Kansei Comparison of Form -ratio by Factor Analysis

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Abstract. Form-ratio means the ratio of Height/Width/Depth in 3-dimensions. The golden ratio or golden section is included as one of the form-ratio. We conducted two kinds of kansei experiments of cubic model and refrigerator varied from 1:1 :1 to 1:1:3.66 on the scale of x:y:z. The subjects evaluate the form-ratios of 3-dimensional cubes and virtual products with SD-scale Kansei words(feelings and images). We applied the factor analysis to identify semantic space in cube model and virtual products . Finally, we compared with kansei structure of cube model and virtual product .

1. INTRODUCTION

Kansei Engineering(KE) is a kind of ergonomic technology for translating human feelings("Kansei" in Japanese) into a new product design. It supports customers and designer constructing a product that is appropriate to his or her Kansei. It is very popular as a product development methodology in the world as well as in Japan.(Nagamachi, 1989)

Kansei Engineering System(KES) which is an expert computer system which enables translation from kansei to product design elements and vice versa. This means that it is able to show the physical product design elements fit to customer feelings(kansei) of product on the basis of kansei database consisted of the relationships between design elements and their kansei. KES has some database and knowledge base used to infer the design element corresponding to customer feelings. So far, many kansei databases such as automobile, costume, cosmetic products have been constructed on the basis of kansei experiments and used as main part in KES. We proposed to construct basic Kansei design database as well as particular database in KES(Nagamachi et al.; Nishino,.1997).

Form-ratio and color are basic design elements and are very influential for human feelings to various products(Nagamachi et al., 1996 ; Ichitsubo et al. ,1998 ; Komatsu et al.,1998). Therefore, the databases of these basic design elements are very important in viewpoint of kansei product design. This means that users who input their Kansei into KES are able to get the basic form-ratio and color design of a target product corresponding to their feelings(Nishino et al., 1998; Nishino et al., 1999).

Accordingly, the purpose of this study is to obtain the construction of form-ratio database for KES. The experiments based on the semantic differential method(SD) were carried out to observe factor structure of kansei using the form-ratio of cube model and refrigerator created by computer graphics. The data obtained in this way provide us a great deal of information concerning the feeling structure of form-ratio through factor analysis , and the relationship between form-ratio and Kansei through quantification theory type I. Moreover, we analyzed the relationship between kansei structure and form-ratio.

2. EXPERIMENTAL AND ANALYTICAL PROCEDURES

2.1 Measurement of Image Perception

Form-ratio meant the ratio of Height/Width/Depth in 3-dimension. Using the software Lightwave 3D, we constructed the cube model and virtual products with a variety of form-ratio. The experimental procedure is identical to the reference(Nishino,T; Magamachi,M,2000). Each objects of cube and refrigerator, has 9 form-ratios from 1:3.66 until 1:1.

We selected 31 adjective pairs of kansei monitoring virtual form-ratio model from kansei word database which has approximately 1,800 Japanese adjective based on three layer kansei structure model that is consisted of physical, impression and value kansei. Each form-ratio and virtual graphics were evaluated by 40 students (20 male and 20 female, age19-22) with SD-scale of each kansei words.

2.2 Statistical Analysis

We obtained the databases of the form-ratio and the kansei words. We applied the factor analysis to find out the kansei structure and the Quantification Theory type I to find out the correlation between the form-ratio and kansei words. Moreover, we classified the correlation pattern of kansei words in each kansei factor and compared with cubic model and refrigerator.

3. RESULTS OF THE ANALYSIS

3.1 Kansei Structure of Cubic Model

Tab. 1 showed the results of factor analysis, after the adjectives pairs had been rearranged according to the factor loading. The adjectives pairs with relatively large factor loading, which were enclosed in thick lines, were considered to be strongly dependent on the specific common factor. The results of this analysis shown that 78.5% of all the data could be explained by the first to fifth factor.

