The Digital Museography Paradigm: Integrating AI-Driven Curation for Dynamic Exhibition Experiences

Man Lai

Xilingol Museum of Inner Mongolia Autonomous Region, Inner Mongolia 026000

Abstract: The rise of digital museums has driven the transformation of museology from a static "cultural relic repository" model to a dynamic "cultural interaction space" paradigm. Empowered by technologies such as artificial intelligence, digital twin, and extended reality (XR), curatorial logic has shifted toward a "user-centric" approach, exhibition formats have evolved into multimodal interactions, and cultural dissemination has transcended temporal and spatial constraints. This paper establishes a theoretical framework for AI-driven curation based on foundational theories, and analyzes the implementation paths of dynamic exhibition experiences through four dimensions: curatorial logic achieved through user profiling, real-time data integration, and cross-media storytelling; spatial reconstruction utilizing digital twins, XR technology, and multimodal perception to create virtual-real hybrid spaces; interactive design leveraging natural interfaces, gamification mechanisms, and generative AI to stimulate audience engagement; and knowledge dissemination built on knowledge graphs, social sharing, and cross-cultural dialogue to construct an open cultural ecosystem. The formation of this digital museology paradigm not only restructures the mechanisms of knowledge production and dissemination in museums, but also transforms culture from a static "past tense" to a dynamic "present continuous," offering new possibilities for the inheritance of human civilization.

Keywords: dynamic exhibition experience; curatorial logic; spatial reconstruction; interactive design

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The rise of digital museums signifies the evolution of museology from a static "cultural relic repository" model to a dynamic paradigm of "cultural interaction spaces". Empowered by technologies like artificial intelligence, digital twins, and extended reality (XR), curatorial logic has shifted from being "object-centric" to "user-centered", exhibition formats have transitioned from one-way communication to multimodal interaction, and cultural dissemination has transcended spatiotemporal constraints to become fully immersive experiences. This transformation not only restructures the knowledge production and dissemination mechanisms of museums but also gives birth to a new paradigm of digital museology centered on the triadic interaction of "technology-cultural-user". Starting from theoretical foundations, this paper constructs an AI-driven curatorial framework and analyzes the implementation paths of dynamic exhibition experiences through four dimensions: curatorial logic, spatial reconstruction, interactive design, and knowledge dissemination.

1.Theoretical basis: Paradigm shift and theoretical support of digital Museum Studies

The formation of the paradigm of digital museum studies stems from the synergistic effect of technological revolution, cultural needs, and academic reflection. Traditional museum studies focus on "physical learning" as its core, emphasizing the material attributes and historical value of collections, while digital technology breaks through its physical boundaries[1]. Zhou Jingjing's "Four Stage Theory of Physical Learning" indicates that the transmission of museum object information needs to go through multiple links, and digital technology can dynamically reconstruct each link with the help of artificial intelligence. Traditional curation relies on expert knowledge and authority, while AI technology can extract cultural patterns from massive data and generate personalized narratives through natural language processing, computer vision, and machine learning algorithms. For example, the Qin Shihuang Imperial Mausoleum Museum uses AI image recognition technology to trigger the "cultural relics self description" function when the audience takes photos of Terra Cotta Warriors, forming a "object human technology" dialogue field. AI becomes the "co creator" of the exhibition and reconstructs the knowledge production mechanism.

About the author：Man Lai, Male, Mongolian. He holds a Master's degree in Cultural Heritage and Museology. He is a Curator at the Xilingol Museum, Inner Mongolia Autonomous Region. His primary research and professional focuses include museum social education, exhibition design, and digital museums.

From an academic perspective, the paradigm of digital museum studies integrates constructivist education, media archaeology, and interaction design theory. Constructivism emphasizes that users actively explore and construct knowledge, while digital technology provides interactive scenarios; Media archaeology focuses on technology reshaping cultural memory, while digital museums recreate history through VR; Interactive design theory guides exhibitions to enhance immersion, such as the "Naked Eye Exploration: 3D Adventure" experience area at Shaanxi History Museum, which follows a "perception cognition emotion" interactive loop.

2.Curatorial Logic: From linear narrative to dynamic generation paradigm breakthrough

2.1 Personalized narrative driven by user portrait

The narrative logic of traditional exhibitions is a one-way model of "curator preset audience acceptance", while AI technology achieves dynamic adaptation of narrative through user profiling analysis. For example, the NFT digital asset platform of Guangdong Provincial Museum uses blockchain technology to record the browsing behavior, stay time, and interaction preferences of visitors, and generates personalized recommendation lists through machine learning algorithms. When the audience approaches a cultural relic, AR glasses can automatically play historical stories related to their interests, such as 3D animations of weapon manufacturing processes for those interested in military, and dynamic maps of mural color evolution for those interested in art[2].

