TRANSACTIONS FROM
THE SIXTEENTH SYMPOSIUM ON QUALITY FUNCTION DEPLOYMENT

QFD℠

July 10, 2004
Chicago, IL

Kansei Engineering for Commercial Airplane Interior Architecture

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Keywords: Kansei engineering, interior architecture, design, commercial airplanes, human factors

Abstract

The Kansei Engineering process was used in a study to evaluate airplane interior concepts.

The process was morphed by joining pre-established Kansei to pre-established interior concepts.

Semantic differentials pairs were rated by 60 participants during the test.

The SAS software was used for the statistical analysis.

The test was performed using a 180 degree projection dome.

Introduction

The Kansei Engineering method was developed by Dr. Mitsuo Nagamashi in Japan and used very successfully on the design of the Mazda Miata car for the first time in 1986. Since its debut, the method has been used in different fields of applications such as automobile design, lingerie, beauty industry, etc. It has been mainly used in Japan but the method is slowly being introduced in the western hemisphere.

The idea behind the method is to understand the user's emotional needs as opposed to functional needs in order to design a product that reflects what the users really want and sometimes cannot articulate clearly. The method creates a common vocabulary to ease the collaboration between specialists from different fields like marketing, engineering, industrial design, psychology, etc.

There are several variations of the method, 1-Category classification, 2- Design relational charts (Kansei Engineering Type 1), 3-Kansei engineering system, 4- Hybrid Kansei engineering system and 5- Virtual Kansei engineering system. A variation of the Kansei engineering Type 1 method was used for this project.

Kansei Engineering applied in airplane interiors evaluation

The Payloads Concept Center (PCC) is a sub-group of the Product Development organization in the Commercial Airplanes division of The Boeing Company. The purpose of the group is to enhance the human experience of flight by exploring and designing future concepts in an advanced product development environment. The Kansei Engineering process was found to be a tool that could ease the difficult task of down-selecting the final Interior Architecture concept for the 7E7 “Dreamliner,” Boeing’s newest model. In the context of commercial aviation, as opposed to automotive design, an interior architecture needs to withstand the passage of time and the evolution of design and trends for decades. Therefore selecting the “right” interior architecture is a very complex task.

The experiment was performed simultaneously with several other methods and the project is still on-going, therefore, many details and results cannot be divulged at this time.

A team of experts with various skill types was assembled for the duration of the project. The process lasted six months from the introduction workshop to the final report.

The members of the team were:

- 7E7 Interior Architecture lead
- Psychologist
- Industrial designers
- Human factors specialists
- Engineers
- Statisticians

Methodology

Glenn Mazur from Japan Business Consultants LTD was hired as a consultant for a two-day workshop to train and guide the team for its debut. The first day was spent to introduce the method and to establish the Kansei domain. The second day was applied directly to the design of the test.

The Kansei Engineering method had to be modified to support the goals of the project. Typically, the Kansei Type 1 method uses the words from the Kansei domain that are defined by the user population and links them to a list of elements from the physical domain to generate the concepts to be tested. In this case, the concepts were already defined. The target customer segment and desired images had also been established from a previous study with similar goals. The process was morphed by joining pre-established Kansei words to pre-established interior concepts.

The Kansei words were extracted from the study for the North American market segment. The affinity diagram was used by the team to classify the words under the Kansei domain as the example demonstrates in the Table 1. Several meetings were necessary to discuss and agree on the mapping of the words.

The physical domain was established by the team of experts, based on the elements that were found in earlier studies to be the most important denominators of an interior architecture. The selection of a single interior architecture that will satisfy the users over an extended period of time is a challenging problem. The use of the traditional Kansei Engineering method, in a complex environment, was limited by the time and resources. Therefore the test was reduced to the use of the design elements considered to be the major contributors of the interior architecture. Several meetings were scheduled to decide what were the elements and levels that were the most significant in defining the general look of the interior architecture. Those design elements were then linked to the Kansei words in order to establish the foundation for the test. Below is an abbreviated example of the mapping process.

