Research on Artistic Innovation of Bamboo Seats from the Perspective of Sustainable Design

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Abstract. In the context of global low-carbon development and cultural confidence, bamboo, as a renewable, high-carbon sink, biodegradable, and environmentally friendly material, has become the core carrier for the sustainable transformation of the furniture industry. Currently, bamboo-made chairs often suffer from problems such as homogeneity in artistic style, insufficient modernization of traditional techniques, limited material expressiveness, and the separation of sustainability and artistry. Guided by the concept of sustainable design, this paper focuses on the characteristics of bamboo, the environmental-friendly material system, and studies and sorts out the cross-theoretical intersections of sustainable design, bamboo science, and furniture art aesthetics. It extracts five technical paths for the artistic innovation of bamboo-made chairs: form, structure, texture, craftsmanship, and cultural symbols. It also establishes a database of the performance and artistic compatibility of environmentally friendly bamboo materials. It proposes an artistic innovation evaluation system under sustainable constraints. Through design practice verification, the methods presented in this paper can effectively enhance the cultural recognition, material aesthetic expressiveness, user emotional value, and recycling efficiency of bamboo-made chairs. The research results enrich the sustainable furniture design theory system and provide technical support and practical models for the high-end, internationalization, and artification of bamboo furniture.

Keywords: Sustainable design; Bamboo seating; Artistic innovation; Environmentally friendly materials; Bamboo culture; Furniture aesthetics

1 Introduction

Under the backdrop of the global dual-carbon strategy and the construction of ecological civilization, the furniture industry is undergoing a transformation from a resource-consuming type to a green and sustainable one. Bamboo, with its rapid growth, renewability, strong carbon sequestration capacity, and the ability to be fully biodegraded, has become a core environmentally friendly material for replacing wood and plastic. As a major country in the world's bamboo resources, China has inherent advantages for developing bamboo furniture. However, existing research on the sustainable design of

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bamboo-made furniture mostly focuses on material technology such as bamboo material modification and composite, while there is a significant lack of research on the systematic integration of sustainable concepts and artistic innovation. There is a lack of integration with sustainable processing technologies; all the research has failed to systematically integrate the sustainable design concept and artistic innovation, and there are obvious theoretical gaps.

In relevant domestic and international studies, the field of sustainable design has established a theoretical framework covering the entire life cycle, reduction, reuse, and resource utilization, which has been widely applied in the design of green products and ecological furniture. The research on bamboo materials mainly focuses on modification techniques, formaldehyde-free gluing, and reconstituted bamboo production, with an emphasis on improving material performance. The research on furniture art innovation mainly focuses on recreating traditional styles and expressing formal aesthetics, lacking systematic innovation paths under ecological constraints. In summary, the existing research has not yet deeply integrated the sustainable concept, bamboo engineering technology, and contemporary art innovation. In particular, there is a lack of specialized theories and feasible methods for bamboo-made chairs. This article takes this as the starting point to conduct research.

The significance of this research lies in that it theoretically constructs a theoretical framework for sustainable design and artistic innovation of bamboo seats, and improves the ecological furniture aesthetic system; practically, it provides a replicable artistic innovation route for enterprises, and promotes the modern expression of traditional bamboo craftsmanship. The research adopts methods such as literature review, material analysis, and design practice.

2 Theoretical Foundation of Sustainable Design and Artistic Innovation of Bamboo Seating

2.1 "The Concept of Sustainable Design and the Characteristics of Bamboo Materials"

Sustainable design is a design paradigm based on ecological protection, efficient utilization of resources, and low-carbon principles. Its core adheres to the principles of reduction and degradability, emphasizing that products should minimize environmental load and achieve economic value balance while meeting functional and aesthetic requirements. In the field of furniture, sustainable design not only involves the greening of materials, but also encompasses the entire process of structure, technology, usage, and recycling, requiring products to have features such as long lifespan, easy maintenance, and low emissions [1,2]. Bamboo, as a typical environmentally friendly material, has advantages such as biodegradability after use, and is an ideal carrier for sustainable furniture. Bamboo has a density, strength, and hardness similar to high-quality hardwood, with excellent toughness and processing performance [3,4]. The following is a specific comparison of carbon footprints of common bamboo materials as shown in the figure 1 below:

