INHERITANCE OF TECTONIC AESTHETICS AND CULTURAL SIGNIFICANCE OF DOUGONG STRUCTURE IN CONTEMPORARY PUBLIC SPACE INSTALLATION ART DESIGN IN MING AND QING DYNASTIES

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ABSTRACT

As an important part of ancient Chinese architecture in the Ming and Qing dynasties, the dougong structure shows the complex mortise and tenon joint skills and rich cultural connotation. Dougong is not only unique in structure, but also has an irreplaceable position in visual beauty and symbolism. With the development of modern design, the integration of this traditional element into the art design of contemporary public space installations has become a key topic in the field of architectural design. This research aim to analyzes the structural aesthetics, formal language and decorative elements of the dougong, and deeply explores the inheritance of the structural aesthetics and cultural significance of the dougong structure in the contemporary public space installation art design. Through a combination of quantitative and qualitative methods. On this basis, combined with the design needs of modern public space, the inheritance and innovative application path of dougong structure in contemporary design are discussed, and its new vitality and cultural value in modern design are demonstrated. Through the analysis and practice of cases, this paper attempts to provide a theoretical basis and practical reference for the transformation of traditional architectural elements into modern design.

Keywords: Ming and Qing Dynasty Dougong, Structural Aesthetics, Cultural Symbolism, Public Space, Installation Art, Inheritance and Innovation

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INTRODUCTION

The dougong structure of the Ming and Qing dynasties is an important part of ancient Chinese architecture, showing a unique mortise and tenon joint technology and profound cultural heritage. With the acceleration of modernization, traditional architectural elements have been gradually neglected, but as a typical representative, the dougong structure still has important historical and cultural significance for its craftsmanship and aesthetic value. In contemporary public space design, how to effectively inherit and innovate this ancient architectural element has become an important topic in the field of architectural design and cultural inheritance. The purpose of this study is to explore the innovative design and application path of dougong structure in modern public space in the Ming and Qing dynasties. Through the in-depth analysis of the historical background, structural characteristics and aesthetic value of the dougong structure, this paper studies how to transform it into mortise and tenon installation art that meets the needs of modern aesthetics and functions, and applies it to the design of public space, so as to achieve the integration of cultural inheritance and modern innovation. The application value is reflected in the combination of traditional dougong structure and modern public space design through innovative design, which not only retains the essence of traditional culture, but also meets the needs of contemporary society for functionality and aesthetics. The research results can not only provide a new source of creativity for the design of public space, but also enhance the cultural atmosphere and user experience of the space, and enhance the influence and identity of traditional culture in modern society. At the theoretical level, the research provides a new perspective for the reuse of traditional architectural elements in modern design, and enriches the academic research on architectural design and cultural heritage protection. At the practical level, the research results provide practical application strategies for public space design, show how to realize the modern transformation and continuation of traditional culture through innovative design, and have a guiding role in modern architectural design and cultural inheritance practice.

Research Objectives

1) To understand the development history, structural principle and artistic value of the traditional mortise and tenon building structure "dougong" in the Ming and Qing dynasties of China.

2) To analyze the innovative application of the mortise and tenon "dougong" structure in installation art in the Ming and Qing dynasties of China.

LITERATURE REVIEWS

The development history, structural principle and artistic value of the mortise and tenon joint dougong structure in the Ming and Qing dynasties of China

As an important component of ancient Chinese architecture, dougong has undergone a long period of development and evolution, and its form and function have been gradually improved, reflecting the changes in the form of traditional wooden frame architecture. There are three theories about the origin of the bucket arch: one is that it originates from the intersection of the well and trunk structure, the second is the evolution of the beam, and the third is the evolution of the diagonal brace of the eaves column into the bucket arch. The development of dougong can be roughly divided into three stages: the prototype appeared in the Shang and Zhou dynasties, which was mainly used for wooden connections; During the Sui and Tang dynasties, dougong was widely used and reached new heights; The Song Dynasty was the peak of the dougong, and the "Construction of the French Style" regulated its form and use. During the Ming and Qing dynasties, dougong was still widely used in palaces, temples and other buildings, such as the Forbidden City, showing its dual value of support and aesthetics, and became an iconic element of traditional Chinese architecture.

