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Research Article

Ceramic Shape Design Based on Intelligent Space Simulation Technology

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With the development of the times, intelligent space simulation technology has gradually emerged in the design of ceramic forms, and the development of modern ceramics has gradually transformed into artistic development. The development of ceramics must conform to the design trend, adjust the rhythm, and seek development opportunities. Organic design opens up a green channel for ceramics and integrates into the lives of today's people. This paper mainly discusses the external form of ceramics and studies from two levels of curve form and bionic form. Through the intelligent space simulation technology, the shape design of ceramics is studied, and the optimal shape of ceramics is obtained, which enables people to have a better understanding of ceramic art.

1. Introduction

Ceramic is an ancient and traditional product. The historical value and cultural value carried by ceramics are immeasurable. During the development of ceramics, the design of ceramics is constantly changing, expanding, and enriching. The development of ceramics must conform to the design trend, adjust the pace, and seek development opportunities [1]. The organic design concept pays attention to balance and coordination. In the complex material life, people constantly seek the balance between things, which is a dynamic balance relationship. The combination of modern ceramic design and intelligent space simulation technology, under the pressure of high energy consumption of materials and resources, and intelligent space simulation technology has opened up a green channel for ceramics, allowing ceramic art to be integrated into people's lives, so that ceramic art can be produced in people's daily life [2].

In the classification of ceramic product design, in terms of its design nature, it can be divided into the improved design and innovative design. The so-called improved ceramic product design is based on the use of the original ceramic product, improving the design in some aspects of the ceramic product to make the ceramic product easier to use, easy to use or easy to process and manufacture [3]. However, because its nature is to improve on the basis of existing ceramic products, it does not make a leap over the main functions and properties of ceramic products, so it is difficult to achieve breakthrough results, which is an increase in "quantity" and "quality." The core of an innovative ceramic product design is to redefine the way users use it and then reorganize the internal factors of ceramic product design, that is, there are breakthrough changes in the use purpose, material, structure, shape, etc. of ceramic products. Redefining the way users use ceramic products is the basis of innovative ceramic product design. Once the use purpose, operation method, and use environment of ceramic products are redefined, the internal factors of ceramic products must be recombined [4]. This is exactly what innovative ceramic products are fundamentals of product design. The form of ceramic products is the realistic basis for the formation of ceramic products, and it is also the precondition for the realization of the material and spiritual functions of ceramic products. When consumers choose and use ceramic products, they often judge their use methods through the information conveyed by the visual or tactile forms of ceramic products [5]. For example, the shape and structure of the teapot handle suggest how people pick up and pour the teapot; the shape of the plate in the tableware indicates that it is used for dishes with less soup. All of these, without the need for textual explanation, show that the form can accurately reflect the operation mode and function of the ceramic product.

After the advent of the industrial age, science and technology developed rapidly. People's observation and understanding of nature are more in-depth and thorough, and they have experienced a cognitive process from the outside to the inside, from the macro to the micro [6]. The study of biological forms and structures in nature has gradually formed a professional discipline—bionics. Under the guidance of bionics, the designer combines nature and human needs, uses a variety of craftsmanship, highlights the concern for human nature and emotion, combines practicality and artistry, and makes ceramics a naturalistic spirit and humanistic care. Modern ceramics pay more attention to the extraction of balance and rhythm in natural forms and elevate bionic design from figurative to abstract, so as to design porcelain works that can better serve people's material and spiritual life [7]. The reason why daily-use ceramic products can exist in life for a long time and is welcomed by people is that it has its use value, conforms to functional utility, and is closely related to people's lives. The design of daily-use ceramic products has specific functional attributes. Its material characteristics and processing methods must meet the requirements of people's use and, at the same time, adapt to people's aesthetic habits, thus forming unique aesthetic characteristics. As an important part of daily life, it is the most common and common aesthetic object for consumers. Consumers choose, purchase, and use under the control and adjustment of certain psychological laws. Therefore, the design of daily-use ceramic products is inseparable from the analysis and research of consumer psychology. This paper discusses the application of intelligent space simulation technology in the shape design of ceramic products, hoping to let more people understand the art of ceramics and promote its inheritance and development.