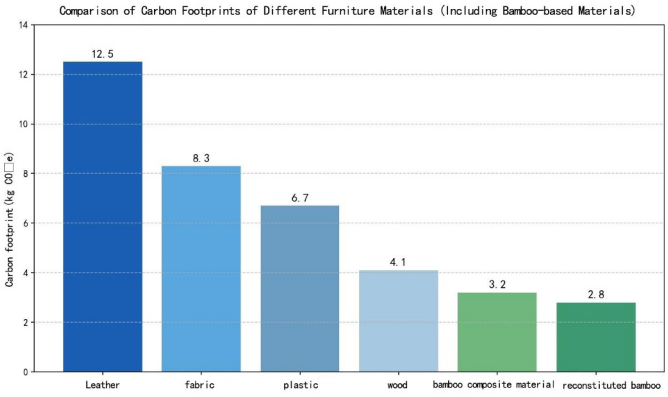

Fig. 1. Artistic innovation design scheme of sustainable bamboo seats

3 The Compatibility of the 3D Friendly Bamboo Material System with Artistic Innovation

3.1 Classification, Properties and Artistic Adaptability of Bamboo Materials

The types and processing forms of bamboo directly affect the expression methods and effects of artistic innovation. Mechanical strength, environmental friendliness, texture and processing performance tests were conducted on raw bamboo, bamboo laminated materials, reconstituted bamboo and bamboo veneers. Raw bamboo retains natural bamboo nodes and has the strongest ecological texture, making it suitable for naturalism and mostly used for seat frames, supports and decorative components; Bamboo laminated materials have a smooth surface and good stability, suitable for modern simplicity and can be used for seat surfaces, backrests and other large-area components; Reconstituted bamboo has high strength and uniform color, featuring modern industrial aesthetic characteristics, and is suitable for load-bearing structures.

To clarify the application boundaries of different types of bamboo, a comparison of the performance and artistic adaptability of four major types of bamboo was conducted. The results are presented in the table 1 below:

Table 1. Comparison of Environmental-Friendly Bamboo Material Properties and Adaptability to Artistic Innovation

material type	Environmental protection fea-	mechanical property	Surface texture	Artistic style adaptation	Seat application area
Raw bamboo	Completely biodegradable	good	Natural bamboo joints	Nature, Zen, New Chinese	Frame, legs, decorations
bamboo based panel	All-wood, eco-friendly	fine	Flat and uniform	Modern minimalism, Nordic	Seat surface, backrest, side
Reclaimed bamboo	High carbon sink	excellent	Compact and fine	Industrial style, light luxury	Base, load-bearing, support

material type	Environmental protection fea-	mechanical property	Surface texture	Artistic style adaptation	Seat application area
Bamboo veneer	Lightweighting	ordinary	Delicate and smooth	light luxury, New Chinese	Finishing, edge treatment, details

3.2 The Sustainable Principles of Bamboo Art Innovation

Environmentally friendly bamboo materials need to follow three principles in artistic innovation: prioritize the use of natural and low-processing bamboo materials, maintaining the original aesthetic of the materials; adopt environmentally friendly processing techniques without formaldehyde, heavy metals, and high VOC content to ensure health and ecological safety; in structural design, prioritize the use of detachable and glue-free connections, making it convenient for later recycling and material reuse, achieving sustainable development throughout the entire life cycle [5].

4 Technological Pathways for Artistic Innovation of Bamboo Seating from a Sustainable Perspective

4.1 Innovation in Form, Structure and Texture

The design of bamboo seats is innovative based on ergonomics. It emphasizes simplicity and adopts smooth curves and natural biomimicry as the main directions. It should match the natural texture of bamboo and be suitable for modern spaces, while also considering packaging, transportation and recycling to achieve the unity of aesthetics and low carbon [6].

Structural art innovation integrates mechanical structures with visual aesthetics, highlighting the rhythmic sense of the structure and achieving the concept of "structure as decoration". Sustainable structures employ non-glue plug-in connections and other detachable connections. The nodes themselves become the visual focus. Through structural exposure and node optimization, while ensuring strength and stability, it forms unique artistic recognition and extends the product's lifecycle [7].

The innovation of texture art focuses on the visual and tactile effects of the surface of bamboo materials. It enhances the aesthetic appeal of the materials through physical and technological means, and is divided into three types: natural texture, technological texture, and composite texture. The main surface treatment is environmentally friendly, avoiding chemical coating to maintain the breathable and degradable characteristics of the bamboo materials [8].

Cultural symbol innovation involves abstractly translating the bamboo culture, Eastern aesthetics, and regional intangible cultural heritage elements into contemporary design language. It avoids literal replication and integrates form, structure, and texture in a minimalist way, conveying the humble, resilient, and natural characteristics of bamboo culture. This aligns with the spiritual needs of contemporary consumers and enhances the cultural connotation and differentiated competitiveness of the seats[9, 10].

5 Sustainable Bamboo Seating: Artistic Innovation Design and Practical Application

Based on the previous theoretical and technical approaches, an innovative design practice for sustainable bamboo seating art was carried out. The design was positioned as a contemporary minimalist natural style, targeting high-quality home and public spaces. With the theme of "natural sustainability", it followed the principles of environmental friendliness, ergonomics, and recycling. It used raw bamboo and bamboo laminated materials in combination, adopted an adhesives-free gluing process, and the structure mainly consisted of mortise-and-tenon joints and detachable plug-in connections.

