

CORRELATION BETWEEN INTRINSIC CHARACTERISTICS OF INDUSTRIAL PRODUCTS AND USER'S PERCEPTION

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The present study bases on the statement that the product experience is becoming a more and more important element in the user's assessment and selection of an industrial product. Different areas of research (consumer sciences, psychology, ergonomics, industrial design, engineering) are opening to the emotional aspect of products, among which those investigating the aesthetic perception as a part of the emotion. This paper aims at investigating the existing correlation between form features of an industrial product and the user's perception at the aesthetic level. The purpose of this study is to formalize a test able to return the connection existing between intrinsic features of a product and the user response in terms of meaning attribution. The present study will focus mainly on the form parameters of products.

Keywords: User's perception, Product's form, Product experience.

1. INTRODUCTION

In studying the correlation between intrinsic characteristics of products and the user's perception, it is essential to introduce the concept of product experience.

Product experience is "the entire set of affects that is elicited by the interaction between a user and a product, including the degree to which all our senses are gratified (aesthetic experience), the meanings we attach to the product (experience of meaning) and the feelings and emotions that are elicited (emotional experience)" [1].

The product experience therefore originates from the properties of the product and results into an emotion. Most interesting for the present study are the three levels of the product experience (aesthetic, meaning, emotional) and in particular their correlation. Desmet [2] proposed a framework of product experience where aesthetic and meaning experience determines the emotional experience related to a product. This relationship is somehow hierarchical, where the emotional experience results from the composition of aesthetic and meaning experience.

In particular it has been proposed by many researchers [1–3] that the aesthetic pleasure, which is not an emotion itself, is derived from the detection of "structure, order, or coherence and assesses a product's novelty/familiarity" [2] in the product features.

It has been argued that the aesthetic response and aesthetic pleasure is derived from perception as such and does not imply evoking an emotion. Hekkert and Leder stated that "An aesthetic response [...] is 'disinterested' or distanced in that no motives other than perceiving the object of perception 'as

such' are at stake. The pleasure 'simply' results from the act of perception itself' [4]. When speaking of product aesthetic it is intended not only the final surface treatment of a design or its styling but all those product properties which contribute to the sensory pleasure that is evoked by the product. Indeed, the product properties are defined at the beginning of the product development process and determine not only the aesthetic impression of a product but also its meaning [5].

Experience of meaning bases on a cognitive process which connects the stimulus perceived with the significance of a product, its expressive characteristics and its personal or symbolic significance. It is what Crilly *et al.* define with 'semantic interpretation' and 'symbolic association' [6]. Krippendorf affirmed that products' semantic is what gives sense to products, that is what makes people attribute a meaning or significance to products [7, 8].

To involve users at an emotional level, design should be able to stimulate aesthetic and meaning experience manipulating the formal and material features of a product [9]. An understanding of users' aesthetic and meaning experience and the reuse of this information as input in the product development process, can help the designer to manage these emotional effects and therefore to avoid the ones unwanted, such as feelings of disgust in response to a new design.

Formal and material features of a product are basically what a consumer perceives of industrial products through senses, since these are the objective properties related to it.

Cognition can be defined as the attribution of a meaning to a stimulus coming from the environment and captured by our senses. Objects surrounding us are part of the environment and, therefore, can be considered stimulus, not only during the interaction with the user, but also simply through their visual features. When it comes to the senses, design activities are often mainly dominated by the visual appearance. Visual appearance has a specific language (size, shape, colour, etcetera) [10], through which meaning and aesthetic impression is transmitted to the user.

In the present study the authors decided to focus on the aesthetic and meaning experience and just as a reflection on emotional experience of products. Nevertheless it is commonly agreed that the three components, despite they are conceptually separated, are strictly connected and difficult to distinguish. [1, 10]

1.1. Emotion through form

It has been stated by different authors [5, 11] that aesthetic emotions are elicited by products through a product experience process which involves the aesthetic experience, the experience of meaning and the emotional experience connected to it [12].

Speaking of visual experience of a product this same aesthetic process occurs in the observer; indeed this process was built by psychologists for the understanding of artworks' appreciation, which especially bases exclusively on visual responses and no other sense is involved [5, 13].

The kind of experience treated in the present paper is limited to visual experience of product form.

