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Kansei Engineering Based Emotional Product Design: An Illustration by a Battery Drill Case-Study

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Abstract: This paper is looking at the ways of incorporating engineering emotional values into product design through Kansei engineering. The first part of the paper describes the Kansei engineering methodology. The second attempts to link emotions and product properties through various methods from Kansei engineering. Some results from the second part have been used in the first part as illustrated examples. The second part is used to validate Kansei engineering methodology through this study some questions have been investigated: Which methods within Kansei engineering can be deployed in design practices? Is Kansei engineering a tool which can be used by most designers to link emotions and product properties? Do users know how to describe their ideal products through words? And what is the future for Kansei engineering in India?

Keywords: *Kansei engineering, Emotional design, Industrial design, Design methodology, and Human factors.*

1. INTRODUCTION

This paper is an edited version of work carried out by “Kjetil Grimsaeth”, done as a study before his master thesis at NTNU, Norway. It was supervised by Alex Booker and Bjørn Baggerud and published in by NTNU [1]. A short paper was also presented at the conference “Design & Emotion 2006” [2].

The recent years have seen a growing interest in emotional design. Today products need to evoke the right emotions into the user to differentiate themselves from other products. Emotional design is an area integrating design, engineering, mathematics, psychology and art. This paper is divided in three main parts. The first part is a brief introduction to emotions and emotional design. In the second part Kansei engineering is introduced and the elements within the Kansei engineering technique are described by proposing a generalized model. In the last section, this technique is deployed in the analysis of a product by means of a case study on battery drill with the aim of linking emotions with product properties and to study how Kansei engineering works.

2. EMOTIONS AND EMOTIONAL DESIGN

2.1 Emotions

Emotion is described by Damasio as the antithesis to reason [3]. Emotions are evoked by feeling. They are mostly more subjective and complex than feelings. An emotion is often built up by many feelings and is more

difficult to describe. Feelings are connected to physical properties and are on a lower level of consciousness. There are two types of feelings: internal and external. Internal feelings are physical feelings and external ones are social feelings.

Emotions are inseparable from cognition. Everything humans do is tinged with emotions. Emotions change the way we think and guide us towards the good [4]. Affect and emotions are crucial in everyday decision making according to neuroscientist Antonio Damasio who studied people with impaired emotion systems. These people are unable to function effectively in the world because of their inability to make decisions. They could describe how they should have functioned in a logical and rational way but still couldn't determine where to live, what to eat or what products to buy. The people in Damasio's study were often unable to choose between alternatives, especially those that appeared equally valid. This is where people with intact emotions would choose something because they “just feel like it”. Such feelings are expressions of emotions and are crucial to human behavioral [4].

2.2 Emotional Design

Emotional design uses knowledge about feelings and impressions that a product evoke through our senses. These feelings are often difficult to map. Feelings can be unconscious and we often have trouble rationalizing our feelings. There are different reasons for emotional design. Some use emotional design with the sole purpose of selling more products. Attractive products that evoke positive emotions have great showroom appeal. Others have more holistic

reasons, where the emotions occur as a result of looks, feelings, use, etc. Many use the term emotional design about objects which evoke only certain feelings that are easy to label like safety or humor, but emotions could be far more complex. All products evoke some level of emotions, even when they cannot be described in words.

There are three elements of emotional design according to Norman [4]:

- Visceral
- Behavioral
- Reflective

Visceral design is about the appearance and how users evaluate it through their senses. The visceral system works by what cognitive scientists call pattern matchmaking. They claim that people are genetically programmed through evolution for situations and objects that offer food, warmth or protection and give rise to positive effect [4]. Behavioral has to do with the pleasure and effectiveness relating to the use of a product. Effective products that are easy to use gives people a good or satisfying feeling. Usability issues have also been recognized as a vital part of product design. Reflective has to do with the rationalization and intellectualization of a product. Even useless products can be appreciated as long as they give the user something else. It could tell a story or appeal to the user's self- image. All three elements given by Norman can be linked to the emotional aspects related to a product.