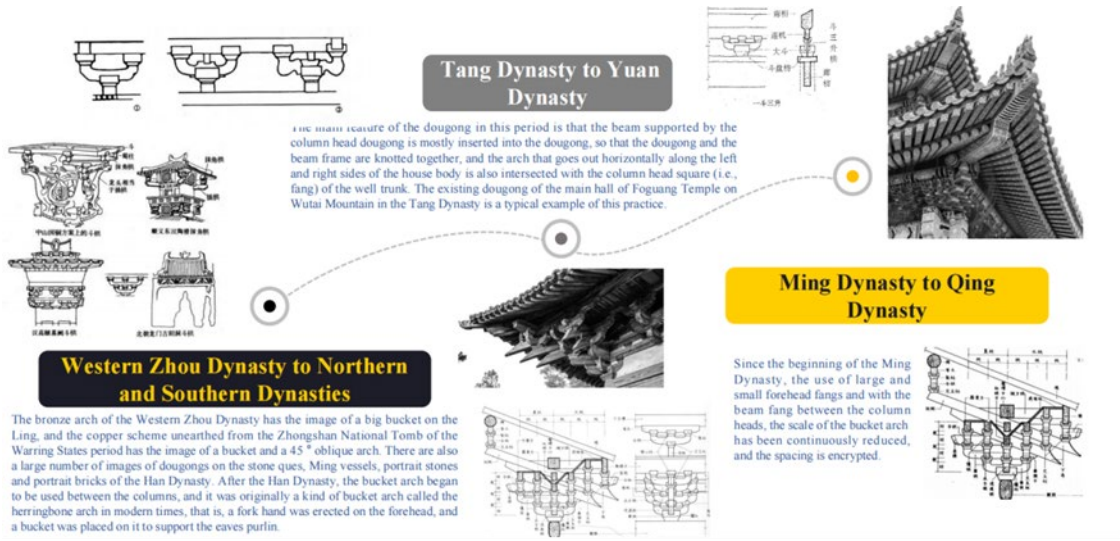

Figure 1 The history of the development of the dougong structure

As a unique structure of Chinese architecture, the dougong structure carries the precipitation of history and the inheritance of culture, and is one of the essences of architectural art. The bucket arch is composed of square buckets, ascending, arches, warping, ang and other parts, and forms a bow-shaped load-bearing structure by superimposing layers of them. Among them, the arch is the main body of load-bearing, and the bucket plays the role of support and balance, and the two complement each other and together constitute the unique building component of the bucket arch.

