Coventry
University

Coventry University Repository for the Virtual Environment (CURVE)

Author name: Roy, Rajkumar , Goatman, M. and Khangura, Kieran

Title: User-centric design and Kansei Engineering

Article: Postprint corrected proof

Original citation: Roy, Rajkumar , Goatman, M. and Khangura, Kieran (2009) User-centric design and Kansei Engineering. *CIRP Journal of Manufacturing Science and Technology*, volume 1 (3): 172-178

Publisher: Elsevier

DOI: 10.1016/j.cirpj.2008.10.007

Website: http://dx.doi.org/10.1016/j.cirpj.2008.10.007

User-Centric Design and Kansei Engineering

Rajkumar Roy, Michael Goatman and Kieran Khangura
Centre for Competitive Creative Design (C4D), Cranfield University, UK
Email: {r.roy, m.c.goatman, k.khangura}@cranfield.ac.uk

Abstract
Kansei Engineering is a Japanese originated technique that is often used to provide information on a sensual level in the application of products to markets. This paper explores a method of applying Kansei as part of a product design creative process. It explores the use of face-value testing through web-based pictorial questionnaires, firstly applied to a range of existing products, and then to two new product proposals created from information gained in the first questionnaire. The Paper then considers if this technique demonstrates a development in the design process that can reasonably be considered to increase product success.

Keywords:
Product, Design Method, Evaluation, Emotional Design.

1 INTRODUCTION

In recent years the way in which products are designed, developed and produced has changed. Technology is moving rapidly and the market is more competitive, giving customers more choice. Manufacturers are increasingly required to produce customisable mass-produced products to satisfy the customer requirements. Brand, image and style have become important in product selection; technology is no longer the sole driving force in the development of a product. As the market is becoming more saturated, consumers are able to choose products in terms of what they like, and what expresses their own individual style and status. The new challenge for designers and manufacturers is being able to understand what customers like and what will help to build more pleasurable products. Kansei engineering was originally developed in Japan to help market existing products to the relevant segments. It is now being tailored to gather information that can be used by designers to build new products, which will suit different lifestyles. It essentially gathers information about all of the senses, what looks, smells, tastes, and sounds the best. This paper initially describes the principles of Kansei, and then explores their application in the user-centric design of new mobile phone products. It provides a description of the stages of the experiment, which seeks to establish if a methodology using response to existing products through the use of Kansei words can be used to create new designs that will evoke a positive response. Kansei Engineering can be used as a scientific of research through the application of factor analysis. The experiment described in this paper can potentially demonstrate a link by which emotional response to design for a competitive market place can be identified scientifically, and applied to new design in the same way. This potential link will enable opportunities to develop creative activities in this domain on a calculated basis, providing a predictable model for new product generation, and a relationship to the other development activities that take place in the product creation process.

2 KANSEI ENGINEERING

2.1 History of Kansei

Kansei Engineering was developed in the early 70's at the University of Hiroshima, through the work of Mitsuo Nagamachi, since then many companies and universities in Japan have adopted the methodology. The methodology is used as a marketing tool to help efficiently place soon to be released products/services into the right market. Helping to predict the type of consumer who would wish to buy the item and then ensuring the product is launched appropriately. It has since been adapted to be used much earlier in the design process (, essentially exploring the feelings consumers have about different products and then translate this information into tangible results to enable the application of data into the development and build of a new product [5] [3].

'Mazda used a method of category classification to develop a sports car, Miata. We started from the survey of customers' driving behaviour, .and conducted a questionnaire survey about life style and valued customers' behaviour. From analysis of these data, we put down keywords on cards one by one and found the zero-level concept of the new product at the starting point.'(Nagamachi, 2002 from [6])

2.2 What is Kansei?

The Japanese expression Kansei is difficult to translate. It means approximately "total emotions", but that does not fully explain it's meaning – in fact not more than partly. Kansei is the impression somebody gets from a certain artefact, environment or situation using all of their senses of sight, hearing, feeling, smell, taste as well as their recognition [1].

