



Visual Narrative of China's Aerospace Spirit: Design Strategies for Virtual Exhibition Halls

Qiyong He

College of Humanities, Xi'an Shiyou University, Xi'an 710065, Shaanxi, China.

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***Corresponding author:** Qiyong He, College of Humanities, Xi'an Shiyou University, Xi'an 710065, Shaanxi, China.

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Abstract

Communicating abstract and technical content, such as China's aerospace spirit, to the general public remains a significant challenge in digital heritage dissemination. This paper investigates visual narrative design in virtual exhibition halls, proposing an exploratory framework to bridge the gap between technical visibility and spiritual understanding. Utilizing theories of embodied cognition, we identify "semantic opacity"—defined as the cognitive disconnect between seeing physical artifacts and understanding their underlying values—as a major barrier in traditional displays. The study develops a "Five-Step Design Methodology" encompassing symbolic encoding, spatial sequencing, multimodal integration, interaction mapping, and aesthetic identity construction. This procedural framework emerged from the iterative design practice of an aerospace project in Xi'an and was further refined through expert evaluation. The research demonstrates how unified visual metaphors and sequential storytelling can transform virtual space into a cohesive digital journey. Design-led strategies, emphasizing sensory and narrative rhythms, are found to be effective in triggering cultural identification and reducing semantic opacity. Ultimately, this study provides a preliminary protocol for the digital dissemination of technological modernization heritage in the digital age.

Keywords

Aerospace spirit; visual narrative; virtual exhibition hall; design strategies; immersive experience

1. Introduction

The acceleration of digitalization is prompting contemporary museums to evolve into dynamic environments that prioritize visitor engagement over passive observation (Yang et al., 2025). This transformation is particularly significant for China's aerospace spirit, a specialized technological heritage that embodies the country's modernization journey. Despite its cultural importance, aerospace heritage often remains "semantically opaque" to the public, as traditional displays frequently fail to translate abstract scientific values into relatable visual narratives (Huang et al., 2026). While Virtual Reality (VR) and integrated XR platforms offer a resilient new frontier for cultural preservation (Shin et al., 2024; Buragohain et al., 2025), the efficacy of these virtual spaces depends fundamentally on design-led strategies rather than technical fidelity alone.

Our research addresses this challenge by proposing a preliminary framework for the visual narrative of aerospace spirit in virtual exhibition halls. By integrating theories of embodied cognition and narrative infrastructure, the following sections explore strategies such as symbolic encoding and sequential spatial storytelling. Taking a virtual project of an aerospace institution in Xi'an as a case study, the paper provides actionable design guidance to enhance cultural identity and ensure the sustainable dissemination of scientific heritage in the digital age.

2. Theoretical Logic of Virtual Narrative Design

The design of virtual exhibition halls is predicated on a multi-layered logic that transforms abstract values into tangible digital experiences. Our analysis conceptualizes the theoretical foundation through three distinct levels of design interaction.

2.1 The Cognitive Level: Embodied Interaction

In virtual domains, the visitor's experience is no longer confined to passive visual perception but is transformed into a dynamic interaction involving multi-sensory coordination. According to the embodied cognition theory discussed by Chen et al. (2025), successful cultural communication depends on activating the audience's bodily experiences. For the dissemination of aerospace culture, this implies a paradigm shift where the body becomes the subject of cognition (Ariya et al., 2025). Enabling users to perform physical acts—such as navigating a 3D spacecraft or triggering an interactive sequence via hand gestures—allows the virtual space to function as a cognitive extension, facilitating a deeper emotional connection.

2.2 The Narrative Level: Reducing Semantic Opacity

A recurring challenge in technological heritage is “semantic opacity,” which refers specifically to the inability of non-expert audiences to associate physical forms (e.g., a satellite model) with their historical and spiritual significance. Huang et al. (2026) argue that narrative serves as a “cognitive infrastructure” that can reduce this opacity in virtual spaces. Therefore, visual narrative design must provide the necessary “interpretive scaffolding” to bridge the gap between visible forms and invisible spiritual stakes. By synchronizing visual storytelling with the visitor's attention, designers can orchestrate a coherent logic that guides the audience through complex historical contexts (Goud et al., 2022).

2.3 The Spatial Level: Cognition and Navigation

The spatial layout of a virtual exhibition hall acts as the primary medium for storytelling. As explored by Zhang et al. (2024), optimizing navigational design elements is essential for enhancing spatial cognition in digital environments. Within an aerospace-themed hall, the spatial sequence must create a narrative rhythm that aligns with the visitor's cognitive habits. Strategic spatial metaphors—such as transitioning from a historically dense chamber to an expansive future hub—reinforce the temporal arc of China's aerospace progress. This spatio-temporal alignment allows visitors to maintain a clear sense of location while absorbing the multidimensional facets of the institutional spirit.

