Research on the Modern Design Transformation and Digital Empowerment Pathways of Paper-Cutting Art within the Framework of Information-Based Education

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Abstract. As a resplendent jewel of China's traditional intangible cultural heritage, paper-cutting art embodies the cultural DNA distilled over millennia and a distinctive aesthetic paradigm. The dual onslaught of modernisation and the digital revolution have plunged this ancient craft into a crisis of transmission disruption and creative stagnation—who could have foreseen that the delicate artistry once illuminating windowpanes now risks being forgotten by the times? The true essence of intangible heritage preservation has never been to consign tradition to museum dust, but to foster symbiotic coexistence between tradition and modernity. Today's focus on 'technology-empowered educational innovation and digitally reconfigured cultural dissemination' reveals how the rise of information-based education and computer technology is forging a revolutionary pathway for the living transmission and design innovation of paper-cutting art. This paper, grounded in the perspective of intangible cultural heritage preservation, systematically explores the diverse application scenarios of paper-cutting art within contemporary design. It conducts an in-depth analysis of practical strategies that employ digital technology in the transmission of paper-cutting techniques, creative transformation, and dissemination promotion, thereby constructing a tripartite development model that integrates 'traditional art + modern design + digital technology'. This not only provides a theoretical reference for the creative transformation and innovative development of China's outstanding traditional culture but also paves a practical path for educational innovation and technological application in the transmission of intangible cultural heritage within the information age.

Keywords: Intangible cultural heritage, paper-cutting; modern design, information-based education; computer technology, digital empowerment; cultural heritage

1 Introduction

1.1 Background

Paper-cutting art, this living fossil of Chinese folk art, has endured the passage of millennia to become deeply engraved in the nation's cultural DNA, earning its place

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on the UNESCO Intangible Cultural Heritage list. Yet within the fast-paced rhythms of modern life, its traditional mode of transmission—relying on oral instruction and heartfelt teaching—struggles to resonate with the cognitive habits of younger generations. The intricate craftsmanship faces a shortage of successors, and the cultural influence of paper-cutting is quietly waning. Concurrently, breakthroughs in information and educational technology are reshaping the fundamental logic of knowledge dissemination and cultural consumption. Technologies such as artificial intelligence, cloud computing, and virtual reality have not only revolutionised traditional educational paradigms but also provided innovative pathways for revitalising traditional culture through enhanced interactivity and accessibility. Against this backdrop, deeply integrating paper-cutting art with modern design, broadening transmission channels through digital education, and enriching creative forms via computer technology have become essential choices for overcoming the challenges of intangible heritage transmission and activating the contemporary value of traditional arts.

The advent of information-based education has utterly dismantled the temporal, spatial barriers and resource constraints that once shackled the transmission of traditional paper-cutting techniques. It has established a more inclusive and interactive inheritance system, perfectly aligning with contemporary principles advocating for the ‘construction of efficient learning environments’ and the ‘enhancement of educational inclusivity’. The digital paper-cutting education platform, built upon cloud computing technology, functions as a boundless online classroom. It integrates paper-cutting resources from across the globe, forming a one-stop learning ecosystem encompassing technique instruction, cultural interpretation, and artwork exhibition. The platform's thoughtfully tiered teaching modules demonstrate considerable ingenuity: for beginners, AI-driven interactive tutorials employ video breakdowns, step-by-step demonstrations, and real-time feedback to enable even novices to swiftly master foundational techniques; for advanced learners, live streaming courses led by intangible cultural heritage inheritors utilise real-time interaction to deliver ‘cloud-based face-to-face instruction,’ resolving the traditional apprenticeship challenge of ‘difficulty in finding master teachers’; For researchers, the platform's integrated digital repository of paper-cutting artistry houses high-resolution imagery, technical documentation, and folkloric contexts spanning diverse regions and eras. Supported by keyword search, online comparison tools, and academic exchange platforms, it propels the digital advancement of paper-cutting cultural studies.

The integration of Virtual Reality (VR) and Augmented Reality (AR) technologies breathes new life into paper-cutting instruction. VR recreates the folk contexts of traditional paper-cutting creation—such as the festive atmosphere of pasting window decorations during Spring Festival or crafting ceremonial ornaments for holidays—immersing learners in the cultural milieu of this art form within virtual environments. AR technology achieves seamless integration between ‘virtual teaching aids’ and real-world practice. When learners practise wearing AR devices, the system captures motion trajectories in real time, overlaying virtual layers such as line guides, proportion calibration tools, and error alerts to significantly reduce learning difficulty. More excitingly, the development of interactive paper-cutting teaching games integrates skill acquisition into engaging level designs. Features like ‘pattern unlocking’, ‘colour

coordination challenges', and " Folk Scene Creation". These gamified elements ignite the younger generation's enthusiasm for learning, truly achieving the inheritance goal of 'learning through play".

