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The Collaborative Development of Digital Printing and Traditional Techniques in Textile Innovation

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Abstract

Under the dual waves of consumption upgrading and green transformation, the coordinated development of digital printing and traditional craftsmanship has become an important path for innovation and breakthrough in the textile industry. It not only meets the flexible production needs of small and medium-sized production capacity, but also caters to the consumption preferences of young consumer groups for cultural and creative products, helping intangible cultural heritage to shift from inheritance and protection to market-oriented monetization. Digital printing, with its efficient, precise, and low-carbon technological characteristics, breaks the bottleneck of large-scale production in traditional processes; The cultural heritage and handmade warmth carried by traditional crafts endow digital printing products with differentiated competitive value, helping to promote the dynamic inheritance of intangible cultural heritage crafts and the green upgrading of industries. This article is based on authoritative research data and practical cases in the industry, analyzing the technological adaptation points and industrial foundations of their collaboration, exploring innovative paths for the entire chain of design, production, and market, sorting out the practical obstacles in the development process, and proposing optimization strategies, providing feasible references for the high-quality development of the textile industry.

Keywords

Digital printing, Traditional craftsmanship, Textile innovation, Collaborative development, Green transition.

1. Introduction

Textiles are an important carrier for inheriting national culture and meeting diverse consumer needs. Currently, they are facing three challenges: the surge in personalized demand, the tightening of environmental regulations, and the sluggish transformation of small and medium-sized production capacity. Small and medium-sized textile enterprises account for over 80% of the industry's main body, which is constrained by the low manual production capacity and difficulty in standardization of traditional crafts, as well as the high cost of digital technology implementation. Traditional crafts themselves are also trapped in the dilemma of "difficulty in inheriting craftsmanship and monetizing value" due to the lack of systematic methods for digital transformation and a shortage of young inheritors [1]. Digital printing technology has become a key support for industry transformation due to its environmental advantages of water conservation of over 70% and dye utilization rate of up to 95%, as well as its production characteristics of small-batch customization and rapid response. Nowadays, it has gradually penetrated from high-end customization scenarios to large-scale production. Several small and medium-sized enterprises in Jiangsu, Zhejiang and other places have achieved transformation through lightweight collaborative models. The intangible cultural genes contained in traditional crafts such as Su embroidery, batik, and Miao embroidery are the core resources for textile differentiation competition, which is in line with the development direction of non-

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heritage industrialization in the "14th Five-Year Plan" for cultural development. The consumption proportion of culture-embedded textiles by young consumer groups has exceeded 40%. The current market demand for the integration of the two has shifted from simple superposition to deep collaboration, which is also an inevitable choice to break through the bottleneck of industry development. According to the industry report released by the China Printing and Dyeing Industry Association in 2025, the penetration rate of digital printing in the textile industry in China has reached 34%, and the export growth rate of digital printing products that integrate traditional techniques has reached 27%, significantly higher than the industry average, fully demonstrating the huge potential for collaborative development. This article focuses on the practical path and industrial value of the collaboration between the two, providing new ideas for industry innovation.

2. The Development Status and Complementarity of Digital Printing and Traditional Crafts

Digital printing technology has undergone multiple iterations and has formed a large-scale application pattern. According to the 2025 annual report of the China Printing and Dyeing Industry Association, the global digital textile printing market has reached 3.68 billion US dollars and is expected to increase to 12.1 billion US dollars by 2035, with a compound annual growth rate of 12.2%. Among them, inkjet printing technology accounts for 71% and is currently the mainstream application form. In the domestic market, the sales of digital printing machines reached 5,700 units in 2023, a year-on-year increase of 17.8%. The single-pass digital printing equipment with a wide width can print up to 80,000 meters per day, and the production efficiency is more than four times higher than traditional flat-screen printing equipment. The processing cost has been reduced to 2.1 CNY/meter, and the proportion of water-based and reactive inkjet inks in China exceeds 60%. It is suitable for mainstream fabrics such as cotton and polyester, completely reversing the industry image of "high price and low efficiency" in digital printing [2]. Its core advantage lies in on-demand printing to reduce resource waste, with VOCs (volatile organic compounds) emissions reduced by over 89% compared to traditional processes, highly in line with the industry's development direction under the "dual carbon" goal [3].

