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Article

The Creation of 3D Modular Furniture Design Inspired by the Arts on Beam of Huizhou Architecture

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Abstract: In the global design trend, integrating traditional aesthetics into modern design to achieve innovative transformation is an urgent need. Huizhou architecture, as a world cultural heritage, its beam art combines mechanics and aesthetics and has distinct regional characteristics. Modular furniture design, with its flexibility and adaptability, has become the key to addressing modern space demands. This research aims to analyze the beam artistic features of Huizhou architecture and creatively transform them into 3D modular furniture designs. Through literature analysis, field investigations, and expert interviews, the core characteristics of Huizhou beams in components, mortise and tenon combinations, and decorations were systematically examined. Subsequently, the research proposed a design path of "form extraction - element deconstruction - modern translation - module reorganization", completing the design of 4 modular units and the 3D conceptual display of 6 spatial combination forms. The results of a questionnaire survey conducted by professional designers showed that the design achieved a satisfaction rate of 93.2% in cultural inheritance and 93.2% in industrialization potential. The high recognition of the design successfully explored an innovative path for the contemporary dynamic inheritance of traditional architectural culture.

Keywords: Huizhou architecture; beam art; modular furniture; Hui style furniture; 3D design

1. Introduction

In the current globalized design context, how to combine excellent traditional culture with contemporary expression methods to achieve creative transformation and innovative development has become an important issue in the design field. "Chinese-style modernization is a modernization that integrates material civilization and spiritual civilization," highlighting the need to integrate excellent traditional culture across multiple fields and elevating its importance to an unprecedented level.

Integrating excellent traditional culture into modern art design has been identified as an important pathway for achieving creative transformation and innovative development [1]. Huizhou architecture, as a significant school of traditional Chinese architecture, is widely recognized for its construction wisdom and artistic achievements, particularly its refined beam structures and mortise-and-tenon craftsmanship, which embody the philosophical concept of harmony between humans and nature [2].

With the diversification of lifestyles, people's demands for furniture have gradually shifted from purely functional needs to a dual pursuit of functionality and cultural expression [3]. As a result, modular furniture-characterized by functional diversity, flexible combinations, and strong spatial adaptability-has become an important option in

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modern space design. However, current modular furniture design exhibits a high degree of homogeneity and lacks cultural depth, making the integration of regional traditional architectural culture an effective approach to addressing these issues [4,5].

Existing studies mainly focus either on the overall characteristics of Huizhou architecture or on the functional aspects of modular furniture design, while research on the deep integration of Huizhou beam art with 3D modular furniture remains insufficient.

This study takes the beam art of Huizhou architecture as its primary source of inspiration and focuses on the modular furniture design of public spaces. Through a systematic analysis of the core characteristics of Huizhou beam art, it explores translation methods and application pathways for its integration into modern modular furniture design. Digital modeling tools such as SketchUp are utilized to support conceptual design and virtual assembly processes [6]. Furthermore, expert interviews and questionnaire surveys are conducted to optimize the design, ultimately achieving a 3D modular furniture system that integrates Huizhou cultural connotations, modern functional requirements, and market applicability [7,8]. This research provides both theoretical insights and practical references for the modern transformation of traditional architectural culture and the innovative development of modular furniture design.

2. Research Objective and Methodology

2.1. Objective

1.To Study and analysis of the artistic characteristics of the beams of Huizhou architecture

2.To Creation 3D Modular Furniture Design Inspired by The Arts On Beam Of Huizhou architecture

2.2. Methodology

This research takes the architectural beam art of Huizhou as the cultural core, focusing on the 3D modular furniture design creation based on the artistic features of this art. It comprehensively employs methods such as literature research, field investigation, expert interviews, questionnaire surveys, and digital modeling. Through the research logic of "theoretical review - empirical analysis - design transformation - effect verification", it systematically analyzes the artistic features of Huizhou architectural beam art and explores the innovative translation paths of this art in modern modular furniture design. This ensures the scientificity, rigor, and practical guidance of the research process, and ultimately completes the conceptual design and three-dimensional presentation of modular furniture that combines Huizhou cultural connotations with modern functional requirements.

