

Technological impact on buildings: The extent to which the technology effects on buildings and its relationship to the environment A case study between the past and the present

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Summary:

There is a severe neglect in the surrounding environmental resources, where materials and elements are used directly in environmental buildings, which leads to the rapid expiration of available resources without taking into account the rights of future generation. It turns out that there is a clear impact of the use of technological materials on buildings according to the nature of the surrounding environment, where technological development has a clear impact on reaching the same characteristics of the building to be compatible with its environment in a way that keeps pace with the current era, and this effect comes in the clarity of the full image of the building, whether it is for the building systems or the outer cover of it, and this varies according to the surrounding environment. It is known and followed that buildings associated with the environment have the ability to achieve complete comfort for its users using the environmental elements available to them from the surrounding environment, but rapid technological development and the emergence of technological materials, led to a new breakthrough in our society, where it is possible to apply and use technological materials to reach the same purpose required of buildings compatible with the environment in full, which contains the characteristics and features of the environmental building, but under its submission to modern technological materials and elements to keep pace with the times. Where the correct use of technology in terms of treatments is of great importance in finding solutions that are compatible with the environment and full respect for it through the correct employment of the technology used, such as reusing materials, taking advantage of the waste rates, recycling them and using them again. The design should be within the intellectual and technological context of the era, while avoiding the introduction of environmental solutions for later ages in the design of the contemporary urban environment. This is what will be discussed by the research with clarification of examples of buildings.

Key words:

technological elements, environmental elements, environmental compatibility, technological impact

الملخص

يوجد اهمال شديد في الموارد البيئية المحيطة حيث يتم استخدام المواد والعناصر بصوره مباشره في المباني البيئيه مما يؤدي الى انتهاء الموارد المتاحه بشكل سريع مع عدم مراعه حقوق الاجيال القادمه , ومع التطور السريع يتبين ان هناك تأثير واضح لاستخدام للمواد التكنولوجيه على المباني على حسب طبيعه البيئه المحيطة لها ,حيث يعتبر التطور التكنولوجي له تأثير واضح في الوصول الى نفس صفات المبني المتوافق مع بيئته بشكل يواكب العصر الحالي ويأتي هذا التأثير في

وضوح الصورة الكاملة للمبنى سواء اكان لانظمه المبنى او الغلاف الخارجي له ويختلف ذلك باختلاف البيئة المحيطة له ,ومن المعروف والمتبع بأن المباني المرتبطة بالبيئة لها قدره على تحقيق الراحة التامة لمستخدميه بأستخدام العناصر البيئية المتاحة لها من البيئة المحيطة ,ولكن مع التطور التكنولوجي السريع والحادث وظهور مواد تكنولوجيه ادى الى حدوث طفرة جديده فى مجتمعنا حيث من الممكن تطبيق واستخدام المواد التكنولوجيه للوصول الى نفس الغرض المطلوب من المباني المتوافقه مع البيئة بصوره كامله والذى يحتوي على صفات وسمات المبنى البيئى ولكن تحت خضوعه للمواد والعناصر التكنولوجيه الحديثه لمواكبه العصر . حيث يعد الاستخدام الصحيح للتكنولوجيا من حيث المعالجات لها اهميه كبيره فى ايجاد الحلول التى توافق البيئة والاحترام الكامل لها عن طريق التوظيف الصحيح للتكنولوجيا المستخدمه مثل اعاده الاستخدام المواد والاستفادة من معدلات الهالك وإعادة تدويرها واستخدمها مرة اخرى.وبالتالى يتضح ان هناك انسجام بين التكنولوجيا والبيئة من حيث استخدام المواد التكنولوجيه دون التأثير على البيئة المحيطة ويرجع ذلك للتطبيق الصحيح للمواد المستخدمه. ينبغى أن يكون التصميم ضمن السياق الفكرى والتكنولوجي للعصر، مع الابتعاد عن اقحام الحلول البيئيه لعصور متأخره في تصميم البيئة العمرانيه المعاصره. وهذا ما سيطرق اليه البحث مع التوضيح بأمثله للمباني.

الكلمات الدالة

العناصر التكنولوجية، العناصر البيئية، التوافق البيئى، الاثر التكنولوجي

1. Introduction

The technological development is considered to be having a significant impact on buildings, as the technological elements and materials can be properly used and applied in order to achieve the same purpose required of buildings, especially the environmental ones, in addition to maintaining the available resources of surrounding environment to preserve the rights of future generations.

It is well-known that the environmental building is composed of the elements of surrounding environment, which contribute to providing the complete comfort for its users. Likewise, the rapid development of technology has led to use a new technology having the same characteristics of materials used directly from the nature and achieving the same purpose. It is possible to consider these new trends to keep up with the current era, move from the past to the present and think about the future.

2. Research Problem

The problem of this research lies in the excess use of surrounding environmental resources and the use of materials and elements directly in the environmental buildings, which lead to a rapid depletion of available resources and not taking into account the rights of future generations, in addition to not using the new technological development to keep pace with the times and preserve the rights of future generations.

3. Research Hypothesis

The new technological elements and materials can be used in buildings, which leads to increase the complete comfort for its users, keep pace with the times and contribute to create buildings compatible with its environment, which, in turn, connects the building with its environment.

