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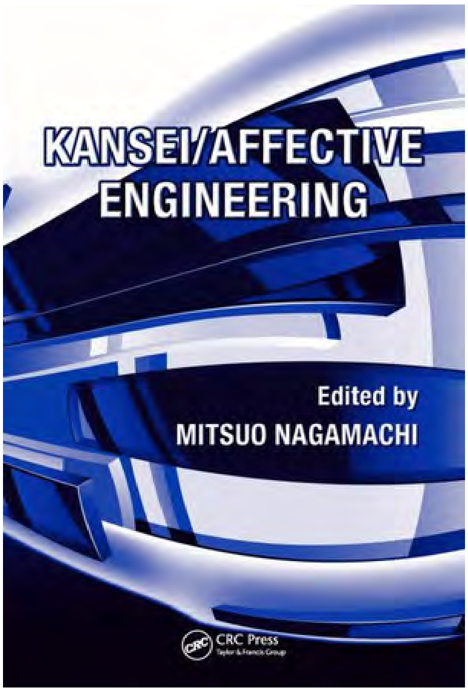

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Kansei/Affective Engineering and Web Design

Anitawati Mohd Lokman

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8.1 Introduction to Web Design

A Web site is a collection of related Web pages accessible using a domain name or IP (Internet protocol) address via the Internet or a private local area network. A Web page consists of contents such as text, images, videos, or other kinds of digital assets. Designing a Web site requires skill in creating presentations of content that is delivered ubiquitously through the World Wide Web. Typically, the basic components of Web design include content, usability, appearance, and visibility. Web site design, or Web design, may involve multiple disciplines in information systems, information technology and communication design, graphic design, human–computer interaction, information architecture, interaction design, marketing, photography, search engine optimization, and typography. Thus, to successfully produce a good Web site, a proper approach before one can start creating Web sites is required.

Web site architecture (WA) is an organized approach in planning and designing a Web site. Like the traditional architecture, WA involves technical, aesthetic, and functional criteria. Similarly, the main focus is on users and user requirements. Technical aspects of WA address the back-end components that deal with the underlying technology such as source code, data warehouse, and server-side component. It also addresses the business plan and the information architecture (IA), which deals with the structural design, method of organizing and labeling Web pages, and ways of demonstrating the Web site to the digital landscape. The aesthetic aspect addresses the user friendliness of the Web site and the visual and audible impressions. Functional aspects deal with the front-end components, which include usability, visibility/searchability, and accessibility.

8.1.1 Positioning Kansei/Affective Engineering in Web Design

In the process of designing Web sites, the aesthetic and functional criteria require particular attention to *user experience* (UX), the term used to describe the experience that a user has as a result of his or her interactions with the Web site. The consequences of UX in Web design result from the user's perception toward the elements of functional and nonfunctional qualities. Perception of functional qualities particularly lies in the usability and usefulness of the Web site. On the other hand, perception of nonfunctional qualities particularly lies in the aesthetic aspect, which includes visual and audible quality of the Web site. The most important component that cannot be neglected is the affective qualities that address the aspect of feelings, reaction, appraisal, and behavior from users. Affective qualities encompass both the components of functional and nonfunctional qualities.

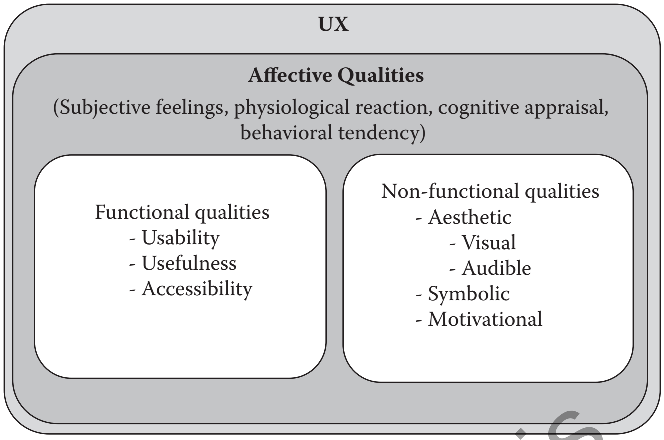

FIGURE. 8.1
Elements of UX in Web design.

In the process of designing Web sites, designers have been putting effort into what the user wants in order to come out with the desired result. However, by its very nature and similar to any kind of software system, Web design always produces conflicts regarding designer specification and user conformance. In realizing the concept in terms of Web site appearance, designers often misunderstand the description provided by users or user advocates, who in turn do not really understand the concept that they actually want. Designers possibly come out with the specification by their own intuition and creativity. Another problem is that even though the users may have well described the concept that they want, the designer's side has no clue on the design requirements to produce the kind of Web site that the users have described.

Kansei/affective engineering (KAE) provides a systematic way of understanding the insights of user perceptions toward artifacts via several physiological and psychological measurement methods. These insights are then translated to the design characteristic of the artifact. This approach of KAE matches the concern of requirement specifications to correspond to the foundation of UX in Web design, providing the possibility for users to express their concept and providing clues to designers in the form of design requirements so that the designer can objectively develop the desired Web design. In every aspect that contributes to the desired UX, where the design needs to match the insights of the users' experience, KAE is seen as a possible requirement generation technique. The implementation of KAE in every possible aspect of UX in Web design will enable the identification of the concept of Kansei in Web design and the contributing design specification to the concept in the form of design requirements.

8.2 Engineering Kansei in Web Design

This chapter attempts to demonstrate the implementation of KAE in Web design, focusing on the visual quality of design that shapes one of the elements that have consequences on the user experience. The detail of the implementation is described in the following sections, beginning with the building of a reference model for the implementation of KAE in Web design.

8.2.1 Structuring the KAE Method into Kansei Design Model

From the review of KAE literature, a gap in terms of the description of steps to be performed in the implementation method of Kansei engineering was identified. There are many types of techniques in different kinds of implementation, but the description of the method is largely narrative. For this reason, based on previous literature involving the adoption of KAE, setting the foundation to the basic principles of KAE, the method is structured into a model called the *Kansei design model*. In structuring the model, careful attention was given to the capacity and availability of infrastructure, facilities, and cost. The structured model employs a self-reporting method in the measurement of Kansei, allowing KAE implementation in a basic environment where no special equipment and skills are required. With this model, the audience can have a useful guide to the implementation of KAE.

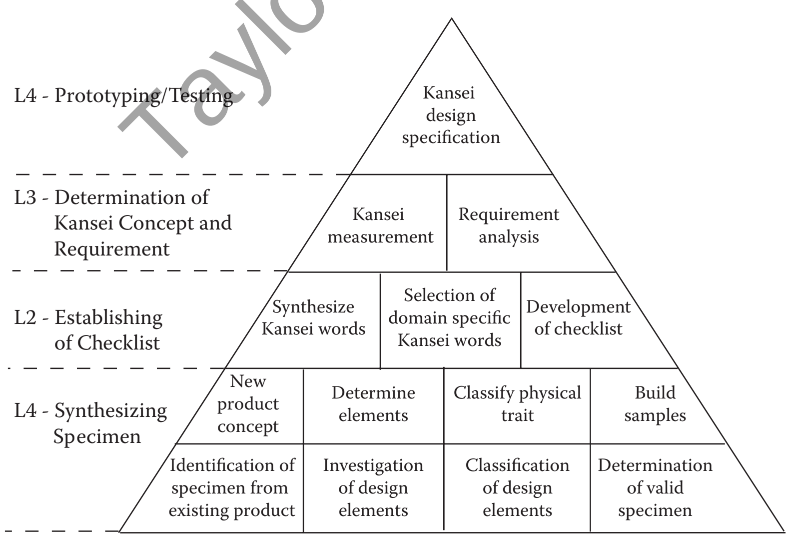

FIGURE 8.2
The Kansei design model.

The model is developed to provide a systematic approach to the implementation of KAE in designing Kansei products. The model presented is a useful mechanism for industries, designers, academic researchers, and other stakeholders in discovering Kansei concept, and design requirements for the development of Kansei products. The model is divided into four levels: L1, L2, L3, and L4. The following sections describe details of each level.

8.2.1.1 L1: Synthesizing the Specimen

L1 is the level of synthesizing the specimen. The level is subdivided into two different procedures, PI and PII. These procedures differ in the process of synthesizing the specimen. There are four steps in both PI and PII, which are essential in determining a valid specimen. The procedure can be decided according to one's objective.

PI is applicable to products that already exist in the market where the maker needs to improvise the design. The procedure begins with a collection of samples with visible differences from existing products in the market within a specific domain. KAE emphasizes controlling the domain, as the consumer's response is unique with different domains (Nagamachi, 2003; Ishihara et al., 2005). Previous KAE studies have suggested different techniques for determining specimens from using actual products and using pictures of product. The choice of specimen depends on its suitability to the experimental design.

Then, the following procedure is the process of investigating design elements in all samples. Determination of the number of design elements depends on the level of detail that needs to be included in one study. Controlling the number of elements enables a more objective measurement. On the other hand, including all identifiable elements from the consumer's point of view enables a more accurate measurement. The latter ensures the accuracy of design requirements as an outcome of a study, as consumers are assessing a product as a whole. To match the consumer's emotional response to design elements, this chapter suggests that controlling the number of elements will produce a less accurate result.

The next procedure is the classification of design elements. The identified design elements are further classified into item and category. *Item* is the type of common physical traits of all specimens such as background color, body shape, and text alignment. *Category* is the specific attribute of the item in each specimen, such as red as a background color of specimen A, and blue as a background color of specimen B. The process is crucial since the findings will be the essence in the success of the requirement analysis stage. Finally, based on a set of rules, a valid specimen for Kansei measurement can be synthesized among all the initial samples.

PII, on the contrary, is designed for application when a company or designer plans to design a new concept of a product based on their objectives. This is applicable to the development of product that has yet existed on the market. In this case, designers and experts have to determine product specifications based on their inspiration in relation to the target concept. For instance, to design an *elegant* mobile phone, the process begins with synthesizing words related to the concept of *elegant* within the domain. Then, designers or experts have to determine design elements that have a connection with an elegant feeling, classify the physical traits, and build a number of prototypes based on the technical specification. This prototype will then be used as a specimen at the following level of the model to confirm their design with consumers.

8.2.1.2 L2: Establishment of Kansei Checklist

L2 describes preparation and establishment of Kansei checklist. The level is divided into three steps: (1) synthesizing Kansei words, (2) selection of domain-specific Kansei words, and (3) development of checklist. The level synthesizes Kansei words, from a larger number of possible Kansei words to focused Kansei words that highly related to the product domain. Kansei words can be adjectives, such as *calm*, *sophisticated*, and *natural*, or nouns. These Kansei words can be synthesized from pertinent literature, technical magazines, or even consulting experts. Finally, utilizing the Kansei words, L2 produces a Kansei checklist in the form of the semantic differentials (SD) scale as a measurement tool for Kansei measurement in the next level.

8.2.1.3 L3: Determination of Kansei Concept and Requirement

L3 describes determination of the Kansei concept and requirement. This level is divided into two steps: (1) Kansei measurement, and (2) requirement analysis. In the first step, Kansei measurement is performed using expert or ordinary consumers as test subjects. The subjects are required to rate their impressions toward product specimen on the Kansei checklist. Results from the evaluation will be analyzed to interpret links between subjects' Kansei and design elements identified in L1. The outcome can be used to determine design requirements for the development of the Kansei product.

8.2.1.4 L4: Prototyping/Testing

L4 describes prototyping/testing. In this final level, the results from L3 will be used as the foundation to build a prototype of the Kansei product. The process will involve the employment of the Kansei concept and design requirements identified in L3. To develop a successful Kansei product, experts' creativity should be included in the design process. Testing may be performed to validate the design requirements.

8.3 Demonstration of the Kansei Design Model Implementation in Web Design

This section demonstrates the implementation of the constructed Kansei design model in Web design to explore the potential of Kansei engineering in Web design.

8.3.1 Synthesizing the Specimen

In order to implement KAE in Web site interface design, the first procedure, PI, of the Kansei design model is adopted. The procedure is applicable in engineering the Web site interface designs and provide guidelines for designers to improvise Web site interface design into Kansei design. This section focuses on the context of interface design that is visible to users of clothing Web sites.

Four stages are involved in implementing level 1 of the model:

1. Identification of initial specimens
2. Investigation of design elements
3. Classification of item and category
4. Finalizing valid specimen

8.3.1.1 Identification of Initial Specimens

Table 8.1 shows the controls and criteria used to select initial specimens as part of preparation of the instruments to be used in the Kansei measurement process.

In identifying the initial specimens, 163 Web sites were selected based on their visible design differences in both content and layout context (color, typography, layout, etc.). These Web sites were chosen according to their listing on the Apparel Search Web site (http://www.apparelsearch.com). Apparel Search is the leading online clothing directory and has the categorization structure that helped in selecting Web sites.

8.3.1.2 Investigation of Design Elements

Each component within the basic structure of the Web site was used as the basis during the empirical investigation of all design elements that compose all of the 163 specimens. The design elements are broken down into item and category so that clear categorization of designs can be organized. In total 77 items have been identified from the empirical investigation. These items

TABLE 8.1

Control Condition

No.	Item	Condition
1.	Web site criterion	Visible differences in design
2.	Focus context	Design content and layout
3.	Screen resolution	1024 × 768 pixels
4.	Access/download date	June 1–30, 2006
5.	Platform	Win32
6.	Operating system	Windows XP
7.	Color quality	32 bit
8.	Browser	Opera 9.00
9.	Browser control	Encoding = Windows-1252 Default language = English, [en] Default Text Size = Medium Colors = Windows 32 bit color
10.	Encoding	Windows-1252
11.	Language	English
12.	Default text size	Medium (3 pt)

were then investigated individually from each Web site to identify categories assigned to each. Table 8.2 summarizes all design elements in the 163 Web sites that are transparent from the viewpoint of Web site visitors.

8.3.1.3 Classification of Item and Category

In the context of the basic structure of a Web page, each specimen may comprise all or part of the elements within each section: Body (refers to the layer that a Web page may reside on), Page (refers to the page of a Web site), Header (refers to the head section of the Web page, which may contain the menu), Top Menu (refers to the menu on the top of the page), Left Menu (refers to the menu on the left pane of the Web page), Main (refers to the main body of the Web page), Right Menu (refers to the right menu on the right pane of the Web page), and Footer (refers to the footer of the Web page, which may contain a menu). The Web page may also contain pictures and other elements such as artistic menus and logo. From the set of items identified in the previous section, the classifications of categories are identified that form the different characteristics of Web site designs. Table 8.3 gives examples of item and category to be investigated from all specimens. A total of 77 item and 249 category of Web site design elements were identified.

To simplify the organization of the huge amount of data, all the identified design elements (item and category) were organized into specimens by design elements matrix. Each specimen was carefully investigated to check the item and category that make up the characteristic of the specimen.