3. KANSEI ENGINEERING

3.1 What is Kansei?

There is no corresponding term to Kansei in English or Hindi. The term Kansei is a Japanese word and implies psychological feeling and needs in mind [5]. Kansei is imbedded in the Japanese culture in a way that is difficult to translate into words. A specific Kansei arises when a person is subjected to a product in a certain environmental context [6]. Kansei may be easier to experience than define by a western person. Looking at a picture or artifact may evoke a certain "good feeling" that is difficult to describe. This is what Kansei is all about. Kansei is an individual subjective impression from a certain product, environment or situation using all the five senses of sight, hearing, feeling, smell, taste, recognition and balance [6]. Kansei incorporates the meaning of the words: sensitivity, sense, aesthetics, feelings, emotions affection and intuition [7]. Kansei closely related to sophisticated human abilities such as sensibility, recognition, identification, relationship, making and creative action where the process of bidding together these concepts also is part of the Kansei [8].

There are different ways of measuring the Kansei: words, physiological response (Heart rate, EMG, EEG), people's

behaviors & actions and facial & body expressions [9]. The most common way of measuring Kansei is through words. The words reflect elements of the Kansei. They are just external descriptions of Kansei within a person's mind. All the elements of Kansei may not expressed because we do not have words to describe all emotions. The words are not the Kansei itself. Facial and body expressions have been used within emotional design outside Kansei engineering as well. Desmet, Hekkert and Jacobs [10] have developed PrEmo, to assess product emotions. This is a cartoon medium expressing emotions. Most of the Kansei engineering studies which have been published in English use words when measuring the Kansei.

3.2 Introduction of Kansei Engineering

It seems to be a common opinion among designers about the importance of emotional design and the need for practical methods within this field. Emotions have been linked to product properties for decades in Japan. Nagamachi used the term "Emotional Engineering" as early as in the seventies. K. Yamamoto used the term "Kansei engineering" for the first time in 1986 when he gave a speech at Michigan University. Kansei engineering methods build models in which person's emotional responses to design are linked to the product properties. It is a methodology that integrates affective elements already in the developing process [6]. Kansei engineering has been applied in the design of a variety of products. Two of the greatest examples are Mazda's best selling roadster Miata and Sharp's video camera with an external LCD display. Other areas where Kansei engineering has been applied are home appliances, architecture, packaging design and work equipment. A great benefit of Kansei engineering is that it can be used to link a variety of product properties to product emotions. Studies have been done on things like micro level surface finishes of glass materials [11] and music genres for mobile phone ads [12]. Kansei engineering is today a well established and matured design methodology and commercially available service in Japan. Most Kansei studies are done in Japan, Korea and Europe. Most of the literature is even not translated in English.

3.3 Types of Kansei Engineering Techniques

There are six types of Kansei engineering techniques. Four of them are complex systems. Brief introduction of these four is give here because this paper is looking at the simple ways of integrating Kansei engineering in the design process. The model of the proposed Kansei process will mostly focus on the first three types of techniques.

3.3.1 Type I: Category Classification

This type of Kansei engineering technique is the

simplest and the easiest one. A product's details are broken down in tree structure to get the design details. Then customer's emotional needs are connected manually with product properties [13].

3.3.2 Type II: Kansei Engineering Computer System (KECS)

Statistical tools are used to connect Kansei and product properties. This is a computer aided system using interference engines and databases with Kansei words. The KE System typically consists of coupled databases for Kansei words, images, design and color and knowledge about relations between the data. It is also called forward Kansei engineering due to the fact that it only converts the user's Kansei into design parameters [6, 13].

3.3.3 Type III: Hybrid Kansei Engineering System

This is almost similar to Type II except that it also works in the reverse direction. It can predict the Kansei elicited by product properties and is called as hybrid Kansei engineering system. The designer can feed his ideas into the interference engine which links the ideas with Kansei words which are presented [6].

3.3.4 Type IV: Kansei Engineering Modeling

Kansei engineering Type IV builds a mathematical prediction model in place of rule base for obtaining the ergonomic output from Kansei words. The mathematical model works in the same manner as that of rule base [6, 13].

