



Space Design of Paleontological Museum under the Concept of Immersive Experience

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Abstract. Paleontological museum, because of its unique knowledge, interest and importance in the protection of natural resources, has become the “second classroom” for the general public, especially young people to receive education in China. This paper focuses on the concept of paleontological museum and its three important functions of collection and display, scientific research and public education. We introduce digital technology into paleontological museums, whose multi-sensory stimulation dispels the audience’s sense of space-time distance, real-time dynamic scenes deepen the audience’s sense of space immersion, and cross-space-time interaction enables the audience to share cultural learning experience. We should improve the audience’s immersive experience through the reasonable division of functional areas, the organic integration of paleontology and environment, and the improvement of tourists’ attention to make paleontological museums make greater contributions to improving the scientific quality of the whole people in China.

Keywords: Paleontological Museum, Immersive Experience, Space Design, VR, AR.

1 Introduction

In recent years, with the vigorous development of information technology, the concepts of digitalization and multimedia are becoming more and more popular, and related technologies are widely penetrated into a variety of social fields. In this context, as an important cultural service institution, it is necessary for museums to actively explore new ideas of digital-based service construction and new strategies of cultural relics display in order to ensure immersive and high-quality service experience for visitors [1]. As a symbol of human civilization, no matter how its physical space is arranged, the purpose of the museum is always to show people our past, present and future. With the opening of the digital age, the function and significance of the museum is not entirely a collection and display place centered on “things” it is facing the challenge of building its own digital resources and virtual network environment to face more visitors, and it will transform itself into an interactive scene with “people” as the main body. Whether the scene is real or virtual, the construction and design of the immersive interactive scene

transforms the solidified past history in the museum into a flowing and constantly created history, connects the physical space of the museum with the virtual and network space, and produces the real-virtual twin mirror image of the museum. Immersive interaction, as a possible form of digital presentation of museums, focuses on the sense of experience, which evolves passive viewing behavior into active interactive behavior, and forms unique scenes with a variety of media and comprehensive sensory channels.

Paleontology is an important branch of geoscience, which mainly studies the remains of organisms in geological history and their relationship with the evolution of paleoenvironment. Paleontological Museum is an important branch of Natural History Museum, which is a platform for learning, researching and publicizing paleontological knowledge. Because of the unique interest, mystery and appreciation of paleontology knowledge, paleontological museums have always been loved by the masses, especially by young people. As paleontology covers many more detailed research fields such as ancient animals and plants, paleontological museums include dinosaur museums (such as Zigong in China, Fukui in Japan), dinosaur egg museums (Heyuan in Guangdong), pterosaur museums (Beipiao in Liaoning) and wood fossil museums (Shehong in Sichuan, Yanqing in Beijing) [2]. The popular science and educational functions of paleontological museums have affected all levels of society and played a positive role in improving the overall scientific and cultural quality of the public in China. This paper introduces immersive experience into paleontological museums in China, and focuses on the space design of paleontological museums, so as to provide more immersive experience for visitors with better space design.

2 Concept and Function of Paleontological Museum

2.1 Concept

A museum is a place where witnesses of human activity and the natural environment are collected, preserved, and presented to the public for the purposes of education, research, and appreciation. The establishment of museums is to meet the spiritual and cultural needs of citizens and improve their ideological, moral and scientific and cultural qualities. The Museum of Natural History is also a research institution of comprehensive cultural sites for the purpose of education, research and appreciation, collecting, protecting and displaying to the public the witnesses of the evolution of the natural environment in the geological history. Its purpose and function are to meet the spiritual and cultural needs of the masses, improve their ideological, moral and scientific and cultural qualities, especially their ability to understand and participate in natural science knowledge. Paleontological museums are those that exhibit ancient life. Both state-owned and non-state-owned paleontological museums in China have collected a large number of precious paleontological fossils, which show the achievements of Chinese paleontological research and are important windows for understanding Chinese paleontological culture. The most famous paleontological museum in China is the Paleontological Museum of China (PMC), located in Xicheng District, Beijing. PMC was founded by the Institute of Vertebrate Paleontology and Paleoanthropology of the Chinese Academy of Sciences. It is the first national natural science museum in China that

systematically popularizes the knowledge of paleontology and evolutionism based on paleontological fossils, and it is also the largest museum of antiquities in Asia at present [3]. Figures 1 and 2 show the Latimai fish specimen and the Yellow River elephant fossil in PMC respectively.



