



Evolution of Exhibition Space Strategies in Smart Museums: A Historical Transition from Traditional to Digital

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ABSTRACT

Museums have long been regarded as important cultural institutions for preserving and presenting artefacts and artworks to the public. Over time, the strategies employed to showcase these collections have significantly changed, influenced by technological advancements and shifting visitor expectations. This paper explores the historical evolution of smart museum exhibition space strategies, focusing on transitioning from traditional to digital approaches. It highlights the shift from traditional static displays to interactive and immersive experiences, fostering visitor engagement and enhancing cultural understanding. Integrating technology and multimedia has revolutionized exhibition spaces, enabling smart museums to present diverse narratives and perspectives. This evolution has enriched the visitor experience and expanded the cultural value of museums, making them more accessible and relevant to a broader audience.

Keywords: Smart Museum; Exhibition Space; Historical Transition; Traditional; Development; Digital; Cultural Value.

INTRODUCTION

Nowadays, museums' cultural and social attributes are more prominent, and the role of artistic education for the public is increasingly important (Cao, Wei, & Liang, 2021; Ling, 2020; Liakou & Kosmas, 2019). The development of museums so far has been not only just the collection of practical functions but also to the social public education, cultural communication and exchange and other functions; museums contain a thick sense of cultural precipitation, are a place of human thought, culture, experience, memory focused on the site, so the museum is to meet the people to seek the spirit of the pursuit of the best place (Zhou, Q., Li, Z., & Li, J., 2014; Kwon, 2006). The evolution of exhibition space strategies in smart museums, from traditional to digital, has been a significant aspect of the historical transformation in the museum industry. Over the years, smart museums have undergone a remarkable shift in their approach to displaying artefacts and engaging with visitors. This transition has been driven by technological advancements, changing visitor expectations, and the need for smart museums to remain relevant in an increasingly digital world.

The shift from traditional smart exhibition space strategies to digital exhibition spaces has played an important role in the historical development of the museum sector. The way museums exhibit and interact with visitors has changed dramatically. Technological advances, changing visitor expectations and the need for museums to adapt to the digital age have all contributed to these changes. Thanks to digital technologies, museums can increase visitor engagement and offer more immersive and interactive experiences. These advances allow museums to present exhibitions in new and exciting ways, allowing visitors to better understand and appreciate them. Digital technologies also allow museums to reach wider audiences through online platforms, virtual tours and interactive educational resources.

Greenberg, Ferguson, and Nairne (1996) explore the exhibition from multiple perspectives, such as curators, critics, artists and sociologists regarding the exhibition's history, background, law and space. Macdonald (2007) tries to study the visitors' behaviour and cognition in museums from media, social and spatial perspectives. Margaret (1988) systematized the design ideas of exhibition space and discussed 21 problems of exhibition space design with practical cases. Cioffi and Bannon (2007) analyzed the interaction design between museum exhibition space and visitors with the example of interactive installations in several interactive museums. Teufel (2008) systematically summarized the design methods of exhibition space from the perspective of exhibition design and discussed the problems and development trends in exhibition space design. Gautrand (2015) summarizes the design method of contemporary museums in terms of the spatial layout and the design of the exhibition space. MacLeod, Dodd, and Duncan (2015) analyze the interaction design between people who use the space and the audience in the design of the exhibition space based on the design practice of the museum. Stamatopoulou (2016) elaborates on the exhibition space in the site museums opened in Greece in recent years. Claisse et al. (2020) through the design practice, discusses the interactive design of the exhibition space and put forward the concepts of multi-narrative and spatio-temporal interactions to connect interactive behaviours with the site. Vishkaie, Seyed, Emmons, and vom Lehn (2021) explored the application of mixed reality technology in exhibition space and used the Children's Museum of Indianapolis as a design practice.

Historically, museums primarily relied on traditional exhibition strategies involving static displays, physical artefacts, and limited interpretation. Visitors would walk through galleries, observing objects behind glass cases and reading accompanying labels. While this approach provided a sense of awe and wonder, it often needed more interactivity and meaningfully engaged visitors. However, with the advent of digital technologies, museums have embraced new opportunities to enhance the exhibition experience. Digitalization has revolutionized how museums curate, present, and interpret their collections. It has opened up a world of possibilities, allowing for immersive and interactive displays that captivate visitors and give them a deeper understanding of the artefacts.

One of the key drivers behind the shift towards digital exhibition spaces is the desire to create a more inclusive and accessible museum experience. Digital technologies have enabled museums to reach a wider audience, breaking down barriers of time and space. Virtual tours, online exhibitions, and interactive apps have allowed people worldwide to explore museum collections without physically visiting the institution. This has not only increased accessibility but also fostered a sense of global cultural exchange. Moreover, digital exhibition spaces have allowed museums to experiment with innovative storytelling techniques. Through multimedia elements such as videos, animations, and virtual reality, museums can now create immersive narratives that bring artefacts to life. Visitors can engage with historical contexts, explore different perspectives, and gain a deeper appreciation for the cultural significance of the displayed objects.