The form of a product, with all its features, is the first aspect a consumer deals with when facing a product and it is therefore involved in the very first step of the cognitive and affective process which results into an emotion. The form is what a consumer perceives of a product through view and it is the means through which a product gains sense for the consumer. Krippendorf affirmed that "design is making sense of things" [7], that is giving form to an object means to give a particular meaning to it. This means that form and meaning are related because "something must have form to be seen but must have sense to be understood and used" [14]. Therefore in the process of giving form to a product, a designer, consciously or unconsciously, gives a meaning to it which will be transmitted, like in a communication process [6], to the consumer. The designer is the source of the message, written in a code which bases on the formal features of the product, which will then be perceived by the consumer through the senses, in this case through the sense of view. Immediately after the pure perception of the product, in the mind of the observer a cognitive process starts where a meaning is attributed to the product and a consequent emotion is evoked. Of course there are many variables which influence the cognitive and affective process such as the context, the culture of the observer and previous experiences. Nevertheless, as Hekkert affirms [4], as far as people share a common background and comparable

previous experiences “it is most likely, but not necessary, that people will agree on an object’s aesthetic value”.

The connection which links form and meaning of a product, passes through the product’s intrinsic properties [15], that is its physical attributes. Some authors classified these attributes on the base of Basic Design principles and on the base of Gestalt Theory. The physical product may be characterised by many parameters such as its geometry, dimensions, textures, materials, colours, graphics and details [6, 16].

On the base of those proposed by Basic Design and Gestalt Theory some parameters were used in the present study: dimensions, geometry, proportions, composition, details.

2. AIMS OF THE STUDY

In order to enable design to respond to the needs involved in the perceptive and sensorial sphere with accuracy, this study looks at the possibility of providing a test which could return, in a qualitative but objective way, the recurrence of a pattern which associates specific formal parameters to meaning responses.

The aim of this study is related to the following questions: Why do we associate a particular meaning to certain shapes? Are there recurrent patterns which can trace a trend in the manifold perceptions of different users? And, from here, how it is possible to give designers useful information in the design practice?

In this study the formalization and structuring of the test together with the first general results will be presented.

3. METHOD

In order to investigate the field of perception, which is related to the subjective sphere of the user, the research group decided to develop a test which could find out possible connections and recurrent patterns between the aesthetic and meaning response of the user to the visual stimulus given by an industrial product and its intrinsic features. Therefore it was necessary to find and then elaborate a suitable method for the aim of the research and also a repeatable and intuitive structure which could help in collecting data coming from the tests.

The process is as follows:

1. choice of the analysis method suitable for the aim of the research
2. choice of the product family to investigate
3. selection of the morphological parameters to analyze
4. structuring of the test
5. choice of the product samples
6. performance of the test
7. extrapolation of data
8. results

It was decided to base the test on a visual questionnaire since the purpose of the research itself is to investigate the response to visual stimuli given by a category of industrial products. Indeed the perceptive stimulus submitted to the respondents was a sequence of images of the product samples.

The test was developed in Italian language, because all the participants were supposed to be Italian. In the images and tables presented in this paper a translation of the test is proposed, to make it understandable for non Italian readers.

The paper deals with the structuring of the test, together with the way in which the test was performed and the methods which were used to collect data and to extrapolate results. The original test investigates both the formal and materials aspects of the visual stimuli, therefore it is divided into two macro-sections, the formal and the materials one. The present paper focuses exclusively on the

formal section of the test, without making considerations about the materials analysis which will be further handled in a following study.

The study was conducted by a group of design experts of the IDEA Research Unit, INDACO Department, and of the Chimica, Materiali e Ingegneria Chimica Department (Politecnico di Milano).

3.1. Structuring of the test

The best method to find recurring patterns in a great quantity of data is the statistic analysis performed on a sufficiently large number of subjects. In order to find out the above proposed connections and recurrent patterns, it was decided to lay out a test, consisting of a visual questionnaire which presents a multi-layered structure, in which the following aspects of perception are analyzed and linked: the meaning associated to the product; the formal attributes which may influence the perception.

The first one serves to identify the meaning associated by the user to each product. It was thus decided to ask the respondents to describe the product with an adjective [17, 18]. The subject had to select only one adjective - the most representative - from a list created following some steps described below.

Regarding the second aspect, the second part of the questionnaire asks the respondents to analyze more deeply their meaning response. In particular, the questionnaire presents a list of attributes belonging to formal parameters, which could have influenced their adjective selection. These attributes were chosen by a group of experts, basing on the existing literature about the topic of basic design and on the parameters of the Gestalt theory [19]. The group of experts selected the following parameters which describe the formal qualities of a product: dimensions, geometry, composition, proportions, details.

