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Integrating 3D Digital Technologies for the Preservation of Traditional Carving Craftsmanship: A Case Study on Han-style Palanquin Construction

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Abstract

This study focuses on documenting and preserving the traditional craftsmanship of palanquin-making within Han Chinese culture in East Asia. It aims to employ digital preservation technologies to construct a systematic and comprehensive body of knowledge, thereby reducing the risk of losing traditional craftsmanship and fostering its intergenerational transmission. As a symbolic and functional artifact in folk religious practices, the palanquin embodies rich traditional aesthetics while bearing profound historical, cultural, and religious significance. The craftsmanship often centers on mortise-and-tenon joints, achieving structural stability without relying on standardized modern industrial techniques. Among these, certain concealed mortise-and-tenon designs are seamlessly integrated into the structure, achieving an “invisible interlocking” effect that showcases exceptional skill. Additionally, the production process deviates from modern linear assembly logic, instead following a non-linear workflow characterized by “decoration-first, structure-later,” reflecting artisans’ unique understanding of the balance between aesthetics and structure. This study employs digital technologies to document and reconstruct the palanquin-making process, transforming traditional techniques into digitally accessible and operable visual resources. An integrated digital database with both educational and exhibition functions is further developed to systematically present the comprehensive scope of palanquin craftsmanship. This craftsmanship embodies dual cultural attributes, encompassing tangible cultural heritage—such as the physical structure of the palanquin and its carving techniques—and intangible cultural heritage—such as traditional procedures, artisans’ experiences, and orally transmitted technical knowledge. The database provides a valuable resource for craft education, cultural promotion, and academic research, addressing contemporary challenges such as the loss of traditional skills and transmission discontinuities. It thereby establishes a solid foundation for the sustainable development of traditional Han craftsmanship.

1. Introduction

In the context of Han Chinese folk beliefs and traditional ritual systems, the palanquin has long served as a culturally symbolic medium. In earlier societies, palanquins were widely used in ceremonial contexts such as weddings and aristocratic processions, symbolizing honor, social status, and blessings. However, with shifts in social structure and lifestyle, palanquins today are predominantly seen in religious contexts, becoming essential instruments in rituals such as deity processions and temple festivals. They not only embody sacred symbolism and religious faith but also concretely represent local cultural identity and collective memory (Chuang Y.-S., 2021).

Palanquins have evolved into three main types based on function and symbolism: wedding, civil deity, and martial deity. Wedding palanquins emphasize festivity and blessings; civil deity palanquins feature elegance and cultural meaning; martial deity palanquins highlight structural strength and dynamic ritual expression. These three types exhibit distinct characteristics in structural design, decorative style, and ritual use, reflecting the diverse functions and regional cultural values embedded in their respective traditions (Yao B.-H., 2011).

Figure 1. Wedding Palanquin, Civil Deity Palanquin, Martial Deity Palanquin (from left to right)

From a craftsmanship perspective, traditional palanquin construction demonstrates a high degree of manual precision and structural ingenuity, with the use of mortise-and-tenon joinery as one of its defining features. This woodworking technique requires no screws, nails, or adhesives; instead, it relies solely on the interlocking of components and the balance of forces to achieve a stable overall structure. Particularly noteworthy is the mastery of invisible mortise-and-tenon techniques by artisans in certain regions. These joints are ingeniously concealed within the structure, giving the exterior of the palanquin a seamless and unified appearance. This not only enhances structural integrity but also exemplifies the aesthetic sensibility and cultural refinement inherent in traditional craftsmanship.