TABLE 8.2

Item Identified from the Initial Specimens

Section	Item
Body	Background color, background style
Page	Shape, menu shape, style, orientation, color, size, border existence
Header	Existence, background color, background picture existence, font size, menu existence, menu link style, menu background color, menu font size, menu font family, menu font style
Main	Background color, background picture existence, shape, adv. Existence, text existence, text alignment, font color, font size, font family, font style
Top menu	Existence, location, link style, background color, font color, font size, font family, font style
Right menu	Existence, style, font size
Left menu	Existence, link style, background color, font color, font size, font family, font style
Footer	Existence, menu existence, menu link style, menu background color, menu font color, menu font size, menu font family, menu font style, shape
Picture	Existence, size, dimension, focus, arrangement, style, image used?, No of people in 1 picture, body representation type, face expression, face facing? Empty space? Other images? Product display style, product try on? Product view style
Others	Dominant item, artistic menu used? Discount advertisement existence, logo existence, logo location

TABLE 8.3

Example of Design Item and Category

Item	Category
Page background color	Blue
Left menu style	Button
Main text size	Medium

When the category matched the investigated specimen, then the matrix was checked. The process is repeated until investigation of the 249 categories in all specimens is completed. Although the construction of a matrix does not substantially reduce the amount of work, which is impossible, it offers easy management of the knowledge by providing orderly data organization. The matrix data also alleviate the screening procedure, involving 249 categories in 163 specimens, for identifying a valid specimen.

8.3.1.4 Finalizing Valid Specimen

Results from the item/category classification stage were then examined according to the following rules in conformance to KAE methodology

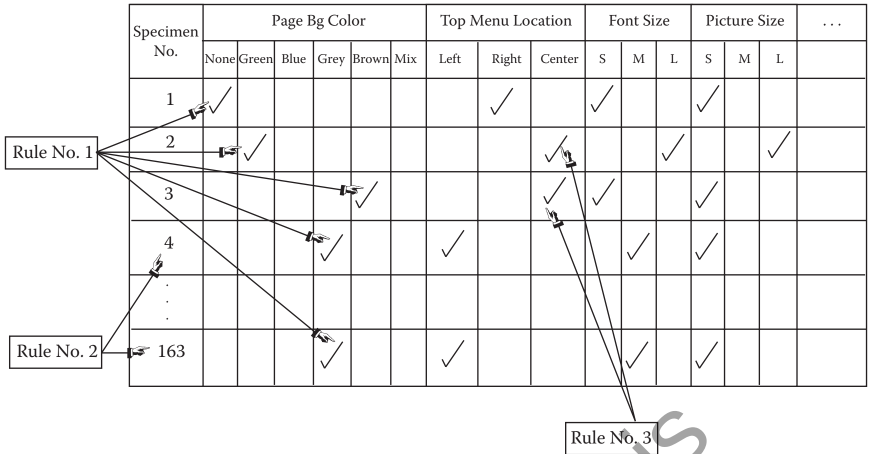

FIGURE 8.3
Rules in screening specimens.

1. For each sample, only one category under one Item is ticked.
2. Only one sample will be taken if exactly the same category under each Item is ticked for more than one Web site.
3. Take two or more sample Web sites where same category is ticked.

Figure 8.3 illustrates how the rules are executed in screening the Web site specimen to identify valid samples.

Conforming the first rule, for Page Bg Color every specimen must only have one color checked. Secondly, specimens 4 and 163 have exactly the same result, so only one can be included as a valid sample. Finally, two or more samples of the same category, for example Top Menu Location and Center in specimens 2 and 3, must be included. This simple set of rules has helped narrow down the previously identified 163 initial specimens into a smaller number to be used as valid specimens in the empirical studies. Although the rules followed are simple, the screening of 249 categories of more than 163 specimens was enormously demanding. With careful attention, 35 Web site specimens were finally concluded. The specimens were coded numerically from 1 to 35. A snapshot of the specimens is shown in Figure 8.4.

8.3.2 Establishment of Checklist

This section develops the Kansei checklist as one of the instruments to be used in Kansei measurement and describes the stages of the establishment of the checklist.

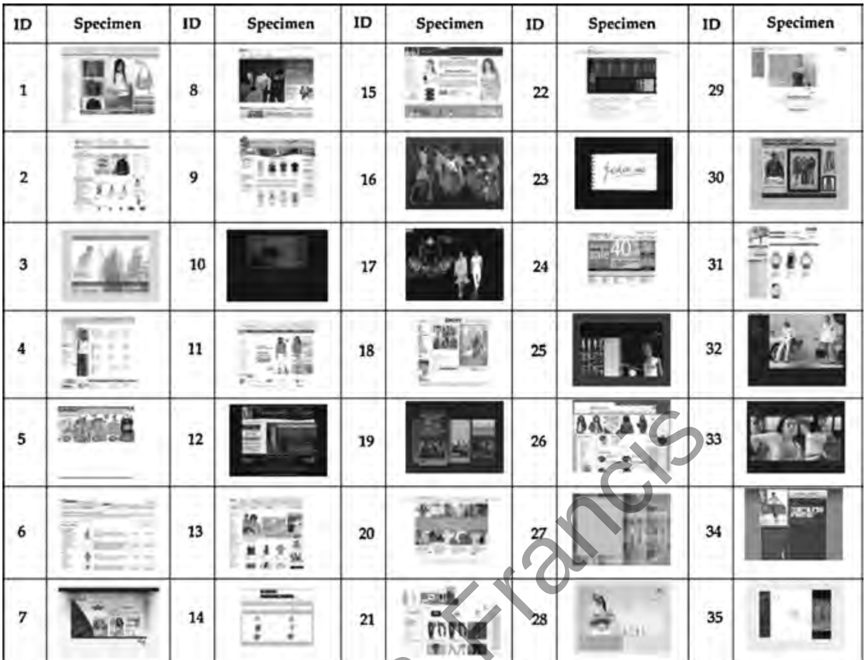

FIGURE 8.4
The 35 valid specimens.

8.3.2.1 Checklist Development

A checklist is developed as one of the instruments used as measurement tools. The checklist comprises Kansei words that are identified according to the steps described in the following sections. The Kansei words are used as the measure of strength of the Kansei, that is, the emotional responses that subjects feel when looking at the Web site.

8.3.2.2 Synthesize Kansei Words

A set of Kansei words was selected based on frequency of appearance in Web design guidebooks, Web sites, research papers, and journals. Additionally, general Kansei words were added according to relevance in describing Web sites. A total of 40 words were then finalized to be used in the experimental procedure. Some of the synthesized words were *adorable*, *classic*, *creative*, *elegant*, *lovely*, *masculine*, and *sophisticated*.

8.3.2.3 Development of Kansei Checklist

The 40 Kansei words compiled in the earlier section were then organized into a 5-point SD scale to form the Kansei checklist. This checklist will be used as a measurement tool for investigating users' Kansei.

8.3.3 Determination of Kansei Concept and Requirement

In determining the Kansei concept and design requirement in Web design, two stages of activities were performed. The following subsections describe the stages.

8.3.3.1 Kansei Measurement

The first stage describes the process of Kansei measurement that is performed to evaluate visitors' Kansei responses when interacting with Web sites. This stage consists of the core activities involved in engineering emotion in Web site design. The instruments and equipments used in the Kansei measurement procedure are the Kansei checklist, 120 test subjects, the screenshot of the 35 valid specimens, a computer, and one large LCD screen.

1. Instrumentation. The instruments involved in the experimental procedure are as follows:
   a. The 35 valid specimens. The specimens were coded numerically from 1 to 35. A snapshot of all specimens can be found in Figure 8.4.
   b. The Kansei checklist, which consists of 40 Kansei words organized in a 5-point SD scale. The order of Kansei words was organized into five different arrangements to minimize bias in the evaluation process. A full Kansei checklist can be found in Appendix 5.7.
   c. One hundred and twenty test subjects. Subjects for the empirical study were employed with equal distribution of male and female subjects of 30 people in four groups. A total of 120 undergraduate students from
      - Information Technology and Quantitative Science Faculty (IT)
      - Architecture, Building, Planning, and Survey Faculty (AD)
      - Business and Management Faculty (BM)
      - Engineering Faculty (ER)

      from the author's university were recruited for the empirical evaluation. All of them were in their 20s, Internet users, and familiar with online shopping. The suitability of the employment of young students as subjects in this research is supported by the literature in information system studies that suggests students and youngsters represent the majority of e-commerce consumers (Saarenpää and Tiainen, 2005). Therefore, they are the best consumer demographic group to be studied. On the other hand, the population of subjects in this research was decided based on the suggested number in KAE methodology. Although the population of test subjects varies from a minimal number such as five to more than a thousand in different KAE implementation, depending on objectives and measurement tools used, the suggested number for this kind of consumer research is around 30–50 subjects (Nagamachi, 2003; Nagamachi and Lokman, 2010).

In the research, in an effort to explore differences in educational background, a total of 120 students from four different academic backgrounds were chosen. Additionally, to facilitate balance of gender population, equal distribution of subject numbers—15 females and 15 males—was employed in each group.

2. Evaluation. Four Kansei evaluation sessions were held separately for each group. During each session a briefing was given before the subjects began their evaluation exercise. The 35 Web site specimens were shown one by one on a large white screen to all subjects in a systematic and controlled manner. Subjects were asked to rate their feelings on the checklist according to the given scale. Subjects were given 3 minutes to rate their feelings toward each specimen. They were given a break after the 15th Web site specimen, to refresh their minds. The order of the checklist was also changed to eliminate bias. Each Kansei evaluation session took approximately 2 hours to complete.

8.3.3.2 Requirement Analysis

This stage is performed to conceptualize Kansei in Web site design and to analyze design requirements. Multivariate analyses were performed to find empirical evidence toward the goal of engineering emotion in Web design. The outcomes of the analyses were used to propose a guideline to the design of a Kansei Web site. We calculated the average Kansei evaluation value of each sample obtained from all subjects from the experimental procedure. These averaged data from the evaluation results were used in the calculation of the multivariate analyses.

Factor analysis (FA) was used to analyze Kansei concept, and partial least squares analysis (PLS) was used to analyze relationships of design and Kansei.

8.3.3.2.1 The Kansei Concept

The research performed FA to determine the concept of Kansei in Web design. Table 8.4 shows the result of FA after varimax rotation. Varimax rotation, which was originated by Kaiser (1958), is the most popular

TABLE 8.4
Factor Contribution

Factors	Variance	Contribution	Cumulative Contribution
Factor 1	16.09262	40.23%	40.23%
Factor 2	12.29421	30.74%	70.97%
Factor 3	3.427578	8.57%	79.54%
Factor 4	1.856272	4.64%	84.18%
Factor 5	1.810882	4.53%	88.70%
Factor 6	0.923415	2.31%	91.01%
Factor 7	0.370649	0.93%	91.94%
Factor 8	0.250962	0.63%	92.57%

rotation method that simplifies the interpretation of variables. In the table, it is evident that the first factor explains 40.23% of the data and the second factor explains 30.74% of the data. Both factors represent the majority of factor contributions. This shows that Factor 1 and Factor 2 have a dominant influence on Kansei words. The first two factors together represent 70.97% of the variability, while three factors explain 79.54% of the variability. Thus, the research considered including the third factor to increase the proportion that represents most of the data. The proportion of variability explained by the fourth factor and the rest are minimal (4.64% and less), and they probably can be ignored as they can be considered insignificant.

Table 8.5 shows factor loading results after varimax rotation. The table shows factor results in ascending order. The structure of Kansei words is observable from the table. Variables that have a high score are perceived as significant factors in Web site design. The research set approximately 0.7 as the reference score and cross-checked with the result of correlation coefficient analysis (CCA) to draw conclusions. The fourth and fifth factors were included since they can be regarded as having a clear image on the Web site Kansei, even though the score is slightly lower. Henceforth, the conclusion from the results of FA was that the Kansei concepts of Web design are structured by five factors: *sophistication*, *elegant-beauty*, *simplicity*, *lightness*, and *tidiness*. These five factors altogether explain 88.70% of the total data.

The first factor, *sophistication*, consists of mystic, futuristic, masculine, luxury, sophisticated, surreal, impressive, gorgeous, cool, and professional. The second factor, *elegant-beauty*, consists of feminine, chic, beautiful, cute, sexy, charming, adorable, and elegant. The third factor, *simplicity*, consists of simple and plain. The fourth factor, *lightness*, consists of light. The fifth factor, *tidiness*, consists of neat and natural.

As can be seen from the result, the first and second factors explain most of the data; *sophistication* and *elegant-beauty* represent 70.97% of data. Thus, these two factors are very important Kansei concepts. This indicates that all

TABLE 8.5

Factor Loading for Kansei Words

Variable	Factor 1	Variable	Factor 2	Variable	Factor 3	Variable	Factor 4	Variable	Factor 5	Variable	Factor 6
Professional	0.805803	Pretty	0.689458	Sexy	0.272922	Impressive	0.202914	Lively	0.201622	Adorable	0.046115
Cool	0.811333	Lovely	0.690027	Classic	0.275441	Masculine	0.211368	Lovely	0.207907	Creative	0.055077
Gorgeous	0.812754	Elegant	0.703414	Boring	0.308598	Adorable	0.21181	Beautiful	0.239447	Classic	0.063075
Impressive	0.822734	Adorable	0.713039	Light	0.313839	Cool	0.284239	Relaxing	0.247409	Light	0.066423
Surreal	0.846445	Charming	0.763686	Neat	0.319281	Interesting	0.308149	Light	0.274663	Plain	0.066736
Sophisticated	0.848426	Sexy	0.787619	Calm	0.339163	Comfortable	0.320447	Calm	0.302602	Chic	0.131081
Luxury	0.878831	Cute	0.794058	Relaxing	0.348516	Lively	0.328505	Comfortable	0.328556	Old-fashioned	0.144072
Masculine	0.899118	Beautiful	0.816958	Natural	0.424887	Refreshing	0.390941	Refreshing	0.354777	Fun	0.222652
Futuristic	0.913165	Chic	0.93916	Plain	0.839005	Fun	0.49998	Natural	0.604973	Cute	0.276694
Mystic	0.941857	Feminine	0.948707	Simple	0.9241	Light	0.610599	Neat	0.738318	Childish	0.633318

Web sites should have these two factors in order to produce optimum results. *Simplicity*, *lightness*, and *tidiness* are also important but have weaker influence. Therefore, it is suggested that these factors be used as background/supporting elements in Kansei Web site design.

8.3.3.2.2 Analyzing the Relationship of Design and Kansei

In analyzing design requirements, PLS analysis is used to link the Kansei responses with design elements. In this analysis, there are three sets of data used:

1. The dependant (objective) variables, *y*, that is, the 40 sets of Kansei responses by 120 subjects.
2. The sample, *s*, that is, 35 Web sites.
3. The independent (explanatory) variables, *x*, the design elements (design category).

