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Natural Lighting of Museums

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Abstract. One of the basic conditions for a higher efficiency of museums is the lighting of their spaces. Proper and balanced lighting helps to focus attention, to create an aesthetic connection between the observer and the work of art as well as to realize a modification to emphasize a conceptual idea. To achieve the maximum lighting needed to highlight exhibits, museums use natural light. They often also consume a lot of electricity when using artificial light. To reduce electricity consumption and to ensure that museum objects are authentically exhibited, most museums have begun to integrate as many natural light solutions as possible. This is being made possible as well through various advanced materials as a result of the latest technologies.

Keywords: Natural lighting, Museums, Efficiency, Exhibits, Advanced Materials.

1 Introduction

Human civilizations have gone through different historical periods so far. Their development has often remained only as folklore, but these civilizations have also been evidenced through artifacts such as various items, objects and writings. Museums have been created as a need to preserve these artifacts in the best possible way and to present them to the public for educational purposes. As such, museums are institutions that care for collections of artifacts of cultural, historical, scientific or artistic value and exhibit them temporarily or permanently. They can be used for various researches as well as for the general public.

The lighting of museum spaces is one of the basic conditions for higher efficiency. However, museums also consume a lot of electricity due to the maximum lighting needed to highlight the exhibits. For the reduction of electricity consumption on oneside, and in order for museum objects to be authentically exhibited on the other side, most museums have begun to integrate natural light solutions into their design. This paper analyzes the inclusion of natural light in various architectural contexts with special emphasis on the ways of its inclusion in museums.

2 Natural Lightning in Modern Architecture

To better understand the importance of the necessary natural lighting in architecture it is necessary to know how natural lighting has influenced architectural objects over the centuries. We need to get acquainted with the strategies that architects have used in the past to bring natural light inside these buildings. The history of natural light in architecture is closely related to the advancement of engineering technology and the development of glass manufacturing. According to Moore "natural light means the symbolism of purity, chastity, wisdom, and paradise apart from its main role - the illumination of space" (Moore, 1985). It categorizes the use of natural light in three different periods - in pre-industrial, industrial and post-industrial (modern) architecture.

After the period of industrial architecture, the modern movement enabled some prominent architects the freedom to use materials and structures to explore new forms of construction. Glass, as the main material and transparency as the theme became dominant in the twentieth century. For instance, Gropius' *Bauhaus*, Rietveld's *Schroder House* and Le Corbusier's *Villa Savoye* share the same concept of light that is understood as *universal light*, which describes the geometric consistency of an architectural object: an ideal midday light bent at 45° penetrates the interior without changing the quality, since all the divisions between the interior and the exterior are temporary and random, and do not *divide* the different worlds, but distinguish the *zones* which share a *microclimate* within the same environment (Portoghesi, 1994).



Fig. 1 Bauhaus_Dessau by Walter Gropius
Source:Wikimedia Commons



Fig. 2 Rietveld Schröder House,
Source:Wikimedia Commons



Fig. 3 Villa Savoye, Interior view, Source: Wikimedia Commons

Natural lighting has returned to modern architecture (in the late twentieth century) after a period when large spaces required a lot of light and for this artificial lighting was also necessary. Now natural lighting in architecture seems to be at a stage which will not end soon. Most people would agree that integrating natural light properly into museums and galleries can be a viable alternative to artificial light. As Architect Le Corbusier points out “as you can imagine, I used light freely; light for me is the fundamental basis of architecture. I compose with light” (Pauly, 1997).

Moreover, the inclusion of natural light in the museum is not just another way of exhibiting works of art, as it also creates a pleasant and relaxed environment for visitors and employees. Natural lighting enhances the quality of the museum visitors’ experience, enabling a connection to the outside environment as light changes colors and intensity as the weather outside changes during the day.

3 Natural Light Technologies through Optic Fibers

Natural light technology through optic fibers is an ideal natural light solution for museums and galleries. Fiber optic technology means that natural light can very easily be directed towards a particular room or quality, and with an identical spectrum of sunlight, the light scattered by the illuminators emphasizes color, shape and texture. In this way museums are able to present their artifacts under light which is completely natural and which contains the full spectrum of colors.

Furthermore, this system is fully modular, which means that the amount and intensity of light can be adapted to the specific needs of rare and valuable artifacts in museums. The light intensity level (lux) can be predetermined in such a way that the right amount of light disseminates and there is no risk of damage. This technology brings all the benefits of natural light to visitors inside museums; added appearance, quiet and pleasant environment as well as elevated concentration. This is why it is increasingly considered in construction sites.

4 Kimbell Art Museum, Victoria and Albert Museum (V&A) and Louvre Museum in Abu Dhabi

The light at Kimbell Art Museum by Louis Kahn was commissioned to design the Kimbell Art Museum in 1966. The museum opened to the public in 1972 and became a center of modern architecture. Kahn designed a building in which the main theme is light. Louis Kahn stated that “no space, in architectural terms, is space without natural light” (Feinberg and Keller, p. 92, 2010). Natural light enters through the upper windows on the roof made of plexiglass along the circular cylindrical domes and is disseminated by wing-shaped perforated aluminum reflectors which hang down giving a silvery shining to the smooth concrete of the dome surfaces and providing a perfect illumination for the artwork.



