A Research for product design and evaluation applied with Human Sensibility Ergonomics
(감성공학을 적용한 제품개발과 검증에 대한 연구)

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Abstract

User's sensibility has an important effect upon appreciating household electronic appliances and user's feeling of satisfaction with products has a good effect on the choice of product on purchasing those items. In this point of view, the human-oriented approach of product development system can be adopted as Human Sensibility Engineering. The target of changed development system is to define user's sensibility factors and to apply them to design and development. In this study, the human sensibility ergonomics approach and usability test have been applied to the development and evaluation of an electronic product model.

I. The Abstract of Development process Applied Human Sensibility Ergonomics

The objective of this study is the development of technique that can be applied function and design of electronic appliance toward human sensibility engineering, understanding of sensibility factor structure, design factors and sensitivity factors to develop the product satisfied to human sensibility.

The subject electronic appliance of this study is refrigerator, the range of that is sensibility adjectives of human feeling. Usability test and analysis is used for the measurement and appreciation of sensibility factors with the data of Korean housewife's use of refrigerator using and the habit of food keeping. The flow chart of development and appreciation system, applied human sensibility engineering, is showed at Figure 1.

1. Development system applied human sensibility ergonomics

FGI data, A/S data, customer card and questionnaire are used to collect sensibility words. Abstracted sensibility adjective words are analyzed to know what kinds of sensitivity factors are affected. Sensitivity words are verified whether they can be used as appreciation criteria.

2. Usability test and analysis

Subjective appreciation method is used with usability test as the appreciation method of refrigerator. Six refrigerators under the same conditions and 13 cameras are established in the usability test room, 12 cameras are for 6 refrigerators and one is for the whole. Twelve subjects, take part in the usability test and FGI, are chosen among housewives and future users who be going to use refrigerator mainly.

