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Contemporary Translation of Traditional Cultural Symbols: An Exploration of the Application Strategy of Dougong Installation Art in the Cultural and Educational Space of the Ming and Qing Dynasties

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Abstract

Background and Aim: Traditional Chinese architectural symbols such as dougong are rich in cultural meaning but often remain isolated from contemporary public spaces. This study aims to explore how dougong can be transformed into modular installation art through digital technology and design strategies, revitalizing its cultural relevance within educational and exhibition environments.

Materials and Methods: Using a mixed-methods approach, the research integrates semiotic analysis, modular design principles, and digital fabrication techniques. Field studies and literature reviews provided the theoretical basis for symbolic extraction and design development. Parametric modeling, AR interaction, and user-centered evaluation tools (e.g., KANO model, AHP) were applied in both prototype development and public space testing at Henan University of Animal Husbandry and Economics.

Results: The resulting modular dougong system demonstrated strong spatial adaptability and symbolic clarity. Public engagement increased significantly through interactive features. Quantitative surveys showed heightened cultural awareness and satisfaction among users, while expert interviews affirmed the design's effectiveness in cultural communication and educational function.

Conclusion: This study establishes a viable framework for translating architectural heritage into contemporary spatial experiences. By combining traditional aesthetics with technological innovation, Dougong installation art can serve as a model for the dynamic inheritance and activation of intangible cultural heritage in modern contexts.

Keywords: Dougong, Modular design, Cultural heritage, Installation art, Parametric modeling, Public space interaction

Introduction

Traditional Chinese architectural elements, especially the dougong structure from the Ming and Qing dynasties, represent a sophisticated integration of mechanical craftsmanship, visual rhythm, and cultural symbolism. As a pivotal component in ancient wooden buildings, dougong embodies not only constructional logic but also the Confucian ideals of harmony, hierarchy, and spatial order. However, in contemporary contexts, these traditional symbols are increasingly marginalized—confined to museums, heritage parks, or static displays—leading to a disconnect between historical heritage and modern experiential culture. Moreover, the absence of dynamic interpretation methods has limited the public's understanding and engagement with such cultural symbols (Yang, 2021).

In response, this study investigates the contemporary translation of dougong as a symbolic and structural element in the design of cultural and educational public spaces. Through the application of modular systems, interactive design strategies, and digital fabrication techniques, the research reimagines dougong not merely as a decorative motif but as a functional, participatory, and narrative device. This exploration aims to activate cultural heritage through spatial engagement, offering a practical model for integrating traditional wisdom into modern architectural discourse while fostering cultural continuity and educational innovation.

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Objectives

1. To investigate the innovative application of the dougong structure in installation art and its role in cultural expression and spatial narrative.

2. To develop and evaluate modular and interactive design strategies that enhance public engagement and promote the integration of traditional craftsmanship into contemporary educational spaces.

Literature review

Zhu and Xu (2019) emphasize the potential of digital representation in preserving and communicating traditional Chinese architecture. Their study highlights how digital technologies—such as 3D scanning, virtual modeling, and interactive exhibitions—can revitalize cultural identity and engage broader audiences. This aligns closely with the present research's use of digital modeling and AR interaction to reinterpret the dougong structure in cultural and educational contexts, reaffirming the value of immersive media in heritage revitalization.

Kolarevic (2003) explores the role of parametric design and digital fabrication in reshaping architectural practices, advocating for a shift from traditional construction logics to algorithm-driven design thinking. His work supports the technical backbone of this study, where modular dougong units are developed through 3D printing and parametric tools. It offers a theoretical framework for understanding how digital methods can reconstruct historical forms with contemporary precision and adaptability.

Smith and Bugni (2006) investigate architecture as a sociocultural text, analyzing how built environments reflect and reinforce cultural meanings. Their focus on form-function-symbol relationships provides a critical lens through which this research interprets dougong not just as a structural component, but as a cultural signifier within public space. Their insights inform the symbolic decoding and spatial implantation strategies developed in this project.

Apei (2024) discusses the inheritance and innovation of traditional architectural elements in modern design, arguing for a dynamic integration of historical aesthetics with sustainable and context-responsive practices. His study directly informs the current work's emphasis on balancing historical authenticity with modular adaptability, offering a practical roadmap for transforming static heritage into evolving design narratives.

Conceptual Framework

This study constructs an interdisciplinary conceptual framework that integrates cultural semiotics, modular design theory, and interactive spatial practice to explore the contemporary translation of traditional architectural symbols, with the dougong structure of the Ming and Qing dynasties as the core. The framework follows a three-stage logic: symbol decoding, modular transformation, and spatial implantation. It emphasizes how historical values—such as order, harmony, and craftsmanship—can be reconstructed through digital tools and participatory design strategies in modern cultural and educational environments. Taking Henan Province as the main regional context, the research tests the framework's feasibility through the development and application of modular dougong installations, aiming to establish a replicable model for cultural revitalization, spatial adaptation, and public engagement (Figure 1).

