A Model and Six Semiotic Dimensions for the Ideation of Products

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INTRODUCTION

People use a variety of mental associations to understand and interact with products. Within design, this situation has been confirmed through studies going from those concerned with how people interpret the functional features of products (Woolley, 1992) to those about how people associate product's features to aspects such as social status (Espe, 1992), their user's personality (Jordan, 2002) and emotional attachment (Ou and Lou, 2004).

For the particular case of concept ideation in product design, studies have been carried out during and after the act of designing. The former have focused on the characterisation of how designers think during the solution of specific tasks, the definition of their individual style of problem solving, the quantification of originality as part of design concepts, and the designers' use of drawings/sketches as well as verbal expressions to define and characterise products (Lacruz-Rengel, 2008b). In relation to the latter, i.e. inquiries developed after the act of designing has come to an end, studies have been carried out based on retrospective techniques using questionnaires, interviews, analysis based on predefined categories, and even self-introspection studies (Lacruz-Rengel, 2008b). Many of them have also involved the analysis of sketchbooks, mostly in qualitative terms. Studies on design concept ideation have come to the point of exploring the possibility of supporting designers' creative gestation with databases of images and descriptive words of pre-established associations/referents (Wu and Johnston, 2005).

Despite of all these research efforts, authors working around the subject of concept ideation seem to take for granted the different aspects or conceptual dimensions involved in the formulation of products, perhaps based on the long tradition of speculative nature inherited from treatises and handbooks of design. In this sense, the present work attempts to outline a proposal about the nature of such dimensions on a scientific basis.

1. DESIGN AND ITS DIMENSIONS

Since the times of the Roman architect Marco Lucius Vitruvius (25 BC) what we now call *design* has been outlined as a field of action comprised by different dimensions or aspects. In the early treatises and handbooks of design these key aspects or dimensions assumed the form of principles.

Later on, they were associated to the functions that design objects ought to fulfil, to the different tasks involved in their creation, and to the sort of pleasures such objects could evoke.

According to Vitruvius (1991), design (with particular reference to architecture)[1] emerges from the understanding of three fundamental principles: *firmitas* or the adequate selection of the materials and means to build a design object, *utilitas* or the appropriate conception of its use, and *venustas* or the realization of harmonious and pleasant configurations. This idea of "principles" persisted throughout the Middle Ages, becoming the common place of theoretical studies during the Renaissance. Indeed, the medieval calligraphy of books, for instance, was based on three design principles (Rotte, 1993): *ordo* (order based on hierarchy to structure complexity), *claritas* (legibility or clarity of meaning and purpose), and *consonantia* (consonance or harmony for the beholder's eye). Similarly, in 1452, Leon Battista Alberti highlighted *unity*, *proportion* and *suitability* as the essential principles of design (Lambert, 1993).

Within the particular field of product design, the first examples of this kind of principles seem to be those of the 19th century. During that century the search for design principles became a real need provided the indiscriminate proliferation of stylistic evocations of the past in architecture during the late-eighteenth century, whose impact also manifested in the design of objects through oversized, over-decorated, of quasi-historical style, impractical and ill-suited creations for the living conditions of that time (Hauffe, 1998). Among the principles then enunciated, those of the architect Owen Jones and the designer Christopher Dresser are well-known. For the former, all works of the Decorative Arts (as well as those of Architecture) should have: *fitness* or be adapted to its purpose, *proportion* or display a clear arrangement of its parts, and *harmony* or display an appropriate balance and contrast among its forms (Jones, 1856). For Dresser, on the other hand, *truth* (to be truthful in the use of materials and what objects express), *beauty* (to be graceful, delicate and refined), and *power* (to be energetically composed) were the three 'art-principles' which, in conjunction with the basic principle of *utility* (i.e. to be suitable for its purpose), defined the primary nature of any design object (Dresser, 1973). The design principles outlined by these authors, however, are not different from those of the Vitruvian triad. Indeed, they encapsulate more or less the same ideas. This might be the reason why the teaching of design "through principles" prevailed until the beginning of the 20th century, especially thanks to the understanding of beauty in utilitarian objects as derived from their fitness to purpose, together with a due recognition of what was sane and suitable for tools and materials (Glass, 1927).

