

Study on design of Chair shaping based on Kansei engineering

YE Yong-jun¹, ZHANG Zhong-feng², HE rui-lin³

School of Furniture and Arts Design, Central South University of Forestry and Technology, Changsha 410004, Hunan, China

E-mail: 382434445@qq.com

Abstract— As a necessity of daily life, furniture is going through a process of consumption transition from rational to emotional. This paper took contemporary-style chair for the study and put forward the framework of chair shaping design based on Kansei engineering of forward quantitative inference, explored the relationship between consumers' preferences and shaping elements. As a result, a mathematical model of chair shaping design based on sensibility intentions was constructed by using of the basic principles and methods of Kansei Engineering which provided a scientific guidance for design a chair to meet the emotional needs of consumers.

Index Terms—Kansei engineering; Chair; Shaping design; Emotional semantics; Quantification Theory Type I

1 INTRODUCTION

As living standards improve, people's consumption concept has gradually increased from rational consumption to emotional consumption which promoted the transition from products to emotional needs gradually. Modeling is an important part to reflect the product's emotional, therefore, it is necessary to pay more attention to research on emotional design of product's modeling. Ishihara *et al* (1997) [1] deduced out of the theories and methods of corresponding modeling to support the emotional modeling design of car by neural network combined with fuzzy backstepping theory method. Su, et al. [2] explored the relationship between psychological emotional imagery of consumer and design elements of product on the quantitative aspects. Lai, et al. (2005) [3] established a gray relational analysis model and neural network model of mobile phone modeling, and formed the best combination of design elements to meet the user's product images. Zhao [4] took "The correlation between shape of electric kettle and emotional appeal" as an study example to verify the feasibility of simplified model and design significance of Kansei engineering in product. Chen, et al.[5] using Kansei engineering theory to seek the relationship between Kansei image vocabulary and design programs of furniture to achieve the target of preferred design program of furniture. In view of the characteristics of various products can be linked with needs of consumers' emotion and psychology through Kansei engineering. Furthermore, few literature focus on Kansei engineering used in furniture design. Therefore, this paper conducted an emotional research to chair modeling based on basic principle and method of Kansei engineering so as to provide a scientific theory for furniture designer and make the chairs better to meet the aesthetic requirements and emotional needs of consumers.

• YE Yong-jun is currently pursuing masters degree program in Furniture engineering in University, China. E-mail: 382434445@qq.com

2 RESEARCH PROCESS AND METHODS

"Kansei engineering" is one of new directions for Japanese design circles committed to opening in the late 1980s, it can quantify the emotional reactions which is difficult to quantify and only qualitative, no logic at all irrational at past, and to develop a new generation design technology and product by use of modern computer technology [6]. The study of Kansei Engineering focuses on exploring the relationship between people and products, which can transform consumers' feel or imagery into design technology of products elements.

This paper proposed a chair design workflow of forward quantitative inferential, and established a design framework of chair modeling based on Kansei engineering (Fig. 1), it is suitable for the stage of chair's conceptual design, and combined with modern style chair design as a example, to got a depth study of chair modeling design based on Kansei Engineering.

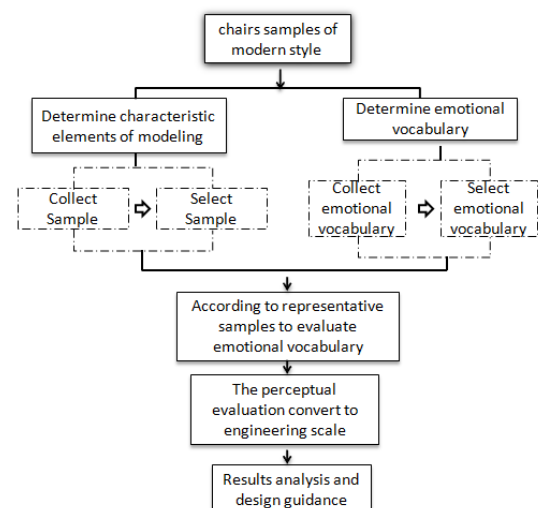


Fig.1 Framework of Chair shaping design based on Kansei engineering

2.1 Product design positioning

The chair is the most common furniture in our lives, and a variety of different types of chairs be used in almost all of the space. However, people not only asked the chair in good use function, but higher aesthetic and spiritual content with the improvement of living standards, so which has inevitably prompted increase emotional demand of chair. This paper take a chair shape design of modern style as example to study, and as young consumers of 4-5 years after graduation for the target, who were mainstream consumer groups with highly educated, a certain economic base and sensibility, follow the trend of the times, and who were delighted trend in products of fashion and full of period features.

