ORIGINAL ARTICLE

Chinese Sensitivity Analysis for the Interior Design of the Automobile

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Abstract: This research is targeted at the perceptual preferences of the China's 80's and 90's young adults when they are planning to buy their first A0 or A level car. 100 subjects participated in the perceptual assessment of 18 specimens using 12 pairs adjectives. A factor analysis was carried out to analyze the perceptual preferences of the subjects, and the perceptual preferences differences and similarities between male and female subjects. Then the design elements of the steering wheel, center console, seats and integral color scheme of A0 and A level car was proposed. Finally, the design trend of A0, A level car interior was summarized.

Keywords: China, Vehicle Interior Design, Perceptual Preferences

1. INTRODUCTION

Kansei engineering (KE) has a history of more than 30 years, and its first application is taken in the auto industry. 30 years ago, Nissan, Mazda, Mitsubishi applied KE in the development of automobiles, and great success was obtained. Now, automobile researches using the KE methods are very common. Not only the styling, but also the car interior has gained more and more attention in recent years.

At present, the research using Kansei engineering methods for car interior are abundant. In a research carried out by Chitoshi Tanoue, Kenji Ishizaka and Mitsuo Nagamachi in 1997, the Kansei Engineering method was applied to evaluate vehicle interior image, especially roominess and oppressiveness. Furthermore, a diagnostic system for comfortableness using design elements and dimensions was developed and introduced [1]. Another research is about quantifying touch-feel perception on automotive interiors. In this paper, the author report the preliminary study of people's subjective feelings on stroking surfaces of different materials and the measured properties of these surfaces using a multi-function tribological probe microscope, in order to understand exactly what properties matter and to what extent the different factors weight the human perception [2]. In 2009, A cross-cultural study of users' craftsmanship perceptions in vehicle interior design was carried out. This paper investigates the user-perception of vehicle interior craftsmanship. A survey, involving subjects of two different nationalities (American and French), was conducted on a set of vehicles. In addition, this paper

proposes an interesting illustration of the use of social science techniques to investigate differences in the perception of products [3]. There are also researches about customer satisfaction model. Heecheon Youa, Taebeum Ryua, Kyunghee Oha, Myung-Hwan Yunb, Kwang-Jae Kima developed satisfaction models of automotive interior materials for six parts including crash pad, steering wheel, transmission gearshift knob, audio panel, metal grain inlay, and wood grain inlay. The satisfaction models were used to identify relatively important design variables and preferred design features for the interior parts [4]. Moreover, the car interior development procedure is also studied. A paper on automobile interior design based on operation process of Kansei engineering develops a set of applicable design process for small and medium-sized enterprises in China based on Kansei engineering. The proposed method suggests the data and process must be rigorous and scientific. In addition, this method also simplifies the perceptual capture process and data process, and establish a set of suitable application process to determine the connection between user needs and product design features, which is served as the guidance to product design. Furthermore, a case study of center console is proposed to demonstrate the applicability of the method [5].

To summarize the documents, the current studies are targeted at the image perception and evaluation of car interior, the tactile sense of the interior materials, the perception of the interior craft, the development of the customer satisfaction model and the design process of car interior using Kansei Engineering. However, in these research, the targeted car level is broad, facing almost all levels of car, which lacks the pertinence. Moreover, the car market changes rapidly nowadays, emerging new

vehicles sizes such as mini and SUV. In addition, changes also take place in the consumer, their age, background, and consuming concept are of great difference to that of the older generation. Therefore, obviously, the previous studies lacks pertinence both in the product and in the customers, which seems to be out of date. of date.

According to the data showed in Table 1, the vehicle enterprises in China release more new cars with a total of 50 in the past two years, with the total sales of 1.7504 in million in 2011. The next is the SUV with 16 new, and total sales of 508,000 in 2011. Enterprises in MPV market launched 8 new, its 2011 total sales is 104,000. In the car section, on A level car has the largest number of new car with 21; Second is A0 level and B level car, 14 and 12 new respectively; Third is A00 level in which 3 new cars are launched [Source: auto.gasgoo.com].

This shows that the A0, A level car (ordinary car) is of the most competitive area in the automobile market. With the customers' income level rising and automobile price declining, automobile has come into the mass consumption stage. So people now purchase their first car earlier age. Table 2 is the result of an investigation on the age and proportion of different generation to have or plan to have their first automobile in China.

