DIGITAL EXHIBITION ENHANCE VALUE INTERPRETATION AND COMMUNITY SHARING: PRACTICES OF BEIJING CENTRAL AXIS

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ABSTRACT:

The use of multiple digital technologies has addressed conventional exhibition display issues, improving public experience, and aiding in the understanding of historical changes in cultural heritage. This facilitates community sharing and international promotion. Furthermore, the promotion of novel digital application scenarios can encourage the growth of cultural consumption and the digital creativity industry. Beijing's Central Axis is a remarkable and well-preserved example of a traditional central axis in China's capital cities. It is comprised of numerous building complexes and archaeological sites located within the old city. This axis was first constructed in the 13th century, shaped in the 16th century, and continues to thrive today while remaining open to the future. By assessing its dynamic "growth" and "living" value, we have devised an innovative interpretation system plan that includes Augmented Reality Tours, immersive exhibitions in historical buildings, online exhibitions, and a series of public activities. The pilot project, implemented at the Drum Tower located at the northern end of the Central Axis, involved careful restoration and scientific transformation, accurate heritage documentation, and digital reconstruction. Digital creativity empowered and activated the historical building, achieving a comprehensive balance of conservation, utilization, and economics. The exhibition has garnered favorable feedback, particularly from the younger generation, who appreciate the combination of ancient cultural heritage themes and modern digital immersive displays.

RESEARCH BACKGROUND

UNESCO defines heritage as "our legacy from the past, what we live with today, and what we pass on to future generations." (UNESCO World Heritage Centre, 2023) Scholars have made significant strides in heritage conservation theory and practice in the last 50 years, achieving both successes and challenges. As we look towards the future, it is critical to view World Heritage as a source of resilience, humanity, and innovation.

The balance between preservation and usage is complex issue in heritage conservation. In the era of rapid technological advancement and information explosion, selecting an appropriate technology that can directly and precisely support the research, conservation, and communication of cultural heritage has become a critical and fundamental issue for heritage digitization (He, 2012). In recent years, the public's growing demand for high-quality cultural experiences has led to an increasing demand for exhibition-viewing experiences that prioritize storytelling, fun, and creativity. This has resulted in the emergence of various forms of digital creativity in cultural and museum contexts (Yu and Ma, 2021). It is crucial for our generation to better understand and respect our cultural heritage to ensure that we can pass it on to future generations.

In the context of the exhibition and interpretation of Beijing's Central Axis, we have established an innovative process centered around "value interpretation." This process systematically arranges value interpretation tasks at the macro level while also addressing specific protection and utilization issues at the micro level. The project leader has a dual identity as both a scientist and a curator, combining accurate research and documentation of cultural relics and buildings with multi-sensory digital technologies to tell an on-site story that meets the authenticity standards of cultural heritage and elicits emotional resonance from non-professionals.

1. BRIEF OVERVIEW OF BEIJING CENTRAL AXIS

1.1 A Historical Axis co-exists with the Contemporary City

Beijing Central Axis is an exemplary model of traditional Chinese capital city central axes, exhibiting a mature stage of development. The axis runs for 7.8 kilometers from north to south, and its layout and functional organization have governed the overall spatial structure of the old city of Beijing for over seven centuries. Originally built in the 13th century and further refined in the 16th century, it comprises a group of building complexes and archaeological sites, which connect state ceremonial sites with city facilities, creating a well-balanced, symmetrical, and magnificent sense of order. The central axis has witnessed numerous historical events, including the founding of China, and as a cultural concept, it continues to play a crucial role in the emotional connection of people with their urban environment.

The conservation of Beijing Central Axis has been identified as a priority in the *Beijing Urban Master Plan (2016-2035)*. At the northern end of the axis stand the Bell and Drum Towers. The axis then runs south through the Wanning Bridge and the Jingshan Hill, the Forbidden City, the Upright Gate, the Tian'anmen Gate, the Outer Jinshui Bridges, the Tian'anmen Square Complex, the Zhengyangmen Gate, the Southern Section Road Archaeological Sites, and finally reaches the Yongdingmen Gate at its southern end. The Imperial Ancestral Temple, the Altar of Land and Grain, the Temple of Heaven, and the Altar of the God of Agriculture are located on the east and west sides of the axis. In the latest report submitted for world cultural heritage status, the nominated property includes 15 components that can be categorized into five types, comprising imperial palaces and gardens, imperial sacrificial buildings, ancient city management facilities, national ceremonial and public buildings, and central axis roads remains. The buffer zone surrounding the nominated property is also

covered in the application and includes the urban area that forms the immediate historic setting, including historic water systems, roads, cultural areas, and visual corridors, ensuring the comprehensive conservation of the property. (National Cultural Heritage Administration of the People’s Republic of China., 2023)