II. The Analysis System Applied Human Sensibility Ergonomics

1. Customer needs analysis and Sensibility words abstraction

FGI data, questionnaire data, customer card, agency sales data and A/S data are used to analyze customer's needs. Important needs are bound together by common factors. Common and important needs are 5 common factors, 66 needs factors in sum. Sensibility words are abstracted from 66 needs factors. The appreciation of adjectives, whether words are sensibility level or sensitivity level, is done to abstract sensibility words. From the procedure, 38 sensibility words are abstracted. The procedure of sensibility words abstraction is showed at Figure 1.
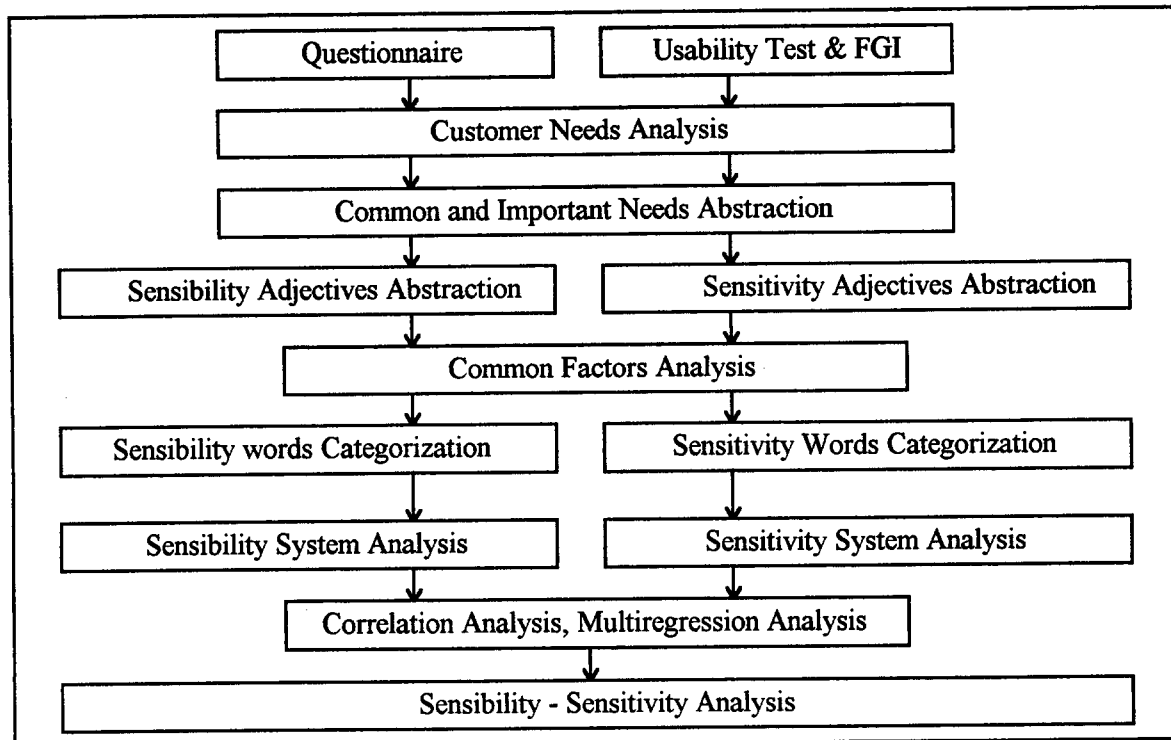
<Fig.1> Household electronic appliance development and appreciation system applied human sensibility ergonomics
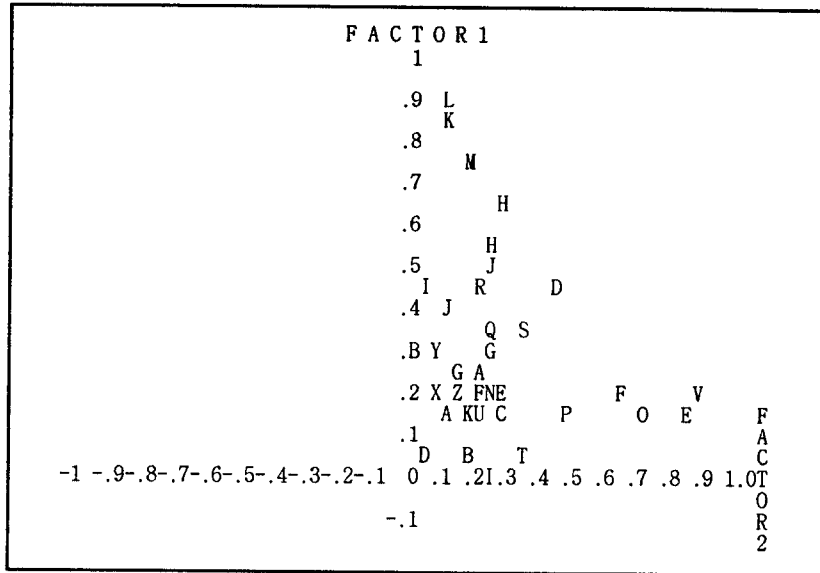
< Table 1 > factors coefficient of sensibility words

Word \ Factor	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
different	0.88204*	0.10911	0.20135	0.06043	0.03646	-0.00357	0.06714
new	0.83856*	0.11470	0.23208	0.13677	0.17098	0.02275	0.03785
ultramodern	0.75926*	0.17155	0.22343	-0.01160	0.11006	0.21845	0.09726
specific	0.65743*	0.27482	-0.04414	0.19468	0.17240	0.16721	0.14945
minute	0.51509*	0.24795	0.29208	0.22997	0.17089	0.08474	0.02199
harmony	0.46614*	0.22624	0.23151	0.02651	0.07152	0.06660	0.05410
scientific	0.45731*	0.44176	0.12929	0.19265	0.27946	0.08698	0.21237
strong	0.18218	0.87744*	0.22515	0.07702	0.09451	0.05842	0.00545
hardy	0.16639	0.84465*	-0.01896	0.16157	0.20490	0.16579	0.02551
firm	0.15580	0.72665*	0.09198	0.25254	0.12478	0.14528	0.15061
stable	0.21658	0.63382*	0.17431	0.25844	0.20740	-0.02441	0.02840
smart	0.17255	0.47143*	0.26173	0.30078	0.25374	0.24434	0.14048
soft	0.19223	0.09350	0.85504*	0.13818	0.12859	0.11113	0.11737
pretty	0.28298	0.07035	0.77122*	0.23215	-0.13475	0.03586	-0.07388
natural	0.22009	0.16611	0.55020*	0.18394	0.10278	0.17214	0.02553
neat	0.21061	0.09841	0.53788*	0.26370	0.08053	0.19726	-0.11083
not crude	0.02818	0.19241	0.52241*	0.22921	0.16208	0.45814	0.01152

2. Sensibility factors analysis

The common factor analysis is executed using 38 sensibility words, the result of VARIMAX rotation make sensibility category with 19 sensibility factors. Seven important sensibility factors, sense of discrimination, security, attraction, pleasantness, usability, cleanliness, freshness, that have cumulative 80.5% and eigenvalue 1.0 or more, are chosen. The result of factor coefficient analysis is showed at table 1.