To explore the reasoning behind why Kansei Engineering is becoming an increasingly important tool to use in Product Design, examination is made of the rate with which new products entering the market place are becoming mature, due to a shorter lifecycle and increased competition [1]. Companies now have to look at

alternative solutions to improve turnover, as quick model changes, technical updates or price reduction are no longer fulfilling customer requirements.

Many customers, *in these high-choice market-places*, make their final decision unconsciously and based on rather subjective factors. They purchase the product, which "feels" better, and are often unable to explain why. Taking this "feeling" into account already in the design process can give substantial selling advantage. Kansei Engineering is a methodology for systematically exploring peoples "feelings" about a product and translating them into design parameters [1]

Kansei Engineering is adaptable to a wide range of product applications.[2] describes how Professor Nagamachi explains the two directions of 'flow'. One of which is 'from design to diagnosis'. This involves manipulating individual aspects of a product's formal properties in order to test the effect of the alteration on users' overall response to the product. This technique has been used to assist in the design of a diverse range of products.

Kansei is often used as part of other methods and practices.

*'This is often performed in the Define Phase of a Lean Six Sigma Project and more common in Design of Six Sigma and even TRIZ projects. (*Steven Bonacorsi from [7])

The other is from 'context to design' Which involves looking at the scenarios and contexts in which the product is used and then drawing conclusions about the implications of this for the design. This second direction of flow involves the gathering of qualitative data via field observations. In this case, the data is used to help establish the link between the formal properties of a design and the benefits associated with the product. In this study the primary focus is the 'design to diagnosis' direction of Kansei Engineering.

2.3 Stages of Kansei

Choice of Domain is where the product/service is defined, including the specification of the product and elements such as the target market or group. Similar products, samples, possible concepts and ideas are also collected. The domain is defined as widely as possible taking into account existing methodologies as well as concepts, which have not yet been developed or created.

Spanning the Semantic Space is a three-step process, which defines the Kansei words to be used later in the model. Step one is collection of words describing the product type chosen, step two selection of the words with the highest impact on the users mind, step three, selection of the Kansei words depending on strategic considerations spanning the Space of Properties is gathering a list of physical properties such as weight, colour and size. Important properties are highlighted and samples for each of these are gathered.

3 USER-CENTRIC DESIGN OF A MOBILE PHONE

3.1 Aim and Objective of the Research

The main aim of this study is to explore and understand Kansei Engineering for Product Design. To achieve the aim, the following objectives have been set:

- To develop a product based on the Kansei principles.
- To investigate the value added to a particular product by the Kansei Engineering Principles.

3.2.1 Methodology

The following method is used for this study; each stage is detailed below and outlines key points regarding the decisions made during the course of the study.

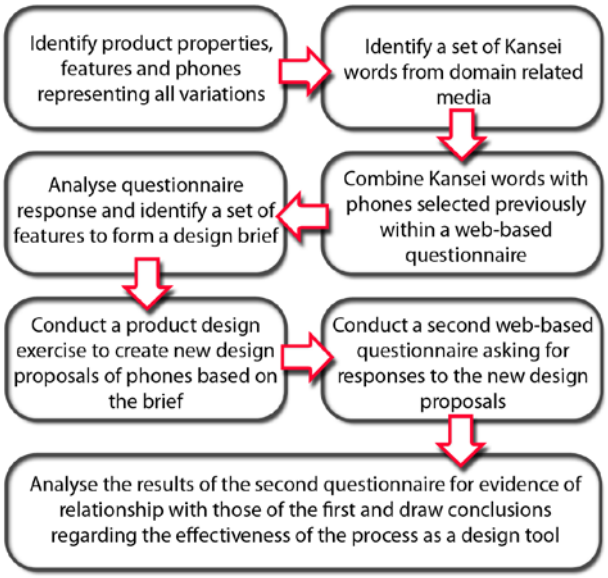

Figure 1: Investigation methodology diagram [4]

