

# Digital Engineering Integration of Non-Heritage Innovation to Promote Rural Revitalization—The Example of "Xiangyun Yarn"

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**Abstract:** Intangible cultural heritage represents the crystallization of human wisdom and the representative of traditional culture [1], and xiangyun yarn culture is one of the important treasures of national intangible cultural heritage, which carries deep historical heritage and unique cultural value. Protecting and passing on this cultural heritage is not only a continuation of excellent traditions, but also a promotion of the national spirit. Therefore, it is important to focus on both the inheritance and innovation of xiangyun yarn culture, actively explore innovative products based on the background of rural revitalization, develop and innovate with the advantages of digital engineering, improve the competitiveness of xiangyun yarn market, open up its market, so that more people can understand and appreciate this unique art form, and contribute to the prosperity of Chinese culture.

**Keywords:** Rural revitalization, digitization, xiangyun yarn, intangible cultural heritage

## 1. Background and significance of the study

### 1.1. The importance of digital engineering in rural revitalization

"Digital Countryside" is a crucial aspect of China's digital construction and a strategic direction for rural revitalization [2]. This is a necessary path and a general trend. China's digital economy has enormous potential for development, and rural digital transformation is essential to accelerate the modernization of agriculture and rural infrastructure. It is an important task in achieving comprehensive rural revitalization and promoting high-quality development of China's rural economy. The construction of digital projects is used to improve the attractiveness of rural areas, and to attract more talents and enterprises to the local development and promote rural revitalization through the creation of digital working environments, convenient living services and a good atmosphere for innovation.

### 1.2. The connection between non-heritage design innovation and rural revitalization

#### 1.2.1. Innovative non-legacy to enhance rural influence

Non-heritage design innovation can add unique charm to rural areas and enhance their attractiveness. Incorporating non-heritage elements into rural architecture and landscape planning can shape the rural landscape with regional characteristics and cultural heritage. At the same time, the innovative design of new non-heritage cultural and creative products can improve the influence of the countryside, attract more tourists and enterprises to come to feel, experience and invest, and help to promote the process of rural cultural tourism and rural revitalization.

#### 1.2.2. Innovating non-legacy and accumulating rural talent

By utilizing local resources and adopting the mode of "non-heritage workshop + cooperative + farmers" model, we can unify the source of raw materials, standardizing the processing standards and receiving orders, integrating and linking up the scattered xiangyun yarn workshops in Lunjiao Street, and driving the farmers to employment in the vicinity. Non-heritage design innovation can attract more attention and recognition of the younger generation, thus accumulating local talent and further promoting the protection and inheritance of non-heritage work. Additionally, through innovative non-heritage design, traditional handicrafts can be better adapted to modern market demands, resulting in higher added value and competitiveness. This can bring growth and development to the rural economy.

### ***1.2.3. Innovating non-legacy and expanding sales channels***

The government aims to guide farmers in selling their products through a combination of offline and online channels. This approach seeks to mobilize individual merchants and e-commerce platforms, while also addressing issues related to non-heritage workshop production and sales. In Lunjiao, the promotion of non-heritage workshop products and the enhancement of local cultural connotation are achieved through the use of traditional festivals, festivals, and activities. This, in turn, drives local economic development and promotes the process of rural revitalization. To achieve this, a xiangyun yarn product display area has been set up.

## **2. Overview of the development of the xiangyun yarn industry**

### ***2.1. Traditional crafts and cultural values of xiangyun yarn***

Xiangyun yarn originates from the Guangdong region and is renowned for its lightness, thinness, softness and smoothness, earning it the nickname of "soft gold". The production process of xiangyun yarn incorporates the traditional dyeing and finishing techniques, while skillfully combining two natural dyeing materials, vegetable dyeing and mineral dyeing, to make the finished product unique. As a traditional Chinese handicraft, xiangyun yarn shows rich cultural value and historical inheritance in the field of clothing. It conveys ancient Chinese aesthetic concepts and life atmosphere of ancient Chinese culture through elements such as pattern, color and texture, which gives the clothing a unique artistic charm and cultural connotation, and embodies the elegance, simplicity and subtlety of the traditional Chinese aesthetic concepts.

