SEMIOTREND : EVOLUTIONAL AND DYNAMIC TREND MAPS SUPPORTING CREATIVITY FOR DESIGNERS

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Abstract

Designers usually works in the early phases of projects with drawings, images and sentences. However, the competitive pressure they are facing and the constantly rapid changing of the commercial world lead them to organise and optimise their creative task with the use of computer tools. Appropriate implementation of the consumers and the company requirements into the product concept guaranties a successful product development. The aim of this study is to present a method supporting the early design phases of concept seeking and to present a new tool, called *Semiotrend*, for the creation of evolutional and dynamic trend maps. The use of multidimensional scaling (MDS) allows the exploration of a product semantics oriented database in a dynamic and evolutional manner, so that the designer can proceed the creativity task as a co-evolution of problem and solution process.

Keywords: Product design, dynamic and evolutional trend maps, semiological analysis, data analysis, multidimensional scaling

1   Introduction

The representation of consumers requirements plays an important role in design. These requirements not only concern the technical functions of the product "what must the product do", but also the semantics of the product "what must the product communicate" [1]. This latter part of the need, generally tackled by industrial designers, is often the hardest to address and is crucial in the product's success. The identification of the trends of influence and the perceived values traditionally goes through a semantic analysis of existing products and a research of archetypal products, representative of certain connotative values. This process necessitates an accurate identification of the trends, an illustration of the fields of influence and a description of representative products attributes. Within this context, the trend maps are an important tool for the industrial designer [2].

This paper is about the generation of trend maps in the early phases of a design project. In both industry and design agencies, the designer has to challenge producing relevant concepts under very strengthened time. He/she must be aware of the last innovation for being ready to include it in the coming consumer goods. There are many examples from the product design activity where poor concept seeking has led to market problems. We notice two major needs in the early phases of design projects: (1) to express a large quantity and quality of ideas under time constraint, and (2) to transmit number of relevant concepts to the other project actors and communities of practice.

We propose to support the early phase of the design with an evolutional and dynamical trend maps environment. The aim of this study is to propose a method which contributes to support

the design conceptualisation phase, helping the designer to associate images with the keywords of the design brief. Since the designer is using both words and images to produce ideas, we consider that the tool proposed, called *Semiotrend,* shall support the creation of original concepts, helping the designer to express significant point of view and relevant relations between the semantics of the product and the physical characteristics achieving it.

This work has the following objectives:

- To build relevant trend maps through selection of images (objects),

- To help the designer to express a relevant point of view and to share a common language with the other actors of the design project,

- To support the creativity of the project team.

Section 2 presents a short overview of the trend maps, a classical tool for the industrial designer. The *SEMIO* database is described, and previous works using multidimensional scaling (MDS) to explore databases, are presented. In section 3, we describe the method we propose for the exploration and the navigation in databases. Section 4 is focused on the use of the method on a design scenario and the description of the new tool called *Semiotrend*. Conclusions and perspectives are drawn in section 5.

2 Backgrounds

2.1 The trend maps

In the design practice, there are many manners to stimulate the creativity of the designers: the trend maps are one of the most common tools used to gather coherent visual information. It helps the design team to highlight the target through visual language for further guidance. It contributes for a new product to make argued proposals in the fields of use, and to control the perceived quality and the connotations to be conveyed by the brand and by the product. The communication of the product requirements between designers and product developers can be difficult in the early stage of the design process because of the lack of concept materialisation [3].. The trend maps are used as a transverse communication support within the company, to express design concepts to the managers and decision-makers. At the strategic level, the trend maps contribute conversely, for the decision-makers, to express a strategic vision of the product development for the company. They provide a panoramic vision of the competitors, of the influential sectors, of the innovations, of the customers and users evolutions. So, they contribute to a better comprehension of the strategy of the company by the whole design and development teams.

The trends can be studied in two ways: the first one is to carry out a regular and systematic examination of the trends (innovative materials, technologies, mechanisms, gestures of use, etc); the second one is to examine the trends relatively to a punctual request (user values and preferences regarding materials, technologies, gestures of use, context, influential products, etc…). Within this context, the *SEMIO* database was developed to study the trends.

2.2 The *SEMIO*© database [4]

Any industry engaged in the design of products is confronted with the decision-making in the very early phases of the design activity regarding the values to be conveyed by the product. A serious problem in these early phases is the lack of guidance for reducing the gap between the projected quality and the perceived quality of the products.

The failing is to not putting enough time and effort into obtaining a complete list of subjective and objective requirements for the product. The *SEMIO*© database [4] has been developed in order to help the designer to set up concept values linked with semantic attributes and objective attributes, and to support the decision stages through a shared common vision of the project values.

The development of this tool was initiated within the framework of a research partnership in prospective design with the French Electricity Board, aiming at innovations on products and methods [2]. The software is built on a triad of tools to set up a semantic identity for each product:

- automatic construction of a thesaurus related to the vocabulary of the field (in our case, industrial design, product design),

- semiological analyses done by users or experts of the field,

- construction of matrices. The tool has shown successful results for the image seeking process. The matrix presents the result of the request as a 2D table containing products and criteria, and showing for each pair product/criteria one of 5 levels value or missing value. The Principal Component Analysis (PCA) of the matrices leads to the mapping of the product and the related criteria.