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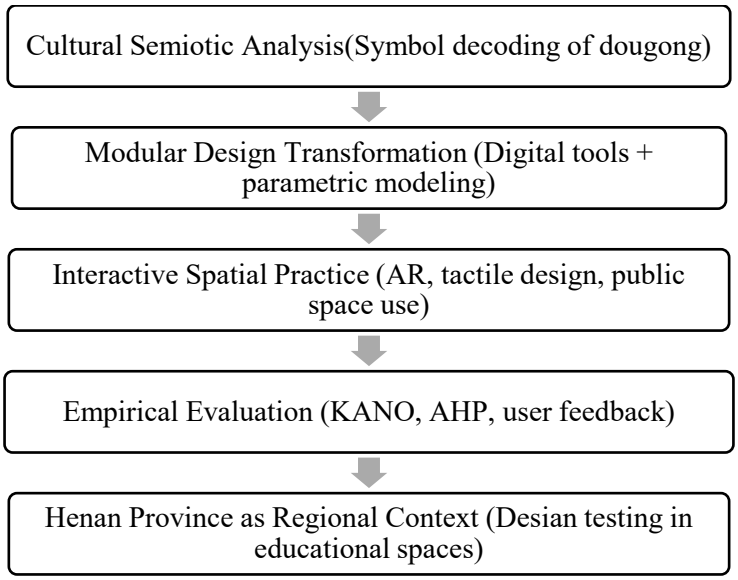

Figure 1 Research Framework
Note: Constructed by the researcher

Methodology

1. Symbolic Interpretation and Modular System Development

The study begins with a comprehensive literature review and field analysis to trace the historical development and cultural significance of dougong structures from the Ming and Qing dynasties. By examining their structural logic and metaphors of "symbiosis" and "order," the research extracts core symbolic and aesthetic elements. Through semiotic deconstruction, these traditional symbols are refined into a contemporary design language suitable for public educational spaces. Guided by this theoretical foundation, a modular design system is developed using parametric modeling and digital fabrication. The dougong components are reconstructed into detachable, recombinable units that reflect both spatial adaptability and the evolving nature of cultural inheritance. Material integration experiments combine traditional wood with modern composites, achieving both symbolic resonance and functional efficiency.

2. Interactive Implementation and Empirical Evaluation

Building on the modular system, an interactive transformation mechanism is designed to support participatory learning and dynamic engagement. Through tactile operations and AR-assisted interaction, users can explore the structural logic of dougong in an experiential manner. The design is applied and tested in educational public spaces—specifically at Henan University of Animal Husbandry and Economics—serving as the regional case site. Empirical data are collected through questionnaire surveys, expert interviews, and field observation, focusing on user experience, cultural cognition, and aesthetic response. To evaluate and optimize design outcomes, the study employs the KANO model, Analytic Hierarchy Process (AHP), and QFD analysis, identifying key satisfaction drivers and functional priorities. This iterative process leads to the refinement of a practical framework—"traditional symbols–contemporary translation–spatial empowerment"—which provides methodological support for the revitalization of architectural heritage through immersive design strategies.

Results

1. The innovative application of the dougong structure in installation art and the analysis of its cultural meaning

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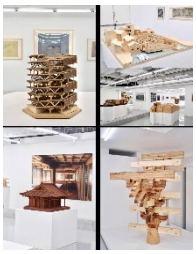
This research focuses on the innovative application of the dougong structure in installation art and explores its design concept, expression, and cultural value through a variety of research methods, such as case studies, observations, interviews, and focus group discussions.

Focusing on the innovative practice of the dougong mortise and tenon structure in installation art, through multi-dimensional research such as case analysis, audience feedback, and technical realization, we will explore its value in the integration of design concept, cultural inheritance, and technology.

Table 1: Innovative application of the dougong structure in installation art

Name of the case	Core Concept	Design Highlights:	Traditional elements wield	Modern technology and cultural values	Image
Qiangeng and Xi	Song-style form + Kengo Kuma's philosophy of "negative architecture".	15 meters of suspended bucket arches, 2 tons of weight, 108 groups of hanging patterns, 28 craftsmen, 25 days of high-altitude assembly	Dougong structure, Song Dynasty form, Oriental crown inspiration	Customized 1,500 pieces of material, 3,000 fasteners, digital craftsman. Redefine the cultural spirit and artistic height of Chinese luxury houses.	
Shanghai K11 Wood Frame Exhibition	Wood Revival + Philosophy of the Unity of Heaven and Man	"Crane beak column" and "braided wooden arch" innovative structure, long-span model, interactive experience exhibition	Song to the Ming and Qing dynasties' wooden structure system, mortise and tenon technology	Parametric design, mirror metal, water system, modular system. Build a closed loop of cultural ecology and explore sustainable urban development.	
Wenzhou X11 mortise and tenon device	Heavenly Creations + Fusion of Traditional and Industrial Aesthetics	Mirror stainless steel + ancient wood, reorganized module experience, reflecting virtual and real space	Mortise and tenon techniques, local waste wood recycling	Parametric standardized components, CNC engraving. A futuristic architecture that interprets the symbiosis of mechanical rationality and manual temperature	
Babama Shanghai Physical Store	Nature, Mechanics, Heart	Simulates the growth of hearts and branches, and the top array of ceilings reinforces the brand image.	Simplify the structure of the bucket arch (retain the bucket, rise, arch, and warp)	Metal + wood fusion, space mechanical aesthetics. Realize the fusion of traditional wisdom and modern design language.	
LINE+ light and heavy confrontat	Philosophy of Materials + Exploration of the	"Brick" pyramid installation, rapid prefabrication of the dougong booth,	Brickwork process, caisson cascading logic	Light steel structure, polycarbonate sheet, digital prefabrication. In-depth Speculation on the Construction of Cultural	

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Name of the case	Core Concept	Design Highlights:	Traditional elements wield	Modern technology and cultural values	Image
ion dual device	Essence of Construction	light and shadow interaction		Memory and Construction Ethics	
Dougong new art	Light steel deconstructs traditional bucket arches + fast construction	Transparent crystal caisson form, 24 hours of rapid construction	Dougong caisson structure logic	Light steel skeleton + polycarbonate sheet + prefabricated components. Dialogue with tradition from the dimension of time, emphasizing construction efficiency and technical interpretation.	

