Chapter XX

Kansei information processes in early design: design cognition and computation

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Abstract: This chapter considers the Kansei information processes involved in the early design process. It emphasizes the necessity of formalizing the earliest phases of design, i. e. the information phase. After a longitudinal research led since 1997, a theoretical model of the information phase of design was proposed. This model was then refined through experiments that we led from various research projects that were developed during the last years thanks to national and European supports. In the framework of the research presented here, the objective was to refine the model especially by considering the cognitive implicit operations which occur in the early generative phases, i. e. between the inspirational phases and the sketching ones. The paper starts with the definition of the following terms: design process, design information, sectors of analogy, *kansei* information, *kansei* structures and *kansei* rules. Kansei information characterizes the whole corpus of information which the designers deal with in the early design process. Especially, from the information phase, the creative process based on metaphors and analogies is decrypted and formalized, with the extraction of generic rules that, after understanding, may be used more systematically in the generative phase of design through future computer aided design tools. Finally we discuss some advances related to cognition and computation of Kansei processes in design.

Keywords

Kansei information, information phase, generative phase, early design, analogical thinking, creativity, metaphors.

XX.1 Introduction

Designers apply a more or less formalized awareness process about design trends. This goes from a simple observation in their everyday life to the regular reading of magazines and the continuous consultation of websites. Inspiration sources play a major role in design in order to define the context, stimulate the idea generation by analogical reasoning, and structure the mental representation in accordance with consumer's values and lifestyles.

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From a study of the cognitive activity of the designers in the inspiration-information seeking phase, we formalized a theoretical model linked to this activity which was defined and validated in an operational context (Bouchard & al, 2002, 2009, 2011). This model describes the initial steps of the design process, where the designers soak up verbal and visual codes in order to transfer them in the generation of new concepts. This process is more or less conscious for designers. The selective process they use in early design is based on emotional, aesthetical, or values linked features. It also involves the freshness of images content.

This chapter is composed of the following sections: section 2 *Theoretical background*, section 3 *Kansei information process*, section 4 *Structure and content of kansei information*, section 5 *Solutions and recommendations* and section 6, the *Conclusion*.

XX.2 Theoretical background

XX.2.1 Formalisation of the early design process

Research advances that were widely developed in design science and other disciplines such as cognitive psychology in the nineties apply mainly to the individual sketching activity and its representations (Tovey *et al.*, 1997, 2000, 2003, Bouchard, 2003, Do *et al.*, 2000, Van der Lugt, 2001, Gero, 2001, Bilda & Gero, 2007, D. Schön, 1992, Suwa & Tversky, 1997). The task of sketches generation was is also analysed from the produced sketches as explicit representations of the activity, by studying essentially the criteria of creativity. Sketching activity refers to the first tangibles and concrete tracks that are produced during the concept's development, following a reflexive and iterative approach which fluctuates between visualisation and sketching. This process may be seen as a continuous reflective conversation (Schön, 1983) between designer's thought and the intermediate representations they produce and visualise. This process is a key step for the conceptualization, by answering to the functions of visualisation and simulation by the externalisation of problem and solution related information when developing new concepts (Tovey *et al.*, 2003).

On the other hand, the early activity situated before sketching remains less explicit and so then less studied (C. Eckert, 1998, 2000, M. Büsher, 2004 , P. Angsburg, 2003, Mc Donagh, 2005, C. Bouchard, 2006, C. Mougenot, 2008, J. Kim, 2010). Indeed implicit activities provide less tracks and their formalisation call for specific methods for the extraction of design proficiency. This is so still an emergent topic with few literature references, whereas many references are available about sketching and detailed design. We did not identify any models which offer a rigorous formalisation of this phase except of those cited in (Eckert & Stacey, 2000), and (Bouchard, 2002, 2003). However, the process according to which the designers integrate information in order to foster mental images is crucial in order to better understand the design problem and to stimulate new directions in the generation of solutions. Both the inspirational process and the information seeking process involved before concepts generation are essential for problem interpretation and solving.