The making of palanquins involves not only structural logic and technical skill but is also deeply embedded in local beliefs, social organization, and cultural rituals. It is more than a utilitarian craft object; it is a highly symbolic cultural artifact that carries a community’s historical memory and values. Traditionally, the transmission of palanquin craftsmanship has relied on the master-

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apprentice model, passed down orally and experientially. As a result, much of the technical knowledge remains dispersed within individual artisans’ experiences, lacking formalized and systematic preservation. With the gradual passing of senior craftsmen and the younger generation’s declining interest and identification with traditional crafts, the continuity of palanquin-making faces a severe risk of knowledge loss and disruption. Finding effective means to document and preserve traditional craftsmanship has thus become a crucial foundation for the sustainable development of cultural identity and heritage. (Smith, L., 2006; Deacon, H. et al., 2004)

Moreover, the use of process animations and dynamic simulations can transform complex craft procedures into concrete and visual learning materials, greatly enhancing the accessibility and effectiveness of craft education and knowledge transmission. (Sylaiou, S. et al., 2010)

2. Materials and Methods

2.1 Research Subject

The research subject selected for this study is a senior traditional artisan who remains actively engaged in the practice of palanquin-making. With decades of professional experience, the artisan has been deeply involved in local religious culture and folk activities over an extended period. His craftsmanship originates primarily from a family-based apprenticeship system, and his skills have been continuously refined through long-term participation in temple festivals, deity processions, and various folk ritual practices.

The artisan plays a vital role in palanquin construction and restoration within the local community, with his works widely utilized in religious celebrations, wedding ceremonies, and cultural performances. This reflects the adaptability and continued relevance of traditional craftsmanship within contemporary cultural contexts. His production style places particular emphasis on structural integrity and visual cohesion, entirely avoiding the use of modern industrial materials such as screws or adhesives. Instead, construction is carried out exclusively through traditional wooden mortise-and-tenon joinery. Notably, he excels in the sophisticated application of invisible mortise-and-tenon techniques, in which all joints are completely concealed within the palanquin structure. This results in a seamless and unblemished surface, showcasing exceptional structural integration and refined aesthetic sensibility.

Moreover, his profound understanding of material properties and structural mechanics enables him to balance functionality and aesthetics throughout the production process. His work not only fulfils the practical structural demands required for religious rituals but also exemplifies the spirit of traditional craftsmanship. Due to his high level of representativeness and technical maturity, this study selects the artisan and his works as a case for in-depth investigation and documentation, with the aim of concretely presenting the cultural value and knowledge system embodied in contemporary palanquin-making techniques.

Figure 2. Target Palanquin of the Study

2.2 Integration of Ground LiDAR and Photogrammetry

Given that traditional palanquin craftsmanship is largely executed by hand and lacks standardized drawings or structural documentation, the transmission of related techniques and knowledge has historically relied on oral instruction within master-apprentice systems. As a result, there is an absence of systematic recording and visual preservation mechanisms. To address this limitation, this study introduces digital scanning and modeling technologies with the aim of creating three-dimensional digital models that offer both geometric accuracy and visual authenticity, thereby facilitating subsequent technical analysis and cultural preservation (Dahaghin, M. et al., 2024；Barzaghi, S. et al., 2024).

The study first employed a FARO Focus 3D terrestrial laser scanner to perform a complete scan of the palanquin body, capturing high-precision point cloud data of its external structure. Laser scanning is characterized by its non-contact, high-density, and rapid recording capabilities, making it particularly suitable for acquiring geometric data of large wooden structures. Through multi-position scanning and data merging, the method accurately documents the overall form, structural proportions, and spatial dimensions of the palanquin, resulting in a three-dimensional point cloud model with spatial logic. This model serves as foundational data for digital preservation, structural analysis, and subsequent modeling, effectively overcoming the limitations of traditional documentation methods in terms of scale accuracy and structural complexity.

Figure 3. LiDAR Scanned Point Cloud

However, while LiDAR excels in capturing overall form, it is relatively limited in recording detailed components and surface textures—particularly in areas with decorative elements, recessed details, and fine corners, where data density tends to be insufficient.

To enhance the level of visual and geometric detail, the study simultaneously conducted high-resolution digital photography from multiple angles and orientations. The captured images were processed using photogrammetry software such as Reality Capture to generate a visually realistic 3D model. Through image reconstruction and point cloud extraction, photogrammetry effectively restores surface materials, colors, and carved textures, compensating for the limitations of laser scanning in fine-detail representation. This is especially crucial for complex components such as carved panels and column transitions on the palanquin body.