The Beijing Museum of Ancient Architecture uses 3D scanning and dynamic projection technology, combined with earthquake simulation experiments, to demonstrate the seismic wisdom of "overcoming rigidity with softness". The modular reorganization device of "Style Lei" hot sample interprets the systematic thinking of traditional craftsmanship from the perspective of prefabricated assembly. These practices use dougong as a cultural symbol and reconstruct the form through technological empowerment (such as 3D printing and virtual reality), which not only retains the philosophical core of "yin and yang" but also expands the narrative dimension of installation art. Its core value is embodied in three aspects: first, it transforms esoteric principles with interactive experience, such as the digital seismic simulation of the wooden tower in Yingxian County, to realize the "perception" of cultural communication; Second, cross-border integration inspires modern engineering, such as the application of the concept of flexible connection of bucket arch to aviation blade design; The third is to build multiple application scenarios, from public art exhibitions to science and technology museum education, especially among young people. The research confirms that the innovative path of "traditional structure + modern media" not only activates the contemporary vitality of intangible cultural heritage skills but also builds a paradigm of creative transformation of cultural heritage through technological empowerment and aesthetic reconstruction, providing a practical sample for the sustainable dialogue between traditional wisdom and modern society.

Together, these cases embody the three major trends of "form translation", "technology integration", and "cultural regeneration" of traditional architectural elements in contemporary expression. Through material innovation, structural reconstruction, and cross-media presentation, the designers have not only become a cultural link between history and the present but also an important means to promote sustainable design, public participation, and spatial narrative, providing a rich path and practical inspiration for the activation and inheritance of traditional crafts in the contemporary field (Apei, 2024).

Through in-depth interviews with 5 senior experts who have been in the field of art design and ancient architecture for 15 to 35 years (including Wang Hai, Wu Haohan, and other representatives in the field of ancient architecture), this study systematically sorted out the innovative path and practical experience of the installation art of dougong mortise and tenon installation. The study found that experts generally emphasized "equal emphasis on structural aesthetics and functional narrative", advocated the reconstruction of traditional mortise and tenon language through modular design and technological media intervention (such as parametric modeling), and paid attention to the "local transformation of traditional crafts" in the application of public space, and proposed the community participation value of activating cultural heritage with interactive installations.

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Table 2: Interviews with 5 artists and designers

Topic	Content overview	Specific Perspectives and Cases
Understanding and views on the art design of the mortise and tenon installation of the dougong structure	The interviewees have an in-depth understanding of the mortise and tenon installation art of the dougong structure, and generally believe that it has unique aesthetic value and structural advantages in public space.	- Wang Hai and Wu Haohan: Mortise and tenon technology is often used in the design of ancient buildings, and it is believed that the application of the dougong structure in public spaces has unique advantages. - Dong Xiaofeng: The mortise and tenon structure has a high degree of stability, and visually presents a complex and delicate beauty. - Qu Yuanyuan: Design should focus on the combination of tradition and modernity, retain the essence of traditional craftsmanship, and integrate modern design elements.
The application of mortise and tenon installation art of the dougong structure in public space	Respondents believe that the mortise and tenon installation art of the dougong structure is the most suitable for the application of cultural venues, educational spaces, and landscape design.	- Bu Ke: The application of dougong design in the public education space of Henan University of Animal Husbandry and Economics can enhance the cultural atmosphere of the space. - Wang Hai and Wu Haohan: Mortise and tenon structures have great potential in landscape design and architectural decoration, especially in the restoration of ancient buildings and modern architectural design. - Future expectations: Combining modern materials and technologies to improve the scope and effectiveness of mortise and tenon structures.
The needs and expectations for the artistic design of the mortise and tenon joint installation of the dougong structure	Respondents wanted to balance traditional and modern needs in the design process, with a focus on cultural communication and technological innovation.	- Dong Xiaofeng and Qu Yuanyuan: Looking forward to combining digital technology and 3D printing technology to improve design accuracy and efficiency. - General expectation: Future design should focus on cultural dissemination and technological innovation, and promote traditional crafts through exhibitions, workshops, etc. - Core Requirements: Preserve the essence of traditional craftsmanship while meeting modern functional requirements.

Through interviews and questionnaire analysis, this study found that the respondents generally emphasized the "modern translation of the traditional core" in the creation of the dougong mortise and tenon device, which not only retained the aesthetic essence and mechanical wisdom of the mortise and tenon structure, but also improved the accuracy and functional adaptability through new materials (such as carbon fiber), digital modeling technology and modular design, and successfully promoted the transformation of traditional craftsmanship to modernization and internationalization. The innovative practice of designers shows that the activation of mortise and tenon technology is not only reflected in structural optimization (such as 3D printing precision nodes) (Zhang & Zhou, 2016). In the future, it is necessary to deepen its application in the fields of smart home and public art, combine digital tools to achieve technical standardization, and build a multi-level cultural communication system with the help of immersive exhibitions and interactive workshops, to rejuvenate the contemporary vitality of millennium skills.

