RESEARCH ON THE DIGITAL INHERITANCE AND INNOVATION PATH OF SHANGHAI FENGCHENG WOOD CARVING INTANGIBLE CULTURAL HERITAGE

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ABSTRACT

This study focuses on the intangible cultural heritage of Fengcheng wood carving in Shanghai, aiming to explore its digital inheritance and innovation pathways. Through methods such as literature review and field investigation, it analyzes the challenges faced by Fengcheng wood carving, identifying issues like high costs of manual skills, insufficient design innovation, talent loss, and low market recognition. The research indicates that digital technology can facilitate the inheritance and innovation of Fengcheng wood carving through pathways such as digital recording and preservation, digital design and dissemination, and integration with industry. This not only helps address traditional inheritance challenges but also enhances its market competitiveness and cultural influence, providing new ideas and methods for the protection and development of intangible cultural heritage.

Keywords: Intangible Cultural Heritage, Shanghai Fengcheng Wood Carving, Digital Inheritance, Digital Innovation, Cultural Industry Integration

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INTRODUCTION

In the process of globalization and digitization, 83% of intangible cultural heritage projects are facing a crisis of inheritance, and 18% may disappear permanently by 2025. Traditional crafts such as wood carving generally suffer from complex techniques, an aging workforce, long production cycles, and insufficient market adaptability. Currently, the international academic community has initiated digital protection practices, such as the Peking University Palace Museum Digital Project and the University of Washington Michelangelo Digital Engineering (Zhang, 2021).

The intangible cultural heritage of Fengcheng wood carving in Shanghai faces four major challenges under the impact of industrialization: first, the long production cycle and high labor costs; second, lagging product innovation, making it difficult to attract young consumers; third, a sharp decline in the number of practitioners, leading to generational gaps in inheritance; fourth, a single channel for cultural dissemination, with insufficient development of online sales channels. Although digital technology has been applied in the protection of intangible cultural heritage, systematic digital path research on regional crafts such as Fengcheng wood carving is still blank, and its technical adaptability and industrial transformation mode need to be explored urgently. This study explores the development path of digital technology to promote the inheritance and innovation of Fengcheng wood carving.

Research Objectives

On the basis of in-depth study of the historical background, technological process and development status of Shanghai Fengcheng wood carving intangible cultural heritage, this paper explores the application path of digital technology to the inheritance and innovation of Shanghai Fengcheng wood carving intangible cultural heritage.

LITERATURE REVIEWS

Research on traditional skills of intangible cultural heritage wood carving

In CNKI search, 450 relevant documents from 2008 to 2024 were retrieved with the keyword "intangible cultural heritage wood carving" (Figure 1). According to the ranking of the keyword, it can be seen that the digital protection and inheritance of intangible cultural heritage is also a research trend.

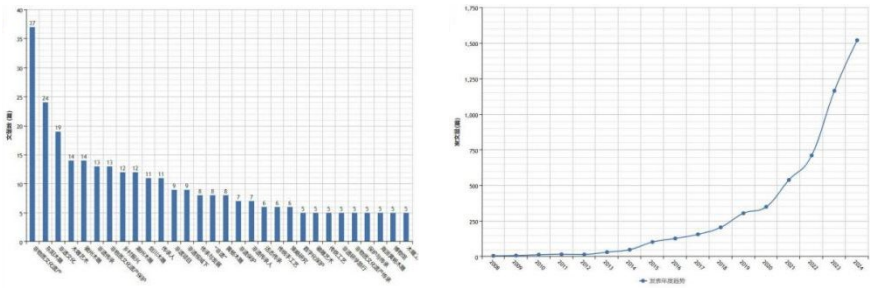


Figure 1 Trend chart of the number of documents related to intangible cultural heritage wood carving (left) and distribution chart of disciplines (right)

From the data on disciplinary distribution, research on "intangible cultural heritage wood carving" is concentrated in two major directions: fine arts, calligraphy, sculpture, and photography (37.89%) and culture (17.86%), reflecting a traditional approach centered on the essence of art and cultural connotations.