Figure 4. Photogrammetry Point Cloud

However, photogrammetry also faces several challenges, particularly given the large volume and complex structural transitions of traditional palanquins. Limitations in shooting angles, insufficient lighting, or a lack of distinguishable surface features often lead to difficulties in image alignment, resulting in geometric distortions or data loss. These issues are especially prevalent around the lower edges, corners, and interior details of the palanquin, where model gaps, reconstruction failures, and other technical problems commonly occur, thereby affecting the overall accuracy and completeness of the model (Poier, G. et al., 2016).

To overcome the aforementioned issues, this study integrates laser scanning and photogrammetry to construct a complementary data framework that leverages the strengths of both technologies. Laser scanning serves as the geometric foundation for capturing the structural form, providing spatial stability and accurate morphological data, and acts as a reference for correcting errors in photogrammetric outputs. Photogrammetry, in turn, supplements the limitations of laser scanning by enhancing detail acquisition, addressing occluded viewpoints, and capturing surface texture information. Through software-based alignment, point cloud merging, and model repair processes, the study ultimately produces a high-quality 3D model that combines geometric accuracy with visual realism (Levoy M. et al., 2000).

Figure 5. Integrated and Complete 3D Model

The resulting model not only serves as a basis for subsequent sectional analysis, dimensional measurement, and structural logic exploration, but also holds significant potential for cultural exhibition, educational applications, and long-term preservation. Through this digital modeling process, traditional craftsmanship is translated into a manipulable, visualizable, and reusable data asset, helping to transcend the limitations of knowledge transmission confined to master-apprentice experience. This enhances both the accessibility and representability of cultural heritage. The integrated scanning and modeling approach thus provides a precise, effective, and scalable method for documenting and transmitting traditional palanquin craftsmanship.

2.3 Component Disassembly and Digital Reconstruction

Upon completing the initial 3D scanning and modeling, the study proceeded with detailed processing and structural reconstruction based on the point cloud data. First, the high-density point cloud data were imported into AutoCAD for vectorization, converting them into plan and elevation drawings with accurate scale. This enabled the acquisition of precise dimensional information and structural outlines. Compared to traditional manual on-site measurement and drafting, point cloud data offer higher accuracy and completeness, allowing for rapid multi-part and multi-angle measurements without disturbing the original state of the artifact. Measurements can be repeated at any location as needed, significantly improving documentation efficiency and data consistency—particularly advantageous when dealing with craft objects of complex structure and subtle dimensional variations.

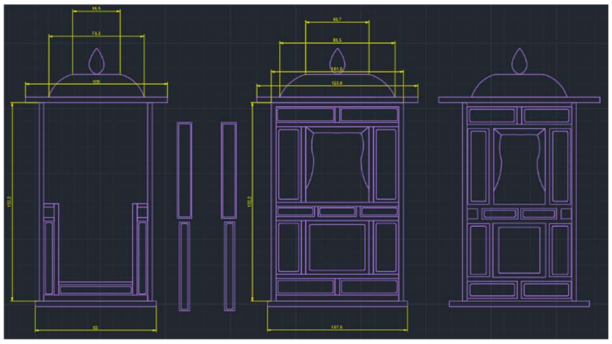

Figure 6. Palanquin Plan View

Through the vectorization process at this stage, the study was able to produce standardized projection drawings, serving as foundational data for subsequent parametric modeling and structural analysis. In the next phase, the Fusion 360 platform was employed for 3D modeling. Based on the scanned data and on-site observations, each component of the palanquin was independently disassembled, categorized, and labeled, with individual parametric component models created accordingly. The model clearly identifies mortise-and-tenon joints, component dimensions, material relationships, and detailed features, resulting in a digital assembly model with coherent structural logic, suitable for simulation and analytical applications. (Giakoumidis, N. et al., 2024)

Unlike traditional approaches that focus solely on the construction of static models, this study emphasizes the reconstruction of the operational logic and technical procedures embedded within traditional craftsmanship. This focus helps to contextualize the geometric data within the cultural and technical thinking that underpins it. Through in-depth interviews with the artisan and direct field observation, the study further analyzes the sequence of operations, component assembly logic, and decision-making principles involved in the production process. The findings reveal that traditional palanquin-making often follows a non-linear workflow characterized by “decoration first, structure later,” which contrasts significantly with the linear sequence in modern engineering practices where “structure precedes decoration.” This order of operations not only reflects the artisan’s strong foresight and integrative capability regarding the overall structure but also demonstrates their ability to balance aesthetic form with mechanical function.