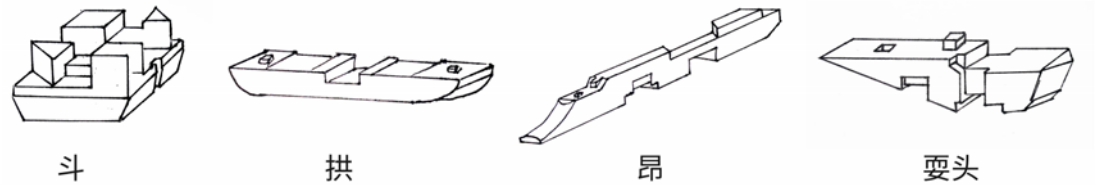

Figure 2 Ming and Qing Dynasty bucket arch member diagram

As an important component in ancient architecture, the bucket arch has many types and complex shapes according to its use parts and functions. According to the position of the bucket arch in the building, it is divided into the outer eaves bucket arch and the inner eaves bucket arch. Stigma section bucket arch: Installed on the column axis of the bucket arch, usually when there is no flat fang, it can be directly placed on the column head, when there is a flat fang, it is installed on the flat fang. The characteristics of the column head department bucket arch are wider than the bucket, warp and ang of the flat body section bucket arch in appearance, and the upper part supports the beam head (pick the tip beam head or hold the head beam head), which is the transition member between the beam and the column. Corner Bucket Arch: The bucket arch installed on the corner column head of the house is similar in function to the column head department bucket arch, but the structure is larger and more complex. The position of the angular dougong is similar to that of the column head dougong, but because it is in the corner position of the house, its structure is relatively complex. Flat bucket arch: Bucket arch installed on the forehead or flat plate between the columns. The shape and classification of this kind of bucket arch are more complex and varied, but in general it is directly placed on the bucket arch.

Table 1 Bucket arch classification table

Name of the bucket arch	Name of Song Dynasty	Name of Ming and Qing dynasties	Name of the bucket arch
Column head bucket arch	The stigma is paved	Stigma family	Column head bucket arch
Bucket arches between columns	Tween paving	Flat body	Bucket arches between columns
Corner bucket arches	Corner paving	Hornaceae	Corner bucket arches

Most of the outer eaves and arches of ancient buildings are raised outward, and they are called "jumping" in "Construction of the French Style" in Song Dynasty, and they are called "stepping out" in the "Engineering Practice" of the Qing Dynasty. According to this statement, we can divide it into two categories: overhanging bucket arches and non-overhanging bucket arches. There are many kinds of overhang bucket arches, generally including column head bucket arches, flat body bucket arches and corner bucket arches. It can be divided into three steps (four paving), five stepping (five paving), seven stepping (six paving), etc., and extending to eleven steps (eight paving). And the overhanging bucket arch mainly has a bucket of two liters and a bucket of three liters, also includes a bucket of six liters and a variety of bucket arches.

Figure 3 From left to right, corner bucket arches, inter-column bucket arches, and column head bucket arches

Dougong has witnessed development of ancient Chinese architectural technology, reflecting architectural styles and technical levels of different eras. As an important symbol of traditional culture, dougong continues to play an important role in modern society and has become an important link connecting ancient and modern architectural art and cultural inheritance. In modern architectural design, more and more designers integrate the elements of dougong into modern architecture, which not only inherits traditional culture, but also gives it new vitality.

The innovative application of Chinese Ming and Qing dynasty mortise and tenon arch structure in modern design

As a unique component of ancient Chinese mortise and tenon wood structure building, the dougong is a cultural symbol of Chinese architecture, with unique artistic charm and historical accumulation. With the passage of time and the development of technology, its structure has gradually changed from simple to complex, and its function has gradually developed from pure support to a structural component integrating aesthetics and mechanics. With the continuous development of modern construction technology, especially the popularization and application of reinforced concrete structures, the use of traditional components in construction has gradually decreased. Modern building structures rely more on new materials and technologies such as reinforced concrete, while the use of traditional timber structural components such as bucket arches is relatively limited. Despite this, mortise and tenon bucket arches play an important role in modern design applications. It has a wide range of applications in the fields of architecture, products, space decoration, etc., and as a cultural symbol and artistic expression

of Chinese architecture, it still plays its unique aesthetic value and cultural value in modern design applications.

The logo of the Architectural Society of China incorporates elements of dougong and modular cubes, symbolizing the combination of traditional and modern building techniques. As an important component of ancient Chinese wooden structure architecture, the dougong embodies the perfect integration of architectural technology and aesthetics, and has been used as early as the period of China Construction Society, expressing the continuity and respect for the academic development of Chinese architecture. The material and design innovation of dougong has promoted the application of modulus in ancient Chinese architecture, and in the context of industrialization, modularization has become the key to large-scale production of buildings. The modular cube symbolizes the standardization and industrial production of the three-dimensional space of the building, and is a symbol of the technological innovation of modern architecture. The combination of dougong and modular cube in the logo shows the development direction of nationalization and modernization of architectural disciplines, which not only inherits traditional culture, but also integrates modern technology, reflecting the exploration and pursuit of future development of the Architectural Society of China.