Each of these parameters is divided into more specific attributes, as follows:

- dimensions: big, medium, small;
- geometry: elementary, organic, rounded, squared;
- proportions: balanced, disharmonic, stretched/thin, squat
- composition: static, dynamic, instable, articulated, uniform
- details: minimal, marked, non-homogeneous, coherent

The research group decided that the survey should involve low-complexity products, to make the analysis by the respondents more simple and immediate. Therefore, it was decided to use pens as sample for the test since they are common and easily recognizable objects.

Pens used as sample were selected by a group of 5 design experts, on the basis of materials and formal attributes previously established for the perceptive analysis in the structuring of the test. Each pen should be strongly characterized by at least one of the form parameters proposed. The identified samples were 9, all belonging to a medium-low price range.

3.2. Application of the test

3.2.1. Representative adjectives

The questionnaire section which analyzes the meaning area — which associates the product to a meaning — consists in the description of the pen through an adjective chosen from a specific list. Before performing the test and in parallel with its structuring, a survey, based on the product sample images, was conducted to collect adjectives suitable for describing the pens.

Forty design students participated in the survey, and they were asked to observe the 9 pens and to describe each of them with one or more adjectives. 124 adjectives were listed, and, after eliminating the similar one and the non consistent one, 66 adjectives were extracted and considered suitable for the test. These adjectives were clustered using the Kawakita Jiro (KJ) method [20], which bases on the classification of different concepts into several groups by their similarity degree. Therefore the adjectives were divided into groups of similar meanings, in which all of them belong to the same

Representative	Family group	Representative	Family group
practical	handy, ergonomics, comfortable, anatomic, functional	elegant	classic, sophisticated, refined
ordinary	daily, common, anonymous, normal	technological	futuristic, modern
dull	boring, monotone, predictable	cheap	inexpensive
playful	cheerful, young, funny	serious	strict, severe
rational	rigorous, impersonal	uncomfortable	bulky
particular	original, unusual, alternative	extreme	redundant, exaggerated
eye-catching	extrovert, loud	essential	minimal, simple, linear, sober, clean
professional	technical, precise	robust	stately
fragile	delicated	informal	sporty
sinuous	fluid, flexible	durable	lasting

Figure 1. Adjective groups.



Figure 2. Images of sample pens.

semantic area. 20 different groups were individuated with this process, and for each one of them an adjective was elected as representative. The final list which was given to the participants was then composed by the 20 families, where the representative adjective was highlighted (Figure 1).

3.2.2. Participants

It was decided to involve design students as participants, in order to use their design experience and background to make the perceptive analysis clear and precise, and to prevent misunderstanding about the formal and material attributes. The total number of respondents was 80, all aged between 20–28 both feminine and masculine.

3.2.3. Stimuli

Coloured photos of the 9 pens (Figure 2), realized maintaining the real dimensions of each object, were used as visual stimuli in the questionnaire. The images were both projected and printed to let the participants see details and materials with more accuracy. The test was submitted contemporaneously to all the respondents in the same room, therefore the context may be considered equivalent and not influential.

Through the use of images, instead of the real objects, the analysis of the visual perception results devoid of interferences given by further information coming from the interaction with other senses [21]. In fact, it was decided for the present study to avoid perceptions deriving from any form of synaesthesia, in order to analyse only the reaction to visual inputs.

3.2.4. Procedure

Participants were explained, through a brief introduction, the purpose of the experiment, then it was introduced to them the procedure of the test and the instructions to complete the questionnaire. They received the questionnaire, the adjective list and the images of the 9 pens, and they were asked to