However, it is essential to acknowledge that transitioning from traditional to digital exhibition spaces is challenging. Museums must carefully balance integrating technology with preserving authenticity and the physicality of artefacts. They must also address issues of the digital divide and ensure that the benefits of digitalization are accessible to all.

This paper will explore the historical evolution of smart museum exhibition space strategies, tracing the journey from traditional to digital approaches. We will examine the impact of digital technologies on the museum experience, the benefits and challenges associated with digital exhibition spaces, and the prospects for this evolving field. By understanding the historical context and current trends, we can gain insights into how smart museums can continue to grow and adapt to visitors' changing needs and expectations in the digital age.

THE CHARACTERISTICS OF SMART MUSEUM EXHIBITION SPACES AND THEIR CULTURAL VALUE

Smart Museum Exhibition Spaces

The "exhibition" of smart museum exhibition space is to show the display; "display" refers to the collection. "Exhibition space" is the space in the smart museum where the physical or virtual media will be presented to the audience, which is the most critical space for information expression. smart museum exhibition space generally includes a showroom, thematic showroom, permanent exhibition hall, temporary structure and regional division of the building space are more flexible, the display function exhibition hall, etc. With the diversified development of smart museum building space, the internal str gradually expanding, and the layout and form of the exhibition space are also changing (Figure 1).

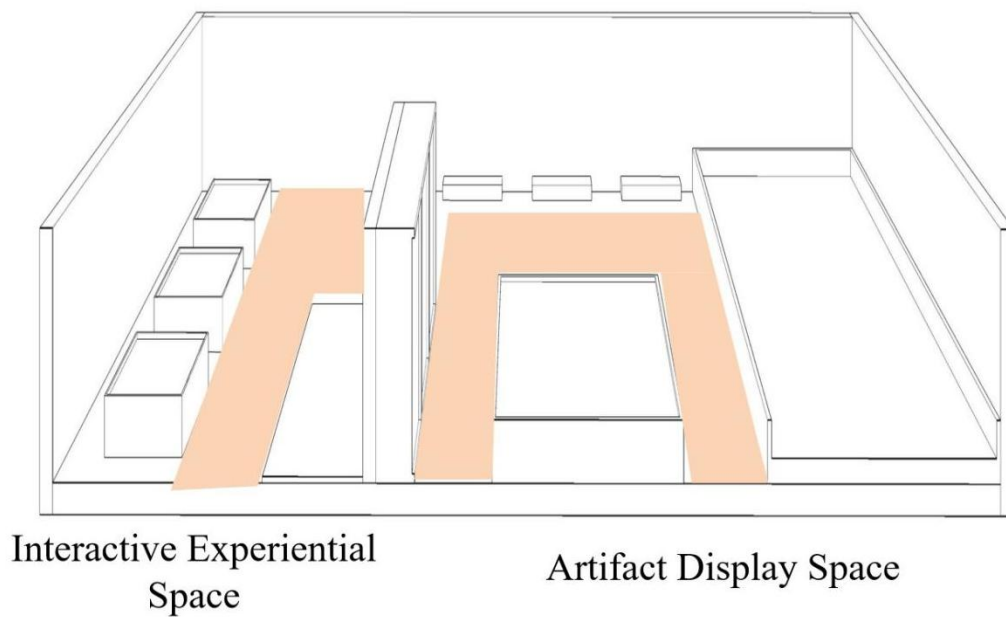


Figure 1. Analysis of the Elements of Exhibition Space

Historical Features and Cultural Characteristics

The integration of digital technologies in museum exhibition spaces has brought about a significant shift from traditional displays to immersive, interactive, and personalized experiences. This evolution has revolutionized the way smart museums engage with visitors, providing them with new avenues for exploration, learning, and connection to art, history, and culture. Enhancing the narrative of the space can stimulate the viewer's curiosity and improve the visitor's experience. The transformation of modern museum exhibition space strategy begins with creating a spatial atmosphere, and the museum carries out narrative throughout, thus enhancing the role of education. For example, in the "Light of Buddha" exhibition at the National Palace Museum (Figure 2), the cabinets are windowed to create a purely experiential atmosphere. Temporary modular units of metal frames combined with specific lighting systems allow viewers to see through the ancient Buddha statues inside to convey a timeless narrative of history and culture. The space is artistically displayed to enable the viewer to add a sense of reverence to the act of experiencing. The central grey space gallery is designed as an art installation of 135 layers of fabric, reminiscent of an ancient Buddhist monk's pilgrimage through the Himalayan region. The viewer walks through the contextualized gallery as if entering a serene, peaceful, timeless and bright tunnel of time and space, embarking on an inner awakening and illumination journey. Creating an area where the mind can have a pure experience deepens the understanding of the theme of Buddha's statue.

