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DESIGN FOR AFFECT: A CASE STUDY IN THE DESIGN OF CONFECTIONERY PACKAGING.

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ABSTRACT
Two distinct affective engineering approaches, robust design (RD) and kansei category classification (KCC), were applied to the conceptualisation of confectionary packaging within an industrial-academic case study. The aim was to increase understanding of this process and enable designers to evaluate design alternatives with respect to the likely affective responses that they will create in consumers. Details of the application of each method are presented and a comparison of the approaches is made both qualitatively and quantitatively. The qualitative comparison presents the approaches taken and highlights issues that arose and solutions generated through collaboration with designers and marketers at Nestlé Product and Technology Centre, York, U.K. The quantitative analysis is a direct comparison between the success of each approach in generating product concepts that best satisfy the affective intent that the company wishes the product to elicit. Semantic differential (seven point) questionnaires, as developed in the research of Osgood et al. [1], were used in conjunction with a target feeling (set by the company's marketers) as used in the work of Lai et al. [2]. This target allowed the forming of the comparison between the two methods based on one number only, a second multi-dimension performance measure is also used presented as radar plots. A group of target demographic consumers completed the questionnaire to record their affect regarding the product concepts generated from the two approaches. It was found that the two approaches rather than offering equivalent alternatives could be complementary and future research is planned to test this hypothesis.

Keywords: Affective engineering, kansei, product design, fast moving consumer goods, robust design, cause and effect, case study

1 INTRODUCTION

'The confectionery market is highly competitive. Each brand must stand out against its competitor at the point of sale (the till or counter where goods are sold). The unique design of packaging must appeal to customers. Even after it is sold, the product should continue to advertise itself with its eye-catching packaging.' [3] Simply put, this quotation epitomizes the potential role of affective engineering as a solution to the problem of designing products for markets saturated with similar brands.

The percentage of products withdrawn from the market due to lack of sales within the first year, is quoted to be in the region of 80% with a further 10% withdrawn within five years [4]. The goal of the research reported in this paper is to reduce this failure rate by enabling designers to evaluate design alternatives with respect to the likely affective responses that they will create in consumers.

Kansei Engineering, established in Japan in the 1970s [5] is being used by companies in Japan such as Mazda and Milbon to create a car for young at heart people and trendy hair conditioning for regular salon goers respectively. More recently, a broader area of research termed Affective Engineering has begun to look beyond functionality, aesthetics, and ergonomics to create, measure and test differentiation between competing products. The identification of underlying qualities, that connect with people either cognitively or emotionally, has become the focus of these research studies.

A key aspect of Affective Engineering lies in the creation of product concepts. This involves the identification of product concept features that influence the affective (emotional and cognitive) responses of consumers and is followed by a tailoring process to create emotional responses that align with the design intent. Two approaches are currently used to achieve this goal. Nagamachi [6] proposes the use of Ishikawa's [7] "Cause and effect diagrams" within a process termed kansei category classification. These diagrams allow a design team to decompose, using a cascading method, a high level purpose or concept for a product into properties that the product should have and subsequent features that might embody such properties. This method has been applied and extended by Nagamachi with companies such as those mentioned above and found to result in innovative solutions to existing or new product opportunities. By contrast, Lai et al. [2] propose the use of robust design methods; this enables the identification of product properties and features through the analysis of a corpus of existing designs. Lai's approach has been applied to a car case study and found to "fine tune" the design, so increasing the positive affect of product concepts or "feeling quality."

The following objectives were pursued during the course of this work, to:

- Explore the applicability of Affective Engineering methods to a Nestlé product.
- Define the physical features of the product that most appeal to consumers.
- Measure the level of appeal of those features.
- Generate and evaluate new design concepts that embody learning from the project.
- Compare the efficacy of the two methods chosen.

2 STRUCTURE OF THE PAPER

Figure 1 shows the structure of the paper. Initially a case study was identified, and information gathered, to enable the robust design and kansei category classification methods to be applied. Design concepts were generated by these two methods. These first stages of the work are described in section 3. Then, as described in section 4, the concepts were compared to assess whether robust design or kansei engineering was more effective than the other in this context.