The interviews with three senior mortise and tenon craftsmen (35+ years of experience, focusing on ancient building restoration and furniture making) in this study reveal the duality of the inheritance of traditional skills: the craftsmen adhere to the precision and aesthetic value of the manual process (such as material selection and tenoning), but face the crisis of "dilution of craftsmanship" due to the impact of mechanization. The study proposes a path of "limited modernization" - using power tools to assist rough machining, CNC technology to retain the core mortise and tenon logic, and emphasizes the need to solve the inheritance fault through "master-apprenticeship + digital archives", and at the same time develop

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popular science devices to promote skills from workshops to public spaces, and activate the contemporary vitality of traditional crafts.

Table 3 Interviews with 3 practitioners of traditional manicrafts of mortise and tenon joints

Classify	Content overview	Specific views and cases
Attitude towards the traditional handicrafts of mortise and tenon joints	All respondents expressed their love and persistence for the traditional handicraft of the mortise and tenon joint, believing that it is an important part of the soul and cultural heritage of traditional Chinese architecture.	- Xu Shaochun: He has been engaged in the design of ancient buildings for many years, and has always regarded the mortise and tenon technique as the core craft, believing that this is the soul of traditional Chinese architecture. - Liu Hailiang and Shi Zhenfu: Emphasizing that mortise and tenon joint skills are not only a technique, but also a cultural inheritance, and hope to pass it on through their own efforts.
Technology and experience	The interviewees have a high level of technical proficiency in mortise and tenon joints and have accumulated a wealth of practical experience.	- Xu Shaochun: The extensive use of mortise and tenon structures in the design of ancient buildings ensures the stability and aesthetics of the building. - Liu Hailiang and Shi Zhenfu: Experienced in carpentry and mortise and tenon furniture, they believe that the accuracy and stability of the mortise and tenon structure are the key to making high-quality furniture.
Perceptions and expectations of traditional mortise and tenon crafts	Respondents generally believe that the inheritance of mortise and tenon skills is facing challenges, and they want to strengthen education, training, and innovation to enhance its market value.	- Inheritance challenge: The younger generation has insufficient interest and understanding of the art of mortise and tenon. - Education and training: We hope to attract more young people to learn and pass on this skill through education and training. - Innovation and promotion: Xu Shaochun and Liu Hailiang believe that innovation should be combined with modern materials and technologies; Shi Zhenfu emphasized the need to strengthen publicity and promotion to enhance the market potential of mortise and tenon furniture.

This study reveals the living protection of traditional skills by mortise and tenon craftsmen: the respondents deeply applied the logic of mortise and tenon to ancient building restoration and furniture design with their exquisite skills, and regarded it as an important carrier of Chinese cultural genes. They proposed a dual-track path of "integrity and innovation" - cultivating the inheritance power of young people through the intangible cultural heritage education system, and at the same time exploring the innovation paradigm empowered by modern technologies such as fiber composite materials and parametric modeling, taking into account the authenticity of the process and the adaptability of functions. The study emphasizes that the revitalization of skills needs to build a closed-loop ecology of "cultural cognition-technology iteration-market transformation", break through the bottleneck of "niche cognition" with the help of digital communication and experiential marketing, and transform the wisdom of mortise and tenon from cultural heritage to contemporary life aesthetic symbols (Jiang, Wang, Chen & Pang, 2024).

Through interviews with five professor-level experts from Shanghai Normal University, Tongji University, and other universities, this research focuses on the interdisciplinary practice of art design and space design. The interviewees have both academic research and practical project experience, and their multi-dimensional perspectives reveal the dual driving logic of "local cultural expression" and "technology-enabled innovation" in the design discipline, providing a theoretical framework and methodological reference for topics such as the modernization of traditional crafts and the construction of public space narratives.

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Table 4: 5 interviews with experts and scholars in other related fields

Classify	Content overview	Specific views and cases
Art design and spatial design from a multidisciplinary perspective	Experts and scholars emphasized that art design and space design need to cooperate with other disciplines across disciplines to enhance the comprehensiveness and practicality of design.	- Jiang Bin and Zhou Hongtao: Emphasizing the importance of interdisciplinary collaboration, it is recommended to combine it with architecture, engineering, sociology, and other disciplines. - Zhang Peng and Wang Qingbin: They believe that design should focus on cultural integration, especially in the combination of traditional Chinese culture and modern design, and the installation art of mortise and tenon joints in dougong structure is a good example.
Views and suggestions on the artistic design of the mortise and tenon installation of the dougong structure	Experts and scholars believe that the dougong structure has unique aesthetic and functional advantages in installation art design, but further innovation is needed.	- Guo Xinsheng: The dougong structure has unique advantages in terms of aesthetics and function, but it needs to be further innovated in modern design to meet the needs of modern spaces. - Zhou Hongtao: It is recommended to improve the design accuracy and application scope of the dougong structure through digital technology and 3D modeling technology.
Suggestions for future research and practice	Experts and scholars proposed that education and training should be strengthened, practice and promotion should be promoted, and cultural dissemination and technological innovation should be emphasized.	- Jiang Bin and Zhang Peng: It is recommended to strengthen the education and training of art design and space design, and cultivate more design talents with interdisciplinary backgrounds. - Wang Qingbin and Guo Xinsheng: They believe that the application of installation art of the dougong structure should be promoted through practical projects and exhibitions, to enhance the public's awareness and appreciation of this traditional craft.

