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Kansei Engineering Toolkit for the Packaging Industry

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1 Introduction

Engineering appealing products has always been the goal of consumer goods companies where competitive markets and crowded supermarket shelves has lead to greater consumer power. Brands are very powerful in this arena and influence both packaging attributes and consumer perceptions. Packaging must now communicate, attract and intrigue the consumer to positively influence the purchase decision.

We have developed a packaging design toolkit based upon Kansei Engineering (Nagamachi, 02) to translate consumer perceptions into design attributes. However the original Kansei Engineering offered little support for the consideration of brand requirements. Thus, we have developed new methods using additional contributions from research in the fields of Psychology and Marketing to extend the scope of the toolkit to include consideration of the brand. We have also supplemented the technique with linguistic expertise to improve the selection process for the adjectives used in the consumer survey which has improved the robustness and repeatability of the results.

This paper presents an overview of the toolkit using illustrative case studies to describe the application of the toolkit to “live” projects. The case studies demonstrate how this Kansei Engineering variant has real value within the packaging development process to inform concept selection decisions based upon actual consumer insights.

2 Toolkit for Packaging Design

The project analysed traditional Kansei methods and focused on the translation of Kansei types I and II because of their applicability and success in industry.

- **Kansei Engineering Type 1 – Category Classification** (Nagamachi, 99)
  The deconstruction of a central concept, or 'zero level concept' into sub-concepts and the eventual elicitation of physical parameters to be optimised.
- **Kansei Engineering Type 2 – Engineering System** (Nagamachi 99)
  The collection of a wide range of designs and the evaluation of the lower level design attributes that consumers prioritise for different affect responses.

However the toolkit is not a direct translation of Kansei, as it also addresses issues specific to the packaging industry.

- Replacement of "zero affective concept" in Type 1 with brand values.
- Adaptation of Type 2 analysis to ensure appropriate packaging attributes are included to deliver the required insights into consumer preference.
- Simplification of the semantic differential survey to reduce demand on participants, survey length and recruitment costs.
- Increasing the robustness and repeatability of the results by developing novel linguistic techniques to identify the suitable adjective list.

2.1 Our Approach

The Kansei based toolkit for packaging design is shown in Figure 1 and comprises exercises and software to support a design team in creating and evaluating packaging against a set of intended qualities and to correlate these with consumer preferences. The traditional Kansei process has been split into a 'Toolkit' of 6 tools to be compatible with different stages within industrial product development processes. The tools have been developed to be used individually or as a holistic process to provide insights and guidance.

This toolkit has been tested in industry and has shown to deliver insights at different stages of the product development process.

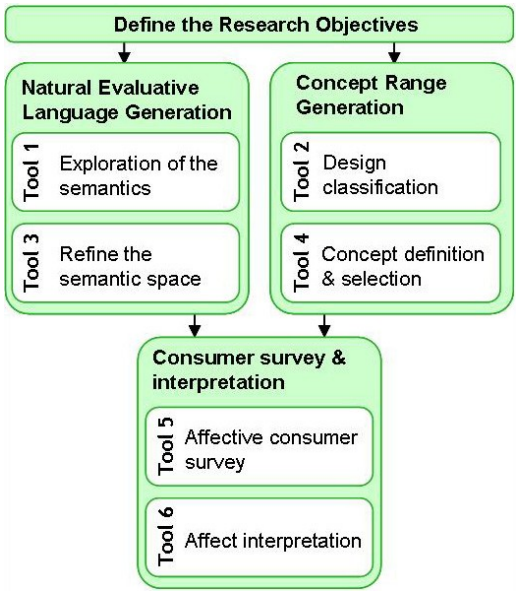


Figure 1: Toolkit for Packaging Design

3 Natural Evaluative Language Generation

It is very important that the right set of adjectives is used for the consumer survey. to ensure that the Kansei process is robust and repeatable and gives relevant results. The adjectives must accurately describe the product and its desired brand identity and also reflect the judgements that participants might want to make. Unsuitable adjective choices can result in a range of problems, including:

- Misinterpretation of an experimental question resulting either in a flat response distribution or a 'double peak' that indicates two interpretations.
- Adjectives with similar meanings can artificially weight a particular response.
- Confusion from unfamiliar or ambiguous adjectives

Kansei Engineering suggests that adjectives are selected by talking to consumers or by searching relevant literature (Nagamachi, 95). These rely upon experience to ensure that words are not missed that represent key design parameters. This issue is especially relevant when designing packaging. The influence of brand is a key to the design process and no method currently exists to ensure that this is represented in the adjective set.