Table 1 Results of the Factor analysis(Cubic Model)

	I	II	III	IV	V
Simple-Not simple	-0.957	-0.067	0.003	0.064	0.378
Heavy-Not heavy	0.916	0.120	-0.053	-0.100	-0.135
Easy to carry-Not easy	-0.902	-0.245	0.243	-0.127	0.093
Compact-Not compact	-0.845	0.085	0.108	0.036	-0.089
:	:	:	:	:	:
Individuality-Not individuality	0.033	0.911	-0.059	0.224	0.156
Impressive-Not impressive	0.251	0.840	-0.138	-0.022	0.066
Ordiary-Not ordinary	-0.163	-0.801	0.284	-0.078	-0.357
Good balanced-Unbalanced	-0.547	-0.663	0.024	0.163	-0.299
Pervasive-Not pervasive	-0.540	-0.619	0.164	0.215	-0.219
Pretty-Not pretty	-0.271	-0.027	0.903	0.057	0.000
	-0.057	-0.430	0.685	-0.091	-0.096
Familiar-Not familiar	-0.232	-0.528	0.591	0.018	-0.388
High class- Low class	-0.318	0.128	-0.024	0.681	0.101
Not tired-Tired	0.331	0.135	-0.240	-0.399	0.238
Modern-Not modern	0.030	0.114	-0.217	0.256	0.205
New-Not new	-0.257	0.381	0.013	0.200	0.598
Clam-not calm	0.900	-0.222	0.097	0.013	-0.565
Eigen value	15.9	5.2	2.0	1.4	1.1
Accumulated Contribution	51	67	72.8	76.3	78.5

As some adjective pairs including "simple-not simple", "heavy-not heavy", "easy to carry-not"," and "compact-not compact" were strongly dependent on the first factor, we referred to this as "physical factor". In the same way, the factor from the second to fifth were interpreted and labeled " impressive factor", "pretty factor"," high class factor" and " novelty factor" respectively.

3.2 Correlation Pattern of Factor in Cubic Model

Fig.1 showed typical category score pattern of the first " physical factor" including "not simple-simple" and " not heavy-heavy". These kansei adjectives which were directly concerned with physical property, had the linear relationship between form-ratio and kansei. That is, the larger the form-ratio, more "simple "and "not heavy .

Fig.2 showed typical category score pattern of the second " impressive factor" including " not individuality-individuality" and " not impressive-impressive". These adjective pairs which were mainly influenced by personal value and prototype image, had curve relationship between form- ratio and kansei and they had a peak in the middle form-ratio.

3.3 Kansei Structure of Refrigerator

Tab. 2 showed the results of factor analysis, after the adjectives pairs had been rearranged according to the factor loading. The adjectives pairs with relatively large factor loading, which were enclosed in thick lines, ,were considered to be strongly dependent on the specific common factor. The results of this analysis shown that 79.5% of all the data could be explained by the first to fourth factor. As some adjective pairs including "good size-not good size", "good balanced-unbalanced", " usable – not usable", "familiar-not familiar" were strongly dependent on the first factor, we referred to this as "impressive factor". In the same way, the factor

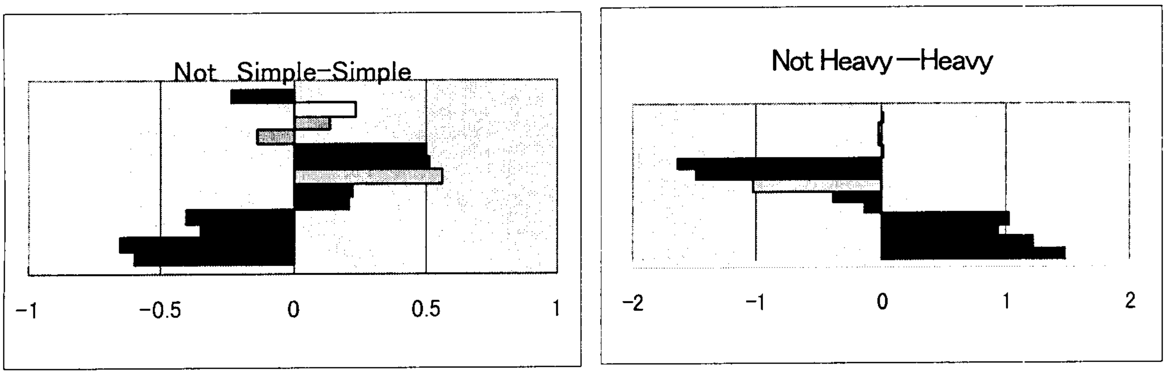


Fig.1 A Result of Quantification Theory Type I Analysis of "Physical Factor"

