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Form Bionic Design Research Based on Product Semantics*

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***Abstract*—This research is to fulfill the visual and psychological requirements through modern design, to analyze the inner connection between product semantics and form bionic design, and to solve the innovation and containment which is the shortcoming during the product design. Extract the main representative features of mushroom in nature, classify and sort based on their forms, further explore the morphological semantics from the modeling features of mushroom, put forward to the basic frame and design cycle, and verify the application taking the simulate lamp design combined with bamboo and wood as an example. Integrating the product semantics and form bionic design, this design can annotate the innovation of simulate lamp and provide a reference for future design of lamps in the new era. The product is designed with more meaning by the combination of form bionic design and product semantics, enhancing the emotional communication between product and user and making the form bionic design to be endued with more containment and cultural connotations.**

Keywords—product semantics; form bionic design; lamp design

I. INTRODUCTION

In the era of high-tech product, basic material consumption has been gradually met and consumers begin to pay more attention to emotional consumption, therefore the natural element is essential to balance the emotion of consumers. Bionic design integrated with the modern design will fulfill the visual and psychological requirements and leave more chance to close the nature for the people. The most important feature of bionic product is the emotional interaction between product and person. Realizing the material function, the bionic product can also integrate user's mood, interest, with surrounding environment and social environment, which is a higher level of exploring direction for bionic design [1]. Form bionics is not a simple form borrowing, but to imitate the nature to convey the inherent functional, symbol, interesting and caring semantics in the product [2].

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II. PRODUCT SEMANTICS

Product semantics is the knowledge to research the meaning of product languages [3]. It breaks though the traditional design concept that the personal factors are simply put into the ergonomics, broadening the category of ergonomics. It breaks through the traditional ergonomics only considering the physical and physiological functions of human beings, and penetrates the design factors into the psychological and spiritual factors of human beings. With the development and progress of society, the materials are rich gradually, the consuming level is increasing and the requirements of psychic function are constantly improving. Except for the expression of function, product model shall convey the cultural connotation through the semantic features, reflect the special social period feel and sense of worth, solve the information expression from different levels from actual function to symbolic meaning, including what is product (cognitive function), what's its function (visualization of function), how to use (indicative use), and so all. Based on these questions, the semantic expressions of product can be divided: functional semantics, schematic semantics, symbolic association semantics, emotional and interesting semantics.

A. Functional Semantics

During the bionic design, the visual expression is making use of biological forms and functions in the nature, while the creative expression which is emphasizing the natural primitive function is to express the functional semantics using original features in natural form and impression in the heart of human beings. There is a relative common understanding of various functions with natural form and the product with which kind of modeling features shall have the relevant function, which has become the semantic appeal point of bionic design in the view of human beings.

B. Schematic Semantics

Bionic design is unique in expressing the schematic diagram and usage mode. During the bionic design, the schematic design using model is usually related to the shape

and structure of human body, such as button, handles, and controllers, and so all. The original form of these product components is not common in recent years. With the material and process technology, these common components are designed through the research of product shape and semantics.

C. Symbolic Semantics

During the design of product, there is much important information to express, including more about the functional quality except for the actual functional semantics associated with the product. Such information shall be expressed in clear modeling language as far as possible. Therefore, it can use the materials or textures. In the bionic design, the functional quality is performed more by the method of association and symbol, just like to express that this product has same capability and feature is through comparing this product to something.

III. BIONIC DESIGN UNDER THE PRODUCT SEMANTICS

Semantics is researching the product language to design the model with special connotations during the use. Product design is invisible, but it can be developed based on the given words according to the language environment [4]. As a kind of design methods, there are many common points between the expression and content of product bionic design and product semantics [5]. The product bionic design involves the content of each level of the product semantic expression, it is the practice and application of the product semantic theory and different semantics are the contents and results of expression. The special association, symbol, interest, function and meaning of product are represented through the combination of the bionic design and product semantics. There should be a physical form of concretization which must has a basic ranking based on a certain structure from the language to emotion, and it is the basic content of morphologic semantics [6].