This study points out that the interdisciplinary integration of art design and space design is the key path to enhance the comprehensive value, taking the dougong mortise and tenon device as an example, through the model of "cultural gene decoding + technology empowerment", the traditional architectural wisdom is combined with digital technology (such as 3D modeling and parametric design tools), which not only retains the authenticity of culture, but also expands the application boundary of public art (Zhang, 2025). The study emphasizes the need to build a dual-driven ecology of "technology chain + cultural chain" that collaborates in multiple fields such as architecture and materials science, and reconstruct the education system to cultivate compound talents with both traditional craft cognition and digital design ability, and at the same time promote the transformation of mortise and tenon wisdom into experiential contemporary cultural symbols with the help of immersive exhibitions and urban space intervention projects. In the future, it is necessary to deepen the practice paradigm of the "technology-culture-scene" trinity, explore its transformation potential in the fields of intelligent architecture and sustainable design, and transform intangible cultural heritage skills from the object of cultural protection to innovative production factors.

2. Exploration of contemporary installation art design based on the elements of dougong, based on the cultural and educational space

By exploring the application of dougong elements in contemporary installation art design, this study demonstrates the organic combination and innovative development of traditional craftsmanship and modern design. The research results provide a theoretical basis and practical guidance for the design and application of the dougong structure in public space, promote the protection and inheritance of intangible cultural heritage, and inject new cultural connotation and artistic vitality into modern public space design.

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Table 5: Stages and steps of contemporary installation art design of dougong elements in public space

Stage	Steps	Specific content and description
Sources of inspiration	Study ancient symbols	Delve into the structure of dougong in the Ming and Qing dynasties to understand its historical background, cultural significance, and symbolic value. As the core element of traditional Chinese architecture, dougong symbolizes stability, harmony, and wisdom.
	Find inspiration	Extract design inspiration from the bucket arch structure and explore its application potential in modern public spaces. The geometry of the dougong, the way it is connected, and its functionality in architecture are all important sources of inspiration for the design.
	Cultural interpretation	This paper analyzes the interpretation of the dougong structure in different historical periods and cultural backgrounds, understands its role and significance in traditional Chinese architecture, and provides cultural support for modern design.
Extract the elements	Symbolic features	The core characteristics of the bucket arch structure, such as the geometric form of the bucket, arch, mortise and tenon joint, as well as its cascading structure and mechanical principles in the building, are extracted.
	Symbolic elements	Excavate the symbolic meanings of the dougong structure, such as stability, harmony, wisdom, etc., and transform them into design elements.
	Material selection	According to the characteristics and symbolism of the dougong structure, choose the right material. Traditional materials such as wood can be combined with modern materials (e.g., metal, glass, composites) to retain the essence of traditional craftsmanship while giving it a modern touch.
Innovative design	Concept development	Combining the symbolism of the dougong structure and the extracted elements, an innovative design concept was developed. For example, the geometry of the dougong is combined with the functional needs of modern public space to design an installation art that is both aesthetic and practical.
	Digital craftsmanship	Using digital techniques and modern technologies such as 3D modeling and printing, design concepts are transformed into installation art prototypes. Through digital technology, the complex geometry of the bucket arch can be accurately restored, and the modular design can be realized.
	Aesthetic expression	Focusing on aesthetic expression, through the combination of lines, shapes, and materials, we create installation works with a unique and modern sense. For example, the cascading form of the dougong structure can enhance its visual impact and sense of engagement through light and shadow effects and interactive design.
Design the app	Modular design	The bucket arch structure is designed as a modular component, which is convenient for flexible combination and application in public spaces. Each module can be designed and manufactured independently and assembled quickly by means of mortise and tenon connections.
	Interactive design	Combined with the design principle of interactive transformation, the installation art of the dougong structure is interactive. The audience can interact with the installation by touching, moving, etc., enhancing the sense of participation and experience in the public space.
	Public space applications	The installation art of the dougong structure is applied to public education spaces, cultural venues, and landscape design. For example, in the public education space of Henan University of Animal Husbandry and Economics, the dougong structure is reinterpreted as modern installation art, which enhances the aesthetics and practicality of the space through interactive and functional design.
Production and presentation	The production process	Choose the right materials and processes, and carefully make the installation art of the bucket arch structure. Traditional craftsmanship is combined with modern technology to ensure that the design concept is perfectly presented.
	3D printing	Part of the design is made using 3D printing technology to achieve complex geometries and details, and accurately present the innovative design of the dougong structure.

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Stage	Steps	Specific content and description
	technology	
	Display & Promotion	Through exhibitions, workshops, and other forms, the design achievements of the installation art of the dougong structure will be displayed, so as to enhance the public's awareness and interest in traditional crafts and promote the protection and inheritance of intangible cultural heritage.