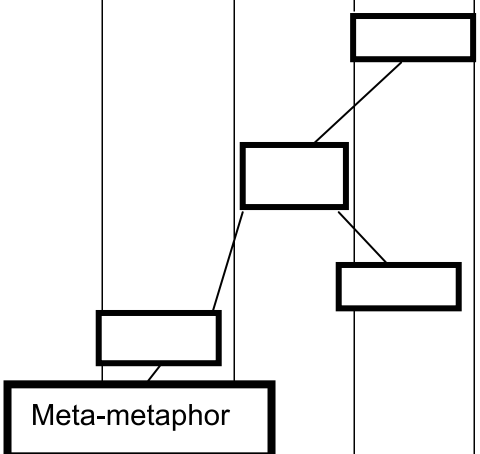
Kansei Domain				**Sensory Domain**	**Physical Domain**			
Kansei level 0	Kansei level 1	Kansei level 2	Kansei level n	Proxemics Auditory Visual Olfactory Tactile Gustatory Psychological Kinesthetic	System elements	Design elements (variables/ constant)	Quality elements Characte-ristics (levels)	Specs
					**Cabin**	**Ceiling** **Lighting**	**Level 1&2**	
						Bins	**Level 1&2**	
						Framing	**Level 1&2**	
						Attendant seat		
						Floor		
						Color		
						Monuments		

Table 1

Since the method was modified for the purpose of the experiment an important step, that usually takes place between the mapping of the Kansei domain and the physical domain, (see Table 1 above) was left out. This phase is meant to express the sensory inputs that apply to each design element in relation to each Kansei words. This step was completed and is part of the database but was not used since the concepts were already pre-established. Table 2 is an abbreviated example of the senses linking a design element to a Kansei level n.

Proxemics	Auditory	Visual	Olfactory	Tactile	Gustatory	Psychological	Kinesthetic
Spacious	Greeter	Colors	Familiar	Temperature		Relaxed	
Self-orientating		Shapes		Humidity		Human greeting	

Table 2

The process was new to the team and somewhat complicated by the fact that the process deviated from the traditional approach.

The following step for the team was to fill the matrix below. To obtain an adequate level of differentiation and coherence, a specific description of each design elements and their level was found to be a necessary task. Definitions were established and agreed upon by the team to validate the concepts and to make sure that the design elements and their levels were clearly identifiable by the test participants for test validity purpose.

Matrix 1 describes the number of concepts and variable elements to be shown to the participants in a specific order as selected for statistical reasons. A common background was also selected for the elements that were remaining constant throughout the test such as color, seats, windows, side panels, monuments and floor.

Framing and level	Bins and level	Ceiling and level	Concepts	Sketches
1	*1*	*1*	767-400 as a practice	
1	*2*	*1*	Concept 1	
1	*1*	*2*	Concept 2	
2	*2*	*2*	Concept 3	
2	*1*	*1*	Concept 4	
2	*1*	*2*	Concept 5 Didn't need to be tested	

Matrix 1

The questionnaires were carefully designed to modify the sequence of appearance of the concepts for each trial to avoid potential error cause by the order's influence as shown in Table 2

	Trials									
Sequence	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
	demo	demo	demo	demo	demo	demo	demo	demo	demo	demo
Image 1	1	2	3	4	5	4	5	1	2	3
Image 2	2	3	4	5	1	3	4	5	1	2
Image 3	5	1	2	3	4	5	1	2	3	4
Image 4	3	4	5	1	2	2	3	4	5	1
Image 5	4	5	1	2	3	1	2	3	4	5

Table 3

The semantic differentials were then established on a 7-point scale that the participants used to rate the concepts during the test. There were 15 pairs. (See Table 3.)

Kansei word	*7-6-5-4-3-2-1*	*Kansei word (opposite)*

Table 4

A pre-test was performed to understand the limitations of the questionnaires and test the logistic. Glenn Mazur attended the pre-test and helped us to refine our process. The data were entered in a matrix for statistical analysis to see if our software and analysis method were ready for the final test.

