Limits of Kansei – Kansei Unlimited

Kerstin BONGARD-BLANCHY, Carole BOUCHARD and Améziane AOUSSAT

Abstract: This article discusses momentary limitations of the Kansei Engineering methods. There are for example the focus on the evaluation of colour and form factors, as well as the highly time consuming creation of the questionnaires. To overcome these limits we firstly suggest the integration of word lists from related research fields, like sociology and cognitive psychology on product emotions in the Kansei questionnaires. Thereafter we present a study on the wide range of Kansei attributes treated in an industrial setting. Concept words used by designers are being collected through word maps and categorized into attributes. In a third step we introduce a user-product interaction schema in which the Kansei attributes from the study are positioned. This schema unfolds potential expansion points for future applications of Kansei engineering beyond its current limits.

Keywords: Kansei Design, product attributes, user-product interaction

1. INTRODUCTION

This article has for objective to lay open limitations in the application of Kansei Engineering methods in hitherto cases and to propose approaches to overcome these limits. At first Kansei-related research and tools that may be directly integrated in the conception of Kansei questionnaires are introduced. Thereafter, we present a study on Kansei factors during product design. The findings of the literature review and the study allow us to establish a model on relevant attributes of Kansei Design. These include attributes, besides semantics of form and colour, that could potentially be treated through Kansei techniques. For example sensations evoked by textures or emotions triggered by visual traces of fabrication procedures. At the end, we discuss the findings under the perspective of Kansei beyond its limits.

2. FROM SEMANTIC DIFFERENTIALS TO KANSEI ENGINEERING SYSTEMS

When Osgood proposed semantic differentials as a tool for measuring meaning in 1957, he provided the basis for Kansei Engineering KE [1]. Nagamachi took on the method and created a methodology for the consideration of Kansei in product development [2]. Since then, the KE methods have been applied and refined in many countries, especially in East-Asia. The Japanese word Kansei, commonly translated as “feeling”, includes a wide range of words related to style, emotion, affect, and semantics. The goal of KE is to facilitate the evaluation of the Kansei evoked by certain product attributes, so that designers can adapt product designs to the envisioned user experience. The classic Kansei Engineering proceeds in the following steps [2]:

1. At the beginning a word base is constituted. The researchers collect terms typical for the product and its sector through brainstorming, journals, websites, etc. They select the most adapted words and group them into pairs of semantic differentials.
2. As a second step, rules for the repartition of the product components are deducted.
3. A large number of participants evaluate the product or its components on the expression of its attributes – like e.g. form or colour – with a questionnaire that contains the previously defined semantic differentials.
4. As a result, statistical data on the relations between the Kansei values and the chosen attributes is available.
5. In order to exploit the results in further projects, the data is kept in a data base which is integrated in a Kansei Engineering System. Such a system links Kansei words with forms, colours or other attributes and can be used as a design tool.

Various Kansei Engineering Systems have been developed to automatically support the design process [3-7]. Sophisticated systems contain interfaces that enable designers to calibrate the design Kansei instantly through e.g. form or colour modifications.

KE methods have been already used in various sectors,
including mobile communication [8-10], transportation interior design [11, 12], architecture [4, 13, 14], tools and technical elements [7, 15], shoe design [16-18], etc.

3. LIMITS OF KANSEI METHODS

Even though KE methods have been successfully implemented in the above listed wide range of projects, there remain certain limitations to their application.

Limit 1: The most evaluated attributes are forms and colours. Of the analysed research papers on Kansei Engineering 40% looked at the Kansei of form factors, about 15% related Kansei with colours and 10% combined both, form and colour. Most other papers presented new algorithms and methods for statistical analysis. A discussions among the Kansei community in social networks already proposes ideas to expand KE application to other fields of human interaction, like advertisement or project management [19].

Limit 2: KE questionnaires are project-specific and can hardly be used in other contexts. Their development is time consuming because a new set of Kansei words has to be chosen for each product. Schütte proposed a generic software for quick creation of Kansei questionnaires [20]. However, the intense work on the word base is still required.

Limit 3: KE evaluations are mostly done on product images of finished products instead of real objects, concept representations or interfaces. This limits the possibilities to influence the design during the conception process. It also inhibits an interaction between user and product. Use sequences cannot be tested on their Kansei. But we find first works from design researchers who have taken on evaluation of use sequences to overcome this limitation [21].

Limit 4: KE measures instant impressions only. The KE methods are usually employed to analyse emotions evoked at the moment of first contact. But the user perception and attitude towards a product change with time, e.g. growing ease with practice or loss of interest. To draw conclusions on the medium- and long-term Kansei, the time component needs to become part of the methodology. Here too design researchers start to propose first approaches [22].

