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Research on Temporal Structures and Cultural Memory Mechanisms in Digital Exhibition Design of Intangible Cultural Heritage

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Abstract: ***With the rapid penetration of digital technologies into the field of cultural presentation, the modes of representation and pathways of understanding for intangible cultural heritage (ICH) are undergoing profound transformation. Among these changes, temporal structure, as a core element embedded in ICH practices, is being reorganized and reinterpreted within digital exhibition environments. Taking "temporality" as its analytical point of departure, this study examines how digital media reshape the indigenous rhythms of ICH through mechanisms of compression, reconstruction, and participation, and further analyzes how such temporal restructuring influences the formation of cultural memory. The study proposes a three-layer temporal structure model—authentic time, representational time, and experiential time—and summarizes the temporal translation methods found in various media forms, including video, immersive environments, interactive systems, and algorithm-driven platforms. Based on this model, the paper identifies four cultural memory mechanisms in digital ICH exhibition: visualization, contextualization, enactment, and communalization. The findings suggest that digitization does not simply reproduce traditional temporalities; rather, it generates composite temporal structures shaped through design mediation, media logic, and participant behavior, thereby influencing how cultural memory is generated and disseminated. This analysis provides theoretical grounding and methodological insight for temporal design and memory construction in the digital display of intangible cultural heritage.***

Keywords: Temporality, Cultural memory, Intangible cultural heritage, Digital design.

1. Introduction

In the context of accelerating digital transformation, the relationship between intangible cultural heritage (ICH) and its modes of representation is undergoing profound restructuring. As digital visualization, interactive media, and immersive technologies continue to expand, the way in which ICH is experienced, interpreted, and transmitted has begun to move beyond material carriers and physical rituals. Compared with tangible heritage, however, the representational challenge of intangible heritage lies not only in the absence of physical form but also in its deep dependence on time—including temporal rhythms, processual sequences, seasonal cycles, ritual durations, and embodied repetitions. Traditional ICH practices are inseparable from their temporal structures, and this temporality is essential for generating meaning and maintaining cultural memory. Consequently, when ICH is brought into digital spaces, how to reconstruct temporal structures becomes a central issue.

Existing research on digital ICH presentation has mostly focused on content visualization, narrative expression, experiential enhancement, and technological innovation. Scholars have discussed fields such as digital archiving, interactive installations, VR/AR reconstruction, and immersive storytelling. However, although these studies have expanded the methods for representing ICH, they rarely address temporality as an independent analytical dimension. Only a few works have pointed out that digital media inevitably reshape the temporal logic of heritage, but most discussions remain descriptive and lack systematic theoretical frameworks. As Parry (2007) argues, digital transformation reshapes the epistemic logic of museums and cultural display, indicating that the temporal reconfiguration of heritage is not simply a technical consequence but reflects deeper shifts in representational regimes.At the same time, cultural memory studies emphasize that memory formation is not merely an accumulation of images but a dynamic process shaped by time, ritualization, and repeated enactment (Hoskins, 2018; Erll, 2011). This perspective provides an important lens for understanding why ICH temporal structures must be preserved, reinterpreted, or re-created in digital environments.

From the standpoint of exhibition design, temporality plays a structural role at multiple levels:

(1) it provides the internal order of heritage practices;

(2) it shapes the external rhythm of audience perception;

(3) it influences the narrative progression and scene organization of the exhibition system.

Digital media, in turn, not only compress or extend temporal sequences through technological means but also generate new forms of temporality—such as fragmented time, algorithmic time, looped time, and participatory time—thus altering how cultural memory is constructed. As Couldry (2012) notes in his media practice theory, digital platforms impose distinct temporal regimes that influence how cultural activities unfold and are remembered.

Based on these research gaps, this study takes "time structure" as its analytical core and explores how digital exhibition design reconstructs ICH temporality through media translation, interaction mechanisms, and experiential organization. Furthermore, it examines how temporal restructuring affects cultural memory formation and proposes a multi-layer temporal model and corresponding memory mechanisms. By doing so, the study aims to provide theoretical grounding and methodological insight for the design of digital exhibitions of intangible cultural heritage.

