



# Creative Development of Intangible Cultural Heritage Driven by Computer Graphics Techniques—A Case Study on the Design Phase of Traditional Chinese Paper-cutting Manuscripts

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## Abstract

The research investigations suggest that digital image technology is presently driving the advancement of Traditional Chinese Paper-cutting intangible cultural heritage (ICH), although it remains in an early stage of development. During the creation phase of Traditional Chinese Paper-cutting manuscripts, creators employ digital image technology to enlarge the manuscripts. The study posits that this process can undergo secondary innovation. Through concrete practice, the optimization of craft steps can produce foundational manuscript images designed and drawn using digital image processing software, along with corresponding physical paper-cutting representations. The significance of this lies in several aspects. Firstly, it enables expansive innovation and development of ICH while preserving its authenticity, and respecting the dynamic nature of intangible cultural heritage. Secondly, design software can assist heritage practitioners in expressing images that are both regular and aesthetically pleasing, innovating paper-cutting pattern design, and facilitating the digital storage and subsequent retrieval of original designs. Furthermore, it allows heritage practitioners to visualize the final product before completion, reducing communication costs and facilitating alignment with consumers. In summary, the use of computer image processing technology enhances the originality of heritage practitioners' artistic works, improves production efficiency, and aids in establishing innovative creative modes for traditional crafts.

## Keywords

Computer Graphics (CG), Digitization of Intangible Cultural Heritage (ICH), Paper-cutting, Heritage Practitioners, Technological History and Traditional Crafts

## 1. Introduction

Computer Graphics (CG) [1] refers to the process of generating graphics and images using a computer, encompassing the design, production, and processing of both two-dimensional (2D) and three-dimensional (3D) graphics. Since its introduction in 1962 by Ivan Sutherland in his doctoral thesis "Sketchpad" (an early computer-aided design system) at the Lincoln Laboratory of the Massachusetts Institute of Technology, this technology has come a long way. Today, it is widely utilized in the digitization of intangible cultural heritage.

In 2009, Traditional Chinese Paper-cutting was inscribed on the Representative List of the Intangible Cultural

Heritage of Humanity, acknowledging its status as an outstanding component of Chinese traditional culture. It has also benefited from the digitization of intangible cultural heritage. Currently, the intersection of CG processing technology and the study of Traditional Chinese Paper-cutting, as driven by academia and practical applications, has become a major focal point. Through the literature review, it is evident that numerous researchers have contributed to this field. Firstly, the establishment of digitized paper-cutting databases has been a notable outcome. One prominent example is the project titled "Construction of the Digital Protection and Display Platform for the Traditional Chinese Paper-cutting Database", sponsored by the National Arts Fund in 2020. Secondly, the emergence of digital paper-cutting, a form of paper-cutting without physical representation often manifested through gaming, has been explored. Researchers such as Zhang Yuqi have studied this phenomenon in their work titled "The Collision of Paper-cutting Art and Game Digitization" [2]. Thirdly, instances of digital media empowering the development and dissemination of intangible cultural heritage, specifically Traditional Chinese Paper-cutting, have been documented. Research works such as "Innovative Development and Dissemination of Nanjing Paper-cutting in the Digital Empowerment Era" by Qiu Yuyu et al. [3], "Research on the Digital Living Transmission of Intangible Cultural Heritage Paper-cutting" by Song Zhiheng [4], and "Research on the Digital Inheritance Mode of Paper-cutting Art" by Wang Xiaoyu [5] delve into this aspect. In conclusion, there is a wealth of research exploring the use of digital technology for the protection, inheritance, innovation, and dissemination of Traditional Chinese Paper-cutting art. However, this article refrains from providing an exhaustive list of such studies.

While there is a considerable body of research in the academic community on digitized paper-cutting, this investigation reveals a gap in the existing literature. Currently, there is a lack of comprehensive research that delves into the application of digital image technology to the traditional craft practices of Traditional Chinese Paper-cutting from the perspective of heritage practitioners. Specifically, there is a dearth of studies summarizing how heritage practitioners incorporate digital image technology into their traditional craft practices. Furthermore, there is an absence of guiding theoretical research on how digital image technology can further inform the traditional craft of Traditional Chinese Paper-cutting. This identifies a need for comprehensive and conclusive research that addresses the practical application and theoretical underpinnings of integrating digital image technology into the heritage practices of Traditional Chinese Paper-cutting.

