
SAM
Science Arts & Métiers
Archive ouverte Arts & Métiers ParisTech
ARTS
ET MÉTIERS
ParisTech

Development of a KANSEI ENGINEERING SYSTEM for Industrial design :

Identification of input data for KES

Carole BOUCHARD, Dokshin LIM, Améziane AOUSSAT

Laboratory of New Products Design, Ecole Nationale Supérieure des Arts et Métiers,
151 Bd de l'Hôpital, Paris, FRANCE, bouchard@paris.ensam.fr

Abstract: The main current evolutions in industrial design research are the following :

1 The computerization of the early design phases

2 Consumer and user centered design with in particular emotional design

3 The concurrent engineering, with collaborative work supporting tools

Our goal is to modelize the preliminary phases of traditional industrial design process, in order to build new computer aided design tools in accordance with these evolutions, and above all based on the natural thought process of the designers including their own intuitive watch activities.

Many research have been led in Kansei Engineering since the seventies, with many successful results. If we consider that the design process includes the three following phases : information, generation and evaluation, we can consider that most part of the studies in Kansei Engineering are more centered on applications for the generation and evaluation phases. We will focus here on the information phase, related to the input data of the Kansei Engineering process, with the presentation of a method of trends analysis, that we defined on the base of the results of a study of the cognitive activity of the designers.

Key words**:** *Industrial Design, Conjoint Trends Analysis, Integration of Knowledge, Kansei Engineering*

1. Introduction

If we consider the whole industrial design process, computers are widely used for the product development to perform the detailed design tasks that meet physical requirements [1]. Due to the specificity of the activity of an industrial designer linked with image, feelings, emotions, and sensations, it is to more difficult to develop Computer Aided Design tools for the earliest phases of the design process, especially where the design information inputs are vague or ill defined. But the need to reduce costs and delays while increasing the variety of the offer, leads to a formalization and to a computerization of the earliest phases in a pro-active way.

Kansei Engineering methods aim to handle with peoples emotion analysis to elaborate new Computer Aided Design Tools for emotional design. Indeed, today consumers satisfaction is mainly based on emotional performance of products. The methodology integrates an evaluation phase (evaluation of the image of a designed stimulus) and a generation phase (generation of design candidates with prediction of the consuming behavior).

Our aim is here to modelize the early design activity, to finally propose an information phase (for the implementation of the databases). The resulting model will be based on a phase like iterative process centered on designers natural thought process, with unprecise data and functions of searching, evaluating, and comparing different alternatives. This modelization will provide input data that are usually involved in the industrial design process. Indeed, the study of the cognitive activity of the designers is very rich concerning the variety and freshness of the input data they use in the design process. Consequently the creativity process is implemented, with a great potential of more or less radical innovation. The following contents of the paper will be presented in five parts :

2 Description of the industrial design process and its phases

3 Problematic

4 Experiment

5 Presentation of the CTA method

6 Conclusion

2. Description of the industrial design process and its different phases

The design process can be seen as an information process where the design space problem (the brief) will be gradually transformed into a space solution (the 3D model). More detailed, the design process can be seen as an information production process, i.e. a set of successive cycles (See figure 1) of design materialization with the manipulation of an increasing number of concrete representations of physical objects to reach the Final Solution, with a space problem being set in a space solution for each cycle [2].

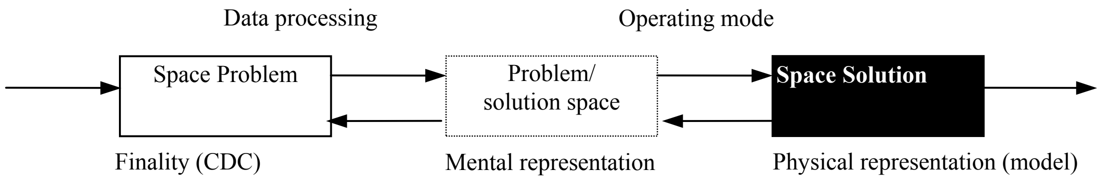
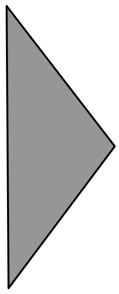