Research on intangible cultural heritage and digitalization

In CNKI searches, using the keyword "intangible cultural heritage digitalization," a total of 5,391 results were found. The publication years indicate a significant increase in research related to the digitalization of intangible cultural heritage in recent years. This is attributed to national policies promoting the digital inheritance of intangible cultural heritage and academic

research making leaps from technical preservation to systematic innovation. Public cultural awareness has also increased, leading to widespread recognition of intangible cultural heritage as a carrier of cultural diversity. The accelerated digital transformation of the cultural industry is driving the value conversion of intangible cultural heritage resources, forming a multi-dimensional driving pattern.

1) Digitization of intangible cultural heritage data collection and storage

According to the CNKI literature search using "data storage, intangible cultural heritage" as keywords, a total of 20 entries were found. For the search with "data collection, intangible cultural heritage" as keywords, a total of 154 entries were obtained. As shown in Figure 2, apart from "intangible cultural heritage," which ranks first among the research keywords in data collection and storage, the main terms include "knowledge graph" ,"digital resources" , "ontology construction" and "database".

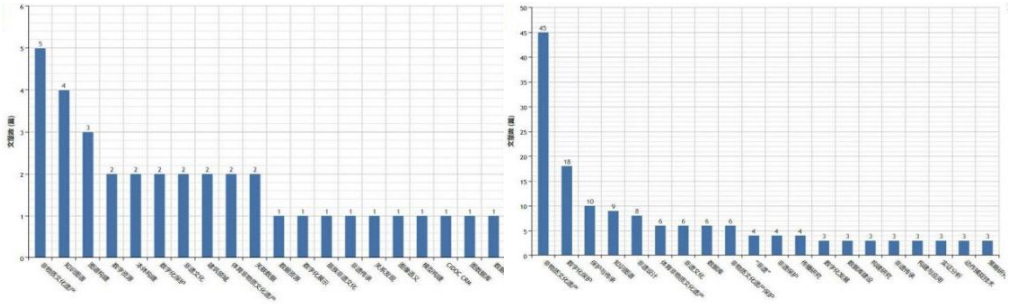


Figure 2 Related research on intangible cultural heritage anddata storage (left) and intangible cultural heritage and datacollection (right) are mainly distributed in the main themes

2) Digital innovation design and dissemination of intangible cultural heritage

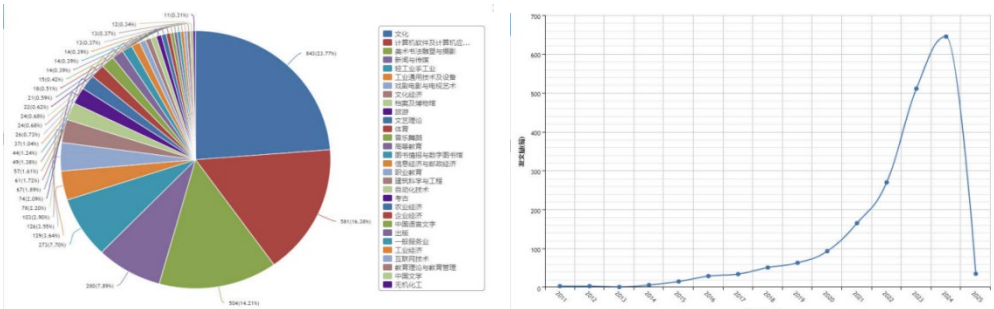


Figure 3 Distribution map of disciplines related to digitalization, design and communication of intangible cultural heritage (left) annual distribution map (right)

According to the CNKI literature search with "intangible cultural heritage digital design and communication" as the key words, a total of 1927 articles were retrieved. From the analysis of the distribution map of subject classification and publication year (Figure 3), it can be seen that culture and computer are the top two, indicating a significant research trend in recent years.

3) Digital integration and value transformation of intangible cultural heritage

According to the CNKI literature search with "intangible cultural heritage digitalization industry" as the key word, a total of 1856 articles were retrieved. From the analysis chart of subject classification (Figure 4), it can be seen that in the process of development, intangible cultural heritage can further strengthen the development of the industry and promote the economic improvement through digital means.