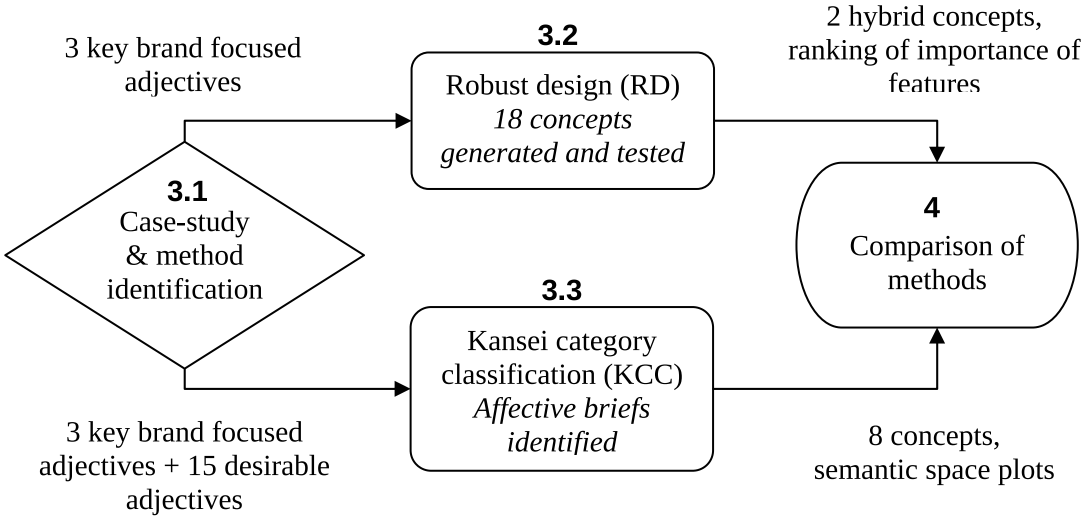

Figure 1. Structure of the paper

3 DEVELOPMENT OF CONCEPTS

3.1 Case study description

The Faraday Packaging Partnership (http://www.faradaypackaging.com/) is a research and technology transfer organisation, with affective engineering as one of its remits. Nestlé UK is a member and proposed that this research might be carried out on its Quality Street confectionary tins.

The marketing department of Nestlé, York were asked to specify the three key adjectives (specifically for use with the robust design approach) and an exhaustive list of adjectives (for use with kansei category classification) that best described how they hoped the Quality Street tin would be perceived by consumers of their identified demographic. When the participant sample was contacted they were asked only to respond if they fitted the demographic.

3.2 Robust Design

3.2.1 Product analysis

The author and a packaging designer from Nestlé analysed a corpus of competitor products, to establish what were the common features were across the product category. A manageable number (based on industrial time constraints) were short-listed, namely sectional shape, colour of tin, diameter, volume, brand label colour, lip height, lid chamfer height and lid chamfer width. They are shown in figure 2.

Figure 2. Common product features amongst a corpus of competitor products.

3.2.2 Concept generation

The identified features were used to decide upon variables that could be adjusted in the generation of concepts. Measurements were taken across the corpus to specify ranges of dimensions or variations of features. Three measurements were recorded for each feature. For geometric features such as diameter these were the largest, the average, and the smallest values in the corpus. For non-geometric features such as colour, a range was decided on to cover the spread of the corpus, or at very least the range of interest to the designer. To combine the variables and generate a number of concepts, an L_{18} pairwise orthogonal array was used in conjunction with standard a robust engineering procedure [8, 9]. The 18 concepts created, represented the spread of all the possible combinations of features. If the features were varied on a one by one basis 6,561 concepts would be produced. Therefore the method represents an approximation that has the advantage of covering a range of possibilities that are practically beyond the timescales and costs allowable in industry. The variables and the concepts generated from them are shown in Table 1 and Figure 3. Each concept (denoted by a code RD01- 18) in Figure 3 can be seen to be constituted of the variations of the eight different features in Table 1. The concepts were printed out in colour on a one to one scale and mounted on boards for presentation to a consumer participant group of fifty people who fitted the target demographic description and who rated them as described next.