Limit 5: KES work on predefined product components. Modifications on each of these product elements can improve the Kansei of the whole object. However, a revision of the component structure, which is also an important part of designing, is not encouraged by the current KE methods.

4. BEYOND THE LIMITS

Despite these existing limits, we believe that Kansei Engineering continues to be a promising approach for the development of user-centred products. To overcome the shortcomings and to explore the presumably unlimited possibilities of Kansei Design, we propose to take into account the manifold research results from neighbouring disciplines like sociology or physiology and to broaden the range of potential Kansei attributes.

4.1 Literature review on Kansei related research data

We reviewed research publications in search of complementary tools from Kansei-related fields. Our focus here was on established word lists that would significantly accelerate the cumbersome creation of Kansei questionnaires (Limit 2). Sets of Kansei words could be a) generic, b) sector-specific or c) product-specific.

Looking at research from cognitive psychology, ergonomics and sociology, we find abundant material on emotions and values. There exist various accessible schemas that contain all possible states of human emotions from which we could extract those important for design. For example, the Geneva Emotion Wheel [23], Plutchik’s multi-dimensional model of emotions and his word-pair list [24], as well as the fourteen basic emotions (in English, Dutch, Finnish and Japanese) elicited by products proposed by Desmet [25]. In fact, lexical methods like semantic differentials are not the only means to access emotions stimulated by product designs. Lang’s Self-Assessment Manikin SAM as well as Desmet’s animated PrEmo character are both visual tools that bring a playful and universal component to the evaluation activity [26].

Sensations by their nature are limited through the available number of senses – visual, audible, tactile, olfactif, and gustatory. Sensation describing words are therefore very closely related to physical product properties. For a basic vocabulary see the work of Karana who assembled a list of verbal appraisals on perceived tactile or visual properties of materials [27]. Another sensation vocabulary was proposed by Zuo et al. who extracted a primary and a secondary “minimum lexicon” on tactile textures. It contains geometrical, physical, emotional, and associative dimensions [28].

In previous Kansei studies undergone by our Master students, we found that the notion of satisfaction or the attitude towards a product or brand has a great influence on the rating of the semantic differentials. If people dislike a certain brand they tend to assign semantic
descriptors that express things they find negative in general, regardless of the actual design expression. The same goes for people who are completely indifferent towards the product. We therefore agree with Mantelet who suggests evaluating the participant satisfaction in Kansei questionnaires [29]. To better understand the user reactions, Mantelet also proposes to integrate questions about the user values at the beginning of Kansei questionnaires. A often cited reference and good word base is Rokeach’s values list [30]. A Master student of our laboratory successfully adopted this list for the evaluation of the coherence of product designs with their brand image[31]. Equally interesting is Schwartz’ “Model of Relations between Motivational Values” [32]. It is based on human values that were found consistent between 40 countries.

While the previously discussed attributes can be represented through a limited number of possible conditions, the number of semantic terms to describe a product is merely infinite. Therefore literature review cannot provide us with an exhaustive list. However, our previous studies have shown that certain terms, (e.g. dynamic, comfortable, funny, luxurious) are often used. This means that there exist generic terms for certain types of products and sectors. Here collaborative work between all members of the Kansei community is desirable to establish a Kansei word pool.

This collection of references on Kansei words and related measurement methods is far from complete. Especially on sensation describing words, further resources are still to be revealed. Some KE researchers have probably already used some of the mentioned lists for the creation of their questionnaires. We will continue the collection and evaluation of these tools and hope to share our experience on their practicability with the Kansei community.

4.2 A Study on concrete and abstract attributes in product conception

The in part one cited research activities already point at the complexity of product Kansei. It cannot be ignored that there are various attributes, not only form and colour (as stated under Limit 1), that influence the perceived Kansei. To identify all these product attributes, we conducted a study on the design conception of a fictive product in an industrial setting.

4.2.1 Method

The study had for objective to detect all user and product related attributes treated by designers and engineers during the conception of consumer products and to indentify relations between these attributes. Eleven professionals from two French companies participated. One was a design agency, the other a manufacturer of telecommunication devices. Among the participants were nine designers and two engineers. The task was to generate a purely lexical design concept for: “A communicating coffee machine for Adidas”.