The statistic shows that 71.5% of the before 60's (generation born before 60s) have or plan to have their first car in the age of 45 or above. And the 70's (50.2%) have or plan to have their first car in 31~35 years old. When it comes to the 90's however, nearly half (46.7%) have or plan to have their own first car in 25 years old and under [Data sources: Netease and Sinotrust joint investigation]. This reveals that more and more young people who are gradually becoming the main automobile

consumption group will carry their car purchase plan onto the agenda earlier. The consumption concept of consumer are resulted from their values. Hence, the 80's and 90's hold different perceptual preference and car image compared to other generations. The younger the customer, the more emotional appeal for car is needed. Therefore, more perceptual factors must be taken into account for the car interior design targeted at this group.

In addition, with oil prices continue to rise, coupled with the encouraging and guiding government policy, people tend to buy economic fuel-efficient cars. At present, people buy their cars mainly concentrated in 1.3–1.6 L and 1.6–2.0 L two displacement section. And young people are more likely to receive 1.0 L and below small-engine cars [Data sources: Netease and Sinotrust joint investigation]. Therefore, the A0, A level car with a displacement of 1.0–1.6 L became the most popular among the young generation whose purchasing power is relatively low. (Appendix I)

According to the changes taking place in the China's recent automobile market---younger generation tend to buy car earlier and A0, A level car market share expanding, enterprise must take response quickly. This paper is aimed at analyzing the perceptual preferences of the younger Chinese generation (between 20 to 30 years old, and born in the 80s and 90s) toward the automobile interior design of A0, A level. Moreover, the similarities and differences between male and female subjects are also analyzed. And then the design elements of the car interior are extracted. At last, the interior design trend of A0, A level car is summarized.

2. THE RESEARCH PROCESS AND METHDOLOGY

2.1 Specimen selection

According to the 2010 annual car sales in China, this study has chosen interior pictures of the top 15 models within the 2010 annual A0, A class car sales. Remove 18 interior specimens of the same brand models, use Photoshop to adjust the pictures to the same size and angle, replace the front windshield with the same background to minimize interference and get the final 18 decorated specimens. (Appendix II–IV)

2.2 Kansei adjectives and evaluation scales

The filter of Kansei adjectives by the KJ method and multidimensional scaling (MDS) method is next. First, we collect 318 adjectives on the vehicle interior from the networks, newspapers and magazines extensively. And then get 170 adjectives after getting rid of the

Table 1: The new vehicle released by Chinese vehicle enterprises in the past 2 years and the total sales in 2011

Vehicle type	Car				SUV	MPV	Total
	A00	A0	A	B			
New car launched in the past two years	3	14	21	12	16	8	74
2011 sales / million	175.04				50.80	10.40	236.2

Table 2: The age and proportion of different generation to have or plan to have their first automobile

Generation	90's	80's	70's	60's	Before 60's
The age to Have or plan to have the first automobile	Under 25	26–30	31–35	41–45	Above 45
Proportion	46.7%	57.6%	50.2%	42.6%	71.5%

negative words and the synonyms by the KJ method. Through the study of features and MDS, 12 adjectives was selected, and when find out their antisense language or deny words, we get the final 12 pairs of emotional adjectives: compact – incompact, exquisite – coarse, magnificent – in ornate, vivacious – prim, personality – general, modern – traditional, handy – cumbersome, commercial – casual, commodious – repressive, expensive – cheap, simple – complicated, fond – dislike.

In choosing the scale of evaluation, the feeling is divided into several levels according to the strength, and 7 semantic differential (SD) with 12 pairs of Kansei adjectives consists the Table 3 to quantify the feelings of the Investigators. The semantic differential (SD) experiment [6], which requests consumers evaluate product samples using specified adjectives, is frequently conducted to obtain consumers' affective responses [7].

2.3 The subjects

The objective population of this study is young people, so 100 subjects whose age is between 21 to 28 years old are choose. The average age is 23.82, including 52 male and 48 female. 18 specimens and perceptual lists have made into a questionnaire to create pages for these Investigators who need to complete online and accomplish the emotional evaluation.