Figure 4 Architectural Society of China logo

Mortise and tenon dougong building block is an innovative cultural and creative product, vividly demonstrating traditional Chinese architectural culture, and becoming an innovative application of dougong in modern art design. Traditionally, people have learned about ancient buildings through site visits or museum visits, but many of them are located in remote areas that are not well known to general public, and the architectural models in museums are difficult to show the inner workings. Through hands-on construction, the dougong building blocks allow participants to understand the dougong structure and ancient buildings more intuitively, cultivate their interest in traditional culture, and promote the ancient architectural culture into daily life. Compared with ordinary building block products, bucket arch building blocks carry the essence of traditional culture, and mobilize the cooperation of hands, eyes and hearts in the assembly process, bringing a sense of achievement and stimulating interest in ancient buildings. Not only does it provide the joy of assembling, but more importantly, it inherits the core of traditional culture. The presentation of ancient architectural models in the form of building blocks is of positive significance for the inheritance and development of architectural culture, and promotes the dissemination and popularization of ancient architectural culture.

Figure 5 Mortise and tenon bucket arch bricks

The China Pavilion at the 41st World Expo in Shanghai in 2010 was designed by Academician He Jingtang, adhering to the concept of "the crown of the Orient, the prosperity of China, the granary of the world, and the prosperity of the people", integrating cultural elements such as Chinese history, painting, landscape, and folk crafts. Its design is inspired by urban layout and garden design, combining traditional dougong elements with modern engineering technology to form a building with the appearance of the "Crown of the Orient". The design team created a modern minimalist style by straightening the curves of the traditional dougong, using reinforced concrete, and superimposing beams representing 56 ethnic groups in the structural way of the dougong, symbolizing harmony and stability. The building adopts a symmetrical and balanced design, with a reduced overhead ceiling, with the function of shading and natural ventilation, presenting a cascading "crown" shape. The bright red exterior shows the enthusiasm and unity of the Chinese nation. The China Pavilion integrates traditional architectural techniques and modern design concepts, embodies the oriental philosophy of "harmony between man and nature" and "harmonious coexistence", and perfectly interprets the essence of Chinese culture.

Figure 6 Pavilion of China

Located in Kochi Prefecture, Japan, the Wooden Bridge Museum was designed by renowned architectural firm Kengo Kuma Japan Architects. It is intended to connect hotels and galleries that have long been blocked by roads and topography through a bridge-like structure. The bridge not only serves as a connecting channel, but also serves as a housing and workshop. The design scheme incorporates the bucket arch, a cantilevered structure commonly used in ancient China and Japan, and uses small-scale timber components to form the structure, reflecting the concept of sustainable design. The use of wood as the main material is both a nod to traditional construction techniques and an emphasis on environmental sustainability. The design of the Wooden Bridge Museum is both functional and innovative, continuing and inheriting the ancient architectural culture.

Figure 7 Kengo Kuma's Wooden Bridge Museum

In public space, the installation art design application of traditional cultural elements is of great significance. First of all, it can enrich the cultural connotation of public space, so that people can feel the charm and historical heritage of traditional culture when appreciating artworks. Secondly, it can stimulate the public's interest and understanding of traditional culture, and promote the inheritance and promotion of culture. Through innovative design, traditional cultural elements are combined with contemporary art, which not only attracts more audiences, but also injects new vitality into the development of the cultural industry. As a form with strong visual impact, installation art has an important impact on the beauty and artistic atmosphere of public space, and at the same time promotes social and cultural development. The "seven-pillar" installation in the "Wood Revival" exhibition of the K11 Architecture Art Festival integrates ancient and modern mortise and tenon design ideas, showing the inheritance and innovation of wood structure technology. Through this combination, the exhibition embodies the dialogue between traditional mortise and tenon craftsmanship and modern design, shows the inheritance of traditional culture and the exploration of modern lifestyle, and provides an innovative design path for cultural development.