3.3.5 Type V: Virtual Kansei Engineering

It is an extension of Type II Kansei engineering technique here a virtual reality system is connected to Kansei engineering computer system (KECS) to place the user in a 3D virtual environment that can be manipulated. This system is a combination of a Kansei engineering computer system (KECS) and a virtual reality system to assist the users in selecting the product with real experience by means of virtual space [6, 14].

3.3.6 Type VI: Collaborative Kansei Engineering Designing

It is the web supported Kansei Engineering system. In this technique the users and designers can interact with each other by means of internet to share their thoughts related to product that will reduce the lead time in product development process. This technique allows the users to design the products based on their Kansei and needs [6, 15, 16].

3.4 Kansei Methodology

The different models within Kansei engineering focus on translating the Kanseis into product properties. The

output does not necessarily reflect the true Kansei somebody has about a product. Schütte [6] compares the outcome with a picture of the real thing that is flatter, less contrasted and more static than the original. Schütte proposed model is a six step process where different methods have been used within each step. Some of the methods are not unique for Kansei engineering like factor analysis and regression models. The Kansei engineering process is rather a methodology that implements different techniques to link product emotions with product properties. In the process the chosen product domain is mapped from both a semantic and physical perspective. The Kanseis are linked to corresponding physical properties. A prediction model is then built and validated.

The following model proposed in Figure 1 is modified version of Schutte model with the aim to connect emotions and product features for existing battery drills by means of a case study, and to get a closer look at the methodology in practice. The model is a six step process which gives the optimized output in the form of a new product by filling up the gap between semantic information and traits information. They are correlated by logical conception and then computational modeling is performed to avoid the unnecessary parameters in the designing phase and to reduce the probability of failure of product during testing and validation. The model is described in the following steps:

3.4.1 Need Recognition and Sample Collection:

This is the first step in the Kansei engineering technique and it should be analyzed in depth. In this step the needs are assessed by selecting a target group, market and specification of the new product. Existing product samples as well as new concepts and design ideas from the surroundings are collected. The span and area in this step should be kept as big as possible.

3.4.2 Semantic Information Related to Product:

The semantic information is considered as *meaningful and related to data* that serves the yardstick in describing the product. In this step the information in the form of adjectives is collected which are used to describe the perceptions on the product. These adjectives are called as Kansei words. These are collected from all available sources like Magazines, Literature, Manuals, Experts, Experienced users, Ideas, and Visions. This collection of words goes on until no new words occur. The number of Kansei words generally varies between 50-600 words [17]. These adjectives are then analyzed and structured to find the high level Kansei words that are representing the product. This is done either manually or statistically in semantic structuring phase.

Figure 1: Proposed model for case study

3.4.3 Traits Information Related to Product:

This is an important step next to synthesis. In this step concrete information about the traits of the product i. e. design parameters that are to be manipulated in its manufacturing are determined. First inspirational material or existing/similar products that are collected in the beginning are deeply examined. Secondly these potential traits are sorted according to impact on product and then most important and appropriate ones are selected for questionnaire study. In the questionnaire study, during the semantic structuring phase, these design traits will be used as questionnaire items.

3.4.4 Semantic Structuring:

This is an intermediate step and is commonly associated with previous two phases. Here two phases are analyzed in depth. The Kansei words and physical traits are structured according to their meaning and impact on user. The structuring is done by manual or statistical methods like affinity diagram, designer's opinion, interview, etc. Then the emotional response to the product is assessed via questionnaire. A survey questionnaire is a quantitative instrument frequently used in combination with qualitative methods to verify research findings. This method

measures which assumptions formed from a small sample can be generalized to a larger population [18]. Questionnaires can also generate a large amount of valuable information to inform the design of a new product. The number of subject should be as high as possible, however according to J. Nielsen minimum eight users are required in usability issues [19]. Kansei engineering technique uses the [20] 'Semantic Differential method' in which the emotional response a word to a product is measured by constructing a 'Semantic Scale'. Each subject or respondent is asked to give their response on each product via a word pair on the semantic scale.