Figure 1. Overlook from Zhengyang Gate to Drum Tower
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Figure 2. Overlook from Yongding Gate to Zhengyang Gate
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Position sequence	Component	Category
1	Bell and Drum Towers	Ancient City Management Facilities
2	Wanning Bridge	Central Axis Roads Remains
3	Jingshan Hill	Imperial Palaces and Gardens
4	Forbidden city	
5	Imperial Ancestral Temple	Imperial Sacrificial Buildings
6	Altar of Land and Grain	
7	Upright Gate	Imperial Palaces and Gardens
8	Tian'anmen Gate	National Ceremonial and Public Buildings
9	Outer Jinshui Bridges	
10	Tian'anmen Square Complex	
11	Zhengyangmen Gate	Ancient City Management Facilities
12	Temple of Heaven	Imperial Sacrificial Buildings
13	Altar of the God of Agriculture	
14	Southern Section Road Archeological Sites	Central Axis Roads Remains
15	Yongdingmen Gate	Ancient City Management Facilities

Table 1. Components of Beijing Central Axis

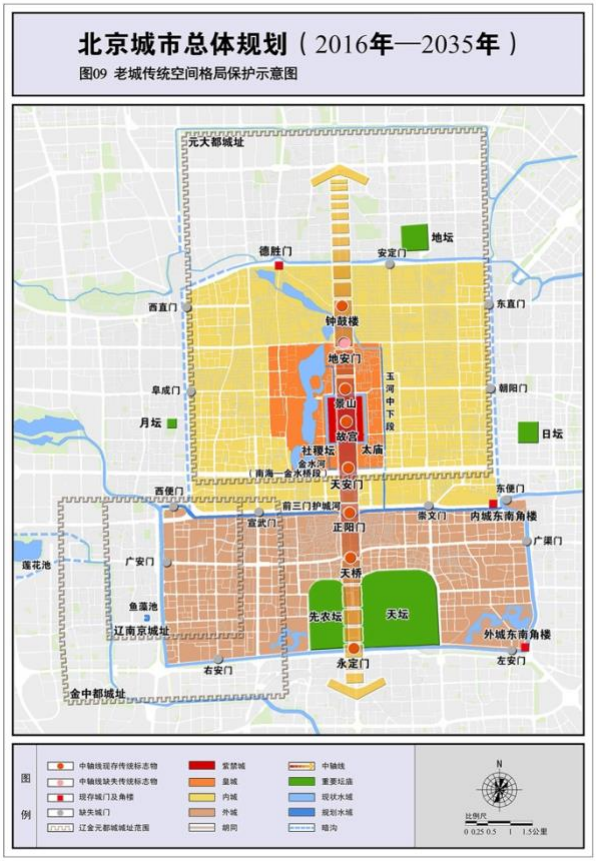


Figure 3. The configuration of the old city of Beijing© Beijing Urban Master Plan, 2016

1.2 Vigorous Axis, Upholding Diversity

The Central Axis of Beijing is characterized by its integrity, consistency, and continuous growth as an urban space that is closely tied to the old city of Beijing. The symbiosis of history and contemporary life, as well as the preservation and inheritance of cultural heritage, are fundamental to its core values.

Many renowned international scholars have acknowledged the significance of the Central Axis. During the International Symposium of the Conservation and Protection of Beijing Central Axis in 2020, Mario Santana Quintero asserted that it represents a geometric axis that embodies spatial relationships and a concept that has governed the development and use of land for over seven centuries. This concept holds far-reaching implications for the history of China and the world. Alfredo Condi argued that the Beijing Central Axis should be regarded as a unified and evolving whole, where buildings from different periods and types can be incorporated into the heritage composition. Edward Denison further added that the application of the Beijing Central Axis for World Heritage status provides an opportunity to acknowledge non-Western perspectives, which can aid in understanding the material heritage along the central axis. The perspective of "historical precipitation" can help us appreciate the ongoing process of the city's evolution and avoid the rigid preservation of any element.

