

Research on the Inheritance Path and Innovation Strategies in the Digital Design of Weifang Kites

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How to cite this paper: Liang Jin, Sharul Azim Sharudin. (2025). Research on the Inheritance Path and Innovation Strategies in the Digital Design of Weifang Kites. *Journal of Literature Advances*, 2(1), 19-24. DOI: 10.26855/jla.2025.06.004

Received: April 7, 2025
Accepted: June 25, 2025
Published: July 18, 2025

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Abstract

This paper takes the digital design of Weifang kites as the research object and systematically explores its historical origin, technological empowerment path, innovation strategies and social value. By analyzing the adaptability between traditional craftsmanship and digital technology, an application framework of technologies such as 3D modeling, virtual reality, and parametric design in cultural gene decoding, form innovation, and community participation is proposed. Research reveals that digital design not only reconstructs the knowledge production and dissemination model of kite culture, but also activates the endogenous driving force of local culture through cultural IP operation and community co-creation mechanisms. This article emphasizes that technological empowerment should be combined with cultural critical thinking. While safeguarding the core values of traditional craftsmanship, it is necessary to promote its transformation into a digital ecosystem where the virtual and the real coexist, providing an interdisciplinary paradigm reference for the digital protection of intangible cultural heritage.

Keywords

Weifang Kite; Digital design; Cultural IP; Parametric art; Community co-creation; Inheritance of intangible cultural heritage

Introduction

Against the backdrop of the global shift in intangible cultural heritage protection from "material preservation" to "living inheritance", the digital design of Weifang kites, as a national intangible cultural heritage, has become a typical case of the integration of traditional craftsmanship and modern technology. The traditional kite-making craft relies on the experience of artisans and physical carriers, facing the dual predicaments of broken inheritance and shrinking market. However, digital technology provides a new path for the deconstruction, reorganization and dissemination of cultural symbols. Starting from historical origins, this article explores how digital design reconstructs the morphological genes, knowledge networks and industrial ecosystems of kite culture through technological tools, and analyzes its social value in community participation and the construction of cultural identity. The research aims to reveal the internal logic of technology empowering the inheritance of intangible cultural heritage, and provide theoretical support and practical strategies for the sustainable innovation of traditional craftsmanship.

1. Analysis of the Historical Origin of Weifang Kite Culture and Its Adaptability to the Digital Design Context

1.1 Analysis of the Current Situation of the Mismatch between Vocational Education and Industrial Demands

The traditional vocational education system has long been confined to standardized courses and closed training

models, and there is a significant gap between its knowledge supply and the interdisciplinary skills required for the digital upgrade of the kite industry (such as 3D modeling, parametric design, and virtual reality interaction) (Ren, 2023). This dislocation is not only reflected in the imbalance of the skill structure - vocational colleges still focus on the mechanical teaching of traditional tie-making techniques, while neglecting the cultivation of digital literacy such as algorithmic thinking and data visualization; It is more manifested as the lag in value cognition - educators have not fully realized that the digital inheritance of kite culture has shifted from "skill replication" to "digital translation of cultural genes", and the core lies in transforming the abstract semantics of folk symbols into interactive digital assets. The actual demands at the industrial end exhibit dynamic and complex characteristics: Kite enterprises not only require designers to have the ability to deconstruct traditional patterns into dynamic geometric shapes, but also demand that they master blockchain technology to achieve copyright protection of intangible cultural heritage ips. We both look forward to simulating the flight trajectory of kites through digital twin technology to optimize product performance and are eager to build immersive cultural experience scenarios with the help of the metaverse platform. The essence of this supply-demand contradiction lies in the fact that vocational education has failed to promptly adjust the chain structure of "knowledge production - skill transformation - value output" in the wave of digital transformation, resulting in a dual predicament of a "technological gap" and a "cultural disconnection" between talent cultivation and the industrial ecosystem. It is urgently necessary to break through the modular reorganization of the curriculum system, the in-depth innovation of the industry-education integration mechanism, and the digital transformation of evaluation standards.