Such a state of the art began to change with the incorporation of new aspects as fundamental elements of design. Among the promoters of this new approach were the Bauhaus School of Design and the pioneer product designers of USA. Indeed, in his *Principles of the Bauhaus production* of 1925, Walter Gropius (2002) pointed out the need of designing objects that clearly serve their purpose, long lasting, of a low cost, and beautiful. As such this was an attempt to embrace the formal, technical and economic aspects of the changing design scenario of that time. Following a similar vision of the new realities, the American designer Henry Dreyfuss (1955)

[1] According to Gasparski (1984:20) "…the ancient concept of architecture embraced civil engineering, clock construction, and mechanical engineering". Therefore, the Vitruvian principles can be understood as applicable to any design object.

asserts that every design problem involves five points that should be tackled: utility and safety, maintenance, cost, sales appeal, and appearance. In the same direction but in a less explicit manner, the designer Harold van Doren (1954) also divided the design concerns into: *practical requirements* (through the study of material and processes, of the client's manufacturing facilities as well as a preliminary investigation of costs), and *merchandising requirements* (i.e. maintain a competitive position by seeking new features for old products and add new products to certain lines).

Besides this, the first half of the 20th century also witnessed how some theoretical proposals from the field of linguistics began to mould new ways of understanding product design. Such is the case of Jan Mukarôvskỳ's typology of functions from 1942. Indeed in his view, man-made objects ought to fulfil four types of functions (Mukarôvskỳ, 1977): *practical functions* or those having to do with a physical and direct transformation of reality as part of a purpose, *theoretical functions* or those in which reality is transformed in a direct but imaginary way, *symbolic functions* or capacity to change reality through the representation of cultural conventions and values, and *aesthetic functions* or capacity to trigger people's self-realisation through supraindividual ways of looking at things. This kind of theoretical contribution - together with those of other theorists from fields such as semiotics and art history - helped to change the concept of function in design as something beyond the strictly practical. Insomuch that Mukarôvskỳ's typology is an inevitably reference for understanding functional typologies such as that formulated by the Offenbach School of Design (Germany) during the 1970s and 1980s (within their *Theory of Product Language*); the typology of six functions for design presented by F. van der Put (1980) at the ICSID Conference of 1979 (in which design functions are divided into economical, technical, physical, psychological, aesthetic and social); as well as those simplified versions of these typologies that define design in triadic terms, that is, as comprised by technical-practical, aesthetic and symbolic functions (Hauffe, 1998).

Differently from this, the second half of the 20th century brought along principles and dimensions for product design in the form of either levels of work within design or as basic requirements. Examples of this kind can be seen in Gillo Dorfles' (1968) idea of tackling mass-produced objects in technological, innovative, commercial, stylistic, symbolic and communicative terms; in Max Bense's hyletic, morphetic, synthetic and pragmatic dimensions for products (Bense and Walther, 1975); in David Pye's (1983) six basic requirements of design (correct arrangement, correspondence of parts, strength, ease of use, suitable cost, and acceptable appearance); in Oscar Olea and Carlos Gonzalez's (1988) five levels of work in design (functional, contextual, structural, productive and expressive); in Richard Buchanan's (1989) three elements of the design argument (technological reasoning, character and emotion); in Angela Dumas and Henry Mintzberg's (1991) three dimensions of design (function, fit and form); in Ray Crozier's (1994) three factors that influence people's psychological response to design (i.e. form, meaning and function); in the marketing emphasis given by Dahl, Chattopadhyay and Gorn (1999) to the product *originality* and *usefulness*; in Hansen and Adreasen (2003) *product's marketing* and *product's functionality* as their dimensions for concept ideation; as well as in the four vectors of design (functional, expressive, technological and commercial vectors) proposed by authors like Luis Rodriguez-Morales (2004), to mention just a few.

At the end of the 20th century came forward another way to approach the dimensions of product design based on the pleasures and benefits that can be associated to design objects and used to understand the sort of creativity from which they emerge. Examples of them are John Walker's (1989) classification of the pleasures derived from design objects (pleasures of use, possession, purchase, and social accomplishment); Patrick Jordan's (2000) three main benefits obtained from design objects (practical, emotional and hedonic benefits), and the aspects of creative product design (novelty, resolution and style) proposed by authors such as Susan Besemer (2000).

2. A Model for the Ideation of Design Concepts

The different ways to define the constitutive aspects of design previously reviewed lead anyone to realise that any theoretical model about the ideation of design concepts for products should consider:

1. *Utility* as most basic dimension, given that no design object is created without a practical function, purpose or technology in mind.

2. *Competitiveness* as a dimension naturally linked to product design, provided that any product aims to provide certain level of satisfaction and commercial success.

3. *Originality* as the dimension embodying the innovative contribution present in each design proposal, since products always bring along something new or different to what already exists.

4. *Pertinence* or dimension dealing with the context in which the product is placed (life style) and used (kitchen, office, etc.).

