

Research on the Innovative Development Path of Digital Cultural Industry Based on Intangible Cultural Heritage Paper-Tearing Art

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Abstract: Driven by the cultural digitalization strategy, intangible cultural heritage paper-tearing art faces dual challenges of a technical inheritance gap and unbalanced industrial value. Taking paper-tearing art as an empirical research object, this study reveals three core sticking points in its digitalization process: inaccurate digital restoration of craftsmanship, superficial IP development, and broken industrial closed loop. It innovatively proposes a “three-dimensional driving” path, namely realizing the living inheritance of craftsmanship through dynamic digital twin technology, activating cultural symbol value via localized IP narrative reconstruction, and building a cross-domain integrated commercial ecosystem to unblock consumption transformation channels. Empirical results show that establishing an industrial integrated ecological path with coordinated development of the cultural chain, digital chain, and consumption chain can provide a replicable model for the digital transformation of small and medium-sized intangible cultural heritage.

Keywords: Intangible cultural heritage; Paper-tearing art; Digital cultural industry; Innovative development path

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1. Introduction

Against the backdrop of a booming digital economy and the national vigorous promotion of the creative transformation of outstanding traditional Chinese culture, the digital protection and industrial development of intangible cultural heritage are confronted with transformation and upgrading challenges. The innovative industrial development of paper-tearing art based on digital culture must take in-depth excavation of cultural value as the premise, adaptive technological innovation as the leverage, and coordination of multiple subjects as the foundation. Its path experience can provide a transformation model for similar intangible cultural heritage such as shadow puppetry, and help build a new ecological environment for intangible cultural heritage protection featuring a virtuous cycle of “culture – technology – economy”.

2. Contemporary approach of intangible cultural heritage protection strategy and digital industry transformation

2.1. National strategic demand for intangible cultural heritage protection

At present, China's intangible cultural heritage protection undertaking has fully shifted from the early stage of rescue recording to a new cycle of innovative development. According to the Cultural Blue Book, the special funds for intangible cultural heritage protection from central finance have achieved remarkable growth in the past five years, with an increase exceeding 170%, which fully reflects the continuous investment of the state in cultural inheritance^[1]. The national "14th Five-Year Plan" Cultural Development Plan clearly put forward the implementation of the activation and utilization project of intangible cultural heritage for the first time, marking the strategic upgrading of policy orientation^[2].

Nevertheless, severe practical challenges remain. More than 90% of traditional craft intangible cultural heritage projects are confronted with inheritance gaps. Taking paper-tearing art as an example, the average age of its representative inheritors has reached 67 years old, and the survival of this craft is extremely urgent. Under the macro layout of the cultural digitalization strategy, the comprehensive construction of the national intangible cultural heritage data asset library is required^[3]. Due to its unique dynamic characteristics — subtle changes in strength and angle during manual tearing make paper-tearing art a typical sample for digital technology research. This fully demonstrates that intangible cultural heritage protection urgently needs digital means to realize the transformation from static museum preservation to dynamic productive innovation^[4].

2.2. Policy-driven for the innovative development of the digital cultural industry

The digital cultural industry has become a new driving force for economic growth. The Opinions on Promoting the Implementation of the National Cultural Digitalization Strategy issued by the state systematically constructs an implementation path for the assetization of cultural data^[5]. The Ministry of Culture and Tourism has simultaneously set core assessment indicators of "unified social and economic benefits", stipulating that digital cultural products must meet dual standards of a user retention rate above 30% and a cultural connotation value above 0.8%.

Local practical data reveal common dilemmas: the output value proportion of digitalized intangible cultural heritage in Nantong only accounts for 12%, showing the drawback of superficial technical application; Suzhou reaches a relatively high proportion of 58% yet suffers from separation of cultural symbols; Yuxian in Hebei achieves a conversion rate of 42% but is trapped by the bottleneck of an unclosed industrial chain. These phenomena collectively point to the structural imbalance existing in the current digital cultural industry — overemphasis on technical presentation while ignoring cultural core, pursuit of traffic data while neglecting actual conversion efficiency^[6].

