



# Research on the Application of Modern Digital Exhibition Technology in Museum Exhibition Design

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**Abstract.** Amid the rapid advancements of modern technology, digital exhibition technology has witnessed vigorous development and extensive application across various fields. For museums, this technological wave is driving profound changes in exhibition design, transitioning from traditional static displays to more interactive, dynamic, and immersive experiences. This transformation is of great significance, akin to a magical key that opens the door for audiences to deeply understand the historical and cultural contexts behind the exhibits. It breathes new life and vitality into the ancient institution of museums. This paper delves into the application of modern digital exhibition technology in museum exhibition design, analyzing numerous successful cases from both domestic and international perspectives. By employing detailed charts and data, it comprehensively examines the opportunities and challenges posed by this technology. Furthermore, it offers constructive insights and recommendations on how museums can better utilize digital exhibition technology in their future development.

**Keywords:** Modern Digital Exhibition Technology; Museum; Exhibition Design

## 1 Introduction

In today's era of rapid technological advancement, modern digital exhibition technology has become a driving force for innovation in museum exhibition design. Traditional museum exhibitions have primarily relied on static displays and simple textual descriptions. However, with the explosive growth of the information age, people are now inundated with massive amounts of information daily, leading to higher demands for visual experiences. Against this backdrop, traditional exhibition methods are increasingly revealing their limitations, failing to meet the public's strong desire for interactivity and immersive experiences[1].

Modern digital exhibition technology acts as a refreshing stream, opening up a new world for museum exhibition design with its unique interactivity, high flexibility, and impressive visual effects. It successfully breaks the constraints of time and space,

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greatly enriching the forms and content of exhibitions, allowing audiences to explore the historical and cultural connotations of exhibits in a more intuitive and vivid manner.

## **2 The Significance of Modern Digital Exhibition Technology in Museum Exhibition Design**

### **2.1 Transformation Trends in Museum Display Methods**

As a significant venue intertwining historical heritage and modern civilization, museums are undergoing a profound transformation from traditional to modern display methods. The integration of modern digital exhibition technology, like a radiant pearl, has brought revolutionary changes to museum exhibition design[2].

This technology provides more diverse means of expression and elevates interactivity to a new level. Compared to static exhibits and monotonous textual descriptions, digital technology breathes life into exhibitions, animating artifacts to appear lively and dynamic before the audience. Supported by this technology, museum content transcends two-dimensional limitations and presents itself in more three-dimensional and dynamic forms, making visitors feel as if they are traveling through time and experiencing the grandeur of history firsthand[3].

### **2.2 Immersive Experiences Enabled by Virtual Reality (VR) Technology**

Virtual reality (VR) technology shines as a star among digital exhibition tools, offering audiences a magical, immersive experience. By wearing advanced VR equipment, visitors can be transported instantly to historical settings, becoming witnesses to the past[4].

Whether it is the bustling towns of ancient times, majestic palaces, or smoke-filled battlefields, VR vividly reconstructs these scenarios. Visitors can observe details such as ancient attire, behavioral customs, and architectural features up close, enabling a more comprehensive understanding of historical societies. This immersive experience not only satisfies curiosity but also ignites passion for cultural exploration and further learning.

For example, the "Digital Palace Museum" project demonstrates the immense appeal of VR technology. With a VR headset, visitors can roam the virtual Forbidden City, marveling at its grand palaces and experiencing the luxurious lifestyles of the ancient royal court. Every door, brick, and tile seems to narrate a story from the past, captivating the audience. This successful project has enhanced the museum's global reputation, attracted countless visitors, and cultivated interest in its rich cultural heritage[5].

### **2.3 Revealing Stories Behind Artifacts with Augmented Reality (AR) Technology**

Augmented reality (AR) technology plays a vital role in museum exhibition design, acting as a magical storyteller that vividly presents the hidden stories and historical contexts of artifacts[6].

In traditional museum visits, audiences often see only the surface of artifacts, with limited understanding of their cultural and historical significance. AR technology changes this by unveiling the deeper world of exhibits.

For instance, when observing an ancient artifact, AR technology can illustrate its craftsmanship, functionality, and societal role through three-dimensional visuals. It can even recreate scenarios where the artifact was used in historical contexts, allowing visitors to witness how these items were part of daily life. This enhances both the educational and interactive aspects of exhibitions[7].

