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Research on the Design of Digital Virtual Display Space for the Haihun Marquis Chariot and Horses Based on Multidimensional Interaction Technology

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Abstract

This research employs qualitative descriptive analysis to explore the display needs of the Han Dynasty haihun Marquis tomb's chariot and horse relics in Nanchang. It investigates how the design of a chariot-and-horse-style digital virtual exhibition hall, leveraging digital media technologies, can present the historical stories behind these artifacts. The aim is to create a new online virtual exhibition experience that effectively promotes the integration and development of the cultural and tourism industries. Ultimately, it seeks to achieve a win-win fusion of cultural and economic innovation by merging online virtual spaces with historical culture.

Keywords: *haihun Marquis, Chariot and Horse Artifacts, Digital Exhibition Space.*

Introduction

Since the 21st century, the application of digital media technology in various exhibitions has significantly increased. Technologies such as virtual simulation, audiovisual materials, touchscreens, holographic imaging, and dynamic cinema have injected new forms of expression into two-dimensional space presentations. The continuous innovation of digital media technology in exhibition halls has enhanced the integration of modern technology and art. As key institutions for inheriting and promoting traditional culture, exhibition halls are crucial channels for spreading traditional cultural stories. The development of digital media technology has driven innovation in cultural display methods, with virtual reality (VR) and multimedia interaction-focused digital exhibition hall design becoming a global trend in museum development (Sun, 2023). While these advances bring significant benefits, the integration of digital technologies also presents new challenges for exhibition design (Li, 2021).

The haihun Marquis Tomb is the largest, best-preserved, and most culturally rich Han Dynasty noble burial site discovered in China to date. The tomb's unearthed artifacts are exquisite, and the craftsmanship is remarkable. Among these, the tomb contains the only genuine chariot and horse burial pit ever found in the southern region of the Yangtze River, which holds profound cultural, artistic, and historical value. This design proposes a digital exhibition space for the haihun Marquis chariot and horses, based on interactive technologies and the historical and cultural background of the haihun Marquis chariot and horse. It offers a digital virtual display solution that caters to the needs of different age groups of audiences, deepening their understanding of culture, and creatively conveying the cultural significance of the artifacts by integrating historical evolution, character stories, and classical allusions (Lin, 2020).

Research Method

This study employs a combination of qualitative research and experimental analysis methods, using the virtual exhibition hall of the chariot and horse artifacts unearthed from the haihun Marquis Tomb as the research text. The research process includes the following steps: (1) literature review and current status survey; (2) data collection, acquiring 3D modeling data of the haihun Marquis chariot and horse artifacts; (3) exhibition space design, creating virtual scenes for different thematic areas; (4) user experience testing, analyzing the effectiveness of the design through surveys and interview feedback. This study also integrates various interactive technologies to enhance the interactivity of the display space, such as virtual stereoscopic

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imaging, 3D video display, and touch-screen interactive panels, ensuring that visitors can deeply understand and engage with the cultural significance of the exhibits.

Data Source

The primary data for this study comes from the Nanchang Han Dynasty haihun Marquis Tomb Relics Museum, including physical exhibits and photographs of the chariot and horse artifacts unearthed from the tomb, craftsmanship analysis reports, and 3D scanning models. These references include historical documents on the haihun Marquis chariot and horse artifacts as well as analyses of their production techniques. In addition, online public resources were used to obtain design case references for virtual exhibition halls both domestically and internationally.

Research Design Analysis

The Nanchang Han Dynasty haihun Marquis Tomb Relics Museum is located in Guanxi Village, Datangping Township, Xinjian District, Nanchang City, Jiangxi Province, adjacent to the geographical center of the Ganjiang New Area. The museum enjoys favorable location conditions with convenient transportation. Covering an area of 118,802 square meters, the total building area is 39,250 square meters, with the site park covering approximately 12.03 square kilometers. The museum consists of two above-ground floors with a building area of 31,465 square meters, and an underground floor with a building area of 7,785 square meters. The floor area ratio is 0.29, the building density is 16.35%, and the green space ratio is 57.62% (including water bodies). On April 7, 2019, the main structure of the Nanchang Han Dynasty haihun Marquis Tomb Relics Museum was capped, with a building height of 18 meters and the highest point of the rooftop protrusions reaching 23.7 meters.

Based on the design of this digital virtual exhibition space, an analysis of the audience demographics was conducted. By reviewing statistical data on the age distribution of audiences in digital virtual exhibition spaces and the reasons for their visits, it was found that the largest group of visitors is aged 19-35, followed by those aged 36-59. The digital virtual online exhibition hall is designed to meet the needs of these target audiences, including those from schools and community organizations. The design integrates cultural connotations to satisfy the general needs of the public.