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To enhance the value of this research in craft transmission and visual education, Fusion 360 was also used to create dynamic simulations of the assembly process. Through animation, key steps such as component disassembly, mortise-and-tenon joinery, and structural arrangement are vividly visualized, presenting the complex construction logic and techniques of traditional craftsmanship. Beyond its academic analytical and exhibition functions, this animation can serve as educational material and a resource for cultural dissemination. It helps lower the barrier to understanding and increases the willingness to engage with traditional techniques, transforming a knowledge system once dependent on master-apprentice transmission into one that is shareable and reconstructible.

2.4 Research Process

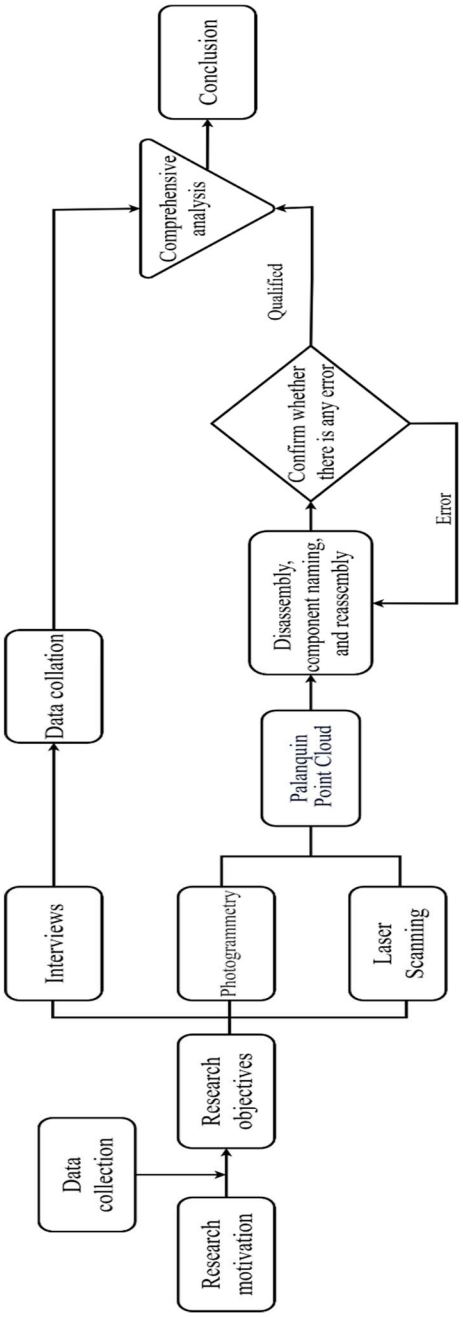

Figure 7. Research Process Flowchart

3. Results and Discussion

3.1 Scale correction and accuracy control

During the validation phase following the construction of the models, this study did not adopt conventional quantitative geometric accuracy analysis as a basis for comparison. This decision was made primarily in consideration of the inherent technical characteristics and limitations of both laser scanning and photogrammetry. While laser scanning provides high-density point clouds and overall geometric stability, it often results in locally insufficient data when dealing with the intricate carvings, recessed features, or highly reflective surfaces of traditional palanquins. These issues are typically caused by constraints related to scanning angles, distance, or lighting conditions, making precise measurement of certain parts difficult. On the other hand, photogrammetry offers advantages in texture representation and visual realism. However, in the absence of external control points or a fixed reference framework, the resulting models are prone to scale distortions and geometric inaccuracies, especially in maintaining overall dimensional consistency.

