KANSEI ENGINEERING AND ITS APPLICATIONS

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Abstract

Kansei Engineering is a consumer-oriented technology for a new product development which was developed in Japan, and it has spread out for utilizing as a new product development technology in Japan as well as in the world. It is defined as "a translating technology of a consumer's feeling and image for a product into design elements". Kansei Engineering technology is classified into three types, Type I, Type II and Type III. Kansei Engineering Type I is a category classification on the new product toward an identification of the design elements. Type II utilizes the current computer technologies such as Expert System, Neural Network Model and Genetic Algorithm. Type III is a modeling using a mathematical structure.

Kansei Engineering is very popular technology of a new product development which has been utilized in Automotive, Electric Appliance, Construction and Housing Design, Costume and so forth.

Introduction

A strategy of the new product development focuses on not "product-out", but "market-in", since the consumers are apt to select the products according to their own preference and amenity. The product-out strategy means a production based on a manufacturer's design strategy, but the market-in strategy a production based on the consumers' desire and preference. Nowadays, the consumers have a plenty of goods in their home and their sensitivity are very severe in choosing the demanded product. The manufacturers should change their product strategy to the consumer-oriented one.

Nagamachi has developed "Kansei Engineering" as an ergonomic consumer-oriented technology for a new product development aiming an implementation of the consumer's demand in the product (Nagamachi, 1989; 1991a; 1991b; 1993). Kansei is a Japanese word which implies a consumer's psychological feeling and image regarding a new product. When the consumer wants to buy something, he or she has such an image of the new product as "gorgous and soft" one. Kansei Engineering enables to develop a new product in which the consumer's feeling and image is

implemented. Kansei Engineering is defined as a translating technology of a consumer's feeling (Kansei in Japanese) of the product into the design elements, as shown in Figure 1.

Fig. 1. A diagram of a process of Kansei Engineering System (KES).

Kansei Engineering aims to produce a new product based on the consumer's feeling and demand. There are four points regarding this technology; (1) to collect the Kansei words appropriate to the concerned domain of the product, (2) to find the correlations between the Kansei words and the design characteristics, (3) to build the technological identification on the design characteristics, and finally (4) to construct a system connecting (1) through (3).

There are three types in Kansei Engineering technique; Type I, Type II and Type III.

Techniques of Kansei Engineering

Type I: A Category Classification

A Category Classification is a method in which a Kansei category of a product is broken down in the tree structure to get the design details. There is a good example of the automotive development applied the Kansei Engineering Type I. A Japanese automotive maker, Mazda, has developed a new sports type car named "Miyata" (Japanese name, Unos Roadster) which was applied Kansei Engineering.

The project team decided to implement Kansei Engineering in "Miyata" development, since Mazda Chairman, Mr. Kenichi Yamamoto has been interested in Kansei Engineering. The team settled the product concept (Zero-level concept in Kansei Engi-

neering) as "Human-Machine Unity (Jinba intai in Japanese) after discussing and the survey of the consumer trend. The concept implies that a driver feels a unification of body and car when driving. The driver images that the half body might be the machine and that the driver is able to control the machine freely with his or her intention.

"Human-Machine Unity" is just a concept and tells nothing about the vehicle specification in dimensions and functions. Therefore, the team have to discuss again and again to reach the final specks of design. In other words, the zero-level concept should be broken down to 1st, 2nd, 3rd...and nth subconcept until the team can get the physical traits of the design specks. This procedure of Type I is shown in Figure 2.

Kansei		sensation	Automotive engineering	Physical traits
zero	1st 2nd.....nth			
HMU	Tight feeling		Body size	Size Width Height Seat
	Direct feeling		Engine Chassis	
	Speedy feeling		Steering yaw	Steering design Frequency
			Noise control	
	Communication		Vibration Exterior Interior	Frequency Design Design

Fig. 2. The translation of Kansei into car physical traits in the case of "Miyata".