Fig. 1. Complete specimen of latimeria in PMC

(Original source: https://www.paleozoo.cn/page8?product_id=186)



Fig. 2. Fossil of Yellow River Elephant in PMC

(Original source: https://www.paleozoo.cn/page8?product_id=138)

2.2 Functions

The main functions of paleontological museum include collection and display of collections, scientific research and public education.

Collection and display of collections. Collections are the most important basic resources of museums. Exhibition is one of the core tasks in museum operation, which is directly related to the effect of museum operation and one of the symbols of museum level. Because of the unique knowledge, interest and long geological history of the Museum of Natural History, as well as the rich and colorful new technologies and means and the unique interactive ability, the paleontological museum pays attention to displaying collections with scientific and advanced exhibition methods, and constantly solicits the opinions and suggestions of the audience. It also represents the most outstanding ability and level of the museum.

Scientific research. With the development of social economy, the demand of scientific research and the improvement of public knowledge, scientific research has gradually become one of the main functions of natural museums, and leads the high-level development of all aspects of natural museums. The naming of dinosaurs and the publication of "Origin of Species" are all produced by the Natural History Museum of London; the birth of famous theories of the founder of invertebrate paleontology, Lamarck of France, and Cuvier, the founder of comparative anatomy and vertebrate paleontology, are also related to their work in museums or part-time work in museums [4]. Many famous natural history museums in the world have gathered many top scientists and outstanding scientific research talents in the world, which have made important contributions to the research of these natural history museums in various professional fields.

Public education. As an important social education institution, the Museum of Natural History undertakes the important responsibility of building a public cultural service system and improving the scientific and cultural quality of the public. Because the exhibition of paleontological museum is more informative and interesting than other types of museums, it often has a stronger shock and persuasion to show the history of natural evolution and development to the public. At the same time, the paleontological museum has a wide audience, the audience is distributed at all stages of age, and its flexible exhibition means and contents are often closer to the audience [5].

3 Immersive Experience of Paleontological Museum

3.1 Multi-Sensory Stimulation Disperses the Audience's Sense of Space-Time Distance

Human beings live in time and space, and know the world through time and space. Because of the existence of time and space, human beings can have sensibility, rationality and intellectuality. The construction of digital paleontological museum makes the original absolute space-time boundary blurred, and makes the exhibition space of cultural relics realize the coexistence of virtual and real. Under the multiple triggers of multi-sensory experience, the audience has a sense of wonder across time and space, ignoring the asymmetry of time and space caused by the real environment of the body,

interacting with cultural relics in depth, and communicating closely with history [6]. Visually, compared with the traditional museum communication, which uses physical exhibitions, accompanied by text, pictures, images and other ways to present planar information in a single cultural communication form, the paleontological museum introduces VR and AR technology, so that the audience can see the virtual image constructed by the museum through wearable equipment, and the audience can see the virtual image constructed by the museum. Or use 3D technology to reproduce the exhibition layout and historical relics of physical museums. In terms of hearing, virtual sound includes the assistance of voice guide or other sound effects, which makes the virtual situation more realistic and makes the audience feel as if they are in a real historical scene. With the improvement of audio-visual experience, the audience can enjoy cultural relics at close range without leaving home, and even interact with cultural relics, as if history is no longer far away. Thus, whether it is historical and contemporary time and space, or virtual and real time and space, it effectively dispels the audience's sense of distance, makes their visual and auditory experience and inner feelings greatly satisfied, makes the extension of the senses realize the deepening and blending from outside to inside, and forgets the existence of time and space [7]. The World Natural Heritage Museum of Chengjiang Fossil Land has launched a guided tour of AR glasses to make paleontological fossils live in front of the audience. Figure 3 is a scene in which a worker displays an AR navigation device.