Our partner synthesized the results in a dashboard for the design, as an operational tool used to feed and control the creative phase. From our partner point of view, this approach released from a purely technological approach and led to new proposals, different and complementary of those that would have been obtained without the use of this tool.

The tool currently includes 511 identity cards (each corresponds to a product), and is running under the PhP-MySQL format. Figure 1 shows an example of the interface in the latest Php-MySQL version.

The identity card describes a product according to:

- 10 objective criteria (price, reference, ...),

- 1 mode "natural language" (press comments - automatically extracted criteria),

- 1 mode "subjective criteria" with 388 referred attributes (semantic attributes rated from "very false" to "very true", with a 5 levels scale),

- 1 picture of the product.

The requests of the database can be done on the objective or subjective criteria, or on the text mode (with OR logic). Typical output data can be:

- a list of Identity Cards (IC),

- a list of products (Figure 2),

- a picture book of the products,
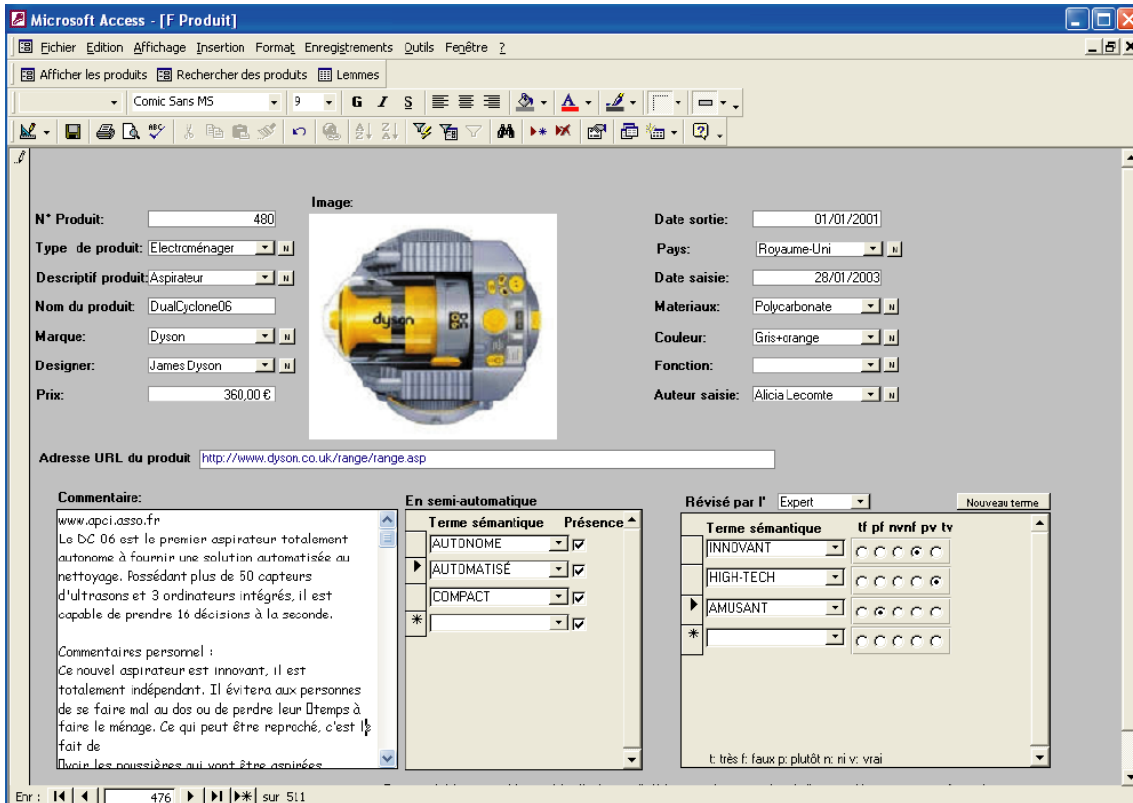
- a Matrix (products, criteria).

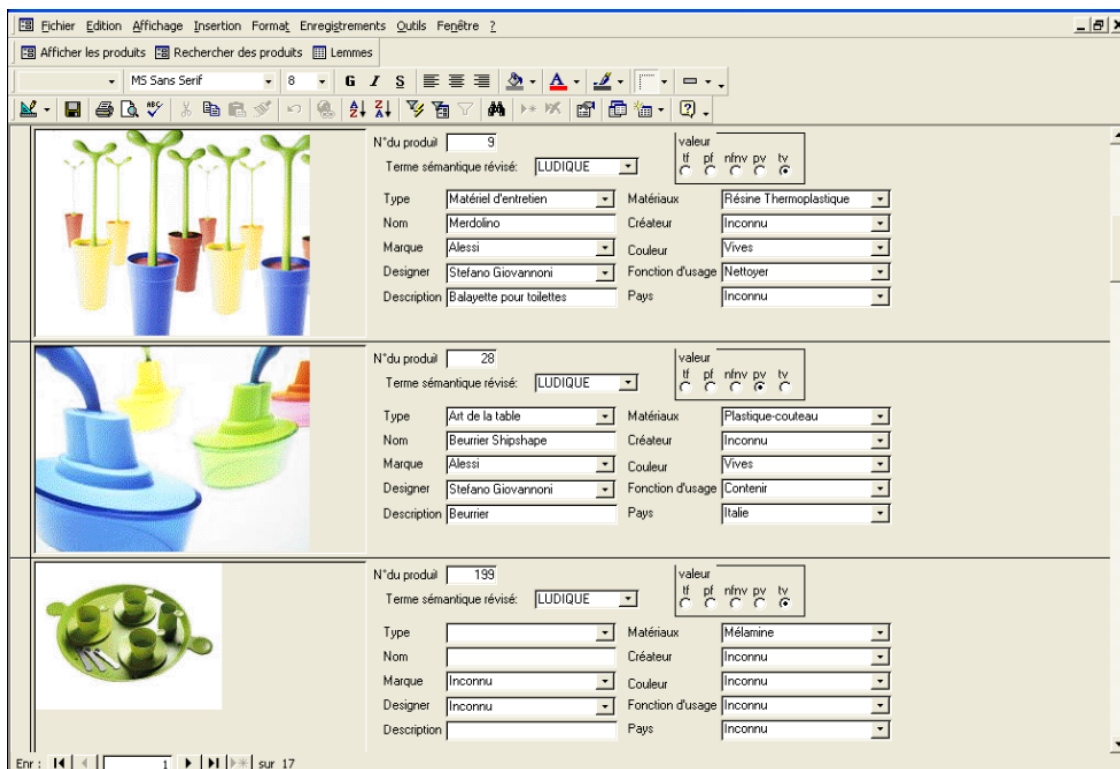Figure 1 : example of the Identity card of a product (*SEMIO*©)