In light of these considerations, this study adopted a field-based measurement approach to calibrate the scale of the digital models. By physically measuring key structural features of the actual palanquin—such as crossbeam widths and column spacing—as well as fixed architectural elements within the environment, reference dimensions were obtained and compared with corresponding parts in the digital models for alignment and adjustment. This method ensures dimensional accuracy of the models in practical applications. Although it does not constitute a full-scale quantitative error analysis, this selective calibration based on representative features significantly enhances the model’s scale reliability and usability, making it suitable for diverse applications in exhibition, education, and analytical research.

3.2 Palanquin Types and Material Usage

In the case studies observed and discussed through interviews in this research, the methods of palanquin construction vary according to their type, function, and symbolic significance. Traditionally, palanquins can be categorized into three main types based on their attributes and usage: **wedding palanquins**, **civil deity palanquins**, and **martial deity palanquins**. These three types exhibit distinct differences in structural design and craftsmanship.

3.2.1 Wedding Palanquin

The design of wedding palanquins primarily features red as the dominant color, complemented by auspicious patterns, paintings, and gold-leaf carvings. Emphasis is placed on achieving a balance between lightness, stability, and aesthetics. The carving style tends to be delicate and graceful, often incorporating motifs such as flowers and birds, mythical auspicious animals, and symbolic representations of dragons and phoenixes.

3.2.2 Civil Deity Palanquin

Civil deity palanquins are relatively enclosed in structure, emphasizing elegance and solemnity. They are commonly used in processions dedicated to civil deities. The design is refined, with elongated proportions in the components and extensive use of intricate carvings, demonstrating the artisan’s mastery of detail and adherence to traditional aesthetics.

3.2.3 Martial Deity Palanquin
Martial deity palanquins feature a more open structural form, with a bold and weighty overall appearance. The sides are generally uncovered, allowing for wide-ranging movement and display during temple festivals or folk performances. The carvings are more exaggerated and forceful, symbolizing the majesty and strength of martial deities.

In addition to differences in structural form, palanquins also involve meticulous material selection. Different parts are constructed using specific types of wood, chosen based on their load-bearing requirements and suitability for craftsmanship, to ensure both functionality and feasibility of construction.

3.2.4 **Cypress** is commonly used for the frame and base of the palanquin due to its solid and stable wood quality, which effectively supports the overall weight and withstands the stress generated from prolonged use.

3.2.5 **Camphor wood** and **mulberry wood** are frequently employed for carved components; their relatively lightweight and workable texture make them ideal for expressing intricate patterns and decorative elements.

3.2.6 **Beech wood**, known for its high compressive strength and resistance to fracture, is often used for load-bearing components during the carrying process, ensuring structural safety and stability.

In contrast, materials prone to decay or with unstable wood properties are limited to external decorative elements, such as openwork panels or lightweight relief carvings, and are not suitable for use as primary structural materials.

The differences in palanquin types and material choices reflect an integrated approach in traditional craftsmanship that considers practical needs, aesthetic expression, and religious symbolism. In the processes of design and construction, artisans must make informed decisions and adjustments based on material characteristics, usage contexts, and regional styles, demonstrating a deep understanding of structure, materials, and cultural significance. This knowledge system is largely the result of accumulated long-term experience and is manifested in the selection of materials and structural arrangements of the artifact. It provides a critical foundation for this study’s subsequent digital modeling and future structural analysis.

3.3 Traditional Joinery and Structure

In traditional wooden structures, the core joining method lies in the flexible application of mortise-and-tenon techniques, which serve primarily to connect and secure individual components while ensuring both structural stability and aesthetic expression. The **tenon**, as the key element within the mortise-and-tenon system, not only transmits forces and resists shear stress but also embodies the artisan’s ingenuity and technical proficiency in structural design. The selection and design of tenon types are often adjusted based on mechanical requirements, joint angles, and the intended assembly sequence of the components, reflecting a seamless integration of structural function and craftsmanship (Lin C.-Y., 2016).