3.2.3 Feature and concept ranking

Seven point semantic differential scales [1, 2, 6] were used and target scores (T) were assigned to each scale in accordance with the method as prescribed in [2]. These were T = 7 in all cases as requested by Nestlé marketers. The value of T is important when calculating feeling discrepancy as it indicates how much the consumers' feeling differs from the target feeling, which can also be considered to be the intent of the company for the product. Three affective words of key interest to the marketers at Nestlé U.K. were used in the semantic scales. A further metric is also defined by Lai, that of feeling ambiguity. It provides a measure of the deviation from the centre of the consumer sample. As its value increases, consumers disagree more about the feelings the concept elicits, indicating that the concept can only satisfy a subset of the consumers tested [2].

The definitive metric that Lai proposes to differentiate between the 'feeling quality' of concepts is that from robust design/engineering theory, the 'smaller the better' signal to noise (S/N) ratio [8]. In this case smallest refers to magnitude of the number rather than the absolute value. Equation 1 is its adaptation to the product concept application of this paper.

$$\frac{S}{N} = \frac{\textit{Energy transformed to elicit the intended feeling (work done by the signal)}}{\textit{Energy transformed that elicits other feelings (work done by noise).}} \quad (1)$$

Figure 4 shows the ranking of importance of the eight features. It should be noted that a longer line between lowest and highest rated variables denotes greater importance of that feature. For example sectional shape is the most important feature as the distance between 'Oval' and 'Circular' is greatest.

Table 1. Robust design feature variables for concepts RD01-18.

Concept no.	Features							
	Sectional shape	Colour	Diameter (mm)	Volume (1 x 10^4 mm^3)	Brand label colour	Lip height (mm)	Lid chamfer height (mm)	Lid chamfer width (mm)
RD01	Circular	Red	235	548	White	20.00	4.8	12.50
RD02	Circular	Red	187.5	469.5	Multi-coloured	17.25	2.4	6.25
RD03	Circular	Red	140	391	Purple	14.50	0	0
RD04	Circular	Blue	235	548	Multi-coloured	17.25	0	0
RD05	Circular	Blue	187.5	469.5	Purple	14.50	4.8	12.50
RD06	Oval	Blue	140	391	White	20.00	2.4	6.25
RD07	Oval	Purple	235	469.5	White	14.50	2.4	0
RD08	Oval	Purple	187.5	391	Multi-coloured	20.00	0	12.50
RD09	Oval	Purple	140	548	Purple	17.25	4.8	6.25
RD10	Oval	Red	235	391	Purple	17.25	2.4	12.50
RD11	Oval	Red	187.5	548	White	14.50	0	6.25
RD12	Oval	Red	140	469.5	Multi-coloured	20.00	4.8	0
RD13	Octagonal	Blue	235	469.5	Purple	20.00	0	6.25
RD14	Octagonal	Blue	187.5	391	White	17.25	4.8	0
RD15	Octagonal	Blue	140	548	Multi-coloured	14.50	2.4	12.50
RD16	Octagonal	Purple	235	391	Multi-coloured	14.50	4.8	6.25
RD17	Octagonal	Purple	187.5	548	Purple	20.00	2.4	0
RD18	Octagonal	Purple	140	469.5	White	17.25	0	12.50

