Research on Form Design of Automotive Dashboard Based on Kansei Engineering

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Research on Form Design of Automotive Dashboard Based on Kansei Engineering

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Abstract. Understanding the driver's emotional needs for the dashboard is crucial to the success of vehicle design. In order to reduce the psychological burden of drivers in obtaining on-board information, the image of automobile dashboard was visually described and quantitatively analyzed with applying Kansei Engineering theory and the principle of Quantitative Class I. The predictive model between the adjectives of vehicle dashboard shape and perceptual image was established by using multiple linear regression analysis method, and the relationship between perceptual image and design elements was analyzed. The results show that the main sensory factors of shape design should be gentle and comfortable in the process of automobile dashboard design. To improve the fit between automobile dashboard design and driver's perceptual needs by transforming driver's emotional perception into design elements.

1. Introduction

Comfortable and well-defined dashboard design can improve driver's attention, driving interest, driving quality and driving safety[1]. Dr. Mitsuo Nagamach believes that Kansei Engineering is a technology that converts users' emotional appeals into design elements. The purpose of this experimental study is to explore drivers' emotional demands for the form of automobile dashboard by using the Kansei Engineering method[2]. In the experimental process, Kansei Engineering and Quantitative theoretical model are used for modeling and analysis.

2. Material and Methods

2.1 Experimental method

The sensory design of automobile dashboard is user-centered. The driver's sensory images of dashboard are deeply discussed, and sensory images are transformed into design reference elements[3]. Kansei Engineering is being used to transform customers' needs and feelings into the elements of product design elements. This study applys quantitative means of Kansei Engineering to explore the relationship between human perception and dashboard[4]. It was found that most drivers pay attention to ergonomics in the design of automotive dashboard, and at the same time, automotive dashboard with morphological design made users more satisfied[5].

2.2 Materials&Constructing Sensibility Evaluation System

2.2.1 Constructing Modeling Element Space

In this experiment, 644 series of automotive dashboard patterns of more than 90 household car brands were selected through magazines and automotive home software. The researchers used Kansei Engineering to analyze the overall shape of automotive dashboards and the internal form of dashboards[6], used KJ method to classify and analyze. In this experiment, the key elements of design need to be defined to construct the intention space of modeling, and the shape of modeling should be extracted by morphological analysis[7]. In order to extract the key factors affecting the automotive dashboard, the subjects were interviewed and investigated by oral analysis and questionnaire survey. Ten representative automotive dashboard pictures were selected as the experimental materials and processed in a unified way, as shown in Figure 1.

Figure 1. Spatial sample image of styling intention.

2.2.2 Constructing Sensual Intention Space

In the experiment, perceptual intentional adjectives were collected mainly through books, magazines, reference books, website surveys and user interviews. A total of 402 perceptual image words were collected[8]. The focus group discussed the perceptual words to test the dashboard[9], excluded words with similar meanings, identified 50 words, and invited 10 graduate students to select 10 pairs of representative perceptual image vocabularies, as shown in Table 1. According to Osgood semantic difference method, 10 pairs of representative perceptual image vocabularies and 10 pictures of automobile dashboard materials are constructed into perceptual image space[10]. According to the semantics difference scale, a 7-level questionnaire was made with Likert scale.

Table 1. Sensual image adjectives for automobile dashboards.

Number	Perceptual Image Adjectives	Number	Perceptual Image Adjectives
1	Low-Luxury	6	Calm-Dynamic
2	Gentle-Strength	7	Moderate-Individual
3	Ordinary-Classical	8	Traditional-Scientific
4	Concise-Complex	9	Simple-Stylistic
5	Safe-Dangerous	10	Comfortable-Artificial

2.2.3 Selection of experimental subjects and experimental tasks

In this experiment, the researchers selected 10 people aged 20 to 35 years old, 35 to 50 years old, 50 to 65 years old on average, and a total of 30 people were surveyed. Thirty people hold driving licenses and driving experience. In the experiment, each age level represented different consumption levels and aesthetic perceptions. According to 7-level Likert Scale, The subjects were asked to observe the shape of the dashboard on the questionnaire and scored it according to their subjective feelings. Finally, the perceptual evaluation scores of the subjects on the shape of dashboard were counted[11].