As mentioned earlier, the investigation of design elements has resulted in 77 design items composed of 249 categories. For PLS analysis purposes, all these categorical variations were converted into dummy variables. The result of averaged data, for example, *adorable* data, was then appended to the next column right after the last column of design category. This research has 40 predictors and therefore the analysis was repeated 40 times, exchanging the predictor into the last column. An instance from the result for the Kansei score by design category can be found in Table 8.6.

The research analyzed the result of the PLS coefficient score to determine relations between Kansei and design elements. In order to determine the influence of design elements to Kansei, PLS *Range* for each Kansei was calculated. The calculation of *Range* enables the identification of design influence, good design and bad design. *Range* is calculated using maximum and minimum value, where

$$Range = \mathrm{PLS}_{\mathrm{Max}} - \left|\mathrm{PLS}_{\mathrm{Min}}\right|$$

Mean of *Range* is calculated, where

$$\overline{Range} = \frac{1}{n}\sum_{i=1}^{n} Range_i$$

Each Kansei has means of *Range*, and if the mean value of a category is larger than $\overline{Range}$, the item is considered to have good influence in design. *Range* for every category having value larger than $\overline{Range}$ implies a best fit category that highly influences users' Kansei in Web site design.

TABLE 8.6
PLS Coefficient Values

	Kansei					
Category	**Adorable**	**Appealing**	**Beautiful**	**Boring**	**Calm**	**Charming**
BodyBgColor-White	−0.0365510	−0.03699	−0.01674	0.024457	−0.02534	−0.0355
BodyBgColor-Black	0.0065448	0.011992	−0.01374	−0.00265	0.028478	0.005989
BodyBgColor-DKBrown	0.0604354	0.067045	0.018645	−0.03459	0.034535	0.062087
BodyBgColor-LtBrown	0.0132480	0.011571	−0.00476	0.006006	0.017753	0.021147
BodyBgColor-Gray	0.0293157	0.036547	0.050832	−0.044	0.006308	0.033964
BodyBgColor-LtBlue	0.0214068	0.004199	0.01559	−0.01155	−0.01207	0.005272
PageMenuShape-Curve	0.0005942	−0.01064	0.006802	−0.00788	−0.00697	−0.01168
PageMenuShape-Sharp	−0.0122160	−0.00199	−0.02235	0.021834	0.006232	−0.00213
PageMenuShape-Mix	0.0286988	0.024137	0.042154	−0.03895	−0.00256	0.026368
PageStyle-Frame	0.0340362	0.025436	0.027154	−0.03955	0.005176	0.005524
PageStyle-Table	−0.0420300	−0.03508	−0.02236	0.04195	−0.01811	−0.01117
PageOrientation-BC	−0.0447260	−0.04155	−0.03098	0.026269	−0.03299	−0.0298
PageOrientation-Content	0.0326846	0.037362	0.004381	0.011088	0.024659	0.034727
PageOrientation-Header	−0.0546260	−0.05817	−0.03232	0.037364	−0.03451	−0.06225
PageOrientation-HF	0.0157878	0.015311	0.026275	−0.01806	0.00773	0.014688
PageOrientation-H Split	0.0228924	0.02168	0.004236	−0.01846	0.016584	0.022154
PageOrientation-V Split	0.0189942	0.034075	0.030549	−0.02336	0.016852	0.028757
PageOrientation-Plain	0.0241808	0.019132	0.007982	−0.01443	0.015297	0.005532
DominantItem-Pict	0.0467300	0.048044	0.030602	−0.04358	0.014746	0.050762
DominantItem-Adv.	−0.0296800	−0.03225	−0.01741	0.019399	−0.00744	−0.02078
DominantItem-Text	−0.0561230	−0.04549	−0.02663	0.050166	−0.00284	−0.04293

TABLE 8.7

Design Influence in Kansei

Design Influence No.	Adorable		Appealing	
	Design Element	**Range**	**Design Element**	**Range**
1	Page Color	0.11488	Header Bg Color	0.12338
2	Product Display Style	0.10644	Face Expression	0.12216
3	Header Menu Bg Color	0.10612	Header Menu Bg Color	0.12077
4	Left Menu Font Color	0.10370	Product Display Style	0.10646
5	Header Bg Color	0.10218	Body Bg Color	0.10574
6	Face Expression	0.10024	Page Color	0.10091
7	Body Bg Color	0.10015	Left Menu Font Color	0.10085
8	Dominant Item	0.09980	Picture Style	0.09771
9	Header Font Size	0.09651	Page Orientation	0.09182
10	Main Text Existence	0.08813	Dominant Item	0.09141
11	Main Bg Color	0.08587	Main Text Existence	0.08811

In every category, maximum value shows best fit value of design elements that influence the Kansei, and minimum value shows the worst value of design elements that influence the Kansei.

Table 8.7 shows an example of the result of the selected category for which *Range* has value larger than $\overline{Range}$, for each Kansei. The results are sorted in descending order to illustrate dominant design category for each Kansei.

The result shows that in designing an *adorable* Web site, the designer must set priorities to design elements according to higher order of influence, such as page color, product display style, header menu background color, left menu font color, and so forth. On the other hand, in designing an *appealing* Web site, the designer must set priorities to design elements according to higher order of influence, such as header background color, face expression, header menu background color, and so forth.

8.3.3.2.3 Proposing Kansei Web Design Guidelines

All the above analyses have enabled the research to propose Kansei Web Design Guideline, a guideline to the design of Kansei Web sites. Results of Kansei structure from FA are used to conceptualize Kansei, and results from PLS scores are used to compose the design requirement. The design requirements included in the guidelines are the elements that have high influence in eliciting each Kansei. Table 8.8 shows examples of the results of the established guideline.

To effectively utilize the guideline, the audience and especially designers are advised to select the best combination possible from a Kansei concept that may consist of one or more Kansei elements. It should be noted that it is important to blend designers' creativity with the guideline to ensure the

TABLE 8.8
Customer Needs Direction Effect Measure (E)

Customer Needs Direction	*Supp*	*Cer*	*Eff*
Simple and Advanced and Beauty	41	0.569	1.387
Simple and Advanced and Young	41	0.569	1.387
Advanced and Original	77	0.535	1.303
Handiness and Original and Young and Functional	50	0.521	1.269

success of the Kansei product (Nagamachi, 2008), in this case an e-commerce Web site. To illustrate an example of the guideline, design elements for the Kansei *mystic* should be interpreted as follows:

Body background color should be in black.
Body background style should be in texture of color tone.
Page shape should be not specific.
Page orientation should be plain.
Dominant item should be picture, and so on.

In KAE, the success of a Kansei design product relies on the idea implied from the result of Kansei evaluation, blended with technical expertise of the designer. In the design process, the guideline should be referenced by and technical specifications must be provided by the expert.

8.3.4 Prototyping/Testing

The chapter performed two stages of activities for the purpose of validation of the successful implementation of the Kansei Design Model in engineering Kansei in Web design. The chapter developed several prototypes using the proposed guideline, and then conducted Kansei evaluation to see if there are any difference in Kansei responses after the implementation of the guideline.

8.3.4.1 Prototyping

In the KAE approach, a designer will design a new product based on a Kansei concept identified from FA results. In the case of this research, in performing confirmatory study, the research attempts to design a Kansei Web site to be used as a specimen. Although a combination of Kansei factors are ideal, in the case of Web site design, due to the large number of design variables, it is almost impossible to combine Kansei factors. For confirmatory purposes, such attempt was conducted where five Kansei were selected and the individual guideline then was used as a foundation for design specimens. The five Kansei were selected from factors 1, 2, and 3 and referred to the pro-

TABLE 8.9
The Selected Kansei Guideline

	Kansei				
Design Element	**Cute**	**Feminine**	**Luxury**	**Masculine**	**Simple**
Body Bg Color	Light Blue	Light Blue	Black	Black	Dark Brown
Body Bg Style	Texture	Texture	Color Tone	Color Tone	Picture
Page Shape	Sharp	Sharp	Sharp	N/S	Sharp
Page Menu Shape	Mix	Mix	Sharp	Sharp	Sharp
Page Style	None	None	None	None	None
Page Orientation	Footer	Footer	Vertical Split	Header	Content
Dominant Item	Picture	Picture	Picture	Picture	N/S
Page Color	Gray	Pink	Black	Blue	Brown
Page Size	Small	Small	Small	Medium	Medium
Other Images?	Animal	Animal	Animal	Animal	Kids
Product Display Style	Filmstrip	Filmstrip	Filmstrip	Filmstrip	Catalog
Product Try On	Yes	Yes	Yes	Yes	Yes
Product View Angle	Rear	Rear	Mix	Side	None
Artistic Menu?	Yes	Yes	Yes	Yes	No
Empty Space?	Less	Less	Less	Less	More
Discount Ad. Existence	No	No	No	Yes	Yes

posed guideline presented earlier. Table 8.9 shows an example of the selected Kansei and guideline.

The guidelines were carefully followed in the development of prototypes to be used as specimens in the confirmatory study. Figure 8.5 shows an example of the developed *cute* Web site to give an illustration of how the guideline is used in the formation of the Web site. It should be noted that the guideline is to be used to support the designer's creativity by providing design requirements to the anticipated Kansei.

Other than the above Web site, the research has developed four prototypes, and altogether five prototypes were developed to be used as a specimen in the experimental procedure. Figure 8.6 shows a snapshot of the developed five specimens.

8.3.4.2 Testing

To test the success of the guideline implementation in the prototype, a comparative study was conducted using two sets of data:

1. The exploratory data—The data extracted from initial study described in earlier sections.
2. The confirmatory data—The data obtained from Kansei evaluation performed using the prototype.

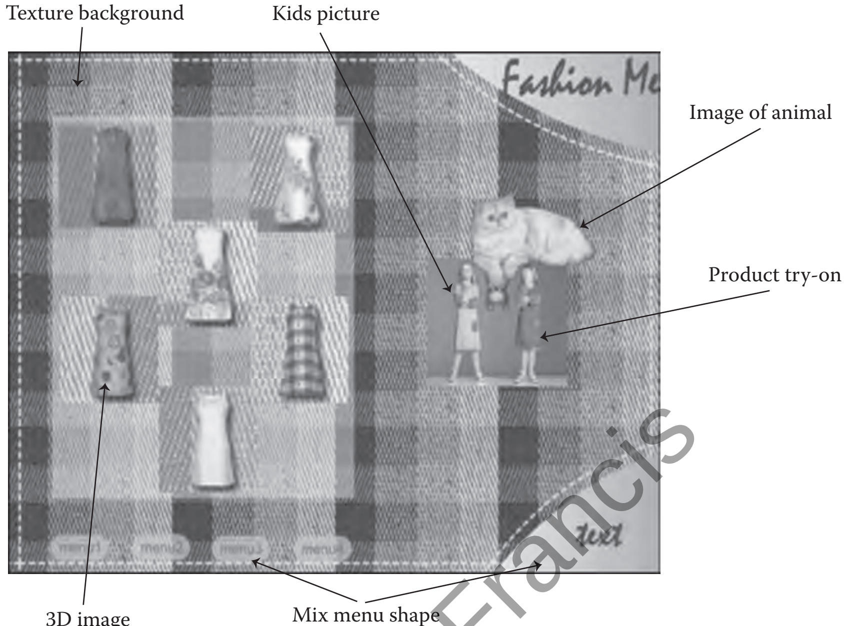

FIGURE 8.5
Example of design requirement for *cute* Web site.

ID	KANSEI	SPECIMEN	ID	KANSEI	SPECIMEN
1	CUTE		4	MASCULINE	
2	FEMININE		5	LUXURY	
3	SIMPLE				

FIGURE 8.6
Confirmatory Web site specimen.

8.3.4.2.1 Extracting the Exploratory Data

Exploratory data are the data extracted from exploratory study results. In the process of identifying which data to extract, the research performed the following procedures:

1. Data coding to segregate all data from 15 good subjects
2. Random generator to select 5 specimens
3. Calculate averaged evaluation value from the 15 good subjects

In the process of extracting data, the Microsoft Excel random generator was used to select the five specimens. Exploratory data were finalized by filtering all the data using the generated sample ID number. Average data were calculated using the filtered data and labeled as the *exploratory data* to be used in the comparison procedure.

8.3.4.2.2 Obtaining Confirmatory Data

To obtain confirmatory data, Kansei evaluation was performed with the newly developed prototype. A checklist comprising five sets of the selected Kansei was developed as a measurement tool to be used in the experiment. Using the five prototypes, the Kansei checklist, and 15 good subjects, the research performed a confirmatory Kansei measurement. The 15 good subjects were selected among good respondents from the initial study. One Kansei evaluation session was conducted to measure Kansei responses from all subjects. During the session a briefing was given before the subjects began their evaluation exercise. The five Web site specimens were shown one by one on a large white screen to all subjects in a systematic and controlled manner. Subjects were asked to rate their feelings on the checklist according to the given scale. Subjects were given 3 minutes to rate their feelings toward each specimen. The Kansei evaluation session took approximately 15 minutes to complete.

The average evaluation result obtained from the Kansei evaluation process was calculated, and the data were labeled *confirmatory data*.

8.3.4.2.3 Comparison of the Exploratory and Confirmatory Data

To provide proof that the implementation of the proposed guideline is successful in producing a Kansei Web site, the chapter performed PCA on both *exploratory data* and *confirmatory data*. Comparison of the Kansei structure formed by the two groups of data also helped confirm the validity of the Kansei design model. Both purposes can be achieved when improvement in the structure of Kansei is evident.

In performing the comparative study, the averaged data from the two groups, *exploratory data* and *confirmatory data*, were combined. PCA was then performed to investigate the structure of Kansei before and after the guideline implementation. Figure 8.7 illustrates the procedure. In the procedure,

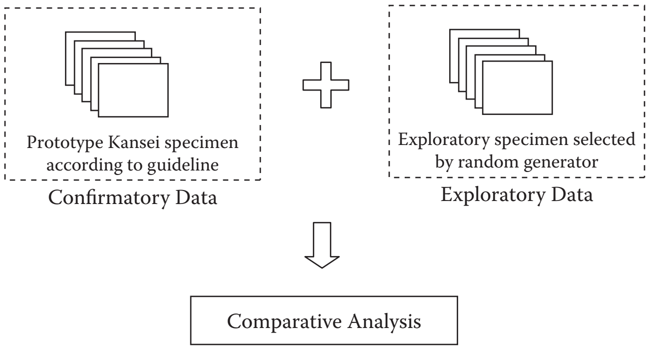

FIGURE 8.7
The testing method.

the *confirmatory data* were appended at the end of the *exploratory data* to make it easier to recognize specimens in the investigation process. In the combination, exploratory specimens were coded from 1 to 5, and confirmatory specimens were coded from 6 to 10. The overall data of the 10 samples were analyzed using PCA to investigate relations between all samples and Kansei.