Common traditional tenon types, such as the exposed square tenon, offer ease of assembly and structural reliability. However, because the tenon remains visible after joining, its grain orientation and surface detailing can disrupt the visual continuity, making it less favourable for achieving cohesive form and ornamentation. As a result, some experienced artisans have, through practical experience, developed more advanced **concealed tenon structures**, allowing joints to be completed without exposing connection marks. This approach maintains both structural stability and the integrity of the external appearance, preserving the visual coherence and purity of the craftsmanship.

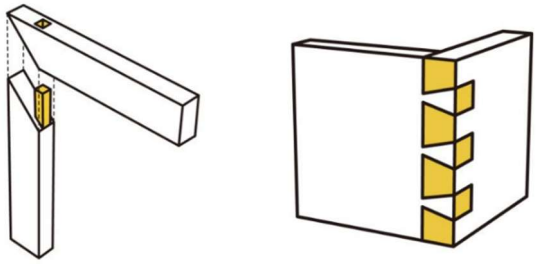

Figure 8. Common Types of Tenon Joints.
(15 Types of Wood Joints, Ichimura Co., Ltd.)

The palanquin construction case observed in this study adopts an “aesthetically integrated” mortise-and-tenon design. Structurally, the joinery serves not only a functional purpose but also expresses a constructive language, reflecting the artisan’s comprehensive mastery of formal aesthetics, structural logic, and traditional craftsmanship. This type of joinery emphasizes the principle of “structure concealed within form,” resulting in an exterior free of visible joint marks, thus achieving both practical utility and aesthetic value. Such an approach offers valuable insights for contemporary craft preservation and digital modeling. This study preliminarily documents and classifies two representative types of tenons as follows:

3.3.1 Half-Tenon Structure: The half-tenon is the most used basic type, primarily applied in orthogonal joints between horizontal and vertical components. In this design, one end is shaped into a tenon that fits into a corresponding mortise, forming a secure connection. The process is straightforward and methodical, effectively enhancing joint strength and maintaining structural stability. The image reveals a tenon with consistent thickness and clean-cut surfaces, demonstrating the artisan’s proficiency in precise dimensional control.

Figure 9. Half-Tenon Joint
(Photograph on the Left, Point Cloud Data on the Right)

3.3.2 Concealed Tenon Structure (Hidden Tenon): The concealed tenon is a groove-type joint hidden within the interior of the components, with the tenon entirely embedded and not exposed on the surface after assembly. This design not only preserves the continuity of the wood grain and decorative elements but also maintains high joint strength without compromising visual integrity. The image shows the refined detailing of the concealed tenon, with tightly fitted contact surfaces, indicating the high level of skill and precision adjustment required in its execution.

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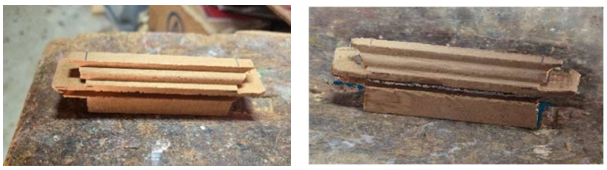

Figure 10. Concealed Tenon Joint
(Photograph on the Left, Point Cloud Data on the Right)

Figure 11. Carving Integrated with Concealed Tenon
(Photograph on the Left, Point Cloud Data on the Right)

The essence of mortise-and-tenon craftsmanship lies in its ability to integrate structure and form; it is not merely a traditional technical vocabulary but also a tangible manifestation of cultural meaning and aesthetic sensibility. The application of such concealed joinery techniques demonstrates the artisan’s capacity to balance material, structure, and beauty. Moreover, it offers valuable guidance for the digital reconstruction and preservation of traditional craftsmanship in contemporary contexts.

