Study on the Materials Design of Furniture Based on Kansei Engineering

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Abstract – **According to the basic theory of the Kansei Engineering, combining with material design of furniture, the emotional appeal of consumers and designers for furniture of different materials was obtained, Kansei Engineering was applied in the material design of furniture to establish the relationship between the emotional factors expressed by the material of furniture and the furniture image of consumers for the material of furniture, reduce the perceptual cognitive bias between the designer and the consumer, and make suggestions on the material design of furniture for designers, so that the design of the product can meet the consumer's perceptual needs better.**

Keywords – **Kansei Engineering, Furniture, Material, Emotion, Product.**

I. INTRODUCTION

At present, the emotional engineering is a subject that analyzes the relationship between the thoughts and emotion of consumers and design. The form of furniture includes three elements, such as shape, color and material. Roland[1] pointed out that material has a large impact on the shape of furniture, the change of the material influences the change of the shape, and when the manufacturing method for its taking shape is changed, the form will change. Currently, the research on Kansei Engineering laid more emphasis on the shape and the form, it lacks the investigation on conveying the spirit of furniture. Material, as a kind of emotional design elements, has a very important position in furniture design, so that how to use the texture of material to enhance the product's emotion and make it easier for consumers to understand the information conveyed in the design by the designer is the part that designers must pay attention to. This paper tries to establish the relationship between the emotional factors expressed by the material of furniture and the furniture image of consumers for the material of furniture, so that designers can express the emotion and the design through the furniture material, and let the material interpret the emotion of the design to make the furniture design meet consumer emotional needs better.

II. RESEARCH PROCESS AND METHODS

Kansei Engineering began in Japan, from the late1980s. In the 90's, Kansei engineering is one of the new discipline and direction in the design field. Dr. Mituo Nagamachi defined Kansei engineering as a product development technology based on customer orientation and a translation technique to translate customer's feelings and intentions into design elements, namely a kind of method of transforming or corresponding the feelings to the design elements of furniture design. It applies Kansei response that was considered difficult to be qualitative, illogical and irrational to modern technology and quantifies the Kansei response to develop a new generation technology of product design [2].

Kansei Engineering is a discipline that can deal with consumer's emotion on the product. Compared with other methods, it creates a new mathematical method to predict the subjective concept of product by using modern technology, and combines language expression with engineering[3]. Based on Kansei engineering research program, the research is divided into six parts: the furniture design positioning, the selection of the typical sample of furniture, the establishment of Kansei semantic space, the establishment of material element space, data analyzing, the conclusions and analyzing. The research flow is shown in Figure 1
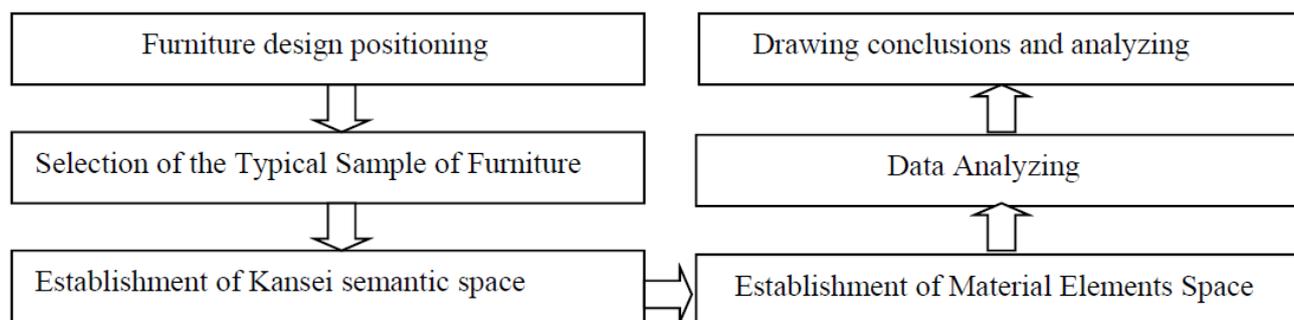

Fig.1. Research flow chart
Figure Source : Self Drawing

A. Furniture design positioning

Product design based on Kansei engineering is from the survey on target users' needs. Different furniture design positioning corresponds to different perception of users for the product, different needs and different purchasing power of users themselves, etc.[4] The author took the material design of the bedroom furniture as an example to study, positioned the university graduates consumer group aged between 35 and 40 as the target user group. They have received higher education and have a certain economic basis. And the group of this age know how to enjoy life and they have the capital to enjoy.