The overall information process is a dynamic process including both an *inspirational process* which is not always conscious, and the *information seeking process* carried out when solving a design problem. The inspirational process involves sources of inspiration encompassing precedents and other sources from sectors of analogy (nature, industrial sectors, arts). Designers use intensively some references from these sources of inspiration which are mainly visual, but also possibly sound or scents. These sources play an important role in order to define new contexts for new designs, to communicate inside of the design team and to inform new design solutions and open the scope of possibilities (Eckert & Stacey, 2000). They

stimulate cognitive operations such as association and analogical reasoning and lead to the emergence of new ideas and concepts. The information seeking process, namely the *exploration* process (N. Cross, 1996) is involved in order to solve a specific problem. It enables to gather the information that is needed in order to understand the design problem (Wallas, 1926, Amabile, 1983), and discover useful ways of solutions (Osborn, 1963, Schneiderman, 1992). We discovered in previous studies the weight of analogies in kansei information. Analogies are a great support for divergent thinking. It is recognized as one of the most powerful process in creative reasoning.

XX.2.2 Information process in design

Design information is conveyed through various media such as conversations, text, images, sketches and models. It can be stored in physical or digital spaces. Even if all the senses come into play in the perceptive, affective and cognitive processing of information, a most important place is still often given to the visual sense. This visual information refers to various angles which can be functional, structural, affective, aesthetic or others. The sectors of influence play a major role in the creative process where designers will re-use some features from the sectors of influence and transfer them into the reference sector. This will bring a creative distance which is necessary to provide original design solutions (Bouchard, 2009). Oppositely, the more these references will be close of the reference sector, the more the implications will be functional or structural (Bonnardel, 2005). The research on modeling the cognitive activities of the designers in this phase is of growing interest in the field of design science, and also in other area such as artificial intelligence and psychology. If sketching activity has been well studied and is still of interest for research, implicit categorization processes which intervene at the same time are more difficult to grasp and were not so studied and formalised so far. Some studies were already led on this topic in the fields of architecture (Büsher, 2004) and of kansei-based image retrieval (Bianchi-Berthouze, 2003). The difficulty comes from the subjectivity inherent to the cognitive operations engaged, and from the multi-dimensional design (Bianchi-Berthouze, 2003) and holistic character of the visual information used and produced in design projects. Some formalisations were proposed in the framework of the development of information systems dedicated to the designers for supporting design activity. These information systems are sometimes accompanied with an annotation system, and more rarely with a search engine. These tools return relevant information to the designers for their activity, especially for the inspirational or information search tasks, by providing them a big quantity of data. These systems are yet insufficiently adapted to designers' needs and natural activity. This is due to a lack of understanding and formalization of the cognitive activity in those phases. In particular, designers' skills mainly lie in applying expert rules. These rules rely on a particular ability enabling them to link high-level information (semantic descriptors) with low-level information (colors, textures, forms). First attempts were achieved in order to propose information systems which would be able to take into account these dimensions (Bouchard & al, 2008).

XX.2.3 Sectors of influence in design

A main information source in the information phase of the design process is coming from the sectors of influence used by the designers during divergent thinking. The identification of information as pertaining to specific semantic sectors is an important means of achieving analogical references for designers. Studies by Bouchard (2002, 2003), investigating the information sources of car designers, have enabled to make explicit the designers' sectors of influence in car design. These studies also confirmed that these sectors are long term indicators. In the context of design activity, *sectors of influence* correspond to discrete semantic domains that bear analogical reference to the target domain (e.g., arts, nature, industrial design, transportation, furniture design). Designers are able to select relevant information, considering also different levels of information abstraction: high/middle (e.g., semantic adjectives, consumer values)

or low-level information (e.g., shape, colour or texture), and in doing so bring analogical references to the target domain. In this regard, *sectors of influence* play a major role in filtering the information that is useful for the designers. A deconstruction of this process, comprising three steps is provided in Figure 2. Starting from the reference sector the designer will investigate and explore analogies in other sectors that are more or less semantically proximate. Having identified inspirational materials that can be extracted, the designer proceeds to the analogical sector and then transfers the solution back to the reference sector. This is also the basic concept model of creativity. With this example we can mainly see the similarity of shape features used between a snake in the analogical sector and the front side of a car in the reference sector, which is car design. This provides an aggressive expression to the vehicle, which is satisfying for a sporty vehicle.