Figure 8.8 shows PC vector for the *comparison data*. The vector plot shows the implied Kansei structure by all specimens in two-dimensional spaces. It is evident from the vector plot that specimens 1, 2, 3, 4, and 5, which are specimens from the exploratory study, are concentrated toward the center

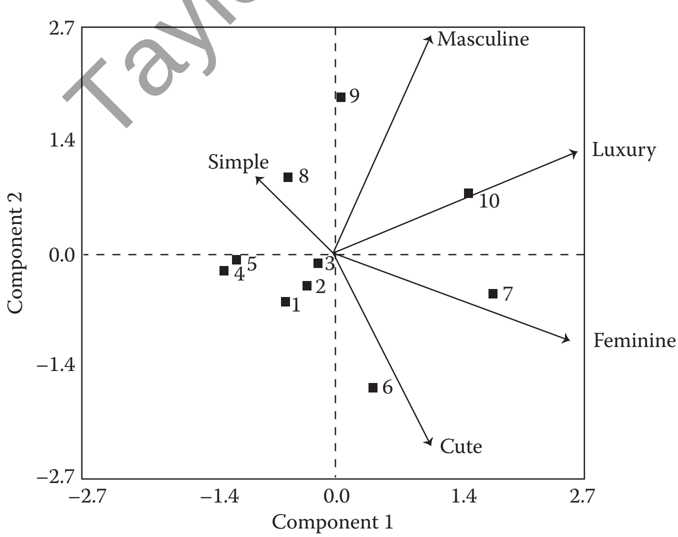

FIGURE 8.8
PC vector for comparison data.

space. This indicates that the specimens have poor influence on Kansei in comparison to the other groups. Specimens 6, 7, 8, 9, and 10, which are newly developed Kansei Web site prototypes designed based on the guideline, are very well spread all over the Kansei vector. This result provides evidence that the newly designed Web site has a good fit to Kansei. Thus, it can be concluded that the Kansei in Web site design has been improved and that the Kansei Web Design Guideline that was referenced is valid and justified.

8.4 Summary

This chapter has explored the potential of KAE implementation in Web design. Literature about product emotion has described the need to design products that capture the user's attention by captivating emotional connectivity with the interface of the product. Many products that were designed geared to the user's emotion have been produced successfully in the market (Nagamachi, 2008). With this motivating factor, the chapter explored the possibility of embedding users' emotion in Web site design. When addressing the diverse aspects of UX in Web design, KAE can be seen to provide a systematic approach to discover the concept of user Kansei in Web design, and thus enable designers to strategize the design of a Web site that caters to the insight of user emotions and feelings in its design by using KAE, the emotion.

Until recently, the design requirement for Web sites has been focused on the aspect of cognitive functionality and usability (Backlund, 2001; Garret, 2003; Ivory and Hearst, 2001; Krug, 2000; Lederer et al., 1998; Marcus and Gould, 2001; Nielsen, 2000). Although recent research has paid increasing attention to the emotional aspect of Web site design (Kim et al., 2003; Li and Zhang, 2005; Norman, 2002; Overbekee et al., 2004; Thielsch, 2005), research is lacking in terms of determining the aspects of emotional design concept and requirements. Consequently, paradigm designs still must include the emotional aspect of Web site design according to designer's interpretation and inspiration. Unfortunately this does not take into account the user's implicit needs and emotions. Thus, this chapter has attempted to engineer emotion in Web site design to fill in the gap of design requirements geared to users' emotional responses.

The chapter has provided evidence that KAE can be used to determine the implicit needs and emotion of users and shape the concept of Kansei in Web design. The chapter has also formulated design requirements to create the desired concept of Kansei Web design. Users or customers will then have a guide to objectively describe the concept of Web design that they view or want, and the designer will have clues for designing such a Web site.

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9

Kansei/Affective Engineering for the European Fast-Moving Consumer Goods Industry

Cathy Barnes, Tom Childs, and Stephen Lillford

CONTENTS

9.1 Introduction

During the last 15 years the number of fast-moving consumer goods (FMCG) available in the average European supermarket has grown exponentially. To be successful in this dynamic environment, companies must constantly launch many new products and build successful brands.

To support the speed of innovation and brand creation, the industry sector has many existing methods and tools incorporated within its product development processes. Thus, to be widely adopted in the FMCG arena, Kansei/affective engineering must fit within the industry's current high-speed product development processes and demonstrate that it addresses gaps in the existing suite of methods. Perhaps even more important, Kansei/affective engineering must ensure it takes full account of the needs of the product brand.

9.1.1 Building a Successful Brand

One of the distinctive factors of the FMCG industry is the importance of the brand. The brand was originally created to reassure the consumer of a quality product by building awareness and developing positive associations. Today, the brand is of significant commercial importance and stretches far beyond having a recognizable logo on the product. Figure 9.1, based on

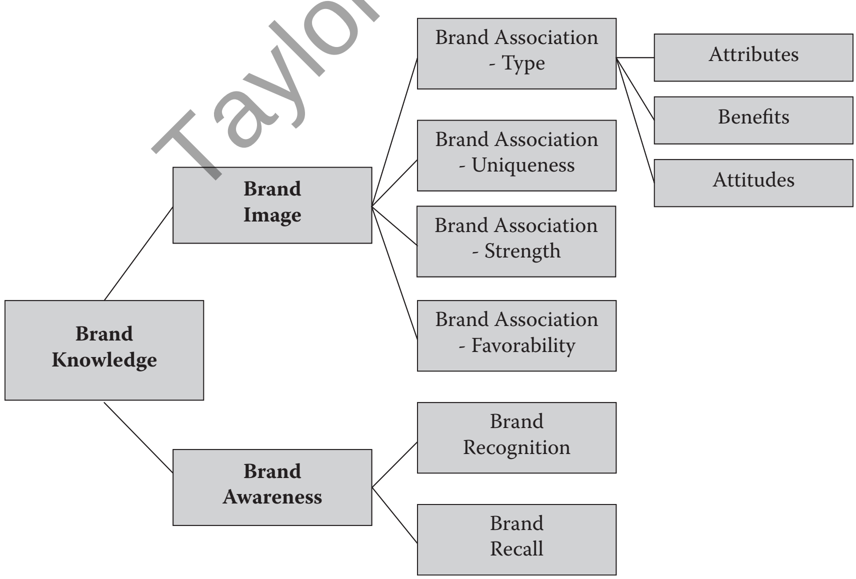

FIGURE 9.1
Dimensions of brand knowledge. (Adapted from Keller, K. L. 1993, *Journal of Marketing* 57 [January], 1–22.)

Keller (1993), shows the many different aspects that comprise the nebulous "brand" concept.

9.1.2 New Product Development in FMCG

Typically most FMCG companies use a variant of the stage-gate process. Figure 9.2 shows a reduced set of stages, from targeting a need to deploying in the market, based on a survey of companies as part of a European Commission (EC)-funded coordination action, the ENGAGE (design for emotion) project (Childs et al., 2006). The impression of a linear activity that it gives is, however, misleading. Although failure to pass a gate (between stages) will result in canceling the development, learning from a later stage can cause an earlier stage to be revisited. The "learning by doing" view of Figure 9.3 shows the stages more truly as activities that can be revisited at

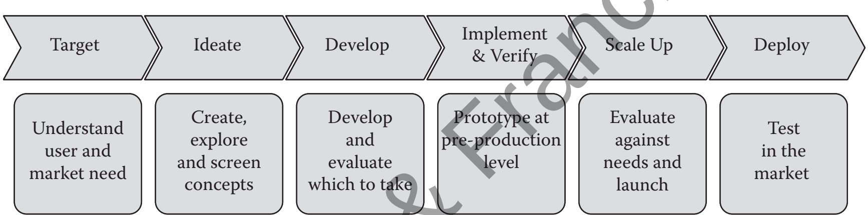

FIGURE 9.2
Steps of a stage-gate development process.

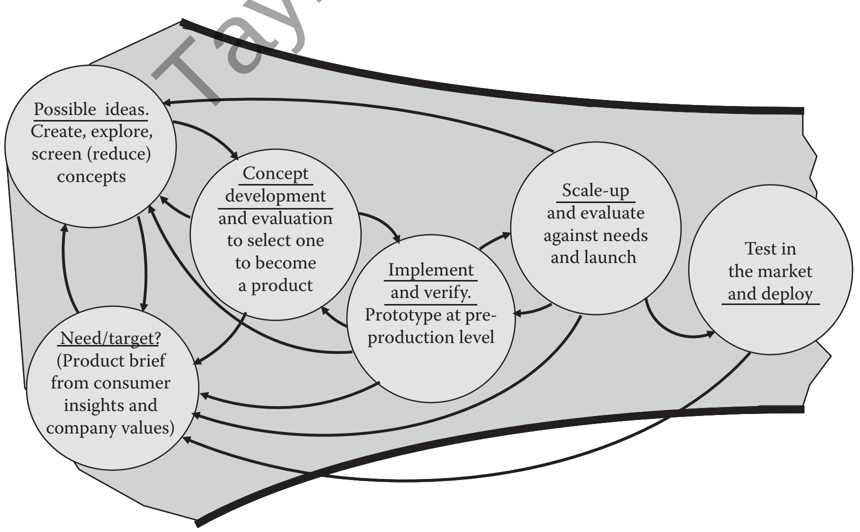

FIGURE 9.3
Learning by doing in a product development funnel.

any time, although that is more common the earlier the stage of development. Particularly at the start of a development the need is to quickly explore and screen out a large number of possible ideas and to move on. New insights during concept development and even during preproduction certainly can lead to design changes. Feedbacks from the later to intermediate stages more commonly relate to aspects such as product color or details of labels rather than, for example, shape changes.

Feedback from the market to the need is usually considered to be part of continuous improvement, signaling launch of a new development, rather than modification to an existing project. One aspect of development that is not shown by either Figure 9.2 or Figure 9.3 is who is involved. Different companies bring together teams of marketeers, industrial designers, engineers, and sales staff in different ways at different stages of the process. In some cases a multidisciplinary group is formed to take a product forward from need to deployment. In others the product is passed from group to group as it develops. In all cases there is a need for good interdisciplinary communication tools.

Designing products and packaging for consumers is considered by most businesses to be a "consumer journey," which is a chronological map of the consumer/brand interactions (Davis and Longoria, 2003). Figure 9.4 shows that there are, in the main, three *touchpoints* on the journey, and lists some of the ways by which the consumer experiences a branded product. However, two of the touchpoints are particularly important to a consumer-centered design process such as Kansei/affective engineering. These are the Purchase Experience and the Use Experience, often colloquially called the First Moment of Truth and the Second Moment of Truth, after a widely reported Procter & Gamble process. The Purchase Experience is particularly important because it occurs within the retail outlet. There the product needs to quickly and effectively communicate its benefits. The messages here impact consumer expectations, but primarily a good design for this touchpoint will certainly

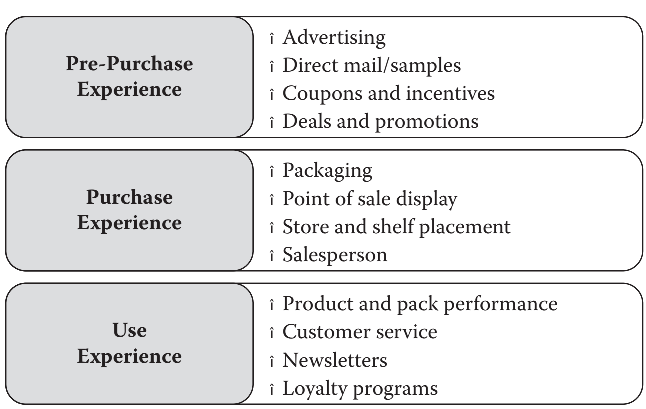

FIGURE 9.4
Experiences on the consumer journey.

sell more products in the first instance. The consumer experience at the Use Experience determines whether the product will be repurchased. A well-designed product for this stage will build brand loyalty and ensure long-term profitability.

9.1.3 Why Does FMCG Need Kansei/Affective Engineering?

It is clear that good design that appeals to consumers throughout the product's life cycle is critical to FMCG. However, it is not just the product that needs to be considered. The impact of the brand communication is critical, as is the packaging that is used to transport and contain the product. Thus, simple but effective tools are needed for companies to be able to quickly understand whether products in development will satisfy consumers and thus be successful.

Kansei/affective engineering fills a gap in the FMCG manager's toolbox. The Kansei/affective engineering variant presented in this chapter can consider all the touchpoints throughout the consumer journey and measure quantitatively whether a concept matches consumer needs. It can also ensure that the brand equity is incorporated within the design and can also test the effectiveness of that communication, critical in this industry. This Kansei/affective engineering is also of benefit over and above more traditional design and market research techniques as it can be used to create a set of assessments from untrained consumers rather than from a trained panel of people. This can both reduce the costs of testing and ensure a wider population sample can be used in the research. A Kansei/affective engineering system, as reported earlier in this book, is rarely needed in the FMCG industry, as the test samples used in the research are not the final shelf-ready design but rather will form a set of fundamental guidelines for the solution. Finally, Kansei/affective engineering provides a unique tool by which all the disciplines involved in product development can be brought together in a team to use a single process.

9.2 Kansei/Affective Engineering Framework for FMCG Products

The world of FMCG is very fast moving and consumer focused and so requires specific tools to ensure these are considered throughout the development process. Figure 9.5 shows the five-stage framework of our Kansei/affective engineering methodology for FMCG products. It has developed from experience gained through some 30 sponsored projects, most of which have been carried out under confidentiality agreements. It is described step by step in this section and illustrated by elements from three case studies that we can talk about. One is based upon a project completed with a drinks

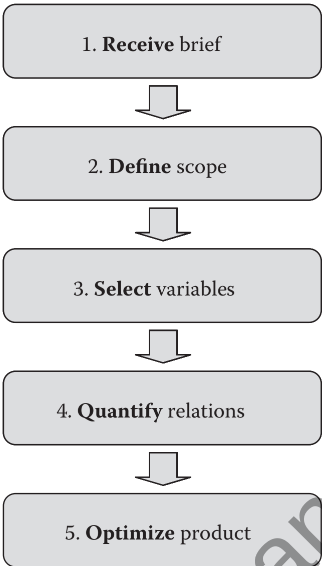

FIGURE 9.5
Kansei engineering framework for FMCG products.

company that had introduced a new bottled product to the UK market. It was an extension to a well-developed brand. The aim of the study was to explore how well the launched product communicated the brand's values as well as the product's intended unique benefits, and to recommend any design changes that would improve user perceptions. The second relates to a project on a personal skin-care product, namely, the container for a body moisturizer. The project was less constrained than the first. Although the product too was to be a branded one, it had not at the time been released on the market, although concept work had started. Guidelines relating to shape, color, and texture (for touch feeling) were requested. The third relates to confectionery product packaging. It was the least constrained of all. Again, it concerned a branded product, but only a need had been identified. The company was open to all ideas about what the product's form should be. These three examples can be seen to fit into different areas of the development funnel (Figure 9.3).