Fig.1 Description of a materialization cycle

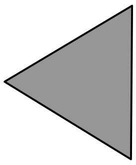
Finalized intangible information is transformed step by step into tangible information by way of mental and physical representations. The physical system supplies the external memory modifying the problem of perception in a decisive way. At any time in the process, designers must be able to assimilate and deal with a large volume of information without losing sight of objectives. This equivalence characterizes the problem/solution space. The design process consists in reducing abstraction through the use of various successive levels of representation integrating increasingly numerous constraints. It is characterized by H. Wang as concepualization including an iterative cycle of mental solutions shown with a given problem [3], where (1) the selection of a solution or partial solutions enable the limitation of uncertainty, and keeping in mind the necessary level of vagueness in modifications during subsequent phases [4]), (2) new constraints are then added by preserving shape and initial ideas, with (3) the display of a new physical representation generating new ideas and new solutions. P. Lloyd and P.Scott [5] describe the design process as generative, deductive and evaluative statements in the activity of design. We consider the design process can be based on the three following phases [6] :

2.1 Information phase



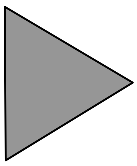
Designers integrate many categories of information that will be gradually formalized as design solutions throughout the design process. The information and data integrated by the designer can be categorized into information connected to the project (brief or datas sought by the designer to complete it), and the designer’s own information stemming from his interactions with the surrounding world. These one include sources of inspiration, references and influences. Sometimes they are dominating over the information connected to the problem. This is both an open and closed phase.

2.2 Generation phase



This phase consists in the generation of new ideas and new solutions : by means of numerous mental images and from brief data and other information contained in any design project, designers can generate physical representations and physical solutions as 2D and 3D models. This requires the use of manual or digital tools, depending mainly on designer skills and on corporate culture. This phase can be performed in accordance with various “applied creativity” methods and tools, which enable the generation of a large volume of ideas, possibly even including the points of view of other non-designer players (ergonomists, sociologists etc.). The generation phase is an open phase.

2. 3 Evaluation and decision phase



The choice of the right design solutions to be developed physically is achieved by an evaluation and deduction process. It uses criteria from the initial or reviewed brief to help choose the best solutions. The Evaluation and Deduction phases are analytical phases. Many methodological tools can back up these phases such as functional analysis and semantic evaluation. This phase is a closed phase.

Designers and non-designers do not posses the same differentiation capability (G. J. F. Smets, C. J. Overbeeke, 1995 [7]). Semantic differentiation by Factorial Analysis is another evaluation/prediction model determined by a visual evaluation of the image of products. Application of semantics helps designers to understand and evaluate their own communication models. Communication is successful by matching the response to the signal.