2. Form Design of Ceramic Products

2.1. Curve Shape Design of Ceramics. Because of the intense loneliness that the increasingly competitive environment makes, people begin to understand themselves and go back to square one. The importance of products that are closely related to nature depends on the recognition of the values of health and well-being in nature. Therefore, all philosophies and attitudes about human life have tended to pay attention to nature. Designers capture inspiration from nature, look for the source of various life, and, through their own refining and processing, consciously shape works of art, giving ceramic works of art a new soul. Design should respect nature. The relationship between nature and design is like blood and veins. It is inseparable. It is a link between nature and life. Under the trend of people seeking a more natural and primitive way of life, and under the trend of the times when the relationship between design and natural life is increasingly close, bionic design and ceramics are combined with each other, and the concept of bionic design came into being. Biomimetic design, as the point of convergence between human social production activities and nature, has achieved a high degree of unity between human society and nature and is gradually becoming a bright spot in the development of ceramic design.

As one of the morphological visual languages, from the perspective of graphic composition, the curve is the smallest unit of artistic form, and it is applied to product design with its various natural forms. The current curvilinear form is one of the characteristics of organic forms, and ceramics have a strong plastic shape, which can well show and express organic forms. A flattening curve is a sphere formed by a uniform rotation of concentric circles and uniform external thrust. Its line form depends on the shape, and the shape depends on the material characteristics of the object itself. Under the influence of the process characteristics, the shape and structure of the ceramic itself present the expression of a flattened curve, forming the basic modeling structure of the sphere, which is the expression of the flattened curve. Kitajun adopts the concept of organic design in many design fields. Native Japanese handicrafts pursue the harmonious coexistence of materials, shapes, technologies, and nature in nature. This is a work of art with a life attitude formed under natural conditions. Sacchetti et al. extracted many oriental elements into their own product creation, forming their own unique style [8].

2.2. Three Dimensional Surface Design of Ceramics. The three-dimensional surface is a geometric body surrounded by a curved surface or a curved surface and a plane. From the perspective of the shape of the ceramic product, the three-dimensional surface is the combination of the curved surface and the plane projection that makes up the curved surface. The works of British ceramist Tina Vlassopulos are one of the representatives of the organic form of ceramic design [9]. In the pottery works designed by the author, the colors used are basically a combination of simplicity and nature, and the morphological structure is more soft [10]. The series of vases he created fully display the lines of ceramics through the overall shape. And in the author's other pottery works, most of them are based on lines to construct unique ceramic works. There is also the work "Toot" by Vlassopulos as shown in Figure 1(a). The neck of the bottle is inclined and curved, the belly of the bottle is protruding, and the outside of the Taiping mouth is still in a protruding state. The shape has a large tortuous transformation, forming an S-curve. When designing ceramic works, Vlassopulos transformed the S-curve into a three-dimensional structure, making the curve more three-dimensional [11]. The outer contour lines of the bottle are also very fine and smooth, which can echo with the overall structure of the bottle. This ceramic product design perfectly demonstrates the organic language form in ceramic design. The overall shape of the plate is like a soft white petal, with three undulating arcs that expand naturally. In order to

Toot Bracelet

Figure 1: Some works displayed.

ensure the area of the plate, the three petals are deformed and designed to be easy for people to grasp, so that while ensuring the function of use, it also shows an organic sense. In a series of ceramic jewelry created by Jack Booth, we fully feel the charm of ceramic materials. Unlike most of the popular ceramics in Jingdezhen, Jack Booth tries to highlight white porcelain. The market-oriented design of Jingdezhen ceramic ornaments is based on the color of the ceramic itself, but Jack Booth uses subtraction and just uses simple geometric shapes to assist the ceramics [12, 13]. For the material [14, 15], there is also a classic design-today's necklace, with a semicircular geometric design and adjustable cotton rope; when worn, the pure white ceramic surface occupies the core of the chest, while the large ceramic surface and the conspicuous white porcelain color, concise and lively, highlight the original sense of ceramic simplicity. The shape of this ceramic ornament is not a simple and sensual mechanical geometry but is inspired by the organic forms of nature. The white porcelain bracelet made of tree trunks is naturally expressed by cylinders and large faces [16]. The cylindrical shape itself has a curved feel, rather than a straight cylindrical shape, and the wavy bracelet is also naturally designed as shown in Figure 1(b). When Jake Booth expresses the sense of wavy curve, he abstracts the design elements but retains the natural meaning and forms an image form. In this ceramic jewelry design, the iconic design vocabulary is composed of bright colors, large-scale block shapes, and simple and soft lines, creating a highly recognizable fashion design style, which is a relatively successful ceramic jewelry. In a case, the designer hopes to reflect today's fashion theme through a simple and organic modern expression: ecological, organic, capable, and orderly.