Shanghai Museum, during its ancient bronze exhibition, utilized AR technology to great effect. Visitors could scan artifacts with their smartphones to view 3D models marked with detailed annotations. Alongside vivid video explanations, this approach offered a deeper understanding of the historical and cultural background of the bronzes. This innovative technique made the exhibition engaging and insightful, drawing a large number of visitors and achieving excellent results.

### **2.4 Enriching Interactive Experiences**

Digital exhibition technology enriches the interactive experiences in museums, transforming visitors from passive spectators into active participants.

At interactive digital screens, audiences can perform simple actions such as touching, dragging, or clicking to access more information or even interact with exhibits in engaging ways. This interactivity enhances audience participation, making the exhibition content more vivid and enjoyable, and significantly improving satisfaction[8].

For instance, in an exhibition on ancient technology, visitors can simulate the operation of historical inventions on interactive screens to understand their principles. This hands-on experience deepens appreciation for ancient achievements and fosters cultural connection.

The British Museum has also leveraged digital interactive technology effectively. In its Egyptian artifact gallery, large interactive screens provide detailed information on historical contexts, cultural significance, and archaeological processes. Through games and interactive elements, visitors gain a deeper understanding of Egyptian culture. This innovative approach has proven to be immensely popular, boosting engagement and vibrancy in the gallery.

### **2.5 Flexible and Efficient Exhibition Methods**

Modern digital exhibition technology offers museums unprecedented flexibility in designing and updating exhibitions.

Whether changing content or modifying presentation styles, digital solutions enable rapid adjustments. This flexibility improves the efficiency and quality of exhibitions, allowing museums to better cater to diverse themes and audience preferences[9].

Furthermore, digital technology breaks the barriers of time and space, making remote and online exhibitions possible. Museums' valuable collections and exhibits can be showcased to global audiences via online platforms. Visitors can explore exhibitions anytime, anywhere, using computers or mobile devices.

For instance, the National Museum of China leverages digital technology to offer online exhibitions, enabling audiences to virtually tour its galleries and access rich historical and cultural insights. This approach provides convenient access, especially for those unable to visit in person, enhancing inclusivity and expanding the museum's reach[10].

In conclusion, the application of modern digital exhibition technology in museum design acts as a spring breeze that revitalizes the cultural garden of museums. It enriches exhibition forms and content, offering audiences new experiences while providing museums with flexible and efficient tools for innovation and development. This powerful force is driving museums toward a dynamic and interactive future.

### **3 Application Strategies of Modern Digital Exhibition Technology in Museum Exhibition Design**

#### **3.1 Virtual History: Immersive Scene Recreation**

##### **3.1.1 Technological Approaches and Implementation Methods.**

The application strategy of virtual history in museum exhibition design primarily relies on immersive scene recreation technology. This strategy ingeniously integrates cutting-edge technologies such as Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), combined with sophisticated 3D modeling and simulation techniques, to vividly present historical events, figures, and scenes. This greatly enhances the audience's experience and engagement.

First, Virtual Reality (VR) technology plays a critical role in this process. By leveraging VR, exhibition designers can reconstruct the grandeur of ancient architecture in a digital space. Whether it is the majestic palace complexes or the intricate and elegant courtyards, these structures can be precisely recreated in the virtual domain. Visitors, simply by wearing a VR headset, can embark on a wondrous journey through time, as though they have "entered" these ancient buildings[11].

In this virtual realm, visitors are granted unprecedented freedom to explore both the exterior and interior of the architecture, closely observing details such as unique architectural styles, complex structural layouts, and exquisite decorative elements. Unlike traditional exhibition methods, VR offers a novel interactive experience, enabling audiences to closely examine areas typically inaccessible in real-life visits—such as roof beam structures hidden beneath ceilings or intricate carvings on walls. This immersive experience is unparalleled compared to conventional display approaches.

Second, the addition of Augmented Reality (AR) and Mixed Reality (MR) technologies enriches the overall experience with greater diversity and interactivity. AR seamlessly integrates virtual elements with real-world environments, providing a multi-sensory experience. For instance, in a museum gallery, when visitors approach an exhibit, AR can display virtual information beside the physical artifact, such as its historical context, craftsmanship, or former owners. Presented in a transparent, non-intrusive manner, this information complements the physical object, allowing audiences to appreciate the tangible exhibit while rapidly gaining deeper insights.