3.4.5 Synthesis

In this phase, the relationship between two information, i. e. semantic information and the traits information is established. For every Kansei word or groups of Kanseis a number of related properties are found. Manual, and statistical methods like; Category Identification, Regression Analysis, General Linear model, and Quantification Theory type 1 [21], etc. are used for analysis purpose.

3.4.6 Validation

In this phase data from the synthesis is checked to see if

the distribution of data is normal. Some test methods are: One sample t-test, Kolmogorow-Smirnov tests, and visually checking of distribution etc. since new techniques have been used in semantic structuring step, therefore the validity of result of research should be tested and be updated correspondingly.

3.4.7 Model Generation

The result acquired during the synthesis phase presents the connection between the product traits and the emotional values to a product. The final model can be mathematical or non-mathematical. Mathematical models can be used to explain the data on a more detailed level. The models are the functions depending on the properties and predict the Kansei score for a certain word [6].

4. A CASE STUDY OF BATTERY DRILLS

This technique is illustrated by a real-world design problem using a Kansei based survey on “Battery Drills”. The study would only look at visual properties of the drills based on pictures. Only the visceral aspect of emotional design was studied. That is why no exploration of new product domains was done or new concepts were developed for the semantic analysis. Only existing drills that are found in the market were chosen to be included in the study. In this paper the terms “battery drill”, “portable drill” and “product” mean the same as portable/cordless/ rechargeable drills for home appliances. The drills in the test as shown in Figure 2 were all commercial and available in the market through outlets or teleshopping/internet sales. The target group was younger adults between 20 and 30 years of age.

4.1 Semantic Information and Traits Information Steps

A large number of adjectives describing the feelings for battery drills were collected from the different sources like magazines, manuals, Advertisements, product reviews, user forums on the internet, brochures, dictionaries and other information resources related to machine tool industries. A total of 156 words were collected. Then synonyms and words of similar meaning were identified and removed from the data, thus reducing the number of total words to 112 for the next step.

The goal in this study was to end up with less than 30

words to reduce evaluating time in the survey. The 112 words were first clustered in 56 initial groups. These were in the second step reduced to 38 groups or single words. Third the most relevant ones representing the semantic space were chosen while others were excluded. Numbers of words were now reduced to a total of 77, spread over 37 groups or single words. One suitable word was chosen to represent each group. These were candidates for Kansei words. Each word was evaluated and 25 were chosen as Kansei words describing the semantic space of portable battery drills. The 25 Kansei words are listed in Table 1.

After collection of final Kansei words, concrete information about the traits of the product i. e. design parameters that are used in its manufacturing are determined by collecting the similar type of battery drills by means of market survey. The aim of this study was to look at showroom appeal for conventional drills. 47 drills that are found in today’s market were studied. These were categorized to look at varying features like shapes, proportions, materials, detailing etc. The main elements building up the drills were battery house, shaft, engine house and chuck. Different elements within these objects were identified as varying properties. It was important to keep the number of varying properties at a minimum so that this data could be implemented in further analyses.

The shape analysis method [22] was used to establish trait information of battery drills. Firstly, the shape of battery drills was divided into number of independent factors, termed as primary elements. Then each element was analyzed and sub-divided into secondary elements, then again, if required, the secondary elements can also be divided into further sub elements, and then a new shape is created by re-arranging theses elements; finally the new shapes are evaluated. For example, the primary element “Engine House” was composed of secondary elements as ‘shape’, ‘details’, ‘materials’, ‘position on shaft’, ‘proportions’, and ‘rear shape’. Further the secondary element ‘Shape’ can be divided into two sub-elements as cylindrical or organic. By the same way, the elements, which affect the emotional judgment, were considered and design traits are established. The trait information phase is constructed by analyzing 13 drills containing 7 primary elements, 15 secondary elements, and totally 22 sub-elements, as listed in Table 2.