The external form of the product contains people's visual, tactile, and other physiological feelings, and it also includes people's aesthetic impression of it. The product image comes from the visual, auditory, tactile, olfactory and other channels. Different material gives people a different feeling due to its own surface texture, gloss, roughness, transparency, and refractive index. The product image of this paper was defined as the intuitive image, that is, giving people a more intuitive feeling through the vision.

B. Selection of the typical sample of furniture

This text collected 118 furniture samples preliminarily through the magazine, the Internet, product catalogs, furniture research, network and other ways. And selected the 20 representative samples finally through multivariate analysis[5], which includes the furniture that were mainly made of solid wood, artificial board, software, rattan, plastic, metal and supplemented by some other materials. In order to avoid the influence of color factors on the emotional image of furniture in this study, the color of the samples were all removed.

Table 1: Selected representative samples

Picture Source：Searching Internet

C. Establishment of kansei semantic space

a. Collecting and screening of representative kansei vocabularies

The author collected 128 Kansei image semantic vocabularies through the magazine, the Internet and other ways. And contacted the classmates and friends through the network to do the survey that selecting the most appropriate Kansei vocabularies they think to describe the material of bedroom furniture according their own experience after observing the samples of bedroom furniture.(20 of them have design background, while the other 12 have no design background) Then made a statistics for the number of Kansei semantic vocabularies to be checked. There was 20 Kansei vocabularies to be selected up to one-third. And 6 pairs of compatible vocabularies with clear image were finally selected by teachers of furniture design major. As shown in table 2

Table 2: Selected adjective couples

Modern - Traditional	Simple - Complicated
Smooth - Stiff	Individual - Popular
Delicate- Rough	Light - Heavy

Table Source: self drawing

b. Questionnaire designing

Questionnaire survey is to investigate and study a subject in the form of questions through tables, cards and bookkeeping, etc. The design of the problems is the core part of the questionnaire. The author rearranged number of the 20 samples of bedroom furniture finally selected through the semantic difference method, namely the SD method[6], and combined with the 6 pairs of compatible vocabularies to establish the 7 level semantic difference schedule(The sample is shown in Table 3), the questionnaire was hence formed.

Table 3: SD scale of sample 1

Modern	3	2	1	0	-1	-2	-3	Traditional
Smooth	3	2	1	0	-1	-2	-3	Stiff
Delicate	3	2	1	0	-1	-2	-3	Rough
Simple	3	2	1	0	-1	-2	-3	Complicated
Individual	3	2	1	0	-1	-2	-3	Popular
Light	3	2	1	0	-1	-2	-3	Heavy

Table Source: self drawing

c. Evaluation of kansei semantic

The subjects of this study are old schoolfellow or teachers of the design major of Central South University of Forestry &Technology. In this study, network investigation and practical investigation were both adopted. Through their active cooperation, the 45 questionnaires were all recovered, and they were all valid.

D. Establishment of material elements space

a. Extracting of the elements

Material elements are important parts of the furniture, and the material elements can be divided into several categories. First of all, the material elements can be divided into several different materials, such as the

materials mainly made of solid wood, artificial board, plastic, metal, rattan, software or bamboo, etc. secondly, each material can then be subdivided into a number of special elements, that is, the intuitive image. For example, solid wood can be divided into sub-light, half-light, bright, rough, and other visual images. In this way, bedroom furniture was well analyzed and the material elements were determined.

b. Questionnaire designing

Based on the material characteristic elements determined initially, the table of material component elements was established according to the project of types and the intuitive images.