### ***2.2. Current development status and challenges of the xiangyun yarn industry***

#### ***2.2.1. Development status of the xiangyun yarn industry***

① Industrial scale continues to expand: As China's intangible cultural heritage gains global recognition, the popularity and reputation of xiangyun yarn has also increased. Its integration and innovation in the fields of high-end gifts and tourist souvenirs have attracted more attention and recognition from consumers, providing more opportunities for expansion. The local government provides policy and financial support to encourage enterprises to expand their operations. The company has integrated modern technology into its production process, introducing mechanized and automated equipment and digital management and production technology. This has resulted in improved production efficiency and quality stability, as well as reduced production costs. As a result, the company is able to produce high-quality xiangyun yarn products at a lower capital cost, which has led to an expansion in sales scale.

② Combination of modern and traditional: Some manufacturers have developed new fiber materials, such as silk, hemp, and cotton, to expand the variety of textures and uses for xiangyun yarn. These material innovations break the limitations of traditional silk yarn raw materials and incorporate modern technology. Xiangyun yarn producers are attempting to modernize the industry by blending traditional craftsmanship with contemporary design and market demand. They are introducing new patterns, colors, and textures to create more fashionable and commercially competitive products, appealing to younger consumers with innovative offerings. These initiatives have revitalized xiangyun yarn and increased its competitiveness in the market.

③ Steady development of the international market: With the growing global interest in traditional Chinese culture, xiangyun yarn has emerged as a handicraft with a long history and unique charm, and has great market potential. Some regions are actively promoting xiangyun yarn as a special cultural product, fully integrating local tourism resources and attracting overseas tourists to experience the production process of xiangyun yarn first-hand. Clothing made with xiangyun yarn as the raw material has been showcased at international fashion weeks, demonstrating the charm and fashion potential of this traditional craft. These initiatives have helped to effectively develop the foreign market for xiangyun yarn.

#### ***2.2.2. Challenges facing the xiangyun yarn industry***

① Difficulty of skill inheritance: The production process of xiangyun yarn is complex and labor-intensive, with a harsh working environment. It is not digitized or automated, and information is primarily disseminated orally. The xiangyun yarn production requires experienced craftsmen, as well as exquisite

skills and patience, but the inheritance of related skills and talent training is facing challenges, fewer and fewer young people are willing to invest time and energy to learn and master this skill, making it more difficult to inherit the skills.

②The pressure of market competition: The textile industry has experienced rapid development, resulting in the flooding of the market with mechanized, low-cost fashionable clothing products that are popular among the public. In contrast, xiangyun yarn has a long production period, is difficult to operate, has a low tolerance rate, and struggles to keep up with the fast-changing market environment. Furthermore, many young consumers may lack a comprehensive understanding of non-heritage culture and traditional skills, which makes it challenging for handmade scented yarn to withstand market competition.

③Insufficient supply of raw materials: The production of xiangyun yarn is influenced by several factors, including weather conditions, land resources, and artificial factors. In the dyeing process, the quality of xiangyun yarn is heavily dependent on three major natural raw materials: potato scapolette, blank silk, and river mud. It is important to note that the use of clear, objective language is crucial in technical writing. To ensure high-quality dyes, the potato scapolette must be grown in a favorable ecological environment between August and September. However, the availability of wild potato scapolette for dyeing is gradually decreasing due to environmental pollution and ecological destruction. Additionally, the river mud required for over-wooling must be rich in high-valence iron ions to make the color of xiangyun yarn fabrics bright black. However, the current utilization rate of river mud is low. The supply shortages of raw materials have caused a challenge in the production of xiangyun yarn to keep up with the market expansion.

### ***2.3. The link between the xiangyun yarn industry and rural revitalization***

①The xiangyun yarn Industry opens up a new road of rural revitalization: It adopts the unique new production mode of "Non-heritage Workshop + Cooperative + Farmers", which unifies the management of raw material procurement, processing standards and order acceptance, and changes the traditional way of labor, so as to make the production of xiangyun yarn realize the integration and linkage, enhance the synergistic effect of the whole industry chain, and promote the economic growth and create more employment opportunities in the villages.

②The xiangyun yarn culture to promote the new development of rural tourism: The development of the xiangyun yarn industry can not only preserve the traditional heritage of rural culture, adding to the cultural charm of rural areas, but also promote the growth of cultural tourism and related industries. The development of the xiangyun yarn industry can help farmers move away from traditional agricultural production. This can be achieved by increasing the value of their products through processing, sales, and other means. It can also promote the development of high-end rural industries and specialties. At the same time, by building tourist attractions in connection with the xiangyun yarn culture, more tourists will be attracted to come to experience and buy xiangyun yarn products, thus increasing the income and contribution rate of the local tourism industry, and bringing a new economic growth point for the local tourism industry.