XX.2.4 Metaphors and analogies

The provision of semantic contexts is crucial to the designers, facilitating the cognitive associations and the identification of analogies. Analogies are called from analogical reasoning in a process where the subject will get from a problem source, to a target solution which partly or fully answers to the problem. In this process, we use the term metaphor, when the relation between the source and the target is not involving a certain amount of similarity of information between the source and the target. Picking and using analogical references is a key part of designers' information process in early design (Bouchard, 2002, 2003). Magazines, internet and exhibitions provide the preferred sources of inspiration. A big amount of these inspiration sources may be taken unconsciously out of a professional context. The designers search for images from semantically related domains, such as *sports*, *nature* (biomorphism, providing analogy in combination with examples of functional efficiency), or *arts* (music, cinema, painting, sculpture).

XX.3 Kansei information process

XX.3.1 Kansei information

Design information is very specific in the way that its integration and transformation involves affective processes. Kansei is a complex informational process carried out by a designer or a consumer who perceives a design stimulus. Kansei is a japanese word which covers multi-dimensional meanings such as feeling, emotion, semantics, affectivity, feelings (Nagamashi, 2002). It can be seen as a function which processes information which is by nature analogical and fuzzy, Kansei also refers to the nature of the relations that the designers are used to establish between various levels of abstraction of information. It involves both cognitive and affective processes which are already involved when designers integrate information. Its content can be classified into information called high-level information, middle-level information and low-level information, according to a terminology on loan from artificial intelligence which defines the levels of abstraction of the information (Black, 2004). We retained this definition which is relevant in our case because it describes precisely the skills of the designers and it covers the whole information levels the designers deal with. These levels of information go from very abstract values such as *purity* to concrete attributes such as the white color. Low-level information encompasses characteristics of shape, color and texture. Middle-level information includes concepts and artifact names. High-level information is translated at the same time by semantic descriptors, sociological values and affective and emotional dimensions, which lead us to the definition of kansei. This emotional dimension is a major one in those which are perceived and processed by the designers. It covers 46% of the whole information integrated and processed by the designers, the other dimensions being style, technology, user and aesthetics (Bouchard, 2003).

XX.3.2 Kansei rules

We emphasized the variety of types of information which are behind the term of kansei. These information are non homogeneous and this is a difficulty when trying to formalize the process. Kansei refers as well as the content of information as the expert relations that can be built by the designers between these various corpus of data involved into the design process. Designer's skills mainly lie in mastering the whole set of data categories working, and above all in the ability to link them together in an intuitive way. The core expertise of designers comes from their ability to link high-level information with low-level attributes and *vice-versa*. In particular, a main part of the expert rules involved of association, categorization, or generation carried-out y the designers, consists in linking low-level information with low-level information and to use various levels of abstraction at the same time. Kansei rules are brought into play in a quasi-continuous way in order to mentally or explicitly categorize design information. They are subtly crossed with other rules applying to the contribution of harmonies intra- or inter-levels which provoke positive emotional reactions. They are conjointly supported by analogical reasoning which will also contribute to provoke some feelings in the presence of more or less evident metaphors.