3.1 Tool 1: Exploration of the Semantics

Figure 2 shows how this tool supports the generation of an extensive list of seed words developed from three sources:

1. *Product functional benefits:* ensures that packaging under consideration is congruous with contents and product purpose.
2. *Brand values*: extracting relevant words from brand documents means that the evaluation also tests for harmony and fit with the values that the brand elicits.
3. *Packaging formats*: we found seed words from this category rarely elicit any useful results. However it is still important that this is considered for a complete analysis.

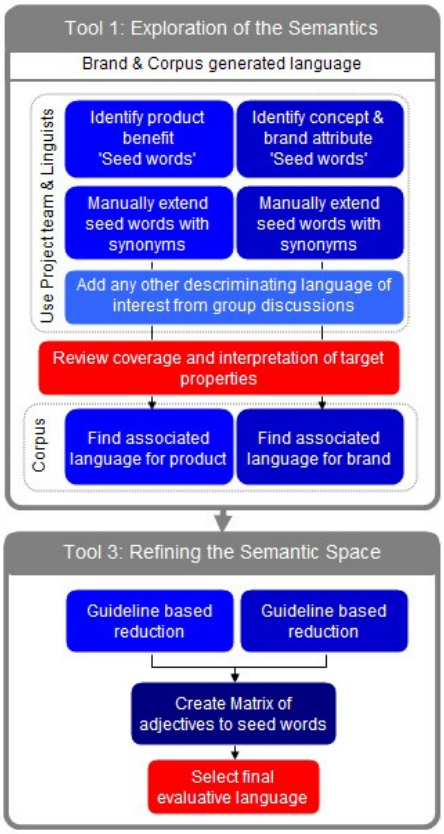


Figure 2: Tools 1 and 3

The next stage is to extend the resultant seed words list by identifying alternative synonyms using a series of accepted linguistic techniques (Delin et al, 07). Then, a corpus based technique, specially developed for this toolkit, automatically generates all possible words from modern English usage relating to the seed words. This is based on the British National Corpus (BNC), a 100 million word collection of texts, representing a comprehensive picture of British English (Aston, Burnard, 98). This approach ensures that the selected adjectives are widely used in everyday language. It can result in over 1000 adjectives related to the desired qualities but this increases the probability of covering all parameters of interest.

3.2 Tool 3: Refining the Semantic Space

Kansei Engineering uses Principle Component Analysis (PCA) to select the adjectives to present to consumers. However this requires an expensive (time and money) survey and can result in missing important product and brand qualities. Our approach, exemplified in Tool 3 and shown in Figure 2, uses linguistically informed guidelines to categorise the adjectives. These guidelines help to identify suitable candidate adjectives and thus eliminate inappropriate candidates. Some examples are:

- Guideline V: Remove adjectives requiring additional context to be understood.
- Guideline VI: Remove comparative adjectives.
- Guideline VII: Remove non-gradable adjectives.
- Guideline XIII: Remove adjectives that relate to a prolonged experience.

After the application of the guidelines there are usually too many candidate adjectives remaining. We link the adjectives back to the original seed words and select a set of 10-20 words representing all product, brand and pack qualities.

3.3 Case study: Natural Evaluative Language Generation for a Cleaner Bottle

We illustrate our description of the Natural Evaluative Language Generation contained within Tools 1 and 3 by means of extracts from an industrial case study, in which we evaluated different packaging concepts for a new cleaning product.

Tool 1: Exploration of the Semantics

We identified a set of appropriate seed words for input into the system. In this situation, packaging attributes did not result in any suitable adjectives and so will not be discussed any further within this case study. These seed words were manually

extended using the linguistic process described in Section 3.1 to about 70 words, see Table 1. Each word was then input into the BNC as described in Section 3.1 to automatically identify other adjectives that occur in natural language and a list was produced of each frequent word from the British National Corpus.