2.3. Research Methods for the Artistic Characteristics of Liang Structures in Huizhou Architecture

2.3.1. Research Content

This study takes the artistic features of the beams in Huizhou-style architecture as the starting point, systematically examines its historical origin and cultural connotation. It focuses on three aspects for research: on the components, it concentrates on the morphological characteristics of typical beam components such as "moon beams" and "spar brackets" in traditional wooden structures, and extracts them as the basic elements for modular design; in the combination method, it deeply studies the connection technology of mortise and tenon structure, and through improvement, makes it applicable for the flexible and stable combination of modular elements; in the decorative art, it explores the themes and techniques of beam carving, and converts these artistic techniques such as relief and hollow relief into applications in furniture component design, making modular products have both structural functions and Huizhou-style artistic characteristics.

2.3.2. Research Area

This study selects Huangshan City, Anhui Province, and Anhui Provincial Museum as the core research areas.

2.3.3. Key Informants: A total of 6 experts were selected as key informants, and they were divided into two groups based on their roles

Interview Experts (3 people): including 1 expert in Huizhou-style architecture (with over 20 years of experience in ancient architecture research), 1 expert in cultural arts (with over 15 years of experience in traditional culture research), and 1 expert in furniture design (who has been engaged in furniture design research for a long time). Their main task is to clarify the direction of modern transformation of Huizhou-style architectural beam art based on modular furniture.

IOC Verification Experts (3 people): including 1 Chinese expert (a professor from the field of art design) and 2 Thai experts (professors from Chakrabongse Bhuvanarth International College of Interdisciplinary Studies, Rajamangala University of Technology Tawanok). Their main task is to evaluate the content validity of the interview outline and design proposal assessment tools.

2.3.4. Research Tools

This study adopts the semi-structured interview method, aiming to deeply explore the feasibility and innovative paths of cultural translation of the beam art in Huizhou-style architecture in modular furniture design. Five core questions were set based on the research objectives, and three experts in related fields were invited to conduct a project goal consistency analysis (IOC). According to the experts' opinions, the interview content was adjusted, and the IOC index was calculated as 0.93, indicating that the interview outline has a high content validity and the research objectives are highly consistent with the questionnaire design. By leveraging the advantages of the interview method to deeply explore professional experience, targeted suggestions and practical guidance for subsequent ecological design were provided.

2.3.5. Data Collection

(1) Literature Review and Field Investigation

The literature collection covered themes such as Huizhou-style architecture, beam art, cultural art, and modular furniture design, clarifying the research context of Huizhou-style beam art and the design methods of modular furniture, providing a theoretical basis for this study. The core research area was the Huangshan City's Yi County's Hong Village and Pingshan Village, with field investigations conducted to measure, photograph, and analyze the beam components, mortise and tenon structures, and carving decorations of the Ming and Qing Huizhou-style buildings, obtaining first-hand empirical data to verify and supplement the conclusions of the literature research.

(2) Expert Interviews

Researchers conducted semi-structured face-to-face interviews with experts in Huizhou-style architecture, cultural art, and furniture design through targeted invitations. In the early stage, they contacted the target experts through phone calls and industry recommendations, clearly stating the research purpose and content framework to obtain participation authorization; during the interviews, professional opinions were collected regarding the decorative art features of Huizhou-style architecture and the design viewpoints of modularization. Later, the thematic analysis method was used to sort out the interview data, converting the expert suggestions into the basis for design idea adjustments, and ultimately forming a Huizhou-style modular furniture design scheme that integrates academic consensus and practical orientation.

2.3.6. Data Analysis

(1) Literature Review and Field Investigation

This study aims to combine the Huizhou-style beam art in Chinese ancient architecture with modern modular furniture design through innovative design, exploring new paths for cultural inheritance and modern design, with the goal of protecting intangible cultural heritage. To achieve this goal, researchers extensively referred to doctoral theses, design books, journals, and related publications, and participated in multiple furniture design exhibitions for on-site investigation and learning, gradually constructing a design framework for the integration of Huizhou-style architectural structural beam art and modular furniture.