XX.3.3 Need to formalize the kansei information process

Nowadays it is necessary to better understand kansei information and kansei rules. Indeed, the development of new computer systems for supporting the early design activity requires a clear and detailed formalization of the latter. Making explicit the designer's cognitive and affective processes becomes a major topic for many scientific communities such as design science, cognitive psychology, computer science and artificial intelligence. This growing interest is partly due to a certain pressure coming from the industrial context where shortening the development durations and increasing the variability of the offer, lead to the formalization and digitization of the earliest phases of the design process. In this context, the domain of kansei in early design tends to be developed with the definition of new models and tools that will help to progressively digitize the early design process. Our research follows three sequential steps which are, at first, the formalization of kansei information, secondly the extraction of kansei rules and skills, and finally their transfer towards formats that can be implemented by design algorithms.

The following study relates an experiment we led previously with professional designers in car design and in product design. In a first time, we investigate kansei information. In a second time, we formalize the relations which exist inside of this information and how they are transformed in different states.

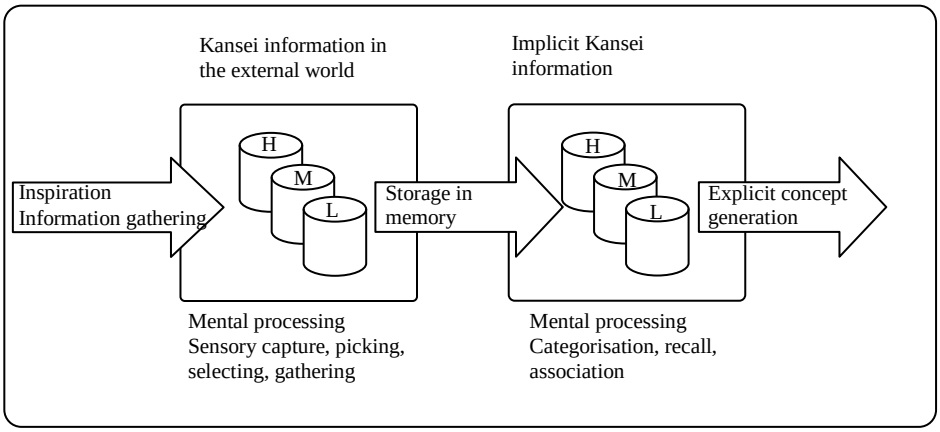

Figure 1. Kansei information processing.

Kansei information processing (see figure 1) is considered from the first phase of inspiration and information gathering, where some multi-sensory information is selected, captured, picked and gathered from the external world, to the one of explicit concepts generation, after building a coherent mental representation, which is by nature implicit, and contains the source and the target, in other terms the problem and the solution. This process involves so a succession of implicit and explicit information processing.

XX.4 Structure and content of kansei information

XX.4.1 Structure of Kansei information

Design information can be structured according to its abstraction level. We gathered lexical data from professional designers during research projects (Bouchard, 2007, 2009, Kim & al, 2010).We structured this information from the most abstract level (values, semantic descriptors, analogies, styles) until the most concrete (color, texture, shape). From these studies a kansei ontology has been defined. Kansei information encompasses principally semantic descriptors, object names, values and low-level descriptors. All content and structure of kansei information is presented table 9. This information is representative of the whole corpus of information the designers deal with. The following table also shows the correspondence the different types of information. Harmony rules may be applied to low-level information (color harmonies, color-from harmonies) but also concern the relation between high-level and low-level dimensions. A codification of the type of information has been established according in the following table according the three levels high, middle, down, and the 10 categories (semantic descriptors (Hs), values (Hv), analogies (Ha), style (Hy), sector names (Ms), context (Mc), function (Mf), color (Lc), shape (Lf), and texture (Lt)).