1.2 The transformation predicament of traditional craftsmanship in the context of digital design

In the context of digital design, the transformation predicament of the traditional craftsmanship of Weifang kites is manifested as a structural tear between technical rationality and cultural authenticity. From a technical perspective, although 3D scanning and parametric modeling can accurately reproduce the shape of kites, they are difficult to encode the tacit knowledge contained in the "touch" of artisans - the subtle adjustment of the curvature of bamboo strips relies on tactile memory, and the dynamic balance of paper tension depends on empirical intuition. These "unspoken" skills are simplified into quantifiable parameters in digital translation. This leads to the loss of the "vitality" of the core process (Zhou, Li, & Wang, 2021). At the cultural level, the semantic network of kites as folk symbols (such as the "Fu" cultural metaphor of bat patterns) has been deconstructed in modular design. Although the form innovation has expanded the visual boundary, it may cut off the connection between the symbol and collective memory, making it become an empty digital decoration. At the industrial end, the extreme pursuit of efficiency in standardized digital production and the personalized features of kite-making (such as the randomness of hand-painted patterns) form an irreconcilable contradiction, forcing traditional craftsmanship to be in a dilemma in the "efficiency first" digital industrial system: it is neither able to return to the inefficient manual mode nor can it be fully domesticated by algorithms, ultimately leading to identity loss under the "efficiency paradox".

1.3 Construction of an adaptation model between traditional craftsmanship and digital technology

The adaptability model of traditional craftsmanship and digital technology of Weifang kites needs to take "decoding of cultural genes - adaptation of technical tools - reconstruction of value networks" as the core to construct a cross-dimensional collaborative framework. By using semiotic and craft anthropology methods, the explicit forms (such as the topological structure of the skeleton and the color spectrum of the patterns) and implicit grammar (such as the temporal nature of the binding process and the ecological wisdom of material selection) of kite craftsmanship are separated to form a "cultural gene bank" that can be analyzed by algorithms, providing semantic anchor points for the intervention of digital technology (Niu, 2023). Dynamic parametric design and generative AI are introduced to simulate the experience of artisans (such as the nonlinear relationship between the curvature of bamboo strips and the wind resistance coefficient) through machine learning. The variation and recombination of pattern genes are achieved through the GAN network, making digital design both stable in cultural inheritance and open in form innovation. The deep logic of technology adaptation lies in constructing a "human-machine-art" trinity collaborative network: Utilizing AR technology to build a virtual-real integrated scene for the inheritance of skills, making digital tools the "externalized carrier" of artisans' experience; Through blockchain rights confirmation and smart contracts, a decentralized cultural property rights distribution mechanism is established to balance the cultural ownership and commercial value of digital assets. The model needs to achieve a paradigm shift from "tool empowerment" to "ecological symbiosis" - digital technology becomes the "ecological catalyst" for activating cultural genes and

reconstructing value networks, promoting the sustainable evolution of kite culture from material carriers to digital assets and from regional symbols to global cultural ips.

2. The inheritance path of digital design for Weifang kites

2.1 Technical empowerment paths based on 3D modeling and virtual reality

In the inheritance path of digital design for Weifang kites, the technical empowerment path based on 3D modeling and virtual reality (VR) constitutes a paradigm leap from physical craftsmanship to a system of coexistence between the virtual and the real. 3D modeling technology, through high-precision laser scanning and reverse engineering algorithms, transforms the physical forms of traditional kites (such as the topological structure of bamboo bones and the texture and wrinkles of silky surfaces) into editable digital twins. The core challenge lies not only in the precise reproduction of geometric data, more importantly, it lies in how to encode the implicit "dynamic parameters" in the artisan's experience (such as the elastic deformation of the skeleton under wind force and the aerodynamic characteristics of the flight trajectory) into computable algorithm models (Wang, 2022). This process requires the integration of finite element Analysis (FEA) and machine learning. By constructing a multi-field coupled simulation system of "material - structure - environment", the digital model can not only simulate the physical properties of kites but also generate morphological variations that conform to traditional aesthetic rules. The intervention of VR technology has further broken the limitations of physical space: Through force feedback gloves and spatial positioning devices, learners can experience the entire process of "tying, pasting, drawing and placing" in a virtual environment. Its haptic feedback system can simulate the flexibility of bamboo strips and the extensibility of paper, while the multimodal interactive interface allows users to control design parameters with gestures, voice and even brain waves, achieving a transformation from "observing learning" to "immersive creation". This technological empowerment path not only reconstructs the knowledge transmission method of kite-making, but also transfers cultural memory from material carriers to the digital ecosystem through the experience design of virtual and real integration, enabling traditional skills to achieve "reversible inheritance" in the virtual space - it can not only trace the evolution trajectory of historical forms, but also generate future-oriented cultural variants through user co-creation.