(2) Expert Interviews

To accurately grasp the integration points of Huizhou-style beam art and modular furniture design, researchers conducted semi-structured interviews with experts in Huizhou-style architecture and cultural art, as well as senior furniture design directors, collecting professional opinions on core issues such as the modern translation of traditional elements, the adaptation of mortise and tenon techniques to mass production, and the balance of cultural connotation and functionality. By transcribing the interview recordings word-for-word into text, using qualitative analysis methods for coding, classification, and correlation analysis, the core design directions of Huizhou elements' lightweight translation, standardized improvement of mortise and tenon structures, and the synergy of function and aesthetics were systematically sorted out. Based on the above professional consensus, the NVivo software was used for qualitative analysis of the interview texts, effectively integrating the research results into subsequent optimization design, ensuring that the scheme has both academic depth and practical feasibility.

2.4. Research Methods for Huizhou Modular Furniture Design

2.4.1. Design Scope

The 3D concept display research on Huizhou modular furniture design focuses on public space furniture design. By systematically transforming the structural framework and decorative elements of Huizhou architecture, a scientific design system is constructed to ensure structural stability and develop a freely combinable module system to meet the diverse needs of modern public spaces. The research explores design strategies from three dimensions: extracting typical component forms such as "moon beams" and "sparings" from model elements, transforming decorative shapes into carving techniques, and improving the jointing process of mortise and tenon; completing the morphological evolution from architectural elements to furniture modules through hand-drawn sketches, making them functional and featuring the regional characteristics of Huizhou; using digital modeling technology for 3D concept display and completing the design of 4 module units using SketchUp program, including basic components and special components, achieving 6 free combination forms, forming a complete Huizhou modular furniture design system. This research not only provides an innovative paradigm for the modern translation of traditional architectural culture, but also explores a design methodology that balances cultural inheritance and functional innovation, having significant practical guiding significance for the contemporary application of traditional craftsmanship.

2.4.2. Overall and Samples

1) The research subjects are design personnel engaged in space design and furniture design in Anhui Province.

2) To ensure the structural rationality and adaptability of modular furniture design to the usage space, the research team conducted a structured questionnaire survey among 32 professionals engaged in related design fields, including 12 interior designers and 20 furniture designers.

2.4.3. Research Tools

After determining the questionnaire content, the research invited three experts to conduct a project goal consistency index (IOC) analysis to ensure the validity of the questionnaire and its consistency with the research objectives. The questionnaire adopts a quantitative analysis method, with precise, concise, and easy-to-understand language, avoiding the use of professional terms or complex sentence structures, ensuring that respondents from different backgrounds can easily understand. This structured design not only enhances the respondents' participation but also enhances the accuracy of data collection. After adopting expert feedback, the questionnaire was further optimized and adjusted to ensure a reasonable structure and clear content. Before the interview, the IOC index was also used to test the validity of the interview outline, with an IOC value of 0.92, indicating that the interview content has high validity.

2.4.4. Data Collection

1) Design Process

In the data collection stage of this research, the systematic design was carried out in three phases: "strategy construction - form transformation - technical verification". At the design strategy level, based on the systematic review of the artistic features of Huizhou architectural beams, a transformation framework was constructed from three dimensions: model elements, decorative forms, and combination methods, clearly extracting typical components such as "moon beams" and "sparings", using mortise and tenon technology as the connection foundation, and taking carving techniques as the decorative source to ensure subsequent design has a basis. In the sketch transformation stage, the morphological evolution from architectural components to furniture modules was completed through hand-drawn deduction, repeatedly comparing the balance between functional adaptability and cultural identification of each component, forming a basic shape library with regional characteristics and modular potential. In the 3D modeling and virtual combination stage, using digital modeling tools such as SketchUp, the sketch schemes were transformed into 3D digital models and the splicing methods between different modules were simulated, through virtual combination to verify their feasibility in structural connection and morphological diversity, ultimately forming a complete design database including 4 module units and 6 combination forms. This process gradually transforms traditional architectural elements into quantifiable and combinable digital design resources, laying a data foundation for subsequent physical production.