Using the guidelines stated in the previous chapter the mobile phone was selected as it is within a rapidly moving market which is mainly technology driven. The market has a diverse range of products, which cross many different features, and brands that will help to investigate which elements of old and existing phones users prefer in terms of the overall aesthetic design of the phone. To understand the potential user group a short questionnaire has been developed, which will give an insight into what sort of lifestyle the target group enjoy. For the purpose of this investigation the target group is male between the ages of 25 to 35. Some of the questions asked explored the users lifestyle, interests as well as what items they currently own and what features they would like to see in their ideal mobile phone.

3.2.2 Product Classification and feature selection

Due to the size of this study and the number of available phones on the market a way to reduce the number of items evaluated was required. A popular website GSM Arena, which showcases and reviews all mobile phones produced in Europe, the UK and America has been used as a basis for the selection of phones to be used within the study. This is an independent site, which gives consumers an impartial review of the phone as well as review and rate phone. By just looking at only new phones (on date) the number of phones displayed was 829. Therefore a further criteria was applied. Phones which were rated above 6 in design using the GSM arena's own rating system. The top three rated manufactures on the site were used. Flip/Clamshell type phones only were considered, this reduced the number of different models to 173. The top 3 manufactures were: Nokia, Samsung, and Sony Erikson.

These models were then categorised according the following traits:

- Navigation Type
- Colour

- Exterior Shape
- With Ariel/without
- With Mini Screen/without
- Pattern/No Pattern

This gave a final set of 22 phones which gave at least one combination of each trait.

3.2.3 Kansei Word Collection/Reduction

Kansei words were collected from existing media, such as magazines, reviews and user opinions. A total of 200 words were collected. These were then reduced using initially an affinity diagram to 23. As these were still seen as too many the remaining words were reduced according to importance and relevance to the study.

The final sets of words chosen were:

Ergonomic, Build Quality, Elegant, Personality, Form Factor, Innovative, Expensive, Durable, Clear, Hands On, Intuitive, Comfortable.

3.2.4 Questionnaire

The selected Kansei Words and Phones were then combined in a web-based questionnaire. To ensure that all users understood the meaning of each word a set of definitions were provided, as well as the words being classified to ensure that they were applied to different aspects of the phone.

An additional question was included where the participant was asked to use the words to describe their ideal phone.

Figure 2: Example of web page for phone questionnaire

3.2.5 Results of the Web based Kansei Questionnaire based on existing products.

24 responses were received through the web based questionnaire, the results are displayed in the table below . The table shows which attributes users most valued (Normal: 5 = most important 1 = least importance) and how many of the phones used in the study were noted as having this quality.

Further to this, certain results were evident in response to the six categorised traits: These were:

- SD and SEA navigation
- Colours: silver/gold, black/red.
- Exterior shapes K and G
- No ariel
- With mini-screen
- Without pattern

Table 1. Showing results of the first web-based questionnaire with data from the survey of existing phones comparison made to the 'normal' values.

Kansei Word	Normal	No. of Phones
Ergonomic	4	2
Build Quality	5	
Elegant	4	
Personality	4	4
Form Factor	4	
Innovative	4	
Expensive	3	11
Durable	5	
Clear	5	
Hands On	4	3
Intuitive	4	5
Comfortable	4	4

3.2.6 Formation of a Design Brief

A study was made making visual comparisons between phones attributed to the particular Kansei words in order to identify common qualities. Observations related to the above words were:

Personality: The commonalities between each of these phones were how different they were from each other and utilised different colours, textures and shape.

