

Product Modeling Design Practice Based on Traditional Bamboo Utensil Schema Prototype*

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Abstract—This paper systematically studies the structure of bamboo and the schematic prototype of traditional bamboo wares, deeply analyses the design elements of bamboo from the aspects of shape, texture, character and cultural connotation, and summarizes its artistic aesthetic implication and morphological characteristics. Combining with design practice, this paper verifies the feasibility of using bamboo in product design, and explores the infiltration and transformation mode of traditional bamboo culture in modern design, so as to realize the inheritance and development of traditional art resources. The research shows that the traditional bamboo cultural resources as the intrinsic motive force of modern innovative design effectively enhance the cultural connotation and artistic value of the design object, and meet the requirements of sustainable design development, which provides references and practical ideas for bamboo creative product design.

Keywords—bamboo culture; bamboo utensils; schematic prototype; product modeling; product design; regeneration design

I. INTRODUCTION

With the continuous development of low-carbon environmental protection and sustainable design concept, the ecological design concept with environmental protection as the core has attracted more and more attention from the design community. As far as the attributes of industrial "material products" are concerned, bamboo products are derived from renewable natural resources and have strong plasticity. The resource cost, production cost and development cost of bamboo materials are low, which conforms to the original ecological moderate design concept advocated at present. On the spiritual level, Chinese traditional bamboo culture has profound humanistic value, aesthetic significance and artistic connotation. Various delicate folk bamboo utensils also reflect the artistic, symbolic and national advantages of bamboo. Modern creative products with bamboo as the main body have huge

design potential.

Understanding and summarizing the core content of traditional bamboo culture in China, using schema prototype analysis method to analyze the form and connotation of traditional bamboo utensils, combining with the aesthetic intention and interest of bamboo culture, this paper discusses the concrete application of bamboo culture in modern product design through design practice, which can convey the unique cultural ideology and artistic interest, present the regional characteristics of cultural ecology, effectively enhance the cultural connotation and value connotation of design objects, provide reference for regional diversified design, and promote the development of characteristic cultural and creative industries.

II. AESTHETIC ELEMENTS OF BAMBOO

Bamboo is an indispensable "cultural gene" in traditional arts and crafts, and an artistic carrier with aesthetic value. The aesthetic elements of bamboo can be summarized into five major points: appearance, internal texture, material texture, natural color and cultural connotation.

Structurally, bamboo is hollow cylindrical with irregular cross section. It has non-uniform distribution of bamboo joints, and different length of internodes. It is dense and orderly. The hollowness and irregularity of bamboo determine that it has the characteristics of wire. Because of its good flexibility, the shape of bamboo has a greater degree of freedom. It can realize the shape space of line, surface and body by bending or turning over. It can also slice bamboo vertically or horizontally, form surface or block by processing, and expand the application dimension of bamboo in design.

Texture refers to the body shape and surface pattern of the material, which reflects the image characteristics of the material surface and aesthetic feeling of texture, and makes the material texture more vivid. The texture of bamboo is mainly embodied in the surface and section. The outer surface of bamboo is smooth and waxy. There are many dark spots with uneven gradient distribution on the cross section, many compact and straight lines on the diametral section, and knot scars similar to wood grain on the section of bamboo knots. The natural texture of bamboo in the process

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of growth gives people a sense of flow and well-being. The bamboo with no axe chisel marks reflects a unique rhythmic beauty.

Texture and color are important design elements reflecting bamboo aesthetic feeling. Bamboo in the growth cycle has a green epidermis and a warm and flexible material. Old bamboo has yellowish or gray epidermis, tough material and clear texture, which gives people a simple and restrained feeling. There are also some special bamboos with striped epidermis, purple epidermis, and special structure and morphology, which have good form shaping potential (see "Fig. 1" and "Fig. 2").



Fig. 1. Different kinds of bamboo and their epidermal texture.



Fig. 2. Tortoise-shell bamboo and its bamboo crafts.

On the cultural level, the natural characteristics of bamboo are consistent with the aesthetic taste and ethical

consciousness of Chinese traditional culture. It fully and comprehensively reflects the ideal personality characteristics and humanistic spirit of Chinese traditional culture. Bamboo is not only a kind of natural objects in Chinese traditional culture, but also a representation of thinking mode. It blends in the depth of Chinese culture and becomes a cultural symbol with rich semantics. The cultural and aesthetic elements of bamboo are involved in modern design. The simple visual language and poetic metaphorical language have distinct characteristics of the times.