4. Environment.

4.1. Definition of Environment

- It is to mainly preserve the nature and an appropriate ecosystem that is structurally and functionally efficient.(1)
- It is a variable and multi-use concept for the geographer, for example, the environment refers to land's nature, its topography, and the climatic conditions affecting it. For the sociologist, it means the organizational nature of different societies, while for the architect, it means the way by which the buildings are built and how the environment in which it is established is externally treated. Therefore, the site climatic influences, such as: Temperature, humidity, land nature, wind speed and directions and solar brightness, are of the most important specific and influencing considerations for any urban and architectural project, as they play a great role in influencing the shape and facades of buildings and its materials to be selected.(2)
- It is the architecture that respects and preserves the environment, by reducing the use of energy, benefiting from renewable natural energy sources, and reducing the impact of buildings on the environment, in addition to providing harmony between the building and nature, so that these buildings take into account the needs of the present and the rights of future generations.(3)

4.2. Environmental Related Definitions

The architect "William Reed" argues that green buildings are just buildings designed, implemented and managed in a manner that takes the environment into account. He also believes that green buildings are greatly interested in reducing the impact of building on the environment and reducing the construction and operation costs.

The architect "Ian McHarg" argues that the human problem with the nature is reflected in the necessity to give it the characteristic of continuity efficiently as a source of life. It considers the problem from an environmental point of view that calls for thinking about the world and learning from it.

The architect "Susan Maxman" believes that the architecture shall be proportional to what surrounds it in some way and in conformity with the people's living and all the driving forces of society.

The architect "Stanley Abercrombie" believes that there is an influential relationship between the building and the land. (3)

4.3. Traditional Local Architecture

The traditional local architecture, which was based on prevailing principles, customs and culture and applied by workers and craftsmen, has continued for generations due to its compatibility with the natural, social and economic environment in terms of place and time across different civilizations and cultures until the middle of the nineteenth century and the beginning to manufacture building materials. Fig(1), followed by the population increase without keeping pace with the development of local resources in light of the increase of behavior.(4)



Figure (1) indicates the traditional architecture and its relationship with climate

4.4. Mutual influence between the man and environment

It is a process used to apply methods and to use processes that take into account environmental conditions and achieve the maximum benefit from resources during the stages of buildings construction, starting from determining the location and design, followed by the stage of construction. Fig (2), operation, maintenance, restoration and demolition. The term includes also the economic considerations and those related to facilities, building's stamina and comfort. (5)



Figure (2) indicates the extent to which the connection with the nature and design patterns are applied, but they may have different shapes, aesthetics, and different building materials related to each region (6)

Sheltering the man and properties to be protected from climate, animals and supernatural powers, in order to create a safe human place in a dangerous world. (7)

4.5. Examples of buildings with local resources

The environmental impact is clearly shown in Suleiman's palace in Jeddah; as the domes and stone were used in hot areas in order to mitigate the intensity of sun's rays falling on the roof. Fig. (3), and the wind catchers were established to cool the air inside the architectural space. (8)