The application of big data and machine learning algorithms enables personalised learning pathways. By analysing learners' operational data, preferences, and progress, the system precisely identifies their skill gaps and development potential: for learners drawn to traditional crafts, it recommends intensive hands-on courses and one-to-one guidance from intangible cultural heritage masters; For those skilled in digital creation, it emphasises innovative courses like digital paper-cutting design and cultural product development; while learners oriented towards cultural studies are recommended theoretical courses on folk traditions and historical origins. The establishment of a dynamic learning assessment system enables real-time adjustments to teaching content and pace through multi-dimensional data feedback, allowing this information-driven inheritance model of 'teaching according to individual aptitude' to take root and flourish.

1.2 Research Gap

Existing research predominantly remains confined to historical verification, technical preservation, or single-domain application exploration of paper-cutting art, lacking systematic construction of a tripartite development model integrating 'traditional art + modern design + digital technology'. Regarding inheritance, investigations into how information-based education can overcome temporal and spatial constraints and resource bottlenecks in transmitting paper-cutting techniques, achieving the coupling of personalised and scaled inheritance, remain superficial. Within the innovation dimension, practical strategies for leveraging computer technology to empower the entire chain of paper-cutting creation, presentation, and dissemination—thereby driving its transformation from cultural symbol to commercial value—remain largely unexplored. More critically, research into the compatibility between paper-cutting's diverse traditions and digital technology remains fragmented, failing to establish systematic digital translation pathways. This fundamentally undermines the practical demands for the creative transformation and innovative development of intangible cultural heritage.

1.3 Research Objectives and Questions

RQ.1:What competencies did educators acquire within the "Creation-Dissemination-Identification" workshop cycle?

RQ.2: How was this developmental process influenced by the interaction between the "Education" and "Media" dimensions?

1.4 Significance

This research aims to enrich the theoretical framework for safeguarding and transmitting intangible cultural heritage, providing a novel theoretical reference framework

for the creative transformation and innovative development of China's outstanding traditional culture. Concurrently, it deepens interdisciplinary research at the intersection of information-based education and intangible heritage transmission, expanding the theoretical boundaries and interpretative scope for digital technology applications within traditional cultural domains. By systematically analysing the digital adaptability characteristics and translation principles of paper-cutting art, it offers a theoretical blueprint for the digital transformation of similar intangible heritage projects. At the practical level, the research will establish a diversified paper-cutting inheritance system, breaking through the inherent limitations of traditional transmission models. This will enhance younger generations' receptiveness and enthusiasm for paper-cutting art, providing concrete pathways and technical support for its modern design innovation. It will facilitate the art's widespread integration into diverse fields such as advertising visuals, fashion design, interior furnishings, thereby achieving mutual enhancement of cultural and commercial value. This will solidify the practical foundation for educational innovation and technological application in intangible heritage transmission within the information age, while providing decision-making references and operational guidelines for relevant authorities in formulating heritage protection policies and advancing cultural industry upgrading.

2 Literature Review & Conceptual Framework

Within the framework of intangible cultural heritage preservation, Liu Wenling (2024)[1] examines the application of Ruichang paper-cutting in the design of ‘Xima-zhuang’ yam packaging. Meanwhile, Shi Jin (2023)[2] explores innovative design pathways for Nanjing paper-cutting, both studies offering single-domain practical examples of integrating paper-cutting art into contemporary living contexts. From a cultural and creative development perspective, the ‘reproduction’ logic of Xinjiang paper-cutting is interpreted, highlighting its potential commercial value[3]. Within inheritance pathway research, explorations have centred on the transmission routes of tribute paper-cutting and ‘red culture’ paper-cutting[4][5], though neither incorporated digital technology as a core consideration. Studies on design innovation in intangible cultural heritage crafts[6] offer indirect theoretical references for the contemporary adaptation of paper-cutting art.

International scholars have also conducted in-depth research on the digital empowerment and innovative inheritance of traditional handicrafts, forming valuable research results for the digital transformation of intangible cultural heritage worldwide. Hickinbotham, S., & Elliott, D. (2021)[7] took traditional handicrafts of China and the United Kingdom as research objects, carried out a comparative study on the application of digital platforms in handicraft inheritance, and clarified the universal laws and regional characteristics of digital technology in the whole-chain empowerment of handicraft creation, production and dissemination. Paka, P. (2024)[8] focused on the traditional crafts in northern Thailand, demonstrated the positive effect of digital technologies such as AI and VR/AR in reducing the innovation threshold of traditional crafts and expanding cross-cultural communication channels, and put forward a set

of digital empowerment strategies for handicraft inheritance combined with educational scenarios.