The survey specimen has some limitations, but the 80's and 90's young people are very familiar with the network and online shopping, and they will also collect some information on internet to provide guidance for shopping before they purchase big-ticket item and expensive goods. So, online survey is relatively suitable for young people.

Young people of this era mostly pursue a fashionable, new and modern life; they may not have large deposits, but has a good income, and they are more willing to put

limited financial resources into car, therefore the car is often the first big expense after their independence. Recently a well-known media published "white-collar car report" shows that young people's car psychological budget is around 15 million. In addition, according to the survey, in the car shopping behavior, especially for young people who are in love, women's opinions on the car shopping have the most direct impact. Moreover, Female consumers are "particularly demanding" of the appearance when they purchase cars. Therefore, the automotive interior design needs to fully consider the characteristics of the women's emotional preferences.

2.4 Factor analysis (FA)

Factor analysis (FA) is the most frequently adopted technique for analyzing the evaluated scores obtained from SD experiments [8]. FA actually forms part of the feature extraction method, which reduces input dimensions [7]. In this study, SPSS (Statistical Product and Service Solutions) Software is used for factor analysis to analyze the results.

3. RESULTS AND ANALYSIS

3.1 Favorite specimen analysis

3.1.1 Favorite specimen analysis of all of the investigators

Calculate the average score of each specimen on each of the perceptual evaluation of language, in accordance with the "like - dislike", we got the score in a descending order, and select the specimens with scores above 4.5 and below 3.0, to be the specimens subjects which are favorite and least like (Table 4). The following are the specimen characteristics of the most favorite (Figure 1), and most dislike (Figure 3).

Table 3: Kansei adjectives and evaluation scales

Score	7	6	5	4	3	2	1	
Specimen X	Highly	Relatively	A little		A little	Relatively	Highly	
1 Compact								incompact
2 Exquisite								coarse
3 magnificent								in ornate
4 Vivacious								prim
5 Personality								general
6 Modern								traditional
7 Handy								cumbersome
8 commercial								casual
9 commodious								repressive
10 expensive								cheap
11 simple								complicated
12 fond								dislike

If we select the specimens that get more than 4.5 in the programmed of “Like or not”, we can make conclusion of its design characteristics:

- The steering wheels are all made by metal or metal-like materials, and shape is very modern;
- The center console: The overall shape of the S7, S13, S11 center console are downward pointed shape or have a trend to gather. Another specimen which has this characteristics is S15 whose score is 4.43, which is fifth high among all the specimens (Figure 2);
- Seat: All of seats are leather made, and has a smooth surface;
- Color: There are always four or five kinds of color in one specimen, but the color of large area maintains to be same, colors like gray, beige are always used in these large area. In the details colors like metallic or light-colored are always used.

Table 4: The most favorite and most dislike specimens

Sample No.	fond- dislike
S7	4.88
S13	4.61
S9	4.54
S11	4.54
S15	4.43
S16	4.37
S18	4.37
S3	4.16
S10	3.94
S4	3.83
S14	3.83
S17	3.66
S5	3.48
S1	3.47
S6	3.34
S8	3.28
S12	2.58
S2	2.57

Figure 1: The most favorite specimens

Figure 2: Specimens with the same characteristics

Figure 3: The most dislike specimens

The characteristics of the dislike specimens are also obvious:

- The steering wheels are all made by only one kind of material, a little drab.
- The center console: The overall shape is square and the components are also Simple modeling without enough design.
- Seat: materials of seats are cloth and complex with spell color or broken flower adornment.
- Color: The color is drab relatively, S2 adopted large areas of gray, and the contrast of color S12 is too intense, have the feeling of harmony.
- Then we draw line charts (Figure 4, Figure 5) to find out the concrete perceptual characteristics of the most favorite and most dislike specimens.

3.2 Correlation analysis of the adjectives

Select scores above 0.9 points in the correlation matrix (Table 5, with yellow mark). From the lateral perspective of the correlation matrix, “fond” has the most relevant adjectives, with 5; And “modern” and “expensive” has 4 and 3 relevant adjectives respectively. From the vertical perspective, “magnificent” and “exquisite” have 5 and 4 relevant adjectives respectively. The scores above 0.95 points meaning the strongest linkage between two adjectives, which includes “personality-vivacious”, “expensive-exquisite”, “expensive-magnificent”, “fond-exquisite”, “fond- expensive”. This indicates that “fond”,

“modern” and “expensive” are comprehensive concepts, and have higher relevance with other adjectives. Among which, “fond” is the biggest concept.