The Statistical Analysis software SAS was found to be the right tool to use for the statistical analysis. The Boeing Phantom Works Applied Statistics group and Glenn Mazur exchanged notes to validate that the software used for the results was in accordance to the Kansei Engineering Japanese software that is especially set-up for this type of experiment.

The final test was performed using a projection dome from the company Elumens that creates a 180 degree vision for the participants, creating a visual effect close to the feel of being in a tri-dimensional space. This equipment was selected as opposed to more costly mock-ups.

Sixty participants were hired from a local recruiting agency, according to specific criteria. It was important to get a sample of the population similar to the one that was hired to define the Kansei words. (The Kansei words were extracted from the market study for the North American segment.)

Three participants at a time were guided to the projection area where the procedure was explained and they were shown a series of concepts that they rated according to the keywords described above. Each questionnaire displayed the concepts in a different order to retain statistical validity. (See Table 3) The participants were standing in a predetermined location to reduce distortion caused by the geometry of the dome. They had three minutes to rate each concept and one minute to adjust their responses before moving on to the next concept. The amount of time was generous without creating boredom. After the test, they were escorted to a conference room where they filled out a questionnaire.

Elumens Dome Projection

Results

The test was successful. Ninety percent of the participants who filled the post test surveys felt the test was well organized, they also felt (95 percent) that the dome projection was representing adequately the feeling of being in an airplane interior.

The Statistics Group processed the data using the SAS software through the Means of each Kansei words and dichotomous pairs, Factors Analysis, Rotated Component Matrix and Bivariate Correlations

Two categories of semantic words were defined and classified under two factors.

The design elements for: Framing, Level 2, Bins Level 2, and Ceiling Level 2 were found to be explaining the Factor 1.

The design element Ceiling, Level 1 was found to be explaining better the Factor 2.

The comments from the participants were collected and compiled for complementary information on the test.

Lessons learned

It should be noted that the results are meant to be used as a guide for the designers to better design products according to the customer needs.

It is very important to use the Kansei words that will be introduced in the design as in this case it was difficult to know which of the two factors was the most important to include in the design.

A very interesting element of the method is about linking sensory perceptions to the Kansei words and the elements of the physical domain. We didn't complete this exercise in this project due to the morphing of the method but it would be interesting to explore this function on a future project.

Another interesting element of the method is the fact that the process and results are forming a database. The database is growing with the numbers of experiments performed, creating a good resource for future testing and product development.

Conclusion

The Kansei Engineering method used was a variation of the “pure” method developed by Dr. Nagamashi. The modified process made it more complex, however the results were conclusive. A deeper knowledge of the method was obtain during the experiment, bringing designers, engineers and marketing people to cooperate on designing for the users. By integrating the users in the process, the team gained a greater understanding of the people reactions to the proposed solutions.

Acknowledgments

- Glenn Mazur who taught and guided us throughout the process
- Martin Meckesheimer and Stephen Jones from Phantom Works Statistic group who went beyond their assignment in this project.
- Domenic Giuntoli, Mark Wentland, Pete Mitchell and Cynthia Vandewall from the PCC who supported the project with enthusiasm
- Peter Guard and Mark Stadum from the 7E7 program who gave us the opportunity
- Rick Fraker, Ralph Bladt and Eric Klein from Teague who designed the concepts
- Blake Emery who clarified the difficult process of defining the Kansei domain

Biography

Jeanne Guerin completed a bachelor degree in the field of Industrial Design and a Masters degree in Human Factors Engineering (Ergonomics) at the University of Montreal.

She has been working in the aviation field for designing passenger’s cabin interiors and flight deck at Bombardier (1988-1996) and at The Boeing Company (since 1996).

She learned about the Kansei Engineering method from personal studies and by working with Glenn Mazur from Japan Business Consultants LTD.