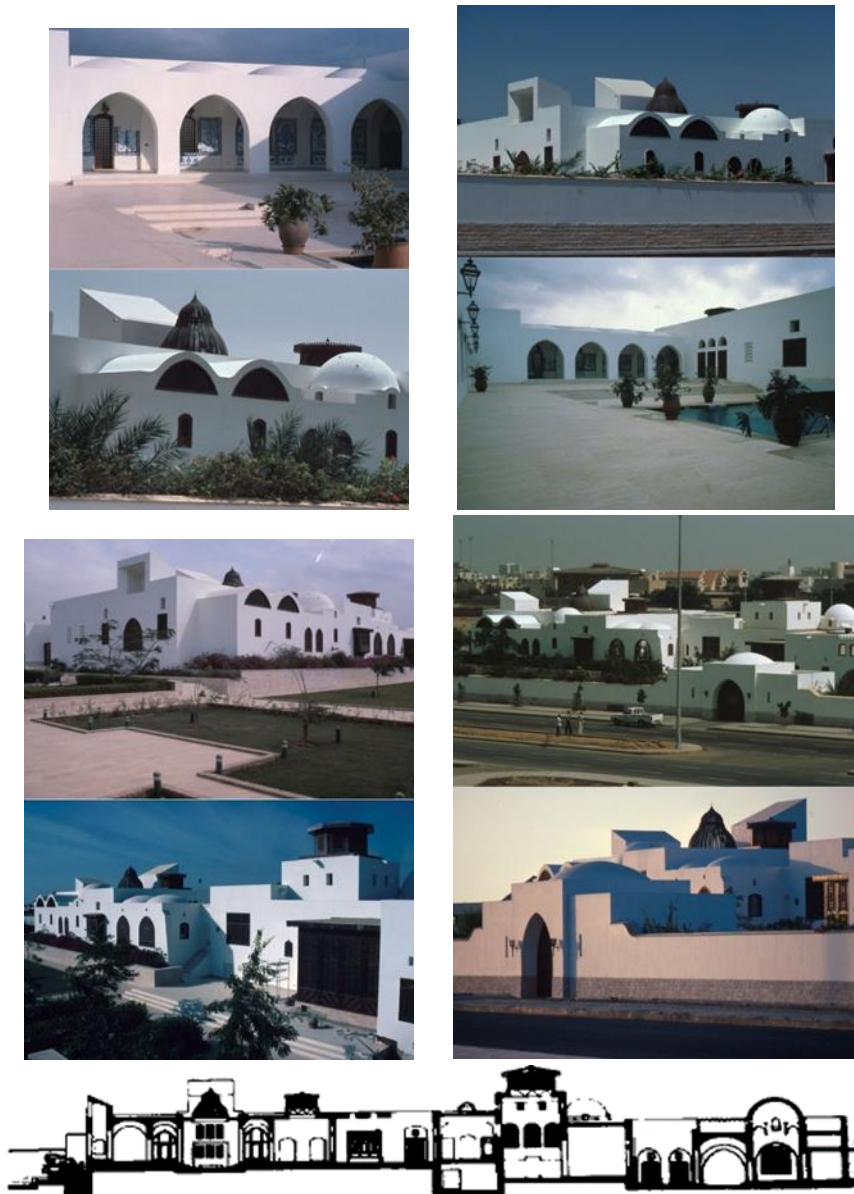


Figure (3) shows the environmental influence on the roof shape, Suleiman Palace, Jeddah
 Source: Alem Al-Binna Magazine, Issue No.54, p. 16

The dwellings model of Abu El-Rish village in Aswan is consisted of one floor. The courtyard of these dwellings is considered as a place for the family future extension, as it is used to build small housing units, Fig.(4). This model also reflects the principle of flexibility and meeting the needs of occupants; as local environmental elements play a fundamental role in establishing this model, which gave respect for the surrounding environment.(9)

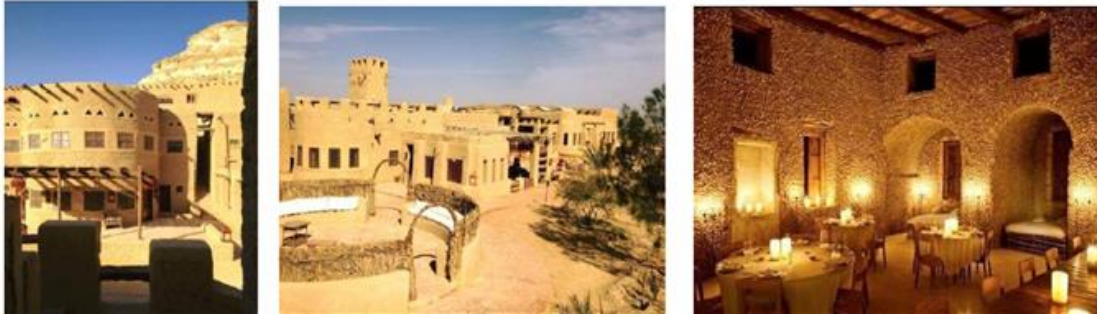


Figure (6) shows a model of a touristic resort in Siwa

4.6. Materials and elements of surrounding environment.

The physical factors of environment are defined by the available materials, topography, and climatic characteristics of place. As such, the local environment and available building materials determine many aspects of ecological and local architecture, **Fig.(7)**. For example, the wooden architecture can be developed in the areas rich in trees, while the mud or stone can be used in the areas poor in wood. For the Far East region, the bamboo is widely used, due to its abundance and diversity. Accordingly, the available materials and the selection of building materials related to the environmental components are greatly used to determine the building shape in conformity with the environment in which it is located.(7)



Figure (7) shows the types of materials used according to the surrounding environment

5. Technology

5.1. Technology Definition

The technology is a set of accumulated and available knowledge and experiences, material, organizational, administrative and moral tools and means used to perform a job or function in the field of daily life to satisfy material and moral needs, at the level of individual or society. The definition of technology may be overlapped with that technique, industry, machinery, art or work. It is sometimes associated with a production field, such as: Space technology or building technology. (11)

5.2. Technology Related Concepts

- Semper argues that the technology is an art represented by what a person does to obtain a miniature world that includes the natural world, seeking to find the lacking integration.
- Fischer believes that the technology is a necessary practice to establish compatibility between the self and the environment on physical and psychological levels; as the man seeks to complete himself by producing a more comprehensive reality to serve human beings and meet their desires. (12)

5.3. Mutual influence between technology and man

– Once upon a time, the man was relied on himself in terms of technology and the needs of society upon the man's instinct without being an innovator or creator. The outbreak of World War II, which is followed by the discovery of new materials and the prosperity of technology, was led to the technological progress. This latter was contributed to interpret the environmental phenomena and solve the problems faced by the surrounded environment in terms of the depletion of local resources and the preservation of future generations rights. (13)

-The technology may be converged and harmonized with the inside of the building, which is considered as evidence of keeping pace with the technology era and achieving the goals of buildings in terms of the mutual relationship between them. As the building of the Sea Towers, **Figures (8), (13).**