More than 3,000 chariot and horse artifacts have been unearthed from the haihun Marquis Tomb. Among the chariot and horse decorations, there are over 80 items such as wheel hubs, axle decorations, and various other ornaments including precious adornments, bronze rings, buckles, yoke decorations, reins, axle decorations, bow caps, and balance decorations. Most of these artifacts are thin-walled, and their forms are diverse. The materials are primarily bronze, silver, and iron, including gilded bronze, inlaid gold and silver, as well as mixed metal materials such as gilded, inlaid, copper, and iron used in the manufacturing of these chariot and horse ornaments. Bronze artifacts are found in large quantities in the tomb and are representative of the main artifact types. A significant portion of the chariot and horse items has surface patterns created through a mix of different materials and techniques. For example, the yoke pieces are made of iron, bronze, and silver, with the surface patterns typically inlaid with gold and silver.

The virtual exhibition hall's design is inspired by the "Danglu" (a type of wheel hub) as the outer contour of the exhibition space. The internal space design is based on the "S"-shaped patterns from the Danglu, forming the primary structural layout of the interior. The space is divided into three main thematic areas. By integrating immersive interactive experiences and utilizing technologies such as Virtual Reality (VR), Augmented Reality (AR), panoramic imaging, and multimedia interaction, the exhibition aims to offer visitors a deeper cultural understanding and experience. The following sections will provide a detailed analysis of the thematic divisions of the exhibition space, the application of technological methods, and their role in enhancing cultural display (Li Chang, 2023).

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Basic Types of Chariot and Horse Artifacts of Haihun Marquis

The chariot and horse pit located on the west side of the Haihun Marquis Tomb in Nanchang, Jiangxi, China, is the first true chariot and horse burial pit discovered in southern China, excavated in 2011. Over 3,000 chariot and horse decorations and artifacts were unearthed from this pit. Among these, more than 2,000 items were neatly placed in painted wooden boxes in the southwest section, while the remaining objects were scattered around the vehicles. The designs of these chariot and horse decorations are diverse, and the craftsmanship is exceptionally sophisticated. They provide invaluable primary materials for understanding how the high-ranking aristocracy of the Western Han Dynasty utilized the chariot system. These artifacts hold unparalleled value in terms of human civilization, aesthetics, and craftsmanship.A large number of chariot and horse decorations were unearthed around the outer area of the Haihun Marquis Tomb, totaling more than 3,000 pieces. These decorations include over 80 examples of chariot axles, hangers, rare ornaments, bronze rings, fittings, crossbars, rein attachments, axle decorations, bow caps, balance ornaments, and more, with a variety of shapes. Most of these artifacts are made from thin materials, and they come in various forms. The materials used for these decorations include bronze, silver, and iron, with some featuring gilded bronze, gold-inlaid bronze, and mixed metal alloys, such as gilded, gold-inlaid, copper, and iron artifacts.Among the items unearthed, bronze artifacts are the most representative and significant in terms of quantity. A large portion of the chariot and horse decorations features intricate surface patterns made from a combination of different materials and processes. For example, the various components of the chariot shafts are made from iron, bronze, and silver, with surface patterns primarily crafted using gold-inlay and silver-inlay techniques. The chariot and horse artifacts from the Haihun Marquis Tomb demonstrate an impressive level of craftsmanship, with patterns such as cloud and vapor motifs, four divine creatures, the sun and moon in harmony, exotic flowers, strange plants, mountains, and running beasts. The composition of these patterns is carefully considered, and the craftsmanship is mature, with finely detailed designs. The majority of the surface decorations are created using gilding and gold-inlay techniques. Gilding is the most widely used technique for creating these artifacts. Most of the chariot axles unearthed from the tomb are made using gilding, with silver-based axles and gilded bronze axles being the most common, along with a considerable number of copper-based axles also featuring gilding.

Theme Area Design and Content Analysis

Through on-site field research, it was discovered that the Gan-Po region, as evidenced by the artifacts unearthed from the Haihunhou tomb, possesses a rich tradition of handicraft skills. These traditional craftsmanship techniques provide valuable inspiration and technical support for modern product design. By cleverly applying these traditional skills, modern products can maintain their practicality while showcasing a profound cultural heritage, thus achieving the dual goals of preserving and innovating traditional craftsmanship.The design centers around traditional culture, successfully extracting and integrating elements of ancient artifacts into the design of cultural and creative products. This innovative design not only demonstrates the exquisite techniques of ancient art and craftsmanship but also allows consumers to deeply experience the unique history and folk culture of the region. For example, the design incorporates elements such as fine jewelry and horse gear patterns unearthed from the Haihun Marquis tomb, blending them with modern aesthetic needs to create cultural products that are both historically rich and suited to contemporary lifestyles. Through this integration of culture, art, and technology, these products become more than just functional items—they serve as carriers of cultural transmission, enabling consumers to experience the charm of traditional craftsmanship in daily life, thereby enhancing cultural identity and the sense of historical continuity.