III. ANALYSIS OF SCHEMA PROTOTYPE OF TRADITIONAL BAMBOO UTENSILS

The word "schema" was first translated from German to express the meanings of "form, style, pattern, chart" and so on. Schema in design art can be regarded as a kind of essential type or universal form of art form. It is a "prototype" with generality, universality and visibility, which is gradually accumulated and refined in the process of aesthetic cognition. Schema is different from image. It refers to the composition of image and the result of abstract evolution and simplification. The ultimate basic structure is schema. Image is individual and diverse, while schema is a model abstracted from individuals, which has universality, generality and universality [3]. From the perspective of visual experience, schema prototype is the initial pattern or original model of artistic form, the norm standard formed by the general consensus and recognition of artistic form, and the basic image unit with agreed characteristics retrospectively deduced in the process of inheritance.

Schema and prototype contain the most typical characteristics of artistic things, and have strong usability and stability, which can inspire design thinking. Starting from the design requirements, combining with the rational construction mode, technological characteristics, perceptual connotation and material adaptability of bamboo, the specific connotation and structure of traditional bamboo utensils are analyzed from the perspective of schema and prototype. From the aspects of appearance, behavior and spirit, the prototype characteristics and attributes of traditional bamboo utensils can be summarized (see "Table I").

TABLE I. ANALYSIS ELEMENTS OF SCHEMATIC PROTOTYPE OF TRADITIONAL BAMBOO UTENSILS

Analysis of Schema Prototype Characteristic and Attribute Extraction			
Appearance	Behavior	Spiritual level	Product transformation
Form	Living needs	Aesthetic concept	Texture of material
Color	Usage mode	Cultural thought	Space
Ornamentation	Behavior pattern	Emotional symbol	Modelling
Utensil modeling	Production techniques	Ideology	Touch
Materiality		Way of thinking	Function

Based on the analysis elements of schema prototype, the traditional bamboo utensils can be transformed into design symbol as a cultural symbol. Through the choice of carrier, material and technology, the relationship between culture and product can be sought, and the combination optimization of design form can be sought through multiple experiments.

In the expression of modeling language, materials and processes are the core content, and also the key technical elements from design scheme to design and implementation (see "Table II").

TABLE II. TECHNICAL ELEMENTS AND CHARACTERIZATION OF BAMBOO UTENSILS

Process Classification	Form Expression	Artistic Characteristics	Technical Elements
Bamboo weaving	Wire rod	Being Natural, smooth, delicate, soft, tough and directional; Bamboo silk can be inserted and woven into three-dimensional shape and structure.	Bamboo has special fibers. Bamboo silk is flexible and can be bended and shaped at will to realize the combination of arrangement, weaving and enclosure.
Bamboo carving	Surface (plane)	Being Introverted and reserved; The natural texture and color of bamboo are expressed with warmth, simplicity and affinity.	On the surface of bamboo, the carving image is similar to painting, and the depth and the three-dimensional degree are different.
bamboo carving	Stereoscopic modeling	The shape is stable and full, and the physical characteristics of bamboo materials are directly applied to retain the unique texture of bamboo.	Round sculpture, relief, valuable carving and other forms are based on the natural form of bamboo or bamboo root carving.
Combined utensils	Multidimensional space	Organic materials, organic forms and a variety of materials of bamboo have a sense of hierarchy and diversity in structure.	Comprehensive Embodiment of Texture, Color, Processing Techniques, Material Application and Morphological Structure

Charting and analyzing the schematic prototype of bamboo products can extract the artistic symbols and visual elements with representative cultural characteristics, transform the "shape" and "meaning" of bamboo into modern visual language with epochal and national characteristics, and draw lessons from the advanced modern design methods, technical links and design procedures, so as to provide a more complete design research and development framework for bamboo creative products. The breakthroughs and innovations in the application of materials and processes, and the exploration of multiple design means can endow bamboo products with profound connotation and diversified forms of expression.