Fig. 3. working personnel showing AR navigation equipment

(Original source: http://news.sohu.com/a/722034464_121106902)

3.2 Real-Time Dynamic Scenes Deepen the Immersion of Audience Space

The virtual scene of the digital paleontological museum enables the audience to devote themselves wholeheartedly, communicate with paleontology in depth, and immerse

themselves in the long river of history and culture. Supported by digital technology, the virtual scene is not a simple reproduction of traditional museum communication, but has the characteristics of dynamic and real-time immersion communication, which can provide personalized customization services for the audience according to their virtual space location and instructions, so as to ensure the continuity and stability of the audience's immersion experience [8]. By clicking the mouse, the audience walks in the immersive communication situation reproduced by digital technology according to the scene prompt or scene map. According to the operation of the audience, the digital system presents the adaptation information in time, switches the scene or shifts the viewing angle, and continuously stimulates the visual nerve of the audience. At the same time, the virtual scene is equipped with voice guide, the audience can use personalized functions according to their own visiting needs, activate the auditory nerve, and enhance the sense of real experience. In addition to visual and auditory mechanisms, digital services also provide technical support for the continuous output of immersion. Under these three mechanisms, the audience's immersion experience has the characteristics of the whole process, and the audience can feel the cultural information conveyed by the virtual scene at all times, enriching emotional experience and cultural cognition. The Wuhan Museum of Natural History officially launched the AR guide service, and visitors saw "living" ancient creatures in Rokid's AR glasses. Visitors can see the skeleton of the Jurassic Mamenchisaurus began to move, and soon grew into flesh. Then the sleeping Mamenchisaurus was awakened, stretched out its long neck, and began to walk out of the exhibition area, stretching to greet visitors." Figure 4 shows the virtual dynamic scene of the paleontological museum.



Fig. 4. Virtual dynamic scene of the paleontological museum

(Original source: https://www.sohu.com/a/558220068_121124707)

3.3 Cross Time and Space Interaction Enables the Audience to Share Cultural Learning Experience

Immersive communication of paleontological museum not only brings basic cognition to the audience, but also stimulates the audience's desire to share cognitive surplus. By interacting with others, the audience can realize the sharing of experience, which can not only deepen the audience's understanding of the existing cognition, but also help to enhance cultural identity in emotional communication [9]. When the audience visits the physical museum, they often exist as independent individuals, and there is almost no emotional interaction between them. The virtual scene created by the digital museum breaks the emotional division between the audience, and the connection between people, people and paleontology, people and the environment are closer. "Immersed people" with multi-dimensional perception actively share cognition and experience, and gather into a group with interest as the guide and identity as the core, which stimulates the vitality of cultural inheritance in the exchange and sharing of group members. On May 18, 2022, the International Museum Day, the Dezhou Museum of Paleontology and Fossils opened a live broadcast, leading the vast number of netizens through the paleontology era to enjoy the dream and magic of nature. The live broadcast room introduces the Earth Spirit dinosaurs, ancient mammals such as spade-tooth elephants and Yellow River elephants, so that visitors can visit the Museum of Paleontological Fossils without leaving home. Here, visitors can stay in ancient times and unlock the mystery of paleontology together. As a different node in the information network, the audience has a desire to share driven by multi-dimensional perception, and interact with other audiences across the screen to inspire and promote each other. The audience's initial immersion in the virtual space is shared in the form of social interaction, and their cognition and emotion become concrete and three-dimensional, and instant gratification is enhanced. These perceptions and satisfactions will eventually be transformed into the cultural value of immersion communication in digital museums, which will have an impact on the audience's cultural awareness, museum communication and even cultural heritage.

4 Immersive Space Design of Paleontological Museum

4.1 Realize the Rational Division of Functional Areas

When carrying out the digital display design of paleontology in museums, we should establish diversified display objectives and design orientations, such as strengthening the expressive force of paleontology, giving full play to the role of cultural science popularization, optimizing the comprehensive experience of visitors, and meeting the needs of various groups of people, so as to ensure that the design results have multiple positive benefits [10]. As a specific building group, the museum building itself is the most basic and important material condition of the museum, which directly affects the major functions of the museum to a certain extent, and the scientific space design of the museum building will bring great potential to the development of the museum. The

main functions of paleontological museum include specimen collection, exhibition, academic research and science education, and the corresponding museum functional spaces are exhibition and display space, science education and education space, academic research and office space, and specimen collection and warehouse space. These four spaces constitute the main layout framework of a paleontological museum building. The rest includes functional spaces such as fossil restoration, administrative office, technical equipment and social services. Spatial zoning layout can also reflect the relationship between the various functions of the museum. For the space layout of the paleontological museum, it is suggested to follow the overall planning and design principle that the exhibition and education space is in the center, the office space is in the subsidiary, and the warehouse and restoration space are relatively independent [11]. As the center, the exhibition and education space have the nature of opening to the outside world and needs convenient accessibility, so that the audience can easily enter the exhibition area and quickly evacuate. The office space is not open to the audience. For the need of the overall management and control of the museum, the space is generally located around the exhibition space. At the same time, it has a smooth connection with other functional areas, and has a clear zoning definition. It can set up independent entrances and exits. The planning of warehouse and restoration space should take into account the requirements of large volume and high load of some paleontological specimens such as large dinosaur fossils.