Expensive: as the majority of phones fulfilled this requirement with no obvious link this word was disregarded

Within the four remaining words **Ergonomic**, **Hands-on**, **Comfortable** and **Intuitive** the 2 of the 6 phones were found to be in all four of the categories 1 within 3 categories each of them showing similar features

Figure 3: Illustration of preferred keypad layout

- The external shape was mainly square with rounded corners.
- Clear navigation and large readable buttons
- Square buttons
- Ergonomic: Particular key layout.
- Personality: Phone shape, all had black, particular textures and key shape.
- Expensive: disregarded since the characteristics were too diverse.
- Hands-on:
- Comfortable:
- Intuitive:

It was noted that some of the words only received two attributions, and where no strongly similar characteristic was noted, the evidence was discarded as not useful for the purpose of brief formation.

The above characteristics were considered appropriate for briefing of a creative exercise to design new phone products.

3.2.7 Creative Product Design Exercise

The characteristics described above were then utilised by the designer in the creation of new ideas for mobile phones. The methodology used was the 'Design Diamond', which is the divergent/convergent model used broadly in the creative design process.

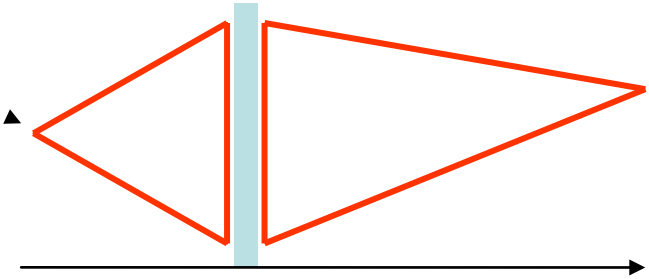

Figure 4: Diagram of the 'Design Diamond' Divergent/Convergent Design Process.

The two-part 'Design Diamond' creative process is based on the principle of maximising the breadth of ideas proposed before submitting any idea to an analytical or 'close down' process. The divergent stage is therefore a total ideation and expansion process, and the second stage entirely an analytical contraction and elimination process.

Stages of the divergent/convergent creative design model:

Divergent

Creation and exploration of ideas through sketching possibilities based on the information and objectives given in the brief. This is the generally universal core creative stage activity utilised by creative designers. Its method is an intuitive synergetic mental activity that allows the mind to mix and consider a collection of data sources producing solution ideas through what may be considered natural mental activity. In effect the designer is applying a large amount of both learnt and observed information in making assertions, This information includes knowledge of proportions, visual balance, consistency of 'form factor', experience of ergonomic expediencies, consumer group expectations, and cultural associations. The difficulty in measuring this process at its source is well-known, so that measurement is usually carried out by:

- 1) Outcome comparison against an agreed set of criteria.
- 2) Reducing the complexity of the input criteria so that measurement comparisons are more explicit.

However, it is essential to the creative method at the Divergent (first) stage of the 'Design Diamond' process that no application of measurement criteria is made in order to allow free expansion of the possibility range. By doing this a wide breadth of proposals are afforded an overview by the full range of objective criteria at the 'decision' point (maximum width of the diamond), which provides multiple cross-connection of ideas and solutions.

Convergent

- Reference back to brief objectives in consideration of the sketched ideas.
- Decision making within ideas created in relation to objectives

- Development of chosen ideas with reference to the brief details and to design expectations of unity of form language, colour balance ergonomic operation, mechanical envelope, and manufacturing feasibility.
- Presentation of design proposals.

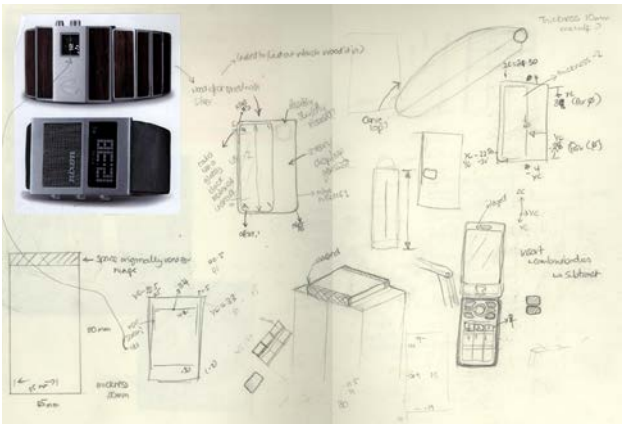

Figure 5: Sample of designer's sketch

Outcome of the Creative Design Exercise

The two finished design proposals:

Figure 6: Design Proposal 1 Touch-screen phone.