Overall, existing research has keenly identified the preservation and innovation demands of traditional paper-cutting art, accumulating some practical experience, and foreign scholars' relevant research results also provide important international theoretical and practical references for this study. However, domestic research still lacks systematic exploration of the deep integration between technology, art, and design, and has yet to establish a systematic digital empowerment pathway, and there is a lack of targeted research on the digital transformation of Chinese paper-cutting art combined with the background of information-based education. This study addresses precisely this research gap.

This study adopts a core stance of safeguarding intangible cultural heritage, employing a logical framework centred on 'traditional art + contemporary design + digital technology'. It progresses through four distinct sections: the first dissects the multifaceted lineage and digital compatibility of intangible paper-cutting heritage, examining its richness through regional characteristics, functional attributes, and technical paradigms, while analysing stylistic expressions and their inherent affinity with digital techniques; The second section focuses on the digital ecosystem for paper-cutting transmission established through information-based education, specifically exploring the application efficacy of digital education platforms, VR/AR technologies, and big data in perpetuating paper-cutting skills. The third section elucidates computer technology as the core engine for innovative paper-cutting design, examining practical scenarios for professional design software and artificial intelligence tools, alongside the integration of paper-cutting elements across modern design fields and the establishment of digital dissemination matrices. The concluding section synthesises core findings and anticipates the future impact of emerging technologies on the preservation and innovation of paper-cutting art.

3 Methodology

1. Case Study Method: Selecting paper-cutting art samples from diverse regions (e.g., Shanghai-style paper-cutting, Dai ethnic paper-cutting), functional categories (decorative, utilitarian, ritualistic), and techniques (carved, copper-chiselled, window-flower), combined with exemplary practices in digital preservation and contemporary design applications, to conduct an in-depth analysis of their distinctive characteristics and adaptive logic.

2. Interdisciplinary Research Approach: Integrating theories and research paradigms from intangible cultural heritage studies, education, design, and computer science to explore intrinsic pathways for empowering paper-cutting art through digital education and computer technology, achieving cross-disciplinary academic convergence and innovative breakthroughs.

3. Empirical Analysis Approach: By examining practical applications such as digital education platforms, VR/AR teaching tools, and professional design software, this approach deconstructs the practical efficacy of these technologies in preserving paper-

cutting techniques and facilitating creative translation. It distils replicable and scalable operational strategies and methodologies.

4 Findings & Discussion

4.1 Practical Applications of Digital Education in Paper-Cutting Heritage Preservation

1. Digital Paper-Cutting Education Platform: Leveraging cloud computing technology to establish a comprehensive learning ecosystem with tiered instructional modules. For beginners, AI-driven interactive tutorials deconstruct the entire process—from folding window decorations to outlining patterns and cutting intricate designs—via video demonstrations, providing real-time feedback on technique deviations to rapidly build foundational skills. For advanced learners, live streaming sessions with intangible cultural heritage inheritors of Gaomi paper-cutting from Shandong Province address technical challenges such as 'multi-layer overlapping cuts' and 'precise engraving' through real-time interaction, delivering an immersive 'cloud-based face-to-face instruction' experience. For researchers, the platform archives high-definition imagery and folklore background materials of regionally distinctive paper-cutting traditions like Helen paper-cutting and Dai ethnic paper-cutting. Keyword search and online comparison capabilities provide digital support for academic research.

2. VR/AR Technology in Teaching Applications: VR technology recreates panoramic scenes of traditional Spring Festival window-decorating and festive paper-cut gift-making, immersing learners in the cultural context and spiritual essence of paper-cutting art; AR technology enhances practical exercises: when learners study 'copper-chisel paper-cutting' with AR devices, the system captures motion trajectories in real-time, overlaying line guides and proportion calibration layers to significantly lower the skill barrier. The interactive educational game 'Pattern Unlocking Adventure' features engaging challenges like 'Traditional Pattern Tracing' and Folk Scene Creation'. This gamified approach ignites young participants' enthusiasm, making paper-cutting heritage more compelling.

3. Personalised Learning Pathway Construction: Leveraging big data and machine learning algorithms, the system deeply analyses learners' operational data and preferences to build a precision learning recommendation mechanism. For learners drawn to traditional crafts, we offer intensive hands-on courses and one-to-one mentoring with intangible cultural heritage masters. Those skilled in digital creation receive tailored instruction in Adobe Illustrator digital paper-cutting design and cultural product development. Students inclined towards cultural studies are recommended theoretical content on folk traditions and historical origins, truly achieving personalised cultivation through tailored instruction.

The following is a simplified explanation using the table in Figure 1.