2. Theoretical Foundations of Temporal Structure in the Digital Presentation of ICH

Temporality constitutes one of the essential characteristics of intangible cultural heritage. Whether expressed through ritual procedures, craft techniques, festival rhythms, or embodied actions, ICH is inseparable from time. Temporality not only provides the internal order needed for cultural practices to unfold but also functions as a structural basis for shaping collective memory. As scholars in anthropology and memory studies have repeatedly emphasized, cultural practices are not static; rather, they are processual, cyclical, and dynamic, continuously forming and reforming meaning through repetition and temporal organization (Assmann, 2011; Ingold, 2011). Rituals, techniques, and performances rely on patterned sequences and temporal rhythms to generate affective resonance, communal identification, and symbolic coherence. Therefore, exploring the temporal structure of ICH is not merely an examination of its procedural qualities but a key approach to understanding how heritage is constituted, sustained, and transmitted.

In traditional ICH contexts, time is expressed through three interconnected dimensions:

(1) Authentic time, which refers to the real temporal duration and rhythm inherent to the original practice—such as the slow processes of handcrafting, the fixed cycles of seasonal festivals, or the ritual sequences preserved through long-term tradition;

(2) Symbolic time, which refers to the temporal meanings encoded in cultural symbols, ritual logic, and collective memory frameworks;

(3) Experiential time, which refers to the temporal perception and embodied experience generated during participation, including immersion, anticipation, repetition, and emotional synchronization.

These three dimensions interact to form the temporal foundation of intangible cultural heritage. This multi-layered relationship between lived time and represented time resonates with the narrative mediation theory proposed by Ricoeur (1984).

However, when ICH enters digital media environments, temporality undergoes a systematic transformation. Digital media reshape time through compression, fragmentation, reconstruction, and algorithmic modulation, resulting in temporal structures that differ significantly from those of the original practice. Scholars of digital culture note that digital time is nonlinear, multi-layered, and hybrid, combining real time, recorded time, simulated time, and interactive time into complex temporal configurations. For example, video media compress long processes into short sequences; immersive environments reorganize temporal causality; and interactive systems generate temporal loops based on user input. These changes necessitate a theoretical reconsideration of how ICH temporality can be represented or re-created within digital exhibition systems.

At the same time, cultural memory studies emphasize that memory is not simply "stored"; it is enacted through temporal frameworks. Cultural memory relies on the reconstruction of past experiences within the present through ritual repetition, symbolic cues, and performative participation (Erll, 2011). Therefore, when digital media restructure ICH temporality, they simultaneously intervene in the mechanisms through which cultural memory is formed. For instance, temporal compression may alter the viewer's understanding of procedural knowledge; temporal fragmentation may weaken narrative coherence; and interactive time may create new pathways for embodied remembrance.

Based on these theoretical perspectives, this study understands temporal structure as a composite concept that integrates technological mediation, cultural meaning, and experiential organization. In digital ICH exhibitions, temporal structure is not a direct reproduction of original time but a process of translation, selection, reconstruction, and design. This provides the theoretical foundation for analyzing how digital exhibitions reorganize ICH temporality and how such reorganization shapes cultural memory.

3. Types of Temporal Structures in Digital Media and Their Reconstruction Methods

Digital media reshape the temporal logic of intangible cultural heritage (ICH) not merely through changes in representational techniques but through systematic interventions in how time is organized, perceived, and enacted. Different media forms generate distinct modes of temporal reconfiguration, each influencing the viewer's cognitive rhythm, experiential duration, and interpretive process. As digital heritage theorists have argued, such transformations align with broader shifts in the representational logic of museums brought by digital media (Parry, 2007). Based on the characteristics of common digital exhibition media, this chapter summarizes four major types of temporal reconstruction—compressed time, segmenting time, simulated time, and interactive time—and analyzes how each structure transforms the temporal nature of ICH.

3.1 Compressed Time: Condensing Duration and Accelerating Rhythms

Video media frequently employ editing, montage, and time-lapse techniques to compress long-duration processes into short, visually concentrated sequences. For traditional craftsmanship, which often involves lengthy, repetitive, or fine-grained manual operations, compressed time highlights processual essence while reducing the temporal burden on viewers. Through rhythm acceleration, key procedural steps become legible within condensed timeframes, enabling audiences to grasp temporal logic at a macro level. However, such compression may also weaken the embodied knowledge inherent in slowness, labor, and repetition. The temporal condensation in videos thus forms a tension between accessibility and authenticity, requiring careful balancing in ICH representation.