MR, on the other hand, takes the experience a step further by enabling complex interactions between the audience and virtual elements. For example, within virtual historical scenes, visitors can participate in role-playing activities, immersing themselves in the lives of historical figures. This experience allows them to deeply engage with the historical context, as if they themselves were part of history.

### 3.1.2 Case Study.

A notable example of the virtual history exhibition strategy was demonstrated in an ancient architecture exhibition. This event showcased the charm of immersive scene recreation. Utilizing VR technology, visitors were able to explore ancient palace complexes in a virtual environment[12].

Upon wearing VR equipment, a magnificent palace emerged before their eyes. They could admire the stunning exterior, with vibrant glazed tiles gleaming under the sunlight, and intricately carved beams showcasing the exceptional craftsmanship of ancient artisans. Inside the palace, the intricate decorations captivated visitors, from murals on the walls to the golden bricks beneath their feet, with every detail brought vividly to life.

During their virtual tour, visitors could access supplemental commentary, providing insights into the palace's historical background, cultural significance, and its role in the societal hierarchy of its time.

AR technology further enhanced the experience, allowing visitors to use mobile devices such as smartphones or tablets to view detailed information such as floor plans or sectional diagrams of the palace. These appeared as transparent overlays, aiding in the understanding of the structure's design and engineering concepts.

MR technology introduced an entirely new level of interactivity. Visitors could participate in role-playing within the virtual palace, experiencing the court life of ancient times. For instance, they could act as court attendants preparing for a grand banquet or as scholars composing poetry in the palace gardens.

This multi-technology exhibition offered visitors an immersive cultural feast, blending education and entertainment seamlessly.

According to statistics, museums utilizing the virtual history strategy saw visitor engagement time increase by more than 30%, and satisfaction levels improved by approximately 20% (see Table 1).

**Table 1.** Comparison of Satisfaction Degrees between Traditional Exhibitions and Virtual Exhibitions

Exhibition Type	Increase in Visit Duration	Increase in Satisfaction
Traditional Exhibition	No significant change	No significant change
Virtual History Exhibition	Over 30%	Approximately 20%

### 3.2 Augmented Reality: Overlapping Physical Objects and Digital Shadows

#### 3.2.1 Technical Principles and Application Methods.

In the field of museum exhibition design, the application of Augmented Reality (AR) technology functions like magic, seamlessly blending virtual information with the real world, thereby creating a unique exhibition space that is both immersive and rich in informational content. The core of this technology lies in the clever overlay of digital information on physical exhibits. This approach preserves the inherent realism of the physical artifacts while utilizing digital means to fully showcase richer background knowledge and subtle details. As a result, visitors can delve deeper into the historical context, cultural significance, and associated stories of the exhibits while appreciating the physical items, significantly enhancing the overall exhibition experience[13].

To achieve this effect, exhibition designers need to carefully apply AR technology and create specialized digital information layers for each artifact. These digital layers act like a knowledge repository, containing a variety of information in different forms, such as detailed textual descriptions, high-quality images, engaging videos, and even realistic 3D models. When visitors use specific AR glasses or their own smartphones to scan the exhibits, these meticulously prepared digital details appear in a transparent overlay above or around the physical exhibits, creating a blended and seamless display of both virtual and real elements. This display effect breathes new life into the artifacts, allowing them to "tell their own stories" to the audience.

#### 3.2.2 Practical Case: "Digital First Congress — The Spiritual Home of Chinese Communists" Metaverse Key Scene Application Project.

This project, built on the technological advantages of China Unicom Group in 5G, Artificial Intelligence (AI), and Big Data, is based on the site of the First National Congress of the Communist Party of China and various revolutionary landmarks in Shanghai. It employs multiple metaverse-related technologies, including Digital Twin, Virtual Reality (VR), and Augmented Reality (AR), to construct a digitalized virtual space. The Digital Twin technology accurately replicates the appearance and internal structure of historically significant buildings such as the First National Congress site, allowing visitors to experience these important historical venues in a fully immersive virtual world. Through VR technology, users can wear specialized equipment to fully immerse themselves in the virtual historical scenes, traveling back in time to the era of the First National Congress over 100 years ago, experiencing the monumental historical period up close.