Two dimensional plot about two factors, sense of discrimination and security, among seven factors show at Figure 2. The correlation between sense of discrimination and security is slight. These two

```
                              F A C T O R 1
                                  1
                                 .9  L
                                     K
                                 .8
                                      M
                                 .7
                                       H
                                 .6
                                       H
                                 .5  J
                                    I   R      D
                                 .4 J
                                        Q  S
                                 .B Y   G
                                      G A
                                 .2 X Z FNE       F      V
                                    A KU C     P     O  E     F
                                 .1                            A
                                    D   B   T                  C
   -1 -.9-.8-.7-.6-.5-.4-.3-.2-.1  0 .1 .2I.3 .4 .5 .6 .7 .8 .9 1.0T
                                                              0
                                 -.1                          R
                                                              2
```

fresh=A	efficient=B	reliable=C	ease=D	practical=E	convenient=F	pleasant=G
unique=H	intelligent=I	minute=J	new=K	different=L	ultramodern=M	clean=N
firm=O	neat=P	smart=Q	harmony=R	adequate=S	simple=T	suitable=U
strong=V	refined=Q	soft=X	pretty=Y	natural=Z	rustic=A	crude=B
sufficient=E	scientific=D	hardy=E	stable=F	stuffy=G	specific=H	rude=I
high-grade=J	stiff=K	neat=X				

<Fig. 2> Plot of Factor Pattern for FACTOR1(a sense of discrimination)
and FACTOR2(a sense of security)

senses have little relation to other sensibility factors, but sensibility factors are not contrary each other. A sensibility word, Scientific, is related to a sense of security much. High-grade and Intelligent is related to discrimination.

3. The sensitivity factors analysis

The abstraction procedure of sensitivity words is the same that of sensibility words, 28 sensitivity words by sensory organs, appropriate to sensitivity level, are abstracted. The VARIMAX rotation make 13 sensitivity categories and 6 important factors, cumulative 82.12% and eigenvalue 1.0 of more, are selected.

4. The correlation and multiregression analysis of sensibility and sensitivity factor

The adjectives, that are used to correlation and multiregression, are sensibility and sensitivity words by sensibility and sensitivity factors. At tables in this paper, the analysis result of just a sense of discrimination and sensibility words related to this sense is described.

The interpretation level of sensitivity words about the sensibility words are analyzed by the correlation analysis, the correlation coefficients of sensibility words of discrimination and sensitivity words are at table 2. The number of sensitivity words of senses of shape, sight and taste, which have significant correlation(p =0.1) to a sense of discrimination, is more than sensitivity words of the sense of smell and touch. This result of correlation shows that the sensitivity words, which are related to senses of shape, sight and taste, are have more correlation to a sense of discrimination than other sensitivity words.

The partial-correlation coefficients of sensibility and sensitivity words are used to analyze the correlation of sensibility factors and each sensitivity word on condition that the effect of other words are eliminated. The result of the analysis shows a sense of discrimination is much related to the sensitivity words of the sense of shape and taste than that of smell and touch at table 3.

The multiregression analysis, STEPWISE (FORWARD, significant level 0.1), is executed to select the sensitivity words that are included in the regression model. The sensitivity words, which have much effect on the sensibility factors, are abstracted at table 4.

<Table 2> Correlation coefficient of sensibility and sensitivity words(α:*0.1, ** 0.05)

sensib. word \ sensit. word	the sense of smell				the sense of touch				the sense of shape	
	not smell of dishes	not foul-smell	not smell of kimchi	not fishy smell	cold	moist	tight	not tough	not complex	not complicate
F A C T O R 1 different	0.28**	0.37**	0.30**	0.13	0.17	0.29**	0.14	0.34**	0.17	0.09
new	0.24*	0.32**	0.28**	0.06*	0.17	0.18	0.27**	0.15	0.18	0.38**
ultramodern	0.10	0.19	0.16	0.06	0.06	0.19	0.09	0.34**	0.22*	0.23
specific	0.21*	0.34**	0.34**	0.24*	-0.05	0.18	0.08	0.22*	0.16	0.23*
minute	0.12	0.17	0.12	0.15	-0.02	0.04	0.03	0.27**	0.17	0.15
harmony	0.25*	0.39**	0.17	0.17	0.13	0.29**	0.33**	0.30**	0.06	0.10
scientific	0.21*	0.28**	0.30**	0.19	0.07	0.21	0.19	0.20	0.35**	0.48**

