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Article

AI-Supported Digital Restoration and Generative Design of Fengxiang Woodblock New Year Prints

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Abstract: This paper investigates how artificial intelligence (AI) can be integrated into the digital restoration and innovative transformation of intangible cultural heritage (ICH), using Fengxiang woodblock New Year prints as a representative case. Rather than framing AI as an autonomous creative agent, the study positions AI as a supportive component within a human-centred, constraint-based design workflow. Adopting a qualitative and practice-based research approach, the paper examines how AI-assisted image restoration, constrained generative exploration, and designer-led evaluation interact during the design process. The findings indicate that AI can contribute to the interpretation and preservation of traditional generative logic while supporting culturally grounded adaptation in contemporary cultural and creative products. The study further argues that maintaining human judgement and cultural constraints is essential for preventing stylistic drift and ensuring responsible AI use in heritage-sensitive design contexts.

Keywords: artificial intelligence; intangible cultural heritage; digital restoration; Fengxiang woodblock new year prints; human-in-the-loop design

1. Introduction

Intangible cultural heritage (ICH) has traditionally relied on embodied knowledge, manual skills, and intergenerational transmission. However, many traditional crafts are now confronted with declining practitioner communities, reduced everyday use, and shifting cultural consumption patterns. In response, digital technologies have increasingly been adopted to document, preserve, and disseminate ICH. Digital restoration, visualization, and online exhibition have improved accessibility to heritage artefacts, yet such approaches often focus on preserving visual outcomes rather than understanding the processes through which traditional forms are generated.

Recent advances in artificial intelligence have further reshaped contemporary design practice by enabling rapid image generation and large-scale visual variation. While generative AI tools offer new possibilities for creative exploration, their application within heritage contexts raises critical concerns related to cultural consistency, authorship, and the erosion of traditional visual logic. Unconstrained AI generation may prioritize novelty or efficiency over cultural coherence, potentially leading to stylistic homogenization or cultural dilution.

Design research has increasingly emphasized the importance of integrating digital tools within culturally sensitive frameworks that retain human interpretative authority. In the context of ICH, this requires shifting attention from automated reproduction

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toward processes that support understanding, interpretation, and responsible transformation. Human-in-the-loop approaches have been proposed as a means of ensuring that AI systems remain subordinate to human judgement, particularly in domains where cultural meaning and historical continuity are central [1, 2].

Against this background, the present study explores how AI can be embedded within a constrained, human-centered design workflow for the digital restoration and contemporary application of Fengxiang woodblock New Year prints. By examining AI-assisted restoration and generative design through a practice-based case study, the research seeks to clarify how traditional generative rules can be preserved and reactivated rather than replaced. The study contributes to ongoing discussions on responsible AI use in cultural and creative domains and offers a design-oriented framework for balancing technological innovation with cultural integrity.

2. Literature review

2.1. Digital technologies and intangible cultural heritage

Research on the digitalization of intangible cultural heritage has primarily focused on documentation, preservation, and dissemination. Digital tools such as image processing, three-dimensional scanning, and online exhibition platforms have been widely adopted to support long-term preservation and public access to heritage materials [3]. These approaches have played an important role in safeguarding fragile artefacts and enhancing visibility, particularly in contexts where traditional modes of transmission are weakening.

However, it has been noted that many digital heritage practices prioritize the reproduction of artefacts rather than the interpretation of underlying cultural processes. Excessive emphasis on technical preservation may reduce intangible cultural heritage to static visual representations, thereby overlooking the embodied knowledge and generative logic embedded in traditional crafts [4]. This critique highlights the need for approaches that engage not only with what heritage artefacts look like, but also with how they are produced and understood.

International frameworks have also stressed the importance of responsible and human-centered applications of emerging technologies in cultural contexts. Recent guidance on generative artificial intelligence emphasizes that digital systems should support cultural diversity, human agency, and ethical governance, rather than replace human creativity or judgement [5]. These perspectives provide an important conceptual foundation for integrating AI into heritage-related design practices.

2.2. Traditional new year prints and contemporary design transformation

Chinese New Year prints represent a significant form of traditional folk art, combining symbolic imagery, ritual functions, and regional visual conventions. Historical research has examined the transformation of New Year prints in response to social and technological change, particularly during periods of modernization and mass reproduction [6]. Such studies demonstrate that adaptation and reinterpretation have long been inherent to the evolution of this craft tradition.