Table 1: Kansei Words used in the Study adapted from [1]

Classic	Fun	Power	Elegant	Safe
Traditional	Personal	Rugged	Fresh	Professional
Plastic	Freedom	Aggressive	Modern	Control
Neat	Reliable	Confidence	Lifestyle	Aesthetic
Value	Functional	Exclusive	Futuristic	Ergonomic

Figure 2: Display of samples used in the study adapted from [1]

Table 2: The traits information related to battery drills [1]

Primary element	Secondary Elements	Sub-Elements	
Engine House (A)	Shape (A1)	Cylindrical (A11)	Organic (A12)
	Details (A2)	Clean (A21)	Detailed (A22)
	Materials (A3)	Single (A31)	Multiple (A32)
	Position on Shaft (A4)	Pointing (A41)	Balanced (A42)
	Rear Shape (A5)	Round (A51)	Straight (A52)
Shaft (B)	Materials (B1)	Single (B11)	Multiple (B12)
	Details (B2)	Clean (B21)	Detailed (B22)
Battery House (C)	Position on shaft (C1)	Balanced (C11)	Pointing (C12)
	Release button color (C2)	Contrast (C21)	Discrete (C22)
Chuck (D)	Shape (D1)	Cylindrical (D11)	Coned (D12)
Form Ratio (E)	Proportions (E1)	Square (E11)	Rising (E12)
Button Colour (F)	Contrast (F1)		
	Discrete (F2)		
Joining Details (G)	Screws (G1)		
	No Screws (G2)		
Handle (H)			

4.2 Semantic Structuring

The 13 battery drills representing the trait information were included in the test. Battery drills were represented in pictures along with Kansei words. The pictures were also of good quality and shading to represent the three dimensional shapes of the products. All participants were skilled in visualization and capable of considering three dimensional shapes from picture. Participants were also asked to describe their ideal drill on the semantic scale.

The participants were 10 design students, 5 of each gender. They were all in their twenties. The low number of participant came as a result of the time consuming test which took up to an hour. The survey was carried out on paper and the participants were given a brief introduction about how to fill in the survey and about Kansei engineering. They were asked to fill in the first thought that struck them for each product sample.

The data was then treated in Excel sheet. Some responses weren't evaluated like "I had expected". Drill number nine scored relatively low on the Kansei word "elegant". Most users found it to be more or less in the direction of "not elegant", which was opposite to the general opinion. No significant differences between male and female ratings were identified. This may be due to the fact that all participants were design students. The most important Kanseis for the ideal drill seemed to be "control", "functional", "ergonomic", "power", "reliable" and "safe". Those considered by the users to be of less importance were "personal", "traditional", "classic", "exclusive" and "lifestyle". The ideal spider web Profile for battery drills is shown in Figure 3. This diagram shows how users describe their ideal product. Hence the relationships between the Kansei ratings of the product samples were not possible to identify manually. Hence structuring of Kansei words was required to establish relation between them. Factor analysis and cluster analysis have been made for this purpose.

4.2.1 Factor and Cluster Analysis

The data was treated in a Factor Analysis with the purpose of semantic structuring. The input data were mean values for the twenty-five Kanseis describing each of the thirteen drill samples.

The factor analysis simplifies this raw material data and reveals connections between words (Kansei ratings). Principal component analysis was used for extraction of factors (components) with the help of SPSS 11.0 (Statistical Package for Social Sciences). Kansei words having factor loading value more than .550 were considered for three factors except for word 'value', which is slightly above the selection criteria listed in Table 3.

The result from the PCA with varimax rotation is shown in Table 3. All Kansei words were reduced to three factors,

"User mood", "Practical purpose", and "Plastic". Factor 1 (User mood) is related to different identities or moods experienced by the use of a drill. Factor 2 (Practical purpose) is related to the description of the drill with focus on practical aspect. Factor 3 contains only one Kansei word. Plastic is a word commonly used to describe plastic products of mediocre quality and few appealing or charming characteristics. The words: functional, neat, elegant and reliable had high loading in more than one factor.