<Table 3> Partial-correlations coefficient of sensibility factor and sensitivity words(α:0.1*, 0.05**)

sensib. word \ sensit. word	the sense of smell				the sense of touch				the sense of shape	
	not smell of dishes	not foul-smell	not smell of kimchi	not fishy smell	cold	moist	tight	not tough	not complex	not complicate
FACTOR 1	0.07	0.12*	-0.05	-0.11	0.18*	0.06	0.01	0.28**	0.19**	0.34**

sensib. Word \ sensit. word	the sense of shape		the sense of sight			the sense of taste				
	wide	big	vivid	not wrinkled	freshly blue	delicious	fresh	refreshing	not sour	crunch
FACTOR1	0.11*	0.16**	0.22**	0.19**	0.32**	-0.04	0.12*	0.17**	0.21**	0.09

<Table 4> STEPWISE multiregression sensibility factor and sensitivity words(α:0.1)

Step	Variable Entered	Number In	Partial R**2	Model R**2	C(p)	F	Prob > F
1	big	1	0.1904	0.1904	172.6775	61.8718	0.0001
2	freshly blue	2	0.0835	0.2740	129.9205	30.1510	0.0001
3	not complicate	3	0.0478	0.3218	106.3327	18.3810	0.0001
4	not tough	4	0.0360	0.3577	89.0626	14.5620	0.0002
5	not sour	5	0.0353	0.3930	72.1584	15.0579	0.0001
6	cold	6	0.0288	0.4218	58.7398	12.8430	0.0004
7	not wrinkled	7	0.0252	0.4470	47.2393	11.7122	0.0007
8	not foul-smelling	8	0.0149	0.4619	41.2455	7.0996	0.0082
9	not fishy smell	9	0.0307	0.4927	26.7870	15.4420	0.0001
10	vivid	10	0.0113	0.5040	22.7176	5.8017	0.0167
11	refreshing	11	0.0109	0.5149	18.8865	5.6766	0.0179

The important qualitative and quantitative functions, which are related to sensitivity words of regression model, can be abstracted from the result of usability test about product functions and techniques. The specifications of physical and technical characteristics for the design of quantitative functions can be achieved from the usability test and ergonomic experiment. From usability test and ergonomic experiment, relations about sensibility-sensitivity-function-physical and technical spec can be established.

5. Development of chilly draft control system

For satisfying customer's sensibility, appropriate temperature of cold-storage room is always keep consistency. Two sensor was adhered for collect temperature data and inference whole inner temperature using Neural Network-Fuzzy-Genetic fusion Algorithm. When abnormal data(some like hot food) is inferred Whaejun Nalgae(swing ala) stop and intensive cooling hot point for quickly recover to regular temperature.

Using Neural Network-Fuzzy-Genetic fusion Algorithm to control three angle of Whaejun Nalgae for select suitable position, and sequentially inference temperature data to immediately control chilly draft.

6. Usability Test & Analysis

Usability Test and FGI method, one of the subjectively evaluation method are used for evaluate refrigerator. Usability Test room was set in S Electronics Co. with competitive 6 sets in same condition. 12 Subjects ,who participated in the usability and FGI, were selected out of the housekeepers who use the refrigerator usually and the potential users.

III. Conclusion

This study applied the human sensibility ergonomics system, which grasps sensibility and sensitivity factors, abstracts function factors

affect these factors from product technique and usability test, and chooses these factors as the important functional design factors to develop the product, to household electronic appliance. In this study, because the part of that, words abstraction, uses limited materials and datum, this system is for want of diverse adjectives abstraction. The Subjective appreciation method using S.D.(Semantic Differential), five points scaling, has the difficulty of diverse and exact expression about appraisers' mind.

Also, this study will progress on abstraction of diverse and objective words during the life cycle, use a fuzzy measuring method as customer's appreciation about product. Usability test and ergonomic experiment system may be going to use the V.R. system and sensitivity measuring instrument to measure sensitivity exactly and efficient, reliable product development system applied human sensibility ergonomics.

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