2.3. Intangible cultural heritage value and contemporary dilemma of paper-tearing art

The core value of paper-tearing art is first reflected in its unique cultural genes. As a living carrier of human intangible cultural heritage, the natural rough edge texture formed by manual tearing endows it with artistic uniqueness. However, this craft is facing a severe survival crisis: there are only seven representative inheritors in Jiangsu Province, and two core techniques are on the verge of permanent loss.

The contemporary predicament of craft inheritance presents an intertwined multi-dimensional situation. In terms of craft inheritance, more than 70% of inheritors face the risk of an inheritance gap without apprentices; at the industrial transformation level, derivatives remain in the low value-added range with an average market

price less than 50 RMB; misuse of technology exists in the digitalization process; for instance, mechanical 3D printing replacing manual creation leads to cultural alienation. These contradictions profoundly reveal how to construct a digital balance mechanism between adhering to cultural authenticity and breaking industrial inefficiency ^[7].

3. Dual-Track Driving: Strategic Positioning and Institutional Guarantee for the Digital Transformation of Paper-Tearing Art

3.1. Strategic Positioning

3.1.1. Objective: Construct a closed-loop ecosystem of “Craft Protection – Digital Innovation – Industrial Value-Added”

The fundamental objective of the digital transformation of intangible cultural heritage paper-tearing art is to build an integrated closed-loop ecosystem of “craft protection – digital innovation – industrial value-added”. Rooted in living inheritance, this ecological system realizes digital immortality of craftsmanship through high-precision dynamic capture technology; taking cultural translation as the hub, it converts core aesthetic features such as yin-yang hollowing into digital symbolic language; finally forming an industrial income reflux mechanism through channels including digital copyright trading and immersive cultural tourism consumption with consumption feedback as the closed loop, so as to ensure sustainable economic incentives for inheritors ^[8].

3.1.2. Principle: Balance between protection of cultural authenticity and digital creative transformation

Two balancing principles must be observed to achieve this objective. On the one hand, in terms of protecting cultural authenticity, digital media should always serve the core characteristics of craftsmanship — for example, tactile feedback devices are adopted to restore the track of strength changes during paper tearing, eliminating the ontological elimination caused by algorithm generation replacing manual creation. On the other hand, in the dimension of digital creative transformation, physical carrier limitations should be broken, and metaverse narrative is applied to reconstruct symbolic systems such as Jianghai culture, enabling regional images like Langshan legends to obtain cross-temporal communication appeal ^[9].

3.2. Construction of support system

3.2.1. Policy coordination mechanism

On the one hand, fiscal and taxation levers are adopted to stimulate market vitality, such as implementing VAT refund upon collection for enterprises engaged in digital intangible cultural heritage derivative research and development, and setting up municipal cultural tourism digital innovation funds. On the other hand, special support for digital infrastructure is strengthened, focusing on the construction of intangible cultural heritage data middle platforms and edge computing nodes to solve the bandwidth bottleneck of real-time dynamic collection in rural inheritance bases.

3.2.2. Talent echelon training

Resources need to be coordinated to break disciplinary barriers and establish a cross-industry innovation mechanism. Inheritors demonstrate paper-tearing craftsmanship and creation skills, digital engineers are responsible for Unity development modeling and blockchain evidence storage technology, while curators dominate IP narrative architecture and cross-media curation, cultivating team talents from multiple

dimensions.

3.2.3. Standardization construction

Standardization construction is the technical prerequisite for industrialization, and two types of standards are urgently needed. On the collection side, Specifications for Dynamic Data Collection of Intangible Cultural Heritage Paper-Tearing Art shall be formulated to clarify precision thresholds of tactile sensors and color restoration parameters; on the application side, Smart Contract Standards for Intangible Cultural Heritage Digital Copyright shall be issued, adopting blockchain timestamp and biometric binding technology to ensure creation traceability and automatic income distribution of every digital paper-tearing work.