3. Intelligent Space Simulation Technology

The advantages and disadvantages of the simulation platform are mainly reflected in two aspects. One is the interactivity of the platform. The interactivity of the platform is essentially reflected in the modeling process in the simulation foundation [17]. In the modeling process, good interactivity is service-oriented. The basic requirements of users are the external requirements of the simulation platform; the second is that the quality of the simulation engine directly determines the usability and main value of the simulation platform, that is, the internal requirements of the simulation platform [18–21]. There are basically two realization methods for the modeling means based on modern simulation: (1) graphical modeling represented by UML (Unified Modeling Language) and (2) scripted modeling based on scripting language. Today, most simulations generally use graphical modeling, which can provide users with a good sense of interactive experience. However, for some complex batch simulations, the interaction of simulation is not the focus, but the pursuit of simulation solutions for large-scale data. Therefore, both aspects are indispensable. The core and top priority of the simulation foundation that the simulation engine mainly completes the execution and scheduling of the simulation tasks and the solution of the solver in the entire simulation process. In terms of practical applications, the simulation platform shown in Figure 2 can reduce the entry threshold and capital investment for building computing clusters for users who need high-performance simulation functions. Users with simulation requirements are not required to use any system. They only need to have a browser locally, and they can access the high-performance simulation function through the web anytime and anywhere to complete any simulation tasks required. Service-oriented is the overall architecture of the entire simulation platform, that is, the platform's construction idea is based on service-oriented, including the construction and implementation of the entire simulation is also based on a service-oriented concept [22–25].

EVS is the explained variance, which refers to the variance score of the model, and R^2 is the coefficient of determination or goodness of fit. The two calculation formulas are as follows:

$$\mathrm{EVS} = 1 - \frac{\mathrm{Var}\left(X_i - \bar{X}_i\right)}{\mathrm{Var}(X_i)}, \tag{1}$$

$$R^2 = 1 - \frac{\sum\left(X - \widehat{X}\right)}{\sum\left(X - \bar{X}\right)}, \tag{2}$$

where Var is the variance, X_i is the actual value, and $\bar{X}_i$ is the mean.

MSE is the mean square error, which represents the expectation of the error variance:

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}\left(X - \widehat{X}\right)^2, \tag{3}$$

where X is the actual value and $\widehat{X}$ is the predicted value.

MAE is the mean absolute error, RMSE is the root mean square error, and MAPE is the mean absolute percent error, as follows:

$$\mathrm{MAE} = \frac{1}{n}\sum_{i=1}^{n}\left|\widehat{Y} - Y\right|, \tag{4}$$

$$\mathrm{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\widehat{Y} - Y\right)^2}, \tag{5}$$

$$\mathrm{MAPE} = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{\widehat{Y} - Y}{Y} * 100\right|. \tag{6}$$

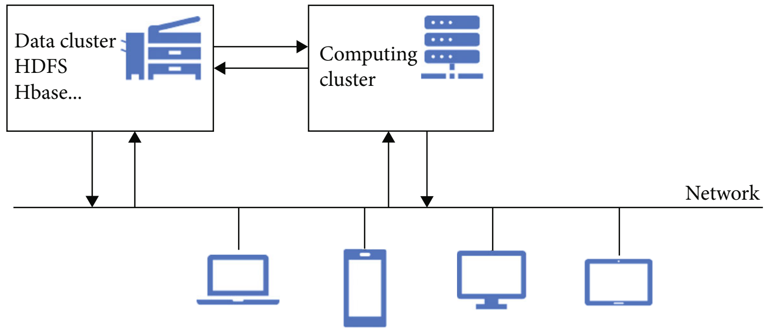

Figure 2: Physical structure of the simulation platform.

In the above formula, Y is the actual value and $\widehat{Y}$ is the predicted value.

Among them, the occlusion angle algorithm is

$$\mathrm{SVF} = \cos^2 \beta \left(\frac{\alpha}{360} \right), \tag{7}$$

where β is the height of the occlusion angle and α is the azimuth.

