

Research on Production of Korin Printmaking and Application of Contemporary Numerical Control Engraving Technology

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Abstract: Korin printmaking is an important intangible cultural heritage. It faces challenges in inheritance and development. Numerical control engraving technology offers new solutions. This paper studies the application potential of this technology. The research adopts the literature review method. It analyzes existing application cases of the technology. It explores the integration path of numerical control technology and traditional craftsmanship. It constructs a complete framework for technology application. The research shows that digital collection is key. High-precision scanning records artistic details. Vector processing retains the essence of the original work. Numerical control engraving improves production accuracy. The human-machine collaborative mode maintains the artistic essence. The application of the technology requires supporting measures. Strengthening cross-disciplinary cooperation is important. Cultivating compound talents is the foundation. Establishing a dedicated database is necessary. Developing industrialization paths promotes development. This research provides theoretical support. It offers new solutions for the protection of intangible cultural heritage. It promotes modern innovation of traditional craftsmanship. It realizes sustainable development of cultural inheritance.

Keywords: Korqin printmaking; numerical control engraving; digital protection; intangible cultural heritage; technology integration.

1. Introduction

Korqin printmaking is an important intangible cultural heritage of Mongolia, originating in the 1950s and renowned worldwide for their unique ethnic style and artistic value. This art form is mainly distributed in Tongliao area, fully demonstrating the lifestyle and aesthetic concepts of the Mongolian people (Bao Jiawei, 2022)[1]. Korqin printmaking prints, with their bold lines, bright colors, and rich ethnic characteristics, have become an important carrier of Mongolian culture. The themes of the works mostly come from grassland life, ethnic costumes, and historical figures, reflecting the spiritual connotations and artistic value of nomadic culture. However, the inheritance and development of Korqin printmaking prints are facing severe challenges. The research by Wulan Tuoya (2023) indicates that the creative team is shrinking, and the shortage of inheritors is becoming increasingly prominent[5]. The traditional production process is inefficient and cannot meet the demands of modern society. The art style is relatively fixed and lacks innovation, resulting in limited public recognition (Zhang Yanxin, Ding Tianyi, 2018). These factors seriously restrict the contemporary development and dissemination of Korqin printmaking prints[9].

Against this backdrop, contemporary digital technology offers new possibilities for the innovation of traditional craftsmanship. CNC engraving technology, as an advanced digital manufacturing technology, has demonstrated significant advantages in multiple traditional craft fields. The research by Wu Qiangqiang et al. (2024) proves that through CAD/CAM technology, the modern transformation of traditional craftsmanship can be achieved[7]. This technology features high precision, high efficiency, and replicability,

effectively addressing the technical bottlenecks in the inheritance of traditional craftsmanship. This paper aims to systematically review the application potential of CNC engraving technology in the production of Korqin printmaking prints. By analyzing existing research results, it explores the integration paths of digital technology and traditional woodblock print craftsmanship. The study will construct a complete technical application framework, providing theoretical support and technical solutions for the innovative development and productive protection of Korqin printmaking prints. The ultimate goal is to promote the sustainable inheritance and contemporary innovation of this intangible cultural heritage.

2. Literature Review

2.1. Research on Artistic Characteristics and Transmission Status of Korqin Printmaking

The Korqin printmaking possess unique artistic characteristics and cultural value. Bao Jiawei (2022) pointed out that the Korqin printmaking art emerged in the middle of the 20th century and gradually formed an artistic style with distinct ethnic characteristics after integrating with local cultures[1]. In terms of both form and spiritual connotation, their works reflect the unique aesthetic features of the Mongolian ethnic group. Ulan Tuya (2023) further classified the Korqin printmaking into three categories: those related to ethnic costumes, those related to daily life, and those related to historical figures[5]. This classification method fully demonstrates the rich content system and cultural connotation of the Korqin printmaking.

In terms of artistic characteristics, the Korqin printmaking

exhibit distinct regional characteristics. Zhang Yanxin and Ding Tianyi (2018) believed that as a branch of ethnic woodcuts, the Korqin printmaking, while boldly innovating, also inherited a unique artistic style[9]. The works usually adopt rough lines and strong color contrasts, expressing the boldness and enthusiasm of the grassland culture. The themes are mostly derived from the daily life, traditional customs, and historical legends of the Mongolian people, possessing a rich ethnic cultural characteristic.