2.2 Determine characteristic elements of modelling

2.2.1 Collect chair samples of modern style

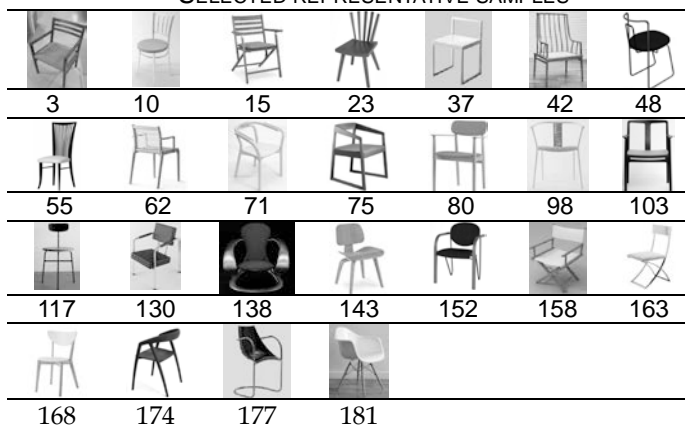
A large number of modern style chairs samples were mainly collected from furniture stores, magazines, internet, books and other media, and finally got 188 chair samples of modern style.

2.2.2 Select chair samples of modern style

Basis on collected samples of modern style chairs, taking into account the reality of the use of the chair at the same time, and then through the orthogonal experiment method, multi-scale analysis and cluster analysis, after several related people with design background discussed and screened representative sample, and ultimately selected 25 chairs as samples of this research (see Table 1). In order to avoid the effect of colour factors on the furniture emotional image in this study, the colours of representative samples were removed.

The basic principle of morphological is used to analysis characteristic elements of modern style chair's modelling. Firstly, took the structure of the chair as the assembly of certain design elements, then the modelling was divided into several independent items, such as backrest, seat, armrest, leg and so on. Furthermore, each item was subdivided into certain characteristic elements which were called categories, such as backrest item was divided into linear type, curve type, line and plane type, plane type, curved surfaces type and so on. Therefore, it identified preliminary characteristic elements rely on deconstructing the chair.

TABLE1
 SELECTED REPRESENTATIVE SAMPLES



According to the identified sequence of item, category of the

modeling characteristic elements, it established the decomposition table o

TABLE2
 BACKREST OF SHAPING CHARACTERISTIC ELEMENTS OF ARMREST

Item(a ₁)	Backrest	Score				
Category(b ₁₁)	linear type	o1	o2	o3	o4	o5
Category(b ₁₂)	curve type	o1	o2	o3	o4	o5
Category(b ₁₃)	line and plane type	o1	o2	o3	o4	o5
Category(b ₁₄)	plane type	o1	o2	o3	o4	o5
Category(b ₁₅)	surfaces type	o1	o2	o3	o4	o5

Considering the furniture modeling needed certain professional knowledge, this study took 30 post-graduates who were majoring in art design in our school as the subjects with the ratio of 1:1 between male and female. With their cooperation, the answers of 30 questionnaires were all effective.

2.3 Determine emotional vocabulary

2.3.1 Collect chair samples of modern style

In the collection of emotional vocabulary, one hand mainly to find relevant literatures on modern-style chairs in domestic and international, the other hand to collect emotional vocabulary related to modern-style chair from furniture-related books, websites, magazines and so on, meanwhile also made reference research of industrial products in domestic and international, and finally 102emotional vocabulary of modern chair have been screened out.