The study consisted of an individual and a collective part. First, each professional faced the fictive brief and underwent a word mapping during one hour. They were asked to note all words on post-its, place them on a paper surface and link related words with marker lines. The duplication or relocation of words was allowed. The participants were repeatedly encouraged to simultaneously verbalize their thoughts which enabled the researchers to follow their reflection during the activity. In addition we handed them a list with different types of product attributes (see Table 1).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>The visible contour</td>
</tr>
<tr>
<td>Colour</td>
<td>The visual property of an object produced as a result of light reflection and emission*</td>
</tr>
<tr>
<td>Material</td>
<td>The matter from which a thing is made* or seems to be made off</td>
</tr>
<tr>
<td>Texture</td>
<td>The appearance or consistency of a surface*</td>
</tr>
<tr>
<td>Patterns</td>
<td>A decorative image or design, a dominant or recurring idea</td>
</tr>
<tr>
<td>Functionality</td>
<td>A technical solution to facilitate the expected function</td>
</tr>
<tr>
<td>Components</td>
<td>Means to implement the expected functionalities of the product</td>
</tr>
<tr>
<td>Process</td>
<td>Procedures of fabrication, assembling, finishing</td>
</tr>
<tr>
<td>Values</td>
<td>One’s judgement of what is important in life*</td>
</tr>
<tr>
<td>Context</td>
<td>The circumstances that form the setting for an event*, like time, place and social environment of the envisioned product use</td>
</tr>
<tr>
<td>Target User</td>
<td>A person selected to use or operate the product</td>
</tr>
<tr>
<td>Analogies</td>
<td>A comparison between one thing and another*, inspirations, conceptual references</td>
</tr>
<tr>
<td>Semantics</td>
<td>Adjectives that describe the product, its character</td>
</tr>
<tr>
<td>Sensations</td>
<td>A feeling resulting from something that comes into contact with the body* (sound, taste, smell, touch)</td>
</tr>
<tr>
<td>Emotions</td>
<td>A strong instinctive or intuitive feeling deriving from one’s circumstances, mood, or relationships*</td>
</tr>
<tr>
<td>Style</td>
<td>A way of painting, writing, composing, building, etc., characteristic of a particular period, place, person, or movement*</td>
</tr>
<tr>
<td>Gestures</td>
<td>A movement of part of the body, especially a hand or the head, to express an idea or meaning*, to interact with the product</td>
</tr>
<tr>
<td>Function</td>
<td>Practical use or purpose of a design*</td>
</tr>
</tbody>
</table>
Following this individual exercise, the produced words were united into a word pool and classed by three researchers. The participants gathered as a group. Each person received a marker of a different colour. During 45 minutes they could choose words from the pool, position them on a wall, and mark relations between words with drawn lines. We encouraged discussion on the choice of relations among the participants. Everybody who agreed on a chosen link marked it with a line of his colour.

The study was videotaped. All word maps were reproduced in Adobe Illustrator. The noted words were sorted by the researchers and listed in excel tables. A data base was programmed, to register all linked word pairs. The data base helped to extract the absolute and relative quantity of relations between words of different categories. We normalized the data by dividing the absolute number of links between two conception attributes by the product of words assigned to them.

\[
\text{normalized value} = \frac{\text{number of links between two attributes}}{\text{number of words in attribute 1} \times \text{number of words in attribute 2}}
\]

4.2.2 Results in general

Each participant produced a word map. Another word map was developed by the whole team in both companies. Figure 1 shows one product designer’s individual production. In Figure 2 the collective word map of one company is illustrated.

The maps include 624 words (mostly in French, here examples are translated into English). The participants linked pairs of these words about 861 times (in average 78 links per person) in the individual phase. The group activity amplified the number of links to 1790, which is equivalent to 163 links per person.

4.2.3 Result 1: Occurrence of concrete and abstract attributes during product design

Among the words written down by the participants were product properties like strait, open, asymmetric (form), blue, black, white (colour), tissue, metal, caoutchouc (material), elastic, plaited, smooth (texture), and points, three stripes (patterns). Furthermore we found words like alimentation, aeration, biometrics related to technical functionalities, strap, display, solar panel (product components), and casting, weaving, engraving (product processes). We call them concrete attributes.

The array of found words related to the user ranges from freedom, liberty, sustainability (values), to fluid, dynamic, masculine (semantic product descriptors), perfumed, warm, aromatic (sensations), and stimulated, pleasant, relaxed (emotions); words that describe a specific style were edge, retro-cool, pop-art, and analogies that transport a metaphoric idea were alembic, water drop, magic lantern. We found words like stroke, rotate, push for gestures of the user to interact with the product, words related to the expected macro function of the product were e.g. communication, cooling, leisure. Morning, at home, and rendezvous were examples for words on the use context, and adolescent, early adopter, sportsman for defining the target user.