Level	***Categories***	***Code***	***Description***	***Examples***
High level (H)	Values	*Hv*	Final or behavioral values	Security, Well-being, Freedom, Ethics
	Semantic adjectives	*Hs*	Most of these adjectives are related to color, shape and texture	Romantic, Aggressive, Muscled, Fluid, Robust, Balanced
	Emotions	*He*	Emotions as effects of design stimuli	Amused, Enthusiastic, Ill at ease
	Analogies	*Ha*	Objects, entities from other sectors from which some design elements are transferred into the reference sector by similarity	Rabbit → quick, fast
	Style	*Hy*	Characteristics of every levels through a specific style	Edge Design, Work wear.
Middle level (M)	Sector names	*Ms*	Objects names describing a sector or a sub-sector representing a specific trend	Sport devices, automotive design, interaction design, cosmetics
	Context	*Mc*	Moment, place, activity	Family leisure
	Function	*Mf*	Function, usage, component	Modularity
Low level (L)	Color	*Lc*	Color properties	Yellow, light blue, pale indigo
	Shape	*Lf*	Shape combinations, size	Square, corrugated, geometric, tight lines
	Texture	*Lt*	Motifs (abstract, figurative) and texture	Plastic, metallic

Table 1: Coding of kansei information (Bouchard & al, 2009, 2011, Kim & al, 2010)

XX.4.2 Design experiment objectives

The aim of our protocol study was to determine the kind of information the designers use and how it is transformed or categorized during early sketching. Expected results are kansei information processing operations and determining how this design information is transformed or categorized during early sketching.

XX.4.3 Methods

For understanding design related kansei information, most of the methods are based on the explicit representations used or produced by designers. These methods show certain limitations insofar as many of the cognitive activities of designers during the early stages of design are implicit. Some approaches are provided by methods drawn from ethnography, or by the think-aloud technique, concurrent and retrospective (Kim & al, 2010). In this experiment we used an activity-based approach, which is a combination of these methods. Indeed, concurrent protocols are considered better suited to our study in that we focus on design information and analogical reasoning. Semi-directive interviews were also conducted at the end of the experiment to compensate for the limits of the concurrent methodology. As participants, two third-year undergraduate design students and six expert product designers were recruited (one female and seven males). The six expert designers had a mean of 9 years of experience. If one designer who had worked in product design for 28 years is excluded, the mean number of years of professional experience decreases to 5.2 years. The experiment was conducted at the design agencies of the participants to collect data in their natural working environments. We used two video cameras and one voice recorder to collect verbalizations. One video camera captured the movements of the hands of each designer and recorded close-ups of the sketches, and the second recorded the entire body of the designer. The protocol involved three phases: (1) Warm-up phase, in which we explained the procedure of the experiment and participants became accustomed to the practice of concurrent verbalization (□15 min). (2) Concurrent verbalization, in which participants were asked to work on the design brief: Designing a Nike vacuum cleaner. During this phase, they started to generate early sketches using traditional tools and simultaneously verbalized their thoughts (□60 min). (3) Semi-directive interview about the mental images, semantic descriptors, and forms generated as well as about the relationships among those three types of data (□15 min).

Using the principles of protocol analysis recommended by Suwa, Tversky, Gero and McNeill (Kim & al, 2010), the entire verbal protocols were transcribed and segmented for coding according to the coding scheme presented Table 1. This scheme includes the 10 categories of design information. Next, written transcripts were attached to corresponding video clips. The complete coding scheme enabled so understanding of connections between mental representation during retrieval and external information during sketching and also yields an encompassing depiction of the cognitive processes involved in analogical reasoning and categorizing design information.

XX.4.4 Results

Both quantitative and qualitative approaches were integrated to describe the analogical thinking process. The first noticeable result is about the type of design information involved during early sketching (see figure 2).

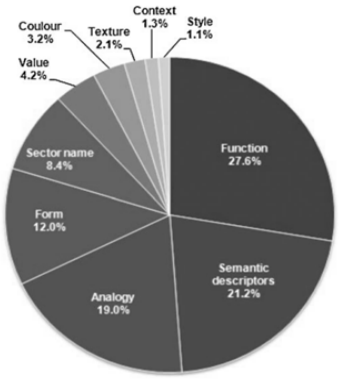

Figure 2. Kansei information processing.