However, the inheritance of Korqin printmaking faces severe challenges. Ulan Tuya's (2023) research reveals that there are currently three main issues: the artistic style is fixed, and the concept update is slow; the creative team is shrinking, lacking a market platform; and the changes in the cultural environment have led to insufficient in-depth artistic exploration. Bao Jiawei (2022) further pointed out that the development of such excellent culture inevitably encounters problems of inheritance and promotion[1]. The traditional apprenticeship inheritance model is difficult to adapt to the needs of modern society, and the interest of the younger generation in traditional craftsmanship is decreasing day by day. Liu Xi (1985) analyzed the development predicament of printmaking art from a more macroscopic perspective, pointing out that printmaking materials and printing techniques are the foundation for the survival of printmaking. However, the traditional printmaking process is complex and inefficient, making it difficult to achieve large-scale production.

2.2. Research on the Application of Numerical Control Engraving Technology in Traditional Craft Fields

The application of numerical control engraving technology in traditional craftsmanship has achieved remarkable results. Wu Qiangqiang et al. (2024) demonstrated in their research on the application of egg engraving art that through CAD/CAM technology, traditional craftsmanship can be modernized[7]. The research team successfully utilized CNC machines to conduct creative design and engraving on eggs, proving the feasibility of this technology in the field of traditional craftsmanship. This study provides important references for the digital transformation of other traditional crafts.

In the field of stone carving, numerical control technology shows unique advantages. Hu Meilian (2021) explored the application of numerical control technology in Huainan stone carving[3]. Through CAD/CAM integration technology, spindle drive system, and graphic image processing technology, the artistic effect and production efficiency of stone carving were significantly improved. The research used a 1325 CNC stone engraving machine as an example, analyzing the composition, performance, and characteristics of the CNC system, providing a technical solution for the modernization of traditional stone carving craftsmanship.

Gao Yifan (2022) studied the development trend of Quyang stone carving under the digital technology background, pointing out that digital sculpture technology has changed the creative mode of Quyang stone carving, which is mainly based on traditional manual production[2]. The research introduced the application of rapid prototyping technology and virtual reality technology in the field of sculpture through case analysis, demonstrating the value of digital technology from three aspects: the efficiency of artistic creation, the

breakthrough of traditional craftsmanship, and the accuracy of technological application.

Yang Jinlin (2021) explored the practical application of three-dimensional CNC engraving technology in jade carving[8]. The research shows that this technology completes three-dimensional graphic design through computer assistance, and uses programming media to input computer-assisted production equipment, enabling automatic engraving of raw materials and obtaining the same original mold as the design. This technology application makes the artistic effect of jade carving more perfect, greatly improving the production accuracy and efficiency.

In the field of redwood carving, Wu Peng (2017) research is of great significance. The research points out that redwood carving faces an inheritance dilemma due to problems such as long processing time, high waste rate, and long training period for engraving technicians[6]. The integration of numerical control technology and traditional craftsmanship can achieve disciplinary integration. The research took relief carving as an example, exploring the technical integration scheme of CNC technology and redwood carving from the perspective of optimizing processing technology.

In addition, numerical control technology has also been applied in the education field. Liu Fuhua and Chen Jinghong (2023) studied the application of CNC engraving in the practical teaching of mural courses[4]. Guilin Tourism University introduced high-tech manufacturing equipment such as CNC engraving machines and laser internal engraving machines, and established corresponding training courses, integrating production practice with modern technology. This teaching mode provides new ideas for the cultivation of traditional craftsmanship talents.

2.3. Summary of Literature Review

The current research in the integration of numerical control engraving technology and Korqin printmaking faces significant deficiencies. Although numerical control technology has achieved remarkable results in fields such as egg carving and stone carving (Wu Qiangqiang et al., 2024; Hu Meilian, 2021), there is still a lack of specialized research on Korqin printmaking. Most of the existing research merely focuses on the surface exploration of technical application, lacking in-depth analysis of the unique artistic characteristics and technical compatibility of Korqin printmaking[3][7]. The studies by Ulan Tuya (2023) and Baogaiwei (2022) have deeply explored the artistic features of Korqin printmaking, but failed to propose specific technical solutions[5]. At the same time, the existing research lacks a systematic technical application framework and fails to establish a complete standard system from design to production. In terms of interdisciplinary integration, the combination of artistic creation and engineering technology fields is not deep enough, and there is a lack of effective collaborative innovation mechanisms. Therefore, it is urgent to conduct research on the application of numerical control technology for Korqin printmaking, explore technical paths suitable for its artistic characteristics, and build a complete technological innovation system to provide new solutions for the contemporary inheritance of this intangible cultural heritage.

3. Application of Integrating Numerical Control Engraving Technology with Korqin Printmaking

The Korqin printmaking, as an important intangible cultural heritage, require innovative technical means for their protection and inheritance. Numerical control engraving technology offers new possibilities for traditional woodblock printing. This chapter will thoroughly explore the specific application paths of numerical control engraving technology in the production of Korqin printmaking, including three key links: digital acquisition and processing, numerical control engraving for plate making, and a new mode of human-machine collaborative creation. These technical paths aim to achieve the organic integration of traditional craftsmanship and modern technology, providing technical support for the contemporary development of Korqin printmaking.