While the same product may be characterized with differing abstract attributes by different users, we consider the perception of the concrete attributes of this same product consistent between all users, except in case of cognitive or physical limitations.

Table 2 shows the distribution of the collected 624 words. We find half of all mentioned concept words under abstract attributes (49.4%). The importance of both concrete and abstract attributes was relatively outbalanced. The attributes containing most conception words were analogies (12.5%) on the abstract side and functionalities (18.4%) on the concrete side. Style and emotions on the abstract and patterns, colour, process on the concrete side were the groups with the least number of words. Furthermore, there were words mentioning the product and the brand name.
4.2.4 Result 2: Relations between concrete and abstract attributes of product design

To investigate the relation between the different concrete and abstract conception attributes, the links on the word maps, produced by the participants, were analyzed. The normalized repartition of links between concrete and abstract attributes can be seen in Table 3. We state the following connections:

1. Words belonging to the same attribute were frequently related. We find strong connections among colours, materials, forms, and words defining target users. The same applies on a slighter level for words belonging to texture, values, sensations, and gestures.

2. Between concrete attributes, colours were often related to forms. Materials were often paired with textures. And patterns show multiple links with textures.

3. Between abstract attributes, values were frequently related to semantic product descriptors and to words describing the use context. The context also appeared often together with terms on target users. Furthermore, emotions and sensations were closely related.

4. Strong links between concrete and abstract attributes were formed between style and form as well as between style and colour. And semantic descriptors where frequently related to material and texture.

5. Pattern, style and emotions were the groups with the least number of words and therefore, despite the normalization, a complete lack of links with many attributes appeared.

4.2.5 Discussion

We gathered a wide base of lexical data related to product design. Sorting and statistical analysis of these terms enabled us to identify various types of concrete and abstract attributes. The obtained data showed tendencies of the occurrence of the various attributes. However, the level of abstraction between the concrete and abstract attributes (Table 1) differs strongly. Some of them are features (e.g. components or functionalities) while others are the characterization of these features (e.g. colours or semantics) [33]. The level of granularity of the categories varies. Theoretically, production processes could be

<table>
<thead>
<tr>
<th>Concrete attributes</th>
<th>Abstract attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form</td>
<td>Colour</td>
</tr>
<tr>
<td>4.2%</td>
<td>2.6%</td>
</tr>
<tr>
<td>42.3%</td>
<td>49.4%</td>
</tr>
</tbody>
</table>
further sub-categorized into fabrication, assemblage, and finishing. Only their occurrence was too low to create relevant subcategories.

Looking at the data from the point of view of Kansei methods, forms and colours were well represented on the concrete side. But we also found a wide range of complementary product properties like texture, material, patterns that might make a difference for the user experience. Kansei relevant attributes like semantic product describing adjectives, emotions, and sensations had their place among the terms identified on the abstract side. Looking at the wide spectrum of found attributes, we propose to broaden the Kansei space to all these factors since they all might effect the user perception. As such we consider values and analogies (associations evoked by the design) as part of Kansei too.

Our second objective was to lay open relations between concrete and abstract attributes of product conception. The fact that intra-category links appeared frequently might be due to their contextual proximity. The other found links like between material and texture or style and form correspond to the common sense of the profession. They show that designers and engineers today already hold the knowledge to estimate the consecutive consequences of choices on one attribute like material on others like colour, values or functionalities. However, the word maps (Figure 1 and Figure 2) illustrate the complexity of the knowledge that has to be treated in the design process. Here the Kansei Engineering tools and even systems could be deployed to take into account relations between more concrete and abstract conception attributes.

5. SCHEMA ON USER-PRODUCT INTERACTION

The findings of the study and the literature review nourished our proposition of a schema that includes the identified concrete and abstract attributes of product design (Figure 3). In accord with other researcher's frameworks [35, 36], we position the user (human sensor SU, affect & cognition, human response RU) on one side and the product (product sensor SP, information treatment, product response RP) on the other. The user perception is triggered by concrete attributes of the product [RP], e.g. its form, colour, or material, and external stimuli from the use context. Parts of the stimulus reach the human sensors [SU] and enter the perceptive system. Two mechanisms operate in human perception: cognition and affect. To this day there is discordance between neuroscientists whether those two are distinct or if cognition is included in the affective process [36]. Affects by themselves can be distinguished between utilitarian (an intuitive response like escape), and aesthetical (judgements of appraisal) [19]. On the cognitive level the memory intervenes to process the information. It holds genetic plans, feature detection, learned rules, desires etc. to enable the computing, measurement, and evaluation of the perceived stimulus information [37]. If the stimulus is identified as relevant, affect and cognitive treatment potentially lead to a response of the human [RU], like a hand gesture. The product, if equipped with the necessary sensors [SP], detects certain characteristics of this user response. Depending on its information treatment algorithms and responsive capabilities, it reacts with behaviour or appearance changes [RP]. The human again perceives these as another stimulus.
through his bodily sensors [SU], for example the roughness of the surface, which might stimulate him to react with a new response [RU], e.g. lift the object to observe its other sides. This cycle is called the “sensorimotor coupling” [38].