The substance of the comments made by the designers is very dependent on the design brief: Designing a Nike vacuum cleaner. For example, representative words in value categories included '*dynamism'* and '*aesthetics'*, and the most common semantic descriptors included *sporty*, *dynamic*, *fluid*, *classic*, *technical*, *fun*, *friendly*, etc. The designers also employed 12 analogical words referring to, for example, *sports* (*using a harness or scooter, lifting weights, using flippers, cycling, dancing, etc*.), *biomorphism* (*animals: shark fin, humans: mouth, and vegetables*), and *shoes* and *luggage* (*backpacks, accessories, etc*.). These references draw heavily on semantic and conceptual associations with the *Nike brand* (e.g., *shoes for sports*). Other sectors (e.g., *industrial products, household electrical appliances* used for protection *and air conditioning, robots, containers, and real estate*) were also mentioned. The category encompassing the function of the target product consisted of responses related to its internal mechanics, units, and uses and operations such as *fan*, *dust bag*, *air cushion*, etc. Consistent with the quantitative results of a study on design information reported by Kim et al. [30], high-level information was used most frequently (47.7%), followed by middle-level (36.7%) and low-level (15.6%) information. Thus, high- and mid-level information accounted for 84.39% of the words verbalized during early sketching. Low-level information tended to be represented in sketches rather than verbalized. The detailed frequencies of each category are presented in Fig. 5. The most frequently verbalized content was related to function (27.6%); this was followed by semantic descriptors (21.2%). The remaining six categories were mentioned relatively less frequently.

The second noticeable result is about how the content of information was structured. The classification was done according to a Kansei ontological model (Bouchard & al, 2007). This model of data classifies all content of lexical information from designers verbalizations in successive columns from the left to the right going from the most abstract to the most concrete (see table 4). So we can find respectively with a ranking going from high-level information the *sociological values*, the *semantic descriptors*, the *analogies* and the *styling names*, for the middle level information the *functions*, *names of sectors*, *contexts* and *targets*, *and for low-level information color names*, *shapes* and *textures*.

High-level				**Middle-level**			**Low-level**		
Values	**Semantic descriptors**	**Analogies**	**Styles**	**Functions**	**Sectors**	**Contexts**	**Color**	**Shape**	**Texture**
Dynamism Aesthetic (beautiful, dynamic x6)	Sport, sportive x6 Dynamic x6 Fluid x3 Classic x3 Technical x2 Fun x2 Sympathetic x2 Playful Close to the body Efficient Professional Soft Static American Clean New Funny Of quality Anti-sportive	Vacuum cleaner slipper Shoe x4 Slipper x4 Weight apparatus x3 Trotinette x2 Flippers x2 Sport coaching Stepper Dance Weight Small bac Sangle Belt MP3 Shark aisle Aspiring tongues Brush Cross country skiyng Backpack Ballerina Cushions Air bubbles Mouth Rythm		Go-back x5 Rolls x5 Wearable x3 Aeration x3 Swip the hand x2 Ergonomic soles x2 Sportive move Sport practice Aeration is going up Contains the vacuum cleaner Precision tools Transport Walk on a vacuum cleaner Motor vacuum-cleaner Wrist Power plug Pipe-bag Brush for vacuum-cleaner Goes into corners Small aspiration Encircling the wrist Contact Battery Small modules Grasp Clean Aspiring pair Anti-move Go into slots	Nike logo x2 Sport brands Vacuum cleaner without bag Floor vacuum cleaner		Touch of color	Tensed lines x2 Circular Big curves Necessary volume Not symmetric The part goes up Too much volume	

				Low apprehension Tools Screen 2 small VC Modulable Aspire Ergonomic Tube with aspiring head No bag					

Table 2: Kansei ontology model, Designer 1 (empty columns have been filled by other designers)

XX.4.5 Sectors of analogy

The sectors of analogy are specific according to the brief and more precisely the reference sector. The reference sector is the sector in which the future product will be designed. The sectors of analogy reveal the richness of the data processed by the designers. They may be used as important input data in information systems that are elaborated for computer aided design information systems. This way, they may have a crucial impact relating the nature and the specificity of the databases to be developed and carried out.