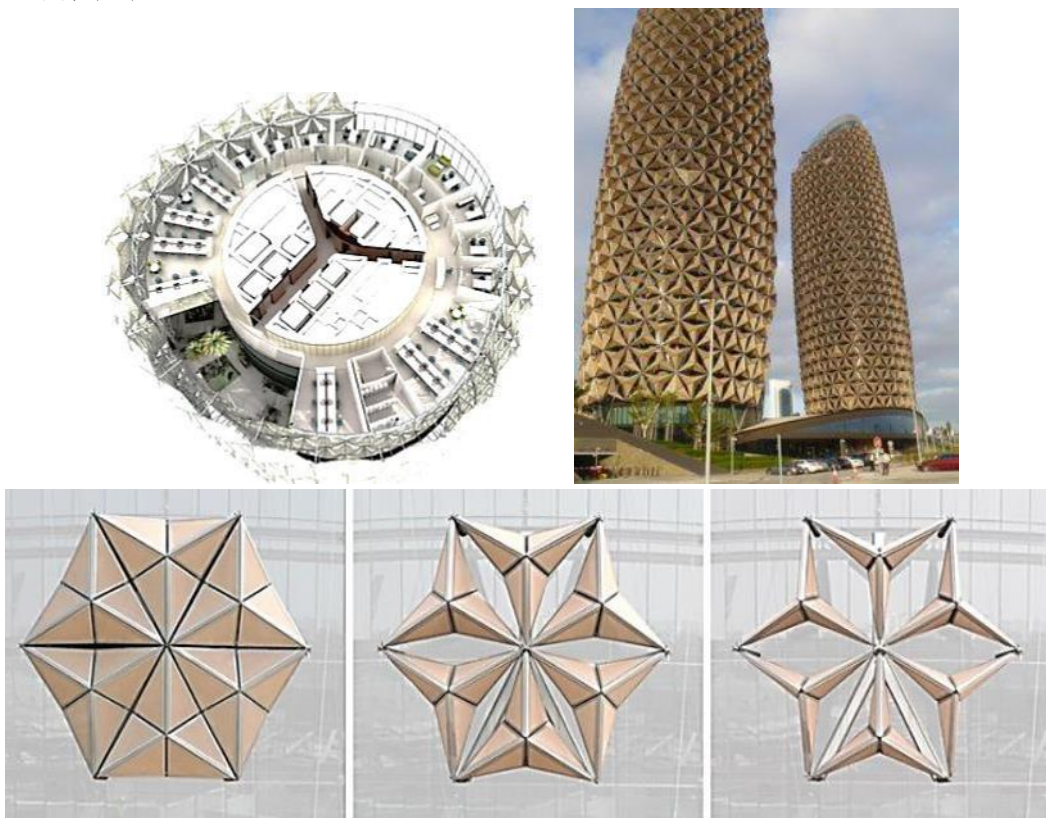


Figure (8) indicates that the technology may be properly applied in the Sea Towers (Abrag Al Bahr)Project and its connection with the surrounding environment.

– The Sea Towers (Abrag Al Bahr) project established in Abu Dhabi is a key factor that may be used to properly apply the technology with the aim to benefit from solar energy, control the heat gained, resist environmental factors and achieve comfort for user by controlling the amount of lighting, ventilation, and heat required for the internal space and linking to the external environment; so as to have a strong connection between the technology and surrounding environment.

5.4. Examples of the application of technology to buildings

Falling Water House

The impact of technological development on the relationship between the building and the surrounding environment is illustrated by using the advanced building materials compared to the local natural materials and the construction of a building suitable for the surrounding environment; as the new materials that allow the entry of natural lighting and give a sense of extension and continuity of the internal space towards the outside and movement between spaces have been used. For instance, the Falling Water House in the Byron Reserve in Pennsylvania is constructed on the flowing water at a high of 1300 feet above sea level and suddenly reduced to a height of 30 feet among the dense trees and stunning views, Fig.(9). This Falling Water House was built by Frank Lloyd Wright, which illustrates the close relationship between nature and architecture; as the waterfall can be seen from the windows and be merged with nature.

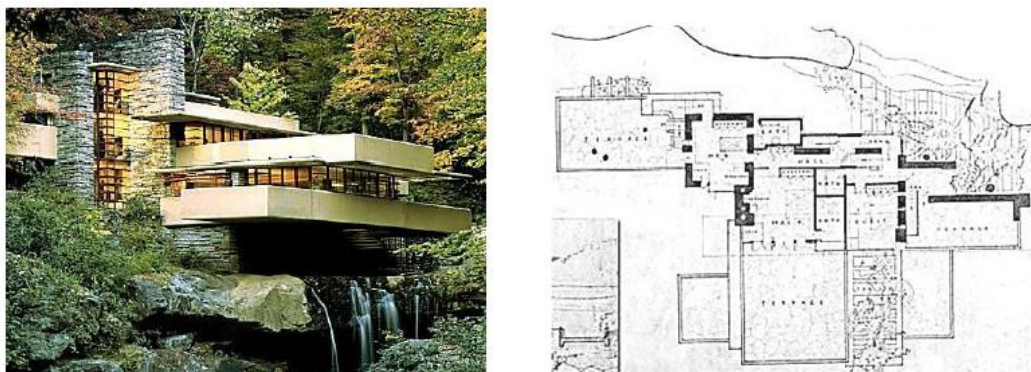


Figure (9) shows that the building technology can be used and that the interior space can be merged with the surrounding environment

Falling Water House - Frank Lloyd Wright, 1935

The architect was able to connect the internal space to the external building although the building materials are different. He used the texture contrast, as its walls are made of untidy limestone as shown in Figure (10), which is placed in contrast with heavy blocks of white cement, iron and shiny glass. In this building, the horizontal lines of concrete were connected to the vertical lines of walls, glass openings and the stems of forest trees. (19)



Figure (10) shows the use of rough and untidy stones in the building

To this end, he has succeeded to merge the house with the waterfall, as the water sound may be constantly heard in all parts of the house, as indicated in Figure (11)



Figure (11): Merging the house with the waterfall and hearing the sound of water movement.