3.3 Factor analysis

Because “fond” is the biggest concept, which will cause significant influence on the factor loading. So it is removed in the factor analysis. Also, male and female subjects are separated to conduct other two factor analysis. The results can be seen in Table 6 to Table 8.

Table 9 is served as a summary to the results of factor analysis, and the main concepts are extracted respectively. The biggest difference between male and female subjects lies in factor 1. Male subjects seem to pay more attention to the “personality” “modern” “vivacious”, while women are concentrated on “expensive” “exquisite “ “magnificent”. Therefore, the factor 1 of all subjects factor analysis can be defined as “exquisite “, while the factor 1 of male and female subjects factor analysis can be defined as “personality” and “expensive” respectively. Factor 2 is of less difference between gender, and it can be defined as “commercial “.

The factor analysis generate not only the main concept (which serves as affective dimensions), but also the factor loadings. And with these two elements, the specimen distribution scatter plot can be made, see Figure 4.

Combined with the most popular specimens analysis (Section 3.1), the area marked in yellow in the scatter plot

Table 5: Correlation analysis

	compact	exquisite	magnificent	vivacious	Personality	morden	handy	commercial	commodious	expensive	simple	fond
compact	1.000	.705	.546	.584	.565	.734	.628	.141	.219	.639	-.238	.656
exquisite		1.000	.946	.890	.881	.940	.680	.172	.778	.979	-.342	.974
magnificent			1.000	.933	.949	.932	.632	.011	.816	.963	-.479	.938
vivacious				1.000	.951	.922	.764	-.194	.649	.887	-.370	.920
Personality					1.000	.939	.673	-.250	.644	.884	-.568	.887
morden						1.000	.762	-.079	.640	.920	-.402	.948
handy							1.000	-.275	.396	.612	.091	.754
commercial								1.000	.364	.199	.218	.089
commodious									1.000	.810	-.209	.768
expensive										1.000	-.410	.958
simple											1.000	-.252
fond												1.000

Table 6: The factor analysis of all subjects

	Factor	
	1	2
2 exquisite - coarse	.977	.156
3 magnificent – in ornate	.977	.017
6 modern - traditional	.973	-.108
10 expensive - cheap	.972	.182
5 Personality - general	.948	-.263
4 vivacious - prim	.947	-.193
9 commodious - repressive	.755	.450
7 handy - cumbersome	.729	-.254
1 compact - incompact	.688	.002
11 simple - complicated	-.423	.320
8 commercial - casual	.016	.974

Table 7: The factor analysis of male subjectst

	Factor	
	1	2
5 Personality - general	.971	.094
6 modern - traditional	.966	.153
4 vivacious - prim	.957	.112
3 magnificent – in ornate	.903	.391
2 exquisite - coarse	.901	.404
7 handy - cumbersome	.883	-.164
10 expensive - cheap	.857	.467
1 compact - incompact	.693	-.116
11 simple - complicated	-.403	-.234
8 commercial - casual	-.195	.812
9 commodious - repressive	.462	.768

Table 8: The factor analysis of female subjects

	Factor	
	1	2
10 expensive - cheap	.988	.031
2 exquisite - coarse	.982	.073
6 modern - traditional	.954	-.201
3 magnificent – in ornate	.951	-.214
4 vivacious - prim	.899	-.265
5 Personality - general	.872	-.453
9 commodious - repressive	.829	.306
1 compact - incompact	.612	-.105
7 handy - cumbersome	.610	-.112
8 commercial - casual	.073	.870
11 simple - complicated	-.211	.691

Table 9: The summarized concepts of factor analysis

	Factor 1		Factor 2	
All	Exquisite, Magnificent, Modern, Expensive, Personality, Vivacious	Exquisite	Commercial	Commercial
Male	Personality, Modern, Vivacious, Magnificent, Exquisite	Personality	Commercial	
Female	Expensive, Exquisite, Modern, Magnificent	Expensive	Commercial

Figure 4: Specimen distribution scatter plot

is the favorite, the green area for non-feeling (neither fond nor dislike) specimens, and gray area for specimens disliked.