Figure 8 The Seven Pillars

The design and application of installation art with traditional cultural elements in public space not only enriches the cultural landscape of public space, but also provides new ideas and possibilities for the inheritance and development of culture. By combining traditional cultural elements with contemporary art, it has become an important trend of modern design to promote cultural prosperity and social progress in an innovative and integrated way. As an important part of classical Chinese architecture, the mortise and tenon dougong not only plays a load-bearing and supporting role in the structure, but also has profound significance in aesthetic performance. Its exquisite structure and elegant form show the exquisite and artistic beauty of ancient building technology, and the dougong is not only a decorative component in the building, but also a symbol of the rheological change and development of the shape of the wooden building, reflecting the evolution process of ancient building technology and concept.

In general, the structural and aesthetic characteristics of the dougong not only reflect the inheritance and development of ancient architectural culture, but also provide rich inspiration for the innovative application of traditional culture in modern design.

RESEARCH METHODOLOGY

In the process of researching the inheritance of the structural aesthetics and cultural significance of the Ming and Qing dynasties in the art design of contemporary public space installations, the preliminary data of relevant books, literature, and related design fields are summarized and sorted.

Data Collection

Data were collected in a variety of ways. By consulting relevant academic literature, professional books and periodicals, this paper studies the historical evolution, current situation and development trend of dougong mortise and tenon installation art. Through the design of questionnaire surveys, the data on the cognition, preference and demand of the public for the installation art of dougong mortise and tenon are collected for different groups, so as to understand its influence and acceptance in modern society. The study used methods such as case studies, observations, interviews and focus group discussions. By analyzing the successful cases of the installation of dougong mortise and tenon joints, the design concept, realization method and artistic value of the installation are studied. Through the observation of exhibitions, artists' studios, etc., to understand the expression of the art form and the audience's reaction. The interviews covered the opinions of experts, artists, designers and other parties, and discussed their evaluations and expectations of mortise and tenon installation art. Through focus group discussions, the perceptions and views of different audiences on mortise and tenon modular installation art are brought together, and the consensus and differences between groups are discussed.

Data analysis

In this study, a combination of quantitative and qualitative methods was used to systematically explore the innovative application path of dougong structure in modern public space design. Focusing on the application and innovation of dougong structure in modern public space in Ming and Qing dynasties, this paper systematically discusses the application.

Through the systematic combing of a large number of related literatures, the literature research method analyzes the historical background, structural principle and artistic value of the dougong structure, and identifies the potential application value of the dougong in modern design, which provides theoretical support for the research direction.

The quantitative research method collected the feedback data of the public on the application effect and cultural atmosphere of the dougong structure in modern installation art through a questionnaire survey. Through statistical analysis, the effective questionnaires were determined according to the number of questionnaires issued, and the usability questionnaire was evaluated. The calculation is based on a margin of error of 4.5% when the 95% confidence interval is reached, which determines the rationality of the sample size It quantifies the audience's acceptance and affection for this traditional element in contemporary public space, revealing the popularity of the dougong structure in modern design. The design was evaluated using the KANO model, analytic hierarchy process (AHP), and mass function development (QFD) methods.

Quantitative study of the KANO model, analytic hierarchy process (AHP) and mass function development (QFD) method method to evaluate the design.

