



# Design Method and Application of DNA in the Design of Cultural Creative Products

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**Abstract.** With integration and regional fusion of global economy, cultural creative industry is also continuously deepening and developing. The Paper aims to analyze DNA evolution and transformation mode in such design from three levels, respectively, instinct, action and reflection for design of cultural creative products through integration and application of cultural design gene DNA in cultural creative design, establish product modeling image model and product modeling design situation model during creative design process of cultural design gene, provide structural rearrangement for design and application demand, complete effective organization and expression oriented at cultural creative design, and verify feasibility of DNA application oriented at cultural creative design through application examples. A cultural gene design method oriented at creative design is proposed from the perspective of cultural creative design, thus providing cultural creative designers with originality, stimulate design inspiration, improve design efficiency, effectively assist in cultural creative design and provide supporting services for development of cultural creative industry.

**Keywords:** Cultural creative design · Cultural design gene · Design method  
Product design DNA

## 1 Introduction

Cultural creative product belongs to product and is also a kind of unique “creative activity” [1]. Its difference from general product lies in that it mainly relies on culture, takes creative design as development means, analyzes and transforms cultural factors contained in substance to design factors, and seek a new physical state form conforming to modern life and emotional need for cultural factors with design. Seeking cultural heredity is also seeking new technology and drive of new technology arising thereby.

Cultural gene decides cultural system inheritance and change and is core to cultural growth and development as well as inheritance and development [2, 3]. It is an effective approach for design of cultural creative product to extract cultural gene, provide design manifestation, form design gene of such specific culture, and apply it to product design. Hence, designers need to emphasize [uniqueness]. In terms of cultural creative

products, source and foundation of [uniqueness] of design creativity connotation are its own cultural characteristics and cultural gene. Therefore, it is another design thought transformation facing designers to extract design inspiration and aided design from heredity of cultural gene.

At present, extraction of cultural design gene is often subject to manual extraction method. Professional designers research related culture, analyze and extract cultural design gene in combination with design knowledge and experience as well as cultural characteristics [5, 6]. Such method is of strong subjectivity and designers will extract cultural design gene according to their own understanding. Hence, design gene extracted by different designers from the same kind of culture may be significantly different. At the same time, there are single extraction methods for cultural design gene at present and they cannot completely reflect cultural characteristics and connotations. For above problems, it is the main research contents of the Paper to control subjective influence of designers on extraction of cultural design gene, keep extraction objectivity with appropriate method, extract cultural design genes from several perspectives on this basis, and make designed products accepted by more people. The basic thought is introduced through examples in this study.

## 2 Extraction Principle of Cultural Creativity Gene (DNA)

### 2.1 Cultural Design Gene

In terms of theoretical research of cultural gene, Schipper [4] firstly proposed the concept of cultural gene pool. Cultural gene is basic factor, basic element to decide cultural system inheritance and change and core to cultural growth and development and inheritance and development [6]. Cultural gene is different from biological gene. Biological gene belongs to biological inheritance and cultural gene belongs to non-biological inheritance and needs to be inherited by people, society and various cultural phenomena in specific cultural field, such as implements, buildings, activities and customs in cultural field [7, 8]. Cultural design gene is basic characteristic element and basic manifestation mode to act on design manifestation with cultural core characteristics to be extracted from cultural gene. Cultural design gene is extraction of basic characteristic element and summary of manifestation mode for cultural gene from the perspective of design. It aims to extract cultural connotation characteristics and apply them to design. Hence, design is linkage of culture and creation as well as experience and is a bridge.

From the perspective of psychology and information theory, under the effect of design concept, functions, actions, cultures and emotions are selected and then corresponding modeling elements are extracted to be component elements of design before permutation and combination through design composition rules and reconstructing overall model of product. It is a process of information processing. During the process, successful brand will form a set of design language which can be deemed as product design DNA. under the trend of increasing homogenization of product production technology at present, the trend of appearance modeling to be attached to traditional function is increasingly weak! Its main function is not technical any more, but to satisfy

people’s aesthetic and other implicit spiritual demands [3]. All manufacturers hope to establish their own brands through design. Hence, it requires designers to extract brand connotation, value, cultural characteristics and other implicit DNA, transform them to modeling language, composition rule and other explicit DNA and convey them to consumers.