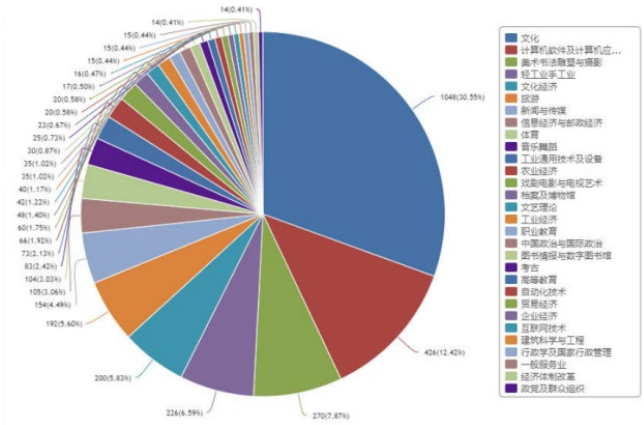


Figure 4 Distribution map of disciplines related to digitalization and industry of intangible cultural heritage

By searching Web of Science with "Digitization of intangible cultural heritage" as the keyword, 118 relevant articles were found. Research on ICH and digitalization shows a trend towards multidisciplinary integration.

Figure 5 Disciplinary distribution of research related to digitalization of intangible cultural heritage

RESEARCH METHODOLOGY

For the research objectives of this paper, qualitative research methods such as literature review, field investigation, and in-depth interviews were employed (Figure 6). The main survey area was selected to be Fengxian District in Shanghai, China. Five individuals related to wood carving from Fengcheng were chosen as interview subjects. The content validity of the interview questionnaire required validation by three university professors and experts.

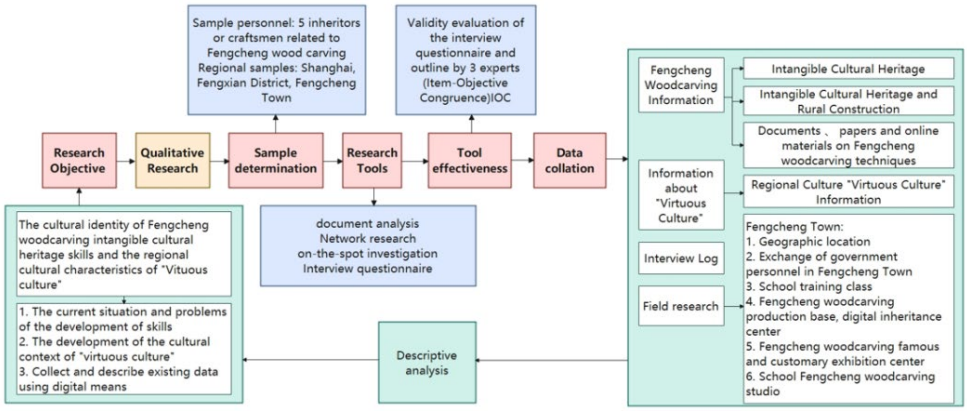


Figure 6 Qualitative Research Path

Literature review

Search historical documents, academic papers, journals, and critiques of Fengcheng wood carving during its development. In-depth discussions on the origin, development, style, craftsmanship, and artistic value of Fengcheng wood carving are provided. Through the study and retrieval using digital technology, this research explores how digital technology can be applied to Shanghai's Fengcheng wood carving, laying a theoretical foundation for further studies.

1) The development of Chinese wood carving art

Chinese wood carving art has undergone a long and arduous development process, with its ups and downs, yet the artistic charm of wood carving still commands admiration from people around the world (Zeng et al., 2013). Some scholars believe that Chinese wood carving art gradually developed under the influence of jade carving, ivory carving, stone carving, and other sculptural techniques (Liu & Ma, 2020).