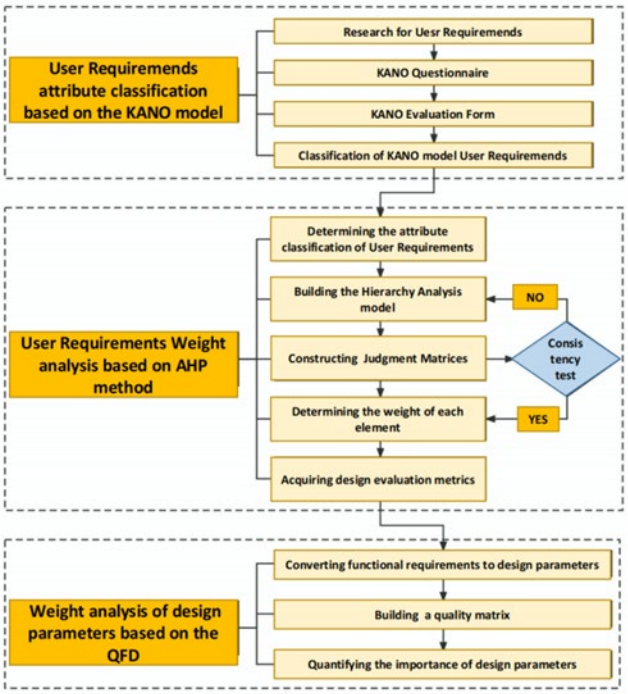

Figure 9 KANO-AHP-QFD design model

Model Analysis: 1) Use the KANO model to understand the public's expectations of the design and application of mortise and tenon installation art in public spaces (which can be obtained through surveys, interviews or questionnaires). 2) Identify and classify design elements, including mortise and tenon joints, materials, shapes, interactivity, etc., to understand their impact on public satisfaction. 3) Based on the results of the KANO model, determine the basic elements, performance factors, and attractive elements. Get a better understanding of how to optimize the art design of the arch mortise and tenon installation to meet the needs and expectations of the public.

Analytic Hierarchy Process (AHP) Analysis: 1) Use the AHP method to determine the relative importance of different design elements and elements. This may include mortise and tenon joining techniques, material selection, shape design, interactivity, and more. 2) Construct a hierarchy that hierarchies goals, sub-goals, and design elements so that you can quantify the relationships between them. 3) Develop a pairwise comparison matrix to help determine the relative importance between different design elements, which can be based on expert opinion or survey data. 4) Use the AHP method to calculate the weights of each design element so that their relative importance can be considered in design decisions.

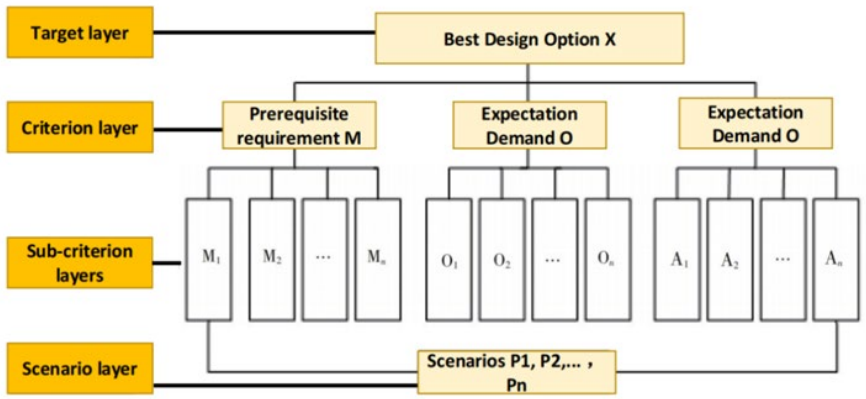

Figure 10 Analytic Hierarchy Model

QFD (Quality Function Deployment) design parameter weight analysis: QFD can improve user satisfaction planning by transforming customer requirements into design elements or production. In addition, it can be used in conjunction with other tools such as AHP (Analytic Hierarchy Process) to provide more comprehensive and in-depth analysis and decision support to ensure that the design and application of the art of the arch mortise and tenon installation in the public space meets the user's expectations and achieves the best results.

Through in-depth interviews with intangible cultural heritage inheritors, designers and experts, the qualitative research method further excavates the application potential and innovation space of dougong structure in modern public space. The interviews provide practical advice on how to incorporate modern design elements while maintaining a traditional aesthetic.

The case study method selects a number of examples of the application of bucket arch structure in modern design, deeply analyzes its design concept and technical implementation, reveals the specific strategy of the integration of tradition and modernity, and provides an effective reference for subsequent design practice.