Figure 2 : example of the result of a request on the *SEMIO* database (list of products)

Based on the above findings, it was highlighted that the early phases of the design process would benefit from a new trend setting method, which would help to identify the influential

trends and to express it through both objectives and subjective data. The tool should help the designer to produce relevant trend boards for each concept and to express it in a manner that is understandable by other communities of practice. The function of this new tool are developed in section 3.

2.3 Exploring and visualising a database via Multidimensional scaling (MDS)

In order to implement the previous functions, data analysis techniques and dimensionality reductions methods must be used [5]. We have taken an interest in a classical method in psychometric analysis for the representation of objects and the creation of maps: multidimensional scaling [6]. This method is a process whereby a dissimilarity matrix among a set of stimuli is translated into a representation of these stimuli inside of a space. With the dissimilarity between the pairs of stimuli (here pairs of products) as input, the method estimates the coordinates of the products in a space of low dimensionality. Technically, the MDS technique amounts to locate the products considered as points in a k-dimensional space such that the Euclidean distances between them correspond as closely as possible to the dissimilarities in the input matrix. Dimension k of the space is a parameter of the method, and the solution is found by minimizing a criterion called *stress,* which represents the "badness of fit". This method provides a space (2D or 3D) for a visualisation of the products. It is well suited to study the relationship between products. Data exploration using MDS mapping is proposed in [7]. A study of product semantics using MDS is proposed in [8].

Stappers and Pasman [9] used MDS and developed an interactive interface for exploring a database in an intuitive manner. The dialogue between the user and the database is mediated through an evolving set of sample objects, which are presented visually by a real-time MDS algorithm. This interface is for example used for a selection task (picking an object or a colour) and seems to be intuitive to use because it doesn't necessitate the use of jargon to formulate the queries. In a similar way, we have used MDS and developed a method for the building of trend maps for designers.

3   Description of the method

3.1 Requirements

The input data of the method is a rating of N products according to P attributes, or characteristics (matrix – *SEMIO* database). We have first defined the following features for the tool *Semiotrend*:

- Dynamical cartographic representation of the results of a request,
- Possibility to express a request in two stages:
  - initial request on the attributes of the objects> first output : representation of the pictures of the products answering the request,
  - intuitive organisation of the images > second output : new images which attributes are close to the previous selected images,
- User immersion,
- Evolutional data base.

This tool should provide the following functions:

- to initiate the trend maps,

- to visualize sets of products,

- to position a set of products regarding a set of semantic attributes, linked to criteria of preferences,

- to give information on competitor products,

- to know different product universes described with an identical vocabulary

- to establish clear marketing orientations (product positioning, etc),

- to choose and diffuse adequate messages to the multiple public of the organization

- to organize the upstream process of the design and use it:

  1. as a platform of synthesis of information and typological analysis during the phase of analysis,

  2. as a platform for piloting the creative phase of the project. The trend maps highlight 5 meta-tendencies, describing five typologies of distinct universes that have to be treated in the design process. It gives an answer to the questions:
     a. Can basic formal elements conveying certain values in a given cultural context be found at a given moment?
     b. What are the relations between the specifications of the form, materials, surface, textures and the perceived quality?
     c. What are the formal and semantic evolutions of a product along the time?
     d. What are the terms (and relations between them) used by the designers and the users to describe an object, and what is the biodegradation of these terms along the time?

These features have been included in the development of the tool *Semiotrend*.

The evolutional and dynamical interface, presented in the following sections, helps the designer to explore the semantics of the products and to easily capture relevant information on the products.

3.2 Implementation

The method proposes to the user a progressive and intuitive navigation in the database instead of brutally facing all the items of the database. It is based on the following stages:

1. **Set up of the database**. The database consists of a set of *N* products described by their rating according to *P* attributes. It is described by a $\mathbf{X}(N \times P)$ matrix of the rating (e.g. on a scale 0 to 5) of the products according to the attributes (generic term x_{ij}). This matrix can be sparse, i.e. some attributes, not relevant for certain products, can be not rated.

