Application of Kansei Engineering in Electric Car Design

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Abstract. Under the background that Chinese automakers are in need of effective approaches in designing electric cars, Kansei engineering enables the designers to apply quantitative analysis from the perspective of user analysis so that they can quickly identify key design elements and build correspondence between the design images and the shape elements. The paper uses cases study to illustrate the application of Kansei engineering in the design of the electric cars.

As the symbol of a new lifestyle, environmental friendly attitude and futuristic design, electric cars have provided the Chinese auto companies with a new opportunity to develop their own brands. The application of Kansei engineering in the design analysis of electric cars not only provides more accurate support for setting the theme in the pre-design period, but also shortens the development cycle and saves R&D cost, thus having significant meanings for the Chinese automobile enterprises.

Problems in the design of electric cars for Chinese automakers

In the design of electric cars, Chinese automakers are in their infancy, so most of them focus on developing electric versions of the traditional car types. As a result, the body shape is basically the same with the current ones and lacks the styling themes and shape elements to reflect their being electric, energy saving and environmental friendly, features that are unique to electric cars. Such situation is mainly due to the following reasons.

Lack of research on users’ needs

Chinese users have different functional requirements and aesthetics for electric cars from those of in western countries, as well as Japan and South Korea. Despite this fact, Chinese automakers keep mimicking foreign car designs without studying domestic buyers’ needs. Although the advantages are low investment, fast production and short R&D cycle, the negative impact cannot be neglected: the consumers would consider the brand lack independent taste and style.

Lack of clear design assessment methods

In the domestic automotive design industry, whether a design plan can be passed mainly depends on the leaders’ assessment recommendations rather than the users’ opinions. With little attention paid to the targeted consumer group, such a subjective assessment method can not find out the potential problems that may lead to users’ negative response.

Lack of engineering test

As most electric car designs still retain at the stage of ABS assessment model without the real chassis, transmission and power equipment, the design data can not be ensured to meet engineering requirements in real life, including the security standard and power and mechanical properties.
Kansei engineering research method in automotive body design

China's independent research and development of electric cars must innovate on the existing design methods and focus on user preference and quantitative analysis. The introduction of Kansei engineering research methods into electric cars design enables the designers to quantitatively regulate users’ perception through research and statistical methods, establish accurate and intuitive analysis framework, and quantitatively analyze the relationship between the users’ experience and design features with the application of statistical algorithms, so that they can meet the user’s aesthetics in the most efficient way.

An experiment on an electric car’s design that the author participated is presented to illustrate the application of Kansei engineering method. The experiment’s technical support and test site are provided by the Design Department of Changchun Automobile Research Institute. The purpose is to determine effective indicators in the visual evaluation of electric cars’ body shape through the special eye tracking test for users. The experiment uses A-SL504 non-helmet eye tracking system developed by USA Applied Science Laboratories (ASL). The subjects are 15 men and 15 women between 20 and 37 years old with driving experience, uncorrected visual acuity of 1.0 or above and no color blindness. During the eye tracking test, they are asked to browse the pictures of eight cars, including the front 45 °view, the front view, the lateral view and the rear 45 °view.

The steps are as follows:
1. “+” is shown in the center of the computer screen for 1.5 seconds;
2. The computer screen is blank for 2 seconds;
3. Pictures of each car are shown on the computer screen for 25 seconds;
4. Repeat Step (2) and Step (3).