2.1 KANO model analysis of the artistic design elements of the dougong mortise and tenon installation

Using the KANO model to understand the public's expectations for the design and application of the arch mortise and tenon installation art in public space (Mao, 2008). Collect data through surveys, interviews, or questionnaires to analyze public satisfaction with different design elements. Identify and classify design elements, including mortise and tenon joints, materials, shapes, interactivity, etc., to understand their impact on public satisfaction (Tang & Long, 2012). Based on the results of the KANO model, essential elements (e.g., stability), performance factors (e.g., functionality), and charismatic elements (e.g., interactivity) are identified to optimize the design and meet public needs and expectations. According to the data of public surveys and interviews (e.g., 83% support "the combination of decoration and practicality", and 61% favor "modular design to reduce costs"), the design elements of the dougong mortise and tenon installation art are classified as follows:

Table 6: KANO model analysis table of the artistic design elements of the arch d mortise and tenon installation

Feature classification	Design elements	Characteristics of the demand	Optimize the orientation
Essentials	Stability and security	Physical stability and safety are fundamental requirements, and failure to meet them significantly reduces satisfaction.	Ensure that the structural mechanics are reasonable, and the mortise and tenon joints meet the traditional process standards.
Elements of Expectation	Functionality and practicality	83% of respondents asked for both decorative and practical (seats, partitions, etc.)	Modular design improves flexibility and scenario adaptability
The charm element	Interactivity, sense of technology	88% of young people prefer digital interaction (AR, somatosensory control), which significantly improves their attractiveness	Introduce AR/VR technology, dynamic light and shadow, or mechanically movable structures
No difference element	The complexity of traditional symbols	Only 12% believe that traditional symbols are complicated and have little impact on satisfaction.	Retain core cultural symbols and simplify decorative details.
Reverse features	High cost	61% oppose high cost and need to control costs	Lightweight materials, prefabricated components, and optimized production processes

The design of the art of the dougong mortise and tenon joint device needs to be based on stability and safety, and the structure is stable through the traditional mortise and tenon joint process and modern mechanical analysis; At the same time, in response to the practical needs emphasized by 83% of the respondents, a modular design is adopted to realize detachable and reconfigurable functions (such as seats and partitions) to adapt to the diverse scenarios of public spaces. To meet the 88% of young people's preference for a sense of technology, AR/VR interaction, or dynamic light and shadow technology is

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embedded to enhance the immersive experience, while traditional symbols need to be reduced to intricate details and core cultural elements (such as moire) to balance the modern minimalist style. In addition, in view of the sensitivity of 61% of users to high cost, the cost is reduced through lightweight composite materials, prefabricated components, and standardized production processes, and finally, the modernization of traditional processes and the synergistic optimization of the functional, cultural, and economic aspects of public space are realized.

2.2 AHP analytic hierarchy process: weight evaluation of design elements

The AHP method was used to determine the relative importance of different design elements (e.g., mortise and tenon joint technology, material selection, shape design, interactivity, etc.). Construct a hierarchy that hierarchizes goals, sub-goals, and design elements to quantify the relationships between them. Based on expert opinion or survey data, develop a pairwise comparison matrix to determine the relative importance of different design elements. The AHP method is used to calculate the weight of each design element to provide a quantitative basis for design decisions.

In order to scientifically evaluate the design optimization path of the dougong mortise and tenon installation art in public space, a three-layer AHP hierarchical structure model including the target layer, the criterion layer, and the element layer was constructed in this paper (Tang, Yang, Zhang, & Zhang, 2023). The target layer is "Optimizing the Artistic Design of Dougong Mortise and Tenon Installation." The criterion layer includes five core dimensions: functional, aesthetic, interactive, cultural, and material, representing the public's comprehensive expectations for the installation in terms of practicality, aesthetics, participation, cultural heritage, and material quality. The element layer is refined into specific design elements such as structural stability, visual modeling, participation methods, cultural symbols, and material touch. The model provides a system logic and basis for subsequent weight calculation and decision analysis.

Table 7: Matrix of expert pairwise judgments on the importance of the criteria

Criterion	Functionality	Cultural dissemination	Aesthetic value	Interactivity
Functionality	1	2	3	4
Cultural dissemination	1/2	1	2	3
Aesthetic value	1/3	1/2	1	2
Interactivity	1/4	1/3	1/2	1

The results show that among the five criteria for the design of the Dougong mortise and tenon installation, the structural stability ranks first with a weight of 0.35, indicating that the public is most concerned about its safety and reliability, aesthetics and culture occupy a weight of 0.20 and 0.18, respectively, indicating the important influence of modeling aesthetics and cultural connotation on the design, the weight of interaction is 0.15, reflecting the importance of experience participation to a specific group, and the material touch is in a relatively secondary position with 0.12. On the whole, stability is the primary consideration for design optimization, followed by aesthetic expression and cultural communication.

2.3 Quality Function Deployment (QFD): Customer demand transformation and design parameter configuration

In the QFD analysis, the public's core needs (WHATs) for bracket and mortise and tenon installation art are first summarized, including six aspects: spatial adaptability, safety and stability, aesthetic expression, cultural inheritance, user interactivity, and material environmental protection (Liu & Zhang, 2000). Subsequently, these needs are converted into corresponding design parameters (HOWs), covering mortise and tenon precision and structural strength, modular design degree, color and lighting design, interactive technology integration (such as AR and tactile feedback), material selection (such as wood, steel, composite materials), and cultural interpretation system. By constructing a WHAT-HOW relationship matrix, the analysis found that safety and stability are strongly correlated with mortise and tenon structural precision and material selection, aesthetic expression mainly depends on color design and material, and

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interactivity and culturality are closely related to interactive technology and interpretation system, providing a clear basis for parameter priority for subsequent design decisions (Ma, 2004).