After delving into the practices of Traditional Chinese Paper-cutting, the study underscores that CG processing technology is presently shaping technological progress in the field, even though it is still in its early developmental stage. While it is an emerging trend, summarizing the observed phenomena and delineating clear objectives has the potential to accelerate the fusion and progress of both technologies. This, in turn, could lead to the rewriting of technological history. In consideration, the study finds it necessary to summarize this phenomenon and identify innovative directions. This approach will help digital image processing technology to promote traditional crafts more effectively and provide more avenues for the preservation and innovation of intangible cultural heritage.

## **2. Digital Image Processing Technology Is Driving the History of Traditional Chinese Paper Cutting Technology for Intangible Cultural Heritage**

### **2.1 Investigation of current traditional paper-cutting crafts and innovative paper-cutting practices**

Tracing its historical roots, Traditional Chinese Paper-cutting is a folk art form that involves cutting or carving patterns on paper using scissors or knives. This traditional craft is utilized in daily life or in conjunction with other cultural activities [6]. The study shows that practitioners of Traditional Chinese Paper-cutting have departed from traditional creative modes. This insight emerged after conducting in-depth research and interviewing several practitioners dedicated to the preservation of intangible cultural heritage. Digital image processing technology has seamlessly integrated into the historical trajectory of Traditional Chinese Paper-cutting. To understand this integration, it is essential to begin the exploration from the perspective of the art of paper-cutting.

In the realm of paper-cutting, practitioners commonly employ scissors for cutting or a knife for carving patterns onto paper. During the paper-cutting process, if cutting is executed without a prior draft drawing, it is termed "mao jiao" (cutting without a guide). Conversely, when a draft is drawn before cutting, it is known as "guo gao jian" (cutting after drawing a guide). When drafts are mainly created with scissors, artists often sketch a basic pattern without intricate details. Throughout the paper-cutting process, artists have the freedom to add detailed patterns to the work spontaneously. This type of creation does not necessitate highly detailed initial drafts. In contrast, for works primarily created using a carving knife, there is a meticulous requirement for the draft. Artists in this category often draw

inspiration from the aesthetic forms of traditional Chinese gongbi painting, known for its intricate lines. In such cases, the practice of "guo gao jian" becomes essential. Additionally, when aiming to create large-scale artwork, the workload for drafting and designing increases, and hand-drawing may lead to less precise strokes, posing a challenge for creators. However, embracing technological advancements, some traditional paper-cutting artists have seamlessly integrated emerging scientific techniques into their traditional crafts. When designing foundational drafts for paper carving, these artists use manageable paper sizes and employ digital image processing technology to enlarge them. The process can be summarized as follows:

### 2.1.1 Steps for traditional paper-cutting creators to use digital image processing techniques in the base design stage

(1) Begin by designing and drawing the foundational draft on A4-sized paper.

Note: In this context, the draft that has not undergone digital image processing is referred to as the "basic draft," while the one processed with digital image technology is termed the "processed draft."

(2) Utilize scanning equipment or photography tools to import the basic draft into the computer for digital enlargement processing. Depending on the requirements, scale up the A4-sized paper to A3, A2, or A1 specifications.

(3) Directly print the processed draft on a printer.

Note: The basic draft can be designed in A4 size and then imported into a computer for enlargement using graphic design software. This enables direct printing on A1-sized paper for paper carving. However, it is essential to note that there might be challenges in this step, as the size of the processed draft may be limited by the printer's specifications. After all, most household printers cannot handle A3, A2, or A1 sizes. In such cases, a flexible approach is required. The processed draft can be divided into several A4-sized pages for printing (referred to as "draft sections"), and then these sections can be glued together. This method allows for obtaining an A3, A2, A1, or even larger-sized processed draft.

(4) Place the processed draft over the Xuan paper used for paper carving (generally Xuan paper, but other materials can also be used). Bind them together using a stapler, stapling in areas intended to be cut.