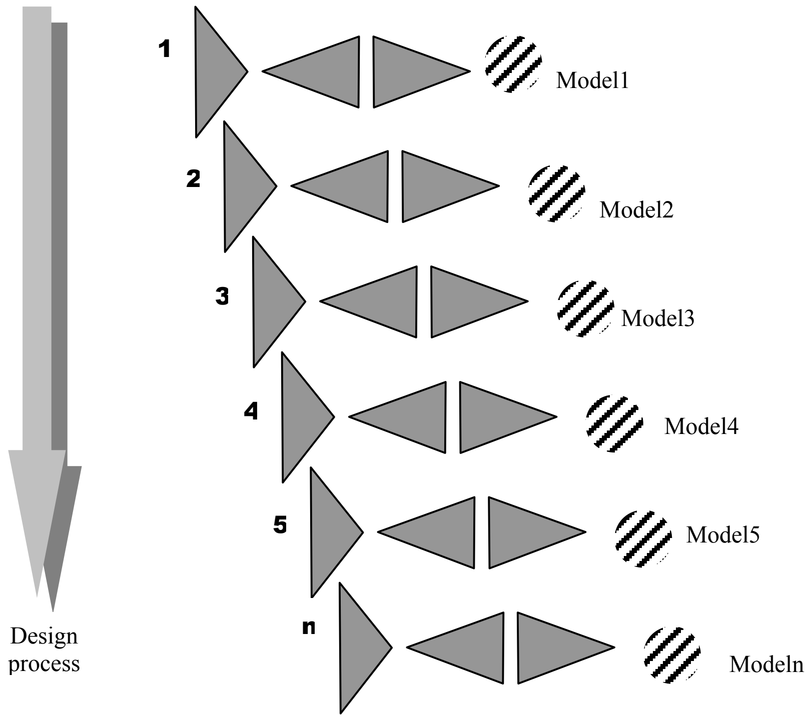


Fig.2 Description of the information process in design activity

All information cycles (see figure 2) contain an informative phase, a generative phase and a decision-making phase (evaluation-selection) whose outcome is an intermediate representation that will be used for the transmission of project information to the other players and - compared with the previous cycle - as a more concrete informative mass. The efficacy of each phase will influence the whole process and the three phases should be of equal value to achieve optimal results. If one of them fails, the general process and of course the final result will fail. Currently, software is being assessed to assist designers in the digital realization of the phases of generation and of evaluation.

3. Problematic

In this part, we will explore many sources in Kansei Engineering before to express the problematic.

3.1 Definitions of Kansei Engineering

Most of the available methodology for consumer oriented design born in Europe to introduce consumers in the design process focus on functional and quality rather than emotional performance of products. On the other hand, the analysis of users perception have been traditionally studied using market research techniques in which users participate only as an evaluation source (and not as requirements generator), and products are evaluated and then redesigned if deemed necessary. This strategy is above all based on trial and error methodology that shows serious drawbacks.

In this sense, Kansei Engineering , sometimes referred to as "emotional design" or "sensory engineering", aims to translate consumers psychological feeling about a product into perceptual design elements, allowing design and evaluation of products before launching them on the market. This technique, which was developed in Japan in the seventies, involves determining which sensory attributes elicit particular subjective responses from people, and then designing a product using the attributes which elicit the desired responses.

In order to perform Kansei engineering, many studies have been led through a semantic approach (Jindo & Al, 1995 [8], 1997 [9], Ishihara & al, 1995 [10], 1997 [11], Tanoue & al, 1997 [12], Yang & al, 1999 [13], Hsu, 2000 [14], Chuang & al, 2001 [15], Hsiao, 2001 [1]), where subjective responses using sets of bipolar attribute rating scales are produced, for the assessment of a set of products sufficiently diverse to provoke a wide range of different emotional responses. The ratings are then statistically compared to provide a distribution of products across the different rating criteria. Analyzing all products rated highly on a particular characteristic allows you to draw conclusions about which perceptual elements are responsible for eliciting this subjective judgment.

More recent approach have been done, based on the recording of action in real time when people are appreciating fine-art work for example (Suh [16], 2000, Lee [17], Harada, 2002 [18]). According to the authors, the langage is not a sufficient modality to describe Kansei. Eyes motions and brain-wawes have to be recorded and mesured as well. Anyhow, this method is not incompatible with other traditionnal Kansei methodologies. It complements those and they could be easily integrated in a single Kansei System. Finally, certain methods focus more on the evolutionary techniques and more particularly on the genetic operations allowing to generate a wide range of design solutions (Sato, 2001 [19]).

3.2 Problematic

The majority of studies in Kansei Engineering are centered on applications for the Generation and Evaluation phases, whatever the direction will be between forward Kansei Engineering or backward Kansei Engineering (Nagamashi, 2002 [20]).