2) Satisfaction Survey

This study conducted visits to design companies and presented the sketches of Huizhou modular furniture designs to interior and furniture design professionals. A questionnaire survey was carried out to explore the feasibility of the designs. The survey was conducted using the Questionnaire Star platform and a collection period was set to quickly and efficiently quantify the sample data and test the design opinions and preferences of the professional group. Before the survey, the purpose of the study, the principle of anonymity, and the use of the data were explained to the respondents to ensure the authenticity and objectivity of the results. By presenting the design sketches and explaining the source of the ideas, the respondents were fully able to understand the design concept. The assessment scale was set up with 6 specific questions and 2 overall evaluations in three dimensions: "Theoretical basis and innovation", "Function and practicality", and "Cultural inheritance and market value". Each question had three options: "Suitable", "Uncertain", and "Not suitable" for the respondents to choose. Based on the survey data, a comprehensive assessment of the design drawings was completed from multiple perspectives, providing empirical evidence for subsequent design optimization.

2.4.5. Data Analysis

In the early stage of the scheme design, a structured questionnaire survey was conducted among 32 professionals in the fields of interior design, furniture design, and ancient architecture research. The professional opinions on the modern translation of Huizhou elements, the functional requirements of modularization, and cultural expression were systematically collected. Key design elements were extracted through cluster analysis, and multiple rounds of iterative optimization were carried out based on expert feedback. Finally, a modular furniture design scheme with cultural inheritance value and market feasibility was formed, effectively ensuring the professionalism and innovation of the design results.

This study systematically deconstructed the typical characteristics of Huizhou beam art, such as decorative themes, carving patterns, and mortise and tenon techniques, based on multi-dimensional data including literature research, field investigations, and expert questionnaires. Through the design transformation path of "Form extraction - Element decomposition - Modern translation - Modular recombination", traditional architectural vocabulary was innovatively integrated with the standardized and combinable requirements of modern furniture, and a three-dimensional model presentation was completed using digital means to explore the modular furniture design method that carries traditional cultural connotations and is in line with contemporary lifestyles.

3. Results

3.1. Research on the Artistic Characteristics of Liang Structures in Huizhou Architecture

3.1.1. Analysis of the Core Artistic Features of Liang Structures in Huizhou Architecture



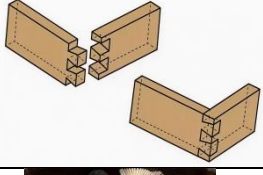

Through literature analysis and field research, combined with the conclusions of expert interviews, the three core characteristics of the architectural beam art of Huizhou architecture were systematically summarized, providing core cultural materials and design basis for modular furniture design.

In terms of components, the new crescent-shaped curve of "Moon Beam" and the triangular contour of "Corner insert" are the most representative, combining mechanical adaptability and aesthetic recognition, and are the most valuable visual symbols for translation.

In terms of combination, the "mortise and tenon" structure is the core connection method, achieving stable connection of components through "yin-yang fitting, no nails or glue", and the standardized mortise and tenon technique formed during the Ming and Qing dynasties provides direct reference for modern modular interface design. Its self-locking property, disassemblability and compatibility with the combination requirements of modular furniture are highly consistent.

In terms of decoration, it forms distinct characteristics such as "subject matter auspiciousness, lightweight craftsmanship, and natural colors". The subject matter mainly includes auspicious patterns such as "peacocks on plum blossoms", "cranes and deer together", "hundred children celebrating the Lantern Festival", etc., and carries clan ethics and beautiful wishes; the craftsmanship mainly uses shallow relief as the core, supplemented by relief carving, line engraving and other techniques, balancing decoration and structural safety, the colors mainly use the original color of wood, with local use of cinnabar and stone blue mineral pigments, highlighting natural texture and achieving the organic unity of function and aesthetics Table 1.

Table 1. The core artistic feature of the beam structure in Huizhou architecture.