I find it...(describe the product with an adjective from the list) _____					
What parameters influence this choice?					
FORM	dimensions	<input type="checkbox"/> NO	<input type="checkbox"/> ENOUGH	<input type="checkbox"/> STRONGLY	why? (only if you selected ENOUGH or STRONGLY) <input type="checkbox"/> big <input type="checkbox"/> medium <input type="checkbox"/> small
	geometry	<input type="checkbox"/> NO	<input type="checkbox"/> ENOUGH	<input type="checkbox"/> STRONGLY	why? (only if you selected ENOUGH or STRONGLY) <input type="checkbox"/> elementary <input type="checkbox"/> organic <input type="checkbox"/> rounded <input type="checkbox"/> squared
	proportions	<input type="checkbox"/> NO	<input type="checkbox"/> ENOUGH	<input type="checkbox"/> STRONGLY	why? (only if you selected ENOUGH or STRONGLY) <input type="checkbox"/> balanced <input type="checkbox"/> disharmonic <input type="checkbox"/> stretched/thin <input type="checkbox"/> squat
	composition	<input type="checkbox"/> NO	<input type="checkbox"/> ENOUGH	<input type="checkbox"/> STRONGLY	why? (only if you selected ENOUGH or STRONGLY) <input type="checkbox"/> static <input type="checkbox"/> dynamic <input type="checkbox"/> instable <input type="checkbox"/> articulated <input type="checkbox"/> uniform
	details	<input type="checkbox"/> NO	<input type="checkbox"/> ENOUGH	<input type="checkbox"/> STRONGLY	why? (only if you selected ENOUGH or STRONGLY) <input type="checkbox"/> minimal <input type="checkbox"/> marked <input type="checkbox"/> non-homogeneous <input type="checkbox"/> coherent

Figure 3. Sample test, form macro-section.

observe the images projected one by one on the screen, and to complete only the section regarding the meaning area and the form and material attributes (Figure 3).

They were asked to associate an adjective from the list to each pen, then to indicate the level of influence of the form parameters proposed and to choose the attribute which specify the selected parameter. Each image was projected for no longer than 3 minutes.

3.3. Extrapolation of data

After collecting data through the questionnaire, they were extracted and arranged following an accurate method.

Regarding the first part of the questionnaire, which consists in the attribution of a meaning to the product, it was calculated, for each pen, the adjectives' recurrence. This association allowed to make considerations and evaluations about the existence of recurrent patterns between the product and the user's meaning attribution.

In order to evaluate the influence of certain formal parameters of an object in the attribution of a particular meaning, a system was studied with the aim of collecting and analyzing data. For each of the 9 pens 20 datasheets were created, corresponding to the 20 adjectives. In these data-sheets the formal parameters and attributes appears. When a respondent associates an adjective to the examined pen, the corresponding datasheet was filled as follows. If the parameter was defined as "enough" influential, 1 point was assigned to the corresponding attribute. On the contrary, if the parameter was considered "strongly" influential, 2 points were assigned to the related attribute.

At the end of a column — each corresponding to one attribute — the total score was calculated. Comparing the total score of each attribute belonging to the same formal parameter, it was possible to evaluate the weight of that attribute in the choice of a particular adjective.

The sum of the total scores related to the attributes of a certain parameter, gives the parameter's total score, which allows comparing the influence of each formal parameter in the assessment of a certain meaning.

4. EXPECTED RESULTS

Data were processed in order to return results which might confirm or disconfirm some hypothesis. In particular, it was expected that results might show some predictable correlations between the visual parameters of the product and the associated meaning; for example, round shapes and marked details

may convey a playful meaning, while basic shapes and minimal details may convey an essential or rational meaning.

Moreover, it was expected to find more agreement in the meaning associations for strongly-characterized pens, while the results of the meaning associations for less defined pens might be spread among different adjectives. The authors supposed to find influential form parameters even for less defined pens.

5. FIRST RESULTS

The results were represented as follows: regarding the semantic area, one histogram as support for the visualization of the adjective's scoring related to each pen. Columns of the histogram allow comparing, in an intuitive and immediate way, the recurrence of an adjective in evaluating the pen. Only high scoring adjectives (more than 30 recurrences) passed to the second phase of the analysis. The resulting adjectives were 8: essential, playful, cheap, serious, elegant, professional, ordinary, practical.

Referring to the association between the meaning and the formal parameters, it was decided to extract results in a transversal way, therefore the analysis was performed considering data related to all the 9 samples together. This way it was possible to highlight general associations between a particular meaning, which is represented by the adjective, and the parameters of the product which influenced the choice of the meaning. Therefore, it was possible to generally establish how much a certain attribute or formal parameter influences the attribution of a particular meaning in products as pens. In order to have an immediate representation of the results, graphics were created to visualize the contribution of each parameter in the meaning attribution, and, contextually, the influence value of the attributes composing the parameters (Figure 4). Thus 8 graphics were generated, each one representing one adjective. The score of each graphic was normalized to make it comparable with others.

What is relevant in each graphic is not only the total scoring for each parameter but also the mix and the relative amount of the different attributes. From the graphics it is possible to know how influential is a parameter and its attributes in determining the meaning assessment. The following are the results for each adjective. Most relevant attributes are reported without numeric indexes since this is a first qualitative analysis.