Brand Equity		**Product Benefits**	
BE_1 Delight	Enjoyment, surprise, joy, content, pleasure, delighted etc.	**PB_1 Skin kindness**	Kind, caring, smooth, moisturising etc
BE_2 High-standard	Best, exceptional, exclusive, extraordinary, unique…etc.	**PB_2 Perfume**	scent , odour, aroma… etc.
……		**…….**	
BE_n		**PB_n**	

Table 1: Extending Seed Words

Tool 3: Refining the Semantic Space

The next stage searches the relevant adjective set to find those suitable for the consumer study, as described in Section 3.2. In this case study there were 100 adjectives which fulfilled all guidelines. Thus, the adjectives were arranged into a matrix, a sample of which is shown in Table 2 to facilitate the selection of appropriate adjectives for the consumer survey. Adjectives that have multiple roots test more than one concept and can reduce the number of questions required. The client must be confident that all the relevant brand, product and pack attributes are covered by the adjectives and this matrix can be used to ensure this occurs. The final adjective list for the consumer survey is highlighted in Table 2, and included words such as *Tender, Conventional, Fun, Luxurious, Everyday, Slender, Cosy and Bold.*

		Highest Coverage							**Mid Coverage**					**Least Coverage**					
		Adjectives chosen for use in survey																	
		tender	**conventional**	**fun**	**luxurious**	**showy**	**everyday**	**slender**	**cosy**	**bold**	**friendly**	**simple**	**traditional**	natural	romantic	advanced	amusing	spiritual	casual
brand	love	y		y	y				y		y				y		y	y	
	delight			y	y	y									y				
	happy			y							y						y		
	comfortable	y	y		y		y	y	y	y			y						
	…		y			y		y		y			y	y					
product	skin kindness	y					y												y
	smoothness	y			y			y	y										
	balanced		y				y	y				y		y		y			
	moisturising	y																	
	…					y				y									y

Table 2: Matrix of Relevant Adjective Set against Original Seed Words

4 Concept Range Generation

It is vital that suitable concepts span all design possibilities and are appropriately presented to survey participants. Kansei Engineering Type 1 can be used to develop product concepts based on the original "Kansei" or feeling. However this technique was found unsuitable as decomposing a brand to feelings was highly subjective.

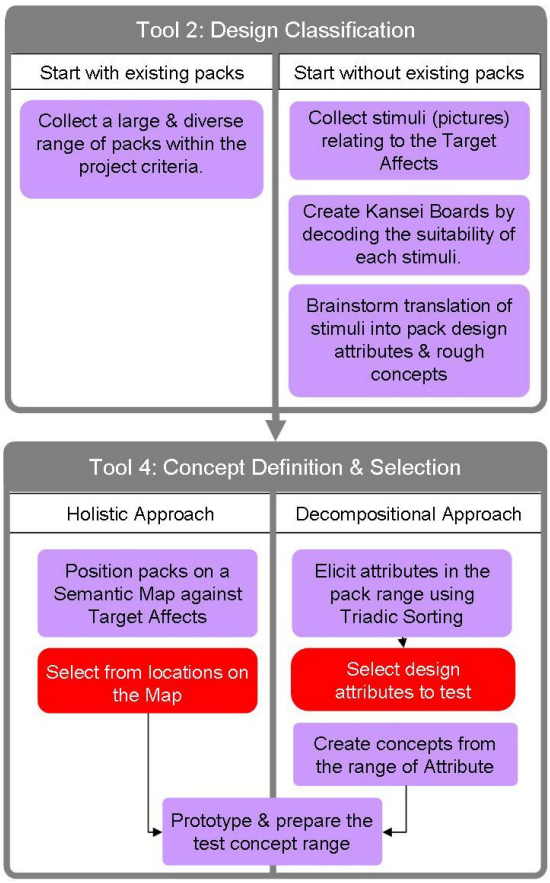
Because of the complexity of packaging, deconstructing into items and categories of attributes (as in Kansei Engineering Type 2) frequently results in many categories. Therefore qualitative research techniques are used to define the concept range by

providing preliminary insights through a more open structure than the semantic differential survey.

Our approach allows the toolkit to be used for incremental change of existing packs or to radically redesign the pack starting from a "blue sky" approach.