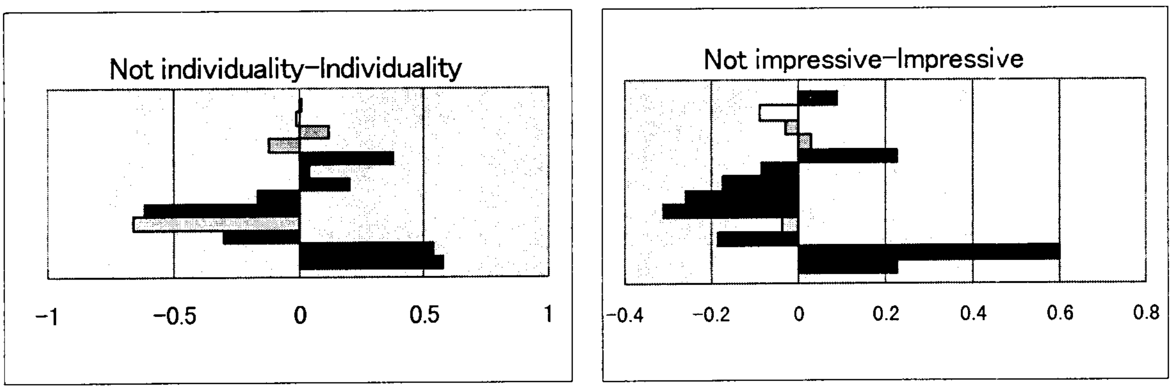


Fig.2 A Result of Quantification Theory Type I Analysis of "Impressive Factor"

Table 2 Results of the Factor analysis(Refrigerator)

	I	II	III	IV
Good size-Bad size	-0.963	0.021	-0.048	-0.064
Good balanced-Unbalabced	-0.944	0.034	-0.046	-0.016
Usable-Not usable	-0.940	0.068	-0.067	-0.114
Familiar-Not familiar	-0.924	0.180	0.063	0.042
:	:	:	:	:
Heavy-Not Heavy	0.086	-0.950	0.163	-0.042
Simple- Not simple	-0.153	0.919	-0.286	-0.025
Compact-Not compact	0.045	-0.889	0.066	-0.097
Individuality-Not Individuality	-0.133	0.888	-0.068	0.087
:	:	:	:	:
Citylike-Not citylike	-0.096	0.365	-0.695	-0.109
Young-Old	-0.009	0.571	-0.676	0.085
Modern-Not modern	-0.034	0.137	-0.622	0.227
High class-Low class	-0.395	-0.520	-0.594	-0.292
Pretty-Notpretty	-0.227	0.291	-0.138	0.760
Cold-Not cold	-0.301	-0.319	-0.306	-0.501
Eigen Value	17.5	6.8	3.2	2.0
Accumulated Contribution	43.9	64.7	73.5	79.5

from the second to fourth were interpreted and labeled "physical factor", "high class factor", and " pretty factor" respectively. The first and second factor was inverse compared to cubic model which had no meaning to human.

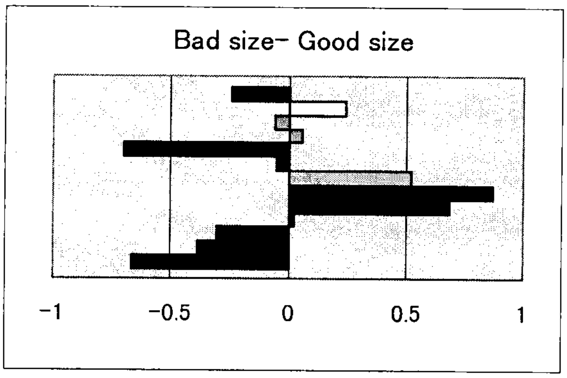
3.4 Correlation Pattern of Factor in Refrigerator

Fig.3 showed typical category score pattern of the first " impressive factor" including "bad size-good size" and "unbalanced-good balanced"," usable- not usable" and " familiar- not familiar". These kansei adjectives which were mainly influenced by personal value and prototype image, had the curve relationship between form-ratio and kansei. That is, the larger the form-ratio, more "simple "and "not heavy .