The sectors of analogy which appeared the most frequently in this experiment when considering the whole set of designers answers are those of (see table 3 and figure 3) *sport* (21%) (*harness*, *weight training apparatus, trottinette, flippers, bicycle, dance* …), that of *wheeled objects* (14%) (*wheels, cars, chariots*), of *biomorphism* (12%) (*animals* (*shark fins*), *human* (*mouth*), *vegetal*), that of *shoes* (10%) (*slippers soft, slipper vacuum-cleaner* …) and that of *luggage* (9%) (*backpack, accessories* …). These sectors are strongly depending on the semantic impact of the brand Nike which associates the concept of sport to the shoes products. Also other sectors appear with a rather smaller influence such as the sector of *domestic appliances*, that of *NTIC*, or other sectors (*protection, air, robots, containers* and *habitat*).

Sectors	**Percentage of citations**
Sport	21%
Wheeled objects, traffic	14%
Biomorphism	12%
Shoes	10%
Bags, luggage	9%
Home appliances	8%
NTIC	7%
Protection	6%
Air	4%
Robots	4%
Containers	3%
Habitat	2%

Table 3: Sector of analogies, cumul for all designers

The sector which has been given the most importance by the designers is that of sports. This is due to the impact of the brand Nike which has been included in the brief. The brand brings both abstract and concrete dimensions such as values (dynamism, aesthetics), semantic descriptors (fluid) or shape descriptors (tensed lines, big curves, …). Then, the sector the most cited is that of wheeled objects, which corresponds to one of the important functions of the vacuum-cleaner: to move during the cleaning activity. There is also a big connection between these two sectors (sport brand and wheeled objects), with specific sectors such as wheeled shoes, sport vehicles, and golf carts. The biomorphism sector is also of great importance, coming in third position. This sector is sub-divided into four pars: mineral, vegetal, human and animal. As relation between biomorphism and sport, we can find items such as water drops. Biomorphic sources bring inspiration mainly for function and shape.