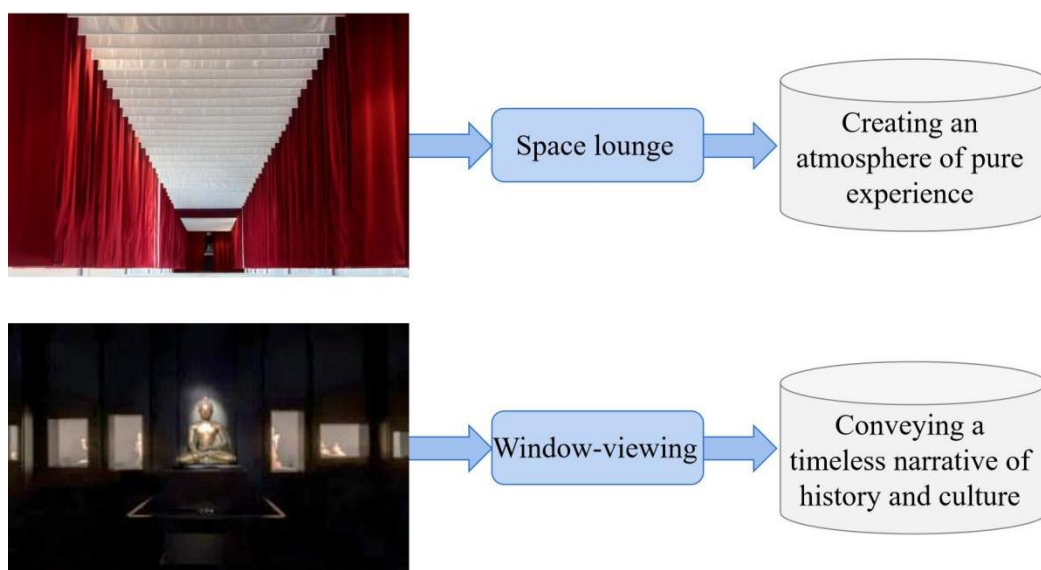


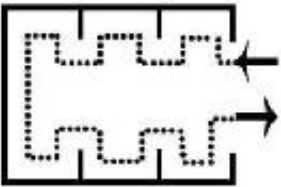
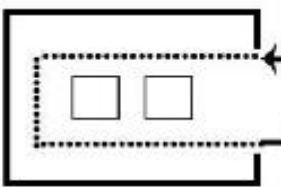
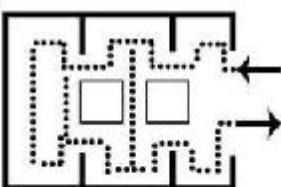
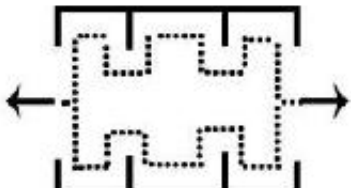
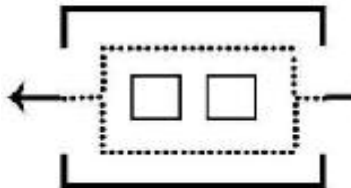
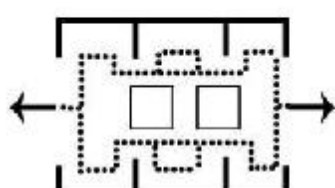
Figure 2. "Buddha's Light" Exhibition

HISTORICAL EVOLUTION OF SMART MUSEUM EXHIBITION SPACE STRATEGIES

Historical Origin of Smart Museum Exhibition Space

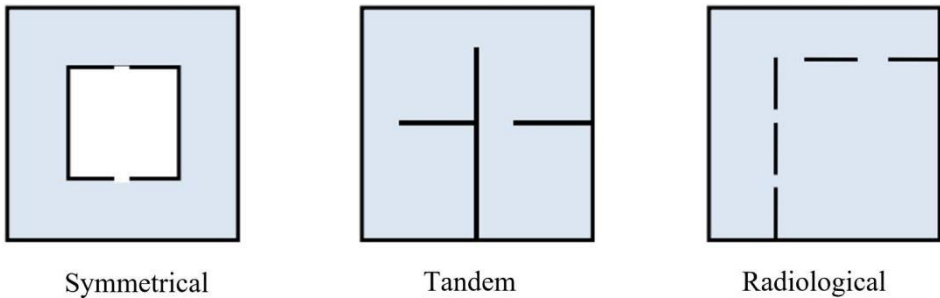
In the traditional exhibition space, the exhibition of exhibits in the form of a display is generally divided into four weeks: display type, independent display type, and mixed display space form (Table 1). The four-week type is generally hanging or placed along the walls and panels; this form is easier to organize and link up the space, guiding a clear route. Freestanding is generally displayed separately in the middle, with exhibits highlighted to emphasize the display of a presentation. Mixed in with the current with more exhibits, show mode update, space flexibility enhancement, space display mode is also more flexible, and display line of mobility more active. Then, the museum's display space is not limited to the traditional sense of just objects; it is the space form of the display board display.