Traditional crafts face dual challenges of inheritance and industrialization expansion. Taking Guizhou Miao embroidery as an example, a cluster of nearly 290 enterprises and over a thousand handicraft workshops has been formed in the local area. However, the traditional pure handmade production mode has low efficiency, with a single Miao embroidery garment production cycle of up to 14 days, which is difficult to match the delivery rhythm of the fast fashion market; The pattern replication accuracy of batik, tie-dye and other processes is limited, and the range of color difference fluctuations during mass production is large, which restricts further market expansion. However, the cultural value of traditional craftsmanship cannot be replaced. Guizhou has completed the digital collection of more than 18,800 pieces (sets) of Miao embroidery traditional patterns, which have become design materials for many international clothing brands, driving the export of related products to 15 countries and regions.

The complementarity between the two forms the core foundation for collaborative development: digital printing solves the problem of large-scale and precise production in traditional crafts, while traditional crafts provide cultural core and design inspiration for digital printing, forming a two-way driving pattern of "technological empowerment + cultural value added".

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3. The technological convergence points and industrial foundation of collaborative development

The high compatibility at the technical level provides feasible support for collaborative development. The core advantage of digital printing lies in digital collection and precise restoration. Through high-definition scanning technology, the stitch texture of Miao embroidery and the ice cracking pattern of batik can be converted into standardized digital patterns. After calibration by a professional color management system, the pattern replication error can be controlled within 0.1mm [4]. For the random patterns of tie-dye, digital printing can simulate manual textures through algorithms and achieve standardized replication. The "flat-screen pre-positioning + digital local overlay" composite process developed by Hanyin Digital combines the high permeability of traditional flat-screen printing with the fine expressive power of digital printing. The produced wax-like fabric not only retains the traditional process's level 4 or above wear resistance, but also achieves natural gradient color effects, shortening the overall production cycle by 29%.

Environmental protection policies and intangible cultural heritage protection policies form a dual support system. The "Green Development Technology Guidelines for Printing and Dyeing Industry (2025 Edition)" clearly requires that the energy consumption per unit product in the industry be reduced by more than 20% compared to 2020. The low-carbon advantages of digital printing are significant - the carbon footprint of single-meter fabrics is only 42%–51% of traditional processes, becoming a key area of policy tilt [5]. Zhejiang Province provides up to 30% of financial subsidies to enterprises that purchase digital printing equipment, and Jiangsu and other places simultaneously launch special support funds for process transformation. Under the promotion of intangible cultural heritage protection policies, Guizhou has established a provincial-level digital public service platform for Miao embroidery, promoting the deep integration of hand embroidery, machine embroidery, and digital printing technology, expanding diverse application scenarios such as wall coverings and decorative paintings, and promoting the transformation of traditional crafts from labor-intensive to technology-intensive.

A complete industrial chain provides solid guarantees for collaborative development. A complete industrial chain has been established domestically, from the manufacturing of digital printing equipment (leading enterprises such as Zhejiang Haiyin and Hangzhou Honghua) to the industrialization of traditional crafts (Guizhou's "Jinxiu (Splendid) Plan"). By 2025, the market share of water-based pigment ink will increase to 44%, providing environmentally friendly material support for the synergy between the two; The sales of customized clothing on e-commerce platforms increased by 34% year-on-year, with 41% of products adopting a production model that combines digital printing with traditional craftsmanship, and market demand continues to expand.

4. The core path and practical mode of collaborative innovation

Collaboration in the design process is the key to achieving deep integration of culture and technology. By building a traditional pattern digital resource library, intangible cultural heritage elements such as Miao butterfly totems and Nanjing Yunjin auspicious patterns are transformed into editable digital materials, combined with professional design software for secondary creation, forming a composite visual language of "manual anchor points + digital expansion". The design team of Beijing Institute of Fashion Technology digitized the Guizhou Miao ethnic paste-resist dyeing patterns and applied them to recycled polyester fabrics to create a fashion series that debuted at International Fashion Week, balancing cultural dissemination and product innovation. This collaborative design model not only retains the handmade texture of traditional craftsmanship, but also aligns with contemporary aesthetic

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trends through digital technology, promoting the application of intangible cultural heritage patterns from clothing to home textiles, cultural and creative fields.