2.2 Curatorial optimization with real-time data feedback

AI's real-time analytical capabilities transform curation into a dynamic "design-test-iterate" process. The Shaanxi History Museum's "Ancient Wisdom—— Digital Integration Experience Exhibition" employs sensors to track visitor movement patterns, hotspot engagement, and interaction frequency[3]. Through natural language processing technology, it analyzes social media comments to generate "exhibition heat maps" and "sentiment analysis reports". Curatorial teams then optimize exhibit layouts by creating narrative connections between less-visited items and trending displays, or enhancing engagement through interactive installations in less-visited areas. This data-driven curation model keeps exhibitions perpetually "in-progress", continuously responding to audience needs.

Table 1 Data-driven curatorial optimization of "Ancient and Modern Wisdom" exhibition in Shaanxi History Museum

Optimization dimension	concrete measure	data sources	Optimized effectiveness
Exhibit layout adjustment	Form narrative associations between exhibits with low audience attention and popular exhibits	The sensor collects data on the audience's walking path and hot spots of stay; natural language processing technology analyzes social media comments to generate "exhibition heat map"	Enhance the narrative coherence of the exhibits and attract the audience's attention to the unpopular exhibits
Regional participation increased	Add interactive devices in unpopular areas	The frequency of audience interaction data collected by the sensor; the "emotional tendency report" reflects the audience's interest points	Improve the participation of unpopular areas, so that the popularity of each area of the exhibition is more balanced

2.3 Logical reconstruction of cross-media narrative

Digital technology has broken down the boundaries of media such as text, images, and videos, and curation requires the construction of a "hypertext" narrative framework. The "Unity of the World - Qin and Han Civilization Theme Exhibition" at Shaanxi History Museum adopts a three-layer structure of "main storyline+auxiliary storyline+multimedia installation": the main storyline presents the unified historical context of Qin and Han through

exhibits and exhibition boards, the auxiliary storyline plays the archaeological discovery process through digital screens, and the multimedia installation creates immersive light and shadow shows with themes such as "Dehua Zhi" and "Harmony of Heaven and Man".

3.Space Reconstruction: From physical container to virtual and real interactive field

3.1 Spatial reproduction of digital twin technology

Digital twin technology transforms physical space into interactive virtual fields through high-precision modeling and real-time rendering[4]. The "Digital Exhibition of Tang Tomb Murals" at Shaanxi History Museum utilizes 3D laser scanning and photogrammetry technology to construct digital twin models of five Tang tombs, including the tomb of Prince Zhanghuai and the tomb of Princess Yongtai. Visitors can wear VR devices to "step into" the tombs and observe the colors and layout of the murals in their original environment. What's even more innovative is that the exhibition uses motion capture technology to record the audience's gestures. When the audience points to the maid in the mural, the system triggers an animation to demonstrate the process of wearing her clothing, and overlays historical literature on the Tang Dynasty's clothing system.

3.2 Extended reality (XR) immersive experience

The "Time and Universe in the Tomb - Tang Tomb Mural Digital Exhibition" of Shaanxi History Museum has set up an MR experience area in the physical exhibition hall. After the audience wears a headset, the originally flat mural will come to life: the dancers in the music and dance picture begin to rotate, and the literati in the figure under the tree will recite poetry[5]. The audience can interact with virtual characters through gestures, such as choosing different costumes for dancers or modifying poetry for literati.

3.3 Spatial design of multimodal perception

The dynamic exhibition experience needs to stimulate the audience's visual, auditory, tactile, and even olfactory senses[6]. The "Prosperous Era Wall Collection - Tang Dynasty Mural Culture Special Exhibition" of Shaanxi History Museum incorporates environmental sound effects and odor simulation into AR guided tours: when the audience approaches the "Hunting Picture", their mobile phones will play the sound of horse hooves and barking dogs, while releasing a faint leather aroma; When approaching the 'Banquet Picture', the sound of guqin and the aroma of wine will be played. The exhibition sets up tactile feedback devices in the "Naked Eye Exploration: 3D Adventure" area. When the audience "touches" virtual cultural relics, the devices simulate the tactile sensation of different materials through micro vibrations.