This research methodology not only comprehensively covers the history and modern application of dougong structure, but also combines theory and practice, providing reliable data support and practical guidance for exploring its innovative application in modern public space.

RESEARCH RESULTS

By analyzing the structural aesthetics, formal language and decorative elements of the dougong, and exploring the inheritance of the structural aesthetics and cultural significance of the dougong structure in the contemporary public space installation art design, the following research findings are obtained:

1) This study systematically reviews the development process of the dougong structure in the Ming and Qing dynasties, and reveals that as an outstanding representative of mortise and tenon technology in ancient Chinese architecture, it not only carries the practical function of architecture, but also has profound value at the aesthetic and cultural level. Through literature research, it is clear that as the core component of traditional architecture, the structural design of the dougong not only realizes the load-bearing and seismic functions, but also shows a high degree of aesthetic characteristics through its fine modeling and craftsmanship. The formal aesthetics of the dougong not only reflects the wisdom and technology of ancient craftsmen, but also one of the symbols of ancient architectural culture. Its combination of decoration and practicality demonstrates the concept of traditional Chinese architecture pursuing the harmony and unity of structure and aesthetics. The study found that the historical and cultural connotations of the dougong, including its symbolic authority, stability and precision design, are still instructive for modern design. The artistic characteristics of the dougong are not only reflected in its geometric form and structural ingenuity, but also in the traditional cultural spirit it symbolizes, which provides a solid theoretical foundation for its innovative application in modern design.

2) Through an in-depth analysis of the application examples of the dougong structure in modern installation art, the innovative possibility of combining its formal aesthetics with modern materials and technologies is revealed. Through the case study, it is found that the dougong structure has not only been reproduced and applied in the design of modern public space, but also realized the leap from traditional architecture to modern installation art in form. It is found that in modern design, the geometric form of the dougong can be perfectly combined with modern materials such as steel and glass, showing a strong sense of modernity and cultural depth. This innovative application not only continues the structural aesthetics of the dougong, but also makes it gain a new form of expression in contemporary art through the combination of new materials and modern technology. Through the re-creation in the context of modern design, the traditional elements of Dougong have been given new vitality, reflecting the

adaptability and continuous influence of ancient architectural culture in contemporary society. The research shows that as a symbol of traditional Chinese culture, the dougong structure can realize the integration of cultural inheritance and modern innovation in a diversified way in public art installations, which provides an effective reference for future design practice.

DISCUSSION & CONCLUSION

As an outstanding representative of mortise and tenon technology in ancient Chinese architecture, the development process of dougong reflects the high unity of practical function and aesthetic value. The dougong not only realizes the load-bearing and earthquake-resistant functions in the structure, but also shows profound aesthetic characteristics and cultural connotations through fine modeling and craftsmanship. The combination of ornamentation and practicality reflects the concept of traditional Chinese architecture in the pursuit of harmony between structure and aesthetics. It's symbolic authority, stability and precision design continue to inspire modern design, showing that the artistic characteristics of the dougong have an enduring value in geometric form and structural ingenuity.

The combination of formal aesthetics and modern materials and technology has the potential for innovation. The geometry of the dougong can be perfectly integrated with modern materials such as steel and glass, showing a strong sense of modernity and cultural depth. This innovative application not only continues the structural aesthetics of the dougong, but also gives it new vitality, so that traditional elements can obtain new forms of expression in contemporary art. As a symbol of traditional Chinese culture, Dougong can effectively integrate cultural inheritance and modern innovation in public art installations, demonstrating the adaptability and continuous influence of ancient architectural culture in contemporary society.

To sum up, this study provides a theoretical basis and practical path for the inheritance and innovative application of dougong structure in modern installation art, and fully demonstrates the possibility of combining traditional culture with modern design. This integration not only enhances the cultural level and artistic atmosphere of modern public space, but also provides new ideas for promoting the revival of traditional Chinese culture in contemporary design, and encourages the recreation and application of traditional art elements.

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