The (Living Room) refers to the energy, movement and vitality stemmed from the waterfall; as the seated person feels the vital force below him, as shown in Figure (12). Likewise, the hollow concrete covering over the eastern terrace gives you an impression of vertical extension towards the sky and horizontal one towards the living room, which is considered as a kind of connection between the inside and the outside. As for the openings of Frank Louise Wright in general, it is noted that the glass panels of corners are converged with each other without being covered with the metal frame so as not to block the view. As for the upper floor, it is divided into apartments that are almost separated. These apartments include a part for living room and another one for bedrooms, in addition to a small private terrace, and one of them include a guest suite. The living room was designed in the south direction, due to their need for the sun. The large openings along the wall were used to receive the maximum amount of sunlight and have the best view, as indicated in Figures (13), (20).



Figure (12) shows the relationship between the living room and surrounding environment and its psychological impact on users



Figure (13) shows Frank Louise Wright's design and the connection between the internal environment and the external one

This connection between the environment and the building would not have happened without the technological development in the construction processes; as the glass and stones were mainly used so that the building becomes closely connected to its environment.

Parliament Building in Berlin

The parliament building is considered among the ones whose internal and external environment are closely connected. It depends on the sources of surrounding environment in terms of use, as the use of technological processing has a significant impact on the connection between the building and its environment, as illustrated in Figure (14).

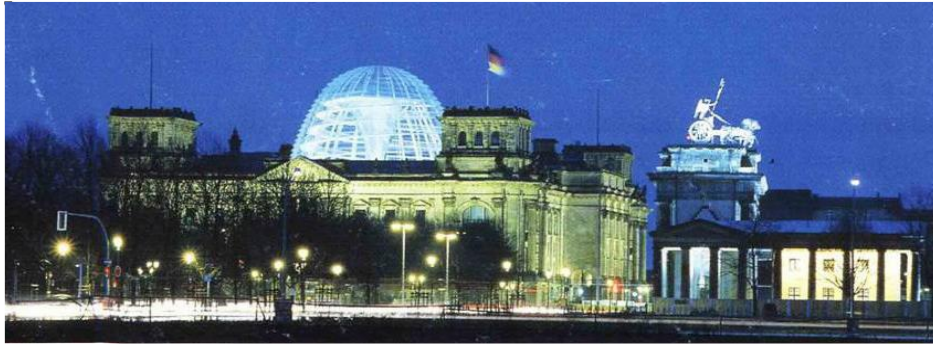


Figure (14) shows that the technology can be used in the Parliament building in Berlin

- The building system replaces the natural environment; as the building is not separated from its environment despite the existence of an outer cover, as shown in Figure (15).
- The cycle of sunrise and sunset takes place outside and inside the parliament building at the same time, and the energy penetrates into the entire spaces.
- The architect "Foster" was able to connect the internal space to the external environment in terms of natural lighting and energy for heating. To this end, he has synchronized the sun movement every hour in the external natural environment with the internal one using glass.
- This connection between the environment and the building “The debating room of Parliament” would not have happened without the technological development of construction. It is mainly based on just one point, namely the obconic mirror that linked the sun movement to the debating room of parliament, as indicated in Figures (16),(17), (21).

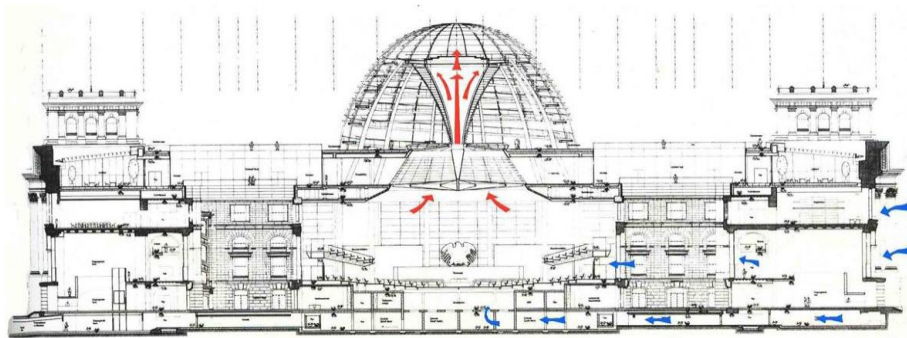


Figure (15) shows a vertical sector passing through the building dome to illustrate the building system and its technological role.



Figure (16) shows the conical mirror used to get rid of hot air and reflect the sun's rays



Figure (17) shows an external image of the glass dome connected between the internal and external environment by means of the advanced building technology

The building includes a main hall that accommodates 750 seats, topped by a glass dome. This technology has been used in the building to increase the communication with the community, understanding and respecting history and fully respecting the environment, as indicated in Figures (18), (21).