In contemporary contexts, design research has explored how New Year prints and other forms of folk art can be recontextualized within cultural and creative industries. Integrating traditional visual symbols into modern design systems has been identified as a key strategy, with emphasis placed on grounding innovation in cultural continuity rather than superficial imitation [7]. At the same time, the role of regional culture in the development of New Year print-inspired products highlights the importance of contextual adaptation and audience engagement [8].

These studies suggest that the successful transformation of traditional crafts requires more than stylistic reference. Instead, it depends on understanding and translating the generative principles that structure traditional visual languages. This insight becomes

particularly significant when digital and AI-based tools are incorporated into the design process.

2.3. AI, digital restoration, and human-centered design

Advances in image processing and artificial intelligence have enabled new approaches to the digital restoration of traditional artworks. Techniques based on feature extraction and image fusion have been shown to improve the clarity and legibility of damaged or degraded visual materials [9]. While these methods offer clear technical advantages, it has been noted that automated restoration must be guided by expert judgement to avoid overcorrection or the loss of material authenticity.

More broadly, AI-supported generative design has attracted increasing attention for its capacity to expand the scope of design exploration. However, existing studies often prioritize algorithmic performance and output diversity, while giving limited consideration to cultural constraints. It has been argued that digital tools applied to intangible cultural heritage innovation should remain subordinate to design intent and cultural interpretation [10].

Research on human-AI interaction further highlights the risks associated with excessive reliance on automated systems. Concepts such as cognitive offloading and automation bias indicate that uncritical dependence on AI outputs may weaken human judgement and critical reflection [1, 2]. In response, human-in-the-loop frameworks have been proposed to ensure that AI systems function as supportive tools rather than autonomous decision-makers.

Building on these discussions, the present study integrates AI-assisted restoration and generative design within a constrained, designer-led workflow. By foregrounding cultural rules and human evaluation, this research extends existing literature on digital heritage and responsible AI, offering a practice-based perspective on how AI can support, rather than undermine, traditional craft logic.

3. Research methodology

3.1. Research approach and design orientation

This study adopts a qualitative, practice-based research methodology in which design activity functions simultaneously as a mode of inquiry and a form of knowledge production. Rather than treating design as a post-analytical output, the research positions design practice as an active process through which cultural logic is interpreted, tested, and articulated. This orientation is consistent with design research approaches that emphasize situated understanding and reflective judgement in culturally embedded contexts [3, 4].

Unlike technology-driven studies that evaluate artificial intelligence (AI) primarily through performance indicators or efficiency metrics, this research focuses on how AI operates within a heritage-sensitive design framework. The central methodological concern is not whether AI can generate visually convincing images, but how its generative capacity can be constrained, interpreted, and evaluated in relation to traditional craft logic. Such an approach aligns with human-centered perspectives on AI that prioritize interpretability and responsibility over automation.

3.2. Case selection and research scope

A single-case study strategy was employed, with Fengxiang woodblock New Year prints selected as the focal research object. This tradition exhibits relatively stable visual conventions, a long history of manual production, and a close relationship between visual form and symbolic meaning. These characteristics make it particularly suitable for examining how traditional generative principles may be translated into AI-assisted design environments without undermining cultural recognizability.

The scope of the research does not aim to reconstruct the entire historical development of Fengxiang New Year prints. Instead, it concentrates on representative visual features and production logic that remain recognizable across different periods. By narrowing the analytical focus, the study is able to examine how specific craft rules—rather than stylistic surface features—can be operationalized as design constraints within AI-supported workflows.

3.3. Data sources and analytical materials

Multiple qualitative data sources were employed to support methodological triangulation. These included digitized images of representative Fengxiang woodblock prints, documentary records of traditional production processes, and design artefacts generated during AI-assisted experiments. The integration of historical reference materials with newly produced design outputs enables the research to move between retrospective analysis and forward-looking design exploration.

Rather than treating these materials as static datasets, the research engages with them iteratively. Visual analysis informs constraint definition, which in turn shapes AI-assisted generation, followed by critical evaluation and refinement. This cyclical use of data supports reflective analysis and reinforces the role of design judgement throughout the research process.