③The xiangyun yarn culture and innovation to broaden the market of new craft products: To realize the innovative design of cultural and creative products, it is necessary to take the needs of the audience as the basis, strengthen the value of the product empowerment, fully excavate the story behind the product, and then integrate the story into the publicity and packaging of the product, to strengthen the connection and interaction with the audience, and to cause emotional resonance within the viewer. By utilizing the local natural environment, history, culture, and humanities, regional characteristics can be incorporated into the design of cultural and creative products. This not only promotes the output and preservation of xiangyun yarn culture, but also adds a unique charm to the product, while simultaneously improving the local income level and boosting the sales value of the product to aid in the development of rural revitalization.

## **3. Integration of digital engineering and the xiangyun yarn industry**

### ***3.1. Fundamentals of digital engineering***

Through digital twin and virtual space technology, digital engineering can connect entities in the physical world with models in the digital world, conduct real-time data capture, simulation and analysis,

create virtual models corresponding to the real world, and realize the whole life cycle management and optimization of engineering projects, thus improving engineering efficiency and quality. Digital engineering can promote the in-depth integration of digital technology and traditional industries, making traditional industries release great potential value, thus promoting the sharing of urban and rural information resources and alleviating the asymmetry of digital resources.

### ***3.2. Contribution of digital engineering to the development of xiangyun yarn industry***

Through the support and application of digital engineering, it can promote the diversified and high-quality development of xiangyun yarn industry.

Digital engineering can monitor and control the production process as a way to increase productivity, reduce costs, and improve the quality of the products produced. The use of digital twin technology, simulation and analysis of the production equipment of xiangyun yarn, optimize the production process, can improve production efficiency and product quality. The use of virtual space technology, applied to the management and monitoring of the production process of xiangyun yarn, through virtual reality technology and sensor monitoring, real-time monitoring of the state of production equipment and production data, which can help the enterprise management to make production decisions and process optimization. The use of Internet of things technology and sensors, real-time monitoring of the operating conditions of textile equipment, so as to achieve the purpose of its fault prediction and intelligent maintenance, can reduce downtime and reduce production costs. Digital engineering optimizes supply chain management for xiangyun yarn Enterprise, promoting transparency and coordination throughout the entire supply chain. By utilizing digital technology and information systems, enterprises can monitor the supply status of raw materials, production progress, and inventory status in real-time. This reduces the risk of supply chain disruptions and increases efficiency.

### ***3.3. Application of digital engineering in xiangyun yarn industry***

The use of digital engineering in the xiangyun yarn industry is crucial in promoting the entire industry chain. Digital technology can enhance production efficiency, improve product quality, support design innovation, optimize marketing, and upgrade management decision-making.

#### ***3.3.1. Application of digital engineering in the production of xiangyun yarn products***

The application of digital engineering in the production of xiangyun yarn products includes the following aspects:

① Digital engineering can help companies optimize their production processes by using advanced algorithms and building models to analyze and predict production data. By mining a large amount of data, potential production problems can be identified and appropriate suggestions for improvement can be provided. The production system can also automatically adjust equipment parameters and optimize the production process based on historical data and real-time feedback, thus improving production efficiency and product quality stability.

② Digital engineering can enable intelligent control and monitoring of the production process of xiangyun yarn. Real-time monitoring of production equipment and data can be achieved through sensors and Internet of things technology, enabling automation and intelligent management of the production process, thereby improving production efficiency and stability.

③ Automated management of the production process through intelligent control and monitoring of digital engineering can reduce the need for human intervention and improve production efficiency and stability. Real-time monitoring and automated adjustment enable enterprises to quickly respond to changes in market demand, flexibly adjust production plans, and reduce resource waste.

In short, the application of digital engineering in the production process of xiangyun yarn products can help enterprises to achieve intelligent manufacturing, improve the quality and efficiency of production, and promote the xiangyun yarn industry to better and faster to the direction of digitalization, intelligent development, and enhance the competitiveness of the industry and the ability of sustainable development.

#### ***3.3.2. Application of digital engineering in the design of xiangyun yarn products***

The application of digital engineering in the design of xiangyun yarn products includes the following aspects:

① Digital engineering can display the product design in the form of virtual reality images using virtual space technology, so that the designer and the audience can better understand and evaluate the appearance, function and characteristics of the product. The intuitive display can provide users with a more intuitive and realistic experience, accelerating the product design decision-making process.