The higher level Kansei words are plotted in a 3-D diagram (Figure 4) according to their factor loading values, e.g. "control" has the co-ordinates X, Y, and Z as 0.853, 0.312, and -0.176. This can be used to find out the interrelation between the words as described by Osgood [23]. Related words will be found in clusters within the vector space. This can be done visually if only three vectors from the factor analysis define the semantic space. Twenty five Kansei words were visually clustered by rotating the 3-D diagram. The final clustering resulted after 8 iterations of rotation. The rotation is based on the consideration that the coordinates of the Kansei words in each cluster must be similar and also maximum distance between Kanseis within each cluster has not fixed. Figure 4 shows any two arbitrary component plots of these matrixes from first rotation to eighth rotation. These plots were generated with the help of SPSS 11.0 tool. The first diagram of Figure 4 shows that the words "neat" and "elegant" can be visually grouped in one cluster easily. "Classic" and "traditional" will be grouped in another cluster as shown in the second diagram of Figure 4. The result of cluster analysis is listed in Table 4.

Some clusters are trivial, like Cluster 1. It was expected that there would be a connection between the two words which are of similar meaning. For example "aesthetic" and "ergonomic" seem to have a lot common regarding this product domain. This may apply that the participants agree with Norman's statement: "Beautiful things work better!" [4]. Comparing the ideal rating with the cluster analysis reveals that Kanseis rated most important by the users are found in clusters 4, 6, 7 and 8. Cluster 1, 2 and 5 contains the lowest rated Kanseis. Cluster 7 contains three high and one low rated Kansei word. "Exclusive" and "confidence" are the two words with different meanings that most users find the connection between, but they don't think so while describing their ideal product on semantic scales. This may imply that the ideal product for a user is something other than the one they describe through one semantic quality at the time. The ideal product is not a result of only following the criteria set by the user, but it is a result obtained through mapping the relations between Kanseis. The Kansei scores for the ideal product should only be used as an additional guideline regarding

Figure 3: Spider Web Ideal Kansei Profile for battery drills [1]

Table 3: Factor Loading Values for Words [1]

Kansei Words	Factor 1	Factor 2	Factor 3
Control	.853	.321	-.176
Functional	.533	.816	.043
Ergonomic	.911	.179	.242
Fresh	.912	-.176	.323
Neat	.342	.678	.528
Personal	.764	-.502	.188
Aesthetic	.845	.265	.289
Traditional	-.621	.670	-.124
Plastic	-.584	-.269	.549
Value	.596	.437	.138
Modern	.916	-.204	.296
Freedom	.918	-.180	.124
Classic	-.507	.806	-.61
Elegant	.576	.701	.348
Exclusive	.886	.046	-.108
Lifestyle	.729	-.561	-.016
Professional	.656	.480	-.361
Aggressive	.856	-.294	-.349
Confidence	.921	.034	-.281
Fun	.766	-.493	.264
Futuristic	.844	-.487	.055
Power	.895	-.022	-.419
Rugged	.881	.024	-.323
Reliable	.560	.750	-.272
Safe	.252	.853	.221

Figure 4: Component plot in 3-D vector space [1]

the importance of each cluster. A cluster with many high rated Kanseis is an important cluster.

4.3 Synthesis

A cross tab analysis was chosen instead of a more time-

consuming and demanding Quantification Theory Type 1 (QT1) for linking semantic information and traits information. The relationship identification was done using statistically methods aided by manual methods. Relation-

Table 4: Clusters. Kansei with high rating from ideal product are in bold and low ratings in italic [1]

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8
<i>Classic</i>	<i>Plastic</i>	Neat	Fresh	<i>Lifestyle</i>	Reliable	Power	Aesthetic
<i>Traditional</i>		Elegant	Modern	<i>Futuristic</i>	Functional	Rugged	Ergonomic
				<i>Fun</i>	Safe	Aggressive	
				<i>Personal</i>	Professional	Confidence	
				<i>Freedom</i>	Control	Exclusive	
					Value		

ships between properties were identified by looking at the properties found within every cluster. Each property was evaluated in relation to each Kansei. Those traits having mean Kansei ratings above four were defined to have positive influence on the Kanseis, only if the traits just opposite to them have negative values. Properties only present for negative Kansei scores were evaluated to have negative influence on the given Kansei word. This doesn't necessarily mean that the opposite property has a positive influence on the Kansei. Some properties would have a many high Kansei ratings and a few low ones. Such properties were identified to have positive influence on the Kansei word if the opposite property only had negative scores. The results of cross tab analysis are tabulated in Table 5.

