

Relationships between Aesthetics and Engineering in Product Design

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Abstract In today's cost competitive global markets industrial design and aesthetics is a significant lever in distinguishing products from others to potential customers. The market success of industrial products strongly depends on their aesthetic character, i.e. the emotional reaction that the product is able to evoke. This paper investigates the current state of practice and research identifies major issues in the integration. The paper presents the potential problems and opportunities for the integration of requirements, concept design and industrial design. The "relationship" between aesthetics and engineering in design is found to be dependant on several factors: cost reduction needs, manufacturing processes, technology, customer requirements, customer satisfaction, to the value placed on emotional influence of product design, and even philosophical issues about the human condition.

Keywords - Aesthetics, Engineering Design, Product Design.

I. INTRODUCTION

Styling is a creative activity where the designer's goal is to define a product that evokes a certain emotion while satisfying the imposed constraints. Therefore, a better understanding of human reactions can allow an easier satisfaction of market wishes and tastes. On the other hand, the