The methodology has five stages to support the designer:

Stage 1: *Receive* brief

Stage 2: *Define* scope

Stage 3: *Select* variables

Stage 4: *Quantify* relationships

Stage 5: *Optimize* product

9.2.1 Stage 1: Receive Brief

The process starts from a high-level design brief concerning the need to be met, including target audience and imposed brand guidelines. In the case of the bottled drink project, the brief was for a drink for young males who enjoy a short social drink with close friends and prefer premium alcoholic drinks. For the confectionery project, the brief was to create packaging to support sharable product moments, and a target group was specified. The moisturizer project was positioned slightly differently. Its brief was to explore what attributes of the container were most important to women who were willing to pay more for products that were good for their skin and who felt neutrally about or were dissatisfied with their existing lotion. Out of this, the guidelines for shape, color, and texture, referred to in this section's introduction, emerged.

9.2.2 Stage 2: Define Scope

The next process stage is to determine exactly what is to be the scope of the investigation, by defining its context and generating the experimental variables. It could be argued that defining the context is a detail of the first stage. In this respect the division into stages is artificial. A continuous development is involved. Generating the experimental variables is, however, certainly separate from the first stage. The experimental variables are the independent and dependent variables of product attributes and evaluation descriptors that are the common aspects of Kansei/affective engineering activities. At this stage the object is exhaustively to generate variables, many more than can be followed up in detail. The purpose is as completely as possible to consider the design space. Reduction of variables occurs in Stage 3.

9.2.2.1 Context

First, which touchpoint is to be investigated needs to be defined. It is possible to study more than one touchpoint in a study, but this requires separate experiments to be run for each. Consumer interactions with products are highly context specific. The most relevant location and environmental conditions must be specified along with determining the exact type of interaction with the product.

Taking the bottled drinks product as an example, many aspects contribute to the whole experience of it: the flavor, the bottle design, and the advertising. The flavor is developed through sensory exercises with trained panels using defined descriptors like *sweet*, *crisp*, and so forth. Advertising is outside the scope of this chapter. The case study was concerned with the bottle design. To select an appropriate design, what qualities are communicated through different bottle designs, what attributes of bottles contribute to communicating different qualities, and what might be done to communicate the ideal qualities more effectively must be clarified. These aspects require the responses of the specific target users to be understood rather than those of a skilled, trained panel. It is here that the sponsoring company found Kansei/affective engineering to give it insights it did not already have. Several points of interaction between bottle and user could have been explored: viewing the bottle on the bar shelf (the product's social context), holding the bottle, opening the bottle, drinking from the bottle, and disposing of it. The scope of the case study was purely on-the-shelf appearance, the purchase experience of Figure 9.4.

9.2.2.2 Evaluation Variables

As with all versions of Kansei/affective engineering, a set of variables needs to be defined that will become the criteria against which all the product concepts will be evaluated by consumers. Often they are word variables, usually adjectives, but they can be phrases. They can also be nonverbal. Hereafter, the terms *evaluations*, *adjectives*, or just *words* will be used interchangeably as seems best to fit the context. Words must be included that describe the full range of desirable product qualities.

Target users' words are collected from a series of discussion exercises in which a recruited target group is asked to interact normally with a set of relevant products and related materials (e.g., images). Their preferences are interrogated using structured exercises such as

1. Articulation of product preferences and reasons
2. Sorting products into groups by both similarities and differences, similar to Kelly's repertory grid method (Van Kleef et al., 2005)
3. Describing ideal or ultimate products

Figure 9.6 shows views of a focus group discussion, both with products as screen images and a wide range of collected actual products, taken during the body moisturizer case study. Words also need to be chosen that accurately describe the essence or personality of the brand. Without them, judgments relating to the brand image will be lost from the experiment. We have found that words supplied directly from the brand owners' resources of brand and product descriptors are often not suitable. Some problems that can arise are as follows:

- Users may not understand a word, resulting in an incorrect response.
- The words may have similar meanings to other words; this can cause results to incorrectly weight a particular response.
- Users can be led or confused by unfamiliar words or by words that may be difficult to consider in the required context (e.g., Is this wristwatch *oppressive*?).

FIGURE 9.6
A focus group session.

We have developed a way to avoid such problems. Words supplied by the brand owner are used as seeds to grow more words that are their synonyms, using the British National Corpus of language (Delin et al., 2007). At Stage 3 (Section 9.2.3) it is decided which of them, with the target user–generated words, to use. More detail of the Corpus tool is presented in Section 9.2.3.

Returning to the bottled drinks product example, small focus groups of 5 to 10 target users were held. Structured exercises were completed in the areas of articulating reasons for preferences (e.g., "Describe your preferred drink and why you like it.") and stimulating insights using previously developed mood boards (see Design Attribute Variables, below). Brand and product benefit adjectives were collected and expanded using the Corpus tool. A selection of the many hundreds of resulting words is shown in Table 9.1.

9.2.2.3 Design Attribute Variables

Similarly to the collection of evaluation variables, a large number of products/product concepts is initially explored from which to generate design attribute variables that might be expected to contribute to the overall affective

TABLE 9.1

Some of the Valuation Words from the Bottled Drink Case Study

Product and Flavor Qualities			Brand Essence		
Lime	**Crisp**	**Refreshing**	**Masculine**	**Modern**	**Urban**
Citrus	Crisp	Arousing	Angular	Advanced	Bustling
Fresh	Dry	Energizing	Bold	Contemporary	City
Lively	Edge	Exhilarating	Definite	Current	Dark
Natural	Firm	Invigorating	Heroic	Influential	Downtown
Piquant	Fresh	Keen	Intense	Hip	Ghetto
Juicy	Piquant	Lift	Macho	Latest	Industrial
Zesty	Ripe	Refreshing	Manly	Modern	Metropolitan
…	Sharp	Regain	Masculine	Now	Neon
	…	Regenerate	Mature	Popular	Suburban
		Renew	Muscular	Powerful	Urban
		Rejuvenating	Potent	Sophisticated	…
		Reviving	Powerful	Successful	
		Rousing	Robust	Trendy	
		Stimulating	Strong	…	
		Tonic	Vigorous		
		…	…		

quality of the product. The generation of sample products from which to extract affective attributes by experiment is straightforward when a large range of products similar to the target product already exists. Sources are shops, catalogs, magazine photographs, and company (including competitor company) Web sites.

Figure 9.6 has shown an example of collected products that were used to stimulate the generation of evaluation variables in the moisturizer case study. These were also used to analyze the typical shapes of moisturizer bottles. From these, images of 48 shape samples were created: jars, cylinders, flasks, downward and upward tapering, waisted, oval, teardrop, and tubular forms. Some were later made as three-dimensional objects by rapid prototyping. They are shown in Figure 9.7. In addition, 72 color patches were generated for color tests. Forty-nine plastic, fabric, paper and board, metal, and miscellaneous samples were collected for tactile tests.

The position is more complicated the more one has to rely on the generation of novel concepts as part of the project, that is, for radical new products. The position is most problematic of all when trying to develop new product attributes to relate to brand qualities, such as *heroic*. Such descriptors seem to be too subjective. Our investigations suggest that transferring brand quality traits to user perceptions of products is particularly difficult.

To overcome this we have developed a new technique based upon mood boards (McDonagh et al., 2002), which has the added advantage that it is aligned with existing practice. Mood boards are common design tools created by a multidisciplinary team and use images, colors, forms, and textures

FIGURE 9.7
A selection of rapid prototyped moisturizer container shapes.

to communicate the feel of a conceptual product to others. A set of images is chosen by the design team to cue the brand qualities. If appropriate, these are checked with consumers to ensure suitable images are used. These images are then used as stimuli in a multidisciplinary brainstorming study to translate them to product attributes. Figure 9.8 is a montage sample from the confectionery product case study. Typically, many tens of concepts are generated, and these are sorted to reveal around 20 diverse concepts. The criterion for selection is team consensus. They would be added to products collected more straightforwardly from the existing market.

9.2.3 Stage 3: Select Variables

This stage determines which adjectives and product concepts are used in the main experiment. Kansei engineering typically uses a large number of both adjectives and concepts. This makes for a very long and costly experiment, which does not fit well into current FMCG product development processes. It is essential to find robust ways to reduce the number of adjectives and concepts.

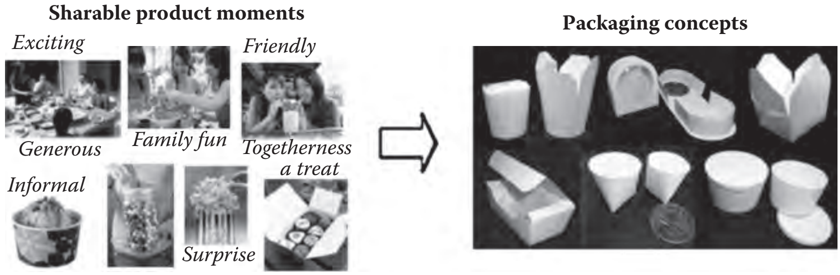

FIGURE 9.8
Mood boards and process of translation to concepts.

9.2.3.1 Evaluation Variables

The outcome from Stage 2 is typically several hundred collected adjectives, from both the target users and brand owners, describing perceived product qualities. The total from both groups must be reduced to an overall total of around 15 to 20, with some balance kept between them. We have developed two procedures to support the reduction process. One of the two is a set of rules involving a simple set of linguistic guidelines. Table 9.2 lists a selection of them. Words from both groups are assessed against these rules to determine whether they will be easily understood in the context of the experiment. Unsuitable words are eliminated from future consideration.

The other procedure relates specifically to the brand-generated words. Table 9.3 was generated, based on the moisturizer study, to help describe the

TABLE 9.2
A Selection of Five Rules from a Total of Almost 20 for Rejecting Evaluations

Rule 1	Remove evaluations that are not plausibly related to objects	While "friendly," for example, may be metaphorically extended to apply to inanimates, words such as "enthusiastic" and "unbiased" may not be.
Rule 2	Remove evaluations that describe purely evaluative reactions	For example "good" and "nice" do not describe products but people's feelings about them. Feelings of like and dislike do not inform us about specific product-related reactions.
Rule 3	Remove ambiguous evaluations	For example "clear" might be a good word to refer to either a concrete or an abstract quality of products that promote cleanliness (i.e., clear skin) or that are themselves without color but it is also frequently used to describe the clarity of an argument or conclusion.
Rule 4	Remove non-gradable evaluations	For example "unique" is not gradable, something cannot be "very unique" or "slightly unique." So using it for a semantic differential questionnaire could be ineffective.
Rule 5	Remove evaluations that are out of context with the research	Remove adjectives that relate to untested senses or that relate to a prolonged experience with the object rather than the controlled conditions of the Kansei study. For example, "satisfying" for an appearance.

TABLE 9.3
Translating Brand Words to User Words with the Corpus Tool

			Synonyms from Corpus Tool																			
			Tender	**Conventional**	**Fun**	**Luxurious**	**Showy**	**Everyday**	**Slender**	**Cozy**	**Bold**	**Friendly**	**Simple**	**Traditional**	**Natural**	**Romantic**	**Advanced**	**Amusing**	**Spiritual**	**Casual**		
Seed Words	**Brand Descriptors**	Love	√		√	√				√		√				√		√	√		8	Number of synonyms the seed word relates to
		Delight			√	√	√									√					4	
		Happy			√							√						√			3	
		Comfortable	√	√		√		√	√	√	√			√							7	
		Believable		√			√						√	√							4	
		…	√	√		√		√		√		√				√			√		8	
		…		√			√		√		√			√	√						6	
					√		√						√								3	
	Product Descriptors	Skin kindness	√					√												√	3	
		Smoothness	√			√			√	√											4	
		Balanced		√				√	√				√		√		√				6	
		Moisturize	√																		2	
		Clarifying					√				√									√	3	
		…		√	√			√			√		√	√			√				7	
		…							√			√			√		√				4	
			6	6	5	5	5	5	5	4	4	4	4	4	3	3	3	2	2	2		
			Number of seed words synonyms relate to																			

TABLE 9.4
The Final Word Selection for the Bottled Drink Study

Intense	Powerful	Sophisticated	Crisp	Lively
Rough	Refreshing	Masculine	Urban	Modern

procedure. Its left-hand column contains the seed words (Section 9.2.2) from the brand owner. Its top row holds some of the synonyms generated from the Corpus tool introduced in Section 9.2.2. These words are placed from left to right in the order of their importance as judged by how many of the seed words they relate to. For example, the word *tender* relates to six of the seed words, as indicated by the ticks in the table elements and totaled in the bottom row. How many times the seed words are related to the synonyms is also totaled along the rows of the matrix and entered in the right-hand column. Synonyms are selected for the main experiment on the basis of their relevance (lower row scores) and inclusiveness (ensuring that seed words remain represented), up to the maximum number that is judged appropriate for the experiment considering that target user words must also be chosen. Normally they would be found from among the 10 top ranked in terms of their relevance.

Usually there are too many target user words remaining after reduction by the linguistic rules. These may be reduced by thinning clusters, in the same way as can be used for reducing samples, as considered next under Design Attributes. If it is found impossible to reduce the number of words to the 15 to 20 range, it is an indication that the planned experiment is too ambitious. Table 9.4 has the final words used in the bottled drinks study.

9.2.3.2 Design Attributes

The last aspect of the experiment that needs to be defined is which design attributes should be considered and how to vary them appropriately. We use two methods for making these choices:

9.2.3.2.1 Semantic Mapping

This method is suitable when it is easy to define just two key evaluations for a product. These are chosen as the axes of a two-dimensional map that physically is a large horizontal board. A small number of consumers, 5 to 10, place the large number of product concepts on the map. Figure 9.9 shows a semantic map being created for the moisturizer shape experiment. Each numbered counter represents one sample, typically the counter's cluster. Analyzing the clustering enables the key design attributes to be identified. Any suitable technique may be used (Bech-Larsen and Nielsen, 1999); however, the Repertory Grid technique has yielded good results. Sample reduction is also based on thinning out the clusters.

FIGURE 9.9
A semantic mapping experiment in progress.

9.2.3.2.2 Pilot Semantic Differential Survey

This is used when it is not possible to identify just two key evaluations to test. A small number of users, around 10, are asked to rate many concepts against a small number of key evaluations on a 7-point Likert scale. Figure 9.10 shows the results of a principal component analysis for the same samples as were used for the semantic mapping, Figure 9.9. The significant design attributes of these concepts can then be extracted using any suitable technique, as with the semantic mapping method.