Table 1. Exhibition Design Layout

Perimeter display	Stand-alone display	Mixed Display
		
		

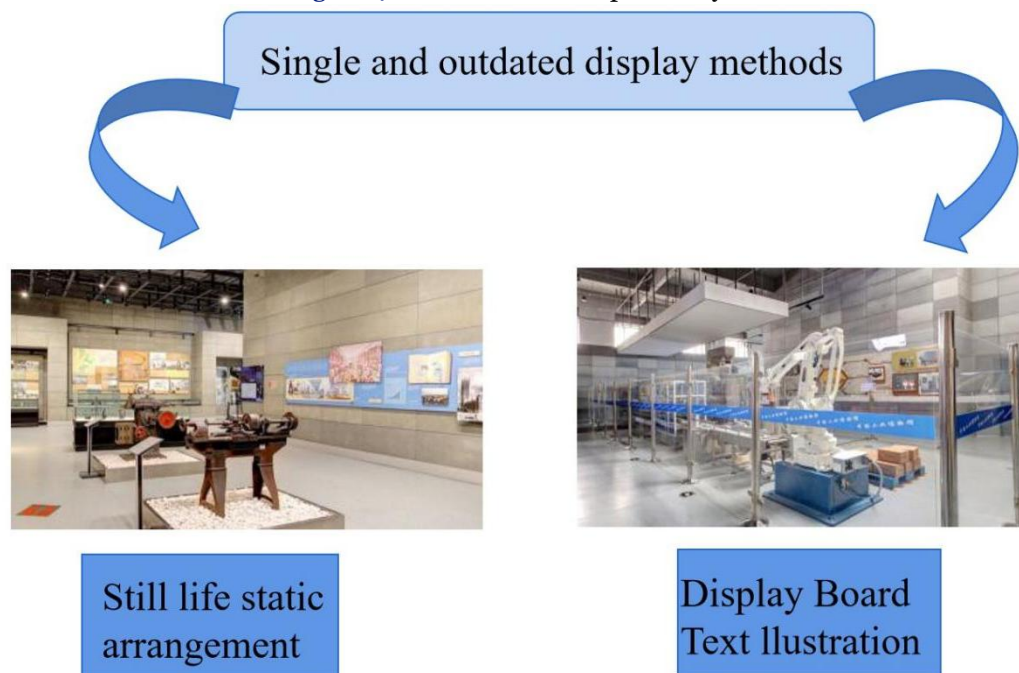
The concept of traditional exhibition design is that museums stand more on the angle of objects and make designs that need more thinking from the viewers. Between the viewer and the museum display is a cut-off state; the positioning of the design object is vague and inaccurate, leading to the viewer of the museum having a psychological emotion of respect and distance, as seen in Figure 3.

Figure 3. Classification of Spatial Layout



The problems of this traditional display method are becoming more and more prominent. The conventional display form can not meet the museum's more open attitude and goal. It can not meet the psychological needs of the current people, so the museum display design needs to be updated, transformed and optimized. A good display is easy and pleasant for the viewer's experience, and a good experience is a three-dimensional to four-dimensional, multi-dimensional and deep-level experience. The exhibition of the China Industrial Museum is only displayed in a static way with exhibition boards and exhibits, which is a single and dull way, and there are still guard boards and fences in the exhibition, which impede the communication between the viewers and the exhibits (Figure 4).