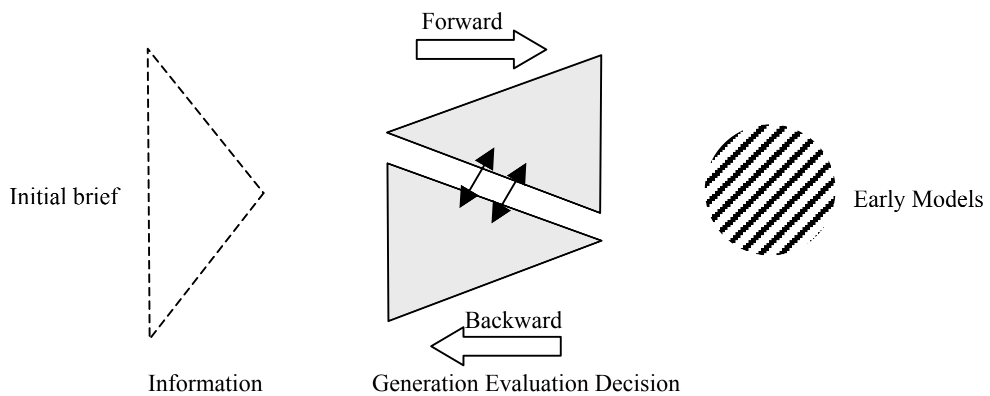


Fig.3 Description of materialization cycle in Kansei Engineering [3]

In the forward approach, the contents of the data bases gathered in the information phase are essentially the words coming from previous consumers evaluations or the commercial litterature, and design elements coming from different sources from the designers. In the backward approach, the evaluation results are the essential source of information.

The information process in the traditional design activity is a crucial part of the design process. The novelty of the design candidates depends mainly of this part, and of the manner to integrate this information during the generation phase too. A specific study showed that creative thinkers usually use more environmental datas (datas not directly linked to the problem to solve) (Ansburg & al, 2002 [21]). Designers could be helped in this phase of information gathering, because they have to manage and categorize a huge number of datas. In that sense, some researchers worked on a new image retrieval system which uses specific object names in addition to impression words which can reflect ambigous human kansei as retrieval keywords (Kuroda, 2002 [22]).

As a matter of fact, sources of inspiration, references, and influences play an important role in the design process, both in defining the context for new designs and in informing the creation of individual designs. Previous designs and other sources of ideas furnish a vocabulary both for thinking about nex designs and for describing designs to others (Eckert, 2000 [23]). Designers use a large variety of types of sources coming from different areas as comparable designs, other types of design, images of art, beings, objects and phenomena from nature and everydaylife. Sources of inspiration are an essential base in design thinking, as definition of context, triggers for idea generation, and anchors for structuring designers mental representations of designs. Our purpose here is to study the cognitive activity of the designers especially during the information phase, in order to extract a model of the cognitive process aiming to develop a specific conjoint Trends Analysis Method. This method will support for the elaboration of new digital tools.

4. Experiment : a study of the cognitive activity of the designers related to the information phase

4. 1 The questionnaire setting

The study [24] included two complementary separate phases : the questionnaire and the protocol study. The extraction of datas concerning the information phase of the design process was maily based on the questionnaires. The questionnaires were centered on the identification of the information and data integrated in the design process by car designers. We sought after 40 professional designers of European car motor companies and students in transport design. Results related to their own design process including a focus on their their sources of inspiration, references, influences and conscious mental images, and were completed with the results of the protocol study. The contents of the answers of the referees were categorized by a contents analysis including the number of occurrences for each category.

4. 2 Results related to information and data integrated in the design process

After consideration of the information contained in the brief, an information search process is systematically performed by the designers to fill in the problem space with non dimensioned values. Strong visual elements are extracted from various sources of inspiration, references and influences, linked with their personality and intuition. The datas integrated in the conceptualization come from different fields, more or less directly linked with the initial domain. The following areas were mentioned :

Table 1 : Sources of inspiration, references, and influences used by car designers during the firt generation of ideas

Universe of Arts	Universe of nature (biomorphism)	Universe of objects and products
Painting	Vegetables	Architecture
Drawing	Plants	Furnitures
Cartoons	Flowers	Fashion design
Graphic arts	Minerals	Aeronautics
Cinema (Science-fiction)	Stone	Hi / fi,
Sculpture	Animals	Video
Music	Insects	Telecommunications
...	Felines	...
	…	

Particular items are sought out across these domains such as (1) impressions connected with global perception (creativity, modernity, innovation, impressions, sensations, spirit, trends), (2) stylistic elements (aesthetics, proportion, structure, shape, line, volume, relief, colour, motifs, textures), (3) technical characteristics (aerodynamics, engineering performance, technologies, materials, internal details) and (4) consumer-related items (adhesion values, semiotics, ergonomics, sensory characteristics, taste). It is true that, to a greater or lesser extent, designers project their own expression through the object. This phenomenon gives partially the originality of a concept, with references that are more or less linked with socially recognized styles. Certain concepts are thus endowed with a signature by which the producer of the Shape can be recognized.