To verify the design effect, a comprehensive evaluation system was established from the dimensions of sustainability, artistic aesthetics, and cultural expression. Material experts, furniture designers, and users were invited to evaluate. A total of 43 valid questionnaires were collected. The results showed that the scheme reached a high level in each core dimension, proving that the artistic innovation path proposed in this paper is feasible and effective, and can balance ecological, functional and artistic values. The comprehensive scoring results of each dimension are shown in Figure 2.

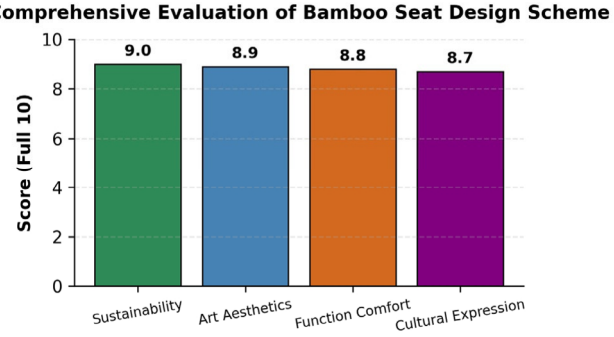

Fig. 2. Comprehensive evaluation radar chart of design scheme

The design process is based on material properties and combines ergonomics to determine the size and surface shape of the seat. With organic curves as the core form, the framework structure and weaving texture as the artistic highlights, the overall design is simple and smooth. The backrest, seat surface, and framework are modularly separated, and the surface is treated with wood wax oil to retain the natural texture of the bamboo. In terms of design iterations, a total of 3 sketch schemes were completed and 1:2 scale mock-ups were made for human-machine verification and load-bearing tests. Based on the feedback, the reclining angle of the backrest was optimized from 98° to 103°.

The design practice results are presented in the form of renderings and structural decomposition diagrams. The overall shape is shown in Figure 3 and 4. The seat retains the natural texture of bamboo while also presenting the delicacy and lightness of contemporary furniture, achieving a combination of sustainability and artistic innovation.

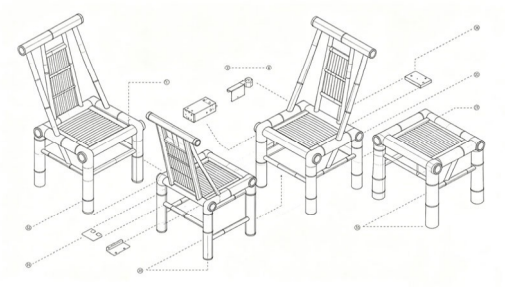

Fig. 3. Overall rendering of minimalist sustainable bamboo seat

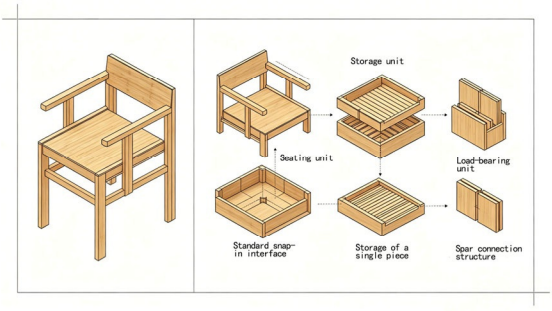

Fig. 4. Modular disassembly structure diagram of bamboo seat

6 Conclusions

This article, from the perspective of sustainable design, systematically studies the theory of artistic innovation in bamboo chairs and the unity between sustainable design and artistic innovation in bamboo chairs. Against the backdrop of low-carbon development and cultural confidence, bamboo, as a renewable and biodegradable eco-friendly material, through the synergy of material selection, structural design, process control and aesthetic expression, builds an innovative framework that emphasizes both ecological and artistic aspects. The research finds that different bamboo materials such as raw bamboo, bamboo laminated veneer lumber, reconstituted bamboo, and bamboo veneer have significant differences in surface texture and environmental protection characteristics, and each path and material type has a clear matching relationship. Morphological innovation is oriented towards organicization and lightweighting, structural innovation is supported by glue-free connections and mortise and tenon joints, texture innovation emphasizes the composite expression of natural and crafted textures, process innovation focuses on the modern translation of traditional bamboo craftsmanship, and cultural symbol innovation is integrated into bamboo culture and oriental aesthetics in a metaphorical way..

In conclusion, this paper, in light of the limitations of traditional bamboo furniture that emphasizes practicality over artistry, tradition over modernity, and material over

design, proposes an innovative system for bamboo chairs under the guidance of sustainable concepts. It clarifies the collaborative mechanism among materials, structure, and craftsmanship, providing theoretical support and technical paradigms for the high-end, international, and artistic development of bamboo furniture.

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