From the specimen distribution scatter plot, we can see the position of some specimens are very close, indicating that these specimens are of the greatest similarity, such as S11 and S15, S18 and S16, S13 and S9, S14, S10 and S4, S1 and S5, S8 and S6. The favorite (yellow area) is analyzed in the following. The area can be divided into section A, B and C, basically is according to the specimens' ranking in Table 4.

The feature of S11 and S15 is very apparent, they share the down pointed outline of the center console (Figure 2). And also, the modules in the center console are complicated so that it looks very powerful. These two specimens' positions are close to that of S7's, which is the most favorite one. Compare S11 and S15 with S7, we can see that the blue color in S7 is very eye-catching and the modules in the center console are briefer. So we can conclude that the color and layout of the center console makes S7 stand out.

S13 and S9 have a lot of curve lines, but still belongs to a middle type. S3's position is close to theirs', but more outstanding. It is because it's center console part adopts the right angle feature, making it a obvious characteristic. In addition, the function is also clear at a glance with a integral style of harmony.

The common point of S18 and S16 is the humdrum color: large areas are gray and coupled with some metal color ornaments. They are two traditional type, and are not liked as well as the above ones.

To sum up, the characteristics of car interior are important concerning the customers' sensory preference if the enterprises want their products to stand out. To achieve this, the design features of both configuration and color are needed:

- The car interior color should be designed according to the appearance of the integral style of car, and also according to the perceptual preference of young people which may need more athletic features such as blue and green, etc. But the attention to the overall coordination sense of the interior must be paid;
- Too much fillet in configuration must be avoided. Mellow with some straight lines can build shapes with tensile force and upright, which is good at creating personality;
- In addition, the steering wheel and seat also require a certain degree of design.

4. CONCLUSION

4.1 Emotional preferences of the subjects

The characteristics of the specimens that subjects like most are exquisite, magnificent, expensive, vivacious, personality, modern, casual; the characteristics of the specimens that subjects unlike most are in ornate, prim, general, traditional, cheap.

The common grounds of perceptual preferences both male and female subjects are compact, exquisite, magnificent, commodious, expensive. However, male subjects prefer casual sports style, and female subjects like modern and business style most.

4.2 Automobile interior design elements

- Steering wheel inlaid with metal materials or metal-like materials, modeling with modern sense and try to avoid the monotony of color and single color;
- The overall shape of the line of the center console is a downwardly pointed shape or has downwardly gather trend. The lines are curve and should avoid simple square circle combination.
- The seat, are all leather seats with smooth surface, should avoid the use of cloth or stitching and floral and overly complicated design.
- Color: Large areas of color maintain unity and use gray, beige color. The details use some metallic, bright or other material colors, avoid the whole use the same color, similar color or colors with strong contrast.

4.3 Car interior design trends of class A & class A0

As the 80's and 90's gradually become the main force in the consumer market, their personality characteristics needed to get attention, and design trend will also follow their preferences. From the former research, it can be seen that car interior design trend of class A and class A0 tends to be use color on the performance of sport and leisure, and modeling on the straight lines of the large arc with strong tension.

5. FUTURE RESEARCH

This paper did not analyzed enough for characteristics of consumer behavior of young people. If we could systematically sum up the purchasing behavior characteristics of young people according to the case of some young first-time buyers, it will be more help to the research objectives. Further research will be considered these factors in future work.

APPENDIX I Comparison Table of Car Classification

		Mainland China	European	US
Rank	Vehicle Class	In the past: Classified with delivery capacity; Now: Classified with price	According to the wheelbase, the delivery capacity, weight and other parameters	Considering the model size, displacement, equipment and price
1	Mini	Mini: Delivery capacity less than 1L& price under RMB10,000	Class A00: Wheelbase 2~2.2m, Delivery capacity less than 1L	Mini: Delivery capacity less than 1L
2	Economy	Ordinary: Delivery capacity 1.0~1.6L, price RMB100,000~150,000	Class A0: Wheelbase 2.2~2.3m, Delivery capacity 1~1.3L	Small: Delivery capacity 1.0~1.3L
3	Compact		Class A: Wheelbase 2.3~2.45m, Delivery capacity 1.3~1.6L	Low Med: Delivery capacity 1.3~1.6L
4	Medium	Medium: Delivery capacity 1.6~2.5L, price RMB150,000~200,000	Class B: Wheelbase 2.45~2.6m, Delivery capacity 1.6~2.4L	Low-end High-end
5	Heavy	Senior: Delivery capacity 2.5~4.0L	Class C: Wheelbase 2.6~2.8m, Delivery capacity 2.3~3.0L	Low-end High-end
6	Luxury	High Level: Delivery capacity more than 4L		Up-Med Large/LUX
		More than RMB200,000	Class D: Wheelbase more than 2.8m, Delivery capacity more than 3L	