No.	Dimension	Element	Feature	Icon
1	Component type	Moon Beam	New crescent-shaped curve	
		Que Ti	Triangular shape outline	
2	Combination method	Mortise and tenon connection	No nails, no glue, interlocking on both sides	
3	Component decoration	Subject matter	Orientalization	
		Technology	Lightweighting	
		Color	Naturalization	

The architectural frame art of Huizhou style is centered around the concepts of "synergy between structure and decoration, and integration of region and culture", and it is the core feature of Huizhou architecture and an important carrier of Huizhou culture. Its design combines mechanical adaptability and aesthetic recognition; the combination is repairable; the decorative expression presents the characteristics of auspiciousness and simplicity; its cultural connotation is profound. It not only embodies the collective wisdom of Huizhou craftsmen, integrates mechanical principles and artistic aesthetics, achieving the organic unity of function and aesthetics, but also carries the clan culture and the spirit of Huizhou merchants - the decorative themes of the frame convey Confucian ethical concepts and the wish for the prosperity of the clan, while the exquisite craftsmanship and simple decoration of the frame not only demonstrate the social psychology of Huizhou merchants as "wealthy and prominent", but also continue the simple and restrained aesthetic pursuit of Huizhou people.

3.1.2. Interview Results

Given the interdisciplinary nature of this research project, three experts specializing in traditional Chinese architecture, cultural arts, and furniture design were invited to conduct interviews. The selected interviewees represented different professional fields, and the information they provided was of extremely high professional value, offering valuable suggestions for the further design of modular furniture in the Huizhou and clarifying the methods and directions for the modern translation of traditional culture Table 2.

Table 2. Keyword Extraction from Expert Interviews.

Expert	Expert 1	Expert 2	Expert 3
Word cloud chart			
Key words	Huizhou, modularization, Traditional, furniture design, modern reinterpretation of traditional elements	Modularization, Huizhou beam structure, traditional culture, mortise and tenon structure, decorative aesthetics	elements, modular furniture, beam art, traditional aesthetics, modern design, Huizhou

The text analysis based on expert interviews reveals that all three experts unanimously recognize the core inspirational value of the architectural beam art of the Huizhou style for modular furniture design: At the component form level, the hierarchical combination logic of the beam is highly consistent with the modular design concept, and can directly guide the division of modules and the assembly structure; At the decorative imagery level, the Eastern aesthetic elements such as wood carvings, lines, and textures help enhance the cultural recognition of the product, achieving a deep integration of function and aesthetics. Regarding the transformation of the mortise and tenon technique, the experts' consensus is to retain the essence of the interlocking nature, through parametric design to form standardized interfaces, to extract symbols instead of full replication, and integrate ergonomics and modern living habits to achieve a balance between the essence of traditional craftsmanship and large-scale production. Each expert has their own focus: Expert 1 and 2 emphasize the overall cultural value of the beam art structure and aesthetics, while Expert 3 highlights the transformation potential of the line rhythm and the market differentiation value.

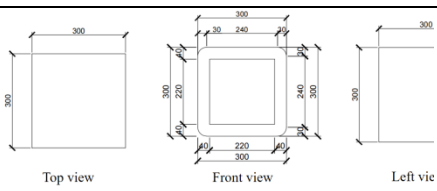
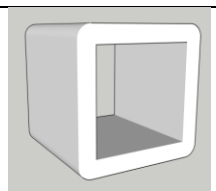
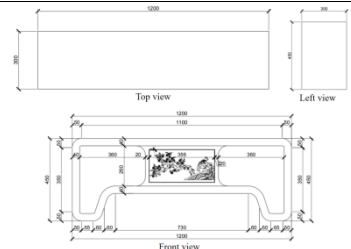
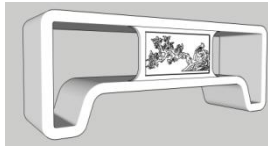
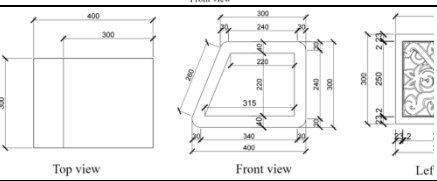
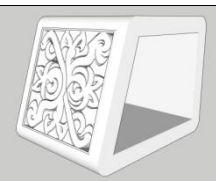
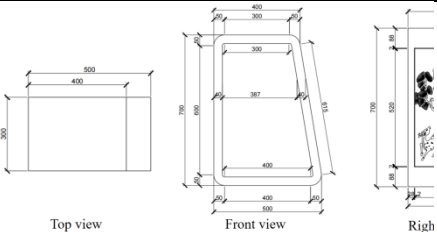
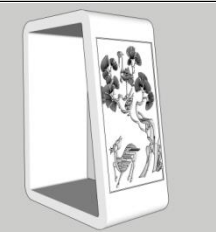
In the subsequent research, expert opinions will be integrated, the literature and field data will be systematically sorted out, typical features such as component form, combination method, and decorative patterns will be extracted, and in-depth exploration of the compatibility between design and modern spaces will be conducted, thereby formulating scientific and reasonable strategies for Huizhou-style modular furniture design.

