

A Study of the Morphological Bionic Design of Beast-faced Tiles

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ABSTRACT

This paper analyzes and explores the beast-faced tile, and explores the application of morphological bionic design in beast-faced tiles. Inductive analysis method was used to analyze the form of beast-faced tiles, factor analysis method was used to extract the form and shape of bionic design, relying on bionic design thinking mode of beast-faced tile creative deduction and design discussion. The bionic design of biology is fully integrated with cultural and creative products, and the way of expression of bionic design in cultural and creative products with traditional patterns is innovatively presented.

Keywords: *beast-faced tiles, bionic design, cultural factors, morphology*

1. INTRODUCTION

With the rapid development of today's information society, cultural and creative products in many forms have entered people's lives. As people's demand for quality of life continues to improve, the previous single form of cultural and creative products are no longer sufficient to meet the modern people's spiritual pursuit of art, and cannot effectively promote the dissemination and development of traditional culture. The popularity of bionic design is due to its unique aesthetic appeal, which not only has a high artistic value but also changes people's daily lives to a great extent. Therefore, it is necessary to apply biomimetic design to beast-faced tiles to create cultural and creative products that meet the aesthetic requirements of modern people.

2. OVERVIEW OF BIONIC DESIGN

Bionic design is the study of the characteristics and symbolic meanings of various organisms, plants and animals in the natural world. It is a design technique that uses simplification, abstraction, metaphor, exaggeration and other artistic modelling methods to create a connection between the product form and the bionic object [1]. Depending on the characteristics of the bionic object, bionic design can be divided into "morphological bionic", "functional bionic", "colour bionic", "material bionic" and "structural bionic" [2]. The core idea is to take humanistic

design as the starting point and to integrate and create a fusion of diverse elements of matter. The designer combines aesthetics with natural elements, taking the physiological structure, phenomena and characteristics of living creatures as a starting point for research, and then combines them with the basic concept of bionic design to selectively create inspiration for aesthetics.

3. OVERVIEW OF THE BEAST-FACE TILES

In primitive societies, people lived in an environment of very low productivity. The need for security led them to seek refuge and protection from certain creatures in the primitive society. As a result, many of these motifs were carved on objects in primitive societies to support their spirit of worship, and it was under these conditions that the beast-face motif was created and developed. The animal-face tiles originated from the Taotie (a mythical ferocious animal) motif carved on the Yan tiles during the Spring and Autumn and Warring States periods, as well as simplified beast-faced motifs from the Wei-Jin and Northern and Southern Dynasties periods in China, through the influence of the culture in Liao and Song dynasties and the culture in Xia and Jin dynasties, before finally declining during the Ming and Qing dynasties. The many stylistic changes during this period are strongly linked to the variety of regional characteristics. This paper extracts and translates the bestial tile pattern and applies the resulting new pattern to the design of the product.

4. IDEAS FOR THE APPLICATION OF ANIMAL-FACED TILES IN MORPHOLOGICAL BIONIC DESIGN

4.1 Morphological Biomimetic Design Process

In the extraction method of bionic design, product semantics, design psychology and other disciplines are used as the basis for design, and design elements such as the structure, colour, main form and product materials of the object of study are used as the object of study for design element extraction, pushing the role of product form and product function back to an extremely important position [3]. The linear structure of the animal-faced tiles also provides inspiration for the product design, and this linear structure is used as the base line for the product, with factor analysis as the starting point for the semantic aspect of the product design to build the basic process of bionic design, as shown in Figure 1. The biomimicry of the creature cannot be one-sidedly reflected in the figurative biological base form, but needs to be penetrated from multiple angles and all-rounded design points, rationalising the linear extraction, so that consumers can produce emotional touch in the use of the product. The starting point is the consumer's distance of vision, which is combined with the various links

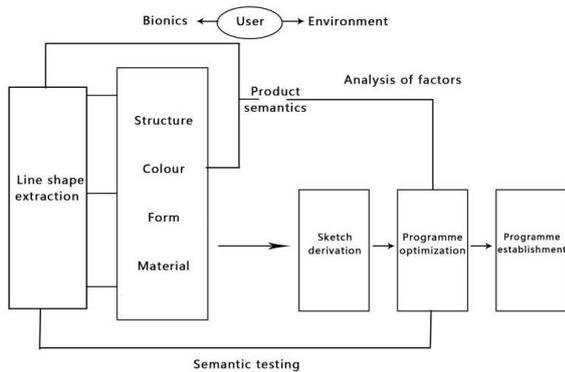


Figure 1. Bionic design flow chart.

between the beast-face tiles and the product before deciding on design ideas and design elements.