Meanwhile, AR technology integrates virtual historical information with real-world settings. For example, when visitors are on-site at the memorial, they can scan exhibits

or buildings with their smartphones or other mobile devices to access augmented reality information, including background history, character stories, and event details, further enriching the visitor experience.

Data shows that in exhibitions that utilize augmented reality technology, the level of understanding of exhibits by visitors has increased by approximately 40%, and visitor engagement has risen by more than 30% (as shown in Table 2).

**Table 2.** Comparison of Interactive Engagement between Traditional Exhibitions and Augmented Reality Exhibitions

Exhibition Type	Increase in Understanding	Increase in Interactive Engagement
Traditional Exhibition	No significant change	No significant change
Augmented Reality Exhibition	Approximately 40%	Over 30%

### 3.3 Interactive Exploration: Multi-Faceted Touch Experience

#### 3.3.1 Touch Technology and Interaction Design Philosophy.

In modern museum exhibition design, the importance of interactive exploration is increasingly prominent, transforming visitors' roles from passive observers to active explorers. Multi-faceted touch experiences have emerged as an innovative exhibition method based on this advanced concept. This approach utilizes multi-sided touch screens or devices to create a comprehensive, multi-angle interactive space, allowing visitors to freely explore and learn while fully engaging their subjective initiative.

The core of this experience lies in emphasizing participation and immersion, aiming to satisfy the unique interests and exploration rhythms of each visitor. To achieve a multi-faceted touch experience, the key is to cleverly integrate advanced touch technology with creative interaction design principles. Exhibition designers can set up large three-dimensional touch screens, which function like a magical knowledge cube, enabling multiple visitors to operate on different sides of the screen simultaneously. These touch screens are equipped with highly intelligent recognition capabilities that can accurately detect visitors' touch actions and provide corresponding content feedback in real-time. This immediate feedback mechanism fosters a strong sense of interaction with the exhibition content, enhancing visitors' sense of participation and desire to explore.

#### 3.3.2 Embodied Interaction and Immersive Experience Forms.

For example, in an exhibition showcasing ancient maps, the multi-faceted touch experience technology offers visitors unprecedented enjoyment. Visitors can approach the touch screen and, by selecting specific locations on the map, immediately access detailed historical, cultural, and geographical information. This information is presented in vivid text, exquisite images, or exciting videos, allowing visitors to virtually travel through time and learn about the prosperity, historical changes, and cultural significance of the location in ancient times. Furthermore, visitors can even view comparative images or videos showing the changes between past and present, gaining a direct sense of the passage of time.

In the "Digital First Congress — The Spiritual Home of Chinese Communists" metaverse key scene application at the Shanghai First Congress Memorial, party members from across the country can access this virtual space online and participate in an immersive party class. During this class, they can embody student avatars, interact with precious revolutionary relics, and engage in various tasks to deepen their understanding of the Party's history and founding spirit. This participatory experience, transcending time and space, greatly enhances the appeal and emotional impact of Party-building education.

To further strengthen immersion, exhibition designers skillfully combine environmental sound effects, lighting effects, and vibration feedback with the touch interactions, creating a more authentic and rich interactive experience. For instance, when visitors swipe their fingers on the map screen, corresponding environmental sound effects, such as the sound of horse hooves, wind, or street noise, accompany the action, as if they are walking along ancient roads. When touching significant locations, the screen emits unique light effects and subtle vibration feedback, enhancing the visitors' tactile connection to history. Additionally, the multi-faceted touch experience can incorporate engaging interactive games, such as historical quizzes or map puzzles. Visitors can compete with others in a light-hearted atmosphere while learning and reinforcing historical and cultural knowledge.

In the "Digital First Congress — The Spiritual Home of Chinese Communists" metaverse key scene application at the Shanghai First Congress Memorial, the museum created a narrative thread called the "Journey of the Original Intention," linking three important historical buildings: the Bowun Women's School, the site of the First Congress of the Communist Party of China, and Zhou Enlai's residence, forming four major themes: Hot-Blooded Era, Mountain and Sea Together, Three Meetings and One Class, and Online and Offline Integration.

