

# The Organic Combination of Artificial Light and Natural Light in the Design of the Museum — A Case Study of Chongqing Natural History Museum

Yiru Wang, Yong Liu

Dalian University of Technology, Liaoning 116034, China

**KEYWORDS:** the museum; natural light; lighting design

**ABSTRACT.** Museums have very strict technical requirements for lighting design, and the research and application of visitors' vision is conducive to improving the lighting quality of the museum. The Capital Museum, the National Museum of China and the Chongqing Museum of Natural History have provided us with a practical foundation in the use of natural light and exhibit lighting. Natural light and artificial lighting are organically combined in the museum. With the support of current technology, the museum creates a space atmosphere full of vitality and vitality, which is conducive to the transmission of display information. One of the most important aspects of museum display design is the design of museum light environment. With the development of society, economy and other aspects, the understanding of light environment in domestic museum exhibits is constantly changing. At present, the museum industry is developing rapidly. This paper makes a scientific summary of the theories, concepts, technologies and methods of shaping the light environment. By discussing the current situation, development and future of the light environment, it is hoped to bring visitors a comfortable and bringing feeling of museum light environment experience.

## Introduction

The main purpose of a museum is to exhibit, communicate, and educate, and these are reflected in the communication between the exhibits and the visitors. Lighting design refers to the design of the light environment that links the exhibits, visitors and exhibition space. It can be seen that lighting design has become a key point to measure whether the museum can accurately convey the message.

## 1. Present situation and analysis of light environment in Chinese museums

The development status of domestic museums can be roughly divided into the following periods according to the chronological order: 1. The early days of the People's Republic of China -- 70 years. 2. 1970 -- 1989 . 3. 1990 -- 2010. 4. Modern. Most of the traditional museums in China in the 1950s used the form of ancient buildings for exhibition. When the Museum of Chinese Revolution was just being built, Mr. Wu Huaqing, an expert in lighting from the People's Theater, was specially invited to guide the lighting design, which can be said to be the initial development of the lighting design of Chinese museums. Later, influenced by the exhibition halls of the Soviet Union, the light environment in the exhibition was based on natural light and assisted by artificial light sources. It gradually became the mainstream design idea of the museum's light environment at that time. Later, with the development of economy and social progress, most museums began to rebuild and renovate. With the development of science and technology, Chinese museums constantly updated their lighting methods and means. In the 1970s and 1980s, China's display design sought after the lighting means of "sound control, light control and electric control". During this period of light environment began to tend to the combination of artificial control and mechanical control light-controlled method, set in the 90 s, the museum a large number of using artificial light, advanced fine cases to put exhibits, and increase in cases to light source, this design makes the museum undertaking, and indicates the lighting design has begun to become an important factor to measure the museum design is mature or not. Subsequently, the Shanghai Museum adopted the method of completely using artificial light source for lighting, which set off the design trend of "lighting in the dark room" in China and produced far-reaching influence. Only individual during this period the museum also follow the combination of natural light and man-made light lighting design, for example: the museum's exhibits on display area, hu bei province quoted out as part of the natural light, nan jing museum displays the patio natural light, human shaoshan MAO zedong's relics hall adopts a large number of glass skylights daylight into the museum. However, due to the lack of research on lighting design in China, lighting design is relatively backward, and the form of lighting and lighting in museums is relatively single. With the increasing pace of China's opening up to the outside world and the improvement of the comprehensive national strength such as economy and culture, the lighting design ideas of China's museums began to be inspired by foreign countries. For example, the Capital Museum, the Palace Museum in Beijing and the Louvre Museum in France are cooperating exhibitions. This lets the domestic audience have the understanding and the understanding to the foreign lighting design thought. In addition, Mr. Pei Li ming's Suzhou Museum has interpreted the

new concept of "light design", which has opened up a precedent for the shaping of light environment in Chinese museums and provided a large amount of material materials for museum lighting design.