3.2 Segmenting Time: Fragmenting Processes and Restructuring Order

Interactive installations often break continuous temporal

processes into independent segments that users may explore in multiple sequences. This segmented time allows ICH knowledge—such as ritual phases, production steps, or narrative components—to be reorganized into selectable fragments. By granting audiences the ability to control sequence order, digital exhibitions transform originally linear temporal structures into flexible, multi-path experiential structures. While this enhances accessibility and interactivity, it may also compromise the holistic understanding of temporal continuity. Therefore, designing segmented time requires coordination between process integrity and user agency.

3.3 Simulated Time: Reconstructing Temporal Causality in Virtual Environments

Immersive media such as VR rebuild temporal structures through simulation. Such simulated environments also reflect what media theorists identify as the emergence of platform-shaped temporal regimes, where temporal flow is governed by the logic of computation and digital mediation (Couldry, 2012). Within virtual environments, creators can reproduce traditional temporal rhythms—such as cyclical festivals or ritual sequences—or construct entirely new temporalities that evoke historical atmospheres or emotional resonance. VR enables synchronized sensory immersion, allowing participants to perceive ritual flow, environmental changes, and symbolic transitions in ways unobtainable through physical observation alone. Simulated time thus becomes a tool for reconstructing cultural meaning; however, its divergence from real temporal duration may also generate discrepancies between simulated experience and authentic practice. This hybrid temporal mode reflects the creative mediation inherent in digital ICH representation.

3.4 Interactive Time: Generating Temporal Loops Through User Participation

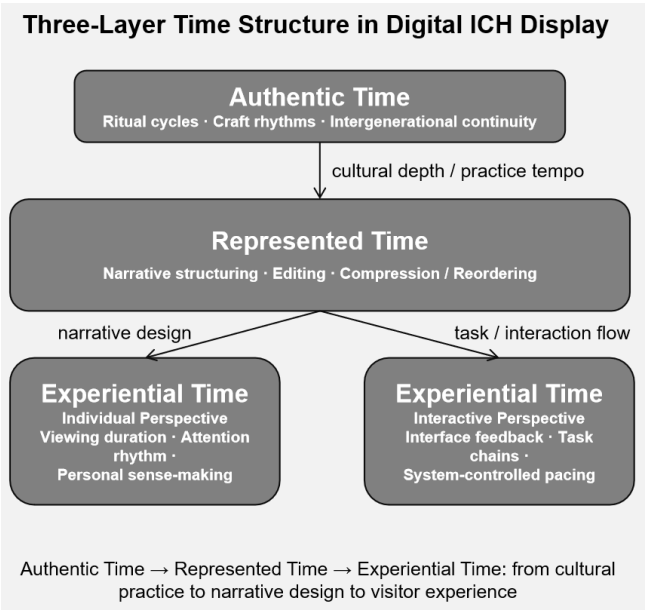

Figure 1: Three-Layer Time Structure in Digital ICH Display

In interactive systems, time is not predetermined but emerges dynamically through user actions. Interactive time is characterized by behavioral feedback loops: each user input triggers temporal changes, which then shape subsequent actions. For ICH exhibitions, this allows visitors to actively engage in ritual gestures, craft motions, or performance cues, generating personalized temporal trajectories. Interactive time enhances experiential participation and emotional engagement but also introduces variability that may fragment collective temporal meaning. The challenge for exhibition design lies in ensuring that interactive time remains anchored within culturally coherent frameworks while retaining space for individualized expression.

4. Cultural Memory Mechanisms in the Digital Exhibition of Intangible Cultural Heritage

Temporal restructuring in digital media environments ultimately shapes how cultural memory is produced, circulated, and internalized. As cultural memory theory emphasizes, memory is not a passive repository of the past but an active, mediated, and socially constructed process (Assmann, 2011; Erll, 2011). Digital exhibitions of intangible cultural heritage (ICH) not only reinterpret traditional temporal structures but also generate new mechanisms for memory formation through visualization, contextualization, enactment, and communalization. These mechanisms determine how audiences recognize, emotionally connect with, and participate in cultural heritage within digitally mediated environments.