The eye tracking indicators of the subjects are automatically recorded, classified and scored by the Gaze Tracker software system. Table 1 is the attractiveness index of front and lateral views based on the eye tracking indicators in different regions.

| Region               | Gaze time | Gaze change frequency | Number of gaze points | Final order |
|----------------------|-----------|-----------------------|-----------------------|-------------|
|                      | Standard score | Order | Standard score | Order | Standard score | Order |             |
| Waistline            | 0.27      | 4         | 0.48      | 4      | 0.35      | 4      | 4          |
| Left headlight       | -0.44     | 8         | -0.62     | 8      | -0.56     | 8      | 8          |
| Right headlight      | -0.28     | 7         | -0.56     | 7      | -0.27     | 7      | 7          |
| Grille               | 0.38      | 3         | 0.60      | 3      | 0.36      | 3      | 3          |
| Bumper               | 0.59      | 2         | 0.77      | 2      | 0.60      | 2      | 2          |
| Wiper                | -0.13     | 6         | 0.15      | 6      | -0.24     | 6      | 6          |
| Hood                 | 1.40      | 1         | 1.36      | 1      | 1.35      | 1      | 1          |
| Window               | 0.25      | 5         | 0.21      | 5      | 0.16      | 5      | 5          |
| Left rear view mirror| -0.93     | 10        | -1.13     | 10     | -0.96     | 10     | 10         |
| Right rear view mirror| -0.89    | 9         | -1.23     | 9      | -0.81     | 9      | 9          |
The analysis of data of different directions shows that the key design elements include headlight, grille, hood and window.

Then image meanings are chosen to assess the key design elements to build correspondence. The extraction of image meanings is conducted for three times.

In the first extraction, the research group obtains valuable adjectives by interviewing the existing and potential users, searching keywords on the internet, and choosing high-frequency words from magazines, books and passages involving electric cars, and then makes them into 78 pairs of perceptual terms.

In the second extraction, ten car salespersons with electric car selling experience and ten designers with electric car design experience are provided with the table of these 78 pairs to select 40 pairs which best describe the design features of electric cars.

In the third extraction, the subjects are 20 college teachers that are engaged in the research of electric car design. They choose in the 40 pairs from the second extraction the ones that best describe electric car’s design features and have quantitative research value. In Table 2, the 13 pairs of perceptual terms which are chosen for over 12 times in total provide meanings to be assessed in the next step.

| 01 | Technological ~ Traditional(18) | 02 | Young ~ Sophisticated(18) | 03 | Vivid ~ Rigid(16) |
|----|---------------------------------|----|--------------------------|----|------------------|
| 04 | Modern ~ Traditional(16)       | 05 | Dynamic ~ Stationary(16) | 06 | Fast ~ Slow(15)  |
| 07 | Avant-garde ~ Conservative(15) | 08 | Creative ~ Mimic(14)     | 09 | Personal ~ Mass(14) |
| 10 | Novel ~ Antiquated(14)         | 11 | Comfortable ~ Uncomfortable(14) | 12 | Kind ~ Cold(13) |
| 13 | Geometric ~ Disordered(12)     | 14 | Popular ~ Nostalgic(9)   | 15 | Splendid ~ Simple(9) |
| 16 | Male ~ Female(9)               | 17 | Luxurious ~ Plain(9)     | 18 | Unrestrained ~ Restrained(9) |
| 19 | Business ~ Casual(8)           | 20 | Unique ~ Ordinary(8)     | 21 | Professional ~ Amateur(8) |
| 22 | Grand ~ Homely(7)              | 23 | Quiet ~ Moving(7)        | 24 | Fine ~ Rough(7)     |
| 25 | Light ~ Heavy(7)               | 26 | Round ~ Pointy(7)        | 27 | Beautiful ~ Indecent(7) |
| 28 | Masculine ~ Feminine(6)        | 29 | Simple ~ Complex(6)      | 30 | Rhythmic ~ Tranquil(6) |
| 31 | Harmonious ~ Inharmonious(6)   | 32 | Clean ~ Colored (6)      | 33 | Mature ~ Naïve(6)  |
| 34 | Smooth ~ Blocked(6)            | 35 | Eye-catching ~ Mediocre (5) | 36 | Clever ~ Dull(5)  |
| 37 | Obedient ~ Rebellious(5)       | 38 | Flowing ~ Blunt(4)       | 39 | Concrete ~ Abstract(2) |
| 40 | Rational ~ Emotional(0)        | 41 | Serious ~ Relaxed        | 42 | Loose ~ Tight      |
| 43 | Romantic ~ Realistic           | 44 | Adult ~ Child            | 45 | Slick ~ Rugged     |
| 46 | Strong ~ Weak                  | 47 | Fancy ~ Sober            | 48 | Interesting ~ Boring |
| 49 | Textural ~ Flat                | 50 | Overbearing ~ Delicate   | 51 | Elegant ~ Vulgar   |
| 52 | Stiff ~ Flat                   | 53 | Practical ~ Decorative   | 54 | Generous ~ Subtle  |
| 55 | Tasteful ~ Common              | 56 | Safe ~ Dangerous         | 57 | Intensive ~ Gentle |
| 58 | Trim ~ Cluttered               | 59 | Smart ~ Clumsy           | 60 | International ~ Local |
| 61 | Colorful ~ Dull                | 62 | Advanced ~ Low-end       | 63 | Hard ~ Vulnerable  |
| 64 | Wild ~ Civilized               | 65 | Steady ~ Frivolous       | 66 | Warm ~ Ruthless    |