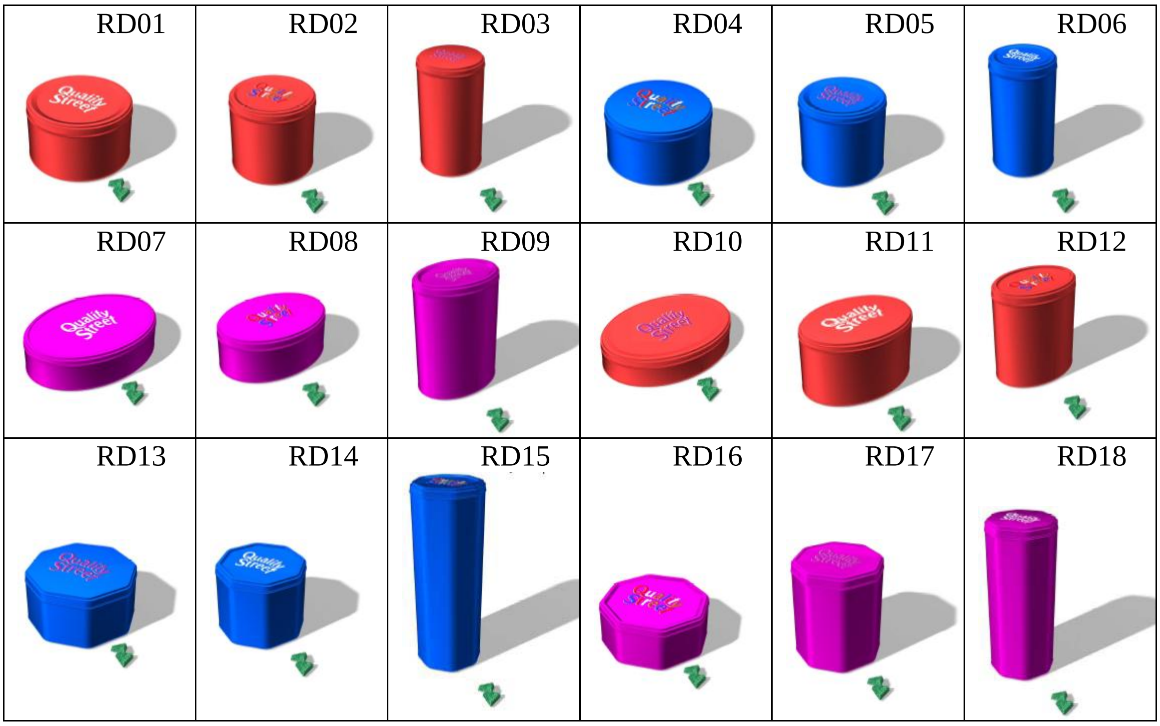

Figure 3. Concepts generated using Lai et al.'s Robust design approach [2].

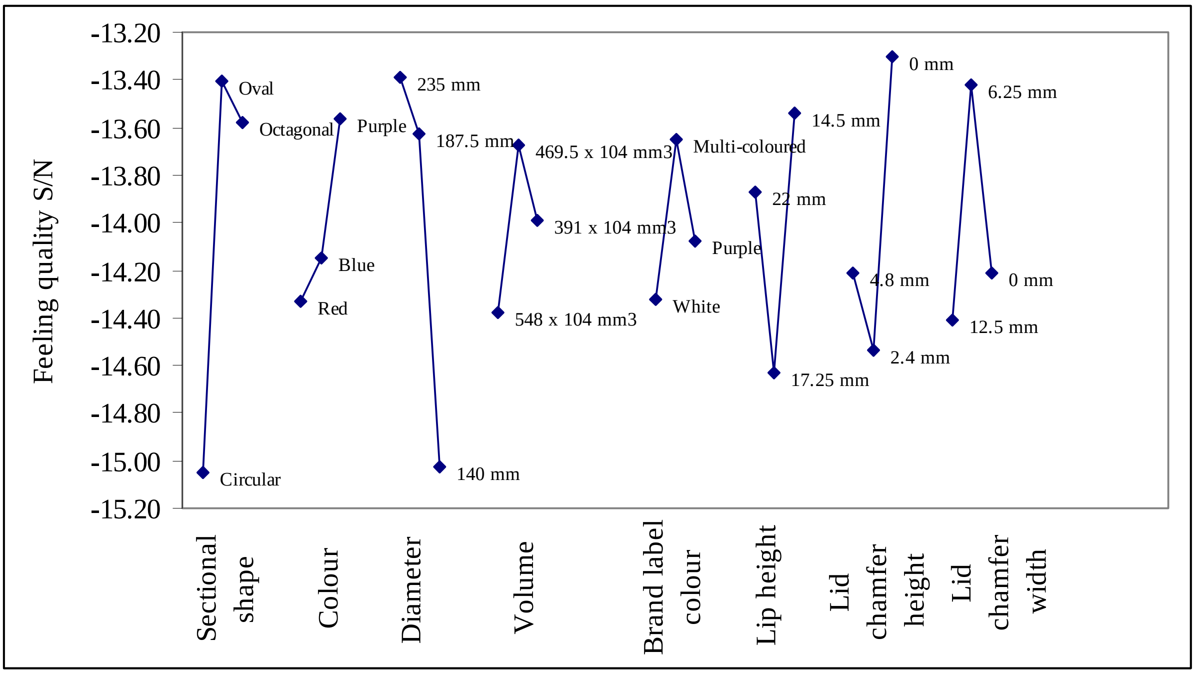

Figure 4. Feature level ranking by S/N ratio.