4.2 Realize the Organic Integration of Paleontology and Environment.

Immersion experience refers to the enjoyment state and perceptual experience of the human body in a specific scene atmosphere and activity situation due to excessive concentration of attention or emotion. Therefore, in the process of implementing the digital display design of paleontology in museums, we should avoid paying one-sided and independent attention to a certain design object or display element, and try to achieve the organic integration of individual paleontology exhibits and museum exhibition environment through virtual or real treatment methods. Only in this way can we create a high-quality situational atmosphere to promote the formation of visitors' emotional and immersive experience [12]. Physical environment is the medium carrying various media information, perception and interactive experience. Immersive physical environment is still the field extension of museums as objects. The immersive experience space of smart museums is not a subversion of the physical space of traditional museums, nor an inheritance of the proliferation of digital museum technology, but a connection to the past, based on the present, facing the future, with deeper interaction and all-round interconnection, to create personalized experience and experience for the audience. Unlike the new formats of digital museums, such as virtual exhibition halls, digital exhibition halls, cloud exhibitions, cloud visits and cloud performances, the immersive experience space of smart museums pays more attention to the combination of online and offline experience, that is, the co-existence of entity and technology. From the perspective of physical space, compared with traditional museum exhibitions, the immersive experience space of smart museums pays attention to the creativity and interaction of

digital content, so as to improve the digital utilization and display level of exhibit resources, activate paleontology, realize the diversified development of exhibition methods, and achieve the immersive interactive experience of the integration of digital technology and physical paleontological fossils.

4.3 Realize the Enhancement of the Attention of Tourists

In today's society where attention economy prevails, if the museum of paleontology still stands there quietly, passively waiting for people to see and discover, it will lose a large number of potential visitors. Nowadays, museums "wave" to people in various ways, delaying opening one day a week, special visiting routes designed for teenagers or disabled people, various theme visiting days or museum nights, a wide range of Museum derivatives and catering delicacies, as well as in airports, railway stations and large shopping malls. These friendly measures make visitors feel that the museum is no longer superior, but willing to lower their stature and interact with visitors. When there is a two-way interaction between visitors and museums, visitors' stickiness to museums will gradually increase, and museums will become a part of their daily life, rather than an occasional embellishment. The immersive experience space of paleontological museum needs digital technology, and its application and selection should focus on the technology of intelligent service and immersive experience, and integrate into the core production chain of the museum to adhere to the core business needs. Therefore, according to the two technical paths of intelligent service and immersive experience, the digital technology of creating immersive experience space of intelligent museum is systematically collected and summarized, which is conducive to the integration and development of the two technical paths and the further rational construction of immersive experience space of paleontological museum. Behavioral psychologists believe that human experience can be designed, and the creation of immersive interactive scenes in museums can start not only with the design of physical or virtual exhibition space, but also with the design of visitors' experience. In the physical museum, the museum can guide the visiting activities by observing and investigating the behavior of visitors in the museum, create personalized visiting experience for visitors with different needs, and make good visiting experience attract visitors to visit again.

5 Conclusions

Immersive interaction focuses on the sense of experience, which evolves passive viewing behavior into active interactive behavior, resets the historical, humanistic and natural science scenes of different time and space in the form of multimedia integration at the moment of visiting physical or virtual museums, breaks the limitations of museums in physical space and real time, and realizes the immersion across time and space. This paper introduces immersive experience into the construction of paleontological museums, and greatly improves the functions of exhibition and popular science education of paleontological museums through high-quality space design. China's paleontological museums will accelerate their development in the future, and they should constantly

improve the innovation level of museums, introduce a new generation of information technology, change paleontology into “living organisms”, and make outstanding contributions to improve the cultural literacy of the whole people.

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