### 2.2 Extraction Principles of Cultural Design Gene

“Cultural design gene” has basic characteristics like “biological gene”. It is basic unit of cultural “inheritance” and inherits cultural characteristic information unlike cultural factors of other cultures. It plays a decisive role in formation of certain cultural characteristics. On the contrary, it is also decisive factor to identify such cultural characteristics [9]. To determine the design gene of certain culture, we can roughly follow principles as shown in Fig. 1:

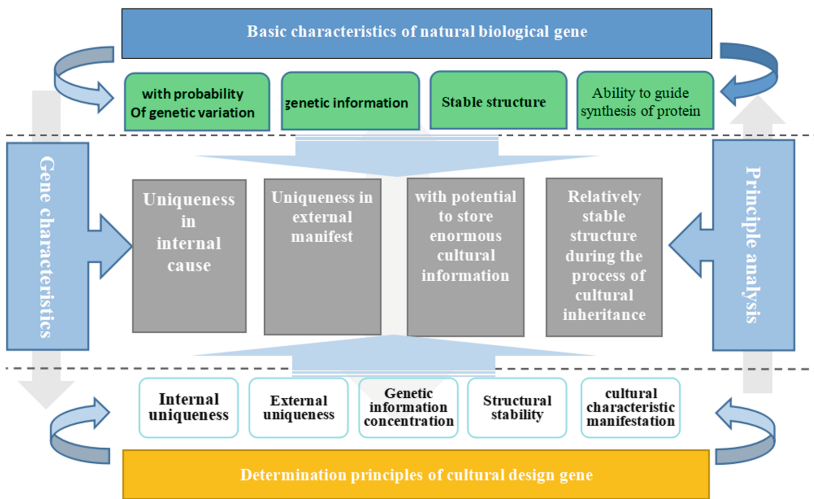


Fig. 1. Principle of cultural design gene

## 3 Product Design Process Model Based on Cultural Creative Gene

### 3.1 Research Method for Extraction of Cultural Design Gene

As one of key elements of cultural inheritance, screening of cultural gene lays a solid foundation for creative design. Cultural creative design is a process to review and reflect on cultural characteristics. It re-defines cultural elements and blends them to product design, thus satisfying cultural and aesthetic demands of consumers [10]. Through cultural gene analysis during cultural creative design, we can understand demand in cultural creative design field and improve accuracy of design service.

different from creative design of traditional functional product and design of complicated product [11, 12], cultural creative designers need to pay more attention to reflection upon traditional culture, identify essential knowledge in traditional culture. The knowledge runs through the whole cultural creative design process and provides designers with creative inspiration and auxiliary knowledge.

**Definition Creative Design Process Model Based on Cultural Gene Can be Expressed as:**

$$C(\text{culture})\{G, D, O\} \rightarrow P \quad (1)$$

Where, C indicates the process that cultural creative designer D formulates design scheme P under support of cultural gene G extracted for creative design according to design objective O. D is the designer conducting cultural creative design, O is objective to be satisfied and demand to be met by design, P is produced design [18–20], G is cultural gene supporting cultural creative design (as shown in Fig. 3). ①Design positioning stage: designers cooperate with investigators to analyze cultural image to be expressed by product, user demand and product positioning; ②Knowledge analysis stage: designers cooperate with research experts to collect, analyze and rearrange involved cultural genes and form knowledge table; ③Implementation stage: designers integrate several cultural genes instructive to design with design method, cooperate with engineers by virtue of cultural creative design method, provide design in modeling, color, function, texture and structure, creative new design scheme; ④Design evaluation stage: designers cooperate with consumers to provide design test and evaluation for new design schemes produced and see whether it satisfies design task and objective. If not, return to the first three steps for positioning, analysis and design. Next, we will prove with specific research cases that this method can effectively promote designers' design in design analysis stage and design implementation stage.