The entire virtual exhibition space is designed with the danglu (a type of horse head ornament) as the inspiration for the outer contours of the space. The internal design draws inspiration from the "S"-shaped pattern of the danglu, which represents the "four cardinal directions and eight positions" in traditional Chinese symbolism. The structure of the interior space is geometric, with a rotational flow of pedestrian movement, combining balance and dynamic energy in its layout.In ancient times, horse head ornaments, mostly danglu, were placed on the horses' noses and foreheads. These ornaments served both a protective function in warfare and an aesthetic role. In the Haihunhou Tomb, the danglu found were specifically used

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for the emperor's royal horses. The danglu designs on the horse harness not only served as decorative patterns but also carried deeper symbolic meanings, reflecting the artistic and cultural values of the period.

The design of the exhibition space is based on the overall theme of "Royal Majesty and Dignity," divided into three main exhibition areas: "Chariot and Horse Through Time," "The Splendor of Chariots and Horses, The Dream of Kings," and "Masterpieces of Craftsmanship." Each area focuses on showcasing a unique aspect of Han Dynasty chariot and horse culture, presenting its multifaceted nature.

"Chariot and Horse Through Time" Theme Area: This area takes visitors on a journey through the development of Han Dynasty chariot culture by showcasing an introduction hall and historical evolution displays (Cai Yuzhen, Hu Dongbao, Guan Bao, Li Wenhuan, 2019). It focuses on the origins, evolution, and symbolic meaning of chariots and horses in the noble rituals of the time. The entrance design is inspired by the architectural style of Han Dynasty palaces, creating a solemn and magnificent atmosphere. The patterns on the walls are inspired by the seal motifs from the haihun Marquis Tomb of Liu He, with the “haihun Marquis” font style prominently restructured for display. This not only enhances the aesthetic appeal but also quickly conveys the theme of the exhibition. In this area, visitors can gradually learn about the historical development of Han Dynasty chariot and horse ceremonial rituals through wall reliefs, paintings, and replica models. To enhance the exhibition experience, Virtual Reality (VR) technology is employed to create an immersive historical scroll. Visitors can use touchscreen displays or wear VR devices to explore chariot models, travel rituals, and listen to background narratives, providing a more vivid and three-dimensional understanding of the historical evolution of chariot and horse culture (Wang Gang, 2023).

"The Splendor of Chariots and Horses, The Dream of Kings" Theme Area: This area focuses on showcasing the "Four-Horse Chariot" style of chariot and horse artifacts unearthed from the haihun Marquis Tomb and their significance in the lives of the elite. The design utilizes Augmented Reality (AR) technology to display different types, functions, and structural features of chariots and horses from the Han Dynasty, representing various social classes. The models in this area can rotate 360 degrees, allowing visitors to examine the details of the chariots and horses from various angles. Using AR technology, virtual scenes are overlaid on the displays to simulate the manner in which emperors and nobles traveled in their chariots, their ceremonial rituals, and the details of the objects they used.The area also features an interactive wall called "Shining Together with the Sun and Moon," which highlights Han Dynasty chariot products, reliefs, patterns, and historical scenes. By tapping the screen, visitors can learn about the craftsmanship behind each artifact and its cultural symbolic significance. The main focus of this area is to display the symbolic meaning of royal status and noble rituals, allowing visitors to gain a deeper understanding and appreciation of the majestic etiquette and unique traditional cultural charm of ancient aristocratic life.

"Masterpieces of Craftsmanship" Theme Area: This area focuses on the craftsmanship and artistic characteristics of chariot and horse artifacts from the haihun Marquis Tomb, highlighting the exquisite skills of Han Dynasty artisans. Multiple floating display platforms are set up, each showcasing a single artifact or a set of chariot and horse ornaments. Visitors can interact with the displays by clicking or touching the screens to learn about the production techniques and historical background behind these works. Another "Craftsmanship Display Station" uses virtual 3D imaging technology to break down the manufacturing process of chariot and horse items into individual steps, helping visitors gain a more intuitive understanding of techniques such as casting, carving, inlaying, and gilding (Dai Yijun, 2022).

To enrich the exhibition, a "Spirit of the Craftsman" virtual recreation is included, where video clips re-enact scenes of Han Dynasty artisans working in their workshops, allowing visitors to appreciate the labor and artistic wisdom behind each artifact. The gallery walls feature patterns such as "Cloud Motifs" and "Four Divine Beasts," which are commonly seen in the haihun Marquis Tomb, symbolizing the Han Dynasty's reverence for nature and the divine. The touchscreens and virtual guides offer multisensory interactions, allowing visitors to fully immerse themselves in the experience. This area also includes a cultural and creative interactive experience zone, enhancing audience participation and creating an educational yet entertaining effect.