The spatial orientation is calculated as follows:

$$\vec{x} = (x, y)^T, \vec{x_1} = (x_1, y_1)^T. \tag{8}$$

Then, (8) can be obtained by a two-dimensional change:

$$\begin{bmatrix} x \\ y \end{bmatrix} = \mu \begin{bmatrix} \cos \alpha & -\sin \alpha \\ \sin \alpha & \cos \alpha \end{bmatrix} \begin{bmatrix} x_1 \\ y_1 \end{bmatrix} + \begin{bmatrix} S_1 \\ S_2 \end{bmatrix}. \tag{9}$$

Among them, x and y are the coordinate values, μ is the scaling coefficient, α is the rotation coefficient, and S is the translation value.

The hardware environment of the cloud platform is composed of a private cloud composed of several servers, disk arrays, graphics workstations, and various terminal computers, as shown in Figure 3, and is connected to each other through gigabit switches to form a LAN (local area network) network environment; graphics workstations and terminal computers in the network are formed. Various simulation services and simulation resources provided by the cloud server can be accessed through Gigabit Ethernet. Supported by their corresponding system software, the servers and disk arrays of the cloud platform are divided into two parts: computing clusters and data clusters according to different functions, which, respectively, carry related services such as simulation scientific computing services and database cluster cloud management [26–28]. The computer terminals of ordinary users carry the interactive functions of simulation task deduction and the functions of visual display and interaction of simulation results, as shown in Figure 4; they exchange data with computing clusters and data clusters through network switches and constitute the entire cloud-based task deduction and virtual experiment platform.

By extracting and tracking the shape contour of the preprocessed image, a digitized shape contour curve is obtained, which is expressed as an ordered set of integers on the plane, and the form is as follows:

$$C = \left\{ c_i \middle| 1 \le i \le N, c_i \in R^2 \right\}, \tag{10}$$

$$P = \left\{ p_i \middle| 1 \le i \le N, p_i \in R^2 \right\}. \tag{11}$$

Among them, N is the number of points on the curve, the ith point is c_i, the approximate point is p_i, and R is a set of real numbers.

Usually, the compression rate CR is used to represent the amount of information, as follows:

$$\mathrm{CR} = \frac{N_C}{N_p}. \tag{12}$$

N_C is the number of points on the shape curve and N_p is the number of approximate vertices. The global error squared sums ISE and CR give the graphics quality FOM:

$$\mathrm{FOM} = \frac{\mathrm{CR}}{\mathrm{ISE}}. \tag{13}$$

4. Application of Intelligent Space Simulation Technology in Ceramic Form Design

The basic simulation software on the platform can realize interactive drag-and-drop simulation model modeling. Users only need to drag and drop the model modules provided in the platform and then combine and connect the existing basic modules according to the user's own modeling and simulation tasks [29]. Then, after a simple interactive operation in the software, the drag-and-drop model can be simulated according to the user's imagination. In the user-oriented interactive simulation interface, the focus should be placed on the realization of the interface and the experience of human-computer interaction [30–32]. Therefore, as shown in Figure 5, in the process of designing and developing the simulation interactive interface, the part displayed to the user should be enhanced, and the implementation of specific functions related to simulation should be placed in the simulator. This part can be bound in one-to-one correspondence with the actual operation of the user's simulation

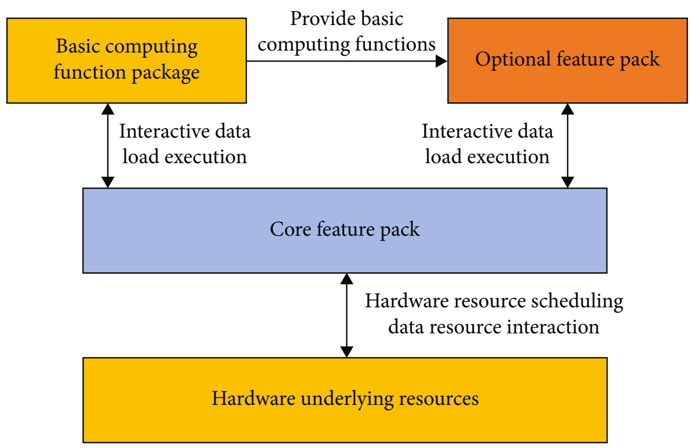

Figure 3: Overall architecture diagram.