Fig.2 showed typical category score pattern of the second " impressive factor" including " not individuality-individuality" and " not impressive-impressive". These adjective pairs which were mainly influenced by personal value and prototype image, had curve relationship between form- ratio and kansei and they had a peak in the middle form-ratio.

4. KANSEI COMPARISON OF CUBIC MODEL AND VIRTUAL PRODUCT

Both Kansei structure of cubic model and



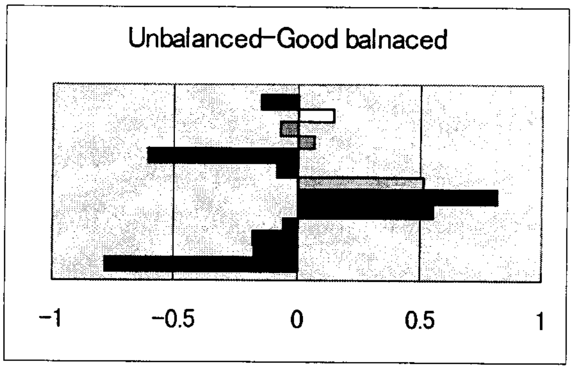


Fig.3 A Result of Quantification Theory Type I Analysis of "Impressive Factor"

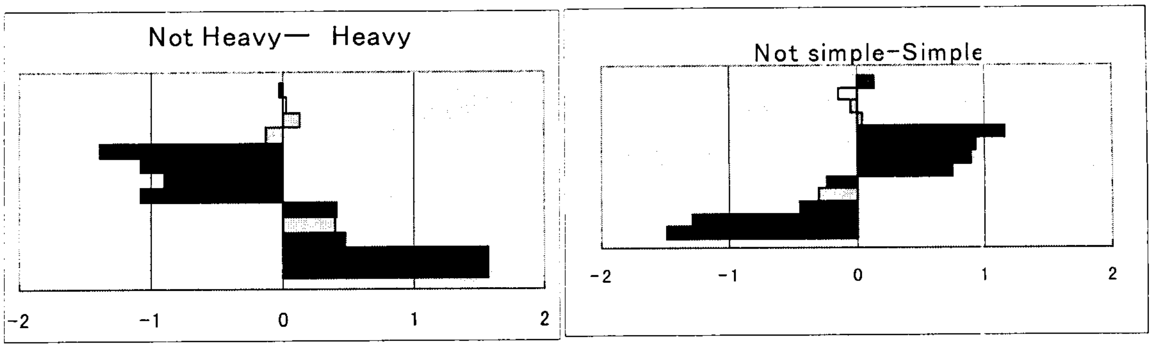


Fig.4 A Result of Quantification Theory Type I Analysis of "Physical Factor"

refrigerator were similar each other, but the order of factors were quite different. We obtained 5 factors for the cubic form and 4 factors for the refrigerator.

The first factor with regard to the cubic form means the kansei group related to the implication of physical traits and expressed the linear characteristics in mathematical meaning. On the other hand, the first factor emerged as second factor in refrigerator which has also linear characteristics. The second factor for the cubic form were curved for the order of common factors.

It was found out that some Kansei in physical factor space have such a linear relation, others in impressive factor space have nonlinear U type relation as shown in Fig. 2 and Fig. 3. This means that kansei with linear relation which always belong in "physical factor" space could not be effected by prototype image of the objects, but kansei with nonlinear relation which always belong in "impressive factor" space could be strongly effected through prototype image of objects. It was suggested that we need to consider the distance from prototype in kansei form-design.

5. CONCLUSION

Conclusion was summarized as follows within the scope of the experimental work. Kansei(human feeling and image) was closely related to the form-ratio. It was found that the form-ratio strongly effected on Kansei through semantic space and prototype image. We attempted to construct a database model as the basic designing database in Kansei Engineering System. It would be useful in designing the form-ratio of various products by Kansei engineering methodology.

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