5. *Representativeness* as the dimension working with the emotional associations and responses products elicit in their users.

6. And *Expressiveness* or dimension liked to the expression of values and social-cultural aspects through the product, that is, the product's symbolic nature.

The dialogue-like dynamic taking place among these six dimensions makes possible their grouping as part of a model comprising two types of axis: vertical-diachronic and horizontal-synchronic. In the vertical axes the changes experienced by a product throughout time are registered, that is, the differences among the commercial models of the same product throughout history. In the horizontal axes, on the other hand, the conceptual configuration -at a given time- of each commercial model of a product take form. This happens in such a way that each set of horizontal axes ends up defining a different plane or level of competitiveness.

Since design products are utilitarian by nature, the *Utility* dimension is taken as the starting point or lower theoretical threshold for the ideation of design concepts, as well as the common root for all the other dimensions of this theoretical model. Given that competitiveness is what triggers the search of new commercial models capable of superseding the achievements of previous ones, the *Competitiveness* dimension is envisaged as the limit or upper threshold for the ideation of concepts for new products. Hereby Competitiveness is placed vertically and diametrically opposed to the Utility dimension. The other four dimensions of this model (i.e. Originality, Pertinence, Representativeness and Expressiveness) are symbolized by four vertical axes departing from Utility towards the Competitiveness dimension, defining different planes or levels of competitiveness throughout the product's history. The

trajectory of Originality, Pertinence, Representativeness and Expressiveness from Utility to Competitiveness is represented with four vertical axes with a growing slant to express the widening of content taking place in relation to the archetypal or original version of the product at stake. Thus, our theoretical model for concept ideation ends up having the three-dimensional form of an inverted pyramid whose square base represents the upper threshold (the Competitiveness dimension), its apex the lower threshold (the Utility dimension), and each of its vertical edges the Originality, Pertinence, Representativeness and Expressiveness dimensions respectively (see figure 1).

Beyond this, it is worth noticing that the location assigned in this model to the Originality, Pertinence, Representativeness and Expressiveness dimensions is not random at all. Based on their meaning and the sort of information (semantic-logic or aesthetic-contingent) which is part of their content, we know that the Originality and Pertinence dimensions are two sides of the same coin, in a similar way as happens with the Representativeness and Expressiveness dimensions. Indeed, the more original / new