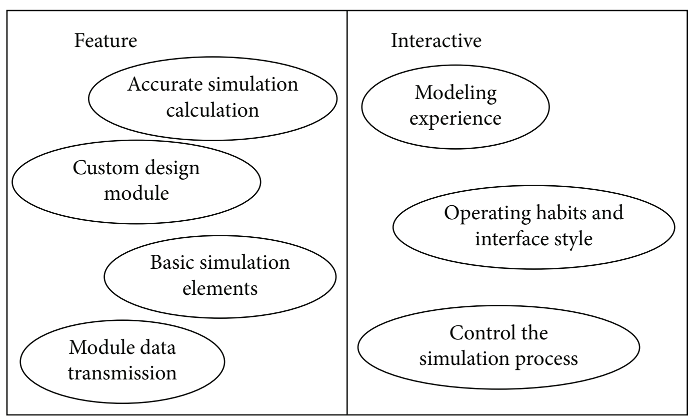

Figure 4: Requirement diagram of interactive interface function package.

modeling by using the interface of the specific simulation function exposed in the simulator.

Since ancient times, nature has been the source of various scientific and technological principles and major inventions of mankind. The biological world has a wide variety of animals, plants, and substances. In the long evolutionary process, in order to survive and develop, they have gradually acquired the ability to adapt to changes in nature. Humans live in nature and are "neighbors" with the creatures around them. The various strange abilities of these creatures attract people to imagine and imitate. Designers use their observation, thinking, and design abilities to gain insight into the subtle changes in the natural world and begin to imitate creatures and express it in their ceramic works. From the human face pattern constructed by the ancient primitive people to the bull-shaped lamp and the chicken-head pot, from the fish-shaped pattern in the primitive period to the persimmon-shaped cup, melon-shaped pot, lotus-leaf plate, tree-head-shaped pen holder, etc. in modern ceramic works, a large number of floral patterns and geometric forms have emerged in handicrafts. From three-color silk camels to shadow celadon horses and the simulation of petal shapes, from the true reproduction of nature to the various imagery expressions based on nature, from the bionic of external forms transplanted to the variant of the internal structure, the bionic design is undoubtedly the protagonist throughout the ceramic art, as evaluated in Figure 6. In the figure, the abscissa represents the number of times and the ordinate represents the percentage, in which the proportion of the space value, artistic value, and design value fluctuates significantly. Flowers, plants, animals, shells, fossils, and water patterns are undoubtedly the most common and vivid forms of objects in ceramic works. From the development of naive and vivid imitation to the realistic reproduction of mature techniques, from the comprehensive expression of all aspects to the ultimate play of individual factors, the bionic design shows the harmonious unity of artistic design and natural life in diversity. Here, the author studies the appearance of bionic morphological design in ceramics from two perspectives.

A concrete form means that a substance has a certain specific form. The figurative form depends on the specific form, and its visual attributes are visible, tactile, detailed, and not abstract, reflecting the essential attributes of specific things. Figurative forms in nature refer to specific images in nature, unrefined prototypes, such as rocks, water marks, animals, and plants. Except for some that show strong rules and sequences, most forms show free, vivid, and irregular. In ceramic design, the concept of figurative generally refers to the form of objective existence. Through the thinking,

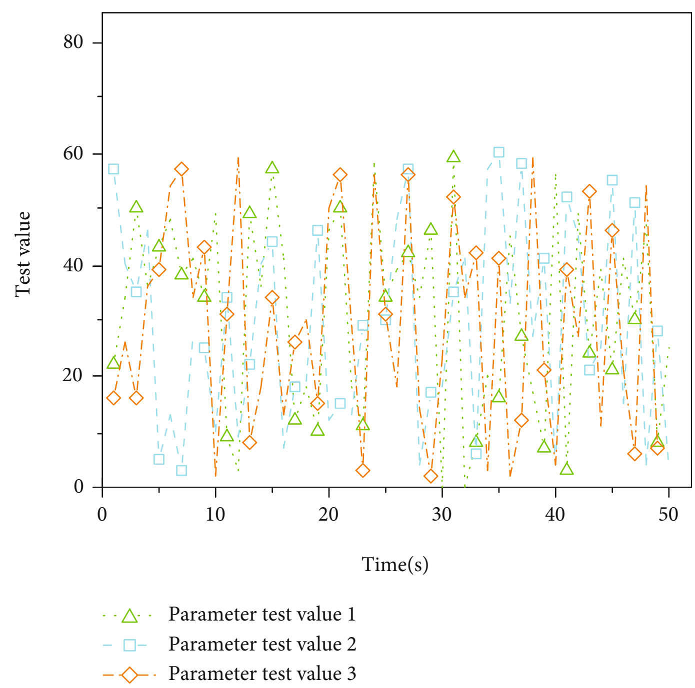

Figure 5: Multiparameter test results.