### 3.2 Application of Cultural Gene in Design Practice-with Chinese Traditional Lion Dancing as an Example

As shown in Fig. 2, we classify and research elements and characteristics of Chinese lion dancing culture. Lion dancing originates from China Han Dynasty, Lion dancing is



**Fig. 2.** Traditional Chinese lion dance

a comprehensive art integrating martial art, dancing and gong and drum, representing good luck and force. It is full of oriental cultural characteristics and artistic charms.

### 3.3 Experiment Mode

Samples of typical cultural characteristics selected in the case of the Paper are mainly manifested in the form of figures and photos and the content and information are characterized with diversification and complexity. We describe indicator meaning and influence factors for eye movement based on photo samples of typical cultural characteristics according to above characteristics in the Paper.

### 3.4 Experiment Purpose

The main purpose of the experiment is to test and analyze areas and characteristic elements most manifesting cultural characteristics highly noticed by tested objects in cultural characteristic samples, providing reference for extraction of subsequent cultural design gene [13–15].

### 3.5 Analysis of Experiment Influence Factor

Through analyzing cognitive process of certain number of tested objects for cultural characteristic samples with eye movement analysis experiment, perceptual cognition process of tested objects is quantified through eye movement data. Through comprehensively analyzing watching time, watching track, backlight times and area of interest

**Table 1.** Analysis of related influence factors in the experiment

Factor classification	Influence factor of eye movement analysis	Scheme
Experiment sample	Size	Uniform size is set up to be 1024 × 680px
	Color distribution	Control group of gray samples
	Demonstration sequence	Determine sequence with Latin square design method
	Playing duration	21 min/person/time
	Switch between samples	Set up with black transition page at interval
Tested object	Number of tested objects	20 tested objects
	Age	21–45 years old
	Gender ratio	The same ratio of the male and the female
	Education background	Above bachelor's degree
	Degree of familiarity with test	Experience to contact or be familiar with cultural creative design. However, all tested

when tested objects observe different area elements of samples, eye movement data are classified, summarized and analyzed to obtain People’s common focus area and elements for cultural characteristic samples. With analysis based on experimental psychology used for extraction of cultural design gene, experimental results are influenced by many factors [16] (Table 1).

### 3.6 Experimental Objects

Tested object of the experiment is 20 people, including 10 girls and 10 boys respectively at the age of 21–45 with education experience above bachelor. Where there are 9 undergraduates, 4 postgraduate students, 4 doctoral students and 3 professors. Naked eye vision of test reaches 1.0 and they do not have color blindness and color weakness. These tests have work experience of cultural characteristics element extraction and cultural creative products design, but it is the first time for all test to see pictures of experiment test samples.

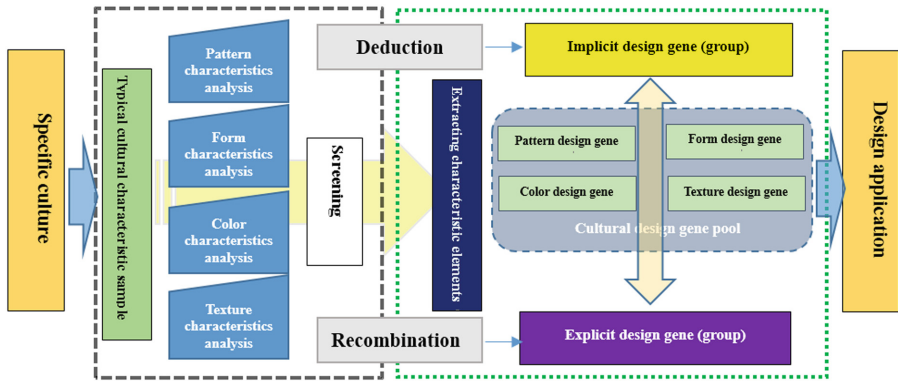


Fig. 3. Flow diagram for extraction analysis experiment of cultural design genes

### 3.7 Experiment Data Analysis

ASL Results Plus (Eye-trace 6) is used for experiment data analysis [31–33]. Cultural sample characteristics element emphasized by tested objects is mainly analyzed through gaze trail of tested objects, heat map and area of interest these three levels. Sample 1, 2 and 3 are taken as example to be analyzed below.