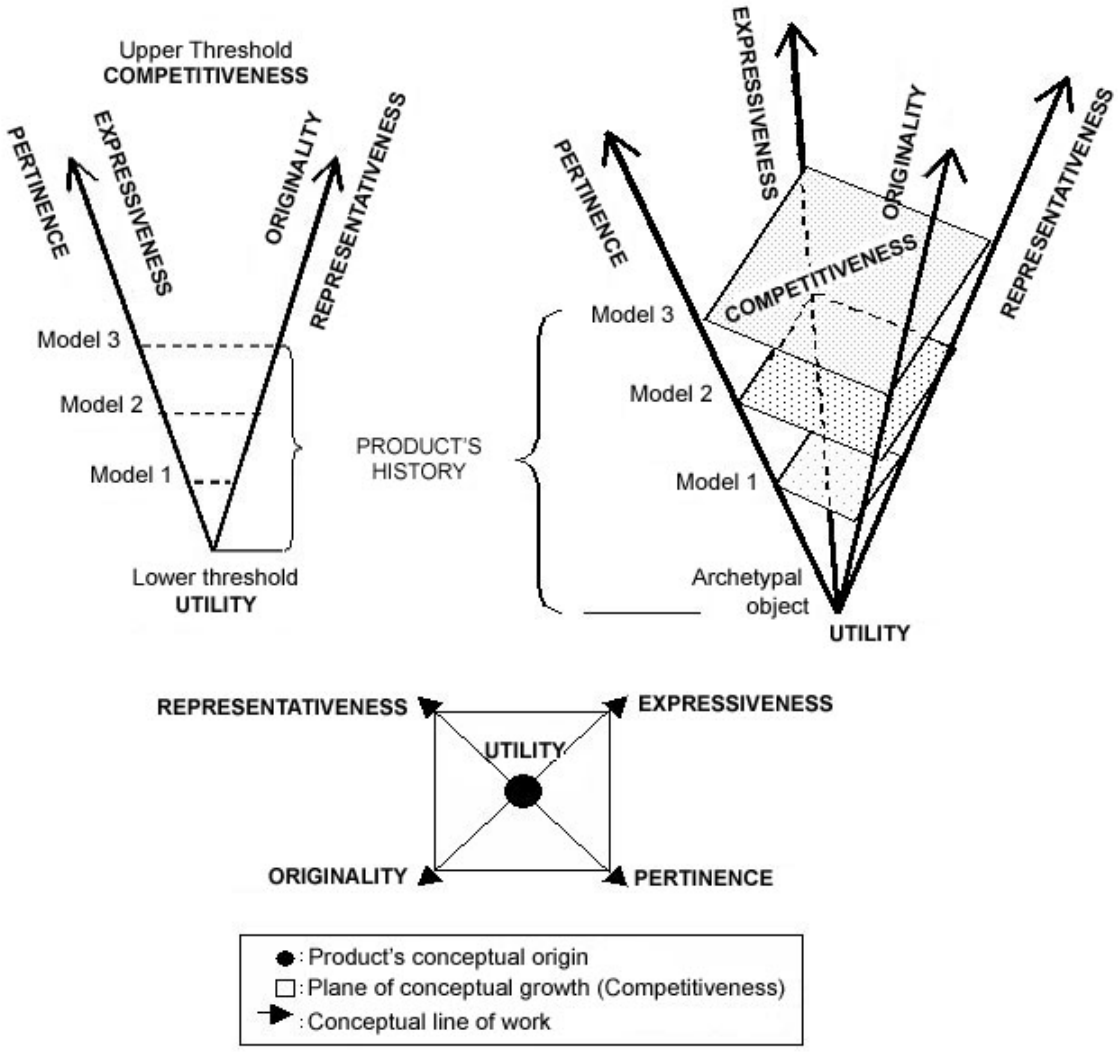

Figure 1. Model to explain the generation of design concepts for products according to the author. Source: Lacruz-Rengel (2008a).

a product is, the more difficult is to link it to a particular context (Palmer, 1975). Thus, Originality and Pertinence are dimensions inversely proportional (the more original a product is, the less pertinent it is and vice versa) and therefore, located in opposite semantic poles. Likewise, the more meaningful a product is for a single person (when its meaning becomes more personal), the more such meaning tends to get away from pre-established cultural interpretations (Csikszentmihlayi and Rochberg-Halton, 1981), that is, from the Expressiveness dimension. This same trend toward the individual / peculiar and the collective / familiar in the ideation of products is what lead us to determine the location of this four dimensions (Originality, Pertinence, Representativeness and Expressiveness) in horizontal-synchronic axes joined by the logics of opposition, implication and contradiction that emerge among them (see figure 2).

3. COMMUNICATIVE AND SEMIOTIC NATURE OF THE PROPOSED DIMENSIONS

A quite common way to look at products nowadays is as an act of communication between designer and user / consumer (Maldonado, 1961; Buchanan, 1989; Bürdek, 1994 and Frascara, 2006). Within this approach, few theoretical models are as comprehensive to link semiotics with communication matters as that proposed by linguist Roman Jakobson. Indeed, his model have been envisaged by renowned semioticians as "…valid for all modes of communication" (Guiraud, 1999, p.11), this being also widely known in theoretical studies on design (Ashwin, 1984; Walker, 1989; Quarante, 1992; Negrin and Fornari, 1992). Standing on these considerations, the functions of language present in Jakobson's model were related to the dimensions of the model here proposed in order to clarify their semiotic-communicative implications.

Jakobson's (1988) model defines communicative acts based on the following six functions: (1) to refer to something through the message or *referential function*, (2) to express the addresser's attitude or *emotive function*, (3) to elicit certain reaction in the addressee of the message or *conative function*, (4) to establish and maintain communication or *phatic function*, (5) to verify / assess how suitable are the message and the codes used or *metalingual function,* and (6) to select and combine the necessary terms to build the message or

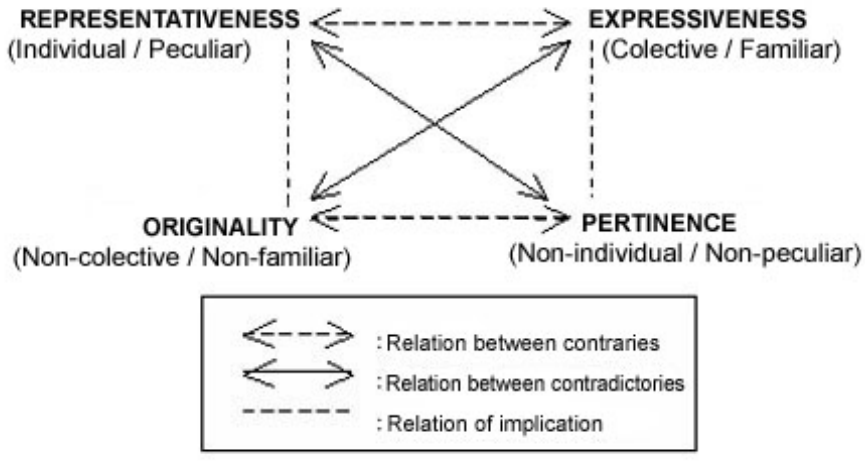

Figure 2. Location of the four dimensions comprising the competitiveness plane of each product with its logical relations. Source: Lacruz-Rengel (2008a).