Figure 1:

Innovation Aspecte	Technical Realization4	Innovation and Expansion
Information-Based Education Empowers Inheritance	Digital Education Platforms	Hierarchical teaching Core technologies
	VR/AR Technology Application	VR AR Gamified teaching
	Personalized Learning	Algorithm-driven Sub-directions digital creation cultural research
Computer Technology Empowers Design	Innovation of Creation Tools	Professional software Artificial intelligence
	Cross-Domain Integrated Application	Logo design Fashion design Interior design
	Digital Communication Matrix	Short video platforms Interactive carriers
Trinity Development Effects	Inheritance Dimension	Break the limitations of time and space to realize the coordination of "personalized cultivation + large-scale communication" Lower the threshold of skills and expand the inheritor group centered on teenagers
	Innovation Dimension	Creation forms Application scenarios
	Value Dimension	Cultural value Commercial value

Fig. 1. Core Dimensions and Practical Pathways for Digital Empowerment in Paper-Cutting Art

4.2 Practical Applications of Computer Technology in Contemporary Paper-Cutting Design

1. Application of Creative Tools: Utilising Adobe Illustrator to extract Buddhist symbolic motifs from Dai ethnic paper-cutting, leveraging the infinite scaling capability of vector graphics to adapt to diverse sizing requirements from business card logos to large-scale outdoor advertisements; employing Procreate's layer stacking functionality to simulate the composite craftsmanship texture of ‘carved paper-cutting + chiseled copper paper-cutting’, creating richly layered decorative patterns; Inputting core keywords—‘Northern rustic style + fish-pattern auspicious symbolism + textile printing’—AI design tools rapidly generate diverse creative proposals. Designers then refine and iterate upon these, substantially enhancing creative efficiency and conceptual depth.

2. Contemporary Design Integration Examples: In logo design, symmetrical compositions and lotus motifs from Dai ethnic papercutting were abstractly reconstructed to embody a modern brand's core values of ‘purity and nature’. Digital rendering enhanced visual texture, creating a brand symbol blending traditional charm with distinct recognition. In fashion design, 3D modelling software converts Shanghai-style paper-cutting patterns, blending Eastern and Western motifs into garment pattern data. Digital printing enables mass production, while laser cutting recreates traditional openwork techniques, launching a collection that marries cultural heritage with contemporary style. In interior design, BIM technology integrates the rhythmic patterns of window-cut paper art into spatial planning. Digital projection techniques cast dynamic paper-cut light and shadow effects onto walls, coordinated with intelligent lighting systems to regulate presentation, constructing an immersive cultural space.

Digital dissemination matrix examples: - Releasing content such as ‘The Complete Process of AI Paper-Cutting Creation’ and ‘Analysis of Paper-Cutting Elements in

Advertising Design' on short-video platforms, leveraging algorithmic recommendations to reach younger audiences; - Developing virtual paper-cutting collections and interactive mini-programmers, utilising blockchain technology for copyright traceability and protection, enabling users to purchase digital collectibles or participate in 'custom paper-cutting pattern' interactive experiences; Employing 3D panoramic technology to establish the 'Digital Exhibition Hall of Chinese Paper-Cutting Art', showcasing classic works from different eras alongside contemporary designs, enabling online interaction, comment exchanges, and digital collection of pieces; launching the 'Digital Paper-Cutting Design Challenge' on social media, encouraging users to create using tools like Procreate, thereby generating organic cultural buzz and expanding the digital dissemination boundaries of paper-cutting art.

5 Conclusion

The profound permeation of informatisation and digitalisation has reshaped the contemporary context for the inheritance and innovation of traditional culture. For intangible cultural heritage paper-cutting art, the dual empowerment of digital education and computer technology is not merely an optional approach, but the core engine revitalising its vitality.

This study confirms that the diverse lineage and stylistic characteristics of paper-cutting art inherently endow it with digital compatibility. The rich variations in regional origins, functional applications, and technical execution have accumulated into vast digital archives. Its distinctive regional identity, symbolic significance, and masterful craftsmanship align profoundly with the application logic of digital technologies.

Digital education dismantles the temporal, spatial barriers and resource constraints of traditional paper-cutting transmission. A multifaceted inheritance system built upon digital platforms, VR/AR technologies, and big data achieves a dual victory: personalised cultivation and scalable dissemination. Computer technology overcomes the physical constraints of traditional creation, propelling paper-cutting to embed itself deeply within contemporary design fields. Through digital dissemination matrices, it achieves a two-way elevation of both cultural and commercial value. The tripartite model constructed in this research – 'traditional art + modern design + digital technology' – paves a viable path for the living transmission and innovation of paper-cutting art.

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