Table 2 78 pairs of image meanings
Then the 13 pairs are put with the samples of electric car’s shape elements to make the image meaning rating questionnaire. The subjects are given these questionnaires to grade each meaning and the average score of each sample under its image meaning is worked out. So the correspondences between image meanings and key design elements are better understood and can be taken as references in the design. Table 3 is the quantitative analysis of the correlation of a group of perceptual terms and shape elements.

Table 3 “Technological~Traditional” quantitative analysis results

| Key design elements | Shape element            | Score |
|---------------------|--------------------------|-------|
| Headlight           | Round / Oval             | 0.335 |
|                     | Polyline LED             | 0.358 |
|                     | Double arc               | -0.188|
|                     | Polyline-Arc             | 0.184 |
| Grille              | Closed geometric pattern | 0.363 |
|                     | Closed organic pattern   | 0.319 |
|                     | Semi-closed geometric pattern | 0.338 |
|                     | Semi-closed organic pattern | -0.102|
| Hood                | Straight line            | 0.152 |
|                     | Arc                      | 0.188 |
|                     | Straight arc             | 0.214 |
|                     | Barbed line              | -0.113|
|                     | Double line              | 0.215 |
| Window              | Straight line            | -0.155|
|                     | Straight arc             | 0.229 |
|                     | Arc                      | 0.285 |

These correspondences from the user information should be seen as assistance and restriction information for the design process. There are many other factors that the designers need to consider to get an all-round view, such as brand awareness, design continuity and user functional requirements.

Conclusion

According to the above analysis of the application of Kansei engineering in the electric car body design, this method can effectively and accurately identify key elements for the automotive body design and transform qualitative descriptions into quantitative data, thus to some extent effectively promoting the efficiency and accuracy in setting the design themes. However, this method functions as guidance and restriction for the design instead of directly giving a feasible plan. So this method of applying Kansei engineering into automotive body design should be seen as an assisting approach and be mainly used in early-stage theme planning (design analysis) and later-stage sample car test (design test).


References

[1] Hu Weifeng, Zhao Jianghong, Zhao Danhua. Car design image research based on the feature line [J]. Chinese Mechanical Engineering, 2009, 4.

[2] Liu Long, Tang Jiayi, Gao Jing. Automotive interior design study based on Kansei engineering workflow [J]. Modern Manufacturing Engineering, 2010, 1.

[3] Jonathan C, Craig M V. Creating breakthrough products innovation from product planning to program approval [M]. New Jersey: Prentice Hall, 2002.

[4] Zhao Qiufang. Kansei engineering and its application in product design [D]. Jinan: Shandong University, 2007.

[5] Yamamoto K. Kansei Engineering—the art of automotive development at Mazda [M]. Ann Arbor: The University of Michigan, 1986.

[6] Senkoushoujyo, Kansei engineering, ESJ Information N72, Japan Kansei Engineering Committee, Tokyo, Japan, 1998.