poetic function. Such functions are linked to the dimensions of our model in the following manner (Lacruz-Rengel, 2008a):

1. *Utility dimension* is associated to Jakobson's *referential / cognitive function* given that aspects such as the product's practical purpose and functionality is basic for any understanding / interpretation of the product.

2. *Competitiveness dimension* is linked to the *metalingual function* provided that the success of a product is always assessed in relation to other products in the market.

3. *Originality dimension* is related to the *poetic function* since the contribution of this dimension to the product's meaning has mostly to do with the selection of the means to represent its design concept.

4. *Pertinence dimension* is envisaged as part of Jakobson's *phatic function* because it is precisely in this dimension where connections with the product's potential contexts and users are established to ease communication.

5. *Representativeness dimension* is associated to the *conative function* given that it works around the effect caused by the product in its potential user.

6. And *Expressiveness dimension* is linked to the *emotive function* since the designer's knowledge and attitude toward the social group or culture he/she works for is reflected as part of this dimension.

These theoretical considerations lead us to realize that any design product implicitly contains all six types of mental associations or referents outlined here (cognitive, metalingual, poetic, phatic, conative, and emotive) as dimensions and communicative functions. Nevertheless, there is always a dimension or type of association prevailing over the others to define each product's fundamental nature, that is, what the competitiveness of such product is about. Thus, while a tool is basically functional (and therefore, competitive based on its utility), the container of a perfume or a watch can be primarily looked up as signs of social status and consequently, competitive based on their Expressiveness or way of translating the culture they are part of.

Furthermore, there are other aspects that need to be clarified in order to understand the implications derived from the use and actual over-estimation of certain dimension / referent during the act of designing. To this aim, some well-known semiotic nomenclatures from design studies were brought forward. This particularly refer to the semantic (form meaning), syntactic (form structure and composition) and pragmatic (form use and ownership) levels proposed by Horst Oelhke (1990); the indexical (clues), iconic (resemblances) and symbolic (agreements) references used by Max Bense (1972) and Susann Vihma (1995) to describe the content or what the product refers to; and the Stylistic, Formalist and Functionalist emphases taking place when the semantic, syntactic or pragmatic dimensions of semiotics are respectively given importance in the product, according to Quarante (1992). Thus, our model's dimensions are semiotically characterised as follows:

CONCEPTUAL DIMENSION	Type of referent or mental association *(Roman Jakobson)*	Prevalent semiotic level *(Horst Oehlke)*	Main type of content *(Bense y Vihma)*	Design emphasis *(D. Quarante)*
UTILITY	Cognitive	Pragmatic	Iconic	Functionalist
COMPETITIVENESS	Metalingual	Pragmatic Syntactic Semantic	Iconic Indexical Symbolic	Functionalist Formalist Stylistic
ORIGINALITY	Poetic	Syntactic	Indexical	Formalist
PERTINENCE	Phatic	Semantic	Iconic	Stylistic
REPRESENTATIVENESS	Conative	Syntactic	Iconic	Formalist
EXPRESSIVENESS	Emotive	Semantic	Symbolic	Stylistic

Figure 3. Semiotic characterization of the six dimensions comprising the model proposed by the author.

4. TESTING THE FEASIBILITY OF THE PROPOSED DIMENSIONS

In order to verify to what extent the proposed dimensions can be differentiated from each other during the ideation of products and therefore, be present, it was assumed that: (1) all the model's dimensions are present at once with a lesser or major intensity in each product, (2) the Competitiveness dimension is built up standing on the other five dimensions of the model (thus, it does not exists on its own), and (3) the Representativeness and Expressiveness dimensions are very difficult to separate in experiments involving designers only, provided that these dimensions mainly take place in the users' views about products.