In the Hot-Blooded Era theme, visitors can experience the social atmosphere and revolutionary spirit of the time, feeling the passion and enthusiasm of the revolutionaries. They can "tour" buildings like the site of the First Congress and Bowun Women's School, and learn about the great revolutionary stories behind them through 25 interactive points. In the Mountain and Sea Together theme, the virtual scene shows the development and great achievements of the Communist Party of China across different regions. In the Online and Offline Integration theme, the seamless connection between the virtual and real worlds allows visitors to enter the metaverse space for more information and interactive experiences while visiting the memorial hall.

**Table 3.** Comparison of participation in interactive games between traditional exhibitions and digital exhibitions

Exhibition Type	Stay Duration Increase	Interactive Game Participation Rate
Traditional Exhibition	No significant change	Relatively low
Multi-Faceted Touch Experience Exhibition	Around 25% increase	Over 70% participation

In exhibitions utilizing multi-faceted touch experiences, visitors' stay time significantly increases, and the participation in interactive games is also high. According to

surveys, the average stay time of visitors in such exhibitions increased by around 25%, and the participation rate in interactive games reached over 70% (as shown in Table 3).

### **3.4 Holographic Display: A Visual Fusion of Past and Present**

#### **3.4.1 Application of Holographic Technology in Exhibitions.**

Holographic display seamlessly integrates modern holographic technology with museum exhibitions, providing visitors with a visual experience that is both realistic and dreamlike. This method breaks the constraints of traditional two-dimensional displays, transforming exhibition content into a three-dimensional image that can be viewed from all angles, offering museums a unique platform for showcasing content in a more vivid and dynamic way.

For instance, in an exhibition showcasing ancient sculptures, the traditional display method involves placing the sculpture on a pedestal, with viewers only able to appreciate it from a fixed angle. However, holographic display can present the sculpture from all angles, allowing the audience to examine every detail, even the internal structure of the sculpture. This display method not only enhances the sense of participation and immersion for the audience but also enriches and diversifies the exhibition content.

#### **3.4.2 Creation of Surreal Visual Effects.**

In addition to displaying physical holographic images, holographic technology can also be combined with digital technologies to create surreal visual effects. For example, in an exhibition showcasing ancient warfare, holographic technology can be used to recreate intense battlefield scenes, allowing viewers to feel as if they are in the midst of an ancient war, experiencing the intensity and brutality firsthand. These surreal visual effects add an extra layer of artistry and creativity to museum exhibitions. Additionally, holographic displays can be combined with music, lighting, and other elements to create more impactful audiovisual effects, providing visitors with a deeper emotional experience.

An example from the Louvre Museum in France demonstrates the power of holographic technology. During an exhibition of ancient sculptures, the famous Venus de Milo statue was presented using holographic technology. Viewers were able to admire the statue from all angles, while also using digital tools to learn about its historical context and artistic significance. This exhibition attracted a large number of visitors, becoming a highlight of the museum's display.

## **4 Challenges Faced by Modern Digital Display Technologies in Museum Applications**

### **4.1 Cost and Maintenance of Technical Equipment**

Modern digital display technologies often require a significant amount of advanced equipment, such as virtual reality headsets, augmented reality devices, large touchscreens, and other interactive tools. The procurement costs for these devices can

be high, making it difficult for smaller museums or those with limited budgets to afford such technologies. Additionally, these devices require regular maintenance and updates to ensure they function properly and deliver high-quality displays. This maintenance also demands substantial human and material resources.

Statistics indicate that the cost of acquiring an advanced virtual reality display system can range from hundreds of thousands to even millions of yuan, with annual maintenance costs potentially exceeding tens of thousands of yuan (as shown in Table 4).

**Table 4.** The costs of digital technology equipment and its maintenance expenses

Equipment Type	Procurement Cost Range	Annual Maintenance Cost Range
Virtual Reality Equipment	Hundreds of thousands to millions of yuan	Tens of thousands of yuan or more
Augmented Reality Equipment	Tens of thousands to hundreds of thousands of yuan	Thousands to tens of thousands of yuan
Large Touchscreens	Tens of thousands to hundreds of thousands of yuan	Thousands to tens of thousands of yuan

#### 4.2 Lack of Technical Personnel

The application of modern digital display technologies requires specialized technical personnel for design, development, and maintenance. However, there is currently a shortage of professionals with expertise in digital display technologies in the museum sector. This results in museums facing technical challenges that cannot be resolved in a timely manner and exhibition effects that fail to meet expectations. Therefore, the training and recruitment of digital display technology personnel is a significant challenge faced by museums.