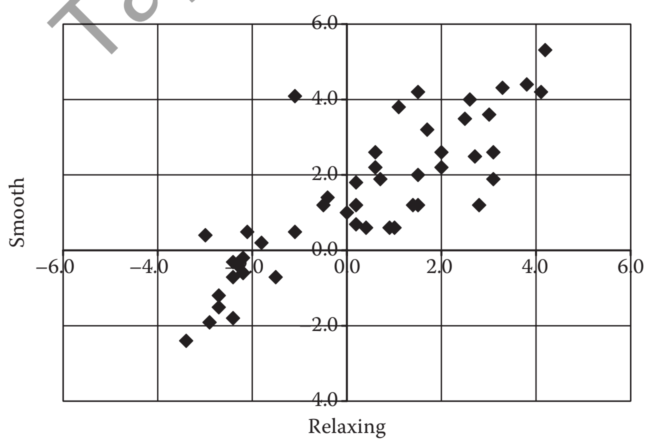

FIGURE 9.10
Outcome of the moisturizer pilot semantic differential test, with 48 samples in place.

TABLE 9.5

The Factorial Design for the Bottled Drink Study

Design Attribute		Shoulder			Body Shape		Neck Length		Color		Surface Detail			Body Width	
Attribute Style		Round	Angled	None	Straight	Curvy	Short	Long	Brown	Clear	Embossed	None	Other	Thin	Wide
Sample	1	1	0	0	1	0	0	1	1	0	0	1	0	1	0
	2	1	0	0	0	1	0	1	1	0	0	1	0	1	0
	3	1	0	0	1	0	1	0	1	0	0	1	0	0	1
	4	1	0	0	1	0	0	1	0	1	0	1	1	1	0
	5	1	0	0	0	1	0	1	1	0	1	0	0	1	0
	6	1	0	0	1	0	0	1	1	0	0	1	1	1	0
	7	0	0	1	1	0	0	1	1	0	0	1	0	1	0
	8	1	0	0	1	0	0	1	0	1	1	0	1	0	1
	9	1	0	0	0	1	0	1	0	1	1	0	1	1	0
	10	1	0	0	1	0	0	1	1	0	0	1	0	0	1
	11	0	1	0	0	1	0	1	0	1	1	0	0	1	0
	12	0	1	0	1	0	1	0	1	0	1	0	0	1	0
	13	0	0	1	1	0	0	1	1	0	0	1	0	1	0
	14	0	1	0	1	0	0	1	0	1	0	1	0	1	0
	15	0	0	1	0	1	0	1	1	0	0	1	0	0	1

After sample reduction, by thinning clusters and/or ignoring areas of the design space that might not be of interest, a factorial experimental design is constructed to test the affect of the selected attributes. Table 9.5 shows the bottled drink study design. Fifteen bottle samples were required to represent the total of 14 attributes (three shoulder types, two body shapes, two neck lengths, two colors, three surface details, and two body widths) to be taken forward to Stage 4. Among the samples there were at least two cases of each attribute style.

9.2.4 Stage 4: Quantify Relationships

This stage comprises a standard semantic differential survey with some supplementary demographic and overall liking/preference questions that allow for additional correlations and consumer groupings. Samples are rated in terms of the adjectives on a 7-point scale, using a semantic questionnaire. The order of the adjectives is randomized in the questionnaire to reduce conditioned responses and any systematic effects of participants' fatigue. An overall liking score is also collected on a separate 7-point scale.

The aggregated data from a sample of users representing the target market are used to identify optimal designs, but before results are interpreted the response distributions are examined to judge the level of consensus. If an evaluation result from a group of users shows a double peak or random distribution, then it is removed and analyzed separately. This is because these distributions could be an indication of disagreement in the meaning/use of the evaluation or that it is not suitable for relation to the concepts (despite the various linguistic tests and rules that have been applied to avoid this).

Outlier users are also identified from their responses: These are users who have scored outside two standard deviations from the aggregated response. Their responses are removed too and analyzed separately.

The cleaned data set is used to display the profile of each of the concepts against all of the adjectives. To reduce the complexity of the results, principal component analysis is used to identify which adjectives have been perceived similarly in the exercise. Those with similar meanings are given a new cluster heading, by making a judgment about the common meaning among them. The concept set can then be displayed in the principal component space to make easy comparisons.

As aggregate scores have been used for the points in the profiles and PCA, a Kruskal–Wallis test (Kruskal and Wallis, 1952) for significant differences is carried out to see if differences between scores of different concepts are important or whether there are overlaps between users. Multiple regression analysis is performed as described in earlier chapters of this book to identify and rank which attributes are contributing to which affect.

9.2.4.1 The Bottled Drink Case Study

Thirty-seven users matching the target consumer profile took part in a semantic differential survey to rate the 15 bottles against the 10 evaluations. The data were collated and outliers were removed. In this case two users were removed. A principal component analysis of the data showed three significant independent components. However, the first two accounted for more than 77% of the variance so they will be focused on here. Based on the adjectives' loading on each component, these were called *flavor intensity* and *masculine strength*. Figure 9.11a shows the type of bottle that made up the study. Figure 9.11b shows how the 15 bottles of the study loaded in the PC1/PC2 principal component space. It is seen that bottles 15 and 11 communicated flavor intensity most; 3 and 10 communicated masculine strength most; and 2, 5, and 8 communicate both qualities to some extent.

There were several bottles that did not have significantly different adjective scores when considering the raw rather than aggregated data. These have been circled in the principal component space to show that, although they locate differently, this is not significant.

A regression analysis between the attributes and the adjectives aligned with the principal components showed that the design of the shoulder shape was the most important attribute for communicating *flavor intensity* and that angled shoulders scored highest. Shoulder shape was also the most

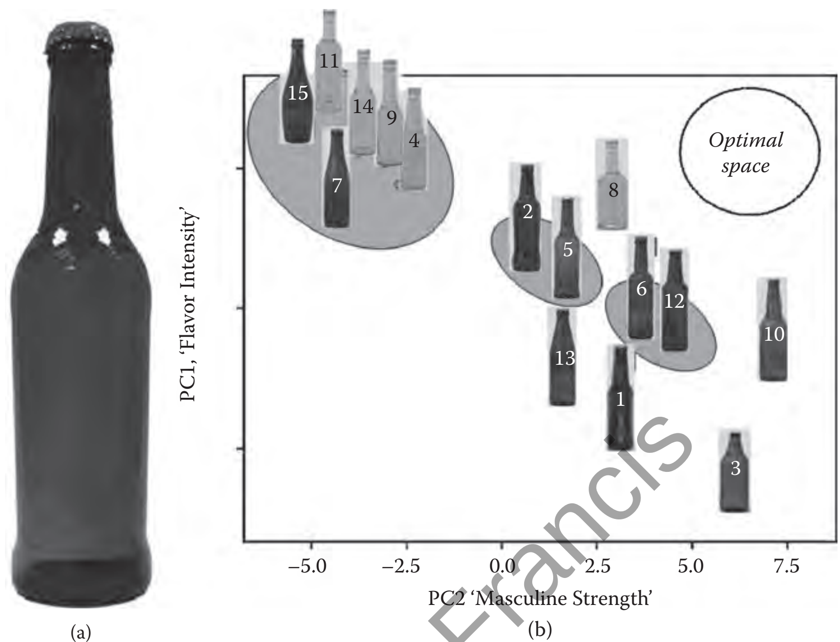

FIGURE 9.11
(a) A standard drink bottle product, and (b) a range organized by Kansei engineering methods.

important attribute for communicating *masculine strength*; however, round shoulders scored highest.

9.2.4.2 The Moisturizer Case Study

Sixty-five women took part in each of three semantic differential experiments, one each for the shape, color, and texture aspects of the design attributes. Figure 9.12a is a partial composite view of the loadings of the samples in the PC space. Further detail is in Childs et al. (2006).

9.2.5 Stage 5: Optimize Product

9.2.5.1 Target Users

Cluster analysis can be used on the overall liking scores to determine if the preferences of the participants in the experiment were homogenous or not. For example, the dendrogram of Figure 9.13 shows that in the bottled drinks case study there were three distinct participant groups within the sample. There are two large groups: one of 25 users and the other of 8 users, and one small group of two users. The scores showed that the group of 8 liked wide bottles whereas the group of 25 did not. The other two users liked both. This result suggests not a single but two possible optimal design solutions.

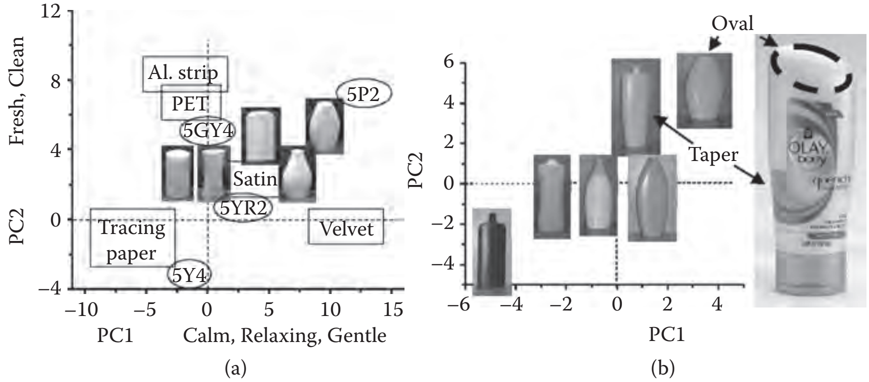

FIGURE 9.12
(a) Composite result of moisturizer shape, color, and texture experiments; (b) combined validation experiment.

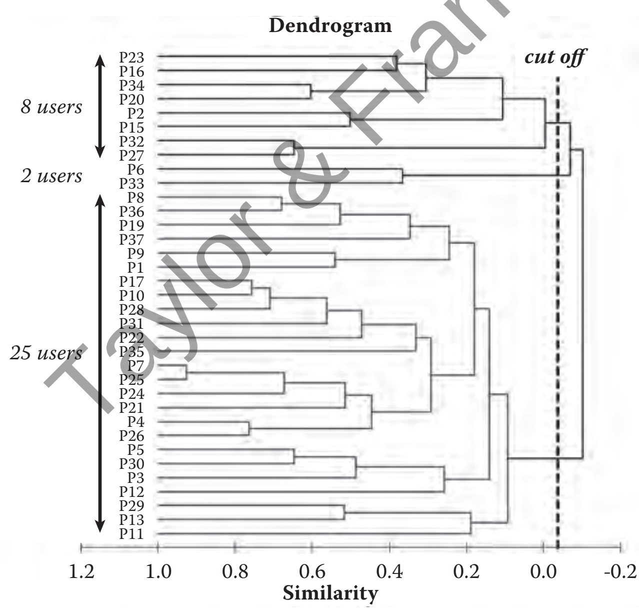

FIGURE 9.13
A dendrogram from the bottled drinks case study.

9.2.5.2 Design Space

To correctly interpret how the principal component (PC) space can be used as a visual design guide, the construction of the space must be checked carefully to determine whether evaluations are correlating negatively or positively with the space's axes. If all evaluations correlate positively and all are equally desirable to the project owner, then those concepts located highly on all the relevant PCs should be recommended. If there is no concept in this location, then a new design could be proposed that is developed from comparing concepts that locate highly on individual components. Integrating consideration of liking score with PC space provides an insight into which qualities relate highly with user preference. Concept liking scores can be overlaid or correlated with PCs but should not be included in the PC analysis itself as they have a different type of semantic meaning.

Continuing with the example from the bottled drink study, Figure 9.11, supposing the aim was to generate a bottle to support both intense flavor and strong masculinity, the optimal concept location in the PC space is indicated as in the top right corner of Figure 9.11b. The location of the existing bottles shows that the wide clear bottle (8) is the most suitable from the set, with the initial concept bottle (5) second. From the locations of the set and visual differences between the bottles we could speculate that change in the initial concept glass color and width might increase affective communication of the product.

9.2.5.3 Design Guidelines

Through a combination of both PC multivariate and regression analyses, design guidelines can be created. Many cases will require the designer to make compromises between the optimal concepts for each PC to achieve a best overall design. The regression analysis gives an order of attribute significance to inform this decision making or can provide guidance for further attributes to test that have not been included.

Again from the bottled drink case study, the regression results that show different shoulder designs are responsible for transmitting *flavor intensity* and *masculine strength* explain why there is not a bottle in the top right-hand corner of the PC space. Therefore to increase communication of both PCs beyond the potential of the variables tested requires a new design of shoulder shape or a new attribute to be tested. From the range of attributes tested we are able to speculate that the shape of bottle 5 communicates the combined qualities fairly well, and a possible alternative would be a wide, clean bottle (based on bottle 8).

In the moisturizer case study, a verification experiment was carried out, combining the shapes and colors expected to create a most clean and gentle effect. Figure 9.12b shows the result. In this case the experiment's samples were simpler than the finally launched product, inset in the figure. However, its oval and downward tapering shapes and heather coloring (code 5P2 in Figure 9.12a) are reflected in the final product. It helped confirm the product development direction.

9.3 Conclusion

Within the FMCG industry the Kansei/affective engineering methods that are the subject of this chapter are widely seen by new product development teams to offer a sufficient number of benefits to make them useful. They are seen as not standing alone but fitting in with and filling gaps between other new product development tools. In particular, they are not used to provide complete design solutions but to define key parameters of a solution to be fleshed out in more detail by other means. In an industry that frequently relies on expert panels for opinions, they also provide a way to involve untrained users (closer to the general consumer) in the development process. They also generate rational reasons for decision making that all the different disciplines involved in new product development can respond to. This communication role lasts after a product's launch, through archival documentation that can be referenced for future developments.

However, Kansei/affective engineering is not universally accepted. It can generate confusion and skepticism. It is perceived by some designers as conflicting with or restricting their own skills and intuition. It is also perceived by some designers and innovation managers as constrictive to the design process itself. By bringing untrained users into the development process, seen by supporters as one of its advantages, it certainly results in decision making relying less on the flair of individuals. The more Kansei success stories can be told, for example, through books such as this, the more the negative perceptions may be countered. However, what may be a best way to balance individual flair and group assessment within a structured process is an area that could benefit from further development.

Acknowledgment

The work reported in this chapter includes work carried out as part of Knowledge Transfer Partnership No 6179, to "apply Kansei Engineering to the European packaging industry" in conjunction with Faraday Packaging Partnership and PIRA International, Ltd. The authors of this chapter would also like to thank all the participating company members of the Faraday Packaging Partnership who had significant input into the definition of this process. Special thanks must go to the client companies who provided the case studies reported here.