A B C

Figure 7 A. Wooden fish carved in Hemudu, Yuyao, Zhejiang province; B. Wooden carving with cloud and thunder patterns unearthed from Panlong City; C. Wooden figurines unearthed from the No.1 Han Tomb of Mawangdui in Changsha

According to historical research, one of the earliest wooden carving artifacts in China is a wooden fish sculpture over 7,000 years old, unearthed from the Hemudu site in Yuyao, Zhejiang (Figure 7-A). During the slave society period, a cloud and thunder pattern wooden carving was excavated from the Panlongcheng site during the Shang Dynasty (Figure 7-B). In the early feudal society, 160 wooden figurines were unearthed from the No.1 Han tomb at Mawangdui in Changsha (Figure 7-C), showcasing more mature round carving techniques. In the middle and late period of feudal society, wood carving pursued the complexity and splendor of craftsmanship, and architectural wood carving became a highlight.

2) The distribution of national intangible cultural heritage wood carving projects

In the national intangible cultural heritage list, traditional wood carving arts hold a prominent position. A total of 22 exquisite skills from all over the country have been included in five batches of the list. Notably, Dongyang and Yueqing in Zhejiang, Longyan in Fujian, and Chaozhou in Guangdong, these four regions, as shining pearls of Chinese wood carving art, have given birth to the most representative four major wood carving schools.

3) The development status of intangible cultural heritage wood carving in Shanghai

Shanghai has a scientific and perfect work system for the protection of intangible cultural heritage, which has been leading and pioneering in the national work on the protection of intangible cultural heritage (Wen, 2021). Intangible cultural heritage wood carving belongs to the category of traditional art. Shanghai has identified two national-level intangible cultural heritage wood carvings and three Shanghai-level intangible cultural heritage wood carvings (Table 1 & Figure 9).

Table 1 National intangible cultural heritage wood carving in Shanghai and Shanghai intangible cultural heritage wood carving

Level	Classification	Year	Name	Number	Belonging region
Shanghai municipal level	Folk arts and crafts	2007	Shanghai style boxwood carving	VII-3	Xuhui District
Shanghai municipal level	Traditional art	2011	Fengcheng Woodcarving	VII-27	Fengcheng District
Shanghai municipal level	Traditional art	2024	Wood carving	VII-27	Fengcheng District
National level	Traditional art	2008	Boxwood carving	VII-42	Xuhui District
National level	Traditional art	2011	Wood carving (Rosewood carving)	VII-58	Shanghai Chinese Purple Sandalwood Culture Research Institute

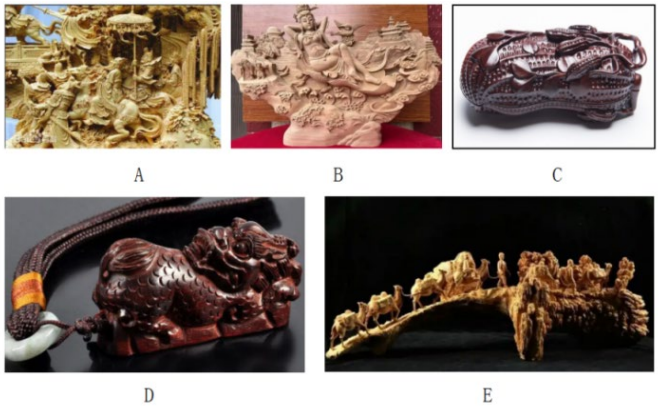


Figure 8 A. Shanghai-style boxwood carving; B. Fengcheng wood carving; C. Wood carving; D. Wood carving (Zitan carving); E. Boxwood carving

4) The history and background of Shanghai Fengcheng wood carving

Fengcheng wood carving originated in the Qing Guangxu period and was included in the third batch of Shanghai's Intangible Cultural Heritage List in 2011, with the number VII-27. It reached its peak in the 1930s and 1940s, forming a prosperous industry with multiple wood carving workshops coexisting. After the founding of the People's Republic of China, with the public-private partnership reform, the traditional workshop system disintegrated into collective handicraft cooperatives. During this period, due to social misconceptions, the artistic value of wood carving was long overlooked. In the 1980s, it experienced a brief revival, with specialized wood carving factories gathering a group of highly skilled craftsmen, thus continuing the craft tradition. With the development of technology, traditional wood carving techniques face challenges. The number of artisans engaged in "Fengcheng wood carving" has been reduced from 50 to 5, and Xu Huabing, a municipal-level inheritor of Fengcheng wood carving, is already 60 years old. He has also trained two Fengxian district-level inheritors.