Following the ranking in Figure 4, two hybrid concepts were constructed as improvements to RD13, the best performing concept from the original experiment. The first, RD19, was a total optimisation of RD13, i.e. every feature that did not already represent the strongest performing level of that feature was replaced with the feature with the highest value. Then concept RD20 followed Lai's proposal that only the most powerful features need be optimised, in this case the four most powerful were selected. Two additional concepts, that represented the original tin, were also printed in colour and mounted on boards for assessment as a benchmarking exercise. OT02 was a CAD representation of the then present tin on the market with only the features examined in concepts RD01-20 present; OT01 was a photograph of the original tin. Figure 5 shows these additional concepts. Their inclusion was designed to answer how strong the concepts produced from the RD and KCC method would be, compared to the original tin, and also what affect the additional features present in the photograph OT01 would have on consumers' rating of the concepts. It was also a check to observe if any major feature had been excluded from the list used to generate the first round of concepts RD01-18. A second experiment was conducted as in [2] and to answer those questions. 39 participants who matched the target consumer description recorded their affective responses to each concept against an extended list of adjectives as described in section 3.3.3. This allowed further comparison with the kansei category classification method. The results are summarised in section 4.

Figure 5. Hybrid concepts from robust design method and two additional original tin concepts added as a benchmark.

3.3 Kansei Category Classification method

3.3.1 Affective brief definition

A "cause and effect" diagram (see Introduction) was created from brainstorming by a team of product experts, aided by a facilitator (someone who understood the method). Its start required a "zero-order" affective concept. This was provided by the marketing department at Nestlé York. Figure 6 illustrates