2. **Querying the database: selection of *p* attributes**. The user specifies rough threshold values for certain attributes, or just select some attributes, relevant for his/her application. The system returns a set of *n* products which satisfy the threshold values.

3. **Representation of the *n* products using MDS**. A 2D representation of the *n* products, coherent with their dissimilarities (dissimilar products are far one to each other, similar products are close), is provided to the user. The dissimilarity d_{ij} between two products *i* and *j* is calculated using the following formula (equation 1). The weights w_k are either all identical or specified by the user if needed.

$$d_{ij} = \sqrt{\sum_{k=1}^{P} w_k (x_{ik} - x_{jk})^2} \qquad (1)$$

4. **Mapping of the *p* attributes on the 2D map**. In order to help the interpretation of the map, the attributes are mapped on the 2D map using "Property fitting". This technique performs a multiple regression using the positions (MDS-map) as independent variables and the attribute rating as the dependent variable. The outputs of the method are the correlation coefficient and the direction cosines (rescalings of the regression coefficients). "Property fitting" allows the representation of the "vector model" of the attributes in the map and thus gives visual information to the user [10]. The attributes for which the multiple regression is significant (according to Fisher-Snedecor table with P-value = 0.05 and determination coefficient R^2>70%) are plotted on the map by their vector model (figure 3). The origin of the vector is located arbitrarily in the origin of the frame, the values of the direction cosines give the orientation of the arrow, the arrowhead points in the direction of increasing attribute values and the norm of the vector is proportional to the determination coefficient R^2.

5. **Selection of products by the user**. Using the 2D map, the user selects v products among the *n*. The user is asked to keep the products which seem to be interesting for his/her purpose, and to remove the others. The idea behind this process is that by the selection operation, the user unconsciously selects interesting but underlying products' attributes. The determination of these attributes will be external to the user and made by the system (Stage 6).

6. **Determination of the differentiating attributes**. The system computes for each (*P-p*) remaining attributes *j* the variance ratio **Vr(j)** (equation 2), and select the λ attributes for which this ratio is maximum (differentiating attributes):

$$Vr(j) = \frac{\text{intergroupe variance}}{\text{intragroup variance}} = \frac{v.(\overline{x_{vj}} - \overline{x_j})^2 + (n-v).(\overline{x_{(n-v)j}} - \overline{x_j})^2}{\sum_{i=1}^{v} (x_{ij} - \overline{x_{vj}})^2} \qquad (2)$$

$\overline{x_{vj}}$: average value of attribute *j* for the v products

$\overline{x_{(n-v)j}}$: average value of attribute *j* for the (*n-v*) products

$\overline{x_j}$: average value of attribute *j* for the *n* products

7. **Representation of the λ differentiating attributes and the products via MDS**. The differentiating attributes are mapped on the 2D map using multiple regressions (property fitting). New products, not selected at stage 2, and such that $\sum_{\lambda} \left| x_{ij} - \overline{x_{vj}} \right|$ is minimal, are added to the map. A representation's update of the products by MDS is performed.

8. **Iterative construction of the map**. Go back to stage 5.

For clarity, each stages of the method will be described on a short example, which concerns the choice of a digital camera.

3.3 Example: navigation in a database of digital cameras

Stage 1: Let consider the N=12 following digital cameras, described by their ratings according to P=7 attributes (table 1). For the data processing, the data are first normalized: a linear interpolation in the range 0-5 of the initial ratings is made.

Table 1 : attributes of 12 digital cameras

	Price (€)	resolution (Mpixels)	Optical zoom (×)	Picture Quality (over 30)	Number Pict.	Weight (g)	Interface ergonomics (over 10)
N° 1	250	3	3	17.5	251	220	7
N° 2	550	5	3.6	26	712	250	10
N° 3	850	6	6	24	1484	300	10
N° 4	160	3	0	16	697	150	5
N° 5	300	3	8	26	2238	430	9
N° 6	240	3	3	24.5	1223	270	8
N° 7	1100	8	5	26	1421	430	10
N° 8	700	5	12	27	1320	340	10
N° 9	400	2	6	20	168	280	8
N° 10	500	3	2	22	250	320	7
N° 11	40	1	0	5	100	140	6
N° 12	130	2	2	19	500	190	7

Stage 2: Let suppose that the user wishes to select products for which the attribute "price" is under 300€and the attribute "interface ergonomics" beyond 6. 4 products (n°1-6-11-12) satisfy these criteria.

Stage 3: The 2D-representation of the 4 products using MDS is given figure 3: "similar" products are close on to each other, "dissimilar" products are rather distant.
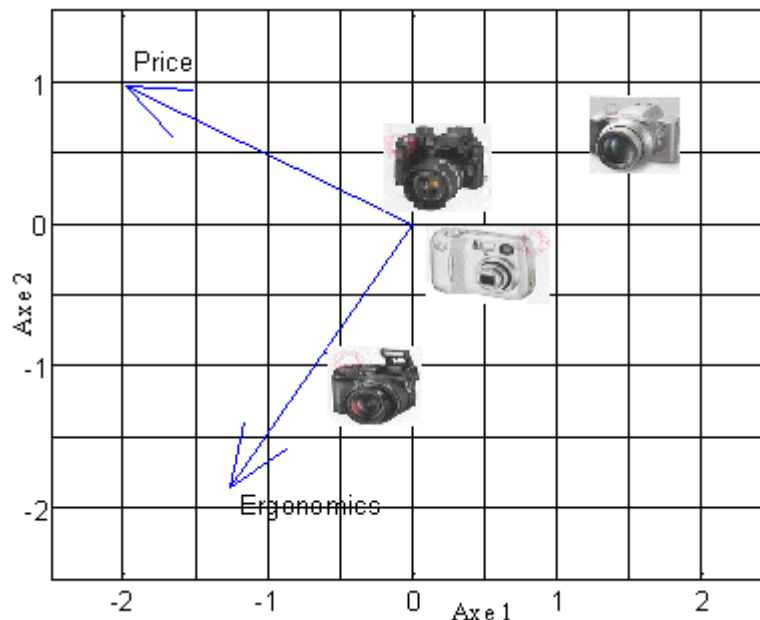