3.4 Digitization and Craft Knowledge Representation

Digital models and interactive displays have been proven effective in enhancing user motivation and engagement in the fields of cultural heritage preservation and educational applications (Bruno et al., 2010). In the region where this study was conducted, scholars have also begun integrating 3D modeling technologies with virtual reality for cultural education, demonstrating a solid practical foundation and strong educational potential for such digital approaches (Kuo W.-L, 2020). This study likewise explores the possibilities of applying traditional palanquin craftsmanship in educational outreach and broader social contexts. By employing diverse digital methods for knowledge translation and reconstruction, it aims to develop an operable and scalable digital craft information system.

In terms of digital modeling, this study integrates high-resolution imagery with terrestrial laser scanning technology to successfully reconstruct a complete and highly accurate 3D model. The model faithfully captures the textural details and proportional relationships of the carved components and serves as foundational data for subsequent structural simulation, dimensional analysis, and exhibition applications. Each component was independently modeled and labeled based on actual disassembly logic, with added structural annotations and parametric classifications, thereby enhancing the model’s retrievability and its flexibility for extended educational use.

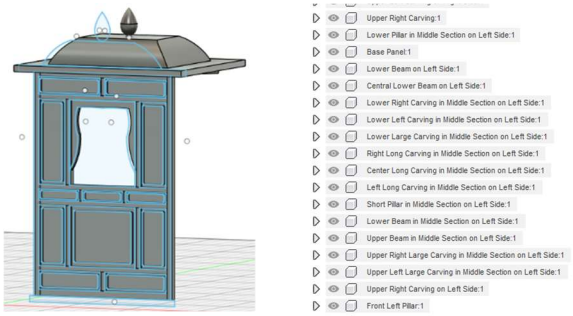

Figure 12. Palanquin Body Modeling and Component Labeling

Furthermore, this study utilized Fusion 360 software to produce animations illustrating the palanquin’s assembly and construction process, thereby visualizing traditional craftsmanship procedures that are typically implicit and difficult to observe. Through modular decomposition and animated presentation, viewers can clearly understand the structural relationships between components, the assembly sequence, and the mortise-and-tenon joinery techniques. This significantly enhances the model’s value in educational and technical transmission contexts, particularly benefiting new-generation learners who may not have the opportunity to observe the process in person.

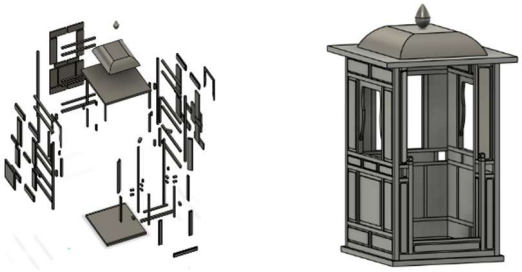

Figure 13. Disassembly and Assembly Process

In addition to the static and dynamic modeling outputs, this study also conducted in-depth interviews to document the accumulated experience and technical insights of a senior artisan. The oral accounts cover topics such as component arrangement logic, material selection principles, mortise-and-tenon design thinking, and craft philosophy, resulting in a historically and intellectually valuable set of interview materials that provide a rich foundation for the future development of a craft knowledge database.

Building on these outcomes, the study preliminarily integrates the collected digital models, animation resources, and interview data to construct a prototype digital archive with a categorized structure and interactive browsing interface. The contents of this archive include 3D component models, animated construction workflows, and annotated structural diagrams. This resource can be widely applied in craft education, cultural exhibitions, research analysis, and digital preservation, thereby realizing the core objectives of digital translation and cultural revitalization of traditional craftsmanship.

However, the study also faces certain limitations. First, laser scanning and modeling require specific site conditions and equipment specifications; some components could not be fully reconstructed due to occlusion, surface wear, or lighting interference. Second, palanquin-making techniques are highly dependent on personal experience and intuitive craftsmanship, and different artisans may exhibit significant variation in process arrangement and tenon design. Thus, while the selected case is representative, it cannot fully encompass the entire spectrum of traditional craftsmanship.