② Digital engineering can unify the management and sharing of data in the process of product design, so that the design team can share design documents and data on the cloud platform, so as to achieve the purpose of multi-person collaborative design and remote cooperation, thus improving the design efficiency and teamwork ability.

③ Digital design, virtual reality and other tools can provide faster and more intuitive support for the design and innovation of xiangyun yarn. This can offer more design solutions and choices for the enterprise, enabling quicker response to market demand.

In summary, digital engineering has an important role in the design of xiangyun yarn products, not only to provide more financial support for enterprises, but also to promote the innovation and development of product design, so that the design efficiency has been improved, the production cost has been reduced, and can better promote the development of the xiangyun yarn industry.

### 3.3.3. Application of digital engineering in the marketing of xiangyun yarn products

The application of digital engineering in the sales of xiangyun yarn products mainly includes the following aspects:

① Enterprises can utilize digital engineering to integrate purchasing, production, and inventory management through refined management systems to obtain better data. By analyzing this data, accurate forecasts of market demand can be made, allowing for reasonable adjustments to production plans. This reduces inventory costs and ensures timely delivery of customer orders. Through the analysis of product data, enterprises can gain a better understanding of their customers' needs and consumption habits. This information can provide decision-making support for developing sales strategies.

② Through digital technology and big data analysis, it can better grasp market demand and consumer preferences, and make accurate market forecasts and decisions for enterprises. In addition, it can also help companies manage and optimize marketing channels, build online sales platforms, expand the scope of sales, improve the efficiency of sales, and enable companies to better promote and sell their products.

In conclusion, the application of digital engineering in the sales process of xiangyun yarn products can help enterprises to achieve refined management, improve efficiency and customer satisfaction, thus enhancing the competitiveness of enterprises. The overall application of digital engineering is shown in Figure 1.

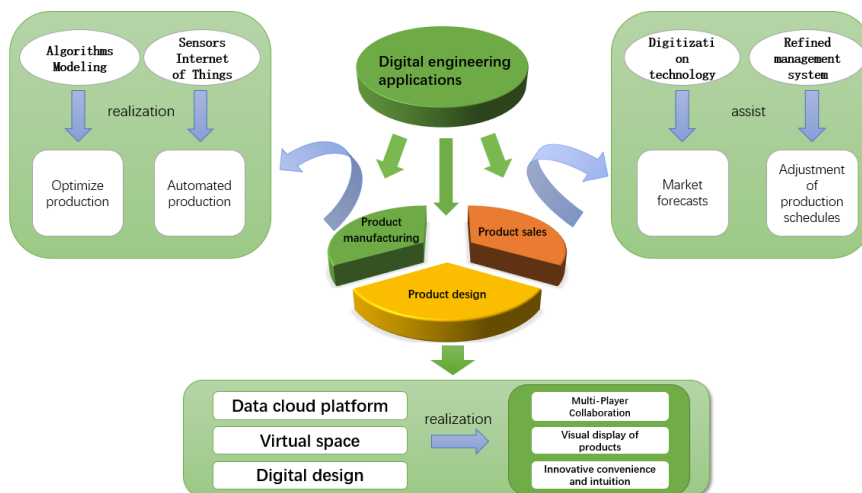


Figure 1: The effect of digital engineering in various aspects for xiangyun yarn products

#### **4. The practice of non-legacy innovation in the xiangyun yarn industry**

##### ***4.1. Linkage between non-legacy innovations and the xiangyun yarn industry***

The xiangyun yarn culture is a significant treasure of China's national intangible cultural heritage. It contains a wealth of artistic information and reflects the country's skills and craftsmanship [3]. Innovative methods and technologies are being employed to protect and preserve this heritage, while also integrating it into modern life and development. Introducing modern design concepts and technology, combined with digitalization and intelligent production and sales, can improve the quality and functionality of xiangyun yarn, making it more adaptable to the needs of modern life.

##### ***4.2. Inheritance and innovation of traditional craft of xiangyun yarn by non-heritage innovation***

###### ***4.2.1. Inheritance of the traditional craft of xiangyun yarn by non-legacy innovation***

① Inheritance of skills: Innovation is the best way to protect and inherit traditional skills. By improving and optimizing traditional crafts and combining them with modern scientific and technological means, it makes it easier for the younger generation to accept and learn traditional crafts and ensures the inheritance of traditional skills.

