Research on an innovative design model

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Abstract: The design methods of furniture are different from east to west; it has been the hotspot of the scholars. However, in terms of the theory of modern design innovation, neither the early creation theory, the modern design theory, nor the widely applied TRIZ theory can fully fit the modern furniture design innovation, so it is urgent to study the modern furniture design theory. This paper is based on the idea of TRIZ theory, using lots of literatures as data, and uses the method of statistical stratification to analyze and sort out the research of modern sitting equipment, and finally put forward the modern furniture design model, which provides new ideas and perspectives for the modern design of Chinese furniture.

1. Introduction

Furniture is one of the representatives of Chinese traditional products, is also the embodiment of ancient Chinese ideas of creation. It can be said that the development of furniture is accompanied by the development of the Chinese nation. Modern design furniture is the continuation of ancient Chinese furniture design. Chinese modern design began in the 1980s, which is subordinate to the traditional design of the creature. The design theory of Chinese modern creation originates from two aspects: one is inheriting the tradition of Chinese ancient creation, and continuing the basic design idea of "Unity of Methods and implements" and "Unity of Man and Nature". The second is from the Western "borrowlism" based on mathematics, physics, natural science evolved from modern design methods. These two aspects finally formed two kinds of thoughts of "the art theory of creation" and "the industrial theory of creation ", and influenced the development of Chinese modern design.

Although the two concepts of "art" and "industry" have different influences on the design of modern products, they all have the same characteristics in nature. First, both of them pay attention to the inheritance of culture. Creationism takes the traditional culture as the main body, embodies the humanistic spirit and artisan spirit. The design of science is standing on the "design culture". The difference is that the culture of "Creationism" refers to the essence and extension of traditional culture, while the culture of "Culturalism" refers more to the complex and multi-meaning modern broad sense culture. Second, both of them focus on the study of needs. The former emphasizes the social needs and emphasizing the practical; while the latter is emphasis on the relationship between people and things, by studying this relationship to derive a new demand, emphasizing that people's demands in different states. Third, both of them attach importance to the designer's knowledge and skills, but the former focus on the "folk art maternal theory", emphasizing the folk arts and crafts skills, and taking traditional court technology, literati and doctoral crafts and religious skills and other folk arts and crafts, as the main body and root of the traditional skills; The latter is based on the reorganization the knowledge of designers, with modern technology as a method, emphasizing the reorganization of resources'. Skills are the relationship between people and objects, providing services for different
states of people.

In terms of the theory of "art" and "industry", the former is based on the traditional crafts, emphasizing the inheritance, which is an important method to study the ancient artifacts, but is lack of cohesion of modern design, and cannot guide the design and innovation of modern industrial production. While the latter is based on the modern, using modern methods specify the way of development for the modern design. However, it separated with the traditional design, ignoring the local experience, even ignoring the traditional and regional of culture.\(^2\)

In the overall historical and cultural perspective, traditions should not be cut off and cannot be cut off. There are only a few intermittent records in the history about the development of technology and the continuation of the style. Meanwhile, under the “westernized” modern education, design has become a simple imitation of the western countries “advanced” mode of production, marketing and other forms.

2. METHODS

2.1 Analysis of TRIZ method

TRIZ theory is a design theory which is used to solve the problem of design inheritance and innovation. Its founder Altshuller has always believed that innovation activities have their inherent laws, and not just based on cognitive science and creative thinking psychology theory that innovation activities only scientists and engineers’ inspiration flashed.\(^3\) Led by Altshuller, tons of research staff comes from research institutions in the Soviet Union, and its affiliated universities and enterprises, based on the 2.5 million natural sciences and technology patent documents, doing systematic and detailed analysis, and extracted 40 thousand patents as the key research, summarized and refined. And integrated the principles and rules of the multidisciplinary field, eventually found that the improvement of the product in any field, the change of technology and the innovation are all the same as the biological system. There exist the cycle of production, growth, maturity, aging and death. On the basis of this, the TRIZ theory is established, and the solving algorithm of invention is described. And after three stages of development, it has developed into a set of theoretical and practical solutions to the problem of the invention, which is based on the principle of technology system evolution.\(^4\)

The TRIZ theory, however, has its scope of application as well as any other theory. The era of these 2.5 million patent documents selected by TRIZ theory is just before the high-tech revolution. At that time, regardless of new energy, new materials, or biotechnology are all in a weak period of development. However, the largest categories of innovation design were from the field of machinery and computer fields at that time. It can be inferred that the 2.5 million pieces of natural science and technology patent literature, mechanical and computer related literature should be in the majority, which is also matching the condition that the TRIZ theory is more applicable to the field of mechanical design and computer field. The vast majority of examples that are cited by Altshuller in introducing TRIZ theory are closely related with the mechanical technology case. However, for the chemical, electronics, medical science and other more abstract technical issues rarely involved.