3.2. Modular Furniture Design of Huizhou Style

3.2.1. Design and Virtual Combination of Huizhou Modular Units

Based on the artistic features of the beams in Huizhou architecture, combined with the modular design concept and expert interview suggestions, four design strategies were formulated: "extracting component shapes, improving combination structures, lightening decorative patterns, and adapting modular furniture scenes to the environment". These strategies aim to achieve an organic integration of traditional elements and modern design. A design path of "element extraction - modern translation - modular recombination" was established, and the design of 1 basic unit (J1) and 3 special units (T1, T2, T3) was completed. All units adopt standardized mortise and tenon interfaces to ensure the flexibility and compatibility of the combination. The size design strictly follows ergonomics and is adapted to the usage requirements of public spaces Table 3.

Table 3. Modular furniture unit parameters.

Module Unit	Unit Number	Dimensions/mm	Three-view Diagram/mm	3D Model Diagram
Basic unit	J1	L:300 W:300 H:300		
				
Special unit	T2	TL:300 BL:400 W:300 H:300		
				

In the modular furniture design of the Hui style, the curve of the moon beam was transformed into the contour of the seat surface, the shape of the purlin was expanded into a framework structure, the Y-shaped dovetail joint was improved to a standardized interface, and simplified decorative patterns were applied. Finally, in the SketchUp software, each independent module was virtually assembled and combined. According to different space layouts and usage requirements, 3D concept displays of 6 spatial combination forms (such as seating series, storage series, and integrated seating-storage series) were completed. It can adapt to the compact layout of small apartments and also meet the partition display needs of large spaces. Ultimately, the multi-functionality and space adaptability of the Hui style modular furniture were realized, while balancing traditional aesthetics and modern practical value.

This research focuses on the core logic of "structure is aesthetics" in Huizhou architecture, designing modular seating combinations of various forms. The core seating is modeled after the new moon shape of the "moon beam", simplified to create a rounded seat surface and shaped supporting legs, and the connection points adopt a simplified visual mortise and tenon structure. The auxiliary seating takes the triangular contour of the "bird finial" as the design basis, and is designed as a single-person stool that can be assembled. The stool surface is restored with shallow lines to recreate the scroll pattern. The combination methods are flexible and diverse. They can be horizontally connected through mortise and tenon interfaces to form long seating areas, or can be disassembled and combined with side tables to form an independent space. The overall design retains the original wood color, and achieves the unity of cultural recognition and spatial adaptability through the design language of "simple form, profound spirit" (Figure 1).



Figure 1. Seating series concept display diagram.

This research draws inspiration from the "coexistence of structure and decoration" in Huizhou architecture and designs a layered modular storage combination suitable for public bookstores. The main unit extracts the horizontal load-bearing logic of "moon beams" to form standardized shelf modules, meeting the storage needs for heavy objects; the cabinet body presents the pattern "magpies on a plum tree" through shallow relief, and the pattern's direction echoes the arc of the shelf, achieving the unity of cultural connotation and visual simplicity. The combination method is flexible and can be adjusted by vertical stacking or horizontal extension to fit the space. The spacing between the shelves can be adjusted through multiple levels of mortise and tenon interfaces, adapting to different size items. Some modules incorporate simplified grass scroll patterns, achieving quick assembly through standardized mortise and tenon connections; local relief carving techniques create hollow light and shadow, enhancing the transparency of the space. The overall design focuses on "lightweight translation", integrating the wisdom of Huizhou architecture structure and decorative symbols into the modular system, meeting the large-capacity storage and flexible layout requirements of public bookstores, and giving furniture regional cultural recognition, breaking the homogeneity dilemma of modular storage (Figure 2).