2.3.2 Select emotional vocabulary

This study have got emotional vocabularies which associated with modern-style chairs by finding literatures of domestic and international in journals, books, websites, magazines and other ways. Then it preliminary selected, modified, classified the emotional image vocabularies with the expert method (The experts are furniture design professional teachers and senior furniture designers) allowing for the characteristics of the modeling of the modern-style chairs, and screened five pairs of adjectives (Table 3) with the explicit image tendency eventually.

TABLE 3
 SELECTED ADJECTIVE COUPLES

Contemporary – Traditional	Brief – Complex
Smooth – Rigid	Light – Heavy
Fashionable – Outdated	

2.4 Determine emotional vocabulary

Semantic differential method (SD method) [8], a psychological determination method, is proposed by the American psychologist C.E Oswald Gu in 1957, it is to measure psychological feelings by verbal scales, and obtain the feelings of respondents to construct quantitative data which is the base data for subsequent analysis and research. Using semantic differential method (SD method) [9] to rearrange the serial number of the eventually selected 25 samples and to establish the

seven semantic differential scale for the five pairs of emotional image vocabularies (Table 3) to make up a questionnaire.

TABLE 4
 SD SCALE OF SAMPLE 11

Contemporary	3 2 1 0 -1 -2 -3	Traditional
Smooth	3 2 1 0 -1 -2 -3	Rigid
Fashionable	3 2 1 0 -1 -2 -3	Outdated
Brief	3 2 1 0 -1 -2 -3	Complex
Light	3 2 1 0 -1 -2 -3	Heavy



This research contacted the 60 students of in our school as the subjects with the male to female ratio of 1:1 with the method of network evaluation. The issuance of 60 questionnaires were fully recovered which were valid questionnaires with their active cooperation.

The data obtained from the two previous questionnaires was processed by EXCEL software, which got the average values (Table 5) of modeling evaluation which came from the subjects' evaluations towards the 25 samples chair, along with the deconstructed items and categories of the modern-style chair with higher scores (Table 6).

TABLE 5
 AVERAGE OF EMOTIONAL SEMANTIC EVALUATION

Samples	1	2	...	25
Contemporary – Traditional	0.433	1.483	...	1.983
Smooth – Rigid	-0.717	1.533	...	1.333
Fashionable – Outdated	-0.483	1.067	...	1.633
Brief – Complex	1.900	1.800	...	0.217
Light – Heavy	1.000	1.171	...	-0.100

TABLE 6
 MAIN SHAPING ELEMENTS

Item (a)	Category (b)				
Backrest (a ₁)	linear type b ₁₁	Curve type b ₁₂	line and plane type b ₁₃	plane type b ₁₄	sur-faces type b ₁₅
Seat Surface (a ₂)	Square type b ₂₁	Circle type b ₂₂	Sur-faces type b ₂₃	Ab-normal type b ₂₄	
Armrest (a ₃)	linear type b ₃₁	curve type b ₃₂	Other b ₃₃		
Leg (a ₄)	linear type b ₄₁	curve type b ₄₂	Other b ₄₃	No b ₄₄	

2.5 The perceptual evaluation converted into engineering scale

In the process of transforming the perceptual evaluation scale into the engineering scale, use the method of the quantification theory I. The quantitative theory I analysis is equivalent multiple regression analysis, which is used to strike a linear relationship between qualitative variables and quantitative variables. The difference is to quantify the qualitative variables

becomes "0" and "1" quantitative data before the regression analysis. When a category in the item, It named $\delta_s=1$, otherwise $\delta_s=0$, and thus obtain a linear relationship between the qualitative variables and quantitative variables.

This study applied quantitative theory I established the relationship between emotional vocabulary and modeling elements of modern-style chairs, When the qualitative data in item a of sample s was the category b, It named $\delta_s=1$, otherwise $\delta_s=0$. Among them: a was the Item, b was the category, and $\delta_s(a, b)$ was referred to the reaction of category b of item a in sample S. In this way to quantize and transform the modeling elements of the 25 samples into quantitative data represented by 1 and 0, which was the reaction value of each sample modeling element, and this study viewed the evaluation average values of modeling elements as the dependent variables and the reaction values of modeling elements as the independent variables to establish multiple linear mathematical prediction model as follows:

$$y = \gamma_{11}b_{11} + \gamma_{12}b_{12} + \gamma_{13}b_{13} + \gamma_{14}b_{14} + \gamma_{15}b_{15} + \gamma_{21}b_{21} + \gamma_{22}b_{22} + \gamma_{23}b_{23} + \gamma_{24}b_{24} + \gamma_{31}b_{31} + \gamma_{32}b_{32} + \gamma_{33}b_{33} + \gamma_{41}b_{41} + \gamma_{42}b_{42} + \gamma_{43}b_{43} + \gamma_{44}b_{44} + \gamma_{ij}b_{ij} + m \quad (1)$$