### ***1.1The use of natural light in museum architecture***

Natural light, also known as "natural light", is light that does not directly show polarization. This kind of lighting has the characteristics of low cost, environmental protection and no industrial consumption, and can be illuminated in a straight and uniform way. It can not only restore the real color of the exhibits, but also the color rendering degree that artificial light can not compare with. There is no substitute for natural light and audience emotion. But the use of natural light needs to pay attention to the protection of exhibits, need to improve the ultraviolet, infrared defense. Pay attention to the visual comfort and the building of the overall atmosphere of the exhibition can bring the audience to meet the psychological needs. And according to the architectural form, the use of natural light can explore the rationality of the museum to use skylight as the basic light source. The Capital Museum and the Chongqing Museum of Natural History, for example, have both made bold attempts to introduce natural light, provided that both have original architectural forms.

There is a statement about the light environment design of the Capital Museum: "The basic exhibition hall surrounded by wood (square exhibition hall), the special exhibition hall with bronze collection (round exhibition hall), and the scientific research office area made of stone wall are connected together by pure glass curtain wall. Sunlight penetrates the "pure glass curtain wall" to provide warm, clear and soft natural light to the etiquette hall and public leisure space, which breaks the closed and depressing visual feeling brought by the traditional museum to the viewer. Natural lighting is also involved in the artificial lighting of each exhibition hall, creating a light space with different colors and forms. However, there are certain defects, such as the foil of the artistic atmosphere and the visual experience of the audience. The discomfort of the visual experience is mainly manifested in the uneven brightness distribution of the entire light environment of the museum, especially the extreme uncoordinated brightness contrast at the critical points of individual exhibition hall entrance.

In the architectural design of the museum, the architectural design of the Capital Museum has a profound implication and cultural connotation. The design of the glass curtain wall is endowed with the modern spirit of combining with ancient art. However, it is precisely because of the unique permeability of the glass curtain wall that the light environment of some exhibition halls has been damaged to some extent. Although the architectural design considers the full use of natural lighting, the lack of understanding and interpretation of innovation at the architectural level only ignores the particularity of exhibition design as a museum and the visual requirements of visitors. Comparison of artificial lighting, visitors are more likely to accept the natural lighting lighting, museum architecture is not lack of success at home and abroad and the successful cases of natural lighting, these successful case that its characteristic is the processing method of natural lighting for the architectural design concept of a very important point, let the natural lighting can not only provide service for the exhibition lighting, and provides the high quality for the visitors to human visual perception and experience emotional resonance. For example, in the architectural design of the National Museum, a large area of glass Windows is used on the east side. The Windows in the exhibition hall cleverly avoid the direct light from the glass Windows in the external walls, so as to eliminate the natural lighting directly involved in the lighting inside the exhibition hall. The public leisure area is set between the building window and the exhibition hall. This area is dominated by natural lighting, which can not only reduce energy consumption, but also provide soft and comfortable natural light environment for visitors.

### ***1.2Present situation and analysis of light environment in Chinese museums***

The use of indoor display colors in museums is also inseparable from the theme of museum design, which perfectly displays the theme of the museum from another more intuitive aspect. Of course, different functions of museums have different requirements for color. The color style of Natural Museum is more inclined to bright and relaxed color tone. Lighting design for museum design, also is the importance of light also don't need to say more, light environment, that is, lighting design is an important part in the exhibition space, can directly affect the entire exhibition will be able to achieve the desired effect, the light will also consider the exhibition theme is not the same to change, make a different effect and atmosphere. The complementarity of light and color can not only better create the theme of the exhibition, but also enable visitors to have a comfortable and resonant visiting environment when viewing the exhibition and communicating, and improve the spiritual quality and ideological level of visitors.

The color design and lighting design of the museum are closely connected with the theme of the museum, which can accurately describe the theme of the museum from different angles.

## **2.Museums need scientific design of light environment**

Light environment design under different architectural forms is different, which can be roughly divided into the

following categories:

- 1) The lighting mode is mainly divided into these kinds:
  - a. Using natural light as the main light source and artificial light as the auxiliary light source.
  - b. organic combination of natural light source and artificial light source.
  - c. All use artificial light sources.
- 2) The method of using natural light can be roughly divided into two kinds
  - a. The use of skylight lighting.
  - b. Use side Windows for daylighting.

In general, LED lights, incandescent lamps and fluorescent lamps are adopted, among which incandescent lamps account for a large proportion in the lighting design of museums.

