires us to rethink how we are designing architecture during this century and how a work is going to be built, this requires us to create buildings and cities that have a positive effect to the environment.

Due to the increasing complexity of buildings and current economic and social factors, new methods of manufacturing, manufacturing and sustainable designs are being required. The future of architecture and construction depends on the scientific and technological advances that will be developed in the coming years, as well as the construction techniques, innovations and research that implement contributions to the architectural design of the 21st century.

The NASA Sustainability Base located at Moffett Field California was designed by William McDonough + Partners and is considered the most sustainable work in the United States. The energy demand of the building was minimized by the application of technology and sustainable design innovation such as narrow floor plates to capitalize on daylight, energy efficient HVAC that includes a geo exchange system and a radiant heating and cooling system, use of natural ventilation, an efficient lighting system and a building automation system. (Picture 5)

It is a government building that has required the latest technology in sustainability, and has put the best engineers to work, in a building of more than 4,500 square meters with the shape of a moon. It has the ability to react, having thousands of wireless sensors that allow it to change the temperature, in the face of the amount of sunlight, wind, heat, or cold that is outside and inside the building. It generates more energy than it consumes, using solar panels and a small wind turbine, aided by a Bloom Energy Box, which is a state-of-the-art fuel cell. It also has a system to recycle gray water, which is what is discarded after being used in bathrooms, for example. It is the same system designed for the International Space Station, which helps reduce water consumption by 90 percent.

Picture 5 Integrated design methodologies are clearly expressed in the resulting project. Measures include a highly efficient building envelope, underfloor air distribution, a total energy recovery wheel and solar hot water harvesting supplying 18 percent of the building's domestic hot water consumption. The net gain: a project 57 percent more energy efficient than a typical office building with gross square footage six percent below program.

It was designed by William McDonough + Partners, and it cost \$ 25 million. It is located at Moffet Field in California. It was built from scratch in order to make the most of sunlight, natural ventilation and shade provided by the surrounding environment. Being narrow, it allows sunlight to reach the middle of each floor, and the entire building is wrapped in a kind of exoskeleton that can provide shade, while allowing the entry of daylight and fresh air. This exoskeleton also provides stability against earthquakes, while making it possible to get rid of the columns that often disturb the interior design of large buildings. The name of the Sustainability Base arises as a tribute to the first astronauts who set foot on the moon more than 40 years ago, and who named the site where Apollo 11 landed Base of Tranquility. According to the Aerospace Institution, the new building is a site where NASA technologies can be reused for application on Earth.

Conclusions

We are entering a very complex era in terms of social, economic and environmental changes, and architecture must reorient its needs and purposes for the twenty-first century. The current paradigm of architecture spans the last two decades for all the technological and material advances that have been developed and software to be able to respect more the environment and the social needs of today. All these problems have developed that technological and innovative practices give a proposal to the problems we face today.

But, how to innovate in architecture? One of the most important aspects is that innovation requires integrated approaches, where design methods, technology and software must provide solutions that create value to the society and for the work. Therefore, new materials, new technologies, design computation play a special role to develop a better project with a better way of designing.

Research in architectural design is not a new phenomenon, during the last 5 decades many investigations have been developed that have been implemented in contemporary architecture. Gradual changes, the development of new technologies, new construction materials, and design representation encourage new research. Today more than ever, research is very important and is an inherent part of architectural design, several factors make the architect's work more complex, including technological factors, environmental needs and the needs demanded by society in the 21st century.

During the last 100 years, architecture and engineering have faced and developed great changes that had never arisen, after the second half of the 20th century, architectural research was more focused on history and theory. But after this date, many changes were integrated into the architectural design due to major changes and problems that influenced the last decades of the 20th century. During the two decades research in architecture has diversified very widely and this helps him develop a completely multidisciplinary panorama. The true value of current architectural research focuses on the evaluation and contribution of an architectural work to society and the environment, the efficiency of the operation, the effectiveness of the design and the environment. The knowledge developed in these works helps to generate a culture of innovation and a critical vision of architecture.

We cannot exactly predict how cities will function in the future, how transport modes will work, it what types of new technologies will be discovered and developed. We cannot precisely predict how economic and societal changes will affect the human population in a long-term context or how will our health be improved by new scientific discoveries and medical advances. But we know that changes are imminent, and that architecture and the built environment will be affected. Contemporary practices that embrace technological, societal and economic changes and establish innovation as a core value and design philosophy are better equipped to face what the future will bring (Aksamija, 2016, p1).

ⁱ The world population is expected to increase by 2 billion people in the next 30 years, from today's 7.7 billion to 9.7 billion in 2050, reaching a peak of about 11 billion by 2100. This drastic growth has been produced to a great extent by the increase in the number of people who survive until reaching reproductive age and has been accompanied by great changes in fertility rates, which has increased urbanization processes and migratory movements. These trends will have important repercussions for future generations. 61% of the world population lives in Asia (4.7 billion), 17% in Africa (1.3 billion), 10% in Europe (750 million), 8% in Latin America and the Caribbean (650 million), and 5 Remaining% in North America (370 million) and Oceania (43 million). China (1,440 million) and India (1,390 million) continue to be the countries with the largest populations. Both have more than 1 billion people and represent 19% and 18% of the world population respectively.

ⁱⁱ (1895 -1983) was an American designer, architect, visionary, and inventor. He was also a professor at the University of Southern Illinois Carbondale and a prolific writer. He became world famous for the invention of the so-called geodesic dome, of which there are over a hundred thousand worldwide. His scarce professional training, essentially limited to studies completed at Harvard University between 1913 and 1915, did not allow him to define himself as an architect in the strict sense of the word. However, his work is linked in a particularly influential way to the artistic trends of the 20th century, with a marked mechanistic aesthetic.

ⁱⁱⁱ (1832-1907) Established as one of the most important engineers of the 19th century. Thanks to his technical contributions, the skyscraper structures gained consistency. Becomes part of the Chicago School. Architects of the stature of Burnham, Root, Holabird and Sullivan passed through his studio. In 1889 he presented in the Leiter Building a significant improvement in the structure of the building, by perfecting the steel skeleton. The importance of this novelty was that it allowed to increase the number of floors starting from a structure of iron

pillars and forged steel beams. This skeleton made it possible to open large openings. After this first experience, the Fair Building was built and then the Manhattan Building with 16 floors, a record at the time. Regarding the artistic style, in most of these buildings he resorted to the eclectic genre on the facades.

^{iv} The building was commissioned by La Home Insurance Company, which wanted to build a new headquarters for its offices that was invulnerable against fires, with a height of 42 meters. It was the first skyscraper built in the world using structural steel. Built between 1884 and 1885. It was demolished in 1931. The building consisted of only 10 floors; Buildings with 9 floors or more were considered skyscrapers.

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