Information details derive from a deliberate information search effort carried out in order to meet the specifications of the brief and from the more or less conscious re-activation of knowledge previously memorized during various activities possibly going beyond the professional context. The result of the information research is translated preferably by the visual shape (trend panels, various sketches, etc.), the textual mode being used to highlight the key points. The designers carry out a more or less systematic and organized investigation, from a simple glance through to the making up of trend panels and databases connected with the initial domain or other domains of influence. This is performed in part by visits to showrooms and exhibitions and by image integration. The investigation process carried out by subjects in areas other than car design remains highly subjective and personal. These areas include various domains, activities, centers of interest or leisure activities to which the designer refers to on an irregular basis and for which frequency and performance are relatively variable. Showrooms or exhibitions visited and regular readings involve transport, with a major representation of this initial domain, architecture and many other fields that are not necessary shared (See Table 1).

Table 2 : Percentage of visited Show rooms, exhibitions and of regular readings of the car designers

Visits of Show-roms and Exhibitions	Transport	72%
	Architecture	10%
	Plastics	8%
	Objects	6%
	Painting	4%
	Information technologies	4%
	Furniture	1%
Regular readings	Transport	58%
	Architecture	10%
	Consumer information	8%
	Design	5%
	Fashion	3%
	Popular science	3%
	Graphic design	3%

5. Presentation of the Conjoint Trends Analysis (CTA) method

The results of the cognitive activity of the designers related to the earliest phases of design allowed the modelization of the method of Conjoint Trends Analysis [25]. This approach enables the identification of formal attributes linked to particular environments in order to use them in the early design of new products. More precisely, it involves the formalization of sociological, chromatic, textural, formal, ergonomic and technological trends.

5.1 Procedure for drawing-up trend boards

The originality of the approach lies in the identification of sociological end values and in the use of various domains of influence (See Figure 4, first step, and Figure 5 on the left), in order to enrich the design solution space. The first analysis tool is the iconic content analysis. The iconic content analysis allows to highlight and build the coherent representation of a perceptual field (ambience), and understand its structuralization (Step 2). This process implements phases involving observation, gathering of information, composition and verbal designation. Then the palettes will be extracted and ordered in harmonies in order to conceive a product's shape, colour, usage and texture components in conjunction the initial perceptual field (Step3). The trend board offers an relatively exhaustive representation of the references usually used by the designers for their composition. It reinforce the link and semiotic coherence between the end values of the consumers, functionalities in any domains of influence, and products attributes as form, colour, texture, and usability principles. The links between semantic choices in a specific context and their formal significants are formalized under the form of a single representation : the trend board. The visualisation of the board enables the observer to become impregnated with a formal impressionist synthesis also called harmony, atmosphere, ambience, context and environment.