## ***2.1 The Natural History Museum displays the main forms of design***

In general, LED lights, incandescent lamps and fluorescent lamps are adopted, among which incandescent lamps account for a large proportion in the lighting design of museums.

The Museum of Nature is a large-scale exhibition museum. Its central idea is to help millions of people to explore and observe and help future generations to better understand the process of human growth. It also gives us a kind of identity confirmation and a place to awaken deep memories. Also save the main places of cultural development of human history, is the social stability and union progress play a crucial useful, so in another point of view, how the progress of a country, whether the high-speed economic development, natural museum plays a force to be reckoned with, is to improve the national knowledge background, an important part in promoting the progress of science and technology. So for a natural museum, a good specimen display design is very critical.

Museum ZhanChen design is the main way to reflect the museum functions, ZhanChen design will succeed depends on whether the museum's space and perfect in the field of harmonious and unified with the planning, to the object is different from each other to create the human existence space, therefore ZhanChen design is the essential and the distinctive a constitute part of the museum. As a public place, a museum is open to the public and has group nature. Therefore, when designing a museum, we should be aware that the target audience is the broad masses of people. For the size of the space area of the museum and the display method, we should implement special design. Let the museum give more direct self-cultivation, to the people's spiritual edification more dense.

Has a lot of museums open soon closed, this is about to mention the vitality of the museum, the museum's vitality is not endless, because museum is behind the government, is in the museum collection of cultural relics, in fact is not, in fact real life museum is the exhibition form and means of modern museum has many types, of course, different types of museum exhibition ways and means are different, indoor ZhanChen design is not only a simple for cultural relics, specimens were put on display, but also different regional history s cultural formation of the different landscape and humanities, only consider these factors fully, Only when integration gives visitors the correct guidance, can it bring them constant inspiration and thinking, and make this museum endure for a long time and become a witness of history.

## ***2.2 The expression of the theme of the Natural History Museum***

Type one: the integration of interior display design and heritage of the natural museum

Modern museum of nature there is a lot of difference between design and traditional natural museum, the first is in museum exhibition, on the site selection of traditional museum basic ignore the importance of sites of cultural relics in the museum design, from the site, not only reduce the visual impact brought by the exhibit to visitors, the more greatly reduces the cultural connotation of the museum itself. However, in modern natural museum design, more attention is paid to the inseparable close relationship between the museum and the ruins, and to the series of functions that the relics and ruins bring to the exhibition. This form of display is not only unique to the design of natural museums, such as ancient cultural relics of the museum exhibition is more focused on the relationship between the museum and the site. We all know the magnificence and strength of the Terracotta Warriors and Horses of the First Emperor of the Qin Dynasty. The visual impact of such magnificence and magnificence is very impressive to the audience. This is the most successful case of the combination of museum and site. However, the design of nature museum pays less attention to this aspect. There are many environmental factors that will affect the site selection of the museum. However, according to the exhibition requirements of different themes, the exhibition space of the museum is divided into different areas. Some areas can directly view cultural relics or simulate the natural environment at that time, such as the huge remains of dinosaurs. These methods are used to show the different charm of museums.

According to the different historical background, s at that time, or for a specific period of the cultural relics is fossils

for the design of the booth fire cases of different style is more regular in the design of indoor display at the museum of natural means, interior space division also use these shelves and booth to complete, according to the time order to route planning exhibition can let the audience feel the history of the different space, like yourself in the gallery of history. The Fossil Hall of Chongqing Museum of Natural History adopts this design method to divide the historical process according to the chronological order to display cultural relics, specimens and fossils.

Type two: the expression of the museum theme

When we design the museum, we must consider the theme of the museum, so that we can not only intuitively display the museum's collection of various cultural relics, such as Shunzhi, but also integrate the architectural design ideas of the museum with the contents of the transmission. The accurate positioning of the subjectivity of museum interior display design is helpful for the dissemination of important historical culture and ideas. It can attract the audience by means of design, stimulate the enthusiasm of visitors, and improve their appreciation ability and level. Only on the premise of a clear theme can we make everyone gain from visiting the entire museum. Chongqing Museum of Natural History divides the whole exhibition hall into several different themes, each exhibition hall has its own characteristics, the theme is clear and prominent, so that people can absorb knowledge and also enjoy the magic of nature.