Figure 3: 2D-representation of the selected products via MDS

Stage 4: The mapping of the attributes "price" and "interface ergonomics" on the 2D map is given figure 3. This map gives to the user a global view of the data and shows to the

user the correlation between attributes. In the example, the price seems to be independent of the ergonomics. The positioning is easy and intuitive to interpret.

Stage 5 and 6: **Selection of products by the user**. Let suppose that the user selects products N°1 and N°6. The variance ratios for all the remaining attributes is given in table 2. The variance ratio is maximal for attributes "Mpixels" and "Optical zoom", i.e the common properties of these two products concern "Mpixels" and "Optical zoom" (the ratings according to these attributes are identical for product N°1 and N°6, so the intragroup variance is equal to 0). Of course, this information is rather obvious on this short example and can be seen in table 1, but it will be a relevant information when the database will be bigger.

Table 2 : variance ratios for the remaining attributes

	Resolution (Mpixels)	Optical zoom (×)	Picture Quality (over 30)	Number Pict.	Weight (g)
Vr(j)	$+\infty$	$+\infty$	3.3	0.4	5.1

Stage 7: **Representation of the differentiating attributes and new products by MDS.** Attributes "Mpixels" and "Optical zoom" are mapped on the 2D-map. The product such that $\left(\left| x_{ij} - \overline{x_{vj}} \right|_{(j=resolution)} + \left| x_{ij} - \overline{x_{vj}} \right|_{(j=optical-zoom)} \right)$ is minimal, product N°10, is added to the map (figure 4). This new product may possess common attributes with the selected products, which the user is not necessarily aware of. The selection process is a way to reveal these underlying attributes. The representation of the product by MDS and the mapping of the attributes is updated. Of course, the positions of the products and of the attributes (figure 4) is changing relatively to figure 3.
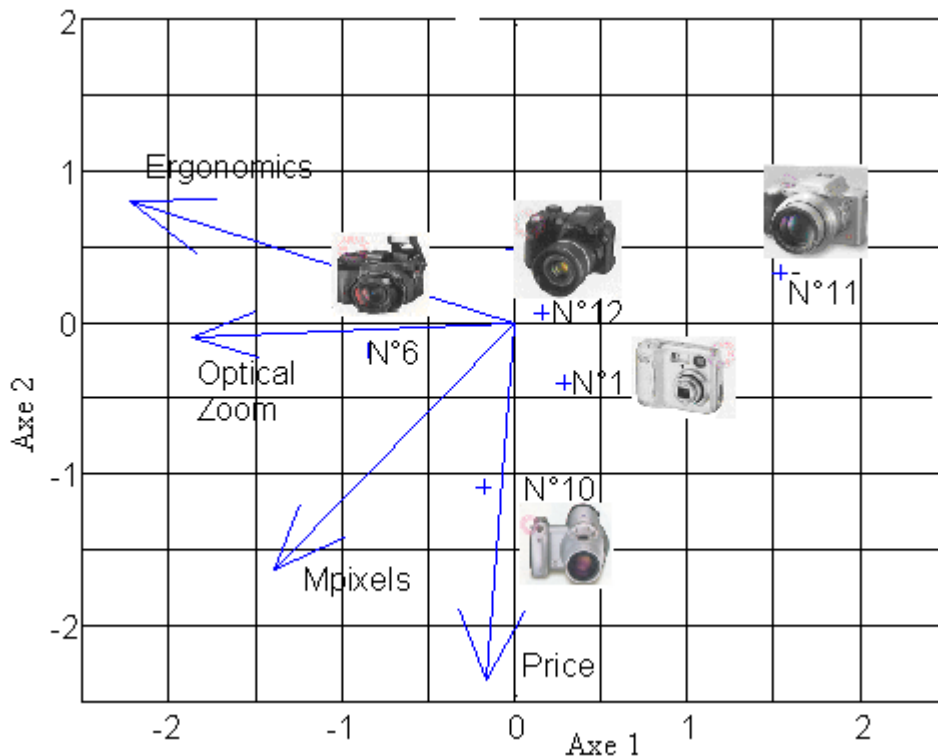

Figure 4: Updated 2D-representation of the products via MDS and the attributes via property fitting.

Next, an iterative construction of the map is eventually possible by repeating stage 5.