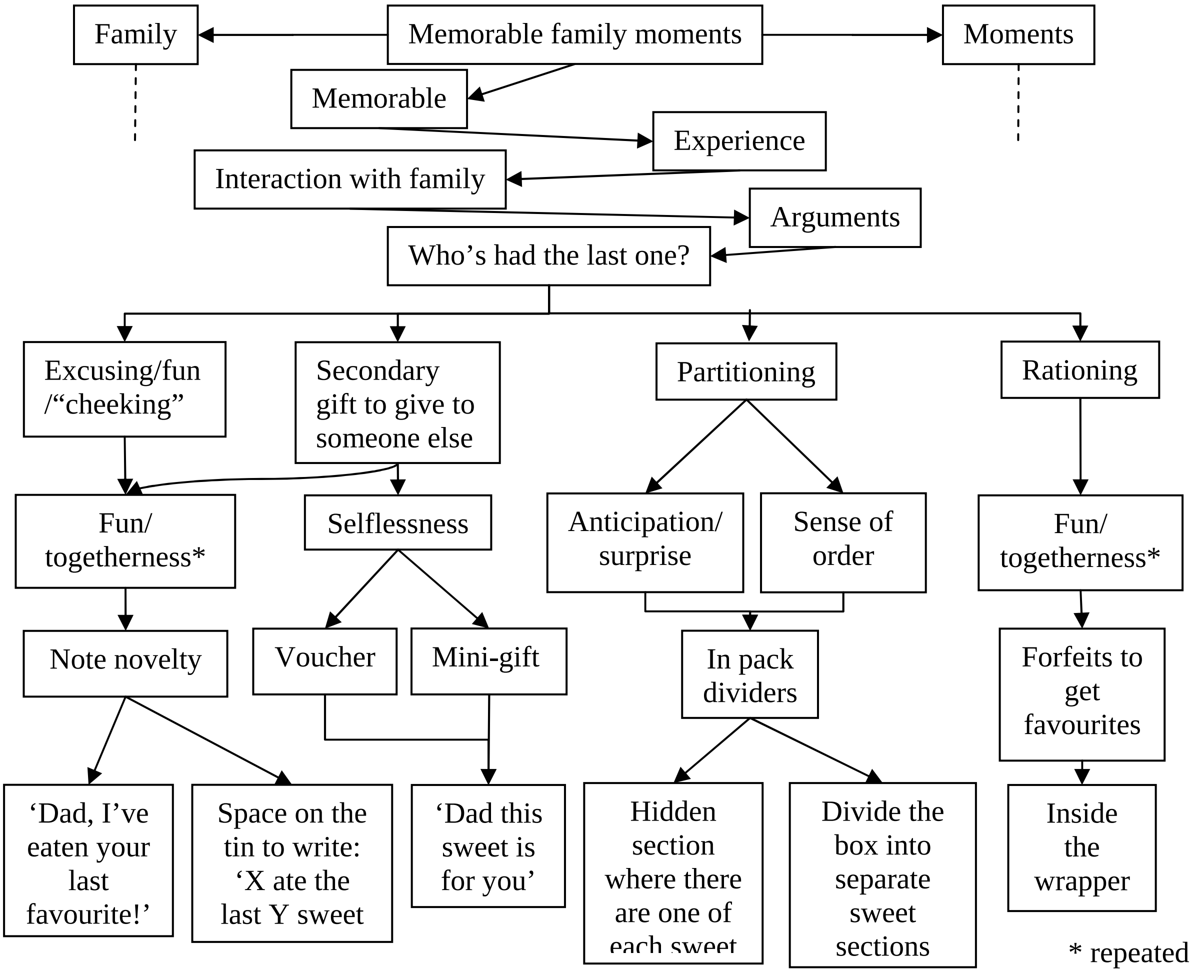

Figure 6. Cause and effect diagram/affective brief, based on [7] and [6].

the development of one branch of the diagram, from the zero-order "memorable family moments". It demonstrates how many alternative (both similar and dissimilar) affective concepts can be developed to a level where they become potential physical features of the product. Repetition of affective concepts was taken as a sign that such concepts supported one another and also that the process had reached a desirable state of exhaustiveness. In fact, continuing the tree analogy, figure 6 more accurately represents one off-shoot from a branch or perhaps even a twig on the entire tree. The whole diagram produced as part of this method covered three pages of A1 paper with font size sixteen letters.

3.3.2 Concept generation

The generation of product concepts from the exhaustive list of affective concepts proved to be a difficulty in applying this method. Clear explanation of how this should be done is not present in the literature on the use of this method [5-7]. Several issues became apparent when conducting the method. Too many affective concepts and thus features were generated that could be practically combined into one sole concept. Also a lot of affective features in one single concept could create confusion when interpreting what was affecting consumer response. A further problem faced was the business constraints that limited the number of concepts that could be produced.

Ideas were discussed for overcoming these difficulties such as using images to assist designers in visualising what the affective concepts meant, defining design briefs from groups of similar affective concepts, and further brainstorming of features. A decision was made to proceed with the definition of affective briefs (Figure 6 was one such brief) and then to hold a meeting of all the experts involved in the project. At the meeting the thinking behind the affective concepts and features was recapped and definitive product concept solutions to each brief proposed. Product concept solutions were developed by packaging designers who sketched the ideas as they were being discussed. This resulted in instantaneous feedback on whether the ideas represented the thoughts of the experts or not and the generation of a number of approximately 20 potential product concepts. The experts then voted, to select the concepts they preferred to go to consumer test. Each expert had ten votes and was allowed to vote up to twice for one concept if they had a strong preference for it. Finally seven were selected for testing (Figure 7). Again the concepts were mounted on boards on a one to one scale. The main difference from the previous (RD) test was inclusion of multiple views of each concept, better to explain the affective feature under test. This was as opposed to the CAD models used in the RD evaluations.