Among them, Y was the evaluation average value of modeling elements; γ_{ij} was the weighting coefficient for each independent variable, b_{ij} was the reaction value of each modeling element (i was the item, j was the category), and m was the constant value.

The model is solved by SPSS software in this research, which viewed the reaction values of 25 samples modeling elements as the independent variables, and the average values of modeling evaluation as the dependent variables, finally got the results of multiple linear regression analysis. After sorting got the available information data table, and took " Brief - Complex" for example are listed in Table 7.

TABLE 7
 ASSOCIATION ANALYSIS OF BETWEEN SHAPING ELEMENTS AND ADJECTIVE COUPLE "BRIEF—COMPLEX"

Item	Category	Category score	
		Brief	Complex
a ₁	b ₁₁	0.096	
	b ₁₂		-0.690
	b ₁₃	Ruled out	
	b ₁₄		-1.261
	b ₁₅		-0.163
a ₂	b ₂₁	0.475	
	b ₂₂	0.675	
	b ₂₃	0.475	
	b ₂₄	Ruled out	
a ₃	b ₃₁		
	b ₃₂	0.092	
	b ₃₃	0.273	
a ₄	b ₄₁	0.774	
	b ₄₂	1.616	
	b ₄₃	Ruled out	
	b ₄₄		
Coefficient of determination	0.800	Constant value	-0.167

3 RESULTS ANALYSIS AND DESIGN GUIDANCE

(1) The category score represents the effect degree and direction of a specified category to emotional vocabulary. And the positive score implies positive emotional vocabulary, and a negative score implies negative emotional vocabulary, and the excluded categories are not obvious to the emotional vocabulary. The results in Table 7 show that the value of linear armrest is 1.616, which is the most in favor of " Brief "; the value backrest of planar shape is -1.261, which is the most in favor of " Complex ", meanwhile, the correlation of line and plane type backrest, abnormal seat surface, linear chair legs and other armrest with the " Brief " is not obvious. Therefore, when designing brief type chair, you can use linear armrest modeling elements, while pay attention to other parts sense bring simplicity. Similarly, the other emotional vocabularies corresponding modeling elements can effectively to guide the design of chair shape.

(2) we can infer the prediction function representing the relationship between the pair of emotional vocabulary " Brief - complex " to all the modeling elements of modern chair from table 7: $y_{\text{brief}} = 0.096b_{11} - 0.690b_{12} - 0.261b_{14} - 0.163b_{15} + 0.475b_{21} + 0.675b_{22} + 0.475b_{23} + 0.092b_{32} + 0.273b_{33} + 0.774b_{41} + 1.616b_{42} - 0.65c_{34} + 1.311b_{44} - 0.167$ (The coefficient of determination was 0.800); so as to verify the effectiveness of the above-mentioned function, we reselected samples to survey, and the results were sent to T testing analysis along with the results predicted by the function. And the T testing analysis implies that the significance level is above 0.050 with no significant differences, so the result is reasonable. The function can provide the judgment on the consistency between the perceptual images delivered by the designers' image modeling design schemes and the emotional needs of customers to provide the evidence for selection of designing schemes and further optimization.

4 CONCLUSION

Kansei engineering is developed to take sense and imagery of personal transformed into a consumer-oriented design support technology in the product design process, it is adapted to the development requirements of market in recent years. According to the basic principles and methods of Kansei engineering, this paper combined with modern-style chair design as an example, established a relationship model between emotional semantics and chair modeling elements, to provide a scientific guidance for the chair design, meanwhile expanding the Kansei Engineering's applications in furniture design.

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