In summary, the Beijing Central Axis represents a unique urban space with values of integrity, continuity, and cultural heritage. Its significance has been recognized by scholars such as Mario Santana Quintero, Alfredo Condi, and Edward Denison, who

advocate for a holistic and process-based approach to its preservation.

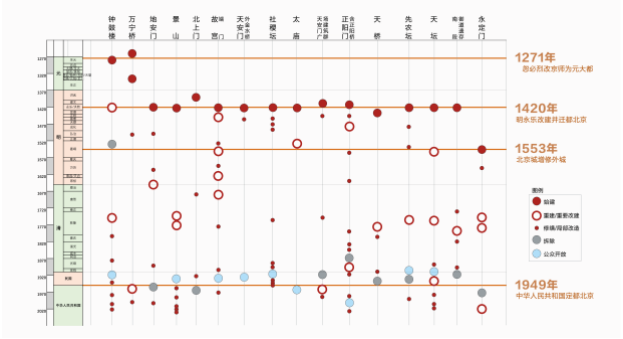


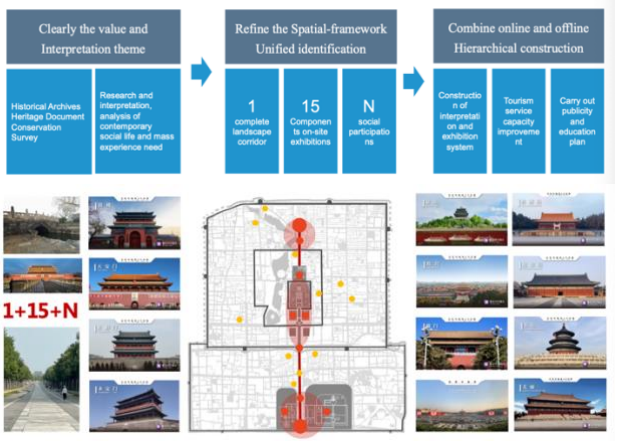
Figure 4. Pedigree Chart of Beijing Central Axis

Figure 5. Space Rhythm Analysis Chart of Beijing Central Axis

2. EXHIBITION AND INTERPRETATION SYSTEM PLANNING

2.1 General Principles

The Beijing Central Axis Exhibition System Plan serves as the overarching blueprint and strategic guide for the development of the central axis exhibition and related display systems. It has been formulated based on *the World Heritage Application* and *the Beijing Central Axis Cultural Heritage Protection Regulations*, providing a systematic and standardized framework for different management entities to follow. By doing so, the plan helps to ensure the coherent and well-organized implementation of the central axis exhibition and interpretation initiatives, while also promoting a unified and comprehensive approach to their design and execution.



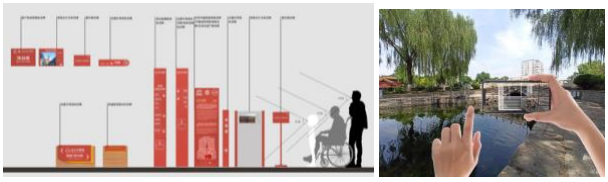


Figure 6. Working Framework

2.2 Three-level Spatial-framework

Drawing upon the inherent value characteristics of the central axis, a comprehensive three-level spatial framework has been proposed, denoted as "1+15+N." The framework is designed to facilitate a cohesive and immersive experience for visitors while also providing a diverse range of opportunities for social participation. At the first level, a complete landscape corridor will be established, complemented by unified visual guide signboards and AR Tour services. This will help visitors navigate the central axis with ease, while also providing an enhanced understanding of the historical and cultural significance of the area. At the second level, 15 innovative on-site exhibitions will be created, aiming to provide visitors with a more in-depth understanding of the central axis, and to enrich their experience by showcasing the unique characteristics of different historical periods and sites. Finally, the third level is characterized by multiple (symbolized by “N”) decentralized and diversified ways of social participation, including community-level cultural cabins, cultural visiting roads, online exhibitions, and related cultural activities. These opportunities will provide visitors with a more personalized experience, allowing them to engage with the central axis in ways that best suit their interests and preferences. Overall, the three-level spatial framework seeks to guide and standardize the construction of the central axis exhibition and interpretation systems under a unified thinking and framework, while also promoting accessibility, inclusivity, and community participation.