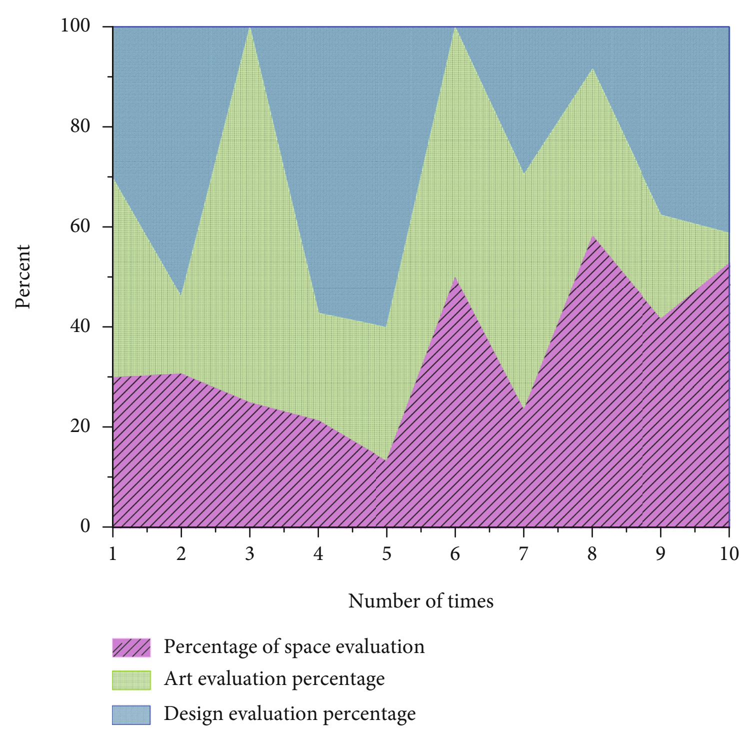

Figure 6: Multiangle evaluation results.

methods, and means of design, such as the use of refining, processing, and organization, the ceramic works have the characteristic modeling form of figurative form, such as characters and animals and plants. From the concept of design, it retains the characteristics, individuality, and typicality of natural forms, but after the works are released, it is no longer a simple simulation of the original form of nature, but the generalization and sublimation of biological forms as shown in Figure 7.

Natural creatures are vivid and natural, and designers constantly dig out their various charms of life to express their subjective intentions and convey various artistic