4.2 The Morphological Bionic Design of the Beast-faced Tile

The selection of a suitable design procedure is the most important aspect of the initial line extraction phase of the bionic design. Biomimetic design involves two methods of biometric feature extraction, the "top-down" parsing and the "bottom-up parsing" [4], as shown in Figure 2. The "top-down" parsing starts with the association of the product with the creature, taking the semantics of the product's function and structure as a starting point and making full use of divergent thinking to associate it with the natural biomorphology associated with it. The "bottom-up" parsing is the opposite of the

"top-down" parsing, in that it takes a clear natural biological form as the basis for design, and uses the morphological characteristics of the natural organism to design products that match it. In a way, this echoes the bionic line extraction method [5].

4.2.1 Factor extraction

Based on the investigation and analysis of beast-faced tiles, combined with the research materials left behind, this paper selects the more representative of them, the Wei-Jin and Northern and Southern Dynasties periods, the Goguryeo period, the Sui and Tang dynasties, the Northern Song dynasty, and the Western Xia period, as examples, for generalization and analysis, and finally collects the highly representative beast-faced tiles.

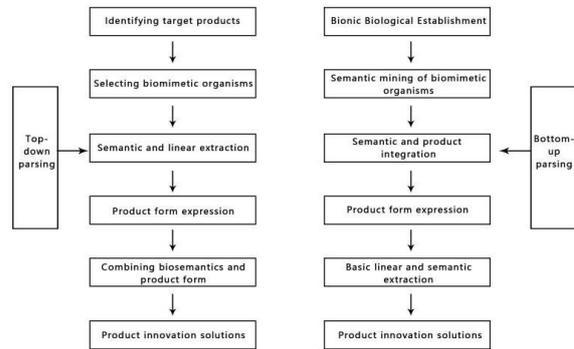


Figure 2. "Top-down" and "bottom-up" parsing.



Figure 3. A collection of beast-faced tiles.

Factor analysis was used to extract the characteristic factors such as the pattern configuration of the bestial tile, and chart analysis was used to summarize the characteristics of the bestial tile pattern, as shown in Figure 3.

4.2.1.1 Morphological factors

With the change of dynasties, beast-faced tiles are also developing, and the variety is getting richer and richer. These patterns can be roughly organized and summarized into nine categories according to their position in the pattern: beast-faced eyebrows, beast-faced eyes, beast-faced nose, beast-faced mouth, beast-faced tongue, beast-faced teeth, beast-faced forehead, beast-faced ears, and side wheel patterns.

The six beast-faced tiles have distinctive morphological features and are designed using a figurative bionic approach. The main content is the figurative and abstract treatment of their main features, and the deletion

of some relatively minor elements or elements not closely related to the morphology of the beast-faced tiles, so that the main features are more prominent, ensuring the main

image of the original beast-faced tiles, and showing the process of morphological factor extraction, as shown in Table 1.

TABLE I. EXTRACTION PROCESS OF THE MORPHOLOGICAL FACTORS OF THE BEAST-FACED TILES

	the beast-faced tiles		
	<i>Luoyang, Northern Wei</i>	<i>Goguryeo</i>	<i>Nanjing</i>
Tile form			
Overall layout	Compact layout and block structure	High relief, angular	Wide at the top and narrow at the bottom, slender and gentle
Beast-faced eyebrows			
Analysis	upside-down eyebrows	Flame-shaped	Dendritic
Beast-faced eyes			
Analysis	circular	circular	Teardrop-shaped
Beast-faced noses			
Analysis	Circular	Ringed	Triangular
beast-faced mouths			
Analysis	wide mouth, outstretched tongue, tooth exposure	The large rectangular mouth is basically "concave" in shape, with a beaded tongue and ten internal teeth	Inverted trapezoidal mouth, with tongue, two rows of teeth and fangs
Beastly forehead ornament			
Analysis	Crossed with wavy wrinkles	Triple "herringbone"	Dendritic
beast-faced ears		None	None
Analysis	Pointed rounded, ears erect	None	None
Edge wheel motif			
Analysis	Convex string pattern and connected bead pattern	Convex string pattern	Short radiating straight lines

	the beast-faced tiles		
	<i>Sui and Tang dynasties</i>	<i>The Northern Song Dynasty</i>	<i>Western Xia</i>
Tile form			
Overall layout	Not very well regulated and roughly decorated	Smaller size and monotonous variety	not very standard, simple pattern