Figure 7: Design Proposal 2 Wood-effect phone

Another web-based questionnaire was then carried out requesting response to the two design proposals using the same set of Kansei words that were utilised in the first questionnaire with the set of production phones

3.2.8 Results of the Second Questionnaire

The two proposed designs are presented back to the same audience with the same questionnaire as used for Table 1. Table 2 presents the results from the design evaluation.

Table 2. Showing results of the second web-based questionnaire with comparison made to the 'normal' values and data from the survey of existing phones.

Kansei Word	Normal	Phone 1	Phone 2	Original Phones
Ergonomic	4	3	4	2
Build Quality	5	4	4	
Elegant	4	3	3	
Personality	4	3	3	4
Form Factor	4	3	3	
Innovative	4	3	3	
Expensive	3	3	3	11
Durable	5	3	4	
Clear	5	3	4	
Hands On	4	4	3	3
Intuitive	4	4	3	4
Comfortable	4	3	4	4

3.2.9 Comparison of Questionnaire Results

The study shows that the two new concept phones were able to meet some of the original word criteria (Normal) that the previous set of evaluated phones were able to achieve. This would indicate that the data originally collected from the first survey has been linked successfully to these new phones however the new concepts did not manage to fulfill the qualities which users indicated as most important: Build Quality, Durable and Clear.

3.2.10 Factors causing inconsistencies in the experiment

Following are a number of factors that has affected the design process:

- Variation in perception of the meaning of a Kansei word as a visual representation
- Influence in response of participants to the same object due to individual association probably held in the sub-conscious.
- The effect of a number of visual characteristics as a package, which may contrast with the impression of those characteristics identified individually.
- The size of the response segments that could be recorded within the extent of the study.
- The inability to highlight the key features of the new concept phones due to the constraints of the study.

4. LEARNING FROM THE KANSEI ENGINEERING APPLICATION

The web based questionnaire was a suitable medium to gain access to the target audience; it enabled them to complete the questionnaire within their own time.

However in future tests a written description of the objects would also be desirable to allow greater precision in communicating any newly generated ideas in the final tests. The study gave the designer an idea of what consumers did not want in their mobile phone. However the designer did feel restricted in their creative freedom by the requirements that the first part of the test imposed. It is suggested that the main potential of the method is in adapting this tool to gain a useful insight into what sort of general style particular market segments prefer and don't prefer. This will provide assistance to the design and development process without putting direct stringencies on the designer. Initial design proposals can then be generated more freely, and compared at the decision stage with the evidence found in the web based tests using Kansei words. If the study was substantially extended to cover a range of different sorts of product, the Kansei words could be linked to product traits and the application in terms of design guidance as described above would be useful on a generic level perhaps addressing products by category, e.g. 'hand-held products', or 'domestic communication products'.