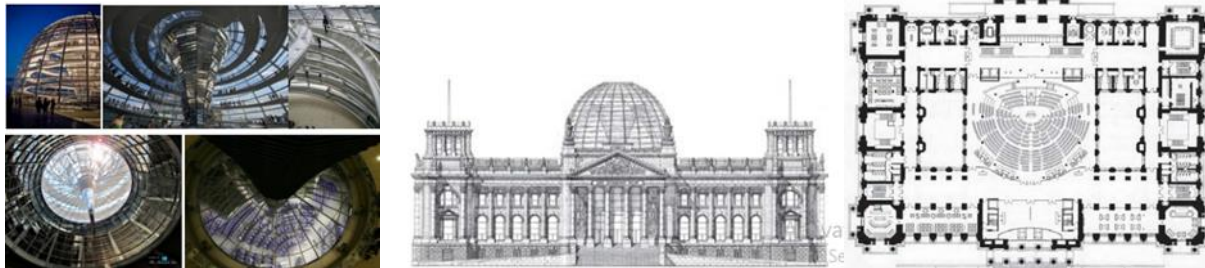


Figure (18) shows the building skylight and the glass dome used to simulate nature.

Merging Technology and Environment

The technology has greatly paid attention to the natural daylight of the surrounding environment, as well as taking advantage of natural ventilation.

Daylight:

The natural lighting aims to reduce the use of artificial one. The glass dome plays a great role in the provision of natural lighting, as the inverted cone, which is called the light sculpture, is used. This latter is installed above the dome, so the light hits the conical shape, then it is distributed in the space. To increase the performance of cone, its concave shape was covered with reflecting mirrors with 360 degrees, as shown in Figures (19), (22).

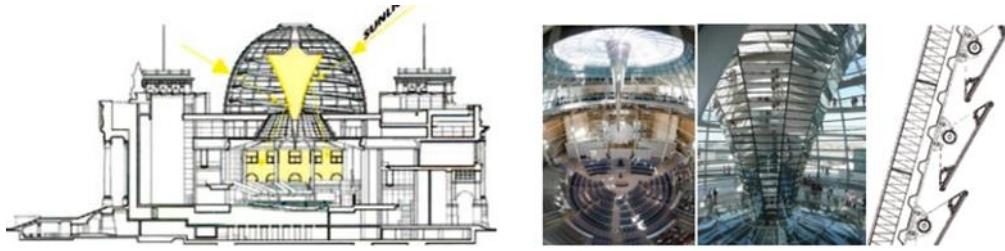


Figure (19) shows the dependence on natural lighting through the glass dome

Natural Ventilation

The glass dome is considered as a key factor in providing the natural ventilation, as the entire building is mechanically ventilated by generating an air current through the glass dome and the opening topped. In addition, the light sculpture has been used in the ventilation process, especially in the main hall, as the fresh air is pulled out the internal space to pass inside the cone body, which, in turn, pulls the air out in a manner similar to the chimney one, as illustrated in Figures (20), (23).

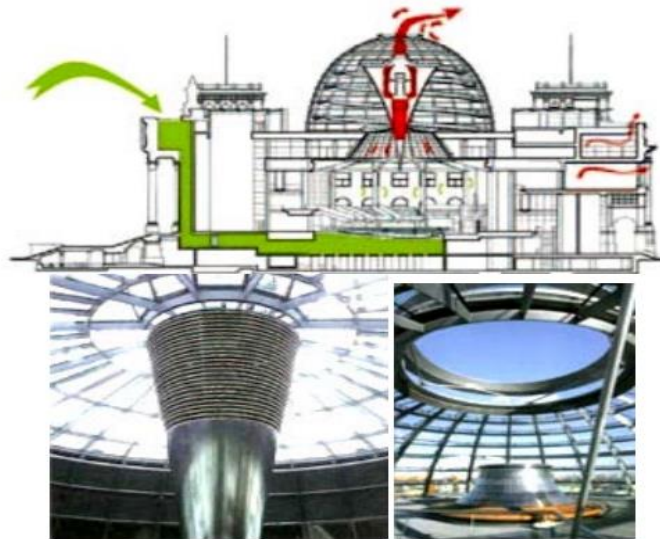


Figure (20) shows the dependence on natural ventilation through the glass dome.

This achievement is considered as evidence of what has been previously mentioned, which is the appropriate application of technology to connect the building with its environment and how to make advantage of this technology to provide human comfort without affecting the surrounding environment.

Based on the foregoing, it is evident that the current era inevitably relies on technology, as it is widely used in the twenty-first century. In future, our generation will take the next step towards the "high-tech buildings" and it will become familiar to humanity.

5.5. Technological Materials and Elements

The building materials are chosen according to their advantages and properties, including the mechanical, functional and aesthetic ones, and durability under the technological denomination that keeps pace with the times, respects the environment, and achieves the full comfort for users, such as the works of environmental architecture, taking into account the economic aspects.

The computer has directly led to the occurrence of a boom in building materials, especially at the end of the twentieth century and the beginning of the twenty-first, whether basic or

supplementary building materials. To this end, computer has played a major role, whether indirectly through manufacturing and testing processes, or directly through various software, including:

Environmental Concrete

The concrete is one of the widespread construction materials worldwide, due to its structural properties, especially when combined with reinforcing steel. It also gives good thermal and sound insulation. With the technological development of cement industry, the cement industry has achieved energy efficiency, which is called the environmental concrete, in which 50% of the cement content is replaced with (PFA) material, which is a gray powder fuel, which reduces the emission of carbon dioxide gas, in which the concrete material is included with a percentage of (15-25%) or (GGBS) material, Ground Granulated Blast-furnace Slag, which is the waste of energy generators which reduces the emissions of carbon dioxide gas by a percentage of (35-45%).