4   A case study with the *Semiotrend* tool

The *SEMIO* database connected with the navigation method presented in section 3 is called the *Semiotrend* tool. The following scenario is proposed to illustrate the functionalities of the tool:

1. Selection by the designer of *n* semantic attributes and their thresholds,

2. Display of the products' pictures (MDS map),

3. Selection by the designer of the relevant objects, by selecting the images that support the designer intentions and ideas,

4. Proposition by *Semiotrend* of new images and new attributes,
   Selection by the designer of the relevant images and relevant attributes
   Update of the display of the results (MDS map)

5. Iterative construction of the trend map (go back to stage 1).

4.1   Application of *Semiotrend* to a user-case

We propose to describe this tool through the simulation of a user-case for which the designer has to produce for example a new fridge concept. Let suppose that the target-user concerns disabled people, and that the main characteristic of the design brief is the fridge maker intends to design a universal fridge, as a "product for all". Once the aims and objectives of the project are discussed and clearly defined between the designer and the maker, the designer selects relevant key-words and starts to seek for products that claim such intentions. He/she wants to know what are the formal invariants that can be found among those products, and wants to organise the selected images through trends maps that will support his/her concept argumentation.

Stage 1: selection of attributes

The first stage consists in selecting keywords according to the design brief. Let suppose that the designer starts the request with the attributes "friendly" and "fun". The user-interface for the request is presented (figure 5) (textual search done with the key-words of the design brief).
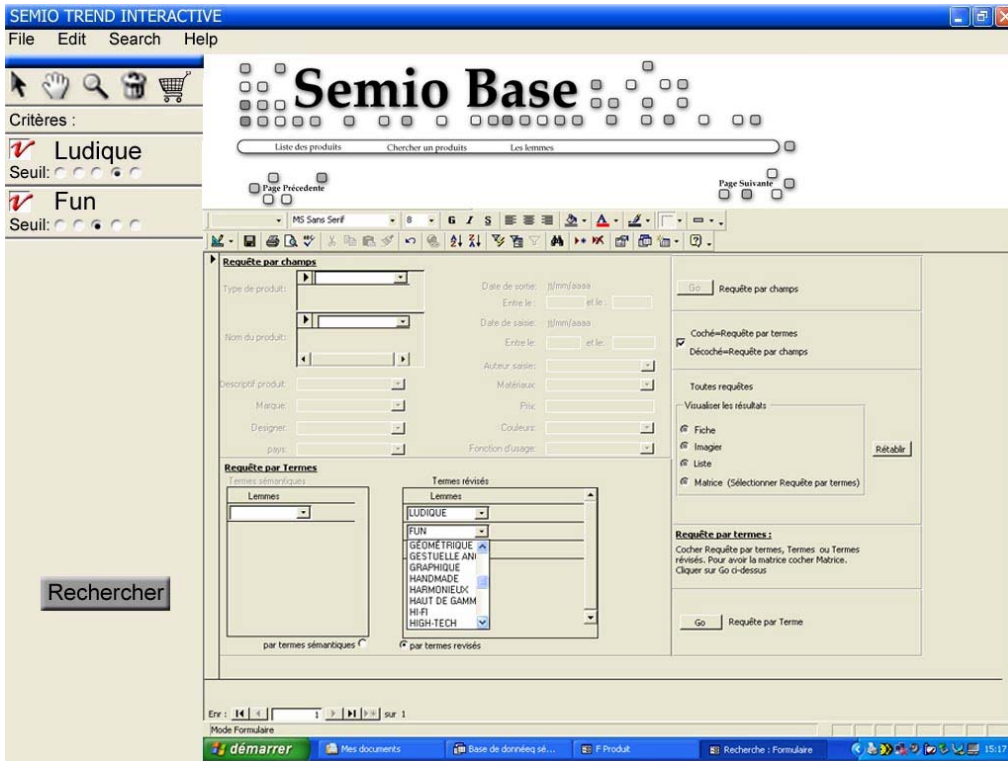
Figure 5: representation of the user-interface for the request

Result of the request : the products defined with at least one of the selected attributes and the selected threshold are displayed on the map (MDS) (figure **6**).
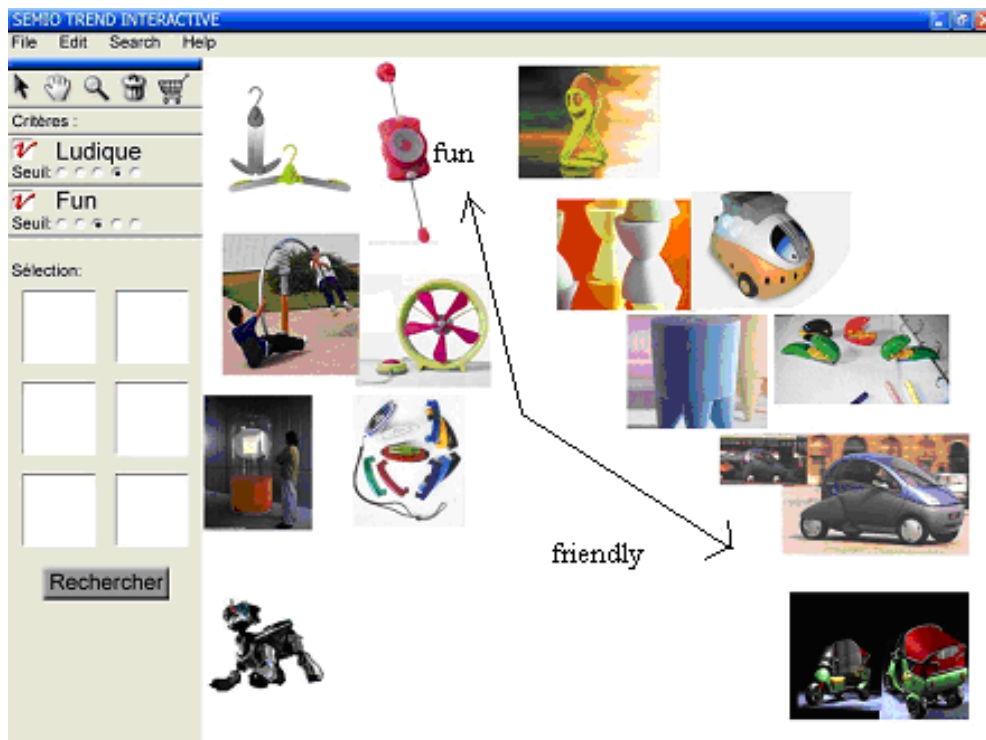
Stage 2: display of the results