In spite of this, the origin way of TRIZ theory that through a large number of investigation and selection, is worthy of our thinking and learning, which identify research points by some statistical methods in deepening research, summarizing and refining the principle and rule for the comprehensive multidisciplinary field, and use the algorithm to solve and ultimately determine the rules and methods of innovation design, and then continue to revise and improve, gradually be applied to the actual design.

2.2 Furniture design literature statistics

The research method of modern furniture design is based on the research method of TRIZ theory. The author search traditional furniture, traditional furniture design, modern furniture, modern furniture design, four groups of key words by Guangdong University of Technology CNKI mirror database. The data from 2005 to 2015 is shown in Table 1, and the search type is subject search. The proportion of research on traditional furniture and modern furniture by modern scholars is basically the same, among them, the number of modern furniture design papers is higher than the number of traditional furniture design papers, but the study of furniture design is only a small part of the study of furniture.
Modern furniture has received more attention from the academic circle by comparing the circulation of traditional furniture and modern furniture articles from 2005 to 2015. In recent years, the circulation number of articles on modern furniture has been maintained at about 100 per year.

2.3 Data selection method

The choice of data is the key problem in the research. In order to effectively pick up and deal with the data, the author uses the Analytic Hierarchy Process (AHP) which was proposed by Professor T L Saaty of University of Pittsburgh in the United States to analyze the literature in quantitative and qualitative way. The literature is divided into different levels, to form a multi-level structure. At the same time, the judgment matrix is established by comparing each layer according to a certain criterion. The weight of the layer element for the criterion is obtained by computing the maximum eigenvalue of the judgment matrix and the corresponding eigenvector. On the basis, we can get the values of different ideas by calculating the combined weight of each level of elements for the overall objective, and taking them as the reference for the selection.

According to this method, 832 articles of traditional furniture and 1215 articles of modern furniture are selected as the main data for this study. In these 2047 selected papers, journals are the largest, with 1653 articles. Conference papers are the least, only 18. The other includes 210 master's theses, 149 newspaper papers and 17 doctoral dissertations.

By calculating the weight value, we elected 17 doctoral thesis, 195 master's thesis, and 1532 journals as the final sample.

| Table 1 Retrieval literature quantity | Table 2 Literature details |
|--------------------------------------|----------------------------|
| Subject Retrieval | Quantity | traditional | modern | total |
| Traditional furniture | 6149 | | | |
| Traditional furniture design | 1162 | | | |
| Modern furniture | 6854 | | | |
| Modern furniture design | 2815 | | | |
| doctoral thesis | 11 | | 6 | 17 |
| master's thesis | 78 | | 132 | 210 |
| Journal article | 633 | | 1020 | 1653 |
| conference papers | 7 | | 11 | 18 |
| Newspaper article | 103 | | 46 | 149 |
| total | 832 | | 1215 | 2047 |

2.4 Research on Data Classification

Factor analysis can break down the original variables in the selected literature and derive the underlying "category" from which is more relevant to indicators. This paper will use this method to study the concerns of scholars in the furniture. The factor analysis principle assumes that there are p variables, $X_1, X_2, \ldots, X_p$ and the observations of p variables in n samples constitute an $N \times P$-order raw data matrix

$$X = \begin{bmatrix}
X_{11} & X_{12} & \cdots & X_{1p} \\
X_{21} & X_{22} & \cdots & X_{2p} \\
\vdots & \vdots & \ddots & \vdots \\
X_{n1} & X_{n2} & \cdots & X_{np}
\end{bmatrix}$$

In order to simplify the comparison between the variables, the standardized variables are set before performing factor analysis. We can assume that the standardized variable is $Z_1, Z_2, \ldots, Z_p$. The p standardized variables can be represented by p new standardized variable factors $F_1, F_2, \cdots, F_p$. We use the equation (1) as follows:

$$z_j = a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jp}F_p \quad (j = 1, 2, \ldots, p) \quad (1)$$

In the formula $a_{ij}$ ($i, j = 1, 2, \cdots, p$) is the factor load matrix of matrix A. And choosing m factors with larger variance contribution (the cumulative contribution rate of m factors is above 85%).
At this time, equation (1) can be written as follows:

\[ z_j = a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jm}F_m + e_j \quad (j = 1, 2, \cdots, m) \tag{2} \]

In the formula, \( E_1, E_2, \cdots, E_P \) is the error term.