4.1 Visualization: Translating Invisible Time into Visible Sequences

ICH practices often contain forms of time that are invisible or difficult to perceive directly—such as micro-level craft processes, subtle bodily rhythms, and symbolic temporal cues embedded in ritual behavior. Digital media, through time-lapse, slow motion, motion capture, and algorithmic visualization, transform these otherwise unobservable temporal elements into visible, analyzable, and perceptually accessible structures. Visualization thus becomes a mechanism that converts temporal knowledge into memory cues. When audiences witness the unfolding of processes that normally require long-term apprenticeship or embodied experience, they form new cognitive pathways for understanding cultural time. However, visualization may also flatten the experiential depth inherent in traditional time, raising the challenge of balancing "clarity" and "authenticity."

4.2 Contextualization: Embedding Temporal Meaning in Spatial and Narrative Frameworks

Cultural memory does not arise merely from temporal observation but from the contextual meaning that frames temporal experience. In digital ICH exhibitions, contextualization is achieved through reconstructed environments, narrative sequencing, spatial symbolism, and multimodal cues. VR environments recreate ritual settings, seasonal atmospheres, or ancestral spaces; interactive media embed processual time within narrative arcs; spatialized sound and lighting create environmental rhythms that subtly guide audience perception. This view aligns with museum studies research emphasizing that narrative and spatial framing shape how visitors construct cultural meaning (Macdonald, 2006). Through contextualization, temporal

structures are not only displayed but also situated within meaningful cultural frameworks. This mechanism connects specific temporal cues to broader cultural narratives, enabling audiences to form memory that is both emotionally resonant and culturally coherent.

4.3 Enactment: Reproducing Memory Through Embodied Participation

Cultural memory theory stresses that bodily enactment — through ritual gestures, repetitive actions, and learned motor patterns—is a key mode of remembering. Interactive media allow audiences to participate in simplified reenactments of ritual movements, craft motions, or performance cues, generating a new form of experiential memory grounded in interaction. This resonates with participatory heritage perspectives, which argue that embodied engagement is central to contemporary forms of cultural mediation (Giaccardi, 2012). By engaging users in action-based participation, digital systems enable visitors to "remember by doing," thereby creating tactile and kinesthetic memory traces. Enactment fosters emotional involvement and cognitive retention, but it may also risk oversimplifying complex embodied knowledge. Effective digital design must therefore ensure that participatory actions remain symbolically aligned with authentic cultural practices.

4.4 Communalization: Producing Shared Memory Through Collective and Networked Experience

Table 1: Comparison of Major Temporal Translation Mechanisms in Digital Media for Intangible Heritage

Media Type	Temporal Translation Method	Core Characteristics	Possible Impacts
Video Media	Compression, editing, emphasis on key moments	Linear, controllable, sequential	May weaken continuous processes and lead to over-visualized memory
Immersive Media	Temporal extension, narrative reconstruction, or segmentation	High immersion, embodied experience, strong temporal cues	Enhances experiential immersion, but may differ from authentic temporal rhythms
Interactive Media	Action triggering, branching pathways	Individualized, multi-rhythmic, user-driven temporal flow	Strengthens participatory memory, but may fragment temporal coherence
Algorithm-Driven Media	Action triggering, branching pathways	High speed, rapid switching, platform-driven rhythms	Drives new forms of temporal perception and produces emerging memory structures

ICH has always been rooted in communal practice and collective remembrance. Digital platforms—particularly those integrated with social media, multi-user environments, or networked interactions—extend this communal dimension into virtual spaces. Through shared viewing, collaborative interaction, or synchronized participation, digital exhibitions generate networked cultural memory, where individual experiences become part of a larger, collectively constructed memory field. Such dynamics reflect findings in digital heritage scholarship that highlight how networked participation reshapes meaning-making processes (Economou, 2015). Algorithmic curation, user-generated content, and participatory storytelling further accelerate the communalization of memory. However, communalization also introduces new complexities: while it strengthens the social dimension of memory, it may simultaneously decentralize or diversify traditional interpretations, requiring curatorial strategies to maintain cultural coherence.