A. Bionic Design

Luigi Colani, a famous designer, once said, “The design should come from the truth of nature's life.” This sentence told us the essence of bionic design is the imitation and recreation based on living prototype. Analyze the simulation objects, extract the morphological features or functional structures that conform to the product design and it is refined, organized and processed based on the principle of feasibility to integrate the product with the better form, proving an inspiration, creativity and design theory for product design. Absorbing nature's nutrition is the basis of bionics, and the bionic design is the application of bionics in industrial design activities, imitating and transcending the superior functions of nature, and improving the design level and space [7]. There are widely contents in bionic design, which can be divided into functional bionics, structural bionics, form bionics, material bionics and color bionics on the basis of different levels and directions. Combing the understanding of imitated object and components of the product, the main contents of bionic design can be summarized as follows:

1) Morphological bionics: Human beings living in nature are “neighbors” with the surrounding creatures. It is the capability of various creatures that attract the people to image and imitate [8]. Morphological bionic design is to simplify or diverge the form based on the cognition of the main shape characteristics natural organisms have. During the design, the external form and symbol moral of imitated objects are designed with relevant artistic treatment in the application of design [9], bringing a natural emotion to users. Therefore, the form bionic lamps are full of affinity and naturalness, and common consumers will generally accept their characteristics generally.

2) Structural bionics: Functional bionics mainly studies the objective function principle of natural organisms. The innovation and the development of new product is inspired by researching the inner structure principle existed in materials of nature and imitating and exploring the potential similarity of the product. In nature, there are also great differences in the structure of different forms of organisms, but in many ways there are also common characteristics.

3) Textural bionics: Texture and pattern are one of the most important aesthetics in the form of bionic design. It provides aesthetic and visual experience for people with shape and texture, and an innervation that other bionic design methods do not possess. Because of the recreation function of bionic design, human beings can easily imitate various forms and materials of nature, which reflects the aesthetic characteristics of human creativity.

B. Semantic Representation of Morphological Bionic Design

Morphological bionic design mainly emphasizes the combination of external morphological features of organisms and aesthetic needs of human beings [10]. Bionic design is a detailed exposition of all the vigorous life in nature, conveying the theme and thought of returning to nature and putting people first. Through careful study and imitation of creatures in nature, designers design products with the same shape and characteristics. The most representative bionic lamp is the artichoke lamp (PH lamp) designed by Poul Henningsen "Fig. 1". Analyzing form the prospect of form bionic semantics, the artichoke ceiling lamp is designed with the combination of shape features and lamp. The layout of 72 blades will have no function of dazzle from different aspects. And its external features are not only prominent, but also shine the soft light by the overlapping appearance. Besides, imitating the natural form, it can convey intrinsic function and interest of the products and realize the organic combination of product function and aesthetic demand. This product has the function of expressing the emotion and can be used for emotional symbol to make people to learn the emotion of subjective reality. "Fig. 2" is a humidifier design in the series of volcano designed by Dae-hoo Kim. It looks like a small volcano. The water vapour can spout from the top to the outside, and it looks like a real volcano with a light LED lighting effect. The variety of color collocations are the representation of different volcanic images. By comparing

the humidifier to the volcano, the product can be expressed with the same quality performance and characteristics.

Fig. 1. Artichoke ceiling lamp (PH lamp).

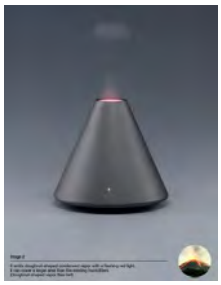

Fig. 2. Humidifier design in the series of volcano.

IV. APPLICATION

A. Design Flow

During the bionic design research based on the product semantics, the core guiding ideology is product semantics, inner connection between design object and simulated object is analyzed from the perspective of form bionic design to determine the design idea. Extract the shape features of different mushrooms, analyze and reprocess the modeling features and derive many design schemes. Finally, the semantic verification is carried out in accordance with the design scheme: (1) whether it can directly make full use of natural biological forms and functions; (2) whether it can express the product semantics depending on the impression of natural form in the heart of the people. After semantic verification, design plan shall be optimized to select a suitable creative concept for verification in the product design. Bionic design flow based on product semantics can refer to "Fig. 3".