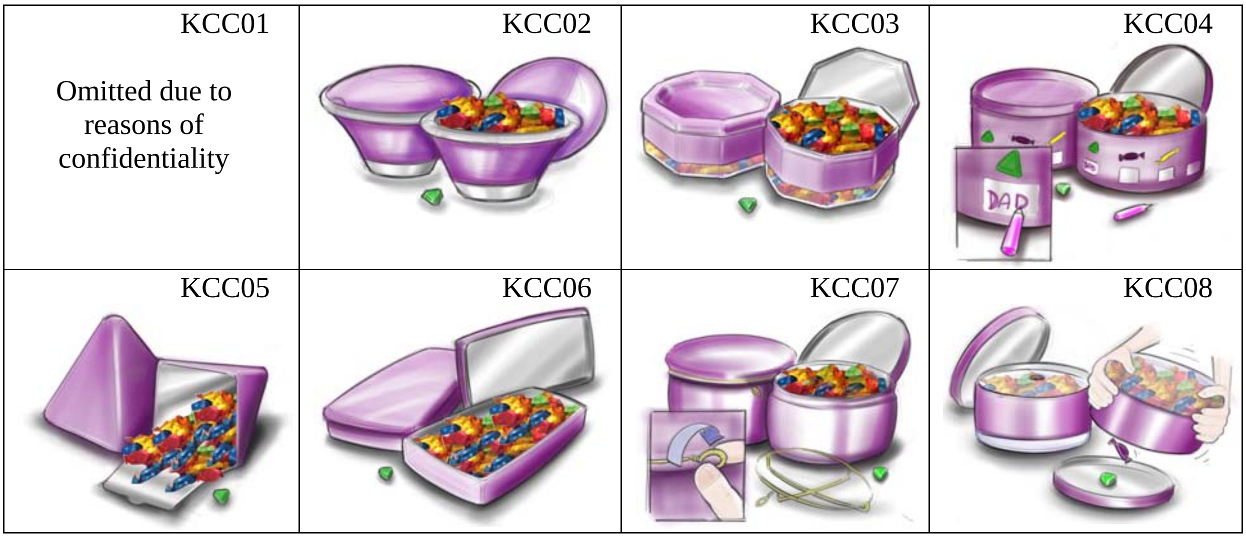

Figure 7. Concepts generated using kansei category classification.

3.3.3 Concept ranking

As with robust design (section 3.2.1) semantic differential questionnaires [1] were used and the target score (T) [2] also applied to assist in making a comparison between the effectiveness of the two methods. Affective adjectives were structured into a semantic differential questionnaire [1] to allow the rating of concepts as in Lai [2] and Nagamachi [6]. The adjectives used included; family, friendly, gift-worthy, dynamic, distinctive, happy, modern, bright, exciting, inviting, attractive, and emotional. The antonyms were created using the adjective with the word 'not' preceding it. Thirty seven participants with the profile of the target demographic recorded their affective responses to each concept. S/N ratios were calculated for each concept on the smaller the better basis and radar plots produced to show how each concept performed on average against each affective adjective. KCC03 and 04 were highest ranked.

4 COMPARISON OF METHODS

Figure 8 plots how the 39 participants rated the top two concepts from the RD and KCC methods (RD 19, 20, KCC 03, 04), and OT01, 02, against the eighteen affective adjectives. Table 4 ranks the top ten concepts from the 22 tested, on the basis of Lai et al's feeling quality measure [2]. Scores for the feeling discrepancy and feeling ambiguity (section 3.2) are also given.