With the above considerations in mind, four experiments were developed with the participation of twenty students (55% women and 45% men), with 22 years old as average age, from the fourth-year of the Bachelor (Hons) in Industrial Design taught at Universidad de Los Andes, Venezuela. The choice of participants derived from the need of assuring an acceptable and even level of development in product ideation as well as sufficient knowledge on materials and manufacturing processes to generate feasible design concepts. The number of participants, on the other hand, was determined following the example of experiments in which participants create design concepts with the same level of complexity to be later assessed under similar procedures (Lacruz-Rengel, 2008b). The goal in all the experiments was the ideation of design concepts for portable box-shaped electrical appliances. The use of this type of products was due to the semantic neutrality of their appearance as well as their not-too-complex functionality. The idea was to challenge the participants' imagination and guarantee the achievement of the task assigned in the time given. Indeed, an average of three hours time was used for each experiment based on similar

experiences carried out by other researchers (Lacruz-Rengel, 2008b).

4.1. PROCEDURE

The four experiments were designed to study the dimensions of the proposed model. Based on the abovementioned considerations, the Utility and Competitiveness dimensions were put together so as the dimensions Pertinence and Competitiveness, Originality and Competitiveness, Representativeness + Expressiveness and Competitiveness. A day before each experiment, participants were involved in an induction session in which the aspects of each dimension were explained and examples of its use in design were given. The idea behind this was to standardise the participants understanding of the dimensions under study. During each experiment participants were asked to produce their design concepts in A3 sheets by sketching and writing words which encapsulated the flow of their thinking process from their very first ideas till their final proposal or concept. All experiments were carried out between 8:30 and 11:30 am, with all participants working in the same studio but in separate work stations to foster collective enthusiasm toward the experiment. No participant was allowed to communicate or look at the work of the others. Indeed, enough space was provided between the work stations to keep participants comfortably apart. During the experiments participants were asked to formulate a design concept in three hours time (as the most), based on a design brief purposely created to this end.

4.2. DATA COLLECTED AND DEPENDENT MEASURES

Two types of data were collected throughout the four experiments: *pictorial expressions* and *verbal expressions*. The former are drawings used by the participants to explore ideas or define aspects of their design proposals. The latter (verbal expressions) are isolated words or chains of words (phrases and sentences) used by the participants to name or describe the associations coming to their minds during the ideation of a design proposal. Given that, from a semantic standpoint, pictorial expressions are holistic and verbal expressions are partial in character and subject-specific, pictorial expression were taken as indications of changes in the participants' pattern of behaviour, and verbal expressions were taken as indications of the presence of mental associations specifically linked to the dimensions under study. To this aim, verbal expressions were divided into two subgroups: *general* (those generated during the creative process regardless of the dimension to which they refer), and *dimension-specific* (those directly linked to characteristic matters of any of the dimensions under study). The number of *dimension-specific verbal expressions* was particularly important to establish the participants' clarity of intention during concept ideation (the more dimension-specific verbal expressions produced, the clearer the participant's realization of the design brief). The repeated verbal expressions and their synonyms were quantified only once, the same as those drawings referring to the same things.

4.3. EXPERIMENTAL HYPOTHESES AND METHOD OF ANALYSIS

In order to verify the extent to which the proposed dimensions can be distinguished from each other in practice, the arithmetic means of general verbal expressions and dimension-specific verbal expressions were compared one to one between experiments. The arithmetic means of pictorial expressions were also compared between experiments to find differences in the behaviour patterns directly linked to

drawing (for instance, in what dimensions people draw more and in what dimensions people draw less). To this aim, three hypotheses were formulated:

H_1: The dimensions of our model can be distinguished from each other based on the number of verbal associations / expressions produced in each of them.

H_2: The clarity of intention, manifested through the number of dimension-specific verbal associations, is different in each dimension.

H_3: The behaviour drawing, manifested through the number of pictorial expressions, is different in each dimension.

The data (pictorial and verbal expressions) was taken from 80 design concepts produced by the students that took part in the four experiments and this was processed using the version 10.0.6 for Windows of the Statistical Package for the Social Sciences (SPSS). Results were analysed in a descriptive manner taking the arithmetic means as measures of distribution and their Standard Deviations as measures of spread. The inferential analysis was carried out using a t-test for related samples in order to compare the paired arithmetic means of the four experimental dimensions under study and determine if there were significant differences among them with a significance level of 5% (α= 0.05). Only six comparisons were carried out between the results of the four experiments, since further comparisons were symmetrical (e.g. Utility and Pertinence is the same comparison to that between Pertinence and Utility). For the sake of simplicity in the description of results, these are here reported without using the word "Competitiveness" as part of each experiment or experimental dimension (e.g. "Utility" instead of "Utility + Competitiveness"), provided that Competitiveness is present in all four experiments.