Figure 6: representation by MDS of the products corresponding to the request.

11

Stage 3: selection of products

The user selects the relevant products and rejects the others. Figure 7 represents the trend map after the selection process.
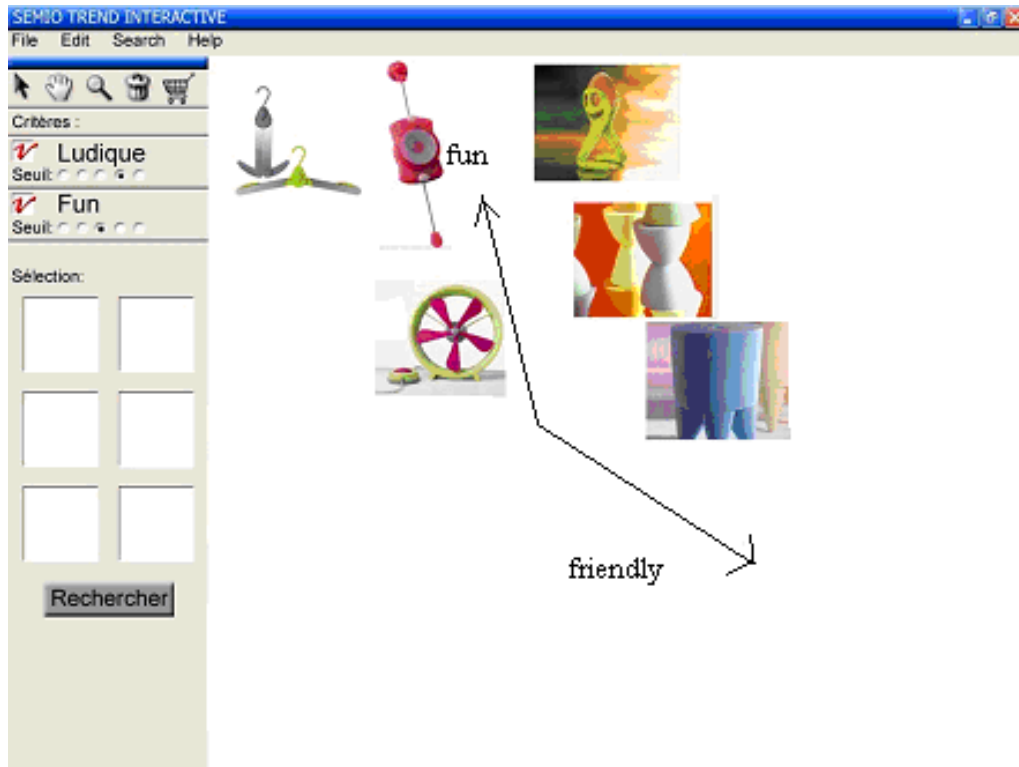

Figure 7: representation of the images after the selection process

The representation can eventually be dynamically updated, based on the weight w_k of each attribute decided by the user (equation 1).