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11

Kansei, Quality, and Quality Function Deployment

Ricardo Hirata Okamoto

CONTENTS

11.1 Introduction

Because of the drastic change in customer needs, the trend for shorter life cycles is increasing in organizations in terms of the importance of finding product development methods and technologies that can reduce development cycle time and cost. This influences a direction to reduce the gap between true needs and expectations of the customers versus the developed product itself. One key indicator to improve is the success rate of newly developed products in the market (sales and profits). In the comparative performance assessment study regarding new products (PDMA Foundation 2004), the "best" companies have a success rate of 75.5%, while the "rest" of the companies average only a 53.8% success rate for newly introduced products. The rate of ideas that become successes in the market is 25% (1 out of 4) in the "best" companies and of 11% (1 out of 9.2) in the "rest" of the companies. The current challenges are related to improving the product development processes and reducing the gap between the final products and services versus the market true needs.

Throughout the past 70 years, the quality standards have reached such a high and competitive level that the product or service differentiation based on quality, delivery times, quality in design, production efficiency, or costs is not enough in current competitive markets. Companies and institutions have developed the ability to translate functional requirements and customer usability needs, and as a consequence, they have developed their capability to design and construct the corresponding products, services, and environments that meet these requirements. But many of these product attributes are mandatory and are already required as well as expected by the customers who do not feel fully satisfied. We are evolving from the satisfaction of the obvious and evident needs, from the functional and usability demands toward the satisfaction of profound, emotional, and affective, customer and market needs (Jordan, 2000; Green and Jordan 2002).

The translation of profound needs is a complex task because the needs are not necessarily known by the customer himself. On the other hand, the design elements of the products as well as the technical requirements to make them feasible are not necessarily known by the designers, engineers, and team of experts, so current organizations require new technologies, processes, and methodologies that allow (1) the detection of these new needs and requirements of the client, and (2) the parametric translation of these needs and requirements into the design elements, its specifications and standards, and most important, adding more value to the market.

The pursuit of this relationship between the consumer, the design, and the development of new products should be the centerpiece of a new deployment of the quality and customer satisfaction approaches. Competitive organizations are clearly oriented to the customers and have found that the translation of the customer's affective as well as emotional needs (Kansei voice of the customer) is critical in the development of a new product or service. Product quality must fit the customer's Kansei value; he/she simply wants to have an enjoyable life, and it is our responsibility to deliver the means for full satisfaction (Nagamachi 2007).

This chapter deals with the relation between the Kansei/affective engineering approaches and the new product development phases and tools, especially that known as QFD (quality function deployment), created by Dr. Joji Akao and Dr. Shigeru Mizuno in the 1960s (Akao 1994; Akao and Mizuno 1994) as a planning process to develop new products, services, processes, and technologies, as well as innovative concepts.

11.2 New Product Development Phases and Tools

New product development refers to the overall disciplined and standardized process of a company for the definition of the steps and activities to convert ideas and concepts into salable products and services. The process usually considers the concept generation, strategy setting and planning, researching, organization, resourcing, product and marketing plan creation and evaluation, as well as the commercialization of the developed individual or portfolio of products or services. Most of the developers are adopting best practices (Griffith 1997) and organization of the body of knowledge of the Product Development & Management Association (Katz 2007; PDMA 2009) which defines three macrophases of the total product life cycle as follows:

The *discovery phase* covers all the process of searching and identifying the customer's problems, needs, and benefits; defining the conceptual features, functions, and attributes to be built or created; as well as all the planning activities and the strategies to achieve these market opportunities. The discovery phase ends with the explicit definition of the formal product or service specification documents and the elaboration of the business case (plan).

The second, named the *development phase*, covers all the process of converting the product or service specifications into designs as well as the definition of all the activities to accomplish this, such as required processes, parts or components, technologies, methods, and resources. It usually includes the design, resource management, test and validation, information, and engineering technology. The development phase ends when the product or service is commercially available.

Finally, the *commercialization phase* includes the whole process of product or service production, launching into the market, postlaunching review, process improvements, performance and evaluations, management of demand, and achievement of financial goals. The commercialization phase ends when the product or service has reached the end of its life cycle and decisions are to be made regarding its retirement, renewal, or regeneration.

Different knowledge areas in the discovery phase are important in order to capture and understand all external insights from clients, buyers, users, channels, competitors, and substitute products, and anything having to do with the understanding of the voice of the customer and its translation into design and technical elements. The development phase must translate all the information captured and defined in the discovery phase into the product characteristics, as well as all the operational dimension of product innovation, processes and tools for the development and management of technical requirements, design, manufacturing, supply chain, and other dimensions for the product creation, process standardization, and improvement.

Various tools and methodologies are used along each one of the phases and also depending on the main objectives or the area of knowledge, such as customer and market research, technology and intellectual property, strategy and planning, people and teams, alliances, and finally, process, execution

TABLE 11.1

Phases and Tools in the Development of a New Product

Discovery Phase	Development Phase	Commercialization Phase
Growth share model	Design automation tools	Advertisement
Benchmarking	Design of experiments	Customer service
Business case/business plan	FMEA	ERP
Ethnography (Mariampolski 2006)	KAIZEN activities	KAIZEN activities
Competitive intelligence (Kahaner 1998)	Kansei/affective engineering	Management
Conjoint analysis (Green et al. 1999)	Market testing	Market research
Kansei/affective engineering (Nagamachi 1999, 2004)	QFD	Outsourcing
Patent mapping and mining (Kahn 2003)	Simulation	Management systems
Pugh analysis	Technology road mapping (García and Bray 1997)	
QFD (Akao 1994)	Toyota production system	
TRIZ (Altshuller 1999)		
Voice of the customer analysis (Katz 2004, Shillito 2001)		

Source: Hirata, R. (2009). Traducción de las emociones y sensaciones del cliente en productos y servicios, Ph.D. Dissertation, UNAM, Graduate School of Management Science, Mexico City, Mexico.

and metrics. Table 11.1 shows an example of the tools and techniques commonly used in each of the product development phases (Hirata, 2009).

Of all these tools, two of them cross the discovery phase and are used in the development phase articulating the market needs, definition of technical requirements, and design elements, as well as the definition of the final product or service attributes or quality characteristics. These tools are QFD and Kansei/affective engineering.

11.3 Kansei/Affective Engineering

Kansei is a Japanese word with no direct and precise translation to English or Spanish, but its meaning is nearer to a psychological feeling rather than an emotion. In the new product development context, it can be defined as the image a person has of a determined product, environment, or situation, when sensed through the senses of sight, hearing, taste, smell, and touch. Kansei is the consumer's psychological feeling and mental image regarding a product or service (Nagamachi 2004). Kansei needs are not easy to measure because they depend on the individual experience and environment, but also because their meaning depends on the context, the time, and the culture of the region or country. The meaning of *elegant* or *masculine* can deliver different mental images in Japan and other countries and 5 years ago versus today.

Kansei/affective engineering was founded by Mitsuo Nagamachi at Hiroshima University about 35 years ago (Nagamachi, 1989; 1995; 1999; 2007). Kansei/affective engineering aims at the discovery and translation of the customer's affective and emotional needs and is considered one of the best-structured methodologies in the world to translate the Kansei needs into attributes of the new product, its characteristics, and its functions (i.e., design elements or decision rules). It is also known by the names of affective engineering, affective ergonomics, and emotional engineering; and it is an evolving (i.e., enriched through other tools and methods) customer-oriented product development technology that invariably leads to a better satisfaction as products and services match and/or exceed customers' profound needs, desires, and feelings (Hirata, 2008).

Different types of Kansei/affective engineering have been defined by Dr. Nagamachi, and they depend on successful applications in new fields based on the following elements: Totally new product or innovation from an existing product; clear definition of customer needs (explicit needs); clear definition of technical characteristics that make customer satisfaction possible; computer system databases with a knowledge base that controls the system and modeling; virtual imaging; methodological approach to define design rules; and finally, product, service, or community-development orientation.

The customer's psychological responses (Kansei) are more general qualitative characteristics, and in consequence, difficult to measure; but in order to transfer Kansei into design elements, qualitative psychological phenomena should be changed to quantified characteristics (linking Kansei with design technical specifications). For example, in the beverage industry, if the developmental target is the design of a new beverage flavor, we must not only define the market's specific segment and its functional needs regarding quality, quantity, cost and delivery, safety, and service, but also understand its Kansei needs (e.g., "I want an urbanlike drink," or "I want a attractive drink"), translate these profound voices of the customer, and deploy them into technical characteristics or design elements that satisfy them (e.g., can color, brand name, letter font, percentage of CO_2, dryness, liquid color).

The applications of Kansei/affective engineering can be found in the automotive industry, construction machinery, electric home appliances, office automation machinery, audiovisual equipment, home construction materials, shoe and garment industry, cosmetic industries and laboratories, stationery products, community design projects, and food industry.

It is important to note that in highly competitive markets, the Kansei/affective engineering approach has a purpose to *enhance quality of life through customer satisfaction.*

The general model of Kansei/affective engineering has the following phases:

1. Selection of the product or service domain and definition of the strategy, which includes the selection of the product or service (existing or totally new one), definition of the market and current

competition with its solutions, potential market segments, senses to be used in the study (sight, taste, smell, touch, hearing) and their combinations, and finally, the general definition of the strategy and plan of the project. This phase shall include potential concepts as well as solutions not yet developed in order to cover a larger scope of the domain.

2. Definition of the semantic space and its structure, which include the collection of adjectives that describe the product or service domain and the potential Kansei needs (i.e., profound needs of the market) called Kansei words (e.g., elegant, masculine, sober, attractive, urbanlike, sexy, heavy), their categorization, definition of the hierarchical structure, and data collection. The Kansei words are collected from various sources such as the team of experts, designers, experienced users, advertisements, magazines, ideas, direct observation, and interviews. The list can go from 50 to more than 500 Kansei words and is commonly categorized (i.e., in groups) in a manual or statistical approach. In the manual form, a group of experts hierarchically organize the Kansei words depending on how specific or general the adjective is (Figure 11.1 shows an example of the hierarchical structure of Kansei words). The statistical approaches include factor analysis, principal component analysis, cluster analysis, and others (Figure 11.2 shows an example of a principal component analysis graph to reduce the dimensionality of Kansei words). The main objective is to determine the most representative Kansei needs.

3. Definition of product or service properties. The objective is to determine potential properties or design elements (i.e., technical and design requirements) of the future product or service, which include the collection of existing products, creation of new concepts, identification of potential customer and company images and priorities, as well as the definition of properties, elements (i.e., attributes or characteristics) and design categories.

4. Data collection. This phase is where the semantic space or the Kansei needs are related to the potential product or service properties through evaluations made by user surveys, direct observation, or physiological measurements. Kansei need is a response variable, and the potential properties or design elements are the independent variables of the model.

5. Data analysis. Data are analyzed and can be processed through manual (e.g., category classification method), statistical (e.g., regression analysis), or nonstatistical methods (e.g., rough sets theory; Nishino, 2005) in order to obtain the best approximation for the relation between the profound Kansei needs and the design elements (Figure 11.3 shows an example of the translation of Kansei needs into design elements).

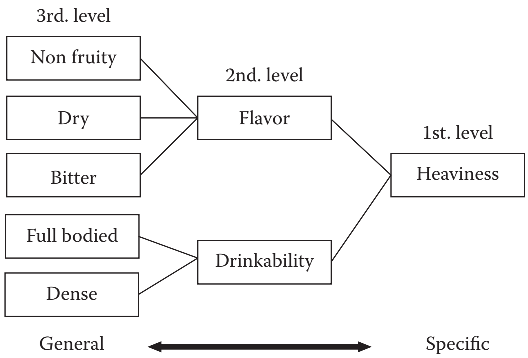

FIGURE 11.1
Hierarchical Kansei word structure.

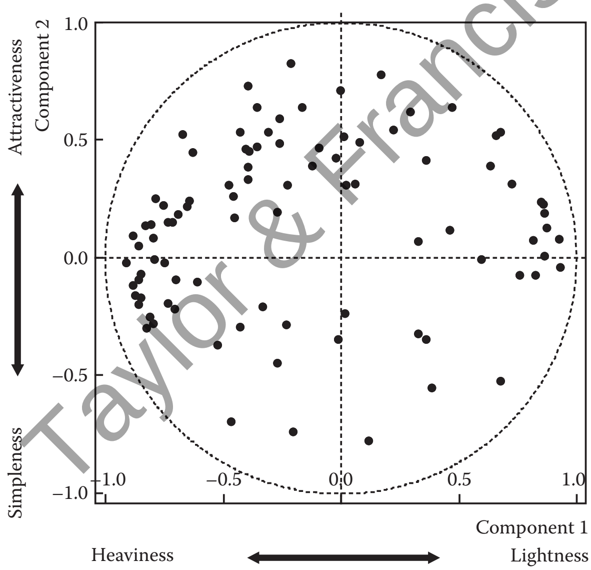

FIGURE 11.2
Principal component analysis of Kansei words (Hirata, R., Nagamachi, M., Ishihara, S. (2004a). Satisfying emotional needs of the beer consumer through Kansei Engineering Study, *Proceedings of the 7th International QMOD Conference 2004*, University of Linköping and ITESM; Hirata, R., Nagamachi, M., Ishihara, S. (2004b). Satisfying emotional needs of Mexican beer consumers market through Kansei Engineering Study, *Proceedings of 10th ICQFD Conference 2004*, Mexico.).

6. Validation and prototype construction. All the results shall be tested for validity and discussed with the team of experts (e.g., technicians, designers, expert users) before proceeding to the construction of prototypes and market testing, as well as planning for the next production and market introduction processes (i.e., development and commercialization phases).

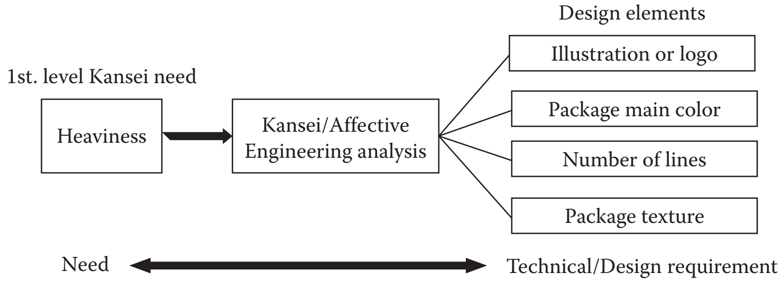

FIGURE 11.3
Kansei need translation to design elements.