2.2 The collaborative mechanism between digital platforms and community-based inheritance

In the inheritance path of digital design of Weifang kites, the collaborative mechanism of digital platforms and community-based inheritance constitutes a dynamically evolving ecosystem, and its essence is the deep coupling of technical infrastructure and cultural community energy (Zhu, Guo, & Sun, 2021). As a hub for knowledge aggregation and dissemination, the digital platform needs to conduct structured analysis of multimodal data of kite culture (such as historical documents, artisans' oral accounts, and craft videos) through semantic network technology, and construct a three-dimensional knowledge system including the "morphological gene bank", "craft knowledge graph", and "cultural narrative chain". And with the aid of natural language processing (NLP) and computer vision (CV), intelligent retrieval and associated recommendation of cross-media content are achieved (Wang, 2022, Zhu, L., Guo, & Sun, 2021). However, simple technological aggregation is difficult to activate the sustainability of cultural inheritance. The intervention of community-based inheritance reconstructs the path of knowledge flow through a "humanized" network: On the one hand, the maker community breaks down geographical barriers through an open-source collaboration model. Designers, programmers, and inheritors of intangible cultural heritage jointly develop digital toolkits through online collaboration platforms (such as the intangible cultural heritage zone on GitHub), converting the tacit knowledge of traditional craftsmanship into reusable algorithm modules. On the other hand, social media platforms build cultural identity fields through hashtags (# Weifang Kite Digital Rebirth #) and virtual exhibitions (such as the Metaverse Kite Culture Festival), attracting Gen Z users to participate in cultural reproduction through secondary creation (such as digital collectible design, AR flight games). The core of this collaborative mechanism lies in the two-way empowerment of "platform - community". Digital platforms provide technical tools and dissemination channels for communities, while communities feed back to the platform's knowledge base through user-generated content (UGC), forming a spiral evolution of "data accumulation - tool iteration - community expansion", ultimately enabling Kite Culture to achieve a paradigm transformation from "passive preservation" to "active growth" in the digital ecosystem.

2.3 Digital inheritance strategies in educational scenarios

In the educational context, the construction of the digital inheritance strategy for Weifang kites is essentially an experiment of deep integration of an interdisciplinary knowledge system and a digital technology ecosystem (Wang, 2022). Its core lies in reconstructing cultural cognition and practical paradigms through a "virtual and real coexistence" teaching field. On the one hand, it is necessary to take the STEAM education framework as the basis and integrate the physical attributes of kite culture (such as aerodynamic principles and material mechanical properties) with digital technologies (such as 3D modeling and sensor programming) across disciplines. For example, through Arduino open-source hardware and wind tunnel simulation experiments, enable students to intuitively understand the dynamic correlation between the flight trajectory of kites and digital parameters (such as lift coefficient and center of gravity offset), and at the same time, use generative AI to assist in designing digital variants of traditional patterns, and explore the contemporary translation path of cultural symbols in the process of algorithm iteration. On the other hand, educational scenarios need to break through the time and space limitations of traditional classrooms and build an "online-offline" hybrid inheritance network: offline, relying on intangible cultural heritage workshops and maker laboratories, digital twin technology is used to reproduce the experiences of artisans (such as the force feedback simulation of bamboo bending), achieving the interaction between "embodied cognition" and "detached cognition". Online, a virtual inheritance community is built through the metaverse platform. Students can transform into digital avatars to participate in global collaborative design challenges. Their creative achievements are confirmed through blockchain rights and then included in the intangible cultural heritage digital asset library, forming a value closed loop of "learning - creation - dissemination". More importantly, educational strategies should be embedded with the cultivation of cultural critical thinking, guiding students to deconstruct the power structure in kite culture (such as gendering patterns and regional hierarchies) through digital tools, and embedding ethical constraints (such as warnings of excessive commercialization of cultural symbols) in algorithm design, so as to safeguard the autonomy and critical nature of cultural inheritance while empowering with technology.