4.1 Tool 2: Design Classification

For incremental design, a large and diverse range of packs should be collected. However designing a totally new pack concept requires a more fundamental approach. Tool 2 supports the collation of a set of visual stimuli to be used as a starting point. Through the use of typically abstract pictures (from image libraries such as Gettyimages) the team creates 'Kansei Boards' by 'decoding' what elements in the stimuli create associations to the target brand qualities. This information is used as the inspiration behind a creative sketching and brainstorming activity to develop a large number of potential pack concepts.



4.2 Tool 4: Concept Definition and Selection

This tool takes the outputs of tool 2, either a set of existing packs or a set of original concepts and delivers 2 processes.

Concept Reduction Process: A Semantic Mapping process supports a representative selection of consumers to physically place pack prototypes on a 2 dimensional map, with axes defined by key product and brand attributes (e.g. clean and fresh or spirited and traditional). Participants find it easy to justify their concept placements which leads to insights into correlations between design attributes and affects. A reduced range of concepts can be selected to test based on the hypothesis that dispersed locations on the map represent a diverse range of concepts and attributes properties.

Preliminary Identification of Important Pack Attributes: This uses a triadic sorting exercise to define the important attributes necessary for multivariate regression techniques. It is based on the Repertory Grid Technique (Kelly, 55). Participants are asked to select 3 packs from the set and identify a likeness between 2 packs and define the contrast with the third. For example, a consumer might say, "Packs 4 and 9 are similar because they have a circular footprint and pack 14 is different as the footprint is square".

Having completed this exercise a number of times, a large number of pack attributes can be recorded that are "obvious" to the consumer. These can be prioritised according to frequency of observation or other design objectives.

4.3 Case study: Sample Range Generation for an alcoholic bottle design

We illustrate our description of the Sample Range Generation contained within Tools 2 and 4 by means of extracts from an industrial case study, in which we evaluated different packaging concepts for a modern bottle for a new alcoholic premixed drink.

Tool 2: Design Classification.
The project addressed the affect evaluation of an existing prototype so Kansei Board and concept generation was not carried out. Instead glass bottles were collected from a wide range of markets and brands. Overall 20 unique clear and brown bottles of volume appropriate to the product were collected and their labelling removed to avoid familiarity biases. Green bottles were not relevant to the product so were not included.

Tool 4: Concept Definition and Selection
Concept Reduction Process: The company selected the 2 axes on the semantic map as modern and American. A representative selection of consumers were given the set of glass bottles and asked to place them on the 2 dimensional grid. Participants were able to clearly distinguish between the suitability of the designs and afterwards could justify why designs were placed in each location. Figure 4 shows one result of the semantic mapping research experiment for the alcoholic premixed drink.

Figure 4: Semantic Mapping Exercise

Identification of Important Pack Attributes

Figure 5: Bottles Being Compared

Figure 5 shows a three bottles selected from the set presented to the participants of the triadic sorting exercise. The explanation of the selection was:

> *Bottles A & B are both clear and have convex collars, contrasting with bottle C which is brown and has an inverted collar.*

This exercise results in decomposition of the concepts into design attributes (even ones that are hard to describe). Participants can often relate the attribute to their preference and with further questioning rationalise their choices. For example participants felt the collar was a feature which contributed to the bottle's *Modern* style.
Results from the 2 exercises were used to inform the creation of a smaller range of bottles of priority attributes to the project domain.

5 Tools 5 and 6 –Consumer Survey and Interpretation

A self report semantic differential survey and statistical techniques similar to those in traditional Kansei is used to understand the underlying relationships.
Participant fatigue and the measurement of the affect that this has on participants' evaluations is a vital issue to the validity of the research. The changes introduced in this toolkit through the earlier tools result in a shorter survey length; this is accompanied by techniques in Tool 5 to uniquely order questionnaires for each participant to reduce fatigue affects.

5.1 Tool 5: Affective Consumer Survey

A statistically significant cohort of consumers is recruited and the pack concepts and adjective lists are prepared. A bespoke programme is used to facilitate data presentation, collection and analysis. It randomises order and polarity of the word pairs helping to reduce survey biases.

Bipolar adjectives (e.g. cosy - not cosy) are used across a 7 point Likert scale (strongly positive – neutral – strongly negative) to increase accuracy of responses and to eliminate misinterpretations from using antonyms. We also include additional questions to gather further insight and to allow us to better interpret the PCA results.