4.4. RESULTS

In the comparison between the experiments on the *Originality dimension* and that on the *Utility dimension*, it was found that the arithmetic mean of general verbal expressions in the Originality experiment (28.55 ± 8.2620) was higher than that of Utility (21.65 ± 4.7603). The difference between the arithmetic means of both experiments was -6.9 expressions, which shows that there *is a statistically significant* difference between both dimensions (t = -5.285; df = 19; p = 0.000). In relation to the clarity of intention during concept ideation, the mean of dimension-specific verbal expressions in the Originality dimension (10.45 ± 3.2359) was higher than that of Utility (9.5 ± 3.5467), with a difference between both means of -0.95 expressions, which is *not statistically significant* (t = -0.894; df = 19; p = 0.382). Regarding the number of pictorial expressions produced, the mean of the Originality dimension (4.15 ± 2.4767) was higher than that of the Utility dimension (3.80 ± 2.8946), with a difference between both means of -0.35 drawings which is *not statistically significant* (t = -0.482; df = 19; p = 0.635).

In the comparison between the results of experiments on *Pertinence* and *Utility* the mean of general verbal expressions in the Pertinence experiment (27.75 ± 7.4189) was higher than that of Utility (21.65 ± 4.7603). The difference between the arithmetic means of both experiments was -6.10 expressions, which shows that such difference *is statistically significant* (t = -5.118; df = 19; p = 0.000). In relation to the clarity of intention during concept ideation for products, the mean of dimension-specific verbal expressions in the Pertinence dimension (6.9 ± 3.4777) was lower than that of Utility (9.5 ± 3.5467), with a

difference between both means of 2.6 expressions, which is *statistically significant* (t = 3.057; df = 19; p = 0.006). Regarding the number of pictorial expressions, the mean of Pertinence (5.15 ± 3.5135) was higher than that of Utility (3.80 ± 2.8946), with a difference between both means of -1.35 drawings which is *not statistically significant* (t = -1.906; df = 19; p= 0.072).

In the comparison between the experiments on the *Representativeness + Expressiveness dimension* and that on the *Utility dimension*, the mean of general verbal expressions in Representativeness + Expressiveness (14.50 ± 3.6491) was lower than that of Utility (21.65 ± 4.7603). The difference between both arithmetic means was 7.15 expressions. This difference is *statistically significant* (t = 7.785; df = 19; p = 0.000). In relation to the clarity of intention during concept ideation, the mean of dimension-specific verbal expressions in Representativeness + Expressiveness (11.55 ± 3.0171) was higher than that of Utility (9.5 ± 3.5467), with a difference between both means of -2.05 expressions which is *statistically significant* (t = -2.259; df = 19; p = 0.036). Regarding the number of pictorial expressions, the mean of Representativeness + Expressiveness (3.30 ± 1.8382) was lower than that of Utility (3.80 ± 2.8946), with a difference between both means of 0.5 drawings and therefore this is *not statistically significant* (t = 0.717; df = 19; p = 0.482).

In the comparison between the experiments on the *Originality* and the *Pertinence dimensions*, it was found that the mean of general verbal expressions in the Originality dimension (28.55 ± 8.2620) was higher than that of Pertinence (27.75 ± 7.4189), with a difference between the arithmetic means of both experiments of -0.80 expressions, which is *not statistically significant* (t = -0.484; df = 19; p = 0.634). In relation to the clarity of intention during concept ideation for products, the mean of dimension-specific verbal expressions in the Originality dimension (10.45 ± 3.2359) was higher than that of Pertinence (6.9 ± 3.4777), with a difference between both means of -3.55 expressions, which is *statistically significant* (t = -3.673; df = 19; p = 0.002). Regarding the number of pictorial expressions, the mean of Originality (4.15 ± 2.4767) was lower than that of Pertinence (5.15 ± 3.5135), with a difference between both means of 1.0 drawings which is *not statistically significant* (t = 1.624; df = 19; p = 0.121).

In the comparison between the experiments on the *Pertinence dimension* and that on the *Representativeness + Expressiveness dimension*, the mean of general verbal expressions in the Pertinence dimension (27.75 ± 7.4189) was higher than that of Representativeness + Expressiveness (14.50 ± 3.6491). The difference between both arithmetic means was 13.25 expressions, which is *statistically significant* (t = 9.25; df = 19; p = 0.000). In relation to the clarity of intention during concept ideation for products, the mean of dimension-specific verbal expressions in the Pertinence dimension (6.9 ± 3.4777) was lower than that of Representativeness + Expressiveness (11.55 ± 3.0171), with a difference between both means of -4.65 expressions, which is *statistically significant* (t = -4.787; df = 19; p = 0.000). Regarding the number of pictorial expressions, the mean of Pertinence (5.15 ± 3.5135) was higher than that of Representativeness + Expressiveness (3.30 ± 1.8382), with a difference between both means of 1.85 drawings, this being *statistically significant* (t = 2.794; df = 19; p = 0.012).

