Kansei Ergonomics applied to a toilet seat design

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Abstract: Kansei Engineering was born from Ergonomics and Kansei Engineering is extending to Kansei Ergonomics for products matching every people's demands. General evaluation procedure of Kansei engineering is applied to determining the design details of the toilet seat. At first, Kansei evaluation was carried out with kansei words on several prototypes of toilet seats. The subjects filled the Kansei questionnaire during sitting on the seats. Finally, relations between design details of the toilet seat (opal hole size, seat width, entire 3D shape and profile shape) and the Kansei evaluations were analyzed with PLS (Partial Least Square), regression analysis. Complete 3D design was determined from these analysis results: 1) Back yard should be a little wider compared with the ordinal toilets. 2) The toilet seat should be wider in the middle area than the ordinal ones. 3) The frontal area of seat should be fit to three-dimensional shape of human body which will be soft touch and soft support to thigh. At the final stage of the development, we measured hip pressure with an electronic pressure measurement device. By comparing the measurement of ordinary seat and this new designed seat, we confirmed that the pressure pattern on the new sheet has natural and comfortable pattern like sitting on a chair. Pressure was widely distributed and its center moved towards thigh under pelvis. The new toilet was named "TRES" and it had a good sales quickly after going into the market in 2004

Key words: *Kansei Engineering, Kansei Ergonomics, Semantic Differentials, Body pressure measurement, Toilet*

1. Introduction

A housing manufacturing division of Matsushita became a child company a long time ago, which was named Matsushita Electric Works, Ltd, and in the last year it has returned again to an umbrella of Matsushita. Matsushita Electric Works (MEW) has been producing mainly all kinds of housing parts from roof to bathtub as well as living and cosmetic parts.

In 2005, Japan's aging ratio over 65 years of age was 19.9% of the population and is predicted to be 27.8% in 2020. Japan is becoming a super-aged society compared to the rest of the world. In addition, Japan's life expectancy is becoming larger. One prediction is that in the future 75% of 50 year olds will survive to 100 years of age. An assistive technology for the elderly will become more important than ever.

The policy of 'Universal Design' emerged in the U.S.A. and has spread quickly throughout the world. This way of thinking affected Japan's business as to aging and it is now common sense to develop equipments to improve the supportive and assisting devices to the elderly. Matsushita Electric Works started early in implementing the Universal Design philosophy in the product development for the elderly and began selling 'Iki-Iki Goods' (goods for assisting the elderly) in 1991. These were related to developing equipments for the home, and in 1997 'Age-free Business' was established as one of the most important company strategies in providing the elderly home-based goods and related services. In 2001, Matsushita's company policy changed from the 'barrier-free concept' to 'universal design philosophy' [1]. This became the fundamental strategy regarding home-based products and life systems. The development of such equipments and systems has been based on human factors, ergonomics, and Kansei engineering[2][3].

We needed an introduction of the kansei engineering into MEW and then we trained our staff the kansei

engineering and ergonomics at Matsushita Electric Works Training Center. Around 200 engineers graduated from the inside-enterprise school with expertise of the kansei engineering. Using the kansei engineering, we have developed a lot of products so far, for instance, grip handle, dresser, roof, concrete wall, kitchen, shaver, handrail for the elderly, toilet and so on. Especially, the latter two products are assistive products for the elderly. The concern of the present paper is to explain the developmental process of the new kansei toilet, namely TRES "

2. The process of the kansei engineering
2.1 The definition of the kansei engineering

Kansei is a Japanese which means psychological feeling in mind. You are entering a new restaurant to take a lunch, we meet a service girl, the girl says something, and you look at the interior and smell a sort of cousin. And then you think that this restaurant looks good. "Looks good" is a kansei which has a kind of sensitive background from vision, hearing, smell and so on. The kansei is a cognitive expression based on cognition and sensations."

2.2 What is the kansei engineering?

The kansei engineering is defined as "a translating technology of psychological feeling, namely *kansei* into design specifications". When we try to develop a new product following the procedure of the kansei engineering, we grasp the customer's feeling on an upcoming product and analyze the kansei data by a multivariate analysis to get the final conclusion of a product design.