3.4. AI integration and human-in-the-loop strategy

AI tools were introduced selectively at specific stages of the research rather than applied uniformly across the entire workflow. During the digital restoration phase, AI-assisted image processing techniques were used to enhance line clarity and color structure in degraded images. Importantly, AI outputs were treated as provisional interpretations rather than authoritative reconstructions and therefore required manual review and adjustment.

In the generative design phase, AI systems were employed to produce multiple visual variations under explicitly defined cultural constraints. These constraints—covering aspects such as colour range, compositional balance, and line density—were manually established based on prior craft analysis. Throughout the process, all critical decisions, including constraint formulation, output selection, and final refinement, remained under the control of the researcher. This human-in-the-loop configuration directly addresses concerns related to automation bias and cognitive offloading in AI-supported creative work [1, 2], while also aligning with recent discussions on responsible AI use in cultural contexts [5].

4. Research process and case implementation

4.1. Analysis of traditional craft logic

The research process was structured as an iterative sequence of interconnected design actions rather than a linear technical workflow. The first stage focused on the systematic analysis of representative Fengxiang woodblock New Year prints to identify underlying visual and structural principles. Particular attention was given to elements such as line hierarchy, color organization, compositional symmetry, and the recurring use of symbolic motifs.

These elements were interpreted not merely as stylistic features but as generative rules governing image construction within the craft tradition. This distinction is critical, as it shifts the analytical focus from visual appearance to production logic. Such an approach aligns with broader perspectives in heritage design research that emphasize understanding how artefacts are generated before attempting digital translation or innovation [3, 6].

4.2. AI-Supported digital restoration

In the second stage, AI-assisted digital restoration techniques were applied to selected images exhibiting wear, fading, or partial damage. The objective of restoration was not to recreate an idealised original image but to support clearer interpretation of visual relationships, including line interaction and colour layering.

AI-generated restoration results were therefore treated as intermediate representations rather than final outputs. Manual intervention played a crucial role in determining which irregularities should be preserved and which elements could be enhanced. This cautious approach reflects concerns in digital restoration research that excessive algorithmic correction may compromise historical authenticity and erase meaningful material traces [9].

4.3. Constrained generative exploration

The third stage involved constrained generative exploration using AI tools. Based on the extracted craft rules, AI systems were employed to generate sets of visual variations rather than single outputs. Batch generation enabled comparative evaluation and facilitated reflection on how different parameter configurations influenced cultural coherence.

Outputs that deviated from established visual conventions or introduced ambiguous stylistic characteristics were excluded through critical review. This evaluative process responds directly to concerns that unconstrained AI generation may result in stylistic drift or cultural dilution when applied in heritage contexts [7, 10].

4.4. Application in contemporary cultural products

In the final stage, selected design outcomes were translated into contemporary cultural and creative products, including decorative prints and festival-related items. This application phase functioned as a form of practical validation, examining whether AI-assisted designs could maintain cultural recognizability when removed from their original production context.

The transition from generated imagery to applied artefacts also enabled reflection on the adaptability of traditional visual logic within modern usage scenarios. Rather than treating application as a purely commercial step, it was used as an analytical lens to evaluate the effectiveness of constraint-based AI integration [8].

5. Discussion

The integration of artificial intelligence into the digital restoration and innovative transformation of intangible cultural heritage inevitably raises complex questions concerning authorship, cultural authority, and the limits of technological intervention. Based on the case study of Fengxiang woodblock New Year prints, this research demonstrates that AI should not be understood as an autonomous creative agent within heritage-related design contexts. Instead, its value emerges most clearly when positioned as a generative support system embedded within a human-centered, culturally constrained design workflow.

5.1. Reframing the role of AI in heritage-sensitive design

Contemporary discourse surrounding AI-driven creativity frequently emphasizes autonomy, efficiency, and the capacity for large-scale generation. While such characteristics may be advantageous in commercial or exploratory design contexts, they are fundamentally misaligned with the values that underpin intangible cultural heritage. Traditional crafts such as Fengxiang woodblock New Year prints are not defined solely by their visual outcomes, but by the cultural logic, symbolic systems, and embodied knowledge embedded in their production processes.

The findings of this study indicate that when AI is introduced without explicit cultural constraints, generated outputs may appear stylistically plausible while subtly

violating traditional visual rules. Such violations are often difficult to detect at a surface level but become evident through comparative analysis with established craft conventions. This risk underscores the importance of reframing AI not as a creative subject, but as a tool whose generative capacity must be carefully guided and interpreted.