(5) Commence the paper-cutting practice and creation. At this point, it is essential for the creator to carry out logical cutting and carving on the processed draft. Start by cutting smaller areas before moving on to larger ones. Failing to follow a logical order may affect the smoothness of the carving process, potentially leading to the deformation of the artwork or rough lines. In severe cases, irreversible damage to the artwork may occur.

In summary, it is evident that digital image processing technology has been integrated into the craft by heritage practitioners of Traditional Chinese Paper-cutting. This innovation addresses certain limitations of traditional craftsmanship. Importantly, this technological advancement does not seem to cause irreversible damage to the authenticity of the paper-cutting intangible cultural heritage.

However, this innovation only requires basic CG technology. Hence, it is apparent that the digital drive in this stage of traditional craft development is still in its infancy. Expanding this perspective could accelerate the influence of emerging technologies on traditional technique innovation. Based on this innovation, this research aims to strengthen the application of digital image technology and carry out secondary innovation. The goal is to optimize the use of digital image processing technology in designing paper-cutting drafts, ultimately transitioning to directly employing digital image technology for draft design.

### 2.1.2 Secondary Innovation: Optimizing the Use of Digital Image Processing Techniques in the Design of Paper Cut Primers

The study advocates optimizing the application of digital image processing technology in the design phase of paper-cutting drafts. To validate this proposition, the following experiments will be conducted:

(1) Creating the foundational draft through design and drawing using the Procreate software on a Tablet Personal Computer device (Alternatively, this step can also be accomplished using a desktop computer with design software like Adobe Photoshop or Adobe Illustrator).

(2) After printing the draft sections, adjustments to the design will be made during the process of pasting these sections.

(3) The remaining steps are consistent with the latter portion of the previous section "1. Steps for Traditional Paper-cutting Artists Using Digital Image Processing Technology in the Draft Design Process," and will not be reiterated here.

The design and drawing of the foundational draft are illustrated in Figure 1.



Figure 1. Design drawn using computer software (Designer: Tang Danlan).

The completed paper-cutting artwork created using both a carving knife and scissors in the study is shown in Figure 2.



Figure 2. The physical finished product made from the design using paper cutting tools. (Artist for Illustration/Design: Danlan Tang; Title of the Artwork: Chinese People Protect the Peace of the World. Title of the work in Chinese: 雄安容和; Name of the work in Japanese: 中国人は世界を守る).

## 2.2 The Significance of Computer Graphics Technology in the Design Stage of Chinese Paper Cut Manuscripts

Inheritors of Traditional Chinese Paper-cutting intangible cultural heritage increasingly use computer graphics processing technology for artistic creation. Starting with the design and drafting of the foundational draft using computer graphics processing software, followed by printing the final draft for paper-cutting, facilitates the establishment of a

personal draft database for future reference. The feasibility of applying digital image processing technology in the design phase of paper-cutting drafts is evident from previous research. This aligns with the core characteristics of intangible cultural heritage, emphasizing human values, dynamic and spiritual factors, and excellence in skills and techniques [7]. Utilizing CG software for draft design holds significant academic importance.

Firstly, it respects the natural development patterns, preserving the dynamic nature of intangible cultural heritage. Intangible cultural heritage needs to evolve creatively, and all existing intangible cultural elements must continually grow, change, and innovate in interaction with nature, reality, and history. This dynamic nature ensures that it remains in a perpetual state of transformation [8]. In many cases recognized by heritage practitioners of Traditional Chinese Paper-cutting, the human-centric approach of using CG technology organically drives innovation in intangible cultural heritage. This empowerment, particularly when used as an entry point in the draft design phase, can protect the authenticity and promote the innovative and developmental aspects of intangible cultural heritage. Unlike mechanized interventions, this approach does not cause irreversible or significant damage to the authenticity of intangible cultural heritage.

Secondly, the essence of the visual tension beauty in paper-cutting works lies in design (in this context, painting is also part of the design). With the assistance of design software, paper-cutting artists can handle patterns more flexibly, facilitating the expression of images that combine regularity and aesthetic tension. This approach is also beneficial for digitizing the storage of original design patterns for future use.