Beast-faced eyebrows			
Analysis	upside-down eyebrows	Inverted octagonal	Reclining silhouette
Beast-faced eyes			
Analysis	Oval	Round and small	Round and small
Beast-faced noses			
Analysis	Garlic-shaped	Garlic-shaped	Garlic-shaped
Beast-faced mouths			
Analysis	Crescent-shaped and outstretched tongue	Curved moon shaped, lingual, single row of teeth, tusks in a figure of eight	Crescent-shaped , with tongue and teeth
Beastly forehead ornament	None	None	
Analysis	Cornerless	None	Engraved in negative with a string pattern
Beast-faced ears			
Analysis	Standing ears	Leaf-shaped vertical ears	Leaf-shaped vertical ears
Edge wheel motif			
Analysis	Convex string pattern and connected bead pattern	Convex string pattern and connected bead pattern	Convex string pattern and connected bead pattern

4.2.1.2 Modelling factors

The full or fragmentary form of the tile comes from the eave-head tile barrel of the building, which acts as a shield at the front of the eave-head tile barrel, protecting the buildings and adding to the beauty of the detail. The use of animal-faced tiles in the Wei and Jin dynasties was a long one, beginning probably in the early Eastern Jin period. As time went on, the style of the tiles took on a simpler and more abbreviated appearance in the mid to late Southern Dynasties, the most distinctive of which are the beast-faced tiles from the capital city of Jiankang in the Six Dynasties, famous for their light, flowing lines outlining the visual characteristics of the animal motifs. There are tiger-faced tiles and monstrous beast tiles, the lines of which are so soft and slender that they have been passed down to future generations as typical of the 'Jiankang style'. During the Sui and Tang dynasties, the number of tiles with animal-face motifs began to show an increasing trend. However, the style presented is very different from the 'Jiankang style' of the Six Dynasties. During the Sui and Tang dynasties, the distinctive feature of the bestial pattern was the use of blockwork to construct it. The blue slip and glazed tiles of this period occupy an important artistic position among the beast-faced tiles of the same period. During the Song dynasty, as well as the

Liao, Jin and Western Xia dynasties, animal-faced tiles were widely distributed in the Ming and Qing dynasties. "It was during this period that the 'tiger-headed tile' and 'cat-headed tile' were created. The tiles were extracted from the figurative forms of the tiles and tile cylinders, and on this basis, their morphological features were extrapolated into bionic designs [6].

4.2.2 Design verification

By simplifying and abstracting the characteristics of the animal-faced tile, the design is transformed and innovated, resulting in a new pattern with clear regional characteristics, and the newly generated pattern is incorporated into the cultural and creative product design, as shown in Figure 4. Using the extraction and translation methods described above, the derived patterns retain the composition, form and colors characteristic of the beast-faced tiles of each period, and have a layered aesthetic.

5. THE APPLICATION OF BEAST-FACED TILES IN MORPHOLOGICAL BIONIC DESIGN IN PRACTICE

5.1 Bionic design approach

Using modern design concepts and methods, the design application of cultural and creative products is

based on the above-mentioned factor extraction and morphological bionic design. These products use the expression of bionic design to fully express the morphological, emotional and functional factors in the design of cultural and creative products, paying particular attention to the relationship between form and function, and giving full consideration to the emotional communication between consumers and the products.

5.1.1 Biomimetic morphogenesis

Select the patterns generated by the above method with the characteristics of the animal-faced tiles of different periods and apply them in different forms in the cultural and creative products; simplify and abstract the characteristics of the animal-faced tiles, then carry out application transformation and innovative design to make the form of the animal-faced tiles fit with the characteristics of the alarm clock, analyse the main and secondary characteristics of the animal-faced tiles and the structural characteristics of the products, and simplify them by using the corresponding techniques such as regularization, organization, order and geometry. After this, the simplified elements are extracted for three-dimensional modelling. Specialized techniques and methods are used to transform the extracted one-dimensional visual elements into two-dimensional patterns and then use the flat visual elements to build three-dimensional models.

5.1.2 Biomimetic function expansion

At the level of the product's biomimetic function expansion, the product's problems should be captured. Firstly, the analysis of cultural and creative products is the starting point, and a full understanding of the user's functional needs for the product is made; secondly, the biological characteristics factor is extracted and the design theme is found at the level of high consumer demand; thirdly, a suitable solution is found by combining the above two points. It analyses product design solutions that meet both the biocultural characteristics and the consumer's needs on a functional level; fourth, it finds the characteristics of the thematic elements in the cultural and creative products and match the product functions with entry points suitable for the thematic elements, then it proposes a design solution that meets the above needs; fifth, it determines the solution and start the 3D model building. The bionic dimension of innovation in cultural and creative products can satisfy consumers' spiritual and cultural needs as well as their material and cultural needs.