Type three: the use of auxiliary facilities in the natural museum

The display and design forms of cultural relics in museums are closely related to many factors. In addition to the above mentioned means, the role of auxiliary facilities in the design of museums should not be ignored. For example, the rapid development of informationization, digitalization and multimedia in today's society has brought a variety of display means and possibilities to museum design, which can get rid of the old and traditional single form of expression of cultural relics, and make them more intuitive, vivid and attractive in front of everyone. Give the audience room to the imagination. Chongqing Museum of Natural History uses touch screen, experience desk and other multimedia display means to enable the audience to absorb more natural knowledge in a more direct and attractive way. While it is open to everyone, it also attracts more visitors to interact and experience. Through modern scientific and technological means, it provides the museum with strong vitality.

### ***2.3 Space and layout of the museum***

The exhibition structure and spatial layout of the whole museum are the main factors that lay the foundation of the exhibition design in the museum of nature, which is also an important part of the rapid progress and realization of the main structure and direction of the museum. What factors affect the effect of museum exhibition design? Museum exhibition display structure of coordination, clear levels of theme, structure of streamline unobstructed, audience and emotional communication of the exhibition, highlighting clear display window, and museum space colour, lighting and the use of modern media technology, and so on, the above factors will affect the effect of the museum is finally presented to the audience and a museum of social influence.

A thing or a person's success is not because there is only one factor, the museum ZhanChen design is also in the same way, there will be a lot of factors can affect a museum has a strong vitality, take the museum exhibition display space is an example of design means and forms, one is the most critical thing is most influential space streamline design. A good designer should make a careful analysis of the museum building space and pay attention to the precise distribution of the flow lines. At the same time to consider a few points:

a. Changes of exhibition lines in the exhibition space of the museum.

What call line development first, bluntly said is space of display lines, general museum building space design will be to the audience the best view of the direction of the line is given priority to, the highlight of this design can highlight, also can avoid displaying content enough too unattractive this defect on average, by a point to drive whole ornamental effect, the whole museum is divided into several exhibition hall, each exhibition hall set up a style of their own and the main content, on the premise of a big theme is constant, it can let the audience in the exhibition can clear different exhibition hall in the transfer of ideas, It resonates with human emotions and leaves a deep impression in the mind.

b. "Space Occupation" -- the basic means in modern museum design.

What does space occupation mean? First of all, make sure that the overall exhibition structure is correct, and divide the whole exhibition space according to the constant opposite direction of the exhibition flow, so that the audience can feel the whole exhibition content step by step, and expand the whole content along the process of time, space or historical development.

c. The spatial display pattern is multi-dimensional, orderly and complementary to each other, forming a complete set of spatial structure. The most essential aspect of the display pattern is the people who come to appreciate it. In the form of design and display, the most needed is to reasonably design space and move line arrangement according to the audience's inner activities and viewing feelings, and to let the media display with ups and downs of frequency along with the audience's psychological and visual feeling of slack period. It is eye-catching and continues to have a sense of

novelty, thus arousing people's thirst for knowledge, leading people's thinking, and promoting their desire to explore the essence of the object.

d. In order to continuously expand the exhibition space, our primary goal is to expand the flow of the visitors' visits. Only by ensuring the unimpeded flow of the visitors' visits can the exhibition space be continuously expanded.

e. The use of science and technology to display cultural relics is no longer a single arrangement, and there are many ways to reproduce and display scenes in the Natural History Museum. There should not be too many forms of expression of the same kind, otherwise it will make people feel boring. Therefore, the reproduction of other scenes of natural relics requires the use of high-end technology to make new changes in the way of display and expression. Design museum of nature ZhanChen is an extremely special category, along with the development of the country, the progress of The Times, science is more and more developed, under the steady transformation idea, peremptory is no longer traditional museum, natural museum has led to the rapid development of science museum display method diversification, also drive the enhanced people's ideological consciousness and culture.

