

Bionic Design Research: Biomimetic Teacup Design With 3D Printing Technology

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Abstract. Tea originated in China. According to archaeologists' research, tea culture has a history of over 4700 years and has profound historical and cultural connotations. Tea utensils, also known as tea-drinking utensils, serve as carriers and become a manifestation of the spirit of the tea ceremony. This article takes product innovation design as the starting point to carry out the conceptual design of creative tea cups. Selecting tea cups as the design subject and lotus flowers as biomimetic entities, based on the characteristics of 3D printing technology, using biomimetic design for form and internal structure design, combined with hollowed-out external structure design, to form the final tea cup design product, effectively enriching the tea cup product form and meeting the diversified needs of modern consumers for tea cup products. Through the specific practical design process of this teacup, the application of biomimetic design, 3D printing technology, and hollowing-out technology will be demonstrated, in order to provide design inspiration for similar product designs.

Keywords: 3D printing; teacup; biomimetic design; plant.

1. Introduction

The development of tea history has become a component of China's excellent traditional culture. Its rich culture not only demonstrates national temperament but also summarizes and integrates the wisdom of different masses [1]. This design will carry out biomimetic innovation in the form and structure of the teacup, selecting the plant lotus with unique form and structural beauty as the biomimetic object, and combining the characteristics of 3D printing technology for integrated molding design to form the final teacup product. The outer part of the teacup adopts a spiral hollow design, which can effectively increase the heat dissipation rate of the tea, and the cup body has a significant insulation effect, effectively solving the risk of scalding caused by the high temperature of the tea inside the cup during use.

2. Background

Tea originated in China. According to archaeologists' research, tea culture has a history of over 4700 years and has profound historical and cultural connotations. Tea utensils, also known as tea-drinking utensils, serve as carriers and become a manifestation of the spirit of the tea ceremony. The connotation of the tea ceremony spirit lies in returning to nature and returning to nature [2]. The direction of this study is to combine the profound connotation of the tea ceremony spirit and study the bionic innovative design of teacups in terms of shape and structure. Select the plant lotus with unique form and structural beauty as the biomimetic object, and ultimately design the corresponding teacup product. In order to maintain the production integrity of product form and structure, research results indicate that combining 3D printing technology can further integrate and shape the designed product.

3D printing technology is a technology based on digital model files, which uses adhesive materials such as powdered metal or plastic to shape objects through layer-by-layer printing [3]. As an innovative additive manufacturing technology in the digital era, 3D printing technology, due to its special working principle, discretizes 3D digital models into two-dimensional layers, overlays and solidifies the raw materials layer by layer, thereby converting the graphic data input to the computer

into 3D solid products. Therefore, using 3D printing technology to produce products can achieve integrated molding, short production cycles, strong structural design, and can be suitable for producing products with complex structures and strong product performance. In recent years, 3D printing technology has been widely applied in various industries of product and material production. The continuous development and improvement of 3D printing technology have also provided a feasible path for the application of 3D printing technology in product production.

The design work presented by this research institute, the teacup, adopts an abstract bionic design method in the form and structure design of the product. Due to the integrated structure and complex shape design of teacups, it is difficult to shape molds that meet production requirements through traditional production methods, and the long production cycle and high production cost of making teacups are also reasons. The design of the teacup combines the principles of 3D printing technology, reflecting the performance and advantages of 3D printing in the spiral structure and overall shape design of the teacup. The use of 3D printing technology for the production and production of teacups can fully reflect the artistic form and form beauty of product design on the basis of its original functionality and integrate the beauty of product form design into modern aesthetic concepts.

3. Design Method

Biomimetic design, also known as Design Bionics, is an emerging interdisciplinary field that has developed on the basis of bionics and design. It mainly involves related disciplines such as biology, mechanics, engineering, economics, color science, aesthetics, communication, morphology, etc. [4]. The development of biomimetic design and its application in product form design can broaden the imagination space of product designers, greatly enrich the quantity of product forms, better meet the psychological needs of modern consumers, and effectively increase the added value of products. The biomimetic design will become a popular trend in product form design in the future.

In the process of using biomimetic design for product form and structure design, two biomimetic methods, concrete biomimetic and abstract biomimetic, are usually used [5]. As the hometown of tea, China's tea culture has accumulated and developed for thousands of years. As one of the components of tea sets and a reflection of tea culture, the teacup can be designed using bionic design principles in its form and structure. Through bionic design, tea culture and natural factors can be organically integrated to form a unique and creative tea set. This is also the original intention and concept of this study's design of this teacup. Based on the above concept, this teacup adopts the principles of bionic design in its structure and form design. Through abstract bionic design, starting from the natural form of the lotus, it repeatedly summarizes the intuitive form of the lotus until its abstract form. By using the abstract form of the lotus, a specific teacup form design is carried out, reflecting the unique and essential characteristics of the lotus in the overall form of the teacup.