IV. DESIGN METHOD AND PRACTICE OF BAMBOO CULTURAL AND CREATIVE PRODUCTS

At present, the bamboo product design level on the market is uneven; the material of bamboo products is single; the function and form of products lack innovation; and the added value of products is low. In order to optimize the utilization of bamboo resources, it is necessary to break the thinking pattern formed by traditional bamboo culture and technology, and build a redesign concept with inheritance and innovation as the core content. From the functional attributes and cultural characteristics, the study of the artistic form, cultural implication and ecological significance of bamboo art can improve the core competitiveness of bamboo products and meet the sustainable concept of integrated design by the organic combination of artistry, technology and commerciality of design.

Referring to the analysis methods and ideas of schema prototype, the bamboo product design and development process is divided into four stages, including "cultural analysis, product attribute characteristics, cultural transformation symbols, design form transformation, material technology" and so on. In the first stage, samples of traditional bamboo utensils of different periods and types are selected and analyzed, and prototype features are extracted and summarized. In the second stage, prototype features of bamboo utensils are separated into three parts: shape, color and decoration, and formal elements are extracted separately.

In the third stage, prototype features of bamboo utensils are reconstructed to combine shape, color and decoration with products. The theme and conception of the design form a new product modeling prototype with clear structure. In the fourth stage, product model and visualized three-dimensional prototype are designed to further explore the design concept, function, shape, size ratio, development and design depth of the product.

After the design concept of bamboo products has been completed, it is necessary to try to carry out multi-dimensional, multi-carrier, multi-material, multi-process experimental exploration to maintain the diversity, originality and novelty of product design. The best combination of different dimensions, different carriers, different materials, different processes and design will be carried out, so as to maximize the content of bamboo products in line with the quality of the form of expression.

The design idea is clarified. The project team carries out a series of original conceptual design schemes around shape and function, product process innovation and product semantics development.

A. Combination of Appearance Modeling and Function

On the basis of traditional technology and guided by modern life aesthetics, the combination of appearance modeling and application function is an effective way of modern life utensils design innovation. The form of appearance design mainly involves shape, decoration, color and so on. It can try the innovative method of "transplanting and reconstructing". It can extract elements from traditional design symbols and cultural symbols and apply them to the design of bamboo products to achieve the purpose of innovation. "Pingzhu" tea set design (see "Fig. 3", designer: Hu Zhengbin) refers to the natural form and the way of creation of bamboo morphologically, highlights the morphology and semantics of bamboo, adopts the bamboo weaving technology of porcelain body, and combines bamboo elements with ceramic technology. While realizing its functions, it can be harmoniously integrated with the modern home environment through moderate innovation in form.



Fig. 3. Tea set design of "Pinzhu".

Because of the strong attributes of bamboo, the use of a single bamboo has great limitations in product modelling design and function expression. The combination of various materials can effectively improve this defect. Under the modern manufacturing technology, it is the general trend that bamboo is fused with other materials. Different materials complement each other in the same product [5].

B. Material Synthesis and Process Innovation Design

Traditional bamboo utensils are exquisitely crafted and pure. The production of each product will consume a lot of manpower and time. With the help of modern science and technology, the traditional bamboo production technology can be better developed in the modern industrial environment by exploring new technological forms. The combination of new experimental materials and traditional materials is one of the innovative means of bamboo product design. It can not only enrich the form and characteristics of products, but also retain the excellent characteristics of traditional technology.

Bamboo material has its own particularity. When bamboo is used in the design of household cultural products, it is necessary to fully consider the tactile, texture, hardness and other factors of the material, make rational use of a variety of material comparison methods, and use traditional bamboo, composite materials and new materials to change the single material manifestation. "Bamboo Elements" tableware design scheme (see "Fig. 4", designer: Xie Tao) combines bamboo and glass to produce visual and tactile contrast. Natural bamboo warmth and cold industrial glass blend, bringing a new sensory experience.

"Bamboo Structure" household product design scheme (see "Fig. 5", designer: Liu Shixiao) mainly combines modern technology to carry out functional module design of bamboo. Taking the single form of bamboo stem as the basic element, the bamboo is curved by using the thermoplasticity of bamboo, and a new product form is produced by arbitrary combination of mortise and tenon structure. The users experience the toughness of bamboo through touch. And it shows the natural material shape and natural physical properties of bamboo. This modular design not only effectively reduces the production cost, but also has better expansibility and is easy to be modified. It not only creates a concise and modern product form, but also simplifies the production process of the product.



Fig. 4. "Bamboo Elements" tableware design.