(1) Gaze trail

Figure 4 is gaze trail diagram of sample 2. In the Figure tested objects gaze at face of dancing lion firstly, and then observe ornamentation in the left side and right side behind lion head successively. Eye leaping activity of tested objects is mainly in lion head and interior of ornamentation area of eyes [30–34]. There are few eye leaping activities in lion head and lion body. Therefore, tested objects mainly pay attention to face of dancing lion and ornamentation on the body.



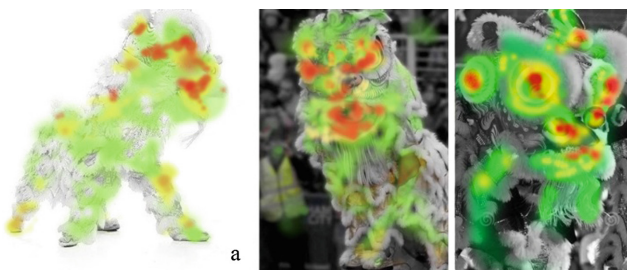
**Fig. 4.** Gaze trail analysis of sample 2

(2) Heat map

Heat map shows gazing conditions of tested objects by color and displays attention heat of samples by different colors. Red shows that attention time is the longest, followed by yellow. Green shows that attention time is shorter. Original color of samples shows attention has not paid on it. Heat map reflects attention degree of tested objects on different areas of samples directly (Fig. 5).



**Fig. 5.** Original sample of thermodynamic diagram of visual focus (Color figure online)



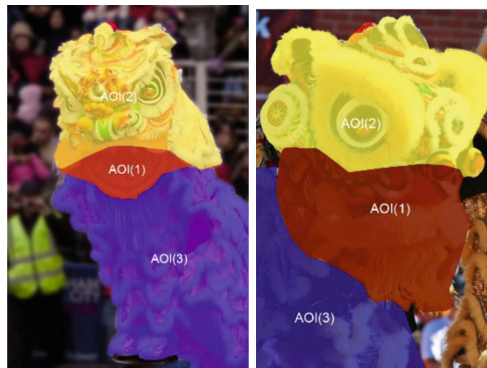
**Fig. 6.** Gray sample of thermodynamic diagram of visual focus



In general, focus is still mainly in the face of lion head and ornamentation on the body. Screen is captured for area with significant attention. Three general areas with significant attention of tested objects on the figure can be seen: eyes, mouth and mane of neck (Fig. 6).

(3) Area of interest

Area of interest refers to that samples are divided into different areas to study visual rules of tested objects in different area and visual browsing conditions in each area of interest can be contrasted and analyzed. As shown in Fig. 7, sample 2 is divided into ornamentation (AOI 1), head of dancing lion (AOI 2) and the upper body of dancing body (AOI 3) these 3 areas of interest. Attention degree of tested objects on two areas is studied by quantitative contrast.



**Fig. 7.** Area of interest (AOI) analysis of samples

Quantity of fixation point in area of interest reflects importance of the same sample in different area. There will be more gazing frequency for more important area; time proportion of gazing AOI area in the same sample is also an important index to reflect area (namely different cultural characteristics), the longer gaze duration is, more important display area is, and corresponding cultural sample characteristics of the area can reflect the importance more. Analysis on eye movement data of 20 tested objects is shown in Table 2.