By embedding AI within a human-in-the-loop framework, the design process prioritizes judgement over automation. AI-generated variations serve as prompts for reflection rather than final solutions. This reframing challenges dominant narratives of AI creativity and aligns more closely with responsible AI perspectives, which argue that human oversight is essential in domains where cultural meaning and ethical responsibility are central.

5.2. Preserving generative logic rather than visual results

A key conceptual contribution of this research lies in shifting the focus of digital heritage practices from result-oriented preservation to the preservation of generative logic. Many existing digital heritage initiatives concentrate on the accurate reproduction of artefacts, treating restoration as a primarily technical objective. While such approaches play an important role in documentation and archival preservation, they risk reducing heritage to static visual forms detached from their production context.

In contrast, the present study foregrounds the extraction and operationalization of craft rules as the core unit of preservation. In the case of Fengxiang woodblock New Year prints, these rules include line hierarchy, color organization, compositional balance, and the symbolic use of motifs. By translating these principles into explicit design constraints, AI-assisted tools become mechanisms for reactivating traditional logic rather than merely replicating historical appearances.

This process-oriented perspective allows for innovation without severing ties to tradition. Instead of asking whether AI can reproduce an "authentic" image, the research asks whether AI-supported design decisions remain consistent with the internal logic of the craft. Such a shift has important implications for how authenticity is understood in digital heritage contexts, suggesting that fidelity to process may be as significant as fidelity to appearance.

5.3. Digital restoration as interpretation rather than reconstruction

The application of AI-assisted digital restoration in this study further illustrates the importance of interpretative judgement. Rather than attempting to reconstruct an idealized original image, restoration was used to support clearer interpretation of visual relationships, such as line interaction and color layering. AI outputs were treated as provisional visual hypotheses that required manual evaluation and adjustment.

This approach acknowledges that degradation, irregularity, and material traces are not merely technical flaws, but meaningful components of handcrafted artefacts. Excessive algorithmic correction risks erasing these traces and imposing contemporary aesthetic norms onto historical materials. By maintaining human oversight, the restoration process becomes an act of interpretation rather than reconstruction, reinforcing the role of the designer as a mediator between technology and tradition.

5.4. Human judgement, automation bias, and design responsibility

Research on human-AI interaction highlights the risks associated with automation bias and cognitive offloading, whereby users may defer excessively to machine-generated outputs. In creative and heritage-related contexts, such tendencies are particularly problematic, as cultural judgement cannot be reduced to computational optimization.

The human-in-the-loop strategy adopted in this research directly addresses these risks by requiring the designer to define constraints, evaluate outputs, and make final selections. AI-generated results are never accepted uncritically; instead, they are assessed

in relation to traditional visual rules and cultural coherence. This configuration reinforces design responsibility and ensures that interpretative authority remains human-led.

Importantly, the findings suggest that AI's value lies not in accelerating production, but in expanding the design exploration space. The ability to generate multiple constrained variations enables designers to compare alternatives and reflect on subtle differences in cultural alignment. This comparative process supports learning, interpretation, and critical reflection, particularly for designers who may not be traditional craft practitioners but seek to engage responsibly with heritage materials.

5.5. AI and shifts in craft authority

The introduction of AI into heritage-related design processes also raises questions about shifts in authority and authorship. Traditional crafts are often sustained through master-apprentice relationships, in which knowledge is transmitted through embodied practice and long-term observation. When AI tools are introduced, there is a risk that algorithmic outputs may be perceived as authoritative, potentially marginalizing the role of craft knowledge.

The framework proposed in this study mitigates this risk by positioning AI as subordinate to human judgement and cultural rules. Authority remains grounded in the interpretation of traditional logic rather than in the technical capabilities of the system. In this sense, AI does not redefine what constitutes "correct" or "authentic" design, but operates within boundaries defined by cultural understanding.

5.6. Comparison with existing digital heritage approaches

Compared with conventional digital heritage pathways, the approach presented in this study occupies an intermediate position between static digital archiving and purely market-driven cultural product development. Unlike archival models that prioritize preservation without transformation, the proposed framework actively supports contemporary application. At the same time, unlike commercial reinterpretations that may prioritize novelty or market appeal, innovation remains constrained by cultural logic.