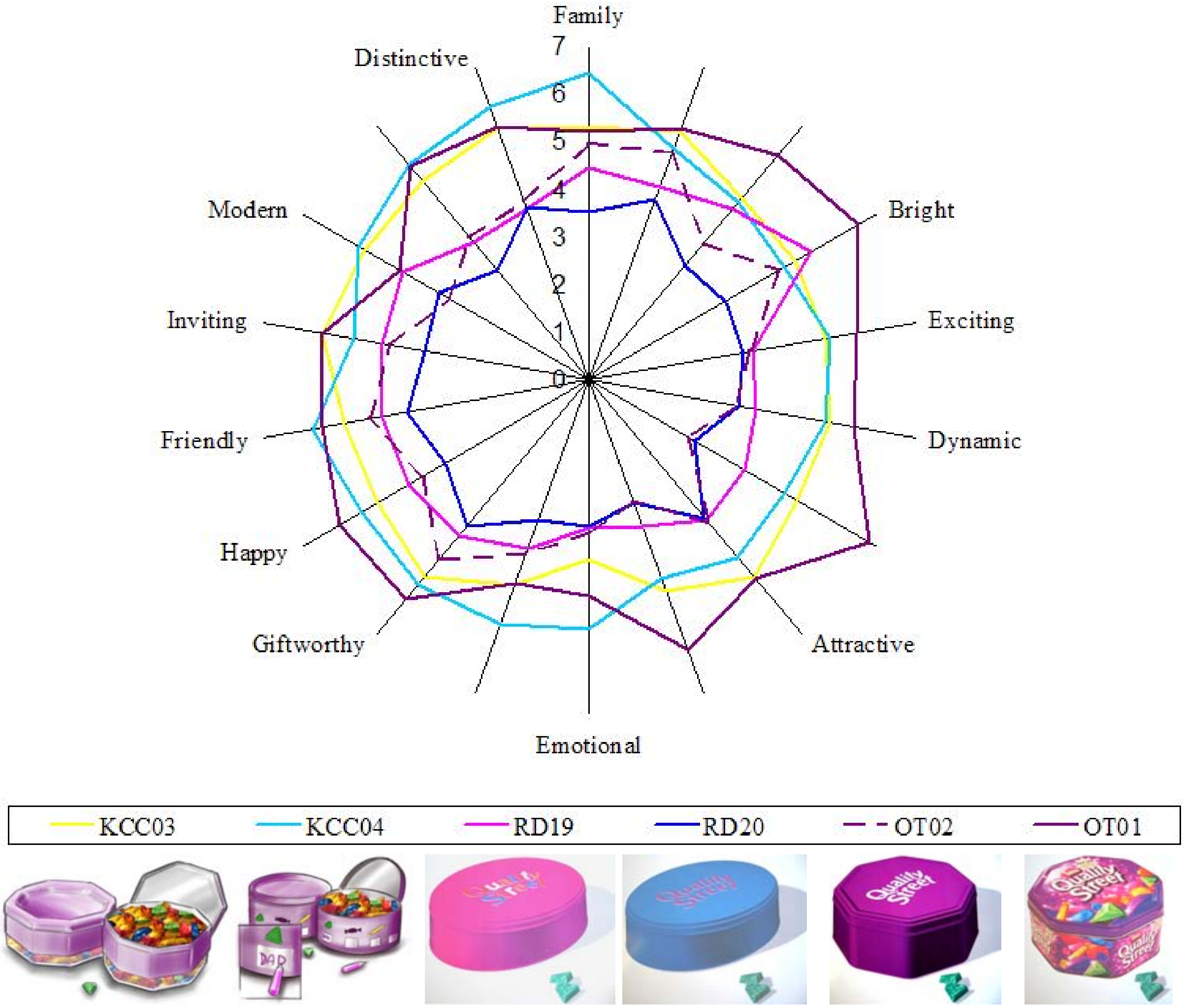

Figure 8. Radar plot to compare the superior concepts from each method and their performance eliciting feelings related to an extended number of adjectives. Some of the adjectives are omitted due to reasons of confidentiality.

Table 2. Ranking of concepts on basis of Lai et al's "feeling quality".

Rank	Concept no.	Feeling quality	Feeling discrepancy	Feeling ambiguity
1	OT 01	-9.484	0.915	0.690
2	KCC 04	-9.841	1.037	0.627
3	KCC 03	-10.326	1.093	0.653
4	RD 13	-11.355	1.050	0.707
5	RD 16	-11.565	1.046	0.789
6	RD 11	-11.649	1.138	0.657
7	RD 08	-12.430	1.237	0.706
8	OT 02	-13.092	1.550	0.848
9	RD 07	-13.243	1.309	0.856
10	RD 19	-13.247	1.595	0.881

5 DISCUSSION & CONCLUSIONS

The comparison of these two potential approaches to the definition of concepts for the use in a larger Affective Engineering process has drawn a number of interesting points for discussion. Although KCC produced the strongest two concepts apart from the original tin, RD produced concepts that filled the rest of the top ten with two clusters of consistently performing concepts. The differences in focus of each approach lead to the conclusion that the two methods could be used together to greater effect. RD method could establish a product that is recognisable and hence rateable by consumers as it would focus on those features present in the corpus of existing products in the market. Following this with KCC method unique and innovative features could be added to the strongest concepts to further enhance the feelings elicited. Conducting an experiment thus would also give a clearer view of the effects of the affective concepts embodied as features in the KCC method because the fundamental features of the concept would already be known and quantified.

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