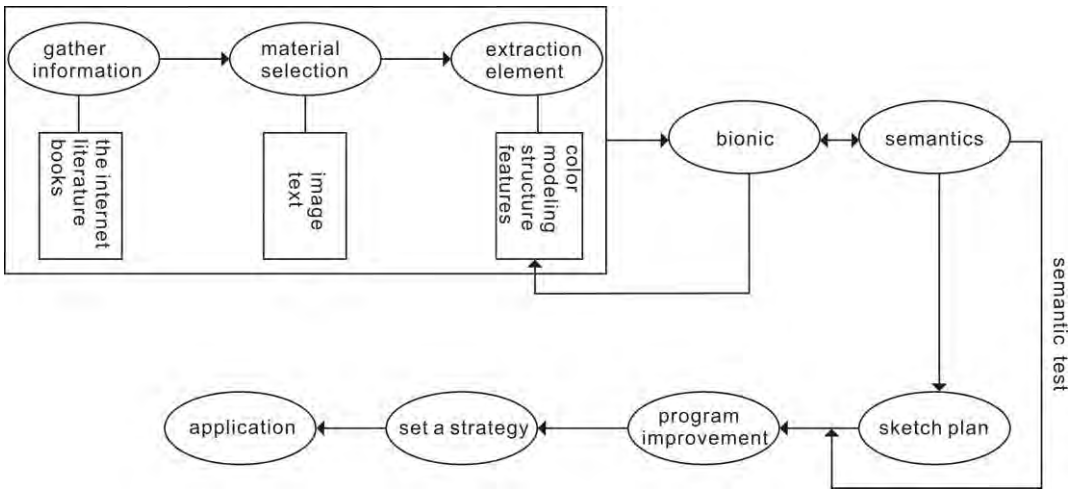

Fig. 3. Design flow.

B. Production Flow from Bionic Object to Product

- Select and determine the simulated object. According to the usage scenarios, product functions and product semantics of lamps, select the similar bionic objects from the nature and determine the bionic target.
- Analyze and summary the features of bionic objects and extract the shape feature elements of mushrooms to process.
- Draw the sketch.
- Evaluate the design plan by making full use of C-Box matrix analysis graph, and determine a design scheme with the highest feasibility and creativity.

1) The extraction of modeling element: Mushroom growing in any space of the world, can adapt to different natural environment, and even affect the surrounding climate, forming an organic landscape in the surface. Different mushrooms have different shapes, such as some are slight, some are strong, and some are short and flat... Element extraction and application flow are shown in "Fig. 4". After further sorting the features of mushrooms, the design elements of features are extracted in "Table I".

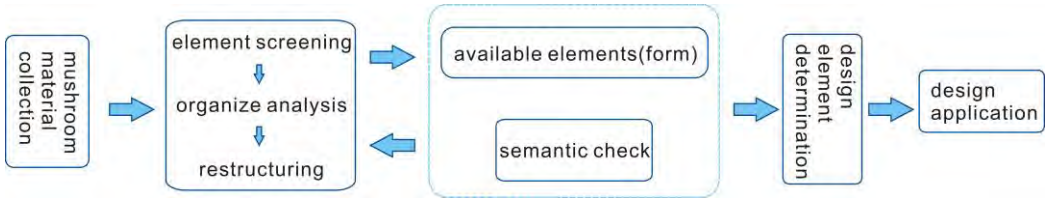

Fig. 4. Element extraction and application flow.

TABLE I. EXTRACTED DESIGN ELEMENTS OF SHAPE FEATURE

	name	legend	feature induction	model extraction	name	legend	feature induction	model extraction
mushroom shape feature extraction	snow skirt fairy		there is a white mesh curtain under the cap, which hangs down like a skirt.		red star head bacteria		the shape is red star-shaped, with a red "tentacle" extending.	
	spooky umbrella		the cap is split into a bell-shaped epidermis and becomes a flat scale.		poison fly geese paste		the fruit body is umbrella-shaped, and the cap is flat and he-mispherical, stretching to the everse.	
	small earth star		the outsourcing is cracked at half ormore than half, forming a petal piece that tapers and rolls outward.		morel		the upper part of the cap is wrinkled and meshed, like a honeycomb and a lamb belly.	
	net cover red pleated umbrella		the cap is hemispherical to oblate, with a concave central portion and an inner edge.		hericium		It looks like a monkey's headand a flat shape or a head shape.	

TABLE II. SIMPLIFIED PROCESS OF DESIGN ELEMENT

name	snow skirt fairy	spooky umbrella	small earth star	net cover red pleated umbrella	red star head bacteria	poison fly geese paste	morel	hericium
element simplification								

According to the whole design concept, all useful elements are extracted and sorted and applied in the design of lamps. However, these elements cannot be used directly but simplified based on modern aesthetic and user demand. The extracted and simplified process of design element and final design elements are shown in "Fig. 5" and "Table II".

Fig. 5. Extracted and simplified process of design element.

2) Options:

Determining the design ideas and elements, we will begin to conceive the shape, technology and materials of lamps integrating symbol semantics, form bionic semantics and texture bionic method. C-Box matrix diagram is used to arrange all the design concepts related to the evaluation scheme in accordance to the level of “innovation” and “feasibility”, achieving a clear design plan. C-Box matrix diagram can be referred to "Fig.6".