This balance highlights the potential of AI-supported design as a mediating mechanism between preservation and innovation. By foregrounding generative logic and human evaluation, the framework offers an alternative pathway for sustainable heritage transformation.

5.7. Implications for design education and practice

Beyond its immediate application to Fengxiang woodblock New Year prints, the findings of this study have broader implications for design education and practice. Intangible cultural heritage can be understood not only as an object of preservation, but as a resource for training design thinking, cultural sensitivity, and reflective judgement.

Integrating AI-supported, constraint-based design workflows into educational contexts may help students develop a deeper understanding of tradition while engaging with contemporary technologies. In this sense, heritage becomes a living framework for learning rather than a static reference.

Overall, the discussion demonstrates that responsible AI integration in heritage-sensitive design is fundamentally a methodological and ethical challenge rather than a purely technical one. The effectiveness of AI depends less on algorithmic sophistication than on the frameworks within which it is deployed.

6. Conclusion

This study has examined the integration of artificial intelligence into the digital restoration and innovative transformation of intangible cultural heritage through a practice-based case study of Fengxiang woodblock New Year prints. By situating AI within a constrained, human-centered design workflow, the research demonstrates that

AI can function as a supportive tool for interpreting and reactivating traditional generative logic rather than as an autonomous creative agent.

The primary contribution of this research lies in clarifying how AI-assisted restoration and generative design can be aligned with heritage-sensitive values. Instead of prioritizing visual novelty or technical efficiency, the proposed framework emphasizes cultural continuity, designer judgement, and process-oriented evaluation. This perspective challenges dominant narratives of AI-driven creativity and highlights the importance of maintaining human interpretative authority in culturally meaningful design contexts.

While focused on a single case, the framework developed in this study offers methodological insights that may be applicable to other forms of intangible cultural heritage characterized by stable visual or procedural conventions. Future research may extend this approach through comparative case studies, interdisciplinary collaboration with craft practitioners, or application within design education. In doing so, AI may be further explored as a tool for responsible cultural innovation rather than a force of homogenization.

References

1. E. F. Risko, and S. J. Gilbert, "Cognitive offloading," *Trends in cognitive sciences*, vol. 20, no. 9, pp. 676-688, 2016. doi: 10.1016/j.tics.2016.07.002
2. L. J. Skitka, K. L. Mosier, and M. Burdick, "Does automation bias decision-making?," *International Journal of Human-Computer Studies*, vol. 51, no. 5, pp. 991-1006, 1999.
3. Y. Huang, J. Chang, and G. Li, "Framework for digital transformation of intangible cultural heritage: Chinese paper-cutting art," *Archives of Design Research*, vol. 37, no. 1, pp. 43-58, 2024.
4. H. Feng, "The application of digital technology in the protection and inheritance of intangible cultural heritage," In *Proceeding of the International Conference on Arts and Humanities*, December, 2024, pp. 1-13.
5. W. Holmes, and F. Miao, "Guidance for generative AI in education and research," *Unesco Publishing*, 2023.
6. L. Zhang, Z. Wang, R. Yang, and Q. Yi, "Digital presentation and interactive learning for intangible cultural heritage preservation using artificial intelligence," *IEEE Access*, 2025. doi: 10.1109/access.2025.3588520
7. X. Peng, "Study on the application and research of visual symbols of traditional New Year pictures in modern design," In *The 6th International Conference on Arts, Design and Contemporary Education (ICADCE 2020)*, January, 2021, pp. 580-583. doi: 10.2991/assehr.k.210106.112
8. G. Guigui, and M. V. Kitan, "The Practical Significance of Chinese New Year Paintings: Experiences of Art Teachers in Shandong Province," *International Journal of New Developments in Education*, vol. 7, no. 10, 2025.
9. Y. Zeng, Y. Gong, and X. Zeng, "Controllable digital restoration of ancient paintings using convolutional neural network and nearest neighbor," *Pattern Recognition Letters*, vol. 133, pp. 158-164, 2020. doi: 10.1016/j.patrec.2020.02.033
10. X. Bai, "Computer-Aided Design and Intelligent Optimization in the Inheritance of Intangible Cultural Heritage," *Computer-Aided Design & Applications*, vol. 22, 2025. doi: 10.14733/cadaps.2025.s7.41-54

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