Figure 4. Classification of Spatial Layout

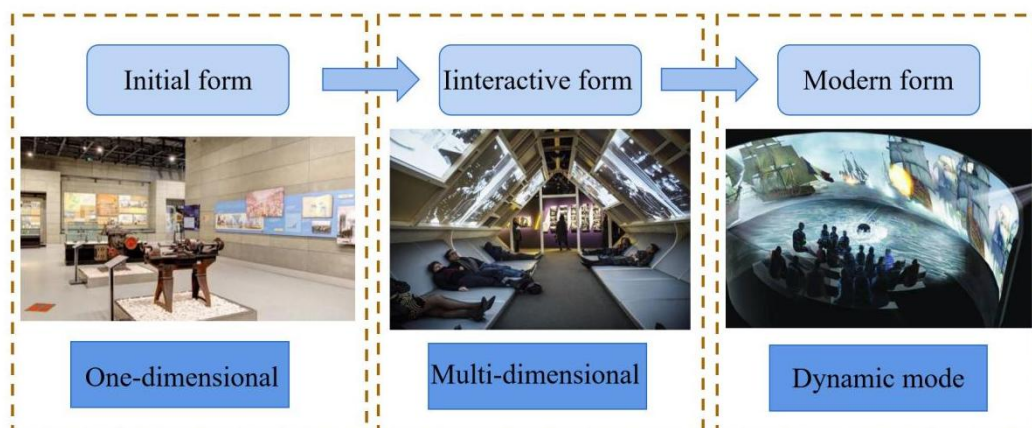


Modern Museum Exhibition Space

With the current development of technology, diversified new materials applied in the smart museum to provide technical possibilities, some smart museums have combined with new technologies to appear the phenomenon of the use of new media methods, but due to the lack of theoretical guidance, resulting in the application of technology is unreasonable and widespread, far-fetched use of technology and exhibitions, the lack of highlighting the cultural theme, which not only allows the viewer to produce inexplicable psychological feelings, experience, too! This not only makes the viewers have inexplicable psychological feelings but also makes them feel dizziness and fatigue when experiencing the exhibition, and also causes a large amount of financial and material resources to be wasted.

The exhibition space design under the influence of new media art makes use of the technical advantage to bring the viewers into the contextualized spatial atmosphere through digitalization combined with scene restoration, and under the unified theme narrative, sets up the plot design to let the visitors travel from reality to a specific scene, which gives them the feeling of being in the realm of reality. According to the theme content, the viewer is brought into the environment to act as a character, and through the storytelling contextual features, the viewer is naturally integrated into the spatial atmosphere, acquiring cognition while deepening the memory impression so that the viewer will have an empathetic experience, and then produce cultural resonance (Figure 5).

Figure 5. Participatory Interactive Device Behavior



The Digitization Period of Smart Museum Exhibition Space

The convergence of traditional exhibition forms makes the exhibition forms of each smart museum similar and cannot emphasize the characteristics of cultural spirituality. People want to seek the breakthrough of cultural value in smart museums' learning and interactive experience. Therefore, the traditional smart museum exhibition design needs to have a fun of viewer's experience. Nowadays, we are in a society with unprecedented information prosperity, and the rate of information processing and dissemination capacity has changed dramatically compared with the past. In the era of informatization, the progress of science and technology has led to the continuous iteration and updating of new media, and smart museums are developing rapidly into digital virtual smart museums. The trend of the future development of smart museum exhibition design needs to be deepened on the road of digitization. "5G Intelligent museum", artificial intelligence technology, VR experience technology applications, and digital technology have spawned a change in interactive learning knowledge. Technology experience breaks the limitations of time and space. In the era of the experience economy, the development of science and technology, media pluralism, and making the application of new technologies possible, the creation of smart museum exhibition space has a different psychological experience for the audience. smart museum exhibition design needs to focus on the viewer's knowledge, the innovative use of artificial intelligence technology makes the space display form more diversified, and the exhibition design is more towards developing humanized trends.

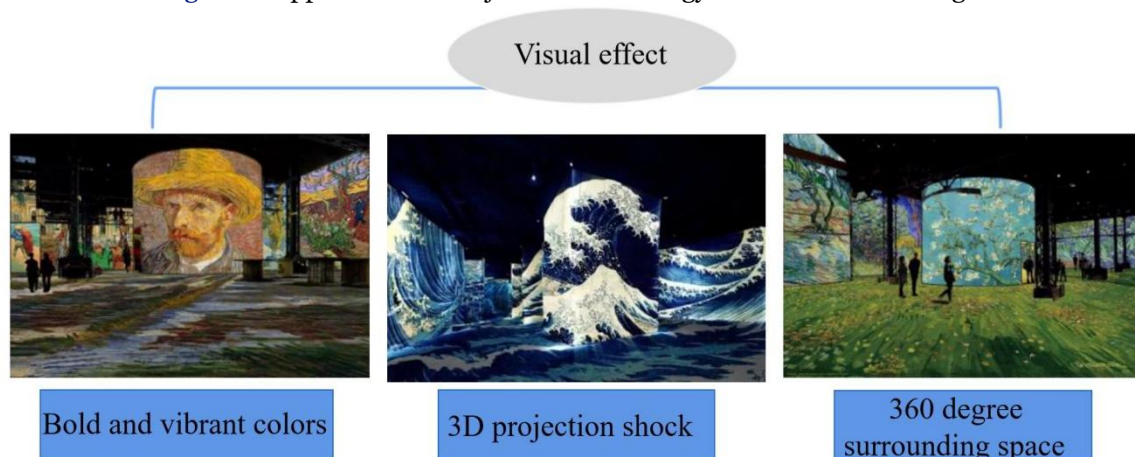
The exhibition of the Forbidden City in recent years has a clear digitization trend. The construction of the Forbidden City Duanmen Digital smart museum is a concrete presentation of the offline experience exhibition hall under the structure of the digital Forbidden City community. Nowadays, smart museums are transforming from collection-based to participatory, and smart museums combined with the Internet are a new way to carry out social and cultural services through information technology. The digital Forbidden City community is the smart museum informatization concept and the path's realization. The digital transformation of the smart museum is about two aspects to consider.