The result shows that the details in engine house and multiple materials in the shaft are the properties that have most connections to the Kanseis. Single material in the engine house has influence in a negative manner on the Kansei words "elegant", "exclusive" and "lifestyle". An ergonomic drill should not have clean details in the engine house and should have multiple materials in the shaft. Ergonomic was in the same cluster as aesthetic. According to the results an "aesthetic" drill has detailed details and multiple material in the shaft (as is the case with "ergonomic"). It is also interesting to see that the important properties for the Kansei word personal are multiple materials and details in the shaft. The fact that the shaft is where the users connect physically with the product may be the reason for this. It was also surprising that no connection between the Kansei "plastic" and number of materials was found. The analysis found no connection between the properties release button color, start button color and the Kanseis. Joining details was only connected to the Kansei word plastic. This may be because of limitations like not enough product samples, missing Kansei words, not enough participants or wrong classification of properties. The assembly property might have been included in the detailed property of the engine house.

4.4 Validation

The output from the cross tabs analysis verifies the

result from the cluster analysis. All Kansei words within each cluster had matching properties. No clusters had Kanseis that were depending on opposite properties. The collected data was treated with a one-sampled t-test (2-tailed) that showed normal distribution of the data. Distribution of the data was also inspected manually.

4.5 Model Generation

The final model is the validated result from the synthesis. It was chosen to give a connection between each cluster and their properties due to the fact that only ten participants were included in the test. The clusters also made more sense than the factor analysis. This gives a more general connection between the affective values and the product traits. Clusters where one property is found to have positive influence, and the opposite negative, have only kept the positive one as a connection. Clusters with only one negative property were included in the model. The final model is listed in Table 6, which gives useful information about different traits that are linked to the Kansei clusters. The model reveals the following connections:

A "classic"/"traditional" drill should have single material in the engine house, straight rear and cylindrical chuck.

A "plastic" drill should have detailed and balanced engine house, straight rear and pointing battery house.

An "elegant"/ "neat" drill should have a detailed details and it should not consist of only single material for a balanced engine house.

A "modern"/ "fresh" drill should have a detailed engine house with a round rear profile, detailed shaft in multiple materials and square form ratio.

A "lifestyle"/"futuristic"/"fun"/"personal"/"freedom" drill should have a detailed engine house with multiple materials and round rear and detailed shaft in multiple materials.

A "reliable"/"functional"/"safe"/"professional"/"control"/ "value" drill should have a cylindrical, detailed engine house in multiple materials with round rear and balanced position, shaft in multiple materials with clean details, pointing battery house, cylindrical chuck shape

Table 5: Result of Cross Tab Analysis [1]

Kansei Words	Engine House (A)										Shaft (B)				Battery House (C)				Chuck Shape (D)	Form Ratio (E)	Button Colour (F)		Joining Details (G)			
	A1		A2		A3		A4		A5		B1		B2		C1		C2				Contrast (E11)	Discrete (E12)	Screw	No Screw		
	Cylindrical (A11)	Organic (A12)	Clean (A21)	Detailed (A21)	Single (A31)	Multiple (A32)	Pointed (A41)	Balanced (A42)	Round (A51)	Straight (A52)	Single (B11)	Multiple (B12)	Clean (B21)	Detailed (B22)	Balanced (C11)	Pointing (C12)	Contrast (C21)	Discrete (C22)								
Control	1			1		1					1															1
Functional	1																									
Ergonomic			-1			1					1															
Fresh				1					1		-1			1							1					
Neat				1				1				1														
Personal												1		1												
Aesthetic			-1								-1															
Traditional					1					1									1							
Plastic				1				1		1						1									1	
Value				1		1						1														
Modern				1								1														
Freedom				1					1			1														
Classic					1																					
Elegant				1	-1																					
Exclusive			-1		-1																					
Lifestyle					-1						-1															
Professional	1			1		1		1				1	1										1			
Aggressive			-1						1														1			
Confidence			-1			1					-1															
Fun			-1										1													
Futuristic						1																				
Power	1			1		1		1				1							1				1			
Rugged				1					1			1											1			1
Reliable	1			1				1		1		1	1			1			1				1			
Safe	1			1		1				1		1														

and a square form ratio. It should also have a handle.