Field investigations and in-depth interviews

1) on-the-spot investigation

Researchers conducted field research and collected professional data, including the tools and process of wood carving in Fengcheng. They also recorded the demonstration of different carving methods on site.

1.1) Shanghai Fengcheng wood carving production process and steps

The production process of Shanghai Fengcheng wood carving is roughly divided into the following seven steps.

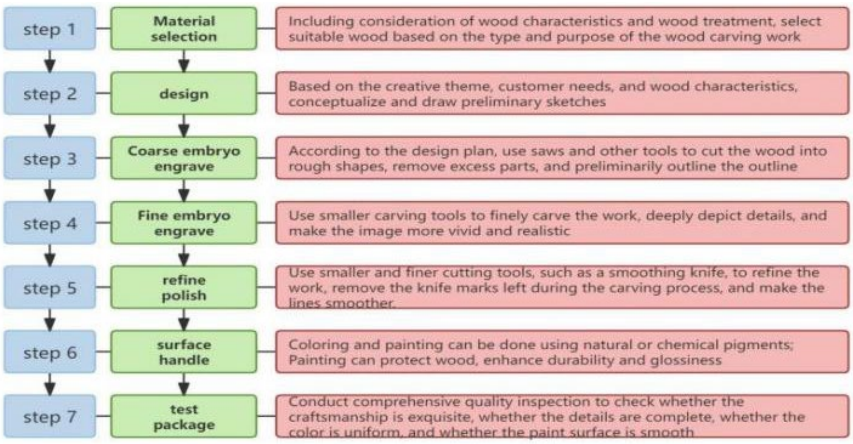
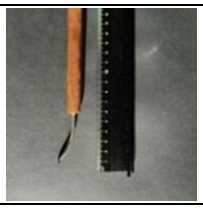


Figure 9 Fengcheng wood carving production process and steps

1.2) The inheritance and present situation of Fengcheng wood carving

In the process of inheritance, there are 118 kinds of tools in Fengcheng wood carving, among which 80 kinds are commonly used. The carving tools of Fengcheng wood carving are divided into four categories: rough carving knife (Rough carving tool), finishing knife (Finishing tool), triangular knife (V-shaped knife, line engraving tool) and white steel knife (Special tool) (Table 2).

Table 2 List of common tools for wood carving in Fengcheng

Cutter broad heading	**Sharpen the knife**	**The Shokudo**	**Triangular knife**	**White steel knife**
Cutterform	A knife	A sharp knife	triangle knife	
Cutter name	The central circle	A sharp knife	Round-bottomed triangular knife	White steel knife
Graphic				
Affect	Shaping medium-sized arcs (such as clothing folds, animal muscles)	Deform the depressed area (such as the gap between petals)	Carve soft concave lines (such as eyelids, midlines of petals)	Carving high density hardwood

In the carving techniques of Fengcheng woodcarving, relief carving, openwork carving, and round carving are primarily used (Table 3). Relief carving in Fengcheng woodcarving is divided into shallow relief and deep relief. Shallow relief is often used for traditional auspicious patterns, while deep relief is mainly applied to furniture construction. Openwork carving, also known as lattice carving, is commonly used for door and window lattices and furniture panels. Round carving is a three-dimensional technique that can be appreciated from any angle.

Table 3 List of three major wood carving techniques in Fengcheng

Technique name	Basso-relievo	Openwork carving	Circular engravure
Define	Floating carving:Low relief, high relief	Openwork carving, strong contrast between reality and illusion	360 three-dimensional sculptures
Application	Lucky patterns in flat decoration	Door and window lattice, hanging screen perforated pattern	Religious statues, carvec columns
Fengcheng wood carving			

2) depth interview

To gain a deeper understanding of the history and current state of Fengcheng wood carving, researchers conducted semi-structured interviews with relevant personnel. Currently, there are three provincial and municipal intangible cultural heritage bearers for Fengcheng wood carving. Among them, Xu Huabing is the provincial bearer, while Zhu Xindi and Jin An are the municipal bearers. Additionally, there are two wood carvers from Fengcheng: Sun Lixin and Xu Jun. The purposeful sampling method was used to select 5 respondents according to the following criteria: 1) the level of inheritor recognized by the government (Shanghai municipal level/fengxian district level); 2) working experience of more than 25 years; 3) directly participating in the creation or teaching of Fengcheng wood carving.