3. Results

3.1 Model Construction and Factor Analysis

A total of 30 questionnaires were taken back and 28 valid questionnaires were screened out, with a valid sample rate of 93.3%. In order to ensure the reliability with the statistical data obtained from this study, the evaluation values of perceptual images were sorted out. First of all, the data reliability analysis was carried out by SPSS software[12]. When the reliability coefficient is between 0.8 and 0.9, the scale has good reliability. The reliability coefficient of this experiment was calculated to be 0.846, which was greater than 0.800, indicating the strong reliability of the questionnaire. The KMO and Bartlett sphericity tests were used to test the validity of the questionnaire. The correlation coefficients of KMO and Bartlett tests reached the significance level of 0.635 greater than 0.600. The questionnaire results in this study showed high reliability, and the experimental data were suitable for factor analysis[13]. Using SPSS software and maximum variance rotation method, factor analysis of experimental data was carried out, and the load of the two factors was obtained. After the analysis, the data were arranged into two factors load matrix according to the factor load coefficient, as shown in Table 2.

Table 2. Each style factor evaluates the load matrix of the factor after rotation.

Rotating Component Matrix		
	Factor I	Factor II
Calm	-.289	.932
Comfortable	.648	.735
Gentle	.098	-.127
Low	.956	.220
Moderate	.233	.833
Ordinary	.952	.223
Traditional	.308	.921
Simple	.851	.185
Concise	-.133	.963
Safe	.803	.580

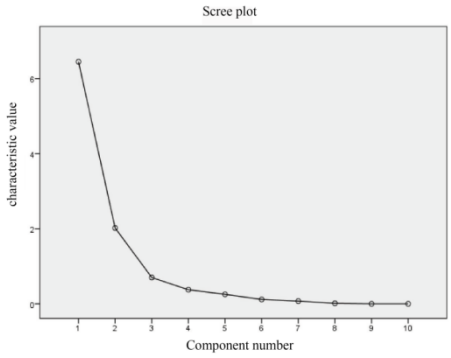

Figure 2. Characteristic scattered lithotripsy.

Through principal component analysis, the total variance of two factors was extracted to explain the cumulative proportion of total variance 83.513%. As shown in Figure 2, the former two factors eigenvalues differed greatly from the others. The former two factors had a strong generality to the automotive dashboard. 10 perceptual imagery words were divided into two categories with Combining factor load matrix and adjective meanings. And one classification was: Low-Luxury; Gentle-Strength; Ordinary-Classical; Concise-Complex; Safe-Dangerous. And the other one was Calm-Dynamic; Moderate-Individual; Traditional-Scientific; Simple-Stylistic; Comfortable-Artificial. The above results were classified and analyzed, it turned out that two kinds of factors were finally named as sensory factor and morphological factor. Sensory factor: Gentle-Strength factor; morphological factor: Comfortable-Artificial factor.

4. Discussion

4.1 Establishment of Prediction Model of Characteristic Relations of Perceptual Images

4.1.1 Parametric Characterization of Perceptual Images

In order to explore the relationship between the design elements and the overall shape of automobile dashboard, five experienced designers were invited to deconstruct and extract the shape elements from

10 sample images of automobile dashboard. The researchers extracted four design items and 16 design categories, as shown in Figure 3. Sixteen design elements were defined as independent variables, and the average perceptual evaluation of 10 pairs of perceptual image adjectives was defined as dependent variable[14]. Using SPSS 24.0 software for correlation analysis, a quantitative theory-model was used to quantify the relationship between design elements and perceptual image vocabularies in various parts of the dashboard. The deconstruction of material pictures was coded as 1, whereas the reverse was 0. In quantification theory, the sum of reactions between items and categories was 1. The load coefficients of each morphological factors were Calculated and Analyzed by Multivariate Linear Regression Analysis， as shown in Table 3.