2.3 Value Interpretation Requirements

It is important to emphasize that each heritage site should adhere to the display guidelines of "value first, multiple integration, dynamic and static combination." This approach entails not only a comprehensive and detailed interpretation of the individual characteristics of each site but also an explanation of its contribution to the overall value of the central axis. Through a continuous series of activities, it is necessary to rebuild the emotional relationship between the community and the heritage in order to stimulate internal motivation for the protection and preservation of these valuable cultural assets.

2.4 Diversified digital forms combining online and offline

Digital creative exhibition forms offer a wide range of possibilities. Online exhibitions, for instance, can take full advantage of the lightweight characteristics of digital technology, offering a "simple, direct, fast" experience that is not limited by time, location, climate, or other objective factors. As a result, online exhibitions can effectively broaden the audience scope and widely promote digital content through Internet dissemination. Conversely, offline digital creative experience forms often excel in creativity, interactivity, and overall experience, providing a rich, immersive exhibition experience that offers "perceptual experience" advantages in terms of depth, comprehensiveness, and multidimensionality. Such immersive exhibitions provide visitors with a more detailed and comprehensive visual and auditory interaction,

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which deepens their understanding and recognition of cultural heritage.

3. IMMERCIVE EXHIBITION AT DRUM TOWERS

3.1 Location and History

The Bell Tower and Drum Tower form an integral part of a complex that serves as a landmark at the northern end of the Central Axis. Originally built in 1272, these towers played a vital role as the time measurement center during the Yuan, Ming, and Qing dynasties. The construction of these two towers to keep time for the city was a pioneering achievement of the Yuan Dynasty's capital, Dadu. This achievement was a reflection of ancient China's remarkable advancements in urban planning, social management, and calendar systems. (Wang, 2022)

Figure 7. Bell Tower and Drum Tower

3.2 Innovation Working methods

The whole process of implementing this project includes heritage survey and documentation, feature mining and value evaluation, interpretation outline and content design, digital exhibition items and interaction, exhibition construction, and post-maintenance.

This project has five innovative characteristics: Firstly, it strictly adheres to the principle of "protection first and minimum intervention" by setting up a special class for cultural relics protection to ensure the safety and reliability of the design and exhibition of cultural relics in the building. Secondly, it completes the transformation from the value excavation of cultural relics and buildings to the design of exhibition items and makes up for the congenital defect of the lack of collections. Thirdly, the design and application of multimedia exhibition items enhance the visibility and interactivity of the exhibition. The central coupon hole digital immersion exhibition has injected new vitality into the ancient architectural space. Fourthly, the telling of the story of time establishes the link between the public and history. Finally, modern technology has made it possible to expand the fixed architectural space indefinitely and has also created conditions for the multi-scene application of space.

3.3 Building survey and Conservation Design

The ground floor of the Drum Tower was previously used for commercial purposes. To restore its original appearance, the design removed all later additions, connecting all the arches with each other. The central vault is particularly high.

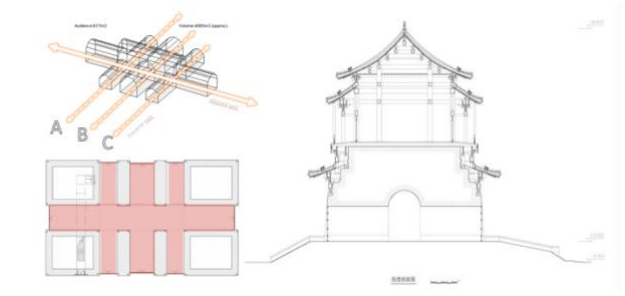


Figure 8. Archway of Drum Tower

Through archaeological surveys, the original earthen wall covered by the subsequent paint layer on the inner surface of the northwest archway has been uncovered. The wall, colored in a light-yellow shade, was constructed from loess, sticky rice, and alum in a 100:7.5:5 ratio, a common construction method employed for imperial buildings during the Ming and Qing dynasties.

Figure 9. Revealed Original Earthen and Imitate color match

To enhance the accuracy and precision of our assessment, we conducted three-dimensional laser scanning of both the arch wall and the ground. We then utilized wall deformation analysis to aid in evaluating structural stability, while also speculating and analyzing the pier and abutment brickwork forms. Additionally, we performed acoustic environment detection and analysis of the interior of the arches to further inform our evaluations.