Table 4 Basic information of inheritors and woodcarvers

Name	Occupation	Age	Number of years in practice	Level of understanding
Xu Huabing	Shanghai municipal inheritor	60	44	Very familiar with
Zhu Xindi	Fengxian District inheritor	58	40	Very familiar with
Jin 'an	Fengxian District inheritor	46	30	Very familiar with
Sun Lixin	craftsman	58	40	Very familiar with
Xu Jun	craftsman	45	29	Very familiar with

The in-depth interview is divided into five sections: First, the basic information of the interviewee. For example, occupation, age at which you started learning, and ancestors in your family; second, the cognitive dimensions and current status of inheritance of Fengcheng wood carving. For example, how to view the development of Fengcheng wood carving skills in recent years and the current challenges; third, the interviewee's understanding and application of the digitalization of Fengcheng wood carving intangible cultural heritage. For example, whether there is an attempt to use digital technology for creation; fourth, the government and social support for the skills of Fengcheng wood carving intangible cultural heritage. For example, what are the expectations of the government, society and ordinary people for the wood carving of Fengcheng; fifth, views on challenges and opportunities faced by Fengcheng wood carving intangible cultural heritage. For example, it is hoped that digitalization can play a role in the field of Fengcheng wood carving to promote its development.

Research on relationship between digital technology and intangible cultural heritage wood carving inheritance and innovation

1) Digital technology for the protection of intangible cultural heritage wood carving

1.1) Innovative strategies for the dynamic protection of intangible wood carving

The development of a CAD-assisted design system for intangible cultural heritage wood carving, such as the auspicious bird and beast patterns in Chaozhou lacquer wood carving, combines traditional pattern databases. Inheritor Zhao Bozuo conducts pattern recombination experiments on digital platforms using generative artificial intelligence technology to analyze scanned data and train models, ultimately forming a unique Chaozhou wood carving Lora model (Figure 10-A).

Figure 10 A. Digital innovation of Chaoshan lacquer wood carved electric guitar; B.Chaoshan wood carving cultural and creative products-a deer in prosperity

1.2) Industrialization transformation of production protection of intangible cultural heritage wood carving

Digitalization has promoted the leap from handicraft to industry of wood carving. The cultural and creative products of Guangdong Provincial Museum successfully revitalized Chaozhou wood carving, and "A Deer in Prosperity Gilded Plaster" won the TOP10 product design award at 2021 Bay Area (Guangzhou) Cultural and Creative Festival (Figure 10-B).

2) Digitization promotes the development of intangible cultural heritage wood carving cultural and creative development

As the cultural and creative industry continues to develop, a craze for intangible cultural heritage (ICH) to be transformed into cultural and creative products has emerged globally (Jin, 2010). Compared to traditional cultural and creative products, digital ICH offers numerous advantages such as diverse dissemination channels, rapid spread, and broad audience reach. Emerging digital technologies, represented by cloud computing, big data, the Internet of Things, artificial intelligence, 5G, VR, and AR, have permeated all aspects of ICH protection and dissemination, also influencing the digital development of ICH cultural and creative products. At the product level, the digitalization of ICH mainly includes virtual ICH cultural and creative products generated by digital technology, as well as physical ICH cultural and creative products designed and developed with the help of digital technology.

2.1) Application of AI technology to assist the development of wood carving cultural and creative products

In the development of intangible cultural heritage creative products, AI technology is widely applied in multiple stages including data collection, processing, analysis, presentation, interaction, and creative transformation. Baidu's AI uses the Wenxin large model to learn the brushwork and style of original paintings, achieving an advancement from a "novice" to a "master" in landscape painting. It then conducts single-sample learning on Mr.Huang Gongwang's "Dwelling in the Fuchun Mountains" (Figure 11-A).