Regarding "Miyata", the zero-level concept was classified into four subconcepts in the 1st level; "Tight-feeling", "Direct-feeling", "Speedy-feeling" and "Communication". "Tight-feeling" implies "fitting closely to the machine" and "not long, nor small". From this subconcept, the team decided that the vehicle length would be around 4 meters. As a result, it was 3.98m after the arrangement of all specks. Regarding the concept of "Direct-feeling", an example of transformation to the design detail refers to a shift lever length. The team carried out a Kansei experiment for decision of the length of shift lever. "Direct-feeling" concept implies the driver's feeling of controlling the vehicle freely on his or her way. The task needed is to decide the length of shift lever fit to this subconcept. Then, the team carried out a Kansei experiment in which a variety in length of shift lever were evaluated by SD scale of "My own way ofcontrolling". As the result of Kansei experiment, the length was decided to be 9.5 cm from joint point.

These are the examples of Kansei Engineering Type I procedure.It

1st level	2nd level	Physical traits
Tight feeling	Appropriately	4 m length
	Narrow	Two-seat
		Width
	Simple	Simple interior design
		Floor carpet
		trait

Fig. 3. An example of refining the physical traits from Kansei Engineering.

starts from the zero-level concept which is broken down and classified to the subconcepts. This procedure continues until the team gets the physical characteristics. Then, the team surveys or carries out the experiment to find the appropriate specks and finally begins to develop the car parts according to the automotive engi- neering, as shown in Figure 2. Figure 3 illustrates an example of break-down to the subconcepts.

Type II: Kansei Engineering System (KES)

Kansei Engineering Type II is a computer-assisted Kansei Engineering System. Kansei Engineering System (KES) is a computerized system with Expert System to transfer the customer's feeling and image to the design domain. For construction of KES, the next procedure as shown in Figure 4 should be followed.

(1) The Kansei words

We collect the Kansei (image) words concerning the product from the sales offices and from the concerned magazines. For instance, we visit the automotive dealer offices to record the dialogue between a dealer and a customer. And we collect the Kansei words from the motor magazines. Using about 600 Semantic Differentials scale, we ask the subjects to evaluate the pictures of the product and analyze the evaluated results by the Factor Analysis. We select 100 Kansei words from each factor in the factor analysis and construct the final Kansei word scale. We carry out the evaluating experiment again for the pictures of the product using the final Kansei word scale. We obtain the results of the factor analysis applied to the second evaluated data.

(2) The relations between the Kansei words and design elements

In this stage, a variety of the product are taken picture to make slides which are evaluated by the Kansei words in SD scale. The Kansei word SD scales have 5-point scale from "highest" to "lowest". On the other hand, We classify the design element into design category and item. The design category means a category

Fig. 4. A schema of the procedure of Kansei Engineering System.

Fig. 5. A system structure of Kansei Engineering System.

which has a group of items. The item implies each type of the specific parts of design. For instance, the type of steering wheel is a design category and the number of spokes are the items, one spoke, two spokes, three spokes and four spokes. Each spoke type means the item. Therefore, in this case the design category of steering wheel has four items consisting of the number of spoke. The evaluated results of the Kansei words $\times$ the design categories/items are analyzed by Hayashi's Quantification Theory Type I which is similar statistical analysis method with the multiple regression analysis with the qualitative data (Nagamachi, 1991).

(3) Construction of the expert system

The next stage is to construct an Expert System. Regarding to the recognition for the Kansei words, we construct the Kansei word database which has one hundred Kansei words and statistical data between the Kansei words like a factor analysis.

In the central mechanism, there are an inference engine and the knowledge-base which are able to recognize the relationships between the Kansei words and the design details by the calculation through the "if-then" rule-bases. The rule-bases consist of the statistical data of Quantification Theory and of the designers' knowledge.

Fig. 6. An example of outputs about kitchen from HULIS.

The KES has another database of design and color which is able to produce the graphics on the display. Figure 5 shows a system structure of KES as an example.