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The Application and Effectiveness of Digital Display Technology

To enhance the exhibition's impact and interactive experience, the program extensively utilizes digital technologies such as Virtual Reality (VR), Augmented Reality (AR), panoramic imaging, and multimedia interaction. These technologies help visitors immerse themselves more vividly in the Han Dynasty chariot and horse culture. Virtual Reality technology is widely applied in the "Chariot and Horse Through Time" and "The Splendor of Chariots and Horses, The Dream of Kings" areas. When visitors wear VR headsets, they can fully immerse themselves in a virtual environment, such as a simulated Han Dynasty street, palace, and chariot procession, offering a unique and immersive experience. This virtual environment vividly presents historical scenes, enhancing visitors' understanding of chariot and horse culture.

Augmented Reality technology is mainly used in "The Splendor of Chariots and Horses, The Dream of Kings" area, where visitors can use handheld devices to scan chariot models or wall patterns to access additional digital information. By overlaying virtual data, visitors can explore the internal structure and manufacturing details of chariots and horses, breaking the limitations of traditional static displays. Panoramic imaging and 3D stereoscopic imaging technologies are primarily applied in the "Chariot and Horse Through Time" area for historical scroll displays, offering a comprehensive visual experience. 3D stereoscopic imaging is also used in the "Masterpieces of Craftsmanship" area to showcase the manufacturing process of chariot and horse products, simulating complex techniques such as gilding and gold-plating. Visitors can freely choose their perspective to explore each step of the process.

Multimedia interactive technologies, including touchscreens, voice guides, and virtual guides, are used throughout the exhibition. On the touchscreens in each area, visitors can click to access more information, watch related videos, listen to audio guides, and even interact with virtual tour guides. Through these multimedia technologies, visitors can independently select the content they are most interested in, exploring the exhibition's themes in greater depth, significantly enhancing both engagement and enjoyment.

The Integration of Cultural Education and Immersive Experience

To deepen visitors' cultural knowledge and enhance their interactive and immersive experience, a dedicated "Craftsmanship Experience Zone" has been set up in the "Masterpieces of Craftsmanship" area. Here, visitors can actively participate in the production process of chariot and horse artifacts. For example, the area features touchscreens where visitors can simulate the entire process of gilding and gold-plating, from cutting and carving to embedding gold and silver pieces, allowing them to personally experience the artisan's creative process. Additionally, visitors can use virtual interactive tools to assemble different components of chariot models, exploring their structural principles and functional applications (Zhang Hongyan, Huang Xi, Han Huarui, Yang Xiaolin, Li Wenhuan, Yang Jun, 2021).

In the "The Splendor of Chariots and Horses, The Dream of Kings" area, a virtual 3D viewing system has been introduced, where visitors can control chariot models using handles or touchscreens to carefully examine every detail from various angles. With the aid of VR technology, visitors can even "drive" the chariots in a virtual world, experiencing the grandeur of a royal chariot procession. This immersive design not only makes the exhibition more engaging but also enables visitors to gain a deeper understanding of the ceremonial system and cultural significance behind the chariot and horse artifacts.

Design and Significance of Cultural and Creative Interactive Experience Area

To enhance the exhibition's engagement and visitor participation, the "Masterpieces of Craftsmanship" area features a special cultural and creative interactive experience zone. In this area, visitors can participate in various activities to deepen their understanding of Han Dynasty chariot and horse artifacts. For example, a "Guess the Artifact" game allows visitors to identify different parts of the artifacts, enhancing their knowledge. The area also includes a chariot and horse model assembly game and a simulated artifact collection parkour game, which further enrich visitors' cultural experience through fun and learning. In addition, a virtual reality horseback riding experience is offered, allowing visitors to immerse themselves in the scene of a Han Dynasty chariot procession. These interactive designs not only provide a vivid visiting

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experience but also attract visitors in an engaging and educational way.

Conclusion and Discussion

The digital exhibition space design of the Chariot and Horse Shaft from the haihun Marquis Tomb breaks the traditional spatial limitations of physical galleries by utilizing various interactive technologies, creating an immersive cultural exchange and enriching educational experience. Through case studies, this design has demonstrated significant success in enhancing exhibition interactivity, deepening cultural understanding, and expanding the audience base, thus promoting the application of traditional cultural relics in modern exhibitions. The implementation of this design has proven the effectiveness of digital exhibition spaces in improving visitors' cultural comprehension and increasing the appeal of exhibitions. Furthermore, the design of the cultural and creative interactive experience zone also facilitates interaction in both entertainment and educational aspects. With the continuous development of digital technology, future improvements can further enhance the precision and interactivity of the exhibition, offering a more personalized and engaging cultural presentation while expanding the scope of educational outreach.

Conflict of Interest

The Authors Declare No Conflicts of Interest

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