3. Innovative Strategies for Digital Design of Weifang Kites

3.1 Formal innovation: The integration of parametric design and generative art

In the innovative strategy of digital design for Weifang kites, formal innovation, through the deep integration of parametric design and generative art, has constructed a dynamic generative paradigm that combines technical rationality and artistic poetry. Its essence is a leapfrog reconstruction of the boundary between traditional kite morphology and digital aesthetics. Parametric design deconstructs the geometric rules of traditional kites with algorithmic logic, transforms the implicit "proportional aesthetics" in artisans' experience (such as the golden ratio of the length and area of the skeleton) into adjustable parameter variables (such as the control point density of Bessel curves and the number of iterations of fractal algorithms), and generates a new type of skeleton form with both structural stability and visual tension through topological optimization techniques. Generative art, on the other hand, uses generative adversarial networks (GAN) and variational autoencoders (VAE) to transfer the style and reorganize the semantics of kite patterns, transforming traditional auspicious symbols (such as cloud patterns and ruyi patterns) into futuristic digital totems within the framework of deep learning. The generation process not only retains the topological structure of cultural genes. Moreover, the infinite possibilities of formal variation have been achieved through random noise injection. The deep value of this integration lies in breaking the linear chain of "design - production". Parametric models provide a controllable underlying framework for generative art, while the randomness of generative art reverse-stimulates the exploration boundaries of the parameter space. The two form a co-evolution of "algorithm - aesthetics" in iterative optimization. This innovative strategy not only gave rise to a kite form that combines traditional charm with digital avant-garde, but also, through the establishment of an open-source code library and a user customization platform, transformed kite design from a craft monopolized by artisans into a cultural experiment participated by the public, achieving the "decentralized regeneration" of cultural symbols in the process of form innovation.

3.2 Industrial ecosystem Reconstruction: From single product to cultural IP operation

In the innovative strategy of digital design for Weifang kites, the core of the industrial ecosystem reconstruction lies in the paradigm shift from single product manufacturing to cultural IP operation. Its essence is to build a closed-loop

system covering "content production - value addition - ecological expansion" through the dual drive of digital technology empowerment and cultural capital operation. The traditional kite industry has long been limited by the life cycle of physical products and the boundaries of regional markets. However, digital design breaks this constraint through the deconstruction and reorganization of cultural IPs. On the one hand, based on 3D scanning and motion capture technology, the form, craftsmanship and cultural narrative of traditional kites are transformed into reusable digital assets (such as high-precision 3D models and dynamic pattern libraries), and through blockchain technology, the rights are confirmed to form intangible cultural heritage digital collectibles, thus separating cultural symbols from physical carriers into tradable virtual capital. On the other hand, by leveraging the metaverse platform to build immersive cultural experience scenarios, the kite IP can be extended to virtual performances (such as kite-themed light and shadow shows involving digital avatars), social games (such as open-world exploration based on kite flight rules), and other cross-media business forms, forming a composite value network of "physical products + digital derivatives + experience economy". More importantly, IP operation needs to build an ecological mechanism of "co-creation - sharing - co-governance" Attract global creators to participate in the secondary development of the Kite IP through an open-source design platform, achieve transparent distribution of revenue through smart contracts, and allow users to directly participate in IP governance decisions by leveraging the DAO (Decentralized Autonomous Organization) model. Thus, a dynamic balance between cultural sovereignty and commercial interests is achieved in the process of industrial ecosystem reconstruction. Ultimately, it will promote the elevation of Weifang kites from local handicrafts to a cultural symbol system with global influence.