3. Design Methodology

To achieve a systematic translation of aerospace spirit into a virtual environment, this study proposes a “Five-Step Design Methodology.” This procedural framework emerged from the practical design workflow of the Xi'an project and was further refined through expert consultations during the design iteration.

The initial phase involves “Semantic Parsing and Symbolic Encoding,” where abstract concepts are deconstructed into iconographic markers, such as using a “mushroom cloud” to anchor the early foundational period. The second step, “Spatio-Narrative Sequencing,” focuses on arranging interconnected spaces to form a coherent story trajectory. This is followed by “Multimodal Technological Integration,” which matches specific immersive tools—like VR spacewalking—to the narrative content to enhance presence (Ariya et al., 2025). The fourth phase, “Adaptive Interaction Mapping,” defines trigger points to ensure that user behaviors lead to “value-inclusive” feedback, actively reinforcing the understanding of spiritual values (Goud et al., 2022). Finally, the “Aesthetic Identity Construction” phase establishes a unified visual language through a cohesive color palette and lighting rhythm, enhancing institutional recognition.

4. Practical Implementation and Design Reflection

The proposed methodology was validated through the design of a virtual exhibition hall for an aerospace research institution in Xi'an. This project, covering 5,000 virtual square meters and integrating over 80 high-fidelity 3D models, serves as an exploratory validation of the visual narrative strategies.

4.1 Construction of Unified Visual Metaphors

In the Xi'an project, abstract spiritual values were translated into a cohesive iconographic system. The aesthetic identity is built upon a palette of “Cosmic White” and “Deep-Space Blue,” punctuated by industrial grey textures to evoke technological precision. For example, the “Two Bombs, One Satellite” zone, the design utilized soft textures in the virtual rendering of a mushroom cloud sculpture to create a tactile visual contrast, emphasizing the humanistic “warmth” behind cold industrial history. Similarly, the UFO-deconstructed entrance in the “Blue Dream” hall serves as a metaphor for the inception of scientific curiosity. These strategic metaphors ensure that visitors can perceive the “spirit” through tangible symbolic forms.

4.2 Spatio-Temporal Narrative and Sequential Rhythm

The seven halls are arranged in a chronological sequence to form a continuous narrative trajectory. The journey moves through “M-shaped” and circular paths, guiding visitors from the foundations of the 1960s to future interstellar exploration. In the “Beidou Spirit” hall, a “Mirror Floor” design was implemented. As visitors walk through the virtual corridor, the reflection of satellite constellations beneath their feet effectively dissolves digital boundaries, helping visitors experience the “vastness” of navigation technology rather than merely reading data (Huang et al., 2026).

4.3 Multimodal Technological Integration and User Feedback

To assess the framework’s preliminary effectiveness, the project underwent a heuristic evaluation based on expert reviews and stakeholder feedback. Experienced designers and aerospace professionals indicated that the iconographic clarity of visual symbols effectively anchored abstract spiritual values to recognizable forms, thereby significantly reducing semantic opacity for non-expert audiences. Furthermore, the chronological spatial sequence established a coherent narrative flow, guiding visitors through the complex historical arc of progress without cognitive overload. The synergy between immersive VR technology and 3D acoustics elicited a profound emotional impact, fostering cultural resonance and transforming the virtual visit into a value-inclusive experience (Goud et al., 2022). As corroborated by facial expression analysis studies (Nubani & Öztürk, 2021), focusing on specific architectural details and the rhythm of spatial transitions is critical for triggering positive user responses in virtual environments. These qualitative reflections suggest that design-led storytelling is a reliable alternative to technical-centric displays for institutional heritage.

5. Conclusion

This study has established a preliminary framework for the visual narrative design of China’s aerospace spirit within virtual exhibition halls. By conceptualizing the “Five-Step Design Methodology,” the research provides a replicable pathway for the digital preservation of technological institutional heritage. The implementation of the Xi’an project demonstrates that a design-led approach, rooted in embodied cognition, can effectively reduce semantic opacity and transform abstract scientific values into immersive experiences. While the current findings are exploratory and require further large-scale validation, they highlight the critical necessity of a synergy between immersive technology and narrative depth. Future work will investigate the integration of AI-driven curators to provide more personalized and adaptive narrative experiences for diverse global audiences.

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Declaration on the Use of AI Tools

The author utilized Google’s Large Language Model (Gemini) for language refinement and readability improvement of the manuscript. All scientific content, design strategies, case interpretations, and final conclusions were critically reviewed, verified, and approved by the author.

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