A B

Figure 11 A. AI is used in Dwelling in the Fuchun Mountains; B. Qiong Meng Meng Travel-Immersive intangible cultural heritage tourism

2.2) Big data drives the industrialization transformation of wood carving cultural creativity
In the development of intangible cultural heritage (ICH) creative products, big data technology collects and analyzes ICH-related data to provide scientific evidence and decision support for product development. The local enterprise "Shijiao Story" is a representative case of using big data technology in ICH creative product development. Its digital exploration not only promotes the inheritance and development of ICH culture but also drives the growth of related industrial chains, offering a replicable model and experience for the development of ICH creative products.
2.3) Immersive technology enables intangible cultural heritage and creative culture
In the development of intangible cultural heritage (ICH) creative products, immersive technology is widely applied to the display, dissemination, and experience of ICH culture. The Qiongyao Dream Journey full IP immersive gamified ICH cultural tourism enabler (Figure 11-B) aims to provide customers with new cultural tourism products and services, as well as experiences, to invigorate the "living" vitality of ICH as local scenic spots.

RESEARCH RESULTS

This study uses qualitative research methods such as literature review, field investigation and in-depth interview to deeply analyze the current situation of Fengcheng wood carving, an intangible cultural heritage in Shanghai, and explore its digital inheritance and innovation path. The specific results are as follows:

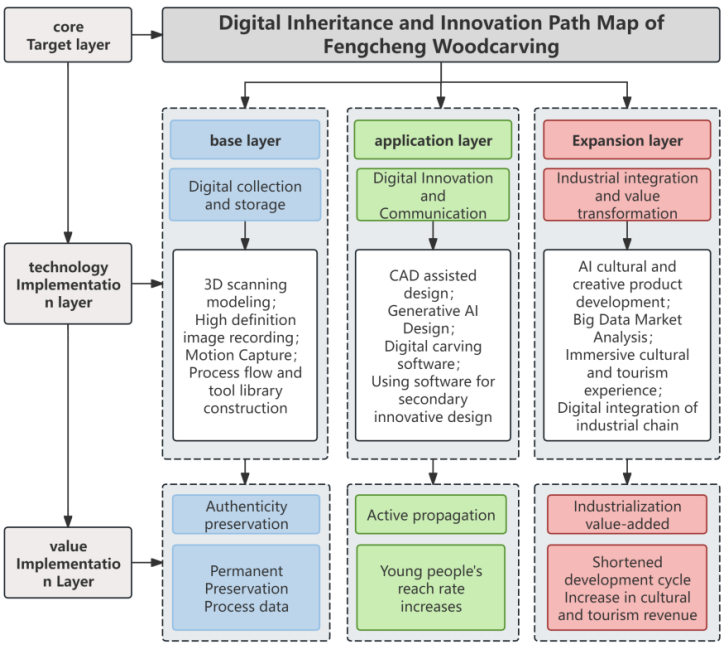


Figure 12 Digital inheritance and innovation path of Fengcheng wood carving

The first path is the digital collection and storage of the basic layer

Using digital acquisition technology, we conduct a comprehensive and high-precision record of the raw material characteristics, design sketches, carving processes, and finished product details of Fengcheng wood carvings. Leveraging 3D scanning and modeling techniques, we fully present their morphological structures; employing high-definition imaging and video recording, we document key stages to form a systematic digital archive.

The second path is digital innovation design and communication of application layer

In the process of digital design of wood carving in Fengcheng, various design tools and software are used to integrate cutting-edge technologies to give new vitality to traditional wood carving.

1) Computer aided design software for assisted design

Computer aided design software is the basic tool of digital wood carving design, which can accurately draw wood carving design sketches, construct three-dimensional wood carving models, associate design parameters, automatically update the model when modified, improve design efficiency and meet diversified design requirements.