Figure 2. Storage series concept display diagram.

This study draws inspiration from the "moon beams" and "sparrows' tails" of Huizhou architecture to design a modular combination of seating and storage. The seating unit features a simplified curve of the moon beam as the seat surface, combined with an improved dovetail joint interface. It can be horizontally connected to form a seating bench or vertically expanded for storage. The storage module extracts the trapezoidal contour of the sparrow tail and transforms it into a cabinet and shelves. The door panels are embedded with "crane and deer together in spring" and scroll patterns relief. The light and shadow interact with the curves of the seating to achieve a balance of hardness and softness. The overall color remains the original wood tone, and the interfaces reveal the mortise and tenon structure. Through the flexible combination of "seating and storage

integration", it meets the storage and communication needs of public spaces and realizes the natural integration of traditional culture and modern functions (Figure 3).



Figure 3. Seat Storage Series concept display diagram.

3.2.2. Verification Results of the Design Scheme Satisfaction of 3D Modular Furniture Design Inspired by The Arts on Beam of Huizhou architecture

Through a questionnaire survey of 32 professional designers, a comprehensive verification of the design scheme was conducted. The results showed that the scheme was highly recognized in all dimensions, with an average Likert scale score of 4.60 and a satisfaction rate of 91.93%. Among the three indicators, "The design embodies the cultural connotation of Huizhou style", "The research results have the potential for industrial application", and "The beam structure of Huizhou-style architecture can provide effective structural reference for modular furniture" received the highest scores, with satisfaction rates of 93.2% each. The respondents covered core fields such as furniture design and interior design, and their feedback fully proved that the design scheme successfully translated the Huizhou cultural genes effectively, gained recognition in the professional field, and demonstrated a promising market prospect, laying a solid foundation for subsequent industrialization implementation (Table 4).

Table 4. Survey results on the satisfaction of design professionals.

Evaluation Indicators	Likert Scale Score (5 full score)	Satisfaction Score (Percent)
The beam structure of Huizhou-style architecture can provide effective structural references for modular furniture.	4.66	93.20
The "structure-decorative-function" three-module division method proposed in the research is reasonable.	4.66	93.20
The joint design of mortise and tenon can ensure the stability of the furniture.	4.63	92.60
The spatial arrangement method of transforming wooden framework into furniture is feasible.	4.53	90.60
The modular furniture design of Huizhou style embodies the cultural connotations of Huizhou culture.	4.66	93.20
The modular furniture design of Huizhou style effectively transforms traditional culture into a modern form.	4.56	91.20
The modular furniture design of Huizhou style meets the modern market demands.	4.41	88.20
The research results have the potential for industrial application.	4.66	93.20
Average	4.60	91.93

4. Conclusion and Future Work

4.1. Conclusion

4.1.1. Artistic Characteristics of the Beam Structures in Huizhou Architecture

This study systematically summarizes three core characteristics of beam structures in Huizhou architecture through literature review, field investigation, and expert interviews. In terms of the component system, representative elements such as the moon beam, winter melon beam, and swallow fin demonstrate both mechanical adaptability and strong aesthetic identity. In terms of combination methods, the mortise-and-tenon structure serves as the core connection logic, while the standardized construction practices of the Ming and Qing dynasties provide an important foundation for modern transformation. In terms of decorative expression, the themes are predominantly auspicious, the craftsmanship is lightweight, and the colors are natural, collectively achieving a unity of function and aesthetics.

4.1.2. Creation of Modular Furniture Works Based on Huizhou Architecture Artistic Characteristics

Based on the artistic characteristics of Huizhou beam structures, this study constructs a design pathway of "element extraction-modern translation-module recombination" and completes the conceptual design and three-dimensional presentation of Huizhou modular furniture. Traditional elements such as the moon beam curve, swallow fin form, and dovetail mortise are lightweight-translated and integrated into furniture structures and interface systems, while classic decorative patterns are refined and applied to local module components using simplified craftsmanship. A modular system consisting of one basic unit and three special units is developed, enabling flexible combinations into six spatial configurations suitable for diverse public scenarios. Questionnaire results indicate an overall satisfaction score of 90.8, with key indicators such as industrial applicability and cultural connotation recognition exceeding 92%, thereby verifying the comprehensive value of the design and effectively addressing the issue of homogeneity in modular furniture.