Table 4: Decomposition of Wood Materials of Components

Project (a_1)	Solid wood	○ 1	○ 2	○ 3	○ 4	○ 5
intuitive image (c_{11})	Matte	○ 1	○ 2	○ 3	○ 4	○ 5
intuitive image (c_{12})	Semi-matte	○ 1	○ 2	○ 3	○ 4	○ 5
intuitive image (c_{13})	Light	○ 1	○ 2	○ 3	○ 4	○ 5
intuitive image (c_{14})	Rough	○ 1	○ 2	○ 3	○ 4	○ 5
intuitive image (c_{15})	None	○ 1	○ 2	○ 3	○ 4	○ 5

Table Source: self drawing

c. Evaluation of material elements

This study was carried out in Furniture and Art Design College of Central South University of Forestry & Technology. The subjects were 30 teachers of Furniture and Art Design College, and the ratio of the male and the female was one to one. Under their cooperation, the 30 questionnaires were all valid.

E. Data analyzing by mathematical tools

Data obtained by the previous two questionnaires was dealt with by the software Excel, so that the average value of Kansei semantic evaluation of the subjects made on the 20 samples of bedroom furniture, the bedroom furniture material project and intuitive images with higher score could be obtained. As shown in table 5 and table 6

Table 5: Average of emotional semantic evaluation

Sample	1	2	...	20
Smooth - Stiff	0.57	0.23	...	1.43
Modern - Traditional	-0.70	-023	...	1.30
Simple - Complicated	0.30	1.50	...	2.30
Light - Heavy	-0.93	-0.23	...	1.73
Graceful - Vulgar	1.77	0.75	...	1.20
Individual - Popular	1.60	1.07	...	0.40

Table Source: self drawing

Table 6   The main material elements

Item (a)	Intuitive Image (c)
Solid wood (a_1)	Matte c_{11} Semi-matte c_{12} Rough c_{13} Light c_{14} Others c_{15}
Software (a_2)	cloth c_{21} leather c_{22} cloth&leather c_{23} Others c_{24}
Plastic (a_3)	Light c_{31} Mattec_{32} Transparentc_{33} Matte translucent c_{34} None c_{35}
Metal (a_4)	gloss c_{41} Light c_{42} Matte c_{43} None c_{44}

Table Source: self drawing

F. Establishment of the relationship between kansei semantic and material elements

Quantitative theory I is the most common method of Kansei Engineering. The quantitative theory I analysis is equivalent multiple regression analysis, which is used to strike a linear relationship between qualitative variables and quantitative variables[7]. It is a mathematical statistical method that study the relationship between the x (independent variable) and a set of quantitative variables y (dependent variable) through the multiple linear regression to establish the relevant mathematical model and realize the observation for the quantitative variable y[8]. This study attempted to use quantitative theory type I to establish the relationship between Kansei semantic and bedroom furniture material elements. When the qualitative data of item a in sample s is the intuitive image c, $ds=1$, or $ds=0$. wherein a refers to the project, c refers to the intuitive image, so that $ds (a, c)$ is called the response of the intuitive image c of item a in sample k. Thus, the 20 bedroom furniture material elements were quantified, and they were turned into the quantitative data expressed by "1" and "0"(i.e. the response value of the material elements of the sample). This study took the average value of Kansei semantic evaluation as the dependent variable, and took the material elements as the independent variables, established the multivariate linear mathematical forecasting model as follows:

$$y=g_{11}c_{11}+g_{12}c_{12}+g_{13}c_{13}+g_{14}c_{14}+g_{15}c_{15}+g_{21}c_{21}+g_{22}c_{22}+g_{23}c_{23}+g_{24}c_{24}+g_{31}c_{31}+g_{32}c_{32}+g_{33}c_{33}+g_{34}c_{34}+g_{35}c_{35}+g_{41}c_{41}+g_{42}c_{42}+g_{43}c_{43}+g_{44}c_{44}+m$$

In the formula, y means the average value of Kansei semantic evaluation; g_{ij} means the weight coefficient of each independent variable; c_{ij} means the material constitute elements of the response value (wherein i refers to the item , j refers to the intuitive image); m means the constant value.