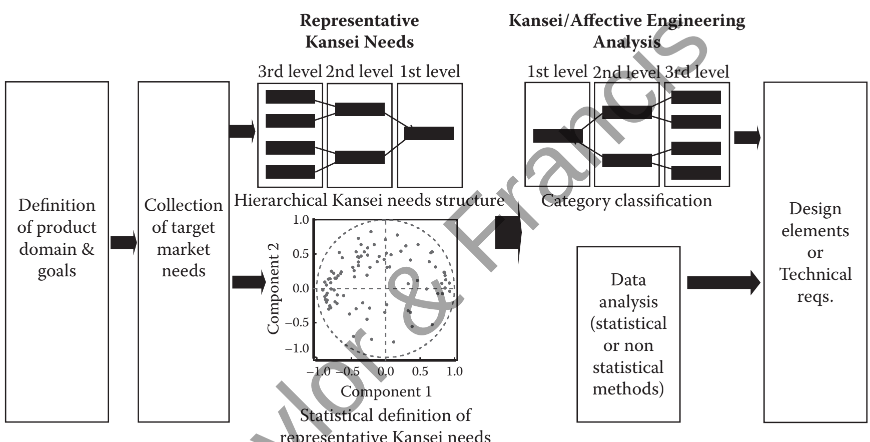

FIGURE 11.4
Translation of market needs and Kansei/affective engineering.

Kansei/affective engineering is a structured approach for the identification, categorization, and translation of profound Kansei needs of the market into physical design elements or technical requirements, using a diverse variety of quantitative and qualitative tools. Figure 11.4 shows a general process for Kansei/affective engineering.

11.4 Quality Function Deployment

Quality function deployment (QFD) was originated in Japan by Dr. Joji Akao while linking the critical points of quality assurance to be carried out through the design and manufacturing processes. Around 1972, he and Dr. Shigeru Mizuno developed a matrix of customer demands and quality characteristics that was used at the Kobe Shipyards of Mitsubishi Heavy Industries. Today, QFD is a comprehensive method for the product or service design and planning ensuring customer satisfaction through meeting and translating his requirements and demands throughout each stage of the product or service development process (Akao 1994; Akao and Mizuno 1994). Its main function is to translate customer needs and desires into the technical requirements of the product or service, as well as deploying its features, components, required technologies, process characteristics, required capability and reliability, and deliverable actions, among others. It links the demanded quality of the market with design, development, engineering, production, and service functions, aligning all company departments to the construction of the benefits the customer requirements and desires (i.e., value from the customer perspective) rather than elimination of errors and claims of defects.

The QFD process gathers and organizes the customer needs and then tailors a specific strategy in order to translate or deploy the market requirements into means to accomplish them using matrix relationships (e.g., target–means matrix) where rows represent the requirements and columns, the alternative or potential means. Figure 11.5 presents an example of how QFD can deploy demanded quality from the market into technical characteristics (quality deployment, matrix 1), demanded quality into product functions (function deployment, matrix 2), demanded quality into failures to avoid (reliability deployment, matrix 3), as well as further deployments such as the relation of functions and technology (technology deployment, matrix 4).

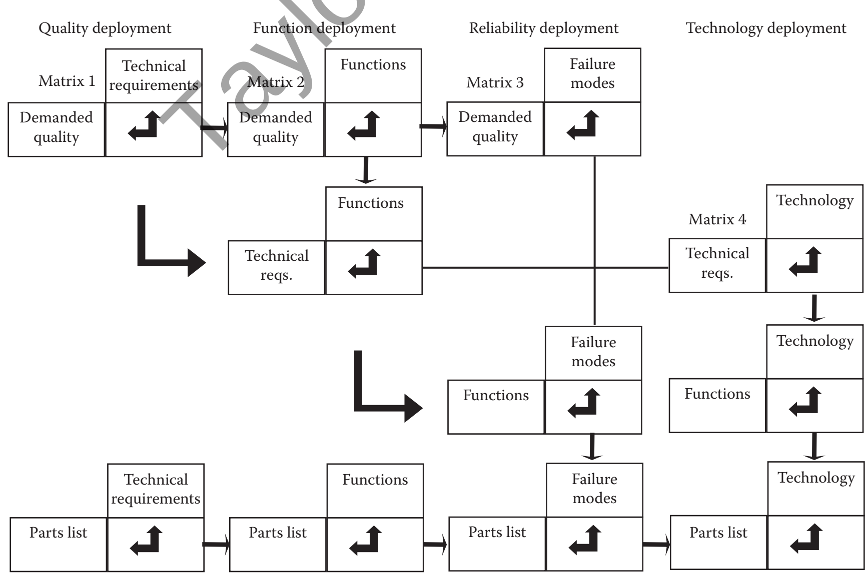

FIGURE 11.5
Comprehensive QFD (example of deployments).

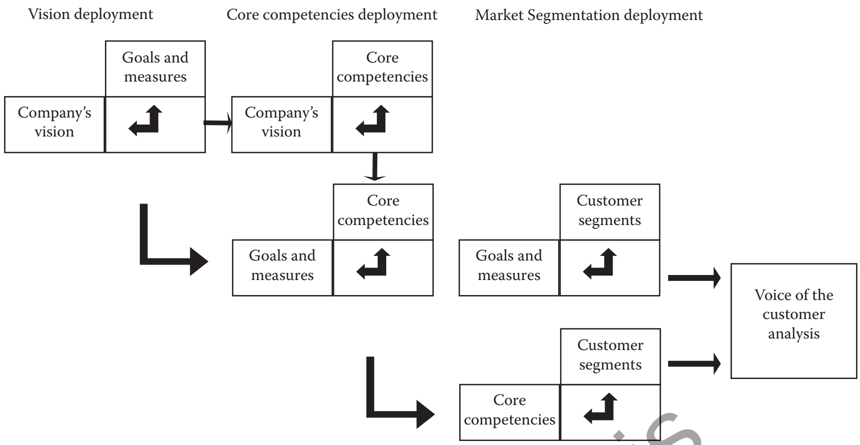

FIGURE 11.6
Vision deployments with QFD matrix (example of deployments).

As a planning and design process, a modern QFD matrix is also used to bridge the gap between the company's priorities and needs with product designs. QFD links to strategic planning deploying the company's vision into its business plan, strategy definition, market segmentation, and customer selection, where it connects into the traditional QFD with the definition of customer needs and demands (Shillito 1994). Figure 11.6 shows an example of the vision deployment into customer needs analysis.

One of the key matrices in the QFD methodology is the relationship matrix in the quality deployment stage (Figure 11.7, matrix 1), where customer needs are related to technical requirements by a group of experts and generally built as the first relationship for product planning. QFD requires the demanded quality to be prioritized, in order to determine key technical requirements and its targets. For this purpose a quality planning table (QPT) is constructed, which includes customer priorities, an evaluation between the company's current products and the competitive products and other elements such as sales opportunities (Terninko 1997). Other relationship matrices such as the product planning table (PPT) are added and create what is commonly known as the House of Quality (HoQ) (Figure 11.7 is an image of the HoQ with its matrices).

Customer needs are collected, interpreted, and organized through various methods such as focus groups, consumer brainstorming, nominal group technique, ethnography (Mariampolski 2006), voice of the customer (VOC) analysis (Katz 2004; Shillito 2001), in-depth interviews, customer visits (McQuarrie 1998), lead user analyses (Von Hippel 1988, 2005), and others. The key point is to clearly differentiate and separate the customer's expected features (functions) and the required and expected benefits, named

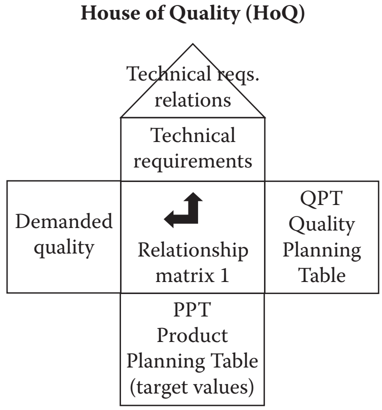

FIGURE 11.7
Quality deployments and the HoQ.

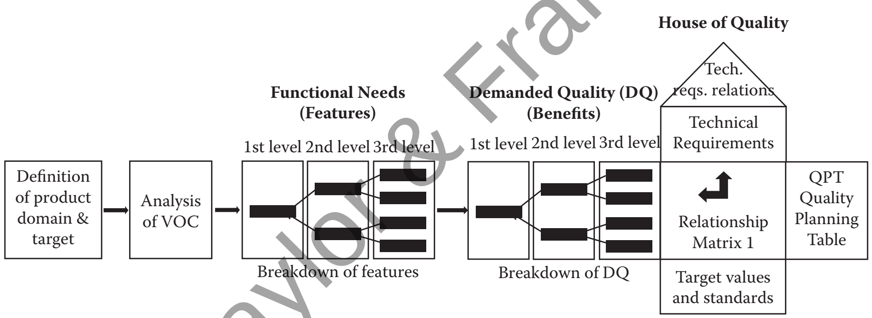

FIGURE 11.8
From VOC to DQ for the HoQ construction.

demanded quality (DQ) for the correct input of the relationship matrix and HoQ. Figure 11.8 shows a general process for the definition of the DQ.

11.5 QFD and Kansei

Since QFD for product planning generally focuses on technical solutions, Kansei needs are difficult to identify, collect, or analyze from the gathered data. Additionally, common tools for traditional QFD grasp explicit customer needs and link them to technical requirements and design elements known by a group of experts (i.e., explicit potential solutions, measures, features).

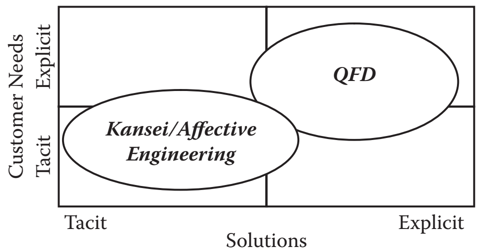

FIGURE 11.9
Relation between Kansei/affective engineering and QFD scope (Hirata, R. (2005). Understanding emotional needs of the Japanese and Mexican beer consumer market through Kansei Engineering Study, presented at International Congress on Quality, Tokyo, 2005.).

Kansei/affective engineering is very useful and an effective technology from the outset, when customer needs are profound and need to be discovered, gathered, and evaluated before deploying solutions (i.e., tacit or unconscious needs). Second, it translates the Kansei needs into technical requirements or design elements not necessarily known by the group of experts (i.e., tacit or unknown potential solutions, measures, features).

Once the Kansei needs and the technical requirements are placed in the explicit arena, QFD is a powerful and profitable technology for the deployment of the product or service. The relation between Kansei/affective engineering and QFD regarding its scope is shown in Figure 11.9 (Hirata, 2005).

Kansei/affective engineering is useful and can articulate with QFD in the identification and categorization of profound, tacit, emotional, and affective needs (i.e., Kansei needs) and is complementary (or prior) to the QFD (VOC) analysis. Both approaches will feed the relationship matrix of the HoQ with categorized and organized explicit demanded quality (DQ) elements (e.g., breakdown of DQ). In QFD, a group of experts defines the possible technical requirements for the DQ elements, and the strengths of their relationships are also determined by distinguishing between a strong, medium, or weak relationship, which accelerates the deployment and the decision making processes under the assumption that all the technical requirements are known, as well as necessary and sufficient. In case the assumption cannot be assured, then further quantitative studies shall be done.

Regarding the determination of the technical requirements or design elements for Kansei needs, Kansei/affective engineering offers quantitative evidence through statistical and nonstatistical approaches (e.g., regression analysis, rough sets) and as a consequence, it also provides a more detailed quantification of the relationships between the DQ and the technical requirements giving more certainty to the design or experts' team. Kansei/affective engineering also feeds the HoQ with the definition of technical requirements or physical design elements, which then can be deployed into other QFD functions. A full approach with QFD and Kansei/affective engineering is shown in Figure 11.10 (Hirata, 2005).

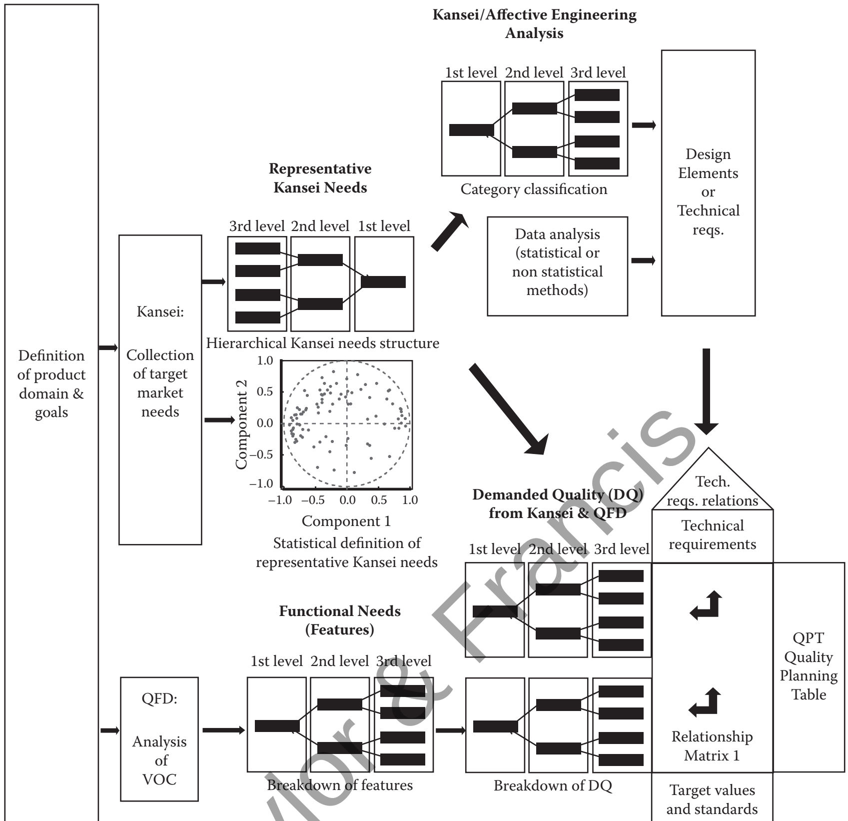

FIGURE 11.10
Kansei/affective engineering and QFD interaction toward HoQ (Hirata, R. (2005). Understanding emotional needs of the Japanese and Mexican beer consumer market through Kansei Engineering Study, presented at International Congress on Quality, Tokyo, 2005.).

11.6 Conclusions

Translation of affective and emotional needs of the markets into design elements and attributes of products and services is necessary to satisfy profound human needs. The discovery phase in the new product development process needs tools and methods to identify, organize, and translate Kansei needs into product or service specifications, and companies shall integrate Kansei/affective engineering as a method for this purpose. In product planning, Kansei/affective engineering is useful to identify the Kansei needs of the target market, especially in the current competitive environments where customer satisfaction is evolving from the satisfaction of the obvious and explicit needs, mostly functionality and usability demands, toward the satisfaction of profound, tacit, emotional, and affective needs.

Kansei/affective engineering, as well as QFD, is a flexible and evolving model that allows the addition and integration of other tools and methods throughout their various stages. Therefore, both can articulate in the process of product and service development providing the tools and processes to translate Kansei needs into design elements, as well as the numerical evidence to support the decision making processes bringing shorter product development cycle times, reduced development costs, and increased satisfaction of functional, usability, affective, and emotional customer needs and in consequence, a better success rate of new products and services in the market.

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