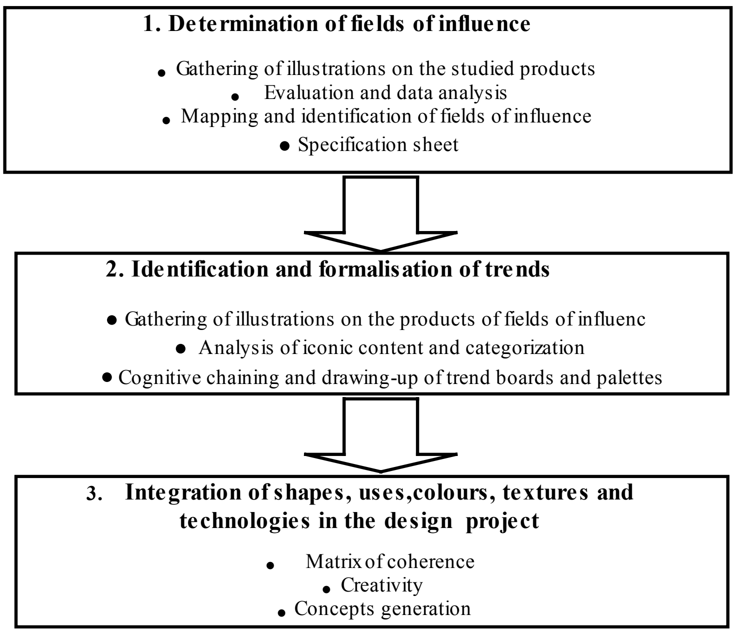


Fig.4 The conjoint Trends Analysis

Contexts are decisive in the attribution of a signification to the object. The fact that the concept is in harmony with its context adds not only to its merely semantic contribution but also to its aesthetic contribution. The context generates an atmosphere by the juxtaposition of different levels (tangible, formal, symbolic, etc.) while taking into account the dynamic relations between these features.

The trend boards thus obtained, as a whole, are representative of trends in the field of investigation. Trend boards represent a powerful representation tool valuable to designers to identify, investigate and represent chromatic, formal, textural, or usability fields so as to understand their structuralization, to position therein the options open with the generation of new concepts, to develop harmonies and styles.

Fig.5 An example of trend panels and palettes : "AQUABIO" trend

The validity of Multi-sectorial Trend Analysis data depends on the replacement and update of developed tools. The follow-up approach is therefore important. Information originating from the achieved follow-up process is centralised, capitalized and redistributed using current Information Technology media (Web, CDROM, Database management systems, etc.).

5.2 Integration of the trends in the design process

Trend analysis corresponds to the information phase (See page 3). It plays an important role in defining and validating the requirement and contributes in translating it into the form of a specification sheet. The trend follow-up which is set into play with creativity sessions sorts information into boards and shade cards which can be digitised and regularly updated within the framework of a follow-up process. The results of trend studies are used either directly by the project team to conceive product attributes, or used as arguments in favour of pre-conceived solutions. It is also a communications tool used within the project team or between the latter and the management team or even for external communication (distribution in press kits, sales brochures, trade fairs, etc.).