Table 8 QFD matrix core matching relationship

Requirements\ Parameters	Accuracy Structure	Modularity	Color Design	Interactive Technology	Material selection	Narration system
Space adaptability	○	◎	○	△	◎	△
Stability	◎	○	△		◎	
Aesthetic expression	△	○	◎	◎	◎	
Cultural inheritance	○		○	○	△	◎
User interactivity	△		○	◎		◎
Environmentally friendly materials		△	△	△	◎	

◎: strong relationship, ○: medium relationship, △: weak relationship

Based on the results of QFD analysis, it is recommended to give priority to improving the three key parameters of "structural accuracy", "interactive technology" and "material environmental protection" in the design, to fully respond to the core needs of the public for safety, participation and sustainability; in terms of the implementation path, the trinity design strategy of "modular assembly + digital interaction + AR guide" can be adopted to effectively balance the preference of young groups for interactive experience and the emphasis of older groups on cultural authenticity; the overall design should be carried out around the triple value goals of "stability, culturality and aesthetics" to achieve the organic integration of traditional skills and modern space.

This study explores the cultural genes and mechanical wisdom of the bracket structure of the Ming and Qing Dynasties, and constructs a systematic path for the modernization of traditional craftsmanship: taking the symbol system of brackets, arches and mortise and tenon joints as the prototype, integrating 3D printing and parametric design technology to achieve the production of precision components, and giving the device space adaptability through modular combination (such as rotatable bracket units), which is transformed into a public art carrier with both cultural narrative and functional carrying in projects such as Henan College of Animal Husbandry and Economics. The case shows that digital reconstruction not only retains the philosophical core of the "round sky and square earth" of the bracket, but also activates its "stable-flexible" aesthetic tension through AR interaction, light and shadow mapping, and other technological means, transforming traditional patterns such as dragon patterns and cloud patterns into tangible and immersive cultural experiences. The study proposes a "four-dimensional model for the activation of intangible cultural heritage" - cultural decoding (extracting the harmonious symbol of brackets), technological empowerment (digital twins to ensure process accuracy), scene implantation (creating a cultural atmosphere in educational spaces), and communication innovation (workshops to build a public participation chain), providing a "form-meaning-use" trinity innovation paradigm for the contemporary transformation of traditional architectural skills.

2.4 Inspiration and design creation

Based on the five-step bracket structure of the Ming and Qing Dynasties, combined with geometric simplification design, modular components, and interactive conversion design principles, this study successfully applied the bracket structure mortise and tenon installation art to public spaces. This design not only retains the essence of traditional craftsmanship but also gives it new vitality through modern design concepts and technologies, promotes the protection and inheritance of intangible cultural heritage, and also injects new cultural connotations and artistic vitality into modern public space design (Yang, 2021).

Table 9: Design inspiration and design creation process

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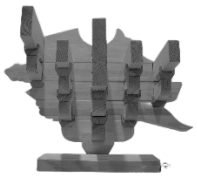
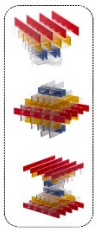
	Inspiration	Extracting Elements	Innovative design
Picture			
Illustrate	Traditional bracket structure: Inspired by the five-step bracket structure of the Ming and Qing dynasties, the project conducts in-depth research into its historical background, cultural significance, and symbolic value. As a core element of traditional Chinese architecture, brackets symbolize stability, harmony, and wisdom.	The modern five-step bracket set structure model component is formed by geometrically simplifying the traditional five-step bracket set structure. The simplified model component retains the basic form and structural characteristics of the bracket set, while making it more suitable for the design needs of modern public spaces.	The innovative design is reflected in the fact that the modern five-step bracket setback structure model adopts a modular component design. Each component (such as bracket setbacks and bracket sets) can be independently designed and manufactured, which facilitates flexible combination and application in different spaces and scenes.

2.5 Innovative display and design application

Based on the mechanical aesthetics of the traditional Chinese five-step dougong, "Pastoral Merchant Suspense" condenses the cultural core of "stability, harmony, and wisdom" into modular installation art through digital deconstruction and contemporary translation. The work takes the campus totem as the gene, uses parametric design to reconstruct the school emblem symbol, forms a freely combinable intelligent dougong unit, and realizes the dynamic breathing and audience interaction of the device form through the mechanical linkage structure and embedded induction system. The modular components are made of wood materials and light-transmitting composite materials, and the cascading bucket arches produce rhythmic changes, which is a metaphor for the cultural ritual field of humanistic symbiosis.

Table 10: Exhibition of design works

Title of Work	Features	Innovation Showcase	Design Results
Preface to the Book of Pastoral Business	The installation art form is inspired by the five-step bracket, which symbolizes stability, harmony, and wisdom. It adopts a modular component design and can be flexibly adapted to different scenarios.	The modular bracket set is used to deconstruct the school logo gene, transform the campus totem into a growable spiritual landmark, and reshape the cultural ritual field where tradition, technology, and humanities coexist.	Using modular brackets to reconstruct the school emblem symbol as a dynamic composite carrier, integrating multidisciplinary technology chains and campus cultural genes, we create a breathable and interactive "campus totem activation system" to activate the symbiotic memory field of tradition, ecology, and community.