Using the above method, the 17 doctoral theses have been divided into four categories (Furniture and life relationship, Culture and elements, Design theory, Style and decoration). From table 3, we can see their respective numbers.

In the same way, 195 master's theses are divided into 16 categories. The classifications and number of each category can be seen in Table 4. It depicts their respective proportions in the total. Meanwhile, 1532 journal articles are divided into 29 categories. The classifications and number can be seen in Table 5.

**Table 3 PhD thesis classification**

| Classification                  | Quantity |
|---------------------------------|----------|
| Furniture and life relationship | 2        |
| Culture and elements            | 4        |
| Design theory                   | 4        |
| Style and decoration            | 7        |

**Table 4 Master's thesis classification**

| Number | Classification       | Quantity |
|--------|----------------------|----------|
| 1      | Style and decoration | 45       |
| 2      | Furniture materials  | 22       |
| 3      | Furniture structure  | 21       |
| 4      | Design theory        | 20       |
| 5      | Literature Review    | 16       |
| 6      | Culture and elements | 14       |
| 7      | Interior furnishings | 12       |
| 8      | Functional furniture | 12       |
| 9      | Special furniture    | 11       |
| 10     | Ecological environment | 5     |
| 11     | Parts & Accessories | 4        |
| 12     | Furniture color      | 3        |
| 13     | Furniture Marketing  | 3        |
| 14     | Modern Technology Application | 3 |
| 15     | Human Engineering    | 2        |
| 16     | Personalization      | 2        |

**Table 5 Journal article classification**

| Number | Classification                  | Quantity |
|--------|---------------------------------|----------|
| 1      | Literature Review               | 264      |
| 2      | Culture and elements            | 159      |
| 3      | Style and decoration            | 129      |
| 4      | region and nationality          | 93       |
| 5      | Furniture structure style       | 78       |
| 6      | Furniture materials             | 63       |
| 7      | Design theory                   | 57       |
| 8      | Chinese and Foreign Contrast    | 55       |
| 9      | Functional furniture            | 55       |
| 10     | Inheritance and innovation      | 54       |
| 11     | Ecological environment          | 45       |
| 12     | Special furniture               | 39       |
| 13     | Furniture collection            | 38       |
| 14     | Furniture Marketing             | 34       |
| 15     | Personalization                 | 33       |
| 16     | manufacturing technology        | 32       |
| 17     | Interior furnishings            | 32       |
| 18     | Computer-aided                  | 32       |
| 19     | modern technology               | 28       |
| 20     | Furniture designer              | 27       |
| 21     | Furniture color                 | 27       |
| 22     | Parts & Accessories             | 24       |
| 23     | Life style                      | 22       |
| 24     | Standardization                 | 18       |
| 25     | Human Engineering               | 17       |
| 26     | Furniture evaluation            | 17       |
| 27     | mechanical property             | 15       |
| 28     | Parameterization                | 8        |
| 29     | Designers cross-border          | 6        |

2.5 Data research conclusion

Compared with these abundant papers, we can find that the scholars contribute a lot to the studies in furniture culture, the furniture structure style and the furniture style decoration, which are the hotspots in modern research. Furniture materials, design principles, functional furniture and other research directions have also been the favor of scholars. In addition, the research directions like inheritance and innovation of furniture, computer-aided design, and designer cross-border have also become new hot spots. In the sample, there are a large number of literature reviews on furniture development, the same classification also includes furniture collection, regional ethnic, Chinese and
foreign contrast, furniture marketing, interior furnishings and other aspects. These cannot help us to study the traditional furniture design concerns, and should be excluded.

The remaining classifications are re-integrated into four directions according to their contents. These four aspects cover 23 research hotspots in the furniture literature, they are design constraints, design source, design skills, design presentation, respectively.  
At the same time, according to the nature of the design, design constraints are the impact from the outside; design sources are the user's needs; design skills are the designer's skills; design presentations are the presentation of the product.

3. DISCUSSION

3.1 Design constraints: Potential

In the above data, the design constraints are made up of many aspects, such as culture and elements, style decoration, ecological environment, heritage, innovation, etc. These aspects are not visible, and we cannot see them with eyes, but they actually affected the design. These invisible constraints and influence can be called “potential” in Chinese culture. We often say that “Size up the situation”, “the wave of the future” and “momentum” in Chinese words. "Potential” is a kind of invisible influence for the surroundings, and it is also called "field" in physics. Here, it is "the culture", it is "the environment", it is the general name of what affects the design; it is a dimension of space and time.

3.2 Design presentation: Pattern

In the above data, the design presentation of furniture contains structure style, materials, colors, special furniture, parts and accessories etc. Design presentation is a kind of external performance, and is the final pattern of furniture products. In the traditional culture, pattern represents the form of the objects existence. The Pattern of creation refers to specific conformation and state of existence, which is shown by the created things. It is a combination of design elements which mankind makes meaningful creation of subjective initiative.