5. Cultural Memory Mechanisms in Digital ICH Exhibition

Digital exhibition reconstructs cultural memory through four primary mechanisms—visualization, contextualization, enactment, and communalization—each operating through different temporal structures and perceptual pathways. These mechanisms collectively shape how intangible cultural heritage is perceived, internalized, and reproduced within digital environments. Their emergence highlights the dynamic relationship between temporal design and memory formation, indicating that memory in digital ICH is no longer a passive record but an active, process-based reconstruction.

5.1 Visualized Memory

Through images, 3D models, and visualization techniques, digital exhibition transforms craft actions, ritual nodes, and symbolic objects into "repeatable visual memories." In this process, the continuity of authentic time is compressed into visual fragments, and memory formation becomes increasingly dependent on highly recognizable and efficiently communicable "symbolic moments." As a result, visualized memory has become the most common recording method for ICH in the digital era. Its strength lies in high transmissibility and recognizability; however, it may also diminish the depth of cultural processes by prioritizing iconic highlights over procedural intricacy.

5.2 Contextualized Memory

In the construction of immersive environments, digital exhibition rebuilds the "context of memory" through virtual spaces, atmospheric lighting, layered sound effects, and spatial immersion. Because many ICH practices rely on specific locales and ritual environments, immersive experiences allow audiences to re-enter reconstructed temporal–spatial contexts and form emotionally embedded scene-based memories. This mechanism enhances cultural atmospheres and facilitates affective engagement, yet it depends heavily on the designer's selective reconstruction and may introduce contextual shifts that differ from the original setting.

5.3 Enacted Memory

Interactive systems translate the learning processes of ICH into chains of action, making memory no longer dependent solely on observation but also on bodily participation and task completion. Through operations, triggers, imitation, and repetition, visitors construct enacted memory within structured experiential time. This type of memory relies on the rhythm and feedback logic of the system, and its value lies in strengthening learning through embodied engagement. However, whether such action-based simplifications can fully

preserve the complexity of authentic skills remains an important consideration.

5.4 Communalized Memory

Digital platforms—through comment sections, user-generated content, and community-based dissemination—enable ICH memory to be continuously rewritten, expanded, and negotiated in public discourse. Visitors' participation, sharing pathways, and creative reinterpretations collectively generate communalized memory, shifting memory from a one-directional record into a dynamic, multi-person co-construction. The openness and continuity of communalized memory allow digital ICH to produce new forms of cultural identity across geographic boundaries.

Taken together, the visualized, contextualized, enacted, and communalized mechanisms illustrate how digital exhibition reshapes cultural memory by generating content that can be seen, experienced, and reproduced through diverse temporal structures. Memory formation is thus closely intertwined with temporal design, and the two together constitute the dynamic communication framework of intangible cultural heritage in the digital age.

6. Conclusion

This study reexamines the generative mechanisms of digital exhibition for intangible cultural heritage (ICH) through the lens of temporal structure, proposing a three-layer model consisting of authentic time, representational time, and experiential time, and summarizing the typical modes of temporal translation in digital media. The research demonstrates that digitization is not merely a technical application; rather, it deeply intervenes in the organization of ICH temporality through compression, reconstruction, and action-based mediation, thereby influencing the pathways through which cultural memory is formed. The four memory mechanisms—visualization, contextualization, enactment, and communalization—collectively constitute the core logic of ICH communication in the digital age.

At the level of exhibition design, it is essential first to preserve the key rhythms of authentic time within the construction of representational time, avoiding excessive fragmentation. Second, the continuity of temporal logic should be enhanced through immersive environments and narrative structures, enabling audiences to form stable pathways of understanding within experiential time. Additionally, in interactive systems and platform-based dissemination, attention should be given to the memory-rewriting effects produced by behavioral rhythms and community feedback, striking a balance between cultural depth and communicative efficiency. Overall, the design of temporal structure should become a central strategy in digital ICH exhibition, allowing digital expression to maintain cultural resilience while achieving more participatory and extensible modes of dissemination.

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