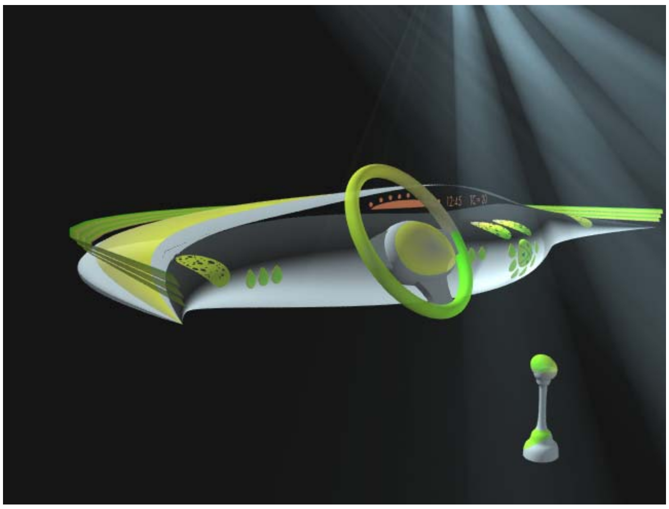
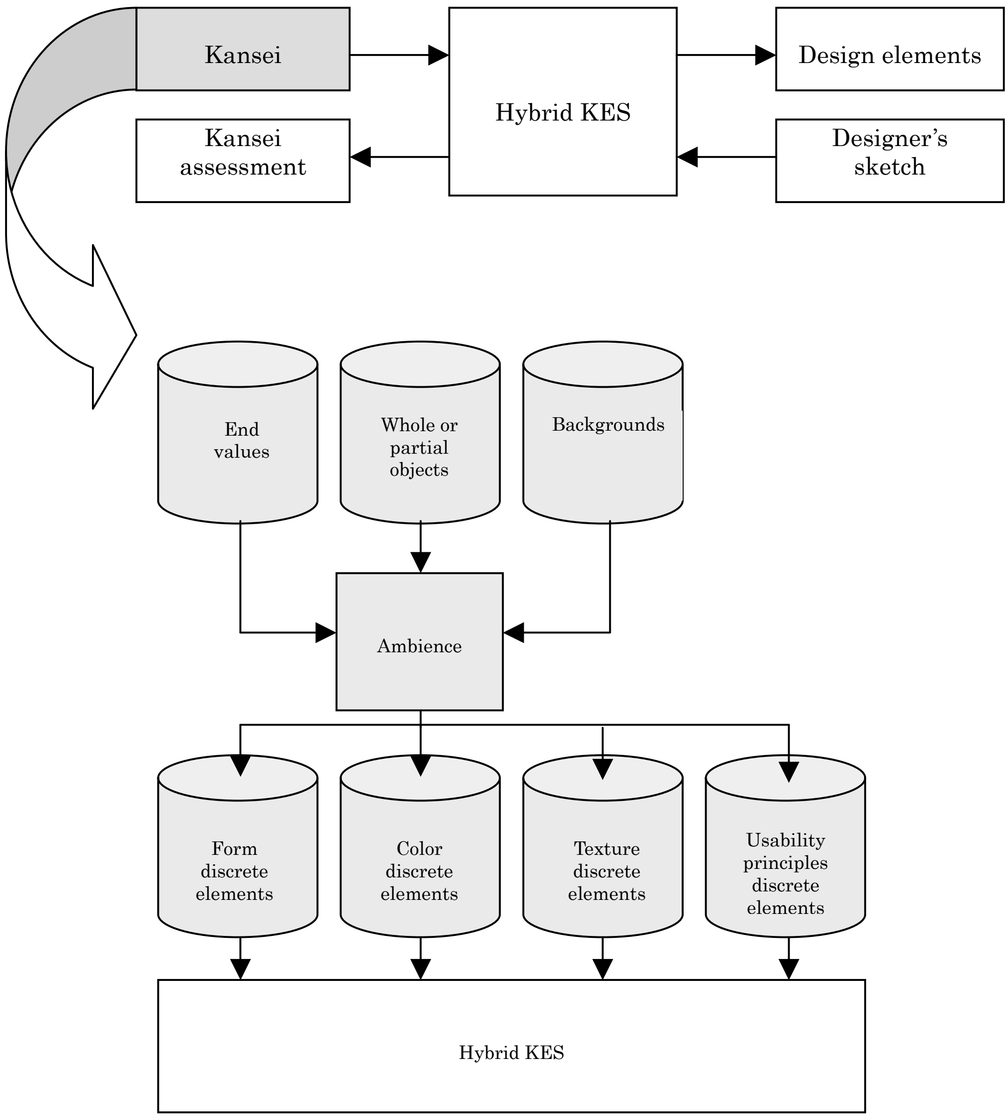


Fig.6 An example of integration of trends in design : "AQUABIO" trend

6. Conclusions



After a presentation of the design process under the form of a succession of information-generation-evaluation cycles, we emphasized the fact that the information process play a major role especially in providing a certain originality in the generated design solutions. Besides, designers, according to the traditional design process, integrate some particular trends linked to the world of the consumer, and that the consumer himself is not able to identify.

Our purpose here was to explore the potential of the integration of the method of Conjoint Trends Analysis in Kansei Engineering, helping to define and formalize input data corresponding to the information phase of the design process.

To our mind, this method based on a deep analysis of the cognitive processes of the designers, will lead further studies in order to implement the actual Kansei Systems with specific mathematic tools as neural networks.