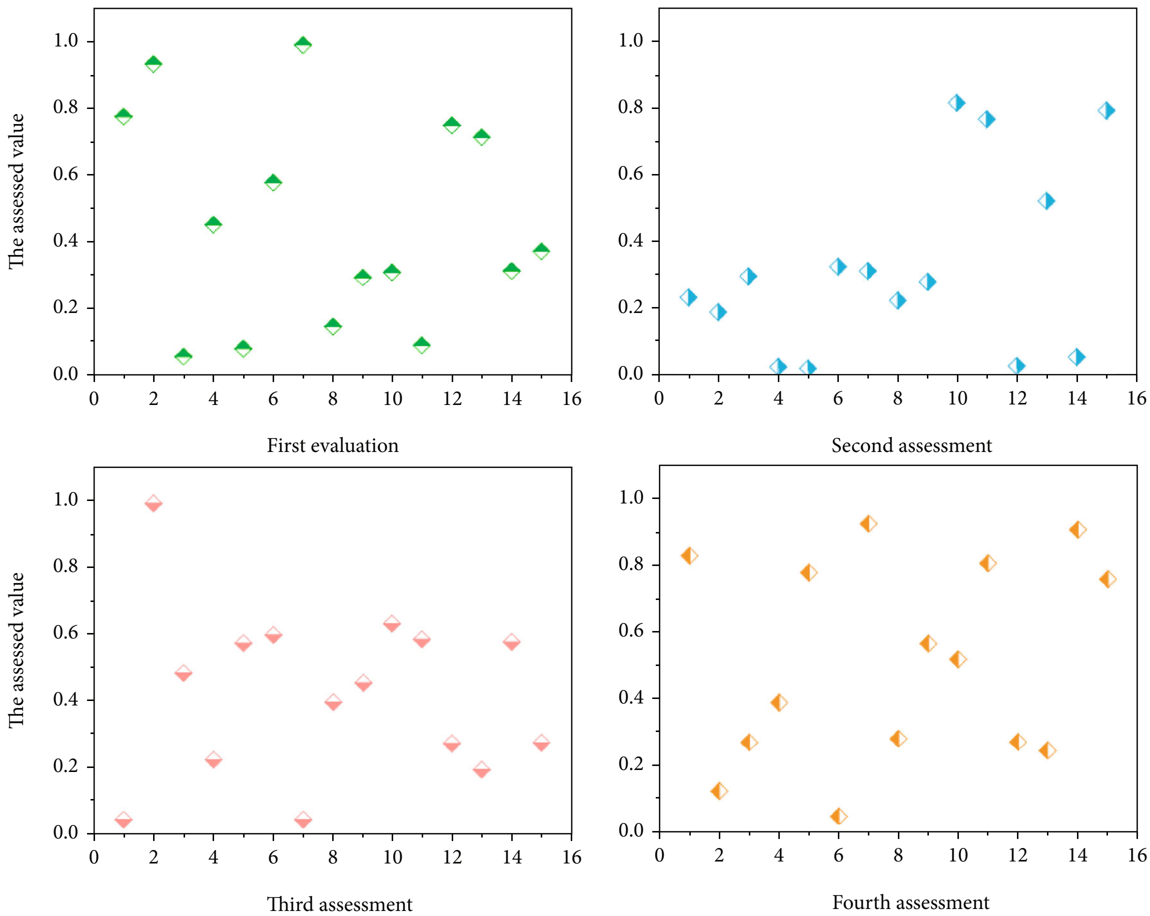

Figure 7: Different test values of space simulation.

feelings to people. The artistic appeal of ceramic works is increased by simulating the representation of the figures and spirits. The characters in the bionic design are used as the medium to connect life and art, as well as ceramics and life, which is the meeting point of nature and art. In fact, the shape and function are mutually influencing and interrelated, and the two are inseparable and interactive. The bionic design of the ceramic shape creates a rich aesthetic effect and also creates a functional beauty that serves people—visually pleasing functional beauty and comfortable functional beauty. There is no doubt that ceramics are utensils with certain practical functions. Generally speaking, bionic modeling is limited by its functions in simulating natural objects. It must be an extension based on utensil modeling that satisfies and adapts to its modeling functions. The "natural form" formed. Under certain special conditions, people often think of looking for them in nature. Something to replace the lacking items, such as using a bamboo tube to cook rice, or using an ostrich egg shell instead of a bowl, etc., so there is egg-shaped tableware. As long as we always have a unique vision and rich associations about everything around us, inspiration sometimes bursts out in this accident. The bionic ceramic works functionalize the shape of the leaf, but it is not a simple and rigid simulation. The designer starts from the perspective of bionic design, as shown in Figure 8, adding personal design elements, thus enhancing the formal beauty of the entire ceramic vessel, vividly. Without losing the sense of rhythm, the color matching is also just right. As the second group, the bionic design of functional space is due to other design methods.

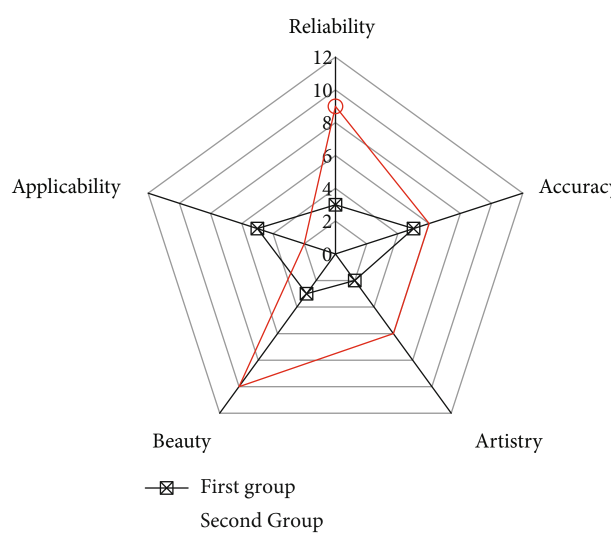

Figure 8: Multidimensional evaluation scoring chart.