4.2. Discussion

This study conducts systematic research centered on two core objectives: analyzing the artistic characteristics of Huizhou beam structures and designing a three-dimensional model of Huizhou modular furniture. It achieves both a structured deconstruction of traditional architectural features and their innovative integration with modern modular design.

4.2.1. Discussion on the Artistic Characteristics of the Beam Bodies in Huizhou Architecture

This study systematically examines the core characteristics of Huizhou beam structures from three dimensions: component systems, combination methods, and decorative expression, and verifies their validity through a combination of existing research and field investigation. In terms of the component system, elements such as beam bodies and swallow-tail forms exhibit both structural adaptability and aesthetic distinctiveness. In terms of combination methods, the mortise-and-tenon structure functions as the central connection logic, demonstrating ecological advantages such as seismic resistance and repairability, which are supported by both prior research and field observations. In terms of decorative expression, the design reflects auspicious symbolism and simplicity, representing the integration of clan culture, commercial aesthetics, and traditional carving techniques, as evidenced by existing studies and practical cases.

Overall, the artistic characteristics of Huizhou beam structures are the result of multiple interacting factors. The conclusions of this study are both systematic and reliable,

and further clarify the transformation dimensions of these characteristics, thereby addressing gaps in their modern application.

4.2.2. Discussion on the Research Results of Huizhou Modular Furniture Design

Based on the artistic characteristics of Huizhou beam structures, this study develops a modular furniture design approach grounded in modular design theory. By incorporating the concept of "integrated structure and decoration" and adhering to the principle of "form simplicity with spirit preservation," the study integrates beam elements, mortise-and-tenon logic, and decorative symbol systems throughout the design process. Furthermore, building on the concept of structural standardization in mortise-and-tenon systems, a "3D lightweight translation method of shape, structure, and meaning" is proposed, leading to the construction of a modular system composed of one basic unit and three special units.

The design focuses on three key functional positions and simulates six combinational configurations to accommodate diverse public scenarios. It not only continues the ecological philosophy of harmony between humans and nature but also meets the functional requirements of modern spaces. At the same time, it provides a practical pathway for the modern transformation of traditional architectural culture and fills an existing gap in research on the contemporary application of Huizhou beam art.

4.3. Future Outlook

Based on the findings and limitations of this study, future research will focus on the following directions to promote deeper integration and industrial implementation of Huizhou architectural culture and modular furniture design:

Design optimization and physical prototyping: Building on existing digital models, customized modules will be developed to address specific needs in public spaces. Physical prototypes will be produced, and the dimensions and mortise-and-tenon interface structures will be optimized through mechanical testing and real-world usage evaluation to enhance durability and practicality.

Industrial implementation and market promotion: A phased industrialization strategy will be adopted. In the initial stage, collaboration with furniture enterprises and cultural tourism sites will be pursued to develop pilot products and establish demonstration cases. In the intermediate stage, standardized production processes will be developed, module interface compatibility will be improved, and production costs will be reduced. In the later stage, collaboration with Huizhou architectural conservation institutions will support brand development, strengthen market education, and enhance consumer acceptance of culturally integrated products.

Adaptation to private spaces and integration with intelligent technologies: The research scope will be expanded from public spaces to private residential environments, with the development of smaller and more personalized modular combinations. Additionally, the integration of smart technologies-such as embedded sensors, wireless charging, and intelligent lighting-will be explored to enhance functionality and user experience.

Comparative studies on cross-regional architectural culture translation: The methodological framework of this study will be extended to other regional architectural traditions, such as Jiangnan residences and Jin-style architecture. This will enrich the theoretical system for translating traditional architectural culture into modern design and further promote the creative transformation and innovative development of diverse regional cultural heritage.

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