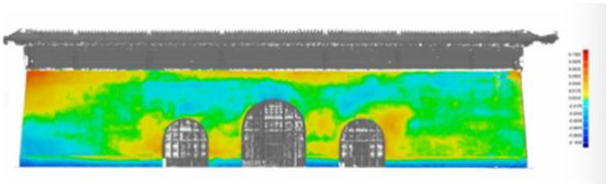


Figure 10. Wall Flatness Analysis

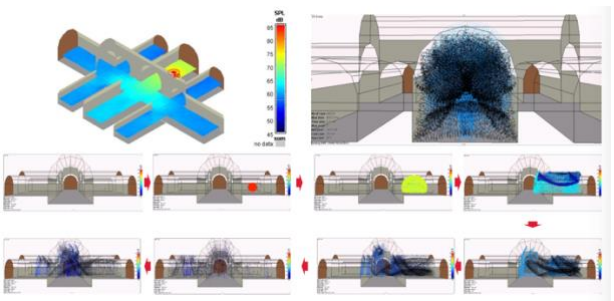


Figure 11. Acoustic Environment Detection and Analysis

The implementation of a prefabricated arch-shaped steel framework has resulted in a self-balanced structure that is independent of the heritage property. The design features mechanic counterweights and resilient legs, which exerts no

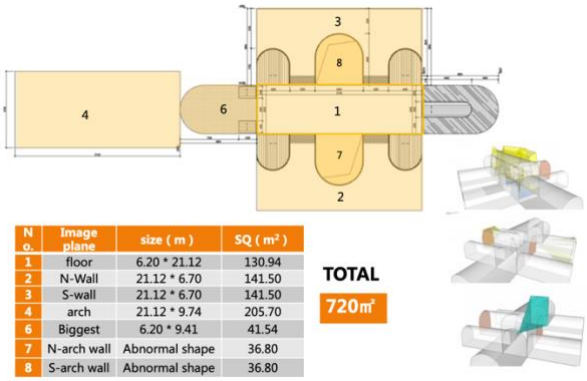
stress on the walls, and ensures proper ventilation. The use of module-based, prefabricated presentation structure minimizes interventions during construction, thereby ensuring safety and reversibility. Additionally, the white metal framework creates a sharp contrast with the ancient building, exemplifying contemporaneity, and identifiability in accordance with international conservation principles.

Figure 12. The Self-balancing steel frame structure

3.4 Creative Design of Double-Mode Immersive Theater

Digital art and information technology enable a dual experience within a confined space. An immersive theater is situated in the central arch, measuring 11.4m high and having a projected area of 720 ㎡, creating a vast immersive experience space of 3000 m³. There are two contexts in this space: the realistic and the digital. In the realistic context, visitors can observe the Jingshan Hill and the Bell Tower through the unobstructed glass windows added during the Republican Period. In the digital context, immersive videos and majestic buildings merge to present a new cultural experience. The central control system sets the timeline, and the two modes switch automatically.

Figure 13. Double-Model of The Middle Arch



No.	Image plane	size (m)	SQ (m²)
1	floor	6.20 * 21.12	130.94
2	N-Wall	21.12 * 6.70	141.50
3	S-wall	21.12 * 6.70	141.50
4	arch	21.12 * 9.74	205.70
6	Biggest	6.20 * 9.41	41.54
7	N-arch wall	Abnormal shape	36.80
8	S-arch wall	Abnormal shape	36.80

TOTAL
720㎡

Figure 13. Image Plane Design

Figure 14. Public Viewing the Immersive Films

Apart from the powerful characteristic arch space, immersive film constitutes the soul of the exhibition. The film, titled "Resonance," embodies three meanings: first, the sound of the bell and the drum resonate; second, the ancient and modern time resonate; and third, there is an emotional resonance between objects and people.

The film commences with "drum beating and bell chiming from sundown to daybreak" and delves into the Chinese cosmological view of the sky and the earth, timing and observation, and the Chinese instrument timing system's wisdom. It explores the evolution of the urban pattern from Dadu to Beijing during the Ming and Qing dynasties and the Chinese concept of city management. As the film travels from south to north along the central axis, it halts at the Drum Tower's first floor to witness the day symbolized by the light and shadow changes. The film features the 108 drums representing the 24 solar terms and the bells that resound throughout the city, culminating in the atmosphere of "sound and politics" in the imperial inscription of the bell tower rebuilt by Qianlong. Finally, the "time axis" emerges slowly, accompanied by a warm soundtrack, presenting the passage of 750 years and recounting the story of time with a sense of ceremony.