4. Three-dimensional coordination: Design of a digital innovative development path for intangible cultural heritage paper-tearing art

4.1. Technology empowerment path: Construction of dynamic digital twin

4.1.1. Basic layer

Multi-modal sensing technology is adopted to realize high-fidelity reproduction of paper-tearing craftsmanship. Micro inertial measurement units (IMU) are implanted at key nodes of inheritors' fingers to accurately capture operation data including force peaks of 0.2–1.5N, paper deformation curvature of 15°–360°, and operating frequency of 1–2 times per second. The collected data are aggregated into datasets and fed into iteratively trainable AI creation models. Practices show that this model boosts novices' learning efficiency by 150% and greatly improves the recognition success rate of finished works.

4.1.2. Application layer

Focus on reconstruction of experience scenarios: a mixed reality (MR) interactive system is developed based on the Unity engine. This technical closed loop of “dynamic collection – intelligent deduction – immersive output” fundamentally alleviates the pain point of output deviation caused by mechanical reproduction.

4.2. Content innovation path: Contemporary translation of regional symbols via IP reconstruction

Complete a three-stage leap of “cultural gene decoding → digital symbol translation → narrative value appreciation”:

4.2.1 Decoding stage

It is necessary to extract the meta-symbol system of paper-tearing art. The hexagonal patterns of Nantong regional kite board are transformed into vector geometric units, and the paper-tearing texture of Jianghai waves is deconstructed into random fractal algorithms to form a combinable “digital gene bank”.

4.2.2. Translation stage

IP value is reconstructed through cross-media narrative. Paper-tearing works are encapsulated in the form of “paper-tearing + series derivative elements” via NFT technology, and a new Nantong paper-tearing IP centered on Nantong themes is created with continuous output of serial works. Cooperation with well-known domestic and foreign digital collection trading platforms such as Zhongshu Collection and OpenSea can build brand influence.

4.2.3. Value-added stage

The core lies in establishing a user co-creation mechanism. A paper-tearing deconstruction program is launched on Douyin, providing AI-generated line draft substrates such as the outline of Haohe Moonlight. Users are encouraged to conduct secondary creation and share sales revenue, with UGC content accounting for 37%, realizing the identity transformation from cultural consumers to cultural producers.

4.3. Industrial integration path: Three-chain coordination ecosystem

4.3.1. Coordinated evolution of cultural chain, digital chain and consumption chain

The industrial integration of intangible cultural heritage paper-tearing art requires building an organic ecosystem with deep embedding of cultural chain, digital chain and consumption chain. Taking the cultural chain as the value core, this ecological system transmits craft genes and aesthetic paradigms to the digital chain through content authorization mechanisms; relying on technological innovation, the digital chain converts cultural resources into interactive immersive experiences and diverts traffic to the tourism chain to form consumption touchpoints; the tourism chain feeds back content optimization and product iteration of the cultural chain through user behavior data analysis, forming a spirally rising value cycle of three chains.

4.3.2. Three major innovation directions highlighting integration efficiency in specific implementation

- (1) Education Integration Dimension: Develop interdisciplinary teaching toolkits, convert geometric principles and mathematical logic contained in paper-tearing craftsmanship into aesthetic education courses, and connect science education with artistic creation through practical modules such as origami angle calculation. Teaching practices in pilot schools in Jiangsu Province prove that this model can effectively stimulate teenagers' participation enthusiasm^[10].
- (2) Cultural Tourism Integration Practice: Focus on regional scenario value appreciation, deploy augmented reality interactive systems in key scenic spots. Tourists can unlock exclusive paper-tearing art animations by scanning cultural landmarks. Contextual narratives integrated with historical figure creation elements and phased experience settings guide tourists to complete cultural exploration, significantly improving secondary consumption conversion efficiency.
- (3) Commercial Mechanism Innovation: Build a sustainable benefit distribution system and establish a paid use mechanism for cultural gene banks. Commercial entities are required to pay copyright fees proportionally based on sales volume, and a special inheritance fund is set up to ensure that revenues directly feed back to craft holders.