On the one hand, the protection of the object, on the other hand, is to give the viewer a better experience in the space of the knowledge of the exploration. At the end of the last century, museums have attempted to apply new media. The Smithsonian was the first to establish a social platform in museums, using new media elements such as digital media and interactive installations in museum displays, which is regarded as the originator of the new media application of "innovative viewer interaction experience" in the relevant theories.

Application Stages of Hologram and Projection Technology

Holographic projection technology is now widely used by museums. For example, the exhibition of Van Gogh (Figure 6) in the Museum of Light uses the visual effect of 3D projection technology to display Van Gogh's expressive brushstrokes and techniques through a 360-degree encircling space, to feel the artist's unparalleled use of bold and vivid colours, and to digitally present the sense of power expressed in the artist's works, and to allow the viewers to immerse themselves into the paintings in all aspects. The exhibition design of the "Museum of Light" revitalizes the charm of traditional art, mixing traditional historical classics with innovative technological art, bringing a brand-new viewing experience to the viewers. The intervention of new media art in the exhibition space also redefines how the exhibition is viewed.

Figure 6. Application of Projection Technology in the Museum of Light



Application Stages of Virtual Reality Technology

At present, the application of virtual reality technology and museum exhibitions, by imitating, copying and restoring the scenes that exist in history, showing the virtual time and space, realizing the interaction between the unreal experience and the real world, and letting the viewer feel and experience immersive. From the perspective of protecting cultural relics, VR technology plays a vital role in protecting cultural heritage. For example, in the special exhibition of the archaeological excavation of the Yinxu Women's Tomb displayed in the Capital Museum, along with 40 years of archaeological excavation, in addition to the last layer of the rest of the layers of the purpose has ceased to exist. Based on textual narratives alone, it is difficult for people to imagine the scene at that time, so to deepen the experience and feelings of the viewers in front of the restored sand table of the Tomb of Women's Hao, VR technology is used to enable the viewers to understand the Tomb of Women's Hao better and to return to the natural appearance of the reasons for the disappearance of the archaeological excavations. The Palace Museum also used VR technology to allow visitors to visit some unopened attractions, greatly expanding the form and content of the tourists' visit (Figure 7).

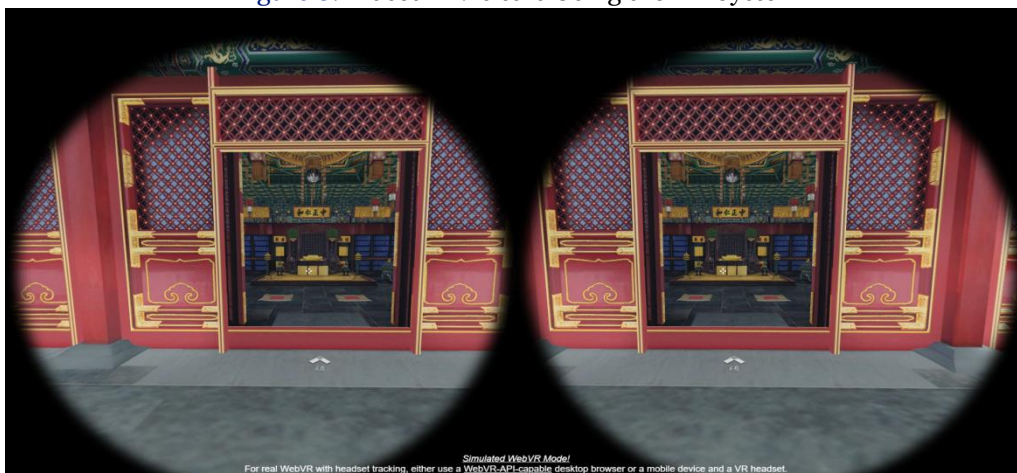
Figure 7. Classification of Spatial Layout



Application Phases of Augmented Reality

AR technology in museum exhibition design creates a fusion between the real and digital worlds, bringing digital 3D objects into our hands. In addition, the application of AR technology in museums has the significance of enhancing educational, social and entertainment (Figure 8). For example, when the viewer browses in the museum, after using AR equipment, the virtual text, related pictures, and even related videos will be automatically superimposed on the cultural relics, monuments, and exhibits that the viewer sees. When the viewer sees the defective cultural relics and monuments, AR will automatically restore the defective part, and the viewer will see the contrast between the "original" and "new" appearance of the cultural relics, making the experience more perfect and in-depth. Smithsonian National Museum of Natural History specimen display, through the terminal mobile application using AR technology, the viewer can use the cell phone to focus on the exhibits of the photo data. You can see the specimen of the three-dimensional restoration of the image.