3.1. Digital-based Image Acquisition and Vector Processing of Printmaking Works

Digital acquisition is the fundamental part of technology application. High-precision scanners can capture the fine details of the prints. The scanning resolution needs to be above 600 dpi. This resolution can record the slightest line variations and color gradations. Multispectral imaging technology can be used as an auxiliary acquisition method. This technology can display details that are invisible to the human eye. It is particularly suitable for historical works of long ago. During the acquisition process, it is necessary to maintain stable environmental lighting. Ensure the accuracy of color reproduction.

Vector processing is a key step in the digitalization process. Professional software can accomplish this task. Adobe Illustrator is a commonly used tool in the industry. It converts bitmap images into vector graphics. Vector graphics are defined and described by mathematical formulas. The greatest advantage is that they can be infinitely enlarged without distortion. This process requires professional technicians to operate. Technicians need to have artistic appreciation skills. Ensure that the conversion process retains the spirit of the original work.

Line optimization and color separation processing require special attention. The lines of the Korqin printmaking have a unique style. The lines are rough yet expressive. The optimization process should maintain this artistic feature. Color separation processing requires accurate reproduction of the ethnic colors. The Korqin printmaking use a specific color combination. These colors have cultural symbolic meanings. Finally, a standardized numerical control file needs to be generated. The file format is usually selected as DXF or AI. These formats are compatible with most numerical control devices.

3.2. Application of Numerical Control Engraving in Key Technology of Printmaking Plate Production Process

The CNC engraving machine is the core processing equipment. This equipment is precisely controlled by computer programs. The movement accuracy can reach 0.01 millimeters. This level of precision far exceeds that of manual engraving. Mechanical engraving uses physical tools for processing. The type of the tool can be replaced as needed.

Different tools produce different engraving effects. Laser engraving uses a high-energy laser beam for processing. It is particularly suitable for the engraving of fine patterns. The effect is especially remarkable on metal plates.

CAD/CAM technology provides important software support. CAD software is responsible for pattern design. It can create complex design patterns. CAM software generates processing path programs. It converts the design into machine instructions. The research by Wu Qiangqiang et al. (2024) has confirmed its feasibility. This technology has been successfully applied in the field of egg engraving[7]. The planning of tool paths affects the final effect. It needs to be optimized according to the material characteristics. The processing parameters need to be repeatedly tested to determine.

Different plates require different processing techniques. Wood is a commonly used material in traditional engraving. CNC engraving can precisely replicate the wood grain texture. Metal plates are more suitable for mass production. Real-time monitoring is required during the processing. To ensure the consistency of the engraving depth. The quality control part is of vital importance. Laser measuring instruments can perform precision detection. A complete quality standard system needs to be established. To ensure the artistic quality of each product.

3.3. New Model of Human-machine Collaborative Printmaking Creation and Production

The new mode of human-machine collaboration emphasizes a cooperative relationship. The artist holds the dominant position in the creation process. Technology provides the tools to realize the creativity. This mode maintains the essential characteristics of art. It avoids excessive intervention of technology in art. It achieves a perfect combination of tradition and modernity. The creative process is divided into multiple professional stages. The creative design stage is entirely completed by the artist. The artist determines the theme and style of the work. The digital processing stage involves technical transformation. The hand-drawn draft is converted into a digital file. The CNC engraving stage realizes automatic processing. The machine performs precise engraving tasks. The manual printing stage returns to traditional craftsmanship. The artist controls the final printing effect. The re-creation stage reflects the artistic value. The artist makes personalized modifications to the work.

This mode has several significant advantages. It greatly improves production efficiency. It reduces production costs and time. It lowers the technical threshold. It enables more artists to participate in the creation. It maintains the uniqueness of the art work. Each work has a handmade touch. It promotes the expansion of cultural dissemination. It enables more people to understand the Khöchinjaina woodblock prints. A supporting training system needs to be established. It is necessary to cultivate multi-skilled artistic and technical talents. An industry quality standard system needs to be formulated. It is necessary to ensure the sustainable development of technological innovation. It is necessary to strengthen intellectual property protection. It is necessary to safeguard the creative rights of artists.

In conclusion, CNC engraving technology provides new opportunities for the development of Khöchinjaina woodblock prints. Through the systematic application of three

links: digital acquisition and processing, CNC engraving plate production, and human-machine collaborative creation, it can effectively solve the technical bottlenecks in traditional woodblock printing. This technological integration not only improves production efficiency, but more importantly, injects new vitality into traditional craftsmanship. In the future, it is necessary to further strengthen technological research and talent cultivation to promote the innovative development of Khöchinjaina woodblock prints in contemporary society.