Figure 15. Time Axis

3.5 Other Ingenious Designs

Two sets of transparent screens skillfully float in front of the old Beijing map, reflecting the "Beijing Time" operation system of the front drum, the back bell, and the city's overall command. The Bell Tower and the Drum Tower stand vertically in the north and south, playing two powerful and solemn notes. Their sound reverberates over the city, carrying memories with chimes and beats. The two buildings embody the wisdom of ancient China, telling the standard "Beijing Time" for over 600 years with their special amplification system.

The whole wall map is based on the capital map of Qianlong in the Qing Dynasty. Through spatial modeling and acoustic simulation, the size of the Bell Tower bells that can be heard at different points in the old city is calculated.

Figure 16. "Beijing Time" operation system

Different from the all-day time report of Western clock towers, the drum beats and bell chimes of the Bell and Drum Towers in Beijing signaled sundown and daybreak every day. The timekeeping system comprised a complete set of devices, including the steel-shaped timekeeper, the bronze clepsydra, the incense clock, the drums, and the bell. To announce each night watch period, the drums would be beaten, and the bell would be struck exactly 108 times, respectively. Such drum beats or bell chimes would be performed in two rotating rounds, each containing 18 in a fast tempo, 18 in a slow tempo, and 18 in a moderate tempo. The number 108 represents a year that includes 12 months, 24 solar terms, and 72 pentads in Chinese culture.

Figure 17. Building Model in Mirror Reflection

Since the clock tower building's sound transmission resonance cavity structure for "amplification" is the unique feature of the cultural relic, the transparent acrylic combination form shows the audience the internal structure that is not easy to understand.

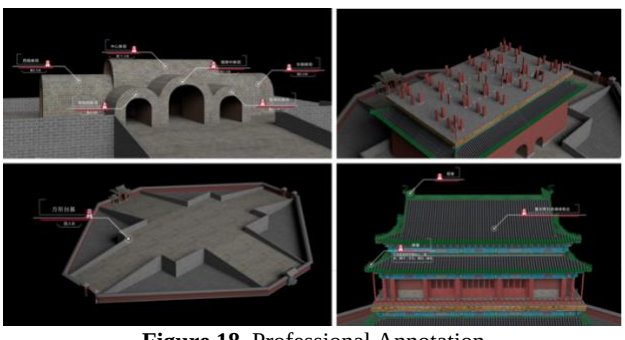


Figure 18. Professional Annotation

Figure 19. Digitally Repaired of the Old Drum

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The remaining old drum from the Qing Dynasty was digitally repaired, and the 25 large drums of the Jiaqing Dynasty were copied based on the records of Qing Dynasty documents and interviews with old craftsmen.

In ancient China, there were two methods of time measurement. One method involved observing the regular movements of celestial bodies, such as with a sundial. The other method involved finding events that could determine time, repeating those events, and measuring time by accumulating their duration. Representative devices of this kind include the clepsydra, incense clock, and stele-shaped timekeeper.

Figure 20. Digital interactive device of Timekeeping Equipment

In addition to the historical narrative mentioned above, the exhibition also highlights individual stories. The area surrounding the Bell and Drum Towers was a bustling commercial quarter during the Yuan, Ming, and Qing dynasties. Despite their majestic appearance as grand architecture, the Bell and Drum Towers were converted into the earliest institute for popular education during the Republican Period. Today, the Bell and Drum Towers, which have stood for centuries, evoke warm memories and a sense of affinity with humanity.

Figure 21. Sound Interactive Art Installation

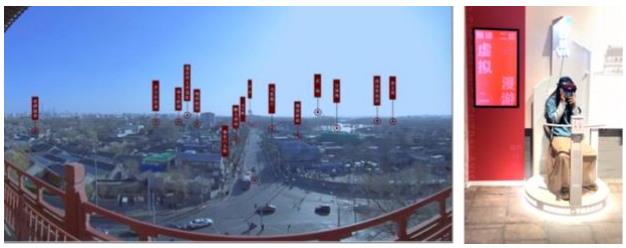

Figure 22. Self-service VR

3.6 Operation effect and feedback

The exhibition has attracted 137,524 visitors in just 63 days, which is close to the annual number of visitors prior to the exhibition. There has been a noticeable increase in the number of young people visiting the Drum Tower. The exhibition has received a rating of 4.9 out of 5 on social media platforms. Additionally, 1884 sets of self-punched postcards and 600 pieces of plastic art ice-cream have been sold. The revenue generated from the exhibition has increased by nearly 2.85 million yuan, indicating the immense potential for growth in cultural consumption.