Figure 8. Museum Visitors Using the AR System



Application Phases of Terminal Guide Technology

The development of mobile terminals and intelligent social software has made exchanging and sharing information more convenient. In the museum, it forms a two-way multi-dimensional interaction between the viewer and the exhibition. According to big data, intelligent, personalized explanation selection, online tour technology, self-guided tour deep people mining heritage information resources, the presentation of information in addition to having a voice, text, pictures and other essential information, including video, animation, detailed information for the audience (Figure 9). For example, some museums are currently set up next to the exhibits of the two-dimensional code. The audience will be able to query the relevant information using WeChat, in which the information content of the presentation is rich and diverse, equivalent to each visitor providing a "private" translation.

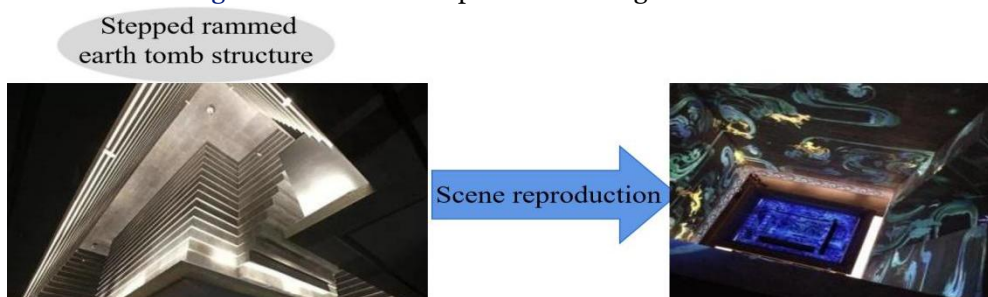
Figure 9. Navigation Technology of the Louvre



Application Stages of Interactive Devices

The way of situation restoration is presented in planarization, elevation and spatialization, and new media art is essentially the designer's conceptual arrangement of light and colour. For example, in the exhibition design of "Changsha Mawangdui Han Tomb Display" of Hunan Provincial Museum, 1:1 restored the structure of the tomb of Mawangdui Han Tomb, using a spatial truss structural system, applying the BIM technology for the structural design, reproducing the original condition of the stepped rammed earth tomb, using the form of three-dimensional superposition, running through the three layers of the audience, making the creation of architectural space and the display of cultural relics. Using the form of a three-dimensional superposition, the flow line through the three levels of the viewer so that the creation of architectural space and the display of cultural relics are intermingled together, and the appearance of the Mawangdui Han Tomb is presented to the viewer intuitively such as Figure 10. The new media holographic projection technology is utilized to project the art creation video works related to the theme in the exhibition space.

Figure 10. Exhibition Space of Mawangdui Han Tomb



EXAMPLES OF EXHIBITION SPACES IN SMART MUSEUMS

The Duanmen Digital Pavilion of the Palace smart museum is an offline experience pavilion structured under the concept of the digital Forbidden City community and the innovative exhibition space design of new media art intervention in the physical pavilion, which is a perfect blend of ancient traditional architecture, cultural aesthetics and digital technology, realizing the digitalization of the smart museum exhibition space and the artistic presentation of the exhibition space (Figure 11). With the theme of "The Forbidden City is a smart museum", the Digital Pavilion includes the "From Forbidden City to smart museum" display area shown in the form of a digital sand table; the "Forbidden Collection. The Forbidden City Collection. The Forbidden City Treasures" digital cultural relics interactive area; let the viewer appreciate the charm of the Forbidden City architecture "Forbidden City - the palace of the son of God" virtual reality theatre. The exhibition design of the Duanmen Digital Pavilion utilizes multi-touch explanation screen equipment, immersive projection screen, virtual reality helmets, somatosensory capture and other interactive equipment to lead the viewers into the virtual reality of space and time. It integrates ancient architecture, traditional culture and modern technology into an all-digital display, which the viewers highly acclaim.