Fig. 4 Kumberly Art Museum.
 Source: (Kahn, L.I (1975) Light is the Theme, p.36



Fig.5 Kumberly Art Museum.
 Source: (Kahn, L.I (1975) Light is the Theme, p.10

The main (western) facade of the building consists of a partition of 30 meters, each facing a portico with a cylindrical dome, with a central entrance of the intermittent and glazed partition. The porches represent the spaces of the domes filled with light on the exterior, which are the defining quality of the interior. Although entirely a modern object in the aspect of the lack of ornaments, this building with large arches and domes resembles Roman architecture, which served as inspiration, which Kahn himself had admitted. The basic materials used are concrete, travertine and white wood.

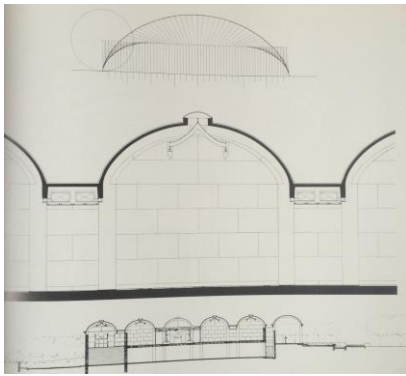


Fig. 6 Kumberly Art Museum. Source: (Kahn, L.I (1975) Light is the Theme, p.31

At the Kimbell Art Museum lighting plays a key role in illuminating the space and creating the atmosphere. In his lessons and designs, Louis Kahn constantly emphasizes the importance of lighting in relation to structure. He above all light sources preferred natural light because of its dynamics and variability. Although most museums avoid natural light due to damage to the exhibits, the Kimbell Art Museum argues that visitors should relate works of art to nature and the effects of changing weather as experienced by their creator, under the conditions of natural lighting.

In order to enable natural light in the spaces without endangering the works of art, Kahn invented a metal "reflector" or "shield" which would be placed directly under the roof windows to reflect sunlight on the smooth gray and curved surface of the dome.

The light thus transforms the surface creating a silvery shining which fills the space below without damaging the Museum collections. Lighting consultants worked with Kahn on arranging reflectors in the shape of seagull wings which were then installed in the museum. These "natural lighting fixtures" made of perforated aluminum were bent so that they could immediately reflect and filter sunlight. When it comes to works of art that do not need a lot of lighting, such as Asian art paintings, a black foil can be placed on the roof windows to further reduce the amount of light reflected in the gallery.

Kahn also incorporated thin moons into each dome to add illumination. The moon also serves as an important element which separates the visible parts of the structure and thus gives shape to those two parts. Its lower part reflects the cylinder, while the upper part is formed by the concrete shell that thickens from its top. Light spaces pass through the length of the dome to allow indirect lighting into the museum spaces.

4.1 Victoria and Albert Museum (V&A)

Regarding Victoria and Albert Museum (V&A), which is one of the most popular museums of Art and Design, throughout the history, this museum has presented contemporary architectural designs and the craft of construction. This project aims to continue this tradition.

The renovation project of V&A Medieval and Renaissance Galleries is the largest that V&A has undertaken since it opened in 2001. The project was led by Arup, an international design and business consulting firm. The basic purpose of the project was to illuminate the renovated galleries with natural light to create atmosphere and drama. The sustainability of this project required balancing and optimizing some issues which had the potential to create controversy, such as between the conservation of art and the use of energy, or improving accessibility while preserving existing building.



Fig. 7 The V&A John Madejski Garden,
Source:Wikimedia Commons



Fig. 8 Southern Entrance of V&A Museum
Source:Wikimedia Commons



Fig. 9 Part of the gallery with zenith lightning, V&A Museum
Source: Wikimedia Commons,

The new Medieval & Renaissance Galleries are located on three levels, in the southeastern part of the V&A, which poses significant challenges in meeting the demands of a modern museum - in particular visitor access, lighting and environmental control.

The gallery had to exhibit about 1800 artifacts, which date from 300 BC to 1600 in such a way that they are clear to the public. Due to the high sensitivity of the historical artifacts, the gallery needed air-conditioned space to have suitable conditions due to the roof with natural light. By examining the materials used in the existing building, moisture and cold were eliminated, so this project can now serve as a testing ground for other museums. (Weideger, 2014)

With the removal of the marble stairs on two levels it was made possible to reconfigure the light to create a vertical circulation and a new gallery with natural lighting.

The rhythm of the space is reinforced by the use of contrasting levels of light and color, helping the maintenance of the focus and avoids the fatigue of the visitors. The most important artifacts are placed on the main architectural points highlighted from existing perspectives and observed from new openings. In this way, the collection is presented to attract visitors through the continuity of spaces in such a way as to make the exhibition fully understandable.