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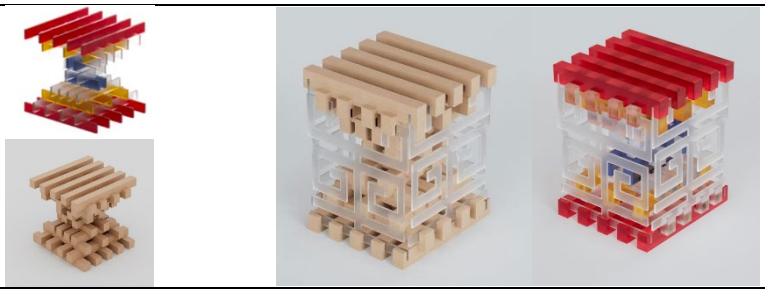

2.6 Design the application

Modular design: The bucket arch structure is designed as a modular component, which is convenient for flexible combination and application in public spaces. Each module can be designed and manufactured independently and assembled quickly by means of mortise and tenon connections.

Interactive design: Combined with the design principle of interactive transformation, the installation art of the dougong structure is interactive. The audience can interact with the installation by touching, moving, etc., enhancing the sense of participation and experience in the public space.

Public space application: The installation art of the dougong structure is applied to public education spaces, cultural venues, and landscape design. For example, in the public education space of Henan University of Animal Husbandry and Economics, the dougong structure is reinterpreted as modern installation art, which enhances the aesthetics and practicality of the space through interactive and functional design.

2.7 Production and display

Production process: choose the right materials and processes, and carefully make the installation art of the dougong structure. Traditional craftsmanship is combined with modern technology to ensure that the design concept is perfectly presented.

3D printing technology: Some designs are made using 3D printing technology to achieve complex geometric structures and details, and accurately present the innovative design of the bucket arch structure.

Display and promotion: Through exhibitions, workshops, and other forms, the design achievements of the installation art of the dougong structure are displayed, so as to enhance the public's awareness and interest in traditional crafts and promote the protection and inheritance of intangible cultural heritage.

By exploring the application of dougong elements in contemporary installation art design, this study demonstrates the organic combination and innovative development of traditional craftsmanship and modern design. The research results provide a theoretical basis and practical guidance for the design and application of the dougong structure in public space, promote the protection and inheritance of intangible cultural heritage, and inject new cultural connotation and artistic vitality into modern public space design.

Discussion

The research set out to investigate two key objectives: first, to explore the innovative application of dougong structures in installation art as carriers of cultural expression and spatial narrative; and second, to develop modular and interactive design strategies that could integrate traditional craftsmanship into contemporary educational environments. The empirical findings and design experiments successfully support both objectives, demonstrating that the modular dougong system not only preserves symbolic and aesthetic values but also enhances user engagement and spatial adaptability.

This outcome is consistent with Zhu and Xu's (2019) argument that digital technologies can facilitate the reinterpretation of traditional architecture in ways that foster cultural identity and public participation. The incorporation of parametric modeling and AR interaction in this study echoes their call for "digitally immersive heritage" experiences, particularly in educational settings. Likewise, Smith and Bugni (2006) emphasized the role of architecture as a cultural symbol and communicative medium—an idea directly aligned with this research's spatial translation of dougong from static relic to participatory

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installation. The spatial implantation of traditional forms as educational tools enhances the semantic density of the environment, confirming the narrative function of symbolic architecture in line with their theoretical assertions.

However, the current study diverges from Apei (2024), who primarily advocates for a more preservation-oriented integration of ancient architectural elements into modern structures, often emphasizing formal continuity over interactive reinvention. In contrast, this research introduces a dynamic design approach that prioritizes modular recombination, experiential interactivity, and real-time user transformation. This divergence highlights a more progressive methodology, emphasizing not only the conservation but also the activation and evolution of traditional symbols in response to contemporary spatial and educational needs.

Overall, the study advances the discourse on cultural heritage revitalization by moving beyond representational preservation and proposing an interactive, modular, and scalable model. It demonstrates that the dougong structure, when strategically translated and technologically empowered, can become a living symbol embedded in the daily experience of modern users—particularly in the realm of public education and cultural space design.

Conclusion

This study demonstrates that the contemporary translation of traditional dougong structures—through modular design, digital fabrication, and interactive spatial engagement—can serve as a meaningful strategy for revitalizing architectural heritage in cultural and educational spaces. By reconstructing the symbolic and structural logic of the Ming and Qing dougong system into a modular and participatory form, the research successfully bridges historical craftsmanship with modern functionality. The findings confirm that such translation not only enhances spatial aesthetics and usability but also strengthens public cultural identity and educational interaction.

Moreover, the study proposes a replicable model of "symbol decoding–modular transformation–spatial empowerment," contributing to the theoretical and practical discourse on cultural symbol innovation. The integration of traditional values with modern technologies supports the evolution of dougong from a preserved artifact into a living component of public design. Through field application, user feedback, and design iteration, the research affirms the potential of immersive heritage design as a tool for both cultural continuity and spatial innovation.

Recommendation

1. General Recommendations

Designers and cultural practitioners should prioritize modular and interactive strategies when integrating traditional architectural symbols into modern public spaces. Institutions such as museums, universities, and cultural centers are encouraged to adopt flexible installation formats that allow for both symbolic interpretation and user participation. Additionally, interdisciplinary collaboration—bridging architecture, digital media, and education—is essential for ensuring that heritage installations remain relevant and adaptable in contemporary contexts.

2. Recommendations for Further Research

Future studies may explore the long-term impact of such installations on cultural cognition and behavioral engagement, particularly among younger audiences. More emphasis can be placed on cross-cultural comparative studies, examining how traditional Chinese structural systems like dougong might interact with or influence global spatial design practices. Expanding the technical scope—such as using AI-driven form generation or immersive storytelling through MR—could further enhance the integration of intangible cultural heritage in future design innovation.

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