Fig. 5. "Bamboo Structure" household product design.

C. Cross-border and Derivative Design

The function and demand of products determine the design dimension, and the design thinking in turn will affect the function. There is the causal relationship between the two. In the process of product design, it is indispensable to continuously try and explore the design scheme until the most appropriate form of expression is found. Multidimensional and multi-carrier cross-border exploration can not only diversify product styles and categories, but also derive more abundant product categories.

Materialized substance of products is realized by means of shape, material (texture, mechanism and color composition) and process. On the basis of paying attention to form presentation, enhancing cultural content can increase the added value of products. The lamp design of Bamboo Rhyme (see "Fig. 6", designer: Zhou Xuhui) mainly considers the shape sublimation of bamboo and the modal implication of bamboo color. It explores the charm of bamboo, the extraction of personality characteristics and the added value of bamboo cultural symbols. The texture of bamboo silk shows brilliant light and shadow effect in the light mapping. The elements of bamboo culture are presented through different forms of products, and are transformed in different media of modern life to form serialization and diversification of creative products.



Fig. 6. Lamp Design of Bamboo Rhyme.

D. Enlightenment and Design Experience

Through the practice of creative design of bamboo products, the development of product shape and function, product processing and technological innovation, induction of cultural symbols and promotion of product cultural connotation are explored, and the development methods and ideas with reference value are formed. The innovative design of bamboo products, first of all, needs to change the traditional design concepts, comprehensive use of cutting-edge innovative design methods and thinking. Secondly, the use of product materials tends to be ecologically, economically and diversified. In the specific design process, different materials are combined to enhance the product's texture and aesthetics. At the same time, the product design is beautiful, simple and generous, functional, and the overall design tends to be intelligent and less material.

V. INHERITANCE AND DESIGN RENEWAL OF TRADITIONAL BAMBOO CULTURE

The innovative design of bamboo products needs to be considered from both material and non-material levels: bamboo materials at "material" level and bamboo culture at "spiritual" level.

Material level includes material selection, processing technology, production technology, and shape and so on. It should avoid singularity and realize the comprehensive use of various materials in terms of material selection; adopt modern industrial technology to enhance the production process of bamboo products, develop new composite bamboo materials, strengthen the transformation of bamboo construction components; and highlight the cultural characteristics and charm of bamboo products in terms of color, shape and texture.

The non-material level includes such factors as art, culture, aesthetics, concept and human nature. Product design expresses regional characteristics, regional culture and national emotions through different bamboo materials, and continues the genetic and aesthetic value of traditional culture; breaks through the functional attributes of products, uses humanized and emotional design to cater to people's aesthetic taste, consumption concept and value orientation; and makes the analysis from traditional bamboo culture, spiritual connotation, humanistic value, aesthetic

significance and other aspects of bamboo graphics. The external form of bamboo products is combined with the internal spiritual character.

At the same time, it is necessary to actively explore more ecological and environmentally friendly manufacturing methods and design methods, and take into account the modularization and scale production of bamboo products, so as to prolong the life cycle of bamboo products from design, production, sale, use to recycling, establish a characteristic bamboo product design system and brand, and promote the transformation of local bamboo industry from traditional manufacturing mode to modern industrial mode.

VI. CONCLUSION

The connotation of traditional bamboo culture is the same as that of traditional Chinese aesthetics. The core value of traditional bamboo culture lies in its personalized nature. In the design practice of modern bamboo products, whether structural or decorative use of bamboo, designers need to thoroughly observe, examine and study the characteristics of bamboo and its visual and tactile feelings, as well as the cultural and psychological experience resulting therefrom, rationally choose the aesthetic elements of bamboo, and display the unique emotional tension of bamboo [1].

The framework of schema prototype analysis provides a complete idea for product innovation design. The understanding and grasp of bamboo form is based on nature, and the emphasis is on the understanding of cultural artistic conception and spiritual content. The ecology of bamboo is in line with the green environmental protection standard advocated by modern design. The cultural connotation of bamboo also provides a new interest for modern aesthetics. On the basis of inheriting and developing the traditional bamboo culture, the innovative design of bamboo products needs to show "human feelings" and "warmth", perfect combination of materials, practical functions and forms, and bring into play the sustainable ecological value of bamboo through diversified, characteristic and nationalized bamboo product design.

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