A “power”/ “rugged”/ “aggressive”/ “confidence”/ “exclusive” drill should have a cylindrical, balanced engine house in detailed and multiple materials with a round rear, shaft in multiple materials, chuck with cylindrical shape and a handle.

An “aesthetic”/“ergonomic” drill should have an engine house in multiple materials without clean details and shaft in multiple materials.

4.6 Discussion

A statistical analysis will always be more reliable if many subjects are and representations of all possible combinations of variables are included. The aim of this study was to find a simple model which also wouldn't

demand too much time. The result shows that the data were representative and that the methods chosen were appropriate. The result from the cluster analysis is validated because it reveals both trivial and more complex connections. The cross tabs analysis had the same tendencies. No clusters had combinations of conflicting properties, even if some were included manually without being hundred percent certain. The final model only predicts Kanseis elected from visual properties. It is also a simplified model that only grasps parts of the visual attributes for battery drills. But it can be said that result illustrates that Kansei engineering can be used as a relatively simple method that gives reliable results from a design perspective. It can be concluded that emotions are difficult to describe through words. They are simply

Table 6: Final Model [1]

<div>Clusters</div> <div> </div>	Engine House (A)										Shaft (B)				Battery House (C)		Chuck Shape (D)		Form Ratio (E)		Handle (H)
	A1		A2		A3		A4		A5		B1		B2		C1						
	Cylindrical (A11)	Organic (A12)	Clean (A21)	Detailed (A21)	Single (A31)	Multiple (A32)	Pointed (A41)	Balanced (A42)	Round (A51)	Straight (A52)	Single (B11)	Multiple (B12)	Clean (B21)	Detailed (B22)	Balanced (C11)	Pointing (C12)	Cylindrical (D11)	Conical (D12)	Square (E11)	Rising (E12)	
Cluster 1																					
Classic, Traditional					1				1								1				
Cluster 2																					
Plastic				1				1	1						1				1		
Cluster 3																					
Elegant, Neat				1	-1			1				1									
Cluster 4																					
Modern, Fresh				1					1			1		1					1		
Cluster 5																					
Lifestyle, Futuristic, Fun, Personal, freedom				1		1			1			1		1							
Cluster 6																					
Reliable, Functional, Safe , Professional Control, Value	1			1		1		1		1		1	1			1	1		1	1	
Cluster 7																					
Power, Rugged Aggressive, Confidence, Exclusive	1			1		1		1	1			1					1		1	1	
Cluster 8						1															
Aesthetic, Ergonomic			-1			1						1					1				

impossible to describe verbally. Better methods will probably be developed making Kansei easy to measure through physiological responses, behavior and body expressions.

5. CONCLUSIONS

Emotions are complex. We can describe parts of them with words. Kansei engineering maps the relations between words that give a more in depth description of a certain emotion. Even product properties and emotions can be linked mathematically with Kansei engineering. This is a big advantage compared to those semantic differential techniques and mood board processes favored in the west. But Kansei engineering is a more time consuming design

methodology. Kansei engineering is a reliable design tool for those interested in emotional design. It is also a flexible tool that can be used within parts or in the whole design process. Case study illustrates how it can be used with few involved actors in the process and gives a reliable result. Japanese industry has used Kansei engineering as an advanced design tool for many years, and very soon Kansei engineering could be seen as a recognized design tool in India. The awareness of emotional design will give both users and manufacturers new possibilities. Finally, it can be concluded that besides boosting sales, Kansei engineering could be used with the purpose of serving the user in a long term perspective. Possession of a powerful tool gives both opportunities and responsibilities.

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