The coordination of production processes achieves a balance and unity between efficiency and quality [6]. Shandong Lisha Textile adopts the "flat-screen base printing + reactive wet digital printing" process, which solves the industry problem of uneven color penetration in high-weight fabrics through digital printing technology, while retaining the high color fastness advantage of traditional processes. Ultimately, it achieves a 39% increase in production capacity and a 28% reduction in labor costs. For crafts that rely on manual skills such as batik and tie-dye, the industry has explored the "digital batch base + manual detail finishing" model. Digital printing completes standardized mass production of basic patterns, while the manual part focuses on core skill processing, which not only improves production efficiency but also retains the core value of traditional skills. A digital printing enterprise in Zhejiang has achieved a 1.4-fold increase in production capacity of traditional screen printing technology through this model, while saving 45.8% of water resources and balancing economic and environmental benefits.

The synergy of market links helps expand the value space of products. By leveraging the integration model of "intangible cultural heritage + cultural tourism" and "intangible cultural heritage + e-commerce", collaborative innovation of textiles can achieve diversified monetization. The "Village T" ethnic clothing show in Rongjiang, Guizhou, mass-produced batik and Miao embroidery elements through digital printing technology, combined with live-streaming e-commerce to drive a surge in online sales of related products. According to data from the Rongjiang County Bureau of Statistics, in 2024, the local area achieved a comprehensive tourism revenue of 10.78 billion CNY through the integration of non-heritage with tourism [7]. In the export market, digital printing products that integrate traditional craftsmanship have broken through some countries' green trade barriers with cultural uniqueness and environmental attributes, and continue to lead the industry in export growth rate.

5. Application scenarios and industrial value release of collaborative development

The fashion and apparel industry is the core scenario for the collaborative application of the two, accounting for 47% of the digital textile printing market share. High-end clothing brands accurately replicate traditional embroidery patterns, and the premium rate of their high-end customized series products has increased by more than 31%; After digitizing tie-dye texture, sportswear brands can achieve personalized customization through digital printing to meet the unique needs of young consumer groups [8]. According to a survey by the China Textile Industry Federation, in 2023, the proportion of products in the customized clothing market that combine digital printing with traditional craftsmanship reached 41%. The fashion series jointly developed by Beijing Institute of Fashion Technology and the "Genius Mom" public welfare project integrates Miao embroidery elements and digital printing technology to help artisans in remote areas broaden their income channels and inject profound cultural connotations into clothing brands.

Collaborative innovation in the home textile industry effectively enhances product added value. Mercury Home Textiles digitizes traditional kesi silk patterns and applies them to high-end bedding, curtains, and other products, balancing mass production efficiency and cultural texture, resulting in a 24% increase in gross profit margin for related products [9]. Driven by environmental policies, the combination of digital printing technology with water-based inks and traditional plant-based dyeing processes has become a new favorite in the market for green

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home textile products. The China Printing and Dyeing Industry Association predicts that the penetration rate of digital printing in the home textile industry will reach 34% by 2025.

The collaborative application boundaries between cultural and creative industries and industrial textiles continue to expand. After the digital transformation of traditional silver jewelry carving patterns, they are applied to cultural and creative products such as notebooks and decorative paintings through digital printing technology, becoming a popular category for cultural and tourism consumption; In the industrial field, the precision of digital printing combined with traditional waterproof technology produces medical protective fabrics that not only meet the requirements of protective functions, but also enhance product recognition with traditional pattern elements, expanding the application dimensions of collaborative technology.

At the level of industrial value, collaborative development not only promotes the dynamic inheritance of traditional crafts, but also enables the commercial authorization of 1,480 patterns in Guizhou Miao embroidery through digital transformation, driving 145 products to enter the international market; Accelerating the market-oriented implementation of digital printing technology, the growth rate of domestic digital printing equipment ownership will reach 28.5% by 2025. Small and medium-sized enterprises will lower the threshold for transformation through the light-asset collaboration model, achieving a leap in industrial level.