**Table 2.** Data statistics of all areas of interest

Area	Area ratio	Average fixation points	Average fixation time [Ms]	Proportion
AOI1	25%	12.8	5617.8	53.7%
AOI2	13%	9.7	3736.3	37.9%
AOI3	23%	1.5	689.2	6.5%
Outside	29%	0.7	178.5	1.7%



According to percentage of fixation time in all areas of interest, attention degree of heat (proportion is 53.7%) in original sample is more than that of body of dancing lion (the proportion is 31.05%), which shows that tested objects are more interested in cultural characteristics of head of dancing lion generally. Through analysis of control experiment, color can attract tested objects to input more attention. According to experiment data, key focus of tested objects on samples ornamentation and head of dancing lion. [17, 19, 20] Therefore, ornamentation and head of dancing lion, especially characteristics of mouth and mane ornamentation can reflect cultural characteristics of dancing lion mostly. In addition, experiment results present that head of dancing lion, especially mouth and eye positions receive more attention than other positions of the body, therefore, it shall be considered emphatically at the time of extracting cultural design genes.











Through analysis of gaze trail, heat map and area of interest these three levels, key extraction objects of cultural design genes in samples can be determined and they are body ornamentation, mouth and eyes of head position of the dancing lion respectively. Through conclusion, key extraction characteristics pattern as shown in the Figure is determined.

## 4 Design Application of Cultural Design Gene

### 4.1 Pattern Design Gene Extraction

Pattern, as typical representative of cultural gene, contains abundant aesthetics and profound cultural connotation. [21–23] Collecting pattern and extracting general core characteristics of ornamentation from characteristics sample is generative process of cultural design gene of explicit pattern. Deducing and recombining general core characteristics of pattern and making expression pattern of pattern ornamentation rich to deduct more pattern ornamentation is generative process of cultural design gene of implicit pattern (as Table 3).

**Table 3.** Pattern design gene extraction

Pattern extraction	Extracting pattern 1	Extracting pattern 2	Extracting pattern 3	Extracting pattern 4	Extracting pattern 5	Extracting pattern
						...
Pattern deduction and recombination	recombining pattern 1	recombining pattern 2	recombining pattern 3	recombining pattern 4	recombining pattern 5	recombining pattern
						...

### 4.2 Form Design Gene Extraction

Extraction of form design gene highlights form characteristics of dancing lion at the same time of keeping main face characteristics of dancing lion, which has important significance on highlighting main characteristics of dancing lion in design application.

Traditional dancing lions in China have various forms. As tested objects pay more attention to lion head in the sample, head form is as main extracted original sample. As shown in Fig. 8, external profile of head and tongue characteristics of lion in the face are extracted and extracted form lines are ratified from the angle of design to make it smoother with strengthened expressive force as form design gene of cultural creative gene.



Fig. 8. Characteristics in the mouth extraction of dancing lion

### 4.3 Color Design Gene Extraction

Dancing lion body and ornamentation these three parts in Tables 4, 5 and 6 to extract color design gene. Extracting color aimed at different characteristics classification helps to study color characteristics [24, 25] of colored drawing and ornamentation of dancing lion with classification. Overall consideration is given to color area, Lab average value and proper threshold value to realize extraction of color design genes in the sample.


Table 4. Color design gene extraction of dancing lion head

Extraction source									
Extraction result									
RGB value	R: 119 G: 139 B: 186	R: 214 G: 121 B: 141	R: 148 G: 101 B: 78	R: 246 G: 216 B: 92	R: 199 G: 56 B: 63	R: 165 G: 132 B: 110	R: 26 G: 28 B: 31	R: 239 G: 238 B: 238	R: 39 G: 50 B: 127

Table 5. Color design gene extraction of dancing lion body

Extraction source								
Extraction result								
RGB value	R: 225 G: 128 B: 86	R: 210 G: 124 B: 106	R: 86 G: 96 B: 99	R: 98 G: 115 B: 165	R: 87 G: 114 B: 84	R: 117 G: 102 B: 58	R: 128 G: 43 B: 47	R: 106 G: 124 B: 135

**Table 6.** Color design gene extraction of ornamentation of dancing lion



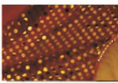


Extraction source							
Extraction result							
RGB value	R: 36 G: 41 B: 38	R: 56 G: 75 B: 69	R: 79 G: 93 B: 94	R: 126 G: 132 B: 136	R: 57 G: 50 B: 48	R: 100 G: 99 B: 88	R: 88 G: 78 B: 66