References

1. Hsiao H, Huang HC. A neural network based approach for product form design. Design Studies, Vol 23, 2002, 67-84
2. Bouchard C, Aoussat A. Modelization of the car design process, International Journal of Vehicle Design, Vol 31, January 2003
3. Wang C. An approach to computer-aided styling, Design Studies Vol 16 N°1, January 1995
4. Lebahar JC. Le travail de conception en architecture : contraintes et perspectives apportées par la CAO, Le Travail humain, Tome 49, N°1, 1986
5. Lloyd P., Scott P., Discovering the design problem, Design Studies, January Vol 15 n.2, 1994
6. Bouchard C, Aoussat A. Design process perceived as an information process to enhance the introduction of new tools, International Journal of Vehicle Design, Vol 32, March 2003
7. Smets G.JF, Overbeeke CJ. Expressing tastes in packages, Design Studies, January Vol 16 n.3, 1995
8. Jindo T, Hirasago K, Nagamachi M. Development of a design support system for office chairs using 3D graphics, International Journal of Industrial Ergonomics, Volume 15, 1995, Pages 49-62
9. Jindo T, Hirasago K. Application studies to car interior of Kansei engineering, International Journal of Industrial Ergonomics, Volume 19, Issue 2, February 1997, Pages 105-114
10. Ishihara S, Ishihara K, Nagamashi M, Matsubara Y. An automatic builder for a Kansei engineering expert system using self-organizing neural networks, International Journal of Industrial Ergonomics, Volume 15, 1995, Pages 13-24
11. Ishihara S, Ishihara K, Nagamashi M, Matsubara Y. An analysis of Kansei structure on shoes using self-organizing neural networks, International Journal of Industrial Ergonomics, Volume 19, 1997, Pages 93-104
12. Tanoue C, Ishizaka K, Nagamachi M. Kansei Engineering : A study on perception of vehicle interior image, International Journal of Industrial Ergonomics, Volume 19, Issue 2, February 1997, Pages 115-128
13. Yang SM, Nagamashi M, Lee SY. Rule-based inference model for the Kansei Engineering System, International Journal of Industrial Ergonomics, Volume 24, 1999, Pages 459-471
14. Hsu SH, Chuang MC, Chang CC. A semantic differential study of designers and users product form perception, International Journal of Industrial Ergonomics, Volume 25, 2000, Pages 375-391
15. Chuang MC, Chang CC, Hsu SH. Perceptual factors underlying user preferences toward product form of mobile phones, International Journal of Industrial Ergonomics, Volume 27, Issue 4, April 2001, Pages 247-258
16. Suh MW, McCord M, Woo JL, Shalev I, Kim HB, Sensory (Kansei) Engineering of Aesthetics in Textile Fabrics, Code Number: F99-S2, This project was a Seed Project discontinued as of 4/30/00.) NC State
17. Lee SH, Harada A, Okazaki A. Modeling structure of Kansei : An analysis of how people appreciate art through a remote controlled robot, Art and Design Institute, University of Tsukuba, Graduate School of Comprehensive Human Science, University of Tsukuba, report of modelling the evaluation structure of Kansei 2001, p.203
18. Harada A. Strategy towards research of Kansei, 8th Tsukuba International Design Forum, on 2 December, 2002
19. Sato T, Hagiwara M, IDSET : interactive Design System using Evolutionary Techniques, Computer-Aided-Design, Vol 33, 2001, Pages 367-377
20. Nagamashi M. Kansei Engineering as a powerful consumer-oriented technology for product development,

Applied ergonomics, Vol 33, 2002, 289-294

21. Ansburg PI, Hill K, Creative and analytric thinkers differ in their use of attentional ressources, PAID, 2002; Article in press
22. Kuroda K, Hagiwara M. An image retrieval system by impression words and specific objects names – IRIS, Neurocomputing Vol 43, 2002, 259-276
23. Eckert C, Stacey M. Sources of inspiration : a language of design, Design studies, Vol 21 Number 5, September 2000, Pages 523-538
24. Bouchard C, Modelization of the car design process, Thesis, 1997
25. Bouchard C, Christofol H, Roussel B, Aoussat A, Identification and integration of product design trends, International Conference on Engineering Design, Munich, August 24-26, 1999