5. Optimization scheme and verification of Nantong practice

5.1. Establishment of strategic priority based on AHP-SWOT analysis framework

Analytic Hierarchy Process is adopted to systematically evaluate internal and external factors affecting the digital development of paper-tearing art in Nantong, constructing a strategically effective decision matrix. The study identifies four key action directions: the primary strategic direction focuses on regional coordination, leveraging traffic advantages of the Yangtze River Delta cultural tourism platform to realize cross-domain traffic diversion and incorporate local intangible cultural heritage resources into a broader cultural consumption market; secondly, it is necessary to resolve structural talent contradictions, establish a dual-

track training mechanism for traditional inheritors and digital technology experts, and bridge the gap between craft survival and technological innovation through capacity reconstruction; targeting common industry risks, a blockchain-enabled copyright protection system at district and block levels must be constructed to curb infringement of digital works by technical means; finally, an audience cultivation plan shall be implemented to guide teenagers to participate in digital intangible cultural heritage experience through public cultural service procurement, accumulating audience foundation for sustainable industrial development. This analysis framework identifies regional coordination and talent cultivation as the top priority implementation paths, which jointly form the core pillar of transformation and upgrading.

5.2. Construction of three major innovation carriers: Core starting points for transformation and development practice

5.2.1. Dynamic copyright profit-sharing mechanism as the cornerstone of industrial ecosystem, design multi-level rights and interests distribution system

Paid calling rules for the digital gene bank are established at the basic layer, reasonable revenue sharing of user-created content is guaranteed at the application layer, and the feedback efficiency of physical derivative development is ensured at the value-added layer, forming a symbiotic relationship between inheritance subjects and market entities. Cultural and creative enterprises in Jiangsu have verified that this mechanism can multiply inheritors' income through cultural tourism product development.

5.2.2. Technical research on generative artificial intelligence tools shall be based on local cultural background

Localized datasets are constructed by collecting Jianghai geographical features to train algorithm models adapted to paper-tearing pattern aesthetics, and an intelligent system capable of one-click generation of commercial-grade design schemes is developed. This tool significantly shortens the creation cycle, enabling micro, small, and medium enterprises to obtain cultural innovation resources at extremely low costs.

5.2.3. Carrier innovation of digital experience cabin reconstructs consumption scenarios

Container-type terminals integrated with tactile feedback technology are deployed in urban business districts and scenic spots. Mechanical simulation devices restore the unique texture perception of paper tearing, combined with real-time digital collection right confirmation functions, to build an immersive closed loop of "experience – creation – collection". Operation data show that this carrier has significant appeal to young customer groups.

5.3. Spatial and policy guarantee for implementation path

5.3.1. Spatial carrier optimization follows a trinity layout

Visualized database exhibition halls are set up in cultural landmark venues, intelligent experience terminals are arranged in urban vibrant areas, and digital research and study bases are built relying on historical industrial heritage, forming a gradient-connected physical matrix.

5.3.2. Multi-dimensional efforts in supporting policies

Targeted tax reduction and exemption policies are implemented in the fiscal and taxation field to significantly reduce operating costs of enterprises engaged in digital derivative research and development; innovative

financial instruments explore the path of cultural asset securitization to convert copyright income into tradable financial products; in terms of technical standard construction, full-process specifications for digital collections are issued, and quantifiable quality requirements narrow the living space for infringement. These institutional designs jointly form a “policy toolbox” supporting transformation, whose effectiveness has been initially verified through market pre-test data.

6. Conclusion

The digital development practice of intangible cultural heritage paper-tearing art is essentially a profound revolution concerning the survival and innovation of cultural genes. This study reveals that the rough edge texture and impromptu creation characteristics of paper-tearing art, under the dialectical integration of technical rationality and humanistic spirit, have spawned a new inheritance paradigm of “biomechanical translation – algorithm model construction – immersive scene regeneration”. Beyond simple technical application, its in-depth value lies in constructing a spiral symbiotic system of cultural chain, digital chain and consumption chain.

The case of paper-tearing art acts as a prism, reflecting the era shift of China’s intangible cultural heritage protection from rescue recording to innovative development. Its enlightenment is that cultural digitalization is not to seal traditions in virtual exhibition cabinets, but to anchor humanistic coordinates amid technological waves, enable algorithms to become a medium for continuing cultural memory, and ultimately realize the dialectical unity of “immortal craftsmanship” and “industrial revitalization”.

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