Although almost all galleries contain light-sensitive artifacts, they are all illuminated by natural light, from sunlight, through diffused natural light, to controlled or filtered light. In one case natural light is filtered through the use of translucent grids - which resemble an interpretation of the use of translucent stone windows of medieval ecclesiastical architecture enabling a sense of serenity and the beauty of the presentation of thirteenth-century religious artifacts.

Also, the materials used to support the artifacts help the presentation of the exhibits. A pale lemon-colored layer covers the floors, plinths and bases of the windows. The structures where the artifacts are placed are made of stainless steel or gray colored steel. The glass and steel have been carefully crafted and used in the new

gallery, on the stairs and in the elevator, making the details visually simple and emphasizing the value of the artifacts themselves.

With the opening of Medieval & Renaissance Galleries in December 2009, the number of visitors has increased by 18% or to 500,000 visitors in six months. (Weideger, 2014)

4.2 Louvre Museum in Abu Dhabi

Jean Nouvel, who was selected to design this museum, was also inspired by the distinctive features of the Saadiyat site - an unexplored island between sand and sea, as well as between light and shadow. Nouvel said that he aimed at a building that would eventually reflect a protected territory, which is prone to Arab culture and geography (An island of its own, a museography of dialogues | ITSLIQUID, 2022). He defined the universal personality of the Louvre Abu Dhabi Museum seeking inspiration in the site itself and the construction landscape, in the history of geometry and in the foundations of Middle Eastern architecture. He added that he is inclined to an experience of theme adaptation, repetitive architecture, molding them into something else and finally reinterpret them with a distinctive approach (An island of its own, a museography of dialogues | ITSLIQUID, 2022).



Fig. 10 Louvre Abu Dhabi's exterior view.
Source: Wikimedia Commons



Fig. 11 Louvre Abu Dhabi's 'rain of light'.
Source: Wikimedia Commons

A white dome in the shape of a sun umbrella with a diameter of 180 m covers two thirds of the museum. This project bears the stamp of a mosque, a museum, a large hotel, a madrasa, and its distinctive features.

Jean Nouvel has intertwined a dialogue between architectural heritage and sensory experience in a basic relationship between light and shadow, and between hot and cool connecting temperatures. He said that a microclimate emerged from the sensations which the wonderful Bedouin design had investigated commonly: by controlling light and math (geometry), by organizing shadows and by opening ways for discovery (An island of its own, a museography of dialogues | ITSLIQUID, 2022).

A carefully designed sequence of geometric holes allows light to enter by illuminating the halls and spaces of the museum, while shading visitors' paths and controlling the temperature without blocking natural light.

The "rain of light" from the dome recalls the cages by presenting shadows on the walls, tents and reeds, sprinkling the alleys and Arab shops, and the leaves through which sunlight penetrates under the palm groves. The shadow is moving and visible, and enables the building to "play with chance to provide as much light as each space needs" (Nos clients | France Muséums. (2021). In the same way, the space which reflects the water at the entrance to the dome transmits light beyond the insulation of the buildings. This constant wavy presence reflects the important role that water has in Arab architecture. At night, on the contrary, this space will turn into an oasis of light under a glittering dome. This museum defines a space which plays the role of an interaction between the interior and the exterior. It changes, distinguishes, it is poetic, intriguing and full of traces for research, and the light is the guide of visitors.

5 Conclusion

This paper elaborates on one of the key elements of architecture - natural light and its importance in museums. The paper consists of several parts in which natural light is first elaborated in modern architecture as a characteristic period of the history of natural light, then its addition through various materials, the application of Nordic light in architecture, the properties of natural light, and natural light as selection for museum lighting. It then mentions the use of new technologies that enable natural light, as well as the description of natural light in certain objects.

Natural lighting, in historical terms, has been treated in the period of modern architecture, taking into account that architecture as a field is historically an early one, and museums as objects with their intended purpose, i.e., preservation of historical values, are mainly of the period of modern architecture. The mentioned authors of some famous buildings of modern architecture such as Bauhaus, Schröder House Rietveld, and Villa Savoye from Gropius, Rietveld and Le Corbusier had marked a turning point in the inclusion of natural light, which after a while eventually became part of the following constructions. The design of the architects for the selection of natural light was made possible by the appropriate materials for the addition of natural light, but the characteristics of the qualities of sunlight were the decisive reasons. In addition to the physiological benefits, sunlight is even more economical and enables easier access of people to museums.

At the time of research of technologies of ecological energy utilization and solar panels as an appropriate alternative, even natural lighting through optical fibers is being considered as an eventual possibility. However, concrete and classic examples related to the theme of the paper are the Kimbell Art Museum by Louis Kahn, who had planned natural lighting as the main theme, V&A Medieval and Renaissance Galleries from Arup, where natural lighting was integrated as part of the renovation, and the Louvre Museum in Abu Dhabi, in which architect Jean Nouvel was inspired by the location itself to design a museum with lighting for visitors to connect with the outside environment.

Based on the data in the paper I can conclude that natural lighting is irreplaceable in museums for many of the aforementioned reasons. The downsides are almost marginalized and remain almost unnoticed. The objects treated as examples serve only as reference points of a predominant element according to many possibilities also for the architecture of the future.

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