5.2 Tool 6: Affect Interpretation

This tool shows how to analyse the data gathered through the survey in Tool 5 and is very similar to a typical Kansei analysis. PCA reduces the data into orthogonal components and multivariate regression is used where possible to investigate which attributes contribute to eliciting each semantic response.

Pack concept results are plotted in semantic space and correlated with additional data for interpretation and design rule definition.

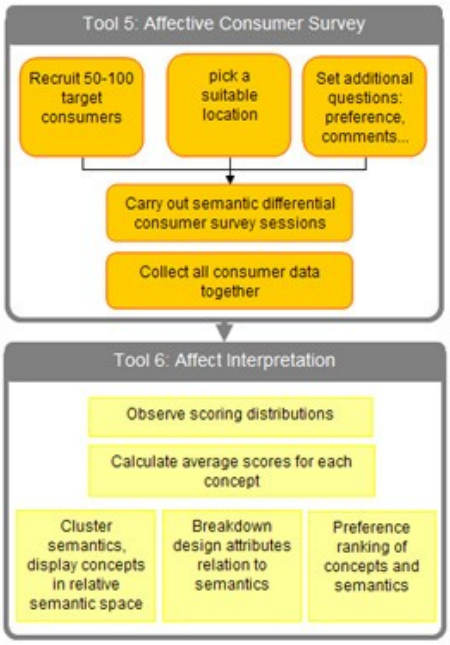


Figure 6: Tools 5 and 6

5.3 Case Study: Interpretation of data from glass bottles for Adult Sauce

We illustrate the setup and evaluation of the consumer survey through a research project to assess the suitability of candidate glass bottle shapes to communicate a brand and 'adult' image of a company's new flavoured sauce.

Tool 5: Affective Consumer Survey

(2) (5) (8)

Figure 7: Test Bottles

The survey tested a prototype design against 7 other glass bottles selected from existing products with similar volume & glass density. Figure 7 shows 3 of the designs. 10 adjectives were selected which closely represented the target packaging domain. 60 consumers took part in the study; they were presented with one bottle at a time and gave their adjective ratings and preference score using the bespoke software.

Tool 6: Affect Interpretation

Principal Component Analysis showed that participants' use of the adjectives could be simplified using 3 factors *Modernness*, *Adultness* and *Uniqueness* and the packaging concept were plotted against these as shown in Figure 8. The study found that the prototype bottle performed well against the range of evaluations, but bottle 2 was the most suitable to product and brand even though it scored low against *Unique*. Recommendations to increase the consumer perception of the prototype were made by assessing common features in well liked bottles. One such observation was that long necked bottles were seen as *appealing*. This provided a basis for further development and explained why consumers did not prefer the prototype.

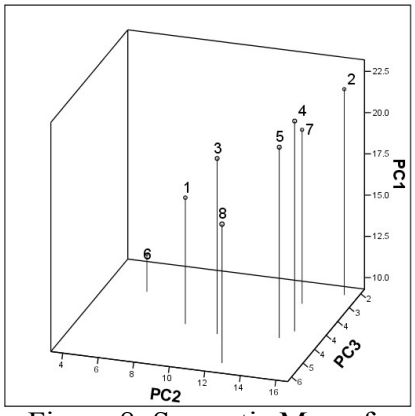


Figure 8: Semantic Map of Sauce Bottles

6 Summary

This paper has presented an overview of techniques to support and improve the well established Kansei Engineering process for use in the Packaging Industry. It has also shown how the philosophy of Kansei Engineering can be used innovatively to add new insights to design decision making. Although the case studies presented in this paper are packaging related, the toolkit has its roots in Kansei Engineering and so would provide insights for products as well.

Other applications of Kansei Engineering have been developed in the packaging industry and could be considered for the next development phase. For example, the use of artificial intelligence techniques to analyse coffee cans, milk cartons and beer packaging (Ishihara et al 97) showed how consumers clustered different packs by label design styles.

Kansei engineering and the techniques presented in this toolkit are inevitably simplifications of the real situation, since many more variables affect the consumers purchase decision than is tested in this process. There is still a need to test the insights gained by the toolkit into a wider investigation.

7 Acknowledgements

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