6. The realistic challenges and optimization paths faced by collaborative development

The coordinated development of digital printing and traditional craftsmanship still faces multiple practical constraints. The cost of transformation for small and medium-sized enterprises is relatively high. The investment in standardized intelligent collaborative production line equipment is about 7.8–11.8 million CNY, which is 3–4 times that of traditional printing equipment. According to research by the China Textile Industry Federation, the average annual profit of domestic small and medium-sized textile enterprises is less than 4.8 million CNY, and their willingness to engage in collaborative production is only 28% [10]. The shortage of composite talents is prominent. The industry urgently needs talents with both traditional technology and digital printing technology. In 2023, the related gap reached 148,000 people. The salary of high-end composite talents is 39% lower than that of the Internet industry, and the brain drain is serious. In addition, the digital transformation of traditional patterns lacks unified industry standards, and the quality of color reproduction and pattern replication varies greatly, affecting the stability of product quality.

Optimizing the path requires efforts from three dimensions: policy support, technological breakthroughs, and talent cultivation. At the policy level, precise support is needed to launch policies such as equipment leasing and loan interest subsidies for small and medium-sized enterprises. Guangdong Province provides 50% interest subsidy support to enterprises that purchase digital printing equipment at the benchmark interest rate. This model can be promoted nationwide; Establish a digital copyright protection mechanism for traditional patterns, relying on blockchain technology to achieve full-process traceability of rights confirmation and authorization, and safeguard the rights and interests of artisans.

At the technical level, it is necessary to strengthen collaborative innovation, promote the compatibility upgrade between digital printing equipment and traditional processes, develop low-cost and easy-to-use small-scale collaborative equipment, and lower the technological threshold for small and medium-sized enterprises; Led by industry associations and in collaboration with leading enterprises and research institutes, a unified digital standard system is established to standardize key parameters such as pattern collection, data conversion, and color reproduction, in order to enhance quality stability. Hanyin Digital achieves efficient

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coupling with traditional processes through self-developed dedicated boards and adaptive inks, and its technical experience can be replicated and promoted [11].

At the talent level, a diversified training system should be established, and universities should add interdisciplinary programs of "textile intelligent manufacturing+ traditional craftsmanship". Five universities in Guizhou have been selected for the national-level intangible cultural heritage inheritor training program, aiming to cultivate composite talents; Enterprises have established a "Digital Craftsman" cultivation plan, combining mentorship with online training to enhance the digital equipment operation ability of traditional technicians. After 6 months of training, a textile enterprise achieved a 91% pass rate in equipment operation for its employees. At the same time, improve the compensation and equity incentive mechanisms for core talents, and enhance retention rates.

7. Conclusion

The coordinated development of digital printing and traditional craftsmanship is an inevitable choice for the textile industry to achieve cultural inheritance and industrial innovation. This model not only leverages the efficient, low-carbon, and precise technological advantages of digital technology, but also resolves the practical difficulties of large-scale production of traditional processes; Relying on the cultural connotation of traditional craftsmanship, it injects unique value into digital printing products, forming a virtuous development cycle of "technological empowerment + cultural value-added". Small and medium-sized enterprises can rely on lightweight collaborative solutions to avoid high equipment investment, and gradually complete technological iteration with the help of local policy subsidies. This path has formed a replicable practical sample in the Jiangsu and Zhejiang regions. The improvement of the digital copyright system for traditional patterns can not only protect the rights and interests of craftsmen, but also stimulate innovative vitality in the design field, laying a solid foundation for collaborative development. From the perspective of practical results, the collaborative innovation model has been effectively implemented in multiple fields such as fashion apparel, home textiles, and cultural and creative industries, driving the export growth rate, added value, and environmental benefits of related products to increase synchronously.

Although current development still faces practical challenges in terms of cost, talent, standards, etc., the collaborative development path will continue to be optimized and improved under the joint drive of policy support, technological innovation, and market demand. In the future, with the maturity of the composite talent training system, the reduction of collaborative equipment costs, and the establishment of industry standard systems, the collaboration between digital printing and traditional crafts will move towards deeper and broader fields, promoting the textile industry to shift from "scale expansion" to "value enhancement", achieving the dual goals of dynamic inheritance of traditional crafts and high-quality industrial development, and providing strong support for the deep integration of cultural confidence and the real economy.

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