Stage 4: proposition by *Semiotrend* of new images and new attributes

Once the selected images are confirmed by the designer (figure 7), the tool computes for each remaining attributes the variance ratio **Vr(j)** (equation 2) and selects the λ attributes for which this ratio is maximum. New products, characteristic of these attributes, are added to the map The user selects the differentiating attributes and the new products he/she wants to keep. In our user-case, the attribute "easy to use" is mapped on the graph. A representation's update of the images is finally made by MDS (figure 8).
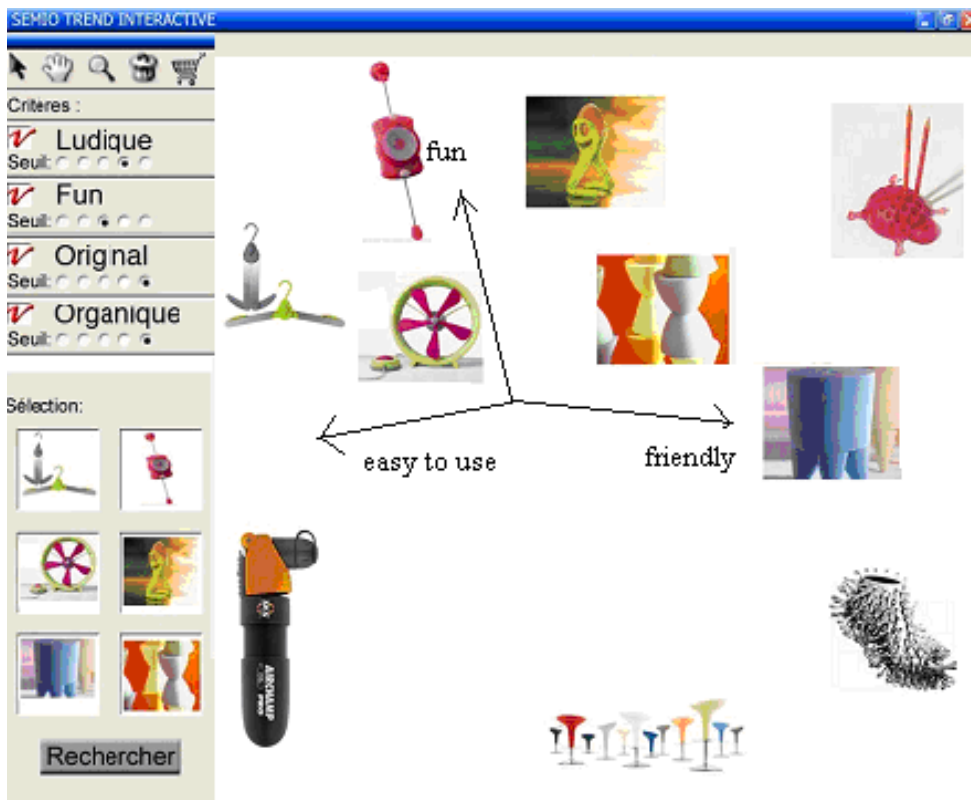
Figure 8: proposal by *Semiotrend* of a new attribute "easy to use" and additional images

Stage 5: Iterative construction of the trend map.

The user can start a new request while including the new attribute with a threshold (start again stage 1). This iterative process leads to the representation of the final trends map (figure 9).
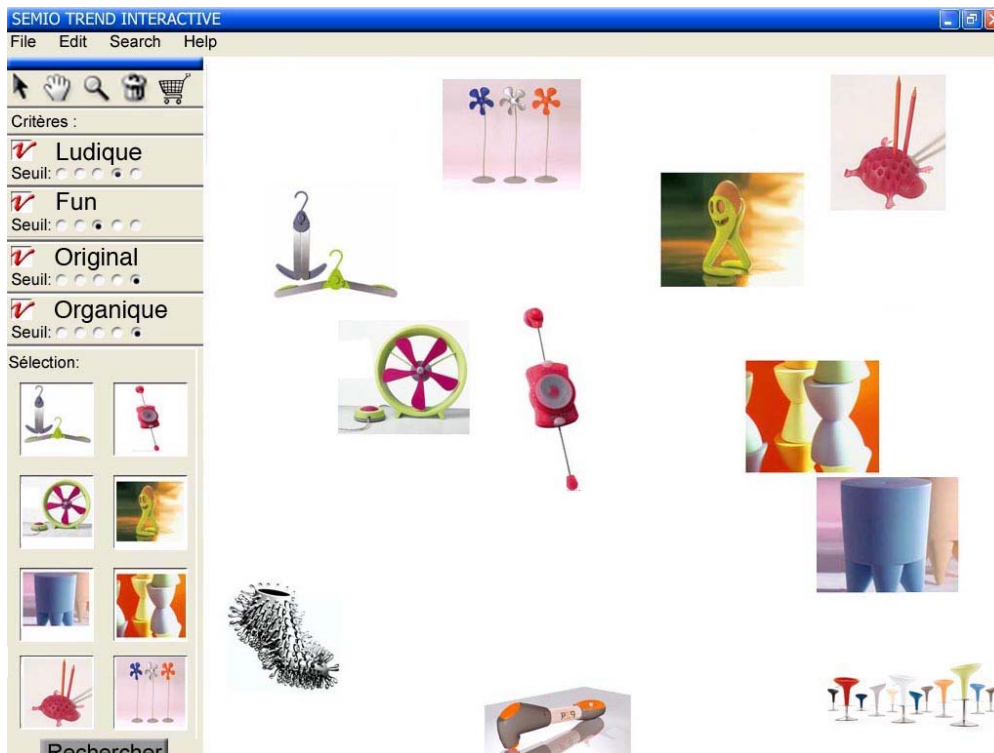

Figure 9: final trends map obtained by the *Semiotrend* tool

13

5 Conclusions

This paper presents a method for an iterative, dynamical and evolutional construction of trends maps for designer. The aim is to deliver ideas and practical recommendations for a design approach which reduces the time of the early design phase and improve design concept relevancy.

The results highlight the relevancy of the MDS method linked to the *SEMIO* database for the creative activity during the design process. Indeed, the dynamical data treatment gives to the designer real time answers that fit his/her request, and anticipates his/her latent request through analysing of his/her 2D organisation of the *Semiotrend* outputs. By the selection process of objects, it allows the revelation to the designer of underlying attributes and example of objects. It's in that sense a creativity method.

The *Semiotrend* supports the seeking and the representation of product trends, in terms of functionalities, services, configurations, distinct identities and of the claims. Thus, it is possible to extract from a group of products with strongly defined trends the common characteristics whether they be configurative, esthetical, instrumental or even mythical. The next stage of our work will be to improve the user interface and to integrate virtual reality tools for the navigation in database.

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