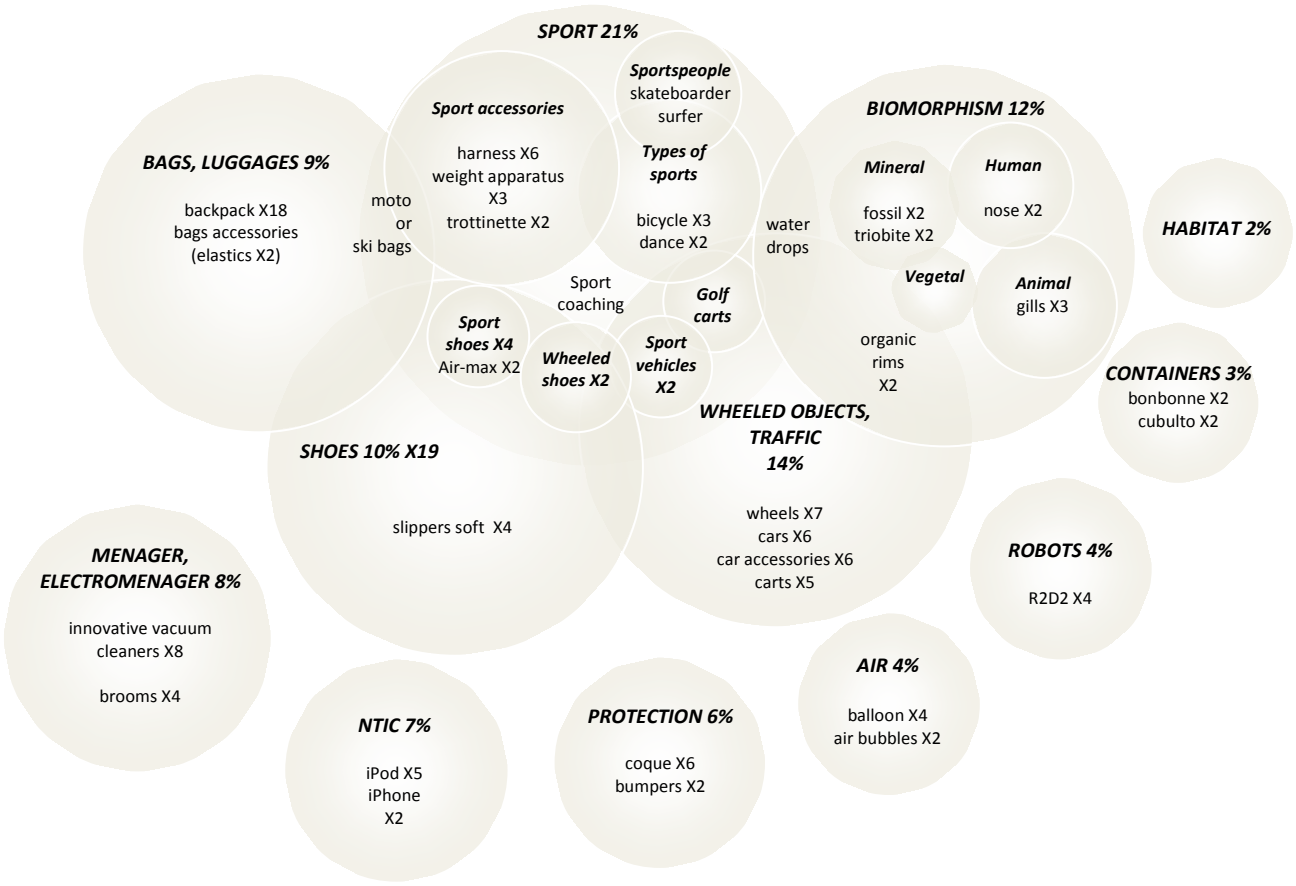

Figure 3. Sectors of analogies (with only the labels which have been cited at least 2 times).

XX.5 Solutions and Recommendations

As seen before, the levels of abstraction of design information may be various. The holistic consideration of those may give birth to new approaches to enrich the design experience. From the results found in the experiment, we sum-up here some important statements:

-through a functional decomposition, more systematic, and then working with creativity tools such as brainstorming and analogies through functions, it could be possible to envisage a more systematic way of discovering and using analogies, which serve one of the most powerful creative process. This approach may enable the elaboration of a more systematic and generic database seen by function.
-some sectors of influence are very poorly represented (under 8%). However, they are important to support divergent thinking.
-there is a sector which is of great interest, the target, because it is not necessarily expressed by the designers but they lack information in this field which is usually given by the marketing.
-finally, when building computer aided design tools for the information phase, the richness represented here, in terms of number of sectors, number of sources by sectors, and widening capability, should be taken into account for any information system.

XX.5 Future research directions

The results presented here enabled to establish a database which is related to the initial design brief of designing a *Nike vacuum-cleaner*. The sectors that have been identified are mainly targeted towards the functions of a standard vacuum-cleaner. But they are also strongly related to the brand which have been stated in the brief. As we applied previously similar methods to formalize the information process involved in early design, we discovered that some sectors may be generic to any design process, such as the sector of biomorphism for instance. Future studies should attempt to elaborate a more general database driven by a more general design activity potentially addressing various reference sectors. This way a generic information system could be used independently from a specific reference sector.

XX.6 Conclusion

In order to elaborate future computer aided design systems for the earliest phases of design, it is important first to model the implicit cognitive and affective processes of designers. The second step is to find and adapt formalisms that will then be implemented through specific algorithms for integrating knowledge and rules. As it has been shown in this experiment, any information system dedicated to the designers should bring more information in shorter times, keeping the divergence capabilities in order to support actually help in the creative steps of design. The relations between the various kinds of information are also of great importance, and may help in the definition of rules that could be implemented in computer aided design tools.

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XX.8 Acknowledgements

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