If we position the identified concrete and abstract attributes in this schema, we see a number of factors that can potentially be addressed through Kansei Design. The concrete attributes that form a stimulus for the human are assigned to product responses [RP]. They include form, colour, material, texture, as well as functions, components, fabrication, and joining. Because of their subjectivity, all other attributes are rather abstract. Sensations (visual, audible, tactile, gustatory, and olfactory) form the data that can be captured by the human sensors [SU]. Emotions are the affective part of perception. In the context of products these are mainly represented by degrees of attractiveness, pleasantness, satisfaction, or surprise [5]. Values, semantics, and analogies, stored in the human memory, help the human to judge stimuli that have been manifested in the product appearance following the designer’s intention. User gestures or facial expressions are positioned among the behavioural responses of the user [RU]. They occur during the interaction with the product. They can only be anticipated by the designer but not assured.

6. PERSPECTIVES OF KANSEI BEYOND LIMITS

The literature review and the study gave us first hints on how to overcome some of the actual limits of current Kansei Engineering. For example, to surmount the first identified limitation (Limit 1: The most evaluated attributes are forms and colours), we propose an extension of the Kansei space. To do so, one can consult the Kansei attributes, introduced in our “schema of user-product interaction”, to choose which attributes on the abstract side (the user) and which on the concrete side (the product) could be relevant for the product in question. The Kansei methods can then be adapted to the evaluation of these attributes.

Another interesting source on widening the Kansei space is the list of Kansei Study Keywords assembled by Levy, Nakamori and Yamanaka. They give an overview on the manifold contents that are being considered important by the KE community [39].

The introduced word-lists from related research fields can be consulted by Kansei Designers for a more efficient creation of Kansei questionnaires, which was the second limitation (Limit 2: KE questionnaires are project-specific). As already mentioned, the semantic differentials are not the only possible method for Kansei Design. Characters like those of Desmet or Lang can change the monotonous filling of a word based questionnaire while providing reliable results too.

Other Kansei researchers propose physiological and comportmental measures to complete the Kansei Engineering methods. They allow the researcher to unveil unconscious relations between visual stimuli and emotional responses [40, 41].

To respond to the third and forth limitation (Limit 3: KE evaluations are mostly done on product image; Limit 4: KE measures instant impressions only) we think it is indispensable to apply Kansei methods from the early design phase onwards. At the beginning of the design process there is still lots of uncertainty and at the same time there are plentiful opportunities for the product design. Continuous Kansei evaluations on intermediate design representations – like scenarios, sketches, 3D models, dummy interfaces, interactive prototypes, and real products over their life cycle – can give designers and engineers useful insights for a better product Kansei. The involvement of potential users through Kansei evaluations over the whole course of product development is one step to test more than the reaction to static stimuli. And if the user tests prototypes in action, we can evaluate use sequences and how Kansei changes over time.

The interesting challenge now is to investigate which combination of methods is the most pertinent to measure the impact of which concrete attribute on the product Kansei.

7. CONCLUSIONS

This paper had for objective to show limits of current Kansei Engineering methods that were unveiled during the lecture of publications on KE projects. To address some of the limitations, we proposed to broaden the scope of Kansei relevant attributes to include aspects of sensations, interactions, modes of fabrication, and others.

References from literature that might be used for a simplified creation of meaningful Kansei questionnaires were presented. We reviewed research of Kansei-related disciplines to propose some useful collections of words describing emotions, values, etc., as well as some additional measurement techniques.

A study was conducted to identify a wide range of abstract (values, semantics, analogies, emotions, and sensations) and concrete attributes (form, colour, material, texture, functionalities, motions, components, and production procedures). These can all potentially become elements of Kansei Engineering studies.
We finished with a brief outlook on how the applications of Kansei Methods could evolve in the near future. One option to augment the pertinence of Kansei evaluation would be its application throughout the whole product design process, and in particular on dynamic product representations like scenarios or interfaces.

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