4. Suggestions and Prospects for Promoting Technology Application

The digital protection and innovation development of Korqin printmaking require systematic support measures. This chapter proposes specific suggestions from three dimensions: interdisciplinary cooperation and talent cultivation, specialized technology research and development and database construction, industrialization development and dissemination innovation. These suggestions aim to promote the deep integration of CNC engraving technology and traditional woodblock print art, and achieve the sustainable inheritance of intangible cultural heritage.

4.1. Strengthen Interdisciplinary Cooperation and Talent Cultivation

Establishing a cross-disciplinary cooperation mechanism is the top priority. It is necessary to build an exchange platform between the fields of art and engineering. Regularly organize academic seminars and technical exchange meetings. Promote in-depth dialogues between artists and engineers. The research conducted by Wu Qiangqiang et al. (2024) has proved the effectiveness of this cooperation[7]. Their team successfully applied CAD/CAM technology to egg carving art.

The talent cultivation system needs innovation. Universities should establish interdisciplinary majors. Cultivate versatile talents who are proficient in both art and technology. The curriculum should balance theory and practice. Art colleges should increase technical courses. Engineering colleges should add courses on artistic literacy. Workshops can conduct apprenticeship training. Inheritors learn digital technology. Technicians learn artistic knowledge.

Establishing an expert resource database is very important. Invite experts from different fields to participate. This includes printmaking artists, software engineers, mechanical experts, etc. Form a professional technical guidance team. Provide intellectual support for the innovative development of Khöreein printmaking. This cooperation model can be extended to other traditional craft fields.

4.2. Develop Specialized CNC Processing Techniques and Database Specifically Adapted for Korqin Printmaking

The development of specialized technologies is the core part. It is necessary to study the unique artistic features of the Korqin printmaking. Develop specialized tool path algorithms. Hu Meilian (2021) provides references in the field of stone carving[3]. The specialized algorithm she developed significantly improved the carving effect.

Establishing a digital resource library is very necessary. The system collects and organizes the fine works of Korqin printmaking. Use high-precision digitalization technology for collection. Classify and store them according to themes and

styles. Establish a complete metadata standard. Ensure the retrievability and usability of the resources. The resource library should be updated and maintained regularly.

It is important to formulate technical standards and norms. Unify data formats and interface standards. Establish a quality control index system. Develop operation norms for process procedures. These standards can ensure the quality of technical application. It is also conducive to the promotion and popularization of technology. The standard formulation requires the joint efforts of an expert team.

4.3. Exploring New Paths for Industrialization and Dissemination of Printmaking based on Numerical Control Technology

Industrialization development is the guarantee for sustainability. Utilize numerical control technology to achieve small-batch production. Meet the needs of different consumers. Develop personalized customization services. Let consumers participate in the creative process. Produce artworks with personal characteristics. This model can increase the added value of the products.

Expand the development of derivative products is necessary. Apply the elements of prints to daily items. Develop cultural and creative products and souvenirs. Use digital technology to achieve rapid prototyping. Reduce product development costs. Shorten the time to market the products. Establish an online sales platform. Expand the market coverage.

It's significant to innovate communication and education methods. Utilize virtual reality technology to display the production process. Develop online education courses. Let more people know about the Kolchin print art. Cooperate with schools to carry out aesthetic education. Cultivate teenagers' interest in traditional art. Hold digital art exhibitions. Display the technological innovation achievements. These measures can enhance the popularity and influence of the Kolchin print art.

5. Conclusion

The numerical control engraving technology has brought new development opportunities to the Korqin printmaking. This technology significantly improves the production accuracy. It greatly enhances the production efficiency. At the same time, it expands the dissemination scope. These advantages help solve the current problem of inheritance. However, technological innovation also brings new challenges. Special attention must be paid to maintaining the artistic charm. The inheritance of traditional skills cannot be ignored. The protection of the artistic essence must be achieved through innovation. A balance between technology and art must be achieved. The application of technology must adhere to the correct direction. Always prioritize the protection of artistic value. Respect the creative dominance of artists. Utilize the auxiliary and supportive role of technology. The ultimate goal is to achieve sustainable development. Let traditional craftsmanship regain its new vitality. Let the Korqin printmaking continue to be passed down and develop in modern society. The future requires continuous exploration and innovation. This includes the following aspects: strengthening technological research and talent cultivation. Improving the standard system and platform construction. Promoting industrialization development and innovation dissemination. Through these efforts, the Korqin printmaking

will surely achieve creative transformation and innovative development, providing a successful example for the protection of intangible cultural heritage.

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