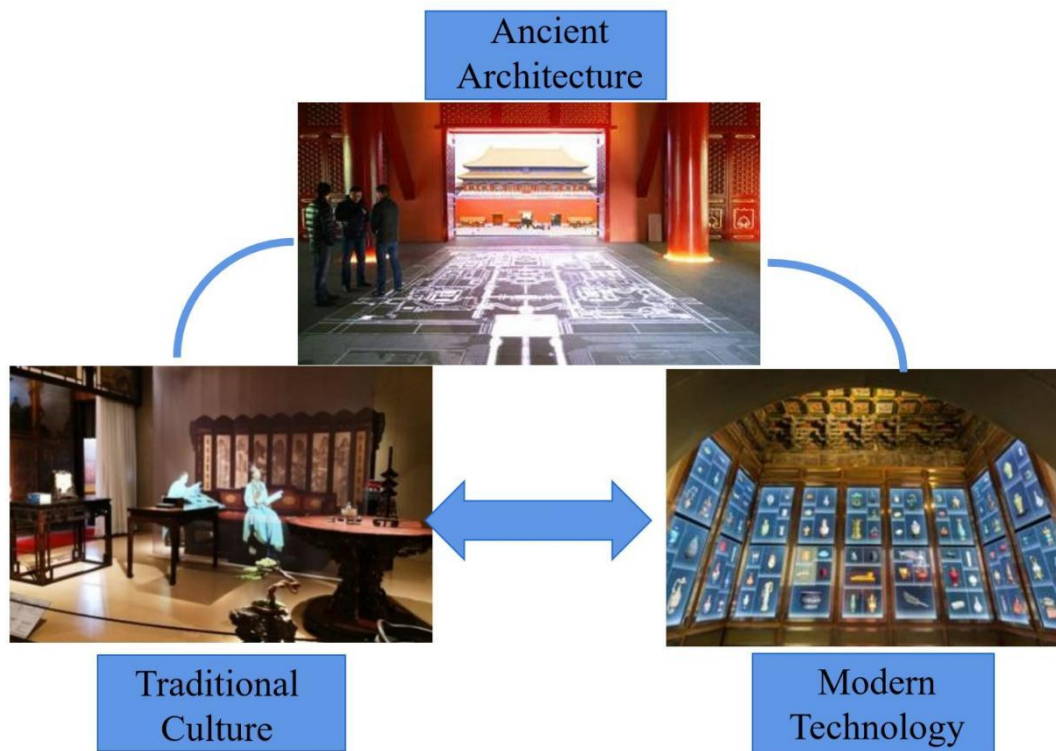


Figure 11. Schematic Diagram of China's Reinterpretation of Stalin's Ethnic Definition

DISCUSSION

Traditionally, the exhibition space is a unique static form, which can be regarded as a "container" used to display exhibits. When digital technology is integrated into the exhibition space, with the help of optical effects, interactive equipment and multimedia technology, the exhibition space and the audience can be displayed as a unified set. The traditional museum exhibition space was characterized by static displays, where artefacts were arranged in glass cases or on pedestals. Visitors would passively observe these objects, often accompanied by textual descriptions or audio guides. However, with digital technologies, museums began to embrace interactive and immersive experiences to enhance visitor engagement.

The application of digitalization in the exhibition space design strengthens the user's participation and interaction, impresses the viewers through the dynamic exhibition way, creates a more influential exhibition space, the digital technology brings a new way of exhibition, expresses the unique atmosphere and culture of the exhibition space, makes the exhibition space in the function, type and form to diversification, digitalization, and the modern public's life and aesthetic habits and the development of the times. It is in line with the modern life and aesthetic habits of the public and the development of the times. Digitalization creates a diversified interactive

auxiliary system for exhibition space design, and the reasonable use of digital technology can not only meet the functional requirements of display and tour in exhibition space design, but also make up for the shortcomings of exhibition space design, and provide a certain basis for the future exhibition space design taking into account the digital exhibition space design of education and learning, interactive experience and media integration. Therefore, in the design process, we should focus on grasping the space elements, behavioral elements and lighting elements and other related elements, so that the design meets the physiological and psychological needs of the audience, so that the audience can get a better experience of visiting and learning.

Future Development

The evolution of smart museum exhibition space strategy has witnessed a significant shift from traditional displays to digital experiences. Integrating digital technologies has revolutionized how museums engage with visitors, providing them with immersive, interactive, and personalized experiences. This transformation has expanded museums' reach and enhanced their collections' educational and cultural impact. As technology advances, we can expect further innovations in museum exhibition space, creating even more dynamic and engaging visitor experiences.

CONCLUSION

As a spatial carrier to show the degree of development of civilization, smart museums have evolved over thousands of years with different styles and forms. However, as a place of cultural convergence, the original intention of transmitting the cultural heritage of humankind has remained the same. With the change of the times, the social responsibility of smart museum exhibitions in cultural appreciation, historical tracing, scientific research, education and promotion has become increasingly prominent.

We combed and summarized the museum exhibition space strategy from traditional to digital historical changes. Traditional museums generally use physical displays on walls and panels, hanging or placed. This form makes organizing and linking the space more accessible, guiding a clear route. The traditional exhibition design presents a dichotomy in the relationship. In the current development of the information age, 5G, VR, AR, holograms, and other new media technology in the smart museum exhibition space design for innovative use and wisdom under the influence of the smart museum exhibition space design to strengthen the theme of history and culture through the digitization can be carried out to restore the experience of the context of the innovative display, and more interaction with the viewers of the exchange of interactive installations and other related smart museum exhibition space design techniques also continue to appear. The exhibition space design of smart museums is also constantly appearing. The advantages and significance of exhibition space design under the influence of new media art are more obvious: it improves the efficiency of cultural dissemination. Through the application of intelligent social media, the cultural brand is deeply rooted in people's hearts, and the cultural aesthetics of the museum are also brought into the life of the audience; the educational function of the museum is strengthened.

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ETHICAL DECLARATION

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