4. 2.5D ONLINE-EXHIBITION

4.1 Value Interpretation and Creative design

Given that online access is characterized by short and fast, fragmented user behavior and personal interaction, "value interpretation" and "user experience" have become important considerations. Firstly, the display interface must be innovative and engaging to attract visitors to stay. Secondly, knowledge and information should be presented in a layered and concise interactive form to cater to the access needs of different levels of audiences. Lastly, we should deeply integrate culture, art, and technology.

The exhibition focuses on the unique heritage value characteristics of the "magnificent order of space" and "symbiosis of history and the present" of the central axis. To showcase this, the exhibition employs parallax rolling patent exhibition technology to build a three-dimensional picture scroll from the Yongding Gate to the Bell and Drum Tower. The exhibition offers a complete scene simulation of the 7.8 km space landscape. The two-dimensional and three-dimensional integration and unified monochrome treatment are used for accurate building models to highlight their integrity. Moreover, parts that have existed in history but disappeared in the future, such as overpasses, are presented in a translucent form. A diachronic translucent photo version is also set up in front of the building to establish the connection between time and space.

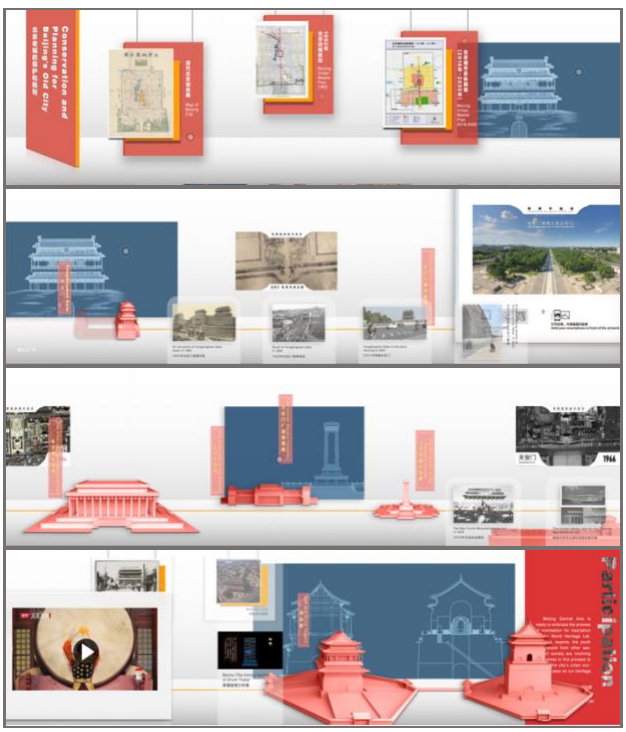

Figure 23. Screen capture of the 2.5D online-exhibition

The exhibition offers a unique way for viewers to experience the spatial landscape and rhythm changes along the central axis in a traditional Chinese fashion. By browsing horizontally from left to right in the computer or mobile phone, like the slow expansion of a Chinese painting scroll, viewers can intuitively feel the ups and downs of the heritage sites' spatial distance and real sense of space. Moreover, the heritage points on the axis

are placed according to their real spatial distance, and the building models use the same zoom ratio, allowing the audience to experience the size, distance, and proximity of the sites.

During the browsing process, photos of different periods overlap in front of the building model through scene displacement, creating various space-time illusions. The exhibition also uses an innovative approach to present the information. The concise spatial interface is enriched with interactive hotspots to link multiple heterogeneous data, such as video, audio, graphics, and text. This replaces the tedious and lengthy straightforward narration, making it easy for ordinary users to quickly browse and allowing deep users to choose to read deeper extended information.

Historical archives, photos of different periods, and mapping drawings are linked with the relevant heritage space to show the authenticity, integrity, continuity, and diversity of the central axis comprehensively.