We have developed a lot of the kansei products so far, automobile, construction machine, folk lift, cosmetics, etc. and all kansei products were successful in business, because they were designed fit to the customer's feeling (*kansei*).

2.3 Examples of kansei products
(1) A sports-car, Miata

Mazda asked Nagamachi to support to develop a sports-car for young drivers. A project team have learned first the kansei engineering and they stared to do survey the young drivers' kansei, which were deployed to find the most important keywords. These keywords were transferred to the ergonomic experiments and the experimental results analyzed to lead to the final design specifications.

(2) A kansei brassiere

Wacoal which is a famous lingerie maker asked Nagamachi to develop a new type of brassiere. After learning of the kansei engineering, the project team did survey two thousand ladies about their wants (kansei) about wearing a brassiere. More than 70% ladies answered that they want to be beautiful and graceful. Nagamachi suggested Wacoal to utilise Kansei Engineering Type I technique to seek a solution. After analytical calculation, we obtained the conclusion leading a good design of brassiere.

The kansei brassiere was named "Good-Up Bra" which became very popular among the young girls, and Wacoal has got a lot of profit from only one kansei product.

3. A development of a kansei toilet, TRES
3.1 Preliminary planning of a new toilet

Matsushita Electric Works, Ltd and Nagamachi jointly endeavoured to make a new type of toilet. We approached it following the next steps;
(1) Water reduction

As house wives are much awared in environmental problem, we decided to reduce water expenditure a lot as much as possible.

For this purpose, we researched to eliminate a water tank and to connect directly to water facility. Due to the new technology, we succeeded in water reduction of almost half. As a result, the exterior design became more simple and beautiful (see Figure 1).
(2) Two arm rests

On the side of inclusive design and assistive technology, we settled two arm rests on both sides of toilet in order to assist the elderly standing up from the toilet. These devices are very effective to stand up.
(3) Tilted surface of toilet seat

In order to support the elderly standing-up behaviour, we designed to tilt a toilet seat in 3 degree forward. This helps elderly people easily standing-up behaviour, if they use arm rests simultaneously.

3,2 Kansei Engineering of TRES
(1) Kansei data of toilet seat comfort
1) Collection of materials and kansei words

In general we can imagine that if we want to make a comfortable toilet seat, we do measure people's hip shape in 3-dimensional style. However, it is very hard work nowadays. Accordingly we decided to utilize the kansei engineering procedure. We collected eight different toilet seats from different companies and the subjects tried to take seat on the different toilet surfaces with 5-point SD scale. We constructed SD scale using the kansei words, as follows, at the time of both before

and after using toilets,

Just watching the toilet seat (before seating)

"wide", "good sense", "premium", "cool", "cute", unique", healing", "easy to sit", "safe", "easy to use", "comfortable", "want to sit long", etc., 16 words

During taking seat (during sitting down)

All the same kansei words were used.

2) Physical measurement of a toilet seat

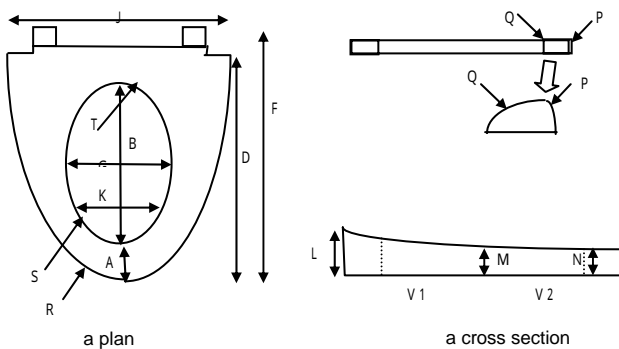On the other hand, we measured physical side of toilet seat shown in Figure 1.

a plan   a cross section

Fig. 1. Items and direction measured on sample toilet seat

The measured dimensions are;

    a. Opal hole size (length and width)

    b. Side seat size (length, width)

    c. Whole shape

    d. Horizontal feature

These data were analyzed by Quantification Theory Type I compared with before the kansei scores. We were able to construct 3 dimensional feature using the analyzed data and the designer shaved off a material following the calculated conclusion and after re-evaluation of the mock-up he made the model of toilet

Fig.2 Whole image of TRES (left-a) and toilet seat (right-b).