5.1.3 Imitation of biochemical emotional expression

With the growing needs of our national spiritual civilization, excellent products need to have the property of reducing the user's life stress and making the user have

a relaxed and pleasant feeling of using them, and the bionic design of the products can well meet such functionality. Donald Norman, author of *Emotional Design*, has suggested that the emotionality of product design is manifested at the instinctive, reflective and behavioral levels, and that the spiritual dimension of the emotionality of bionic design is the reflective dimension.

5.2 Applying features for design

By selecting the theme of animal-faced tiles and developing a relevant cultural and creative product design, the product is able to extract the cultural characteristics and simplify the form, while sporting appropriate expression techniques, such as exaggeration and humour. The comprehensive overview and abstraction of the beast-faced tiles will satisfy consumers' curiosity and enhance the innovation of the product to a certain extent. In particular, the use of distinctive regional culture, design elements and materials can be very effective in evoking the emotional resonance of consumers and play an excellent role in emotional attachment.

The first step is to conduct in-depth research on the bestial tiles, which is a very important step in the emotional expression of the bionic design. The second step is to extract and simplify the cultural elements that resonate with the consumer. Finally, the extracted emotional elements are emphasized. A specialized presentation technique is used to idealize the emotional communication between the consumer and the product, thus meeting the needs of the consumer on a spiritual level. The three views of the biochemical design of the bestial tile are shown in Figure 5.

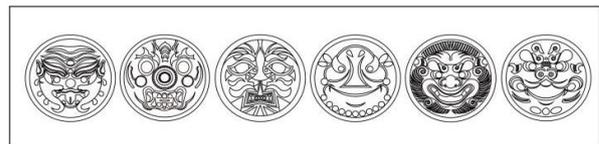


Figure 4. The new pattern generated.

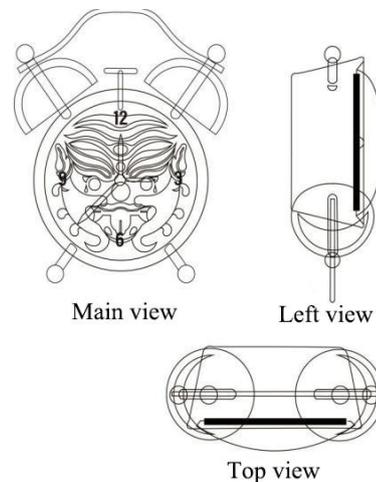


Figure 5. Three views of the morphological imitation of the biochemical design of the animal-faced tile.



Figure 6. Product rendering of the beast-faced tile.

5.3 Effect show

The beast-faced patterned tile design follows the simple lines of the gable head tile barrel in terms of shape, presenting a simple and steady visual effect, suitable for the atmosphere of the home environment. In terms of material, the metal shell material is chosen to accentuate the texture of the product. The product effect is shown in Figure 6.

5.4 Programme evaluation

Based on previous research findings, the design application and design practice of this paper is guided. The subsequent evaluation of the design solution and the design results is an important and necessary process to verify the success of this design practice. The evaluation of the bionic design of the cultural and creative product embodied in the element of the beast-faced tile can be carried out in the following ways.

5.4.1 Assessment of product elements

It is important to consider whether the finished product and the biomimetic elements of the product are consistent with the morphological characteristics of the animal-faced tile and whether the transformation of the biomorphic form is consistent with the principles and design requirements of biomimetic design, with an emphasis on the practical and decorative aspects of the product, as well as the degree of aesthetic appeal to the public and the design principles of the product based on the morphology of the animal-faced tile. It is important to consider whether the design is capable of mass production and the cost of production, to analyse whether the design is simple and easy to produce using the cultural elements of the animal-faced tile, and to consider the convenience of the product for the consumers.

5.4.2 Semantic assessment of product form

The design of the product is based on a cultural creative point of view, and the product needs to have the cultural genes of the animal-face pattern and the fun of the culture in order to attract consumers. The design solution should have the imagery of the traditional cultural element

of the bestial pattern, followed by the design of a bionic form of the beast-faced tile.

6. CONCLUSION

A comprehensive analysis of the animal-faced tile is carried out from the perspective of the research methodology of biomimetic design of product forms. Based on cultural and creative products, a detailed analysis of the beast-faced tiles is carried out by introducing factor analysis. By incorporating regional cultural elements into the design of the bestial tile, the design is transformed from a simple imitation of biological forms to a design form with traditional imagery and cultural elements, allowing specific or abstract cultural connotations to be reflected in the carrier of the beast-faced tile.

This paper gives an example of the process of applying factor analysis and bionic design techniques to the innovative design of traditional culture, using the animal-faced tile as a theme. It provides more options for the design of motifs with similar characteristics or the innovative design of traditional motifs, so as to design a richer and more relevant to the aesthetic and spiritual and cultural needs of the current population.

Fundamental project

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