APPENDIX II Car interior specimens of Class A& Class A0

APPENDIX III List of Specimen Models

Rank	Manufacturer	Brand & Model (Mini)	Sale 2011	Quoted Price -2012.02	L* w*h (mm)	Wheelbase (mm)
1	Shanghai GM Chevrolet	Sail	197548	5.68-7.93	4249*1690*1505	2465
2	Tianjin FAW	Charade	196143	2.88-3.78	3680*1615*1385	2340
3	Shanghai Volkswagen	New POLO	112627	8.59-12.39	3970*1682*1462	2470
4	KIA	K2	58334	7.29-10.99	4120*1700*1460	2570
5	Changhe Suzuki	Changhe SuzukiBig Dipper (mini car)	51976	4.05-5.38	3400*1575*1670	2335
6	Shanghai Volkswagen, Skoda	Fabia	48759	7.89-11.59	4003*1642*1500	2465
7	Changan Ford	Fiesta hatchback	44006	7.99-11.29	3950*1722*1467	2490
8	Changan Suzuki	Swift	42469	6.08-9.18	3765*1690*1510	2390
9	Shanghai GM Buick	Excelle	251719	7.00-13.08	4515*1725*1445	2600
10	Shanghai Volkswagen	Lavida	244271	11.28-16.28	4608*1743*1465	2610
11	Shanghai GM Chevrolet	Cruze	220752	10.89-16.39	4598*1797*1477	2685
12	FAW-Volkswagen	Jetta	218783	7.58-9.88	4415*1674*1415	2471
13	Beijing Hyundai	Elantra	190561	9.98-14.68	4543*1777*1490	2650
14	FAW Toyota	Corolla	170467	12.38-19.98	4545*1760*1490	2600
15	BYD	F3	164022	5.28-6.69	4533*1705*1490	2600
16	KIA	Forte	128112	9.88-13.98	4530*1775*1460	2650
17	FAW-Volkswagen	Sagitar	127275	13.28-18.48	4544*1760*1461	2578
18	Shanghai Volkswagen, Skoda	Octavia	126183	13.83-21.09	4569*1769*1462	2578

APPENDIX IV Auto Sale Rank in 2011

Rank	No.	Manufacturer	Brand& Model(Mini)	Sale 2011-2012.02	Quoted Price
1	9	Shanghai GM Buick	Excelle	251719	7.00-13.08
2	10	Shanghai Volkswagen	Lavida	244271	11.28-16.28
3	11	Shanghai GM Chevrolet	Cruze	220752	10.89-16.39
4	12	FAW-Volkswagen	Jetta	218783	7.58-9.88
5	1	Shanghai GM Chevrolet	Sail	197548	5.68-7.93
6	2	Tianjin FAW	Charade	196143	2.88-3.78
7	13	Beijing Hyundai	Elantra	190561	9.98-14.68
8	14	FAW Toyota	Corolla	170467	12.38-19.98
9	15	BYD	F3	164022	5.28-6.69
10	16	KIA	Forte	128112	9.88-13.98
11	17	FAW-Volkswagen	Sagitar	127275	13.28-18.48
12	18	Shanghai Volkswagen, Skoda	Octavia	126183	13.83-21.09
13	3	Shanghai Volkswagen	New POLO	112627	8.59-12.39
14	4	KIA	K2	58334	7.29-10.99
15	5	Changhe Suzuki	Changhe SuzukiBig Dipper (mini car)	51976	4.05-5.38
16	6	Shanghai Volkswagen, koda	Fabia	48759	7.89-11.59
17	7	Changan Ford	Fiesta hatchback	44006	7.99-11.29
18	8	Changan Suzuki	Swift	42469	6.08-9.18

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