4.2 Operation effect and feedback

The panoramic spatial perspective, combined with a clear and intuitive overall structure and dynamic "growth" expression, helps to enhance the understanding of cross-cultural users and supplements the experience that cannot be obtained in physical space. The use of load balancing and elastic computing technology based on a cloud computing platform, along with whole station acceleration and CDN acceleration, allows for the smooth online access of massive dynamic and static resources and supports multiple users to watch the exhibition simultaneously. During the online test period, the exhibition received positive feedback with the number of independent visitors per day reaching 2000+ and the number of page hits per capita approaching 300 (PV/UV), far exceeding the user stickiness of traditional websites.

5. TEMPORARY EXHIBITION AND ACTIVITIES

5.1 RE-BOX Shines in the 2022 Winter Olympics

RE-BOX (Assembled Intensive Digital Immersion Time and Space cabin, ZL 202021509311.8) is a highly integrated mobile digital museum that combines intelligent equipment with digital twins, digital reconstruction, and immersive high-definition images. It covers an area of only 40 square meters and utilizes 100% prefabricated modularization components that can be rapidly disassembled without welding and recycled. It offers three functions: immersive theatre, VR experience, and AR interaction.

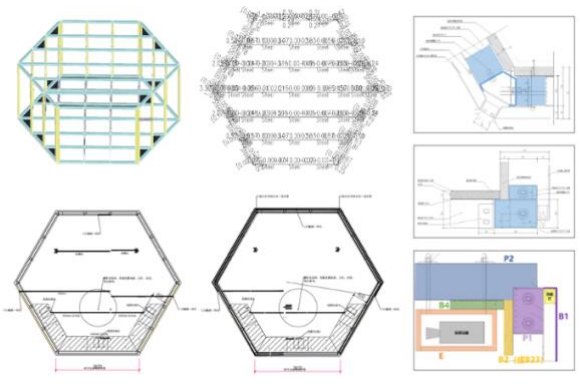

Figure 24. Cabin Design drawings

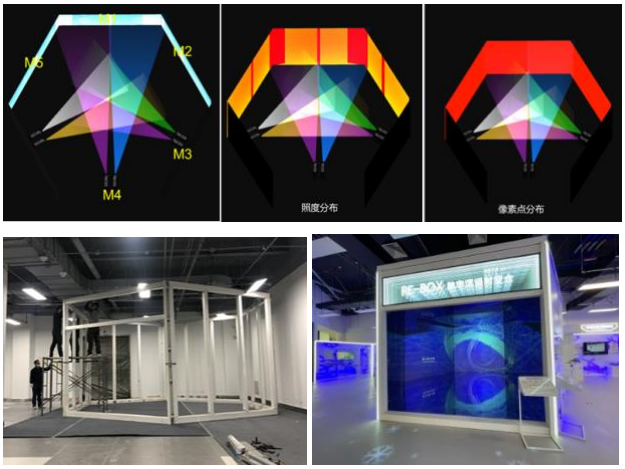

Figure 25. Products light path, Construction and Appearance

Figure 26. Experience and feedback of foreign athletes

From February 1st - 20th , 2022, RE-BOX was settled in the Winter Olympic Village and became the most popular area, receiving thousands of athletes who experienced the charm of Beijing Central Axis. Foreign athletes have highly evaluated the experience, stating that although they were unable to visit the Forbidden City due to epidemic isolation, they could still immerse themselves in the fantastic RE-BOX and feel the essence of the Beijing Central Axis.

5.2 Abundant Activities

Figure 27. Scientific Salon(UL); Youth Education(UM); Food cycling map(R); Jazz Concert (DL); Music TV Show(DM);

Figure 28. People's messages support Beijing Central Axis

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6. CONCLUSION

The immersive digital exhibition of built heritage represents a significant advancement in the display and utilization of heritage while strictly adhering to cultural relic protection norms. It acknowledges that the object of protection is also the object of utilization, and that the building itself serves as both exhibition hall and the most important exhibit. In designing the exhibition space, it is crucial to fully respect the historical pattern and protection requirements of ancient buildings, while also catering to the contemporary audience's needs for activities and experience. Furthermore, the exhibition's content must be presented in a way that quickly conveys information in limited time and space, providing an exclusive local experience through coherent narrative clues. This approach ensures that the cultural heritage's safety is guaranteed, its value is highlighted, and a virtuous cycle is established from protection to renewal. Overall, the digital immersive exhibition of built heritage offers a promising way to connect the past with the present and the future, and to promote cultural exchange and understanding on a global scale.

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