Light-Permeable Concrete

It is a modern material developed in Germany; it contains optical glass fibers that transmits the light from one side of the concrete wall to the other one, using a number of multi-diameter optical fibers (varying from 2 microns to 2 millimeters), Figure (21). In order to achieve multiple light effects, as this material is used to make internal partitions, by which the internal spaces can benefit from daylight and connect with the external environment. (16)



Figure (21) shows light-permeable concrete and its importance in creating connection with the surrounding environment

Self-Cleaning Concrete

A catalyst is added to the concrete materials during the manufacturing process. It makes the concrete activated when exposed to ultraviolet rays. It analyzes the organic materials such as rubbish, airborne pollutants and nitrogen oxides on the surface of concrete, which reduces the air pollution and connects the establishment to the environment in terms of interaction, Figure (22).

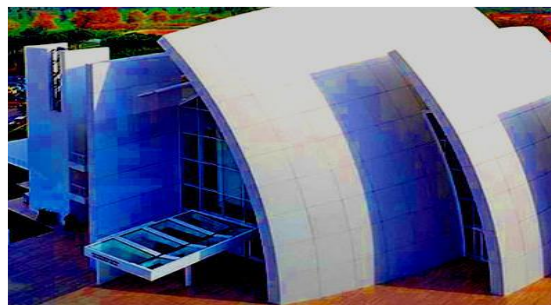


Figure (22) shows the mechanism of action of concrete in the cleaning process, removal of organic compounds and getting rid of toxins

Glass

Technology has a great impact on the glass industry. Thus, many types of glass have appeared, such as: Double glazing that includes electronic charges inside, the glass from which the energy is generated, and the chemically treated glass used for self-cleaning, as it cleans itself automatically through its natural properties. There are many other types used to achieve the full comfort for users automatically, Figure (23), as it closely connects the building to its environment. (17)



Figure (23) shows the use of double glazing, the possibility of being merged with nature and the control of lighting and heat



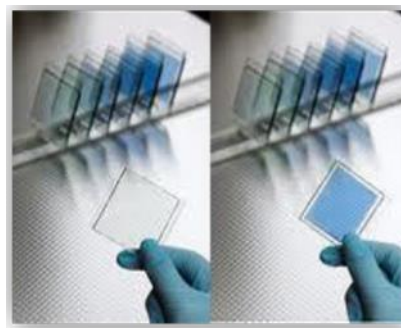
Figure (25) using self-cleaning glass



Figure (24) shows the use of glass to generate energy in Emirates



Figure (26) shows the electrically colored layer in the windows.



Paper

It is an unnatural material, as it is manufactured from wood. It can be also used as a construction material, as it is characterized by its light weight. It was applied before in Swiss pavilion, which had a diameter of 13m and a height of 33m. Technological processing was applied to it to ensure that it withstands various surrounding factors and influences.



Figure (27) shows the application of paper treated in some facilities

Woods

Many additives have been appeared to improve the performance of wood as structural elements, through special painting materials used to increase the hardness of wood, as it can be controlled and flexibly shaped until it dries and then becomes hard.



Figure (28) shows flexible wood, one of the most important types of modern wood.

Technology Reuse of Materials

At the beginning of the twenty-first century and with the increasing awareness among countries to preserve natural and environmental resources, many architects concerned with environmental aspects have called for the need to pay attention to the reuse of materials as an ideal solution to preserve this wealth, so that the huge depreciation rates are taken advantage of, recycled and remanufactured by using the technological methods (concrete - wood - metal - glass - bitumen - paper - etc.) resulted from waste to preserve the environment and the rights of future generations. (18)

6. Results

1. There is a correlation between the architecture of the past and the architecture of the present and the future, taking into account the element of time and the possibility of keeping pace with the times of the surrounding environment, achieving environmental compatibility, where access to the optimal situation of the residential environment (the material part and the human part) in which the maximum benefit is achieved from the positives of the environment over its negatives, in order to achieve the greatest benefit for the individual and society as a whole.

- 2.The surrounding environment resources can be preserved to provide opportunities for future generations by directly reducing the use of environmental resources.
- 3.The connection of building to its environment is necessary for all types of buildings, in addition to achieving the comfort for its users in a way compatible with the current era.
- 4.The correct use of technology in terms of treatments is of great importance in finding solutions that are compatible with the environment and full respect for it through the correct employment of the technology used, such as reusing materials, taking advantage of waste rates, recycling them and using them again.
- 5.Taking into account the negative impact of technology to avoid any negative effects on the environment as a result of the excessive use of technological materials and methods without any awareness or study.
- 6.The architect shall realize that there is harmony between the technology and the environment, in terms of the use of technological materials, without affecting the surrounding environment, which makes the building compatible with its environment due to the appropriate application of materials used.
- 7.The design should be within the intellectual and technological context of the era, while avoiding the use of old environmental solutions of late eras when designing the contemporary urban environment.
- 8.It is necessary to deal with the environmental solutions and processing within a comprehensive framework that takes into account the sustainable environmental behavior.