Ceramic art culture has a long history. As a comprehensive artistic phenomenon that entrusts people's pursuit and shaping of beauty, it not only provides material services for human life in function but also meets people's aesthetic needs spiritually. In a sense, ceramics has become an artistic medium that can enrich and satisfy human emotional needs, and the human breath and emotional temperature it carries go beyond its physical form. Natural form bionics has a natural advantage in building an emotional bridge between man and nature. The bionic design of the form of ceramics is conducive to awakening the natural desire in the depths of human beings, so that the soul can escape from the steel forest in the industrial age and return to the most primitive and simple natural spiritual home. We use the ceramic form bionic design to communicate the emotional communication between man and nature, build a more harmonious relationship between man and nature by conveying the beauty of nature, and, at the same time, use the bionic design of the natural form to continuously enrich the design level to meet the spiritual needs of modern human beings. Ceramic art is the artistic carrier of human material and spiritual needs. To explore the cultural connotation and design principles of natural form language in ceramic form design is not only the inheritance and continuation of traditional natural spirit and ceramic culture but also for the further construction of human, ceramic, and ceramic art. The harmonious relationship in nature provides a reference. The in-depth discussion on the bionic design of ceramic form broadens the space and dimension of ceramic form design, which is conducive to the emotional injection of ceramic artworks, so as to transcend the material body and bloom with life, thus becoming a spiritual carrier for emotional communication between humans and nature.

5. Conclusion

The mystery of nature can never be explored. It is our inexhaustible and inexhaustible driving force for design. For us, the form of natural objects is just a starting point for design. The key is to form a bionic form to form reconstruction. The ceramic works are perfectly presented. This process is a peculiar and arduous adventure road for the designer, which is mixed with adventure and excitement, joy and pain, which reflects the struggle and running-in between man and nature. The form design of ceramic products should consider the following elements of use behavior: First, ceramic products require full grasp of ergonomic principles, as well as the user's psychology and behavior in the process of form design, so that the designed product conforms to the user's use habit and psychology. When designing the form of a ceramic product, the most important thing is to consider which body parts the user uses to use the product. For example, when designing a ceramic tea set, it is necessary to consider whether the structural characteristics of the tea set are consistent with the user object, and whether the handle design of the tea set is suitable for the hand shape characteristics of the user; the handling of the handle is not ergonomic, and it will make it difficult to handle when holding it. People have a feeling of being too heavy or strenuous; too large a cover is difficult to grasp, and too small makes the fingers tense. Secondly, in the process of user operation of ceramic products, it is necessary to consider whether the product is smooth and convenient to use, and its shape should be suitable for user operation, whether the shape of the surface is suitable for use actions such as grasping, pinching, and rotating. When designing the shape, it is also necessary to consider the specific actions of people when using ceramic products. For example, people in Fujian, Guangdong, Taiwan, and other regions like to drink "Kung Fu tea." Therefore, the capacity of the tea set is smaller. In ethnic minority areas such as Mongolia and Tibet, large-capacity tea bowls are generally preferred due to the dry climate and the habit of drinking milk tea or butter tea. This requires that the form of ceramic products can meet various operating actions. The shape design of ceramic products is for the purpose of being convenient for people to use, so it must first make people feel satisfied and satisfied physically, and then make people feel happy spiritually. Again, the shape of the ceramic product should conform to the sequence of operations. When setting the form of a ceramic product, to ensure the correct operation of the user, two aspects of information must be provided from the design: the operating device and the operating sequence, and the combination of the ceramic product components must conform to the operating logic. "Slanted" teapot is designed according to the order in which the tea is brewed. When using it to make tea, you should first put the tea leaves on the inner partition and place the teapot lying down. The table top is at an angle, and some of the tea leaves leave the water. After the tea is completely brewed, the teapot is erected, and the tea leaves are no longer in contact with the tea water. In addition, the environmental factors used are more complex, and different environments used require ceramic products to be considered in terms of shape processing, material selection, and even color to meet the needs of users.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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