Figure 2(a) illustrates whole scene of the new product of toilet which was named TRES, and Figure (b) shows TRES seat. The main points resulted from the statistical analysis are

1) Back yard should be a little wider and backward compared with the ordinal toilets.

2) Toilet seat should be wider in the middle area than the ordinal ones.

3) The frontal area of seat should be fit to three-dimensional shape which will be soft touch and soft support to thigh.



Fig. 3 The horizontal scene of TRES

From Figure 3, you can see;

4) Surface tilted in 5 degree toward forward which will assist standing-up behaviour.

5) You can find the wider and sink backward which supports fit to hip round shape.

6) The frontal tip area shapes up and the next area of tip oppositely goes down. This 3-dimensional shape is fit to the thigh posture, like soft touch and soft support to thigh section.

3) Measurement of body pressure

We checked the kansei research outcome using body pressure measurement. The measurement devise of body pressure is named FSK made in Canada. FSK sheet was set on the new toilet seat and the subject sat down on FSK sheet. It shows us very clearly the level of body pressure.

Hip pressure by the Ordinary Toilette.
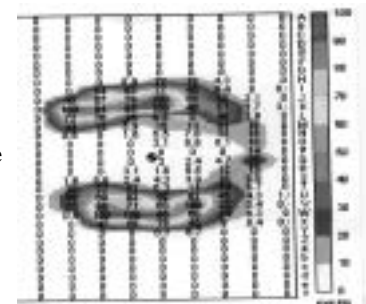
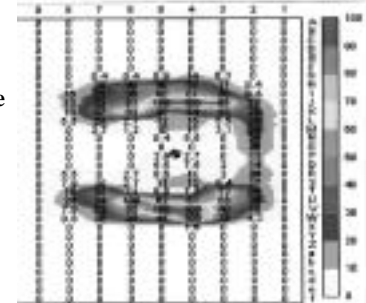**Hip pressure by the new product, Matsushita TRES.**

Fig. 4. Body pressure measurement. Black lines on both wings show the heavier area.

The upper shows the ordinary toilet and the lower one the kansei toilet.

Figure 4 illustrates the body pressure measurement to the ordinary and kansei product, TRES. You can see the long lines on the both wings of toilet seat of the upper figure which is an ordinary toilet. It shows a long and strong pressure from sciatic ischium to frontal area which means bad design of ordinary toilet provides the strong pressure to thigh part. On the other hand, the lower figure illustrates the pressure result which shows shorter line of body pressure from aciatic ischium to middle area. This is the results due to the curved shape of frontal area of the kansei toilet.

All people were surprised when sitting on the kansei toilet, TRES, because it was very comfortable and they wanted to sit down on the new seat so long time. It is clear that this outcome comes from the kansei engineering analysis, even though we do not have 3-dimensional measure data.

4. Remarks

Our attempt in this paper is to show you an application of the kansei engineering technique to create a new toilet.

The kansei engineering is an ergonomic customer-oriented technology of a product development. It aims to create the well-designed product easy to use, very comfortable and affective, because it is designed on the basis of the customer needs and feeling (kansei). Since the kansei product is created based on the customer's kansei, it is always successful in business and the company can get a lot of profit from the kansei product.

The kansei engineering technology starts from collecting the kansei words (keywords of an upcoming product), and secondly from collecting the different products in the same area of goods. The subjects evaluate these samples on the kansei SD scale and the evaluated data are analyzed using multi-variety analyses. These analyzed data are transferred to domain of the product design and the new design specifications are decided.

During this process of the kansei engineering analysis, ergonomic analysis is conducted in order to aim at easy operational product. The kansei product TRES made by Matsushita Electric Works utilises the kansei engineering as well as ergonomic analysis, which is called *Kansei Ergonomics*. In addition to this, nowadays we are extending the kansei engineering method to Rough Sets Theory which is able to make a decision rules to create the kansei as a design element group.

Kansei Engineering was born from Ergonomics and Kansei Engineering is going to be extended to Kansei Ergonomics. And nowadays, it is toward to   growing up to Kansei Rough Sets Model [4][5][6][7][8][9]. Science is always moving toward the future.

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