② Integration of tradition: The innovation of traditional non-heritage is not only "new", but also "integration". At the design level, the innovation of non-legacy is not simply combining traditional cultural elements with modern design concepts, but rather integrating modern design concepts into traditional skills, injecting new vitality and inspiration into xiangyun yarn. With the craze of "revitalizing and rejuvenating national education", more and more designers are digging into the traditional Chinese cultural elements and modern cultural design to produce a blend, so as to get greater development [4], such design innovation can not only attract more young people to participate, but also expand the market of xiangyun yarn, which provides more possibilities for the inheritance of traditional crafts.

###### ***4.2.2. Non-legacy innovation on the traditional craft of xiangyun yarn***

① Innovative design: The innovative design of non-heritage focuses on integrating traditional cultural elements into modern design concepts, so as to revitalize and inspire the traditional craft of xiangyun yarn. Through VR/AR technology, combined with multimedia display, it gives new life and vitality to the ancient craft of xiangyun yarn; At the same time, the non-heritage culture of xiangyun yarn is digitized for a more comprehensive, rich and in-depth display and innovation, creating the world's first non-heritage cloud map.

② Improvement of craftsmanship: Non-legacy innovation improves and upgrades the traditional xiangyun yarn textile craft. Through the introduction of digital technology, the use of new tools, equipment and materials, the improvement of process technology and the improvement of the production environment, it is possible to improve the quality and output of xiangyun yarn, while preserving and passing on its traditional skills.

③ Product innovation: Non-heritage innovation can assist xiangyun yarn in entering the market. This can be achieved through environmentally friendly design and the utilization of excess materials from xiangyun yarn production to create new products. Innovative designs for jewelry, keychains, and other peripheral products derived from xiangyun yarn can fuse traditional crafts with new forms of publicity, establishing xiangyun yarn as a cultural brand. This will make xiangyun yarn more fashionable and practical, attracting greater attention and appreciation.

##### ***4.3. Cultural valorization of non-heritage and sustainable development***

Non-legacy culture is China's unique cultural heritage and an important part of the traditional culture of the Chinese nation. It contains profound historical, cultural and artistic heritage and is an indispensable part of China's cultural treasury. Therefore, the value excavation and sustainable development of non-heritage culture should attract great attention from the whole society.

① In terms of value excavation, we should pay attention to excavating its cultural connotation and historical value, and strengthen the inheritance and promotion of non-heritage culture. For example, through the innovative design of xiangyun yarn products, the development of related cultural and creative products and tourism resources, not only can make more people understand and recognize this non-heritage culture, but also drive the development of the local economy, so as to enhance people's sense of

identity and pride in traditional culture.

②In terms of sustainable development, emphasis should be placed on inheritance and cultivation, ensuring the continuation of skills and the transmission of traditional knowledge through the cultivation of generations of non-heritage inheritors. At the same time, it should also focus on market development and promotion, focusing on the combination of modern means and innovative ideas, through the market-oriented operation, the establishment of non-heritage cultural products exhibition centers, e-commerce platforms, etc., non-heritage cultural products to the market, and improve its economic value.

## 5. Conclusions and outlook of the study

With the advent of the digital era, the preservation of non-heritage is facing new developments and challenges. Digital engineering and non-heritage innovation provide more ways and possibilities for non-heritage preservation.

①The study shows that digital engineering offers a wide platform for promoting non-heritage culture globally through social media and other channels, attracting more attention and participation. The production process has been automated and made intelligent through the use of sensors, technology, and other technologies, resulting in improved production efficiency and product quality. The application of big data analysis technology to delve deeper into production data has optimized the production process, reduced costs, and increased production capacity.

②The study shows that digital technology has been used innovatively to establish a digital archive of intangible cultural heritage. This has enabled the collection, organization, preservation, and dissemination of non-heritage information for better inheritance and protection. Additionally, VR technology has been explored to create an immersive digital inheritance experience for non-heritage projects, allowing more people to personally experience non-heritage culture.

The existence of development also has risks, so the development of non-heritage protection in the digital era needs to make full use of the advantages of digital technology, but also to recognize the potential risks, and take corresponding measures to avoid and solve. Through scientific and reasonable planning and efforts, we can better protect and pass on the non-heritage culture and make it revitalized and charming in the digital era.

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