References

- 1- D. Huda Abdul Saheb Alwan , Yasmin Haqqi Hassan Beik ,Harmony of architecture with nature Sustainable design towards human health and well-being , College of Engineering Department of Architecture Engineering / University of Baghdad Emirates Journal of Engineering Research (2017)(55-37)1(22 - Published Research **(Arabic)**
- 2- Prof. Dr. Magdy Mohamed Kassem, "The Impact of Technology on the Design of the Outer Shell of Desert Environment Buildings", Professor of Architecture - Faculty of Engineering - Al-Azhar University (International Journal in: Architecture, Engineering and Technology) Published Research **(Arabic)**
- 3- Dr. Mohamed Haitham Busais, "The Role of Traditional Architecture in Supporting Green Architecture", Faculty of Architecture, Tishreen University, Workshop (2014)
- 4- Dr. Amal Abdel Halim Mohamed Suleiman, "The Impact of Contemporary Urbanism and its Technologies on the Environment" Technology and Sustainability Conference in Urbanism **(Arabic)**
- 5- Alan Millin, Freelance scientist, engineer, environmentalist and thinker, email: akmillin@hvacandr.com green buildings (sustainable) and water use efficiency, Issue Ten – January 2015 **(Arabic)**
- 6- Green, Judith." Back to Nature for Good: Using Biophilic Design and Attention Restoration Theory to Improve Wellbeing and Focus in the Workplace". Master Thesis. Faculty of the Graduates School, the University of Minnesota, 2012.

- 7- Assoc. Prof. Dr. Maha Mahmoud Ibrahim, "The Mutual Influence between Man and the Environment: The Concept of Universal Design and its Relationship to Sustainability in the Interior Space, Journal of Architecture and Arts, Issue Seventeen, Published Research **(Arabic)**
- 8- Ahmed Nabih Al-Manshaw, "The impact of building technology and the environment on the architectural space and its role in achieving thermal comfort, an applied study of the project (Sea Towers Abu Dhabi)", Al-Azhar Magazine, Issue 38, January 2016 **(Arabic)**
- 9- Kazimee, B.A. " Learning from vernacular architecture: sustainability and cultural conformity, WIT Transactions on Ecology and the Environment, Vol 113, 2008. www.witpress.com, (accessed on 20 June 2018).
- 10- Dabaieh, Marwa. "Energy efficient design strategies for contemporary vernacular Buildings in Egypt". Vernacular Heritage and Earthen Architecture: Contributions for Sustainable Development Correia, Carlos & Rocha (Eds), 2014:599-604
- 11- Knowledge and Technology, 1993, p. 59 **(Arabic)**
- 12- Wisam Anwar Fadl Al-Khalidi, "An Analytical Study of the Impact of Contemporary Building Technology on the Architectural Character of Residential Buildings" 2016, p. 9 (Arabic)
- 13- Nasser Fawzy Ramadan, "An Approach to Measuring Environmental Combinations of Building Technology in Housing Projects", p. 4 **(Arabic)**
- 14- Abdul Rahim bin Hassan Al-Shehri, "Building Technology and its Role in Achieving Thermal Comfort within Architectural Spaces", p. 155 **(Arabic)**
- 15- (Adam Ritchie & Randle Thomas- 2009)
- 16- Journal of Engineering Sciences, Assiut University, Faculty of Engineering, Vol. 41, No. 2, pp. 640 - 665 March, 2013, E-mail address: jes@aun.edu.eg
- 17- Eng. Lina Ali Ibrahim, "Techniques for the implementation of smart destinations", Al-Baath University Journal - Leather 38 - Issue 49 - 2016 **(Arabic)**
- 18- Prof. Dr. Samia Kamal Tawfik, Prof. Dr. Sahar Suleiman Abdullah, "Harmonization of the development of building technology with local building materials in Egypt" The Seventh International Engineering Conference, Mansoura University, Sharm El-Sheikh (March) 2010 **(Arabic)**
- 19- http://creative-architecture96.blogspot.com/2016/07/blog-post_17.html
- 20- <http://www.bonah.org/%D8%A8%D9%8A%D8%AA-%D8%A7%D9%84%D8%B4%D9%84%D8%A7%D9%84-%D9%81%D8%B1%D8%A7%D9%86%D9%83-%D9%84%D9%88%D9%8A%D8%AF-%D8%B1%D8%A7%D9%8A%D8%AA> 19/10/2022
- 21- Ruesink, Herm; Ploeg, Marjolein & Herder, Arnoud, Norman Foster. Sustainable design approach. Transparency and accessibility of the democratic process. Methods & Analysis
- 22- Phillips, D., 2004, Daylighting – Natural Light in Architecture, First published, Architectural press, Oxford, Burlington, p. 3, 5-6, 8, 4, 7,23 ,72, 73, 74.

- 23- Hala Shamsi, Asmaa Sadek, the dome and the duality of openness and closure, an analytical vision of the intellectual, structural and environmental aspects, Emirates Journal of Engineering Research 20(1) 1-21 (2015) (**Arabic**)
- 24- The Egyptian Code for Improving Energy Efficiency in Buildings, (The Permanent Committee for the Preparation of the Egyptian Code for Improving Energy Efficiency in Buildings), National Center for Housing Research,2006.(**Arabic**)