5 DISCUSSION AND CONCLUSIONS

The Kansei principle provides a transferable and formal method of interpreting human response to objects in terms of emotional reaction. Whether it can be called a scientific method is dependent on definition. Factor analysis of emotional response can certainly be applied scientifically if the research segments addressed and the methods of process are substantial enough to afford homogeneity and reliability of results. In that case the results could be processed to mathematical verification. However, the difficulty in requesting responses to randomly produced objects such as mobile phones is that the reaction of each individual is dependent of their prior conditioning that is the associations that exist in their minds, which are not explicit and usually possessed subconsciously. To enable this degree of process able data the test subjects would have to take a personality categorisation indicator such as the 16PF (ref), involving a 150 statement questionnaire, from which categorisation is made by defined method, usually involving licensed psychologists. In the application of a web-based questionnaire as utilised in this case, which is appropriate to a broad based consumer product such as a mobile phone, it is impossible to identify for instance that a tick against 'personality' as a response to polished silver keys on a phone is representative of similar emotion by all participants. For this reason the Kansei process when applied to an individual item, particularly one consisting of a composite number of distinct visual elements, is scientific. However it does provide data of preference responses, and a platform where categorisation can be made on this level. This may be reasonably applied as a 'guidance' tool in the process of product design within a complex consumer market place. In this experiment the Kansei process has been applied to a range of products in a mature and saturated market place where a wide variety of products compete having the same functional specification and the same basic visual configuration. They provide a useful platform of comparison because the differences can be identified on a detail level and recorded into categories. The web-based questionnaires presents the products in a representation giving a non-shadow front and side view and so a high level of consistency for comparison. The results demonstrate however those differences in response to these overall objects still exist, and that the comparison of a 'composite object' (like the proposed designs) is a more complex relationship. It suggests that a further dimension of the response is that there is also an emotional response to the juxtaposition of characteristics when put together. This would make the available responses a multiple of those recorded in the questionnaire carried out in this study, and seemingly impractical for administration on this format. One of the necessary factors in a questionnaire like this is that it must take a very short time and be enjoyable and undemanding to answer.

The study also suggests that a much larger participant segment is necessary in order to produce outcomes that are 'statistically valid'. It would however be questionable whether results obtained with the inherent variance of an open web-based survey may be considered to provide data suitable for valid scientific processing.

Another variance factor is the interpretation by the designer of evidence from the first Kansei survey, translating Kansei evidence into composite objects in a creative design exercise. If for a moment we imagine a software programme that could perform this exercise independent of a creative designer (which since it applies consistently would be scientifically valid), it would first of all need to identify a set of factors that the designer applies in the creative process. One factor for instance would be visual balance or rhythm. If such a study were done to record mathematically a set judgements in this area, along with that of other creative factors, would the outcome be emotionally pleasing to the eye?

The study demonstrates an application by which the Kansei method can be applied to provide data of emotional response to existing products that can be used in the design of new ones as a vehicle to pursue added value in the consumer product market place. It did not show a high degree of reliability in the transition of these characteristics through the process of creative product design, but this may be because the segment of investigation would have to be much larger to produce briefing characteristics with statistical significance. It does demonstrate however a method that can be used to reduce the arbitrary decision making that is often applied in the creative product design process, which often produces decisions made for inappropriate reasons due largely to the absence of an identified system. It presents a method that quantifies preferences and provides a platform of reference in the process of human interpretation.

6. ACKNOWLEDGMENTS

We would like to extend our sincere thanks to all those who contributed to this study, especially the participants who took the trouble to respond to the web questionnaires. The authors are grateful for the contributions received from the members of the C4D and Decision Engineering Centre.

7. REFERENCES

[1] Schutte, S. and Eklund, J. (2003). *Product Design for the Heart and Soul*. Linkoping University, Sweden

[2] Jordon, P. W. (2002). Methods. In: *Designing Pleasurable Products*. 1st ed. Taylor & Francis, London, p136-204.

[3] Schutte, S. (2002). *Designing Feelings into Products* - Integrating Kansei Engineering Methodology in Product Development. Linkoping University, Sweden.

[4] Grimsaeth, K (2005). *Kansei Engineering Linking emotions and product features*. PhD Thesis. Norwegian University of Science and Technology.

[5] Lanzotti, A. and Tarantino. P. (2008). *Kansei engineering approach for total quality design and continuous innovation.* The TQM Journal, volume 20, issue 4, pages 324 – 337.

[6] Nagamachi M. (2002). *Kansei engineering as a powerful consumer-oriented technology for product development.* Applied Ergonomics, volume 33, Issue 3, pages 289-294.

[7] Steven B. (2008). *Kansei Engineering: Translation of Consumers Voice into product designs.* Ezine Articles.