Playful: rounded and organic geometry, dynamic composition, marked details.

Economic: elementary geometry, static and uniform composition, minimal and non-homogeneous details.

Serious: squared and elementary geometry, balanced proportions, static and uniform composition, minimal and coherent details.

Practical: medium dimensions, rounded geometry, balanced proportions, coherent details.

Essential: small and medium dimensions, elementary geometry, balanced and stretched proportions, static and uniform composition, minimal details.

Professional: elementary geometry, balanced proportions, uniform composition, minimal details.

Ordinary: medium dimensions, elementary geometry, balanced and stretched proportions, static and uniform composition.

Elegant: small dimensions, squared and elementary geometry, balanced and stretched proportions, uniform composition, minimal and coherent details.

In summarizing the results, only relevant attributes were reported, whilst the flattened ones were not considered.

It is possible to notice that some patterns are similar in more adjectives, probably because they seemed the respondents to belong to the same semantic area, such as serious and elegant; but also some peculiar attributes stand out for some adjectives, such as dynamic composition in “playful”, rounded geometry in “practical”, non-homogeneous details in “economic”.

6. FURTHER DEVELOPMENTS

The first step in the future developments of this study will be further critical discussion about recurrent connections between the formal properties of products and the meaning associations.

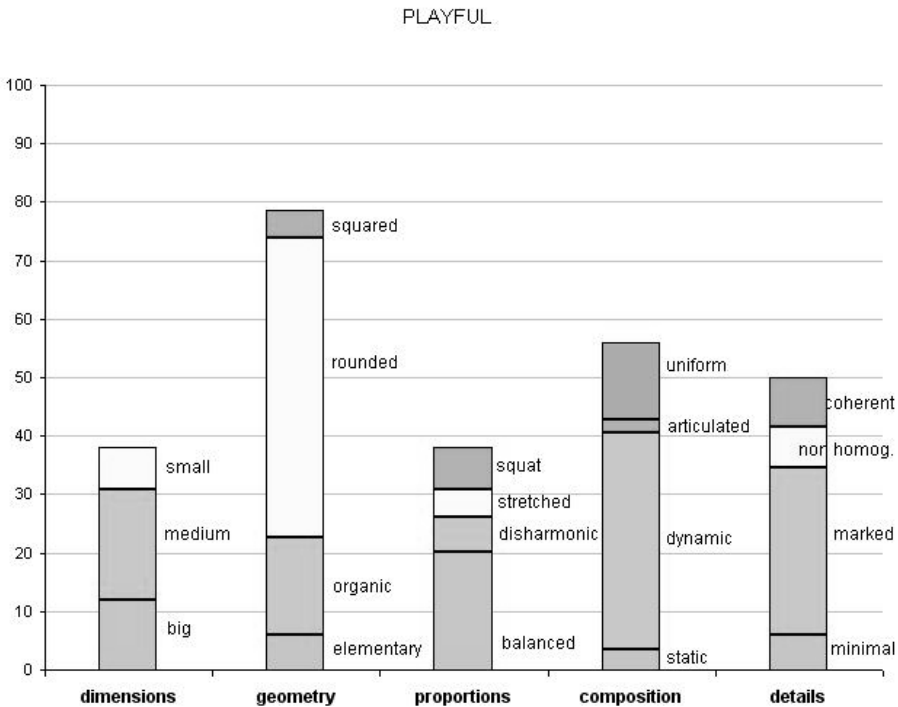


Figure 4. Sample graphic (Playful), with most relevant attributes highlighted.

Another future development will be to perform data extraction on materials macro-section of the test and to link these data with those from form macro-section. The authors expect that from the analysis of form and materials sections, some relations and connections will be found. In particular the connection between meaning attribution and form and materials parameters will be studied and deeply analyzed.

The authors also intend to perform the test with different target participants to individuate possible variations in the collected meaning-parameters connections. Since the respondents in this first test application can be considered as design experts, the next group of respondents will be chosen among non expert people, in order to analyze consistent variations.

Moreover, in parallel, the authors think it could be interesting and useful in order to generalize the meaning-parameters connections, to perform the test basing on a different product category, probably using more complex product samples. In order to do it, it may be necessary to review the adjectives list in order to adapt it to the new product category.

Starting from the considerations about the first test execution, some corrections will be eventually made to the test procedure to improve it before reusing it with other target respondents and other product categories.

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