3.3 Enhancement of social value: The stimulation of community vitality by digital design

In the innovative strategies of digital design for Weifang kites, the core of enhancing social value lies in activating the cultural genes of the community through digital design and reconstructing the symbiotic relationship between traditional handicrafts and the local society. Essentially, it is a cultural empowerment movement mediated by technology. Digital design not only transforms kite-making techniques into interactive digital resources (such as virtual strap-making workshops based on augmented reality and dynamic kite pattern generators), but also breaks down professional barriers through the "technology" strategy, enabling community residents to shift from cultural consumers to cultural producers: The elderly can transform their family kite pedigree into a digital family tree with the help of simple programming tools. Teenagers can reconstruct traditional competitive rules through gamified design platforms (such as kite flight physics engines), while the disabled can achieve barrier-free creation through haptic feedback devices and voice interaction interfaces, forming a cross-generational and cross-ability cultural co-creation network. This participatory design not only reshapes the way community memories are stored and disseminated (such as marking the spatial nodes of kite culture with Geographic Information System (GIS) and constructing digital cultural maps), but also deeply coupling the physical space of the community (such as kite Square, intangible cultural heritage workshop) with the virtual space (such as metaverse community) through digital twin technology. It has given rise to a new type of cultural field where the virtual and the real coexist. During this process, digital design has become a catalyst for community identity - through collective actions such as jointly maintaining digital cultural assets and participating in the global virtual Kite Festival, residents have elevated local knowledge into cultural capital with global dialogue capabilities. Ultimately, while activating community vitality, they have achieved a transformation from a "cultural island" to a "digital cultural hub". Provide a social foundation and value fulcrum for the sustainable inheritance of traditional handicrafts.

4. Conclusions

The practice of digital design of Weifang kites shows that technology is not a substitute for traditional culture, but a catalyst that activates its vitality. Through 3D modeling, generative art and community co-creation mechanisms, Kite Culture has achieved a form leap from physical craftsmanship to digital assets, and a value upgrade from regional symbols to global IPs. However, this process requires vigilance against the dissolution of cultural depth by technological rationality, emphasizing the embedding of cultural critical thinking in algorithm design and balancing commercial interests and cultural sovereignty in IP operation. In the future, the digitalization of intangible cultural heritage should further explore the ecological model of "coexistence of the virtual and the real", transform technological empowerment into social innovation momentum, enable traditional craftsmanship to be rejuvenated in the digital age, and become a cultural bond connecting the past and the future, as well as the local and the global.

References

- Du, L. (2024). Research on cultural and creative design strategies of Weifang kites from the perspective of intangible cultural heritage. *Footwear Technology and Design*, 4(20), 117-119.
- Niu, L. (2023). Research on the digital innovation and development of kite culture industry in Weifang city. *Journal of Shandong Open University*, (1), 82-85.
- Ren, X. (2023). Interpretation of regional culture and digital design practice of Weifang kites. *A Comparative Study on Cultural Innovation*, 7(4), 94-97.
- Wang, S. (2022). Research on the digital application of "Weifang elements" in urban image. *Comedy World: China*, (1), 159-160.
- Wang, X. (2022). Research on the protection and development of intangible cultural heritage kites from the perspective of intangible cultural heritage. *Tomorrow's Fashion: Last Half of the Month*, (7), 159-162.
- Zhou, Y., Li, T., & Wang, N. (2021). Research on the digital survival path of intangible cultural heritage: A case study of Weifang kites. *Science Communication*, 13(10), 3.
- Zhang, Y., & Song, Q. (2024). Research on digital display design of Weifang kites based on interactive narrative. *Beauty and the Times (Creativity)*, 7(1), 129-131.
- Zhu, L., Guo, L., & Sun, Y. (2021). Research on the digital protection and inheritance of intangible cultural heritage - Kites. *Business Culture*, 1(3), 40-41.