3.3 Design source and skills: Principle

Design source and skills serves for the pattern, which are the embodiment of human factors. Design sources are the internal representation of the relationship of user and the furniture pattern, and design skills are the external representation of the relationship of designer and the furniture pattern. Traditional objects continue to inherit and innovation according to users’ requirement in different periods. Users’ requirements are divided into material needs and immaterial needs, which are corresponding to material factors and immaterial factors, at the same time, designers need to have knowledge and skills to meet material factors and immaterial factors. 
This relationship between people and products is called “principle “in science of design.

The relationship between designers and users is changing all the time. In the primitive society, design appeared to meet human’s needs. Designers and users were the same person in the beginning when products related to human survival. These products’ designs are successful as they can play a role in the critical time, although their shapes are very simple.

3.4 Relationship among the three

The French philosopher Sia had put the traditional artifacts into a multidimensional system to define. He believes that material culture and spiritual culture are all changing in a dynamic process and each of the traditional artifacts is bearing the change of the brand. Creative culture always takes the human’s basic needs as a basis research spot. It not only concerns about the external structure of the material, but also includes various cultural phenomena in creation activity. It has a positive significance for the development of new life styles.

Today we refine architecture culture not only from the "pattern" of product, but also putting the "pattern" in the " principle" of the associated system, ultimately, we have to put the "pattern" and " principle" into the space of "potential" to interpret. "Pattern" shows “principle” and "principle" is used to explain product; and "principle" guides "potential" and "potential" is used to discuss people. "Interpretation of the Great Learning" refers to: "Things have their root and branches." "Principle" and "product" have been always developed simultaneously in Chinese culture. From the view of design point, the "principle" we talk about is the purposeful activity of human beings and the resulting of
social phenomenon, a hidden structures which is behind the creative design and the fundament and causes "pattern" change. In a certain conditions, human purposeful activity must match up to the specific spatial "potential". It happens in behavioral interaction or information exchange, among people, or between human and everything\textsuperscript{11}. In this process, people's consciousness has produced a certain meaning, and things have changed their "pattern" and it is consistent with the goal of science of design to create a richer human life style. Through the research on the external factors, we explore a new way of life which explores the cultural values of the dimensions; by adjusting the internal factors, create a suitable internal structure of external environment to manifest itself in the form of an object.

"Pattern" is the external display of "principle", which exists before things and determines existence of "pattern"; "principle" is an internal extension of "potential", which controls "principle" and gives the rule of "principle". Thus, it is not only to determine an object which is not another, but also as a link with the relationship between people and things, using a whole and dynamic vision to study the evolution and logic of design, as well as the relationship between the various elements in the system.

4. CONCLUSIONS

The furniture design model conforms to the traditional design features. Traditional design is based on three basic logic points: the first is the ruling systems logic, the second is the social relationship logic; and the third is the using logic of things. These three logical concepts are related to the three factors in the modern design: environmental factors, human factors and material factors. Design constraints are the modern extension of the traditional logic system, including culture, environment, style, genre, tradition, inheritance, and many other factors, which is also a modern continuation of the traditional system logic.

As Professor G Z Liu emphasizes that design is a kind of relationship\textsuperscript{12}, and emphasizes that "potential" determines the design expression and strategy. Modern design is based on the inheritance of the traditional design, the relationship among "potential", people and objects is just like the relationship among human, machine and environment in the early stage of industrial design.

The research of creation culture is proposed by summarizing the "traditional creation" and "modern industry" on the creation culture, it is a kind of theoretical research, which aims to excavate the material and spiritual relationship behind the ancient artifacts and summarizes the law of the development of the traditional artifacts, bringing inspiration for the modern design\textsuperscript{13}. Science of design is a methodology, which can be considered as a research method that is like a kind of knowledge system for guiding practice. It also points out the research model of the lifestyle and the research methods are more diverse than traditional creation.

They belong to different research levels; one is “ancient research ”, and another is "modern research", but the purpose of them is all for the future design. “Traditional and modern” just like "the East and the West", they are not antagonistic, but should be unified. In essence, they are consistent with the starting point, research methods and directions in design. They integrate the content on human lifestyle and creative intelligences in lives, through some research methods to develop the rules. As shown in figure 1, the furniture design model better reflects the relationships in modern furniture design. “Potential” is used to cover the constraints factors for design, "pattern" is used to cover the presentation factors for design, and “principle” is used to express the design sources and design skills which are reflected in human factor.
Figure 1 Furniture design model

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