## ***2.4Chongqing Museum of Natural History displays the combination of light and natural light in design***

The new Chongqing Museum of Natural History was opened on November 9, 2015. Many modern advanced technologies were applied in the construction process of the new Chongqing Museum of Natural History. The lighting design of the exhibition hall is very elegant, so take Chongqing Museum of Natural History as an example, talk about the application of lighting design in the museum.

In terms of the nature of museums, it is to let the audience appreciate the exhibits to spread knowledge and ideas, so the lighting design in the exhibition space should be able to truly show the colors and morphological characteristics of the exhibits, and at the same time, it should avoid the exhibits or cultural relics from being damaged. The function of a museum is to collect rich cultural materials, precious historical relics, simulation models or replicas of cultural relics of equal proportions for people to appreciate, visit, keep and protect. Museums are also important places for academic research and discussion. Therefore, museum lighting design should be considered from the perspective of exhibition and storage. Among them, the display area is the key point of lighting design. The lighting design of the display area needs to be considered from the two aspects of technology, viewing and viewing people's psychology and emotion. When the main purpose of viewing is the brightness, contrast, color and other factors of the exhibits are mainly considered, and the spiritual level above the original appearance of the exhibits is required to be displayed as perfectly as possible. When academic research is the main purpose, it is necessary to correctly display the real shape, color, texture and other characteristics of the exhibition objects. In addition, in order to prevent the exhibits from being damaged by environmental factors such as direct visible light, ultraviolet light and air, it is necessary to conduct comprehensive analysis according to the reference protection measures and the safety of visitors, and finally get a reasonable lighting value.

### **1. The processing and application of lighting design to exhibits in lighting**

#### ***3.1Natural lighting***

The public areas in Chongqing Natural History Museum are mainly illuminated by natural lighting, with lighting as auxiliary lighting. The combination of high side window lighting and skylight lighting forms the natural lighting of the whole public area; The space of Chongqing Natural History Museum is up to 24 meters high, and the artificial lighting is formed by the combination of fluorescent light source and LED light source. Considering the climatic environment of Chongqing, the lighting design in the public area of Chongqing Natural History Museum should prevent the direct illumination intensity from the top of the skylight from being too large. Take a certain method to keep out, posted on surface of the skylight of hollow glass indoor can resist ultraviolet luminous transmittance of 90%, 15% of solar film to weaken the sun point-blank, protect the exhibits from direct sunlight damage, when night with LED light source, the LED light source in the form of lines for light to strengthen the overall structure, showing building its own aesthetic structure, halogen light source as ordinary flood lighting can not only satisfy the requirement of the night light, still can form echo, ground and wall decoration materials. It can be regarded as the model of the combination of lighting and natural light in the exhibition design in the domestic equivalent natural museum.

#### ***3.2The processing and application of lighting design to exhibits in lighting***

The lighting means in Chongqing Natural History Museum are very diversified, including a variety of artificial lighting methods. There are five main types: 1. General lighting; 2. District lighting combined with general lighting; 3. Directional area lighting; 4. Directional area lighting combined with general lighting; 5. Showcase lighting. All kinds of lighting means echo and blend with each other and complement each other. The simulation area of the dinosaur fossil excavation site adopts the means of regional lighting combined with general lighting. The general lighting effect truly

restored the burial state of dinosaur fossils, including the environment of the excavation site. The regional lighting means are used to highlight the dinosaur fossil excavators. The biological fossil exhibition area uses directional area lighting, which can highlight the exhibits to be displayed in a number of exhibits. The restoration area of the dinosaur extinction scene is the technique of directional area lighting combined with general lighting form. Background images using LED flood lighting, background picture the sunlight in the use of the area light foil and reduction of the sunlight, lighting highlight product reuse oriented area, shows the grief and shock, when dinosaurs once earth this species can be said to be the dominant land animals of the earth from the one end in history, will let the audience when watching emotional resonance is not give birth to a desolate feeling. All these are attributed to the rational use of lighting design. Among them, the cold light source of LED tube is installed on the top of the display case for general lighting, and the light guide film is used for shielding, so that the light can be evenly irradiated to each area to achieve a reasonable and scientific lighting effect. In addition, the directional lighting is also used to highlight the exhibits displayed in the display case. Finally in front of the audience presented a vivid and beautiful picture.