4.Interaction Design: Participation Mechanism from Passive Acceptance to Active Exploration

4.1 Intuitive interaction of natural user interface (NUI)

NUI achieves human-computer interaction through natural behaviors such as voice, gestures, and eye contact, reducing the threshold for technological use. The "AR Insight · Time Journey" experience area of Shaanxi History Museum adopts high-precision SLAM spatial positioning technology[7]. Visitors do not need to operate equipment, only need to walk towards the target exhibit, and AR glasses will automatically recognize and overlay the explanatory content; If the audience is interested in a certain cultural relic, depth information can be triggered by staring, for example, when observing the patterns on bronze ware, the system will display a 3D animation of its casting process.

4.2 Participation incentive of gamification mechanism

Gamification enhances audience engagement through tasks, rewards, and social elements[8]. The "Mystery of Tang Dynasty Heritage Treasures" digital exhibition at Shaanxi History Museum transforms the exhibition content into a puzzle game: visitors need to observe the exhibits, crack codes, and complete interactive tasks to gradually uncover the secrets of the Hejiacun cellar. In the "Gold and Silver Artifact Making" level, the audience needs to operate virtual tools through gestures to cast a silver bowl according to the steps recorded in history. After success,

they will receive the title of "Tang Dynasty Craftsman" and unlock hidden exhibits.

4.3 Co-creation experience of generative AI

Generative AI enables audiences to become 'co creators' of exhibitions. The "Cultural and Museum Spirit" exhibition area of Shaanxi History Museum is equipped with a holographic interactive box, where visitors can design an "ideal Tang Dynasty cultural relic" through voice description. AI will generate a 3D model based on historical data and project it onto a holographic screen[9]. For example, if the audience says, 'I want to design a piece of clothing that combines elements of Hu and Han people,' AI will combine the characteristics of Hu clothing in Tang Dynasty murals with the form of Han clothing to generate multiple design schemes for the audience to choose from.

5.Knowledge dissemination: from unidirectional output to multidirectional dialogue in the cultural ecology

5.1 Semantic association of knowledge graph

AI achieves semantic association of cultural relic information by constructing a knowledge graph[10]. The "Digital Cultural Relics Library" of Shaanxi History Museum uses NLP technology to extract metadata such as the age, material, and function of exhibits, and links historical documents, archaeological reports, and academic research through entity linking technology. For example, when the audience browses a Tang Dynasty bronze mirror, the system will automatically display the distribution map of bronze mirrors unearthed during the same period, the timeline of the evolution of casting technology, and the records about the use of bronze mirrors in the Old Book of Tang.

5.2 Fission effect of social communication

Digital technology enables the viral dissemination of exhibition content through social media[11]. The "Spirit Snake Blessing" digital exhibition at Shaanxi History Museum features a "Cultural Relic Emojis Generation" function, where visitors can select exhibition images, add text and stickers, generate personalized emojis, and share them on their social media. The system will record the propagation path and interaction data of emoticons, providing analysis of the dissemination effect for the curation team. For example, the emoji of a Tang Dynasty tri colored figurine became popular due to its "cute and silly" style. Based on this, the curatorial team added interactive installations of the tri colored figurine in the physical exhibition and developed related cultural and creative products.

5.3 A global vision for intercultural dialogue

The digital museum breaks the limitations of geography and language, promoting cross-cultural dialogue. The digital exhibition "Huangdi of the Yellow River - Ecological Civilization and Historical Culture of the Yellow River Basin" at Shaanxi History Museum has attracted global audiences through multilingual support and adaptive interfaces. The exhibition features a "cultural comparison" function, allowing visitors to simultaneously view similar exhibits of the Yellow River civilization in China, the Nile civilization in Egypt, and the Ganges civilization in India[12]. AI will generate comparative analysis reports through NLP technology, such as comparing the urban planning of Chang'an and Baghdad in the Tang Dynasty, or analyzing the exchange of craftsmanship between Tang Sancai and Persian pottery.

6.Conclusion

The paradigm of digital museum studies has emerged under the impetus of technological revolution and cultural demand. Artificial intelligence drives curation and reshapes museums in all aspects. From personalized storytelling through user portraits to creating virtual and real spaces through digital twins; From intuitive interaction facilitated by natural user interfaces to semantic dissemination aided by knowledge graphs, museums have transformed from "cultural safes" to "cultural interaction fields". This transformation enhances the public cultural service efficiency of museums and opens up new paths for the inheritance of human civilization. With the support of digital technology, culture breaks away from static and actively engages in dialogue with users, technology, and the times in a dynamic

manner, showcasing new vitality and value.

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