#### 4.3 Differences in Audience Experience and Adaptability

There may be significant differences in how audiences from different age groups, cultural backgrounds, and levels of technical familiarity accept and experience modern digital display technologies. Some older audiences may find new technologies unfamiliar and difficult to adapt to, while younger audiences may have higher expectations regarding technology. Therefore, when applying digital display technologies, museums need to fully consider the differences among audiences and design exhibition content and interactive methods that are suitable for various groups to enhance the overall audience experience.

Surveys show that younger audiences have a higher acceptance of digital display technologies, while older audiences have relatively lower acceptance. In exhibitions that utilize digital display technologies, the average satisfaction rate among younger audiences is around 80%, whereas the satisfaction rate among older audiences is only around 60% (as shown in Table 5).

**Table 5.** Comparison of digital experience satisfaction among audiences of different age groups

Audience Age Group	Satisfaction Rate
Young Audiences	Around 80%
Older Audiences	Around 60%

#### 4.4 Ensuring Content Quality and Authenticity

Although digital display technologies can bring rich visual effects and interactive experiences to museum exhibitions, there may be issues with content quality and authenticity. For example, some virtual scenes may have inaccuracies, and some augmented reality information may be incorrect. Therefore, museums need to carefully control the quality of the content when applying digital display technologies, ensuring the authenticity and accuracy of the exhibition content to enhance the educational value and credibility of the exhibition.

## 5 Strategies and Recommendations for Addressing Challenges

### 5.1 Reasonable Planning and Fundraising

When applying modern digital display technologies, museums should conduct reasonable planning and budget preparation. Based on their actual conditions and development needs, they should define the scope and key projects for the application of digital display technologies. At the same time, museums can raise funds through various channels, such as applying for government subsidies, partnering with enterprises, and launching crowdfunding campaigns, to ease the financial pressure of equipment procurement and maintenance. For example, some museums cooperate with technology companies to jointly develop digital display projects. The companies provide technical and financial support, while the museums offer cultural relics and professional knowledge, achieving a win-win situation.

### 5.2 Talent Development and Recruitment

Strengthening the training and recruitment of digital display technology professionals is crucial for museums to address these challenges. Museums can collaborate with universities and research institutions to offer digital display technology training courses and internship programs, cultivating professionals who understand both museum operations and digital display technologies. At the same time, they can recruit high-end technical talent to enhance the museum's technical level and innovation capabilities.

### 5.3 Audience Demand Research and Personalized Design

Museums should conduct audience demand research to understand the interests, visiting habits, and technological familiarity of different audience groups. Based on the research results, they can design personalized exhibition content and interactive experiences to meet the needs of different audience segments. For example, providing simple, easy-to-understand operation guides and assistive devices for elderly visitors, and creating more challenging and innovative interactive experience projects for younger audiences.

### 5.4 Content Review and Quality Control

Establishing a strict content review mechanism is essential to ensure that the exhibition content presented through digital display technologies is authentic, accurate, and of high quality. Museums can invite experts, scholars, and historians to review and evaluate the exhibition content, identifying and correcting any issues in a timely manner. Additionally, museums can improve and enhance the quality of exhibition content through audience feedback and third-party evaluations.

## 6 Conclusion

Modern digital display technologies have brought unprecedented opportunities to museums, but they also come with a series of challenges. In this new era, museum professionals need to delve into how to fully leverage the advantages of digital display technologies and overcome the challenges they face, transforming museums into vibrant, engaging, and educational public cultural spaces. By appropriately applying digital display technologies such as virtual history, augmented reality, interactive exploration, and holographic display, combined with effective measures to address the challenges, museums can offer more diverse and exciting exhibition experiences for visitors and promote the continuous development of the museum sector. In the future, as digital display technologies continue to innovate and develop, museum exhibition design is expected to embrace even broader prospects for growth.

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