Finally, in the comparison between the results of experiments on the *Originality dimension* and that on the *Representativeness + Expressiveness dimension*, the mean of general verbal expressions in the Originality dimension

(28.55 ± 8.2620) was higher than that of the Representativeness + Expressiveness dimension (14.50 ± 3.6491), with a difference between the arithmetic means of both experiments was 14.05 expressions, which is *statistically significant* (t = 8.872; df = 19; p = 0.000). In relation to the clarity of intention during concept ideation, the mean of dimension-specific verbal expressions in the Originality dimension (10.45 ± 3.2359) was lower than that of the Representativeness + Expressiveness dimension (11.55 ± 3.0171), with a difference between both means of -1.1 expressions, which is *not statistically significant* (t = -1.218; df = 19; p = 0.238). Regarding the number of pictorial expressions, the mean of Originality (4.15 ± 2.4767) was higher than that of Representativeness + Expressiveness (3.30 ± 1.8382), with a difference between both means of 0.85 drawings which is *not statistically significant* (t = 1.369; df = 19; p = 0.187).

5. Discussion of Results and Conclusion

The study about the number of general verbal expressions used to formulate design concepts showed that the difference between the number of such expressions was statistically significant in five out of the six comparisons carried out. These findings confirm the first experimental hypothesis with more than 75% of certainty and therefore, prove that it is possible to differentiate the proposed dimensions within the realm of our verbal thinking. Only in the comparison between the Originality and Pertinence dimensions, the difference was not statistically significant. This may be due to the fact that these two dimensions were the only ones compared despite of being semantically opposed as well as part of the same axis in our model. The lack of a significant difference between these two dimensions -in terms of verbalization- can also be interpreted as a proof of how correct their association was as part of the same axis in our model. In this sense, it is presumed that something similar could happen if the dimensions Representativeness and Expressiveness were placed in separate experiments and compared.

Another interesting aspect derived from the results on general verbal expressions has to do with the fact that -in those dimensions where the ideation of design concepts depend more on a logic of analytical nature (such as the Originality and Pertinence dimensions)- the number of verbal expressions tends to be higher than in those dimensions whose logic is more of a synthetic nature (such as the Representativeness and Expressiveness dimensions). In this sense, the Utility dimension seems to be a blend of both logics provided that the verbalization of ideas is neither too high nor too low when this dimension is compared with the others.

Regarding the second hypothesis about whether the clarity of intention is different among the dimensions of our model, the results show that this is only true in four out of the six comparisons carried out. Curiously the two comparisons in which the clarity of intention was not perceptible were those between the Originality and Utility dimensions, as well as between the Originality and Representativeness + Expressiveness dimensions. Such a situation makes sense if we consider that the clarity of conceptual intention only became apparent when the Originality dimension was compared with that dimension naturally and directly opposed to it in our model, that is, Pertinence. Thus, the clarity of intention in the Originality dimension only becomes evident when it is compared with dimensions whose nature is neither too factual nor too subjective, provided that otherwise Originality tends naturally to blend with any of these two

extremes. On the other hand, the results of the comparisons carried out show that designers tend to produce less dimension-specific verbal expressions in dimensions where the design solutions are more evident (such as the Pertinence dimension) and more dimension-specific verbal expressions in those dimensions where designs solutions are less evident (such as the Representativeness and the Expressiveness dimensions).

In relation to the extent to which the dimensions of our model can be distinguished in terms of the drawing behaviour of designers or third experimental hypothesis, the results show that the number of pictorial expressions is only significantly different in the comparison between Pertinence and Representativeness + Expressiveness. This situation seems logical since they are extremes. Insomuch that Pertinence is the easiest dimension to be expressed in pictorial terms (given that it deals with what is familiar to us), and Representativeness + Expressiveness is the hardest (provided that it frequently deals with abstract things). Besides these two cases (that is, 16.66% of all comparisons), the differences among the dimensions of our model in drawing behaviour are scarce, disproving the third hypothesis proposed.

These findings confirm the feasibility of the proposed model based on the variations in the verbalization of ideas registered in the dimensions under study. Such feasibility is also supported, even though partially, by the correlations verified among some dimensions of the model.

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