3.5 Future Applications and Research Outlook

This study has preliminarily demonstrated the diverse potential of digital technologies in the preservation, educational promotion, and cultural interpretation of traditional craftsmanship. Through the digital translation of 3D modeling, process animation, and artisan interviews, traditional craft knowledge has been systematically organized and transformed into visual and operable learning resources. However, in addressing the long-term goals of revitalizing and transmitting cultural heritage,

several areas of development remain open for further exploration and enhancement.

3.5.1 Expanding the Scope of Future Research

Incorporating artisans from different regions, stylistic traditions, or technical lineages for comparative analysis can help construct a more representative and diverse craft knowledge system. Cross-regional and cross-school comparative studies facilitate the identification of shared structural patterns and localized characteristics within traditional craftsmanship, thereby enriching cultural interpretation and broadening research perspectives.

3.5.2 Digital Applications Offer High Scalability

If immersive technologies such as AR (Augmented Reality), VR (Virtual Reality), and haptic feedback can be further integrated, they would significantly enhance the sense of presence and interactivity in cultural exhibitions and learning platforms, thereby increasing users’ understanding of and engagement with traditional craftsmanship. Future developments may also explore integration with digital museums and cultural exhibition systems, expanding practical applications in education, tourism, and interdisciplinary fields (Bekele, M. K. et al., 2018; Chang S.-K.et al., 2013).

3.5.3 Visualization of Tacit Knowledge

By integrating additional measurement and recording tools, it is possible to more precisely document the artisan’s hand movements, applied forces, and rhythm variations during the crafting process. This enables the transformation of traditional tacit knowledge into quantifiable and analysable visual data, thereby enriching both the dimensionality and depth of craft knowledge preservation and representation.

3.5.4 Dynamic Analysis

Within the classification of palanquins, the martial palanquin type exhibits pronounced dynamic characteristics and mechanical loading during processions and ritual performances. The interaction between its structure and function presents numerous aspects worthy of deeper investigation. Future research may employ 3D models in conjunction with simulation software to analyse the stresses, shifts in center of gravity, and component displacements experienced during actual use. Such analysis would further illuminate the craft intelligence and safety logic embedded within traditional structural design.

Overall, the digital preservation of traditional craftsmanship should not be limited to static reconstruction, but should progress toward the systematization of knowledge, diversification of applications, and socialization of transmission. If future efforts continue to integrate technological, humanistic, and educational resources across disciplines, it will be possible to establish a more comprehensive and sustainable model for the preservation and revitalization of cultural heritage. Such a model would address current challenges of skill discontinuity and knowledge loss, enabling the regeneration and continuation of traditional craftsmanship within contemporary society.

4. Conclusions

The safeguarding of traditional craftsmanship requires attention not only to the physical object (tangible heritage) but also to the perpetuation of the embedded knowledge and skills (intangible heritage). Through the integration of multiple digital techniques—including scanning, parametric modeling, process animation, and artisan interviews—this study successfully developed a digital documentation and knowledge translation system for traditional palanquin craftsmanship. It demonstrates the preliminary feasibility of preserving, representing, and reapplying traditional crafts within a digital environment. The findings show that combining high-precision point cloud modeling with modular component analysis can effectively reveal the underlying structural logic and technical configurations of traditional craftsmanship.

In addition, the documentation of artisan experience and the deconstruction of techniques underscore the importance of "knowledge systems" and "cultural context" in the preservation of intangible cultural heritage. Traditional craftsmanship is not merely an accumulation of technical practices, but a cultural expression that embodies communal values, religious practices, and aesthetic ideals. By converting experiential knowledge into structured and visualized digital content, this approach helps build an intergenerationally accessible and transferable craft knowledge framework, laying a foundation for future research and educational outreach.

Overall, the results of this study suggest that digital technology serves not only as a tool for preserving traditional craftsmanship but also as a new medium for knowledge reconstruction and cultural dissemination. Further development in data integration, expansion of craft types, and incorporation of immersive interactive technologies will enhance the activation and sustainable transmission of craft culture. This research provides a concrete case study for the preservation of palanquin craftsmanship and offers a methodological reference for the digital translation of traditional crafts, with scalability and interdisciplinary application potential.

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