As shown in Tables 4, 5 and 6, through contrastive analysis, color of three parts of the sample has obvious difference. Color in the head of dancing lion is relatively bright generally, golden (R246, G216, B92) face is matched with creamy white hair and red (R199, G56, B63) lip to highlight bright face characteristics of dancing lion; the color of dancing lion body is slightly dark that is dominated by yellow (R225, G128, B86) and red (R128, G43, B47) and matched with blue (R98, G115, B165), golden yellow (R117, G102, B58) and grayish stripe (R106, G124, B135) for embellishment; dark brown (R57, G50, B48), gray (R126, G132, B136) and dark green (R56, G75, B69) are mainly adopted for color of ornamentation is mainly, which generates comparison with dancing lion with bright color as foreground and highlights sacred and magnificent visual effect of dancing lion.

#### 4.4 Texture Design Gene Extraction

Product material includes organization and texture of material surface and is important carrier to express product design feeling. [26, 27] is painted for silk. Generous and steady dancing lion and lion head surface that is detail of statue are displayed to be finer. Ornamentation of statue is painted out subtly with color taking cork wood and gypsum as adhesive, which highlights sense of depth. Aimed at material utilization characteristics of traditional dancing lion of China, cork wood, plush, silk, painting and other typical materials are extracted respectively. The arrangement is shown in Table 7.

**Table 7.** Texture design gene extraction

Material name	Cork wood frame	Plush edge	Sequin	Embroidery technology	Metal material
Extraction result					

## 5 Design Application of Cultural Design Gene

Overall consideration is given to cultural design gene characteristics and modes that are proper to combine with product design. [35, 36] Cultural design gene conforming to design demands is selected to implement cultural creative design. A cultural creative product – lion tongue fan of dancing lion of China is shown in Fig. 11 by extracting test results in the experiment, and purifying scroll design of dancing lion, tongue form in the mouth of dancing lion and color elements these obtained cultural gene elements, thus application of the method in cultural creative design is verified.

As for the lion tongue fan, dancing lion tongue form is adopted for general form, and fan agitation conforms to action language of moving tongues in lion dancing [37] performance. Chinese red, pink green, golden yellow and orange are extracted from dancing lion head as main color. Extracted scroll design, tooth and tongue pattern are matched. Plush texture of headdress of dancing lion is borrowed in texture to create visual quality. Which symbolizes good luck. The fan symbolizes waving lion tongue. Users obtain this lucky implied meaning at the time of stirring up.



狮舌扇  
The lion tongye fan



The fan is the wind supplies, the summer requisites. But with the development of The Times, young people have rarely used fans. On a hot summer evening, the old people can be seen taking a fan out for a walk. The fans lack a little bit of flavor for young people, so we use the tongue part as the design element for the lion's lion culture, which can be used in different colors to attract young people to use fans. In this way, while promoting the indigenous culture of foshan, it is also advocated to make life more low-carbon and environmentally friendly.

## 6 Conclusion

Cultural inheritance is derived from memories in the life. This sediment and memory conveys the same life experiences and spiritual annotation which people have placed on emotions through products. In the challenging modern cultural creation, the problem that cultural creative products need to solve is how to make cultural characteristics mode well code but continue to have its original characteristics, like the biological

inheritance. With the combination of modern cultural creative product design self-consistently, they show users their own qualities and traditional values. Subsequently, relevant image models are built. From the two aspects, design methods and development procedure, corresponding research and development are analyzed, and product design gene mapping and deduction methods are proposed in accordance with their forms, characteristics and mapping relations.

By doing so, product image design context models are achieved, which makes the transformation from cultural characteristics element to cultural creative products become available. Such achievement not only provides designers some measures and evaluation models to clearly show the spiritual values of traditional culture but avoids the illogical annotation in the transformation. Through the real case, the feasibility of such method is examined, which offer an effective reference to cultural creative products.

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