In Chongqing Museum of Natural History, there are many rational uses of the combination of lighting means, such as simulating the natural environment, light and shadow manufacturing, etc.

### ***3.3Organic combination of natural focus and light***

The rational use of natural light in the architectural design of museums, the interdependence and cooperation of architectural design and lighting design can create more appreciable and successful museums integrating art and humanity. The organic combination of natural light and lighting is the development trend of the whole museum design. In reality, it is the requirement of museum functions to present the exhibits to the audience in a vivid, focused and emotional way and build the exhibition hall into a comfortable space for cultural communication. From the macroscopic natural light to the subtle artificial light projected to the object shadow produced by the exhibits, it can not only bring comfort and shock to human vision, but also the best means to shape the light environment of the museum. It has become an important factor to measure the lighting design of the museum, and also the best way to improve the overall quality of the museum, to develop the lighting design of the whole museum from the perspective of visitors, and to combine the natural focus and light organically.

Chongqing Museum of Natural History can be said to be a model of the organic combination of light and natural light in exhibition design, as well as a relatively successful case, which provides a physical basis for the light environment design of museums in the future.

## **2. Conclusion**

The use of more advanced lighting technology is not equal to having a scientific lighting design method, nor is it equal to mastering a higher level of artistic aesthetic approach. We need to use a scientific attitude to guide the direction of the understanding of museum light environment. The improvement of lighting design level depends on good design idea, perfect technology and scientific method, not just on lighting equipment to have a good lighting design. The design of light is the carrier of art and the medium of artistic creation. Lighting is not only the light of lamps and lanterns, but also the scientific and technical control. In addition, lighting design, of course, should also pay attention to the "lighting economics" method, designers should think for the audience as much as possible, can not blindly pursue the current popular energy saving, electricity saving. Save electricity saving energy for use in the museum, for example, new LED light source, it is said that the service life of fifty thousand hours, which for some small business scenario or temporary buildings, the lighting makes little sense to practical use, in terms of the most demanding museum display, light is also not recommended, especially in the current more carefully consider, don't be so quick to use natural light promotion. Because the performance of this light source is not mature enough at present, it still needs a long period of technical progress to achieve the rest assured promotion of its use.

Another important point is that there are many audiences and experts in the museum industry in China who strongly call for the change of the "dark room lighting" display phenomenon in most museums in China. They require that natural light sources should be re-used in museums. Of course, many people insist on the use of artificial lighting for museums, they think that artificial lighting is easy to control, and it can also protect cultural relics by scientific light distribution.

The purpose of the visitors' visit to the museum is to gain the necessary spiritual feeling in the space atmosphere, to connect with the history in thought and emotion, and to touch our feelings through the display. International lighting design experts weeks Lian Mr Lian thinks "architect's use of natural light lighting designer", use of natural light to the human resources, is any artificial light sources can't compare with, he straight uniform illumination.

## **References**

- [1] An Le.“Thoughts on the design concept of small and medium-sized museums”.Chinese Nationalities Expo, vol.12, no.12, pp.202-204, 2018.
- [2] Zhou Yao.“The present situation and reflection of the methods of audience research in Chinese museums”.Chinese Museum, vol.2, no.2, pp.86-91, 2018.
- [3] Ai Jing.“Research on the Design Concept of Museum Display Lighting”.Century Inheritance, Innovation and Development: Proceedings of the Sixth Academic Conference of Beijing Regional Museum,pp.480-490, November2012.
- [4] Cheng Meng.“The Form and Spatial Layout of Exhibition Design in Natural History Museum”.New West · Medium Issue, vol.11, no.11, pp.59/77, 2014.
- [5] Chi Xianghui.“Discussion on the application of lighting design in museum exhibition—a case study of the new Chongqing Museum of Natural History”.Chongqing Natural History Museum, vol.09, no.36, pp.61-62, 2014.
- [6] Shan Jicheung.“Watch keeping, Exploration and Innovation -- A Summary of the Work of the Palace Museum during Zheng Xinmiao's Term”.Scientific research on cultural relics in China, vol.02, no.005, pp.21-27, 2015.