Some examples of KES

(1) HULIS

Human Living System HULIS is an expert system that is able to translate a customer's feeling about house design in terms of Kansei Engineering. HULIS can illustrate the house appearance, entrance, Japanese-style room, western-style room, kitchen, bathroom, and fence. A customer inputs his or her image on the new house with the adjectives and chooses among the graphics illustrated on the display. Figure 6 shows one of outcomes of kitchen from HULIS, when the customer inputs the adjective "elegant" in the computer system. In HULIS, the customer is permitted to input ten Kansei words at most and the system can infer the customer's image.

(2) The automotive interior design

Regarding an automotive interior design, it is very important strategy to make the driver to feel wider in spite of the narrow space. For the realization of this design strategy, we have to have the data which shows what design specks influence the wide-feeling vs. narrow-feeling.

We carried out an experiment of evaluating the interior of twenty cars with 40 SD scales of Kansei words including the wide- and narrow- feeling words according to the Kansei Engineering procedure, as mentioned above. We analyzed the evaluated data by Quantification Theory Type I and obtained the relationships between these two Kansei words and the design category/item. Then, we constructed a new computerized system through which enables to find the items to influence most strongly on the wide-feeling (or the narrow-feeling).

This system has twelve illustrations in which a designer can input the dimensions that he or she is thinking of. Figure 7 illustrates one of these figures. The system, then, recognizes the data inputted by the designer and calculates according to the rule-base, and finally shows the Kansei evaluation about the wide-feeling (or the narrow-feeling) inferred by the system.

There are many cases applied Kansei Engineering in the automotive interior design (Jindo and Nagamachi, 1991), house entrance door design (Miyazaki, Matsubara and Nagamachi, 1993), const-

Fig. 7. One of illustrations implemented "wide-feeling" Kansei System.

duction vehicle interior design (Nakata, Iwata and Nagamachi, 1994).

Type III: Implementation of mathematical model

Type III implies to implement other system for Kansei Engineering in spite of Expert System. The implementation of a mathematical model is an example. The Kansei Engineering team in Sanyo Electric Company tried to implement Kansei Engineering in an intelligent color printer using Fuzzy Logic (Fukushima, Kawata, Fujiwara and Genno, 1994). The team intended to make such a printer that enables to print more beautiful picture than the original one. It carried out an evaluation experiment about "beautiful girl" Kansei using a SD scale and obtained the data of hue, brightness and saturation for a girl's face color which are represented by Membership Function in Fuzzy Set Theory. These data were transformed to R:G:B in the computer color system. Then, Kansei Engineering color printer is able to reproduce more beautiful colored picture than original one by the Kansei Engineering inference system.

Hybrid Kansei Engineering

From Kansei to design and design to Kansei

Kansei Engineering System as mentioned above is a computerized system aiming to support a consumer's choice of a product fit to his or her psychological feeling. The KES is utilized for a designer to construct a new product following the designer's feeling and design intention. This direction of Kansei Engineering is named the *Forward Kansei Engineering System*. However, it is more useful for the designer to be able to get a Kansei diagnosis to a design which the designer inputs in the system. The designer can check his or her own design referring to the databases in KES and change the original design more fitting to the general Kansei. Then, the designer can create the better design based on the Kansei. The inverse direction of Kansei Engineering is named the *Backward Kansei Engineering* and the combined computerized system of the forward and backward KES is called the *Hybrid KES* (Nagamachi, 1994). Figure 8 shows the system structure of the backward KES and

Fig. 9. A diagram of the Hybrid Kansei Engineering System.

Figure 9 the concept of the hybrid KES. The hybrid Kansei Engineering System is realized by the combination of the systems shown in Figure 5 and 8.

We developed the hybrid KES applied to the automotive interior design which enables to provide the Kansei comments to the designer in terms of the feature recognition system, when the designer inputs his or her idea of the design. Figure 10 shows an example of the hybrid KES for a steering wheel design.

Fig. 10. A steering wheel evaluation by the Hybrid KES.

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Fig. 8 The system structure of the backward KES.