2) Generative AI technology

Generation AI technologies represented by Midjourney and Stable Diffusion bring innovative ideas to wood carving design. Using classic works of Fengcheng wood carving to generate new design elements, it promotes the integration of traditional wood carving skills and modern design concepts.

Figure 13 Artificial intelligence generated Fengcheng wood carving puzzle products

3) Digital engraving software to achieve accurate production

Digital carving software such as Jingdiao software and ArtCAM can import CAD or generative artificial intelligence design models, optimize the details of the model, realize accurate automatic wood carving, improve the accuracy and efficiency of production, and ensure the high quality restoration of the design scheme.

4) 3D scanning and modeling software retention innovation

Through 3D scanning and modeling software such as Geomagic Design X and 3DMAX, precise three-dimensional data of wooden carvings can be obtained. This allows for the restoration and optimization of models, preserving valuable traditional woodcarving works. Additionally, secondary creation can be carried out, integrating modern elements to innovate designs, achieving a blend of tradition and modernity, thus promoting the inheritance and development of intangible cultural heritage woodcarving.

Figure 14 A cartoon image of Fengcheng wood carving created by secondary creation

5) Digital communication and promotion
Utilize diverse digital channels such as social media platforms, digital exhibitions, and short videos to widely promote the culture of Fengcheng wood carving. Leverage immersive technologies like VR and AR to create virtual wood carving studios and online exhibition spaces, enhancing interactive experiences and boosting cultural influence and dissemination effect of Fengcheng wood carving.

The third path is the integration of digitalization and industry

Using AI technology to assist in the development of Fengcheng wood carving cultural and creative products, from conceptualization, design to marketing promotion, achieving full-process intelligence. Leveraging big data to analyze consumer behavior and market trends, optimizing supply chain management based on scientific data, and enhancing operational efficiency. Focusing on Fengcheng wood carvings, integrating local attractions, and launching distinctive tourism routes that combine online and offline experiences, guiding visitors to tour wood carving production bases and participate in wood carving creation activities, forming a complete intangible cultural heritage industry chain, ensuring the sustainable development of Fengcheng wood carvings.

DISCUSSION & CONCLUSION

1) Conclusion and prospect of digital acquisition and storage
Through digital acquisition and storage at the basic layer, 3D database solves the risk of skill disconnection, and records the characteristics of raw materials, design sketches, carving process and details of Fengcheng wood carving in a comprehensive and high-precision way. This process ensures the accurate inheritance of wood carving skills and effectively solves the problem of skill loss caused by traditional inheritance methods.
2) Conclusion and prospect of digital innovation design and communication
Through the application of digital innovation in design and dissemination, generative AI has reduced the design cycle by 50%, while digital processing technology has enhanced creative efficiency, reduced costs, and made it easier to reach a broader audience at affordable prices. This approach enables the widespread dissemination of intangible cultural heritage (ICH) at a cost-effective level. However, whether AI is used to empower creativity or digital processing is used to boost production efficiency, it is crucial to balance artistic individuality and the emotional essence of craftsmanship. It should not degenerate into purely automated production, which could undermine the original purpose of preserving traditional crafts.
3) Conclusion and prospect of digitalization and industrial integration
The digitalization of the industrial sector and its integration with other industries are facilitated by AI technology, which aids in the development of cultural and creative products, big data analysis of consumer behavior and market trends, and the optimization of supply chain management, thereby enhancing operational efficiency. This has led to the formation of a comprehensive intangible cultural heritage (ICH) industry chain, promoting the sustainable development of Fengcheng wood carving. Digital marketing makes it easier for young audiences to engage with and promote ICH, aligning with the communication methods of the

digital age. This approach attracts more young people, fosters the development of versatile talents, improves the talent training system, and promotes the spread and development of Fengcheng wood carving in the market, achieving its sustainable inheritance and innovation in the digital era.

4) Limitations of the study:

The study is limited to small sample interviews, which may not cover all relevant groups and could lead to biased results; data collection primarily relies on interviews and some literature, which may result in incomplete or inaccurate information; this study mainly employs qualitative research methods, which, while capable of deeply analyzing issues in the digital dissemination of intangible cultural heritage, also has certain subjectivity and limitations.

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