We can use the statistical software SPSS13.0 to solve the mathematical model: take the reaction values of the material elements of the 20 bedroom furniture as the independent variables, and take the average value of Kansei semantic evaluation as the dependent variable. We obtained the results through multiple linear regression and partial correlation analysis and got the related information data tables by collating these results. Take a part of the table such as " modern - traditional "as an example, listed in Table 7

III. RESULT ANALYSIS

A. The partial correlation coefficient represents the effect of each item on modelling attraction and the larger the value, the greater the effect[9], the wood furniture is similar to it. The score of intuitive image represents the influence degree of each intuitive image on Kansei semantic and direction. The positive value stands for positive Kansei semantic, while the negative value stands for negative Kansei semantic. The intuitive images already excluded shown no obvious correlation with Kansei semantic. For the "modern - traditional", the influence

degree of the projects in descending sequence is solid wood, software, metal, plastic. Matt wood is best close to the "traditional", while light plastic is best close to the "modern". Other types of materials and featureless metals have no obvious correlation with the "traditional", which verified the fact that in the real living room, other types of furniture are out of favor with people aged between 35 and 40, while the light type solid wood furniture can be seen almost everywhere.

Therefore, in the design of traditional furniture, we can give priority to using solid wood material as the main material and other materials as a supplement, so that the "traditional" furniture design can be achieved the sense of tradition of solid wood materials with different intuitive images can drew people's attention.

B. The predictive function expressing the relationship between the Kansei semantic vocabulary and the materials elements of the "modern - traditional" bedroom furniture can be obtained through table 7 :

$y_{traditional}=1.1c_{11}-1.2c_{12}-0.8c_{13}-1.2c_{14}-1.0c_{21}-1.2c_{22}+0.9c_{23}-0.9c_{24}-2.5c_{31}-2.1c_{32}-2.2c_{33}-1.8c_{34}-0.5c_{35}+0.6c_{41}-1.2c_{42}-1.5c_{43}+0.39$ *(the coefficient of determination is 0.89)*

In order to verify the effectiveness of the function, we can re-select samples to study again and analyze the survey data and the calculated data for prediction function by Student's t test. If the results showed that the level of significance is more than 0.05, there will no significant difference, and the result is reasonable.

Similarly, application of this method can also get other predictive function expressing the relationship between the Kansei semantic vocabulary and the materials elements of bedroom furniture, which can be used to determine whether the Kansei images that designers want to communicate to people through the innovative design is consistent with the feelings and needs of users. So that it can provide a basis for designers to select the scheme and do the further design.

IV. CONCLUSION

Kansei Engineering combines people's Kansei factors with furniture design consciously, and turns the design ideas, feelings and other elements into design languages reasonably, so that such design can reflect the humanity and sensibility of furniture design. This article based on the theory of Kansei Engineering, combined with bedroom furniture design, established the relationship between Kansei semantic of users and material elements of bedroom furniture, provided some guidance for the design of furniture material. Through the combination of the furniture material and Kansei Engineering, it can reduce the perceptual cognition deviation between consumers and designers, and make the design more accord with the consumer's perceptual demand. This method can also be applied to other material innovation design of furniture design and other design research of furniture design, such as the innovative design of function, color collocation, modeling, etc.

Table 7: Association analysis of between material components and adjective couple "modern – traditional"

				Intuitive Image Score	
Item	Intuitive Image	Partial Correlation Coefficient		Modern	Traditional
	c_{11}			1.1	
	c_{12}				-1.2
a_1	c_{13}	0.74			-0.8
	c_{14}				-1.2
	c_{15}			Excluded	
	c_{21}				-1.0
	c_{22}	0.87			-1.2
a_2	c_{23}			-0.9	
	c_{24}				-0.5
	c_{31}				-2.5
	c_{32}				-2.1
a_3	c_{33}	0.95			-2.2
	c_{34}				-1.8
	c_{35}				-0.5
	c_{41}			0.6	
	c_{42}	0.76			-1.2
a_4	c_{43}				-1.5
	c_{44}			Excluded	
coefficient of determination		0.89	constant term		0.39

Table Source: self drawing

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