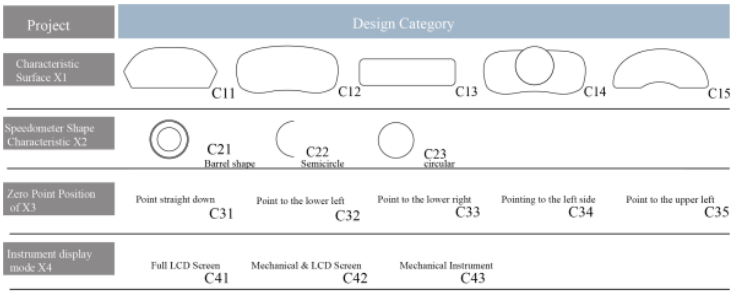

Figure 3. Classification of design elements of automotive dashboard interface.

Table 3. Load coefficients of various morphological factors

Design Project	Design Category	Comfortable-Artificial	Scoring Range	Design Project	Design Category	Gentle-Strength	Scoring Range
	C11	0.421	1.706		C11	0.316	2.321
	C12	0.350			C12	-0.325	
X1	C13	-0.415		X1	C13	-0.983	
	C14	-0.520			C14	-0.697	
	C21	-0.895	1		C21	0.288	0.596
X2	C23	-0.105		X2	C23	-0.308	
X3	C32	0.390	0.390	X3	C32	0.045	0.045
	C41	-0.415	2.275		C41	-0.808	1.091
X4	C43	-0.860		X4	C43	0.283	

4.1.2 Establish Mathematical Model

The project of automobile dashboard shape design was regarded as Item, and the design elements of automobile dashboard were regarded as Category. For the perceptual design of automobile dashboard shape, the mathematical model was established by using quantification theory I[15].

4.2 Solution of Sensory Factor Relation Model

Using SPSS multiple linear regression analysis tool and Matlab software to calculate category scores, the complex correlation coefficient R between the perceptual image of the "Gentle-Strength" interface and the evaluation vocabularies to the prediction model was 0.935, the determination coefficient R^2 was 0.875, approaching 1. The experimental results showed that the relationship model based on sensory factors could fit the real value well and meet the reliability requirements. From the prediction model, it could be seen that the highest score of morphological feature surface X4 was 2.275, the form had great influence on the design of automobile dashboard. The form of design elements C_{43} tended to be more gentle. The lowest score of X3 was 0.390, it had the least impact on the design of automotive dashboard.

4.3 Solution of Morphological Factor Relation Model

Using SPSS multiple linear regression analysis tool and Matlab software to calculate category scores, the complex correlation coefficient R between the perceptual image of the "Comfortable-Artificial" interface and the evaluation vocabulary to the prediction model was 0.968, the determination

coefficient R^2 was 0.937, which was very close to 1. It showed that the overall model was more effective in predicting drivers' evaluation of the instrument panel shape factor. It could be seen from the prediction model that the highest score of morphological feature surface X1 was 2.321. And it had the greatest impact on the comfort of automobile dashboard. The design elements of shape feature surface C_{15} was more comfortable. The lowest score of X3 was 0.045. And it had the smallest impact on the comfort of the automobile dashboard interface.

5. Conclusions

In this paper, the method of Kansei Engineering is used to study the automobile dashboard. The results show that the main perceptual factors should be Gentle and Comfortable in the future design of automobile dashboard interface.

In the case of Gentle-Strength, the emotional perception of dashboard design is obvious when it has the following characteristics: the primary design element is the shape characteristic surface C_{15}. And C_{21} shape characteristic should be considered in two factors of speedometer and tachometer in the dashboard. The mechanical design should be considered as the main instrument display mode. For Comfortable-Artificial perceptual vocabulary pair, C_{13} design element makes subjects feel more comfortable and C_{23} shape is more acceptable in the speedometer and tachometer form design. When the instrument display mode is designed for full all-liquid crystal screen display, the information of the instrument can be acquired more intuitively and comfortably.

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