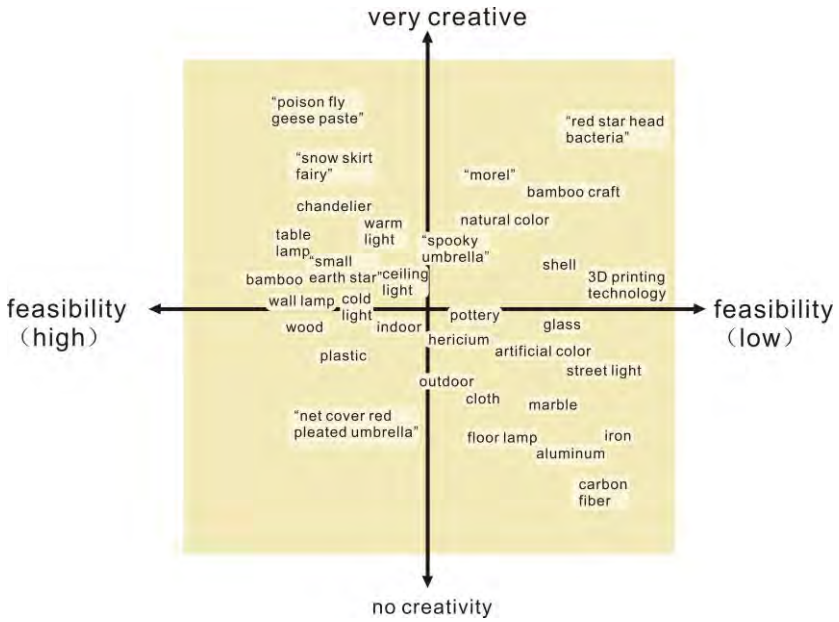

Fig. 6. C-Box Matrix analysis diagram.

Analyzing the C-Box matrix diagram, the final results are: (1) design element: the shape of amanita muscaria; (2) material: bamboo and stock; (3) technology: traditional bamboo weaving technology; (4) product type: floor lamp, ceiling lamp, table lamp. The design plan is determined and the hand-painting diagram is completed after semantic retrieval and sorting the original sketch, referred to "Fig. 7".

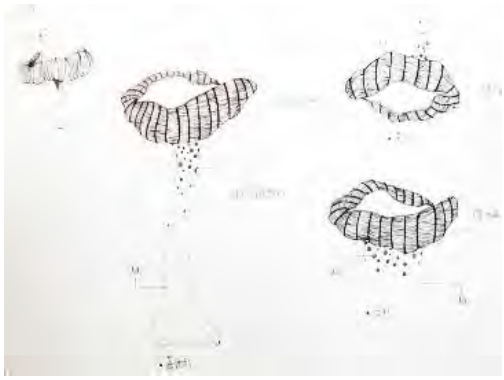

Fig. 7. Final sketch of design plan.

C. Design Example and Semantic Analysis

1) Design example of lamp: A series of indoor bionic lamps based on the prototype of mushroom are designed through extracted and analyzed the modeling elements from different forms of mushrooms. Ultimately, combined with the bamboo and wood materials, the shape of mushroom in the mature period is selected to be the primary color to restore the original beauty of mushroom in the nature. In our daily life, it can be used as the lighting lamps, and can be also used for decoration to active the indoor atmosphere. The unique appearance will make people look bright and their natural sentiment arise spontaneously. This design plan includes floor lamp, table lamp and ceiling lamp. The light can shine through the holes added in the bracket and the holes are gradually increasing from down to up, increasing the functionality, decorative and visual effect, referred to "Fig. 8".

Fig. 8. Bionic lamp shape based on product semantics.

2) Semantic analysis of design scheme: Based on product semantics, simulated lamp modeling is designed and the expression elements are extracted by imitating the shape features of amanita muscaria, Meanwhile, the bamboo and wood materials are selected to show the textures of the imitated object with the combination of symbolic semantics and bionics Design. The shape of amanita muscaria is a unique symbol form to convey the significance of the lamp modeling because the visual stimulation can give you a feeling of visual experience and visual association. During the bionic design of product, the functional quality is performed using the method of association and symbol, just like to express that this product has same capability and feature is through comparing this product to something. After the comparison with other bionic lamps, the final design scheme will be more creative and ore perfect to perform the inner connection between the form bionic design and product semantics.

V. CONCLUSION

This study analyzed the inner connection between the product semantics and form bionic design and extracted the main modeling features of simulated objects. On this basis, the thought for form bionic design research based on product semantics is put forward, C-Box method of matrix of qualitative analysis is applied to integrate the innovation and feasibility, complete the output of sketch plan by processing the final results and the evaluation of product form semantics for the case. This method will provide the performance to modeling design of simulated lamps and will also be suitable for the development and research of relevant design field. It will have a deeper exploration for the product semantics and form bionic design to rich the connotation of product, make the visual form more clear and form design more acceptable.

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