4. Commercial Attributes of the Product

The basic attributes of a commodity are value and usage value. The value of use refers to the attribute of a product that can meet people's certain needs and is the natural attribute of the product. Teacups, as one of the components of tea sets, have a basic function and value and are used for carrying tea and tasting, mainly used in the tea tasting process.

Due to the different properties of tea, it is necessary to use a water temperature of over 70°C for brewing [6]. During the brewing process, the surface temperature of the teacup is high, which can easily cause burns. Therefore, the materials used for brewing tea and carrying tea must have heat resistance thermal insulation, and heat dissipation functions. The process of teacup design, considering the function and purpose of the teacup, the heat resistance of its material, and the overall insulation and heat dissipation design have become important factors considered in the teacup design process.

Teacups are usually made of ceramic liners and plastic shells, with a large internal space. The air insulation design is used between the inner and outer walls of the cup, and the spiral hollow design is used on the outside of the cup. This design can effectively increase the heat dissipation rate of the tea, significantly insulate the cup body, and effectively solve the risk of scalding caused by the high temperature of the tea inside the cup during use.

5. Design Process

The teacup designed using abstract bionics mainly adopts the bionic design of a lotus shape and structure. In the process of product design, the bionic design of product form refers to the extraction of biological form elements through direct imitation of organisms or simplification of external morphological features, and the application of artistic processing design methods to product form design, which is presented in the final product appearance [7]. Structural biomimetic design refers to identifying the organic relationship between the internal structure of organisms and the internal structure of products through external phenomena based on different design needs and purposes, extracting this structural element, and applying it to the final product design.

In the process of studying the shape design of teacups, the main approach is to depict the abstract three-dimensional form of lotus flowers through organic curves and lines through sketches, and then demonstrate the special three-dimensional form of lotus flowers through organic curves. Through the application of abstract bionic design principles, the artistic form elements and order structure elements of lotus flowers are reflected in the design of this teacup. This design effectively achieves abstract bionic requirements by first abstracting and then materializing, achieving innovative product form and structural design, and enhancing the visual effect of teacup products.

Hollow out, as a long-standing Chinese craftsmanship, has been applied in folk clothing, architecture, and other designs since ancient times. It is a traditional artistic form that can reflect decoration and meet functional needs [8]. With the continuous development and innovation of traditional Chinese culture, as well as the continuous improvement of consumers' aesthetic ability, hollowing out, a highly artistic process, has been widely applied in the field of product design and production [9]. The essence of hollow design is transparency. Applying hollow design to product design can not only enhance the artistic and ornamental appearance of the product form, but also effectively save product materials, implement the concept of green product design, and enhance the heat dissipation function of teacup products. In order to achieve the best taste of tea, there is a high requirement for the temperature of the water during tea brewing. Usually, high-temperature water is used for brewing, and some tea enthusiasts prefer to drink high-temperature tea to maintain the taste of the tea. Therefore, it is easy to be scalded by the cup of tea during tea brewing and pouring. In response to this pain point issue, a hollow spiral design is required when designing the external insulation structure of the teacup. The spiral structure increases the stability of the teacup, and the hollow structure is more convenient for tea heat dissipation and insulation, which can reduce waiting time for tea drinking.

6. Design Innovation Points

The teacup design method in this study adopts abstract biomimetic design techniques, achieving design innovation in terms of form and structure design; Using 3D printing technology to improve the production of teacup products and color production; Using hollow-out design methods to solve the pain points of teacups, ultimately forming a design product. Product form can be an abstract conceptual form, which is one of the expressions of product language. It can also be a realistic form that relies on natural forms. The concept of teacup design is based on maintaining the basic functionality of the teacup, coupled with abstract biomimetic form design and structural design. Taking the form and structure of plants as inspiration, it extracts their form and structural elements, integrates them into the concept and ideas of teacup form design and structural design, and carries

out product design innovation. Meanwhile, based on the characteristics and advantages of 3D printing technology, it can break through the barriers in the design of complex teacup structures, greatly expanding the design space of teacup structures [10]. Applying the principles of biomimetic design to the design process of teacups can innovate the form of teacup products, enrich the types of teacups and tea set forms, and greatly enhance the added value of teacups.

7. Conclusion

With the continuous improvement of China's productivity level, the competition in the commodity market is becoming increasingly fierce. Product competition is no longer limited to the use value of products but also includes the added value of products. Using original and inherent design methods in product design innovation can easily lead to inspiration exhaustion and design difficulties. The widespread application of biomimetic design in the field of product design has provided new sources of inspiration for product designers and opened another door to design. The development of 3D printing technology can break through the barriers in product form and structural design, effectively expanding the thinking boundaries of product designers. In product design, making full use of the progressiveness of 3D printing technology and the naturalness of reasonable use of bionic design can greatly improve the innovation of product design. The main achievement of this study is to integrate the two and use advanced 3D printing technology to produce products with advanced concepts, allowing the development of technology to drive cultural progress, in order to provide design inspiration for similar product designs.

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