Furthermore, using CG software for draft design is advantageous for the connection between intangible cultural heritage practitioners relying on paper-cutting for-profit and consumers. Research, such as "Research on the Digital Inheritance Mode of Paper-cutting Art" by Wang Xiaoyu and Luo Kunming, points out that paper-cutting artists can optimize the patterns, size, and position of paper-cutting art based on consumer demand [9]. The study believes that sometimes, inadequate language communication and a lack of imagination among consumers regarding finished paper-cutting products can lead to difficulties in paper-cutting product transactions. If intangible cultural heritage practitioners can provide consumers with a foundational draft that closely resembles the finished paper-cutting product before the actual paper-cutting process, it can enhance communication and reduce the time and energy costs associated with it.

It is important to emphasize that while the author supports and advocates for the use of digital image processing technology by intangible cultural heritage practitioners during the conceptual and emotional expression stages, the author does not endorse the complete replacement of artificial intelligence (AI) painting for draft design. While AI-generated solutions can be highly efficient, the originality of AI painting designs is questionable. It may not truly reflect the thoughts and emotions of intangible cultural heritage practitioners. Additionally, AI-generated painting designs are currently considered products of fragmented plagiarism, which could lead to infringement of the original author's rights, resulting in legal disputes. Adopting such an approach might deviate from the original intention of protecting intangible cultural heritage and fostering artistic creation.

### 3. Final remarks

Chinese paper-cutting intangible cultural heritage practitioners have organically integrated digital image processing technology into the traditional craft, and the author asserts the need to underscore and optimize this process. Through paper-cutting experiments, the study validates that leveraging digital image processing technology for enhancing the creative development of Chinese paper-cutting intangible cultural heritage can be strategically initiated at the design stage of Chinese paper-cutting manuscripts. In terms of significance: firstly, it expands innovation and development under the protection of authenticity, respecting the dynamic nature of intangible cultural heritage. Secondly, design software aids heritage bearers in expressing both the regularity and tension of visual aesthetics, fostering innovation in paper-cutting pattern design, and facilitating the digitization of original design patterns for storage and future reference. Thirdly, it enables heritage bearers to intuitively visualize the finished effect before the completion of works, reducing communication costs and facilitating effective communication. In summary, this approach enhances the artistic originality of intangible cultural heritage bearers, improves production efficiency, and warrants attention and optimization of digital image processing technology for the creative development of Chinese paper-cutting intangible cultural heritage. The design stage of Chinese paper-cutting manuscripts serves as a strategic entry point, contributing to the advancement of the traditional craft and the creation of a new technological history.

With the guidance of digital image processing technology, Traditional Chinese Paper-cutting, an intangible cultural heritage, is experiencing a period of innovation. Intangible cultural heritage practitioners are naturally integrating

digital image processing technology, revitalizing the traditional craft. The study, validated through paper-cutting experiments, emphasizes the feasibility of using digital image processing technology to foster creative development in Traditional Chinese Paper-cutting intangible cultural heritage. The research suggests focusing on and optimizing this process, particularly by considering the design phase of Traditional Chinese Paper-cutting as an entry point. The significance lies in the ability to expand and innovate intangible cultural heritage while preserving its authenticity and respecting its dynamic nature. Additionally, design software aids heritage practitioners in expressing intricate and aesthetically pleasing images, facilitating innovation in paper-cutting pattern design, and enabling the digitization of original designs for future use. Moreover, it allows heritage practitioners to visualize the final product before completion, reducing communication costs and facilitating interaction with consumers. Overall, this approach enhances the uniqueness of intangible cultural heritage artworks, improves production efficiency, and deserves attention and optimization to foster creative development in Traditional Chinese Paper-cutting intangible cultural heritage. The design phase of Traditional Chinese Paper-cutting is considered a pivotal entry point for leveraging digital image processing technology, promoting the development of traditional crafts, and writing a new chapter in technological history.

Furthermore, this article maintains that paper-cutting is merely one of various traditional crafts, and other traditional crafts can also leverage digital image processing technology during the design phase. Although specific steps will undoubtedly vary, the article adopts a narrow perspective to explore the topic of using digital image processing technology to drive the development of traditional crafts. The author hopes that future research will further investigate this perspective. She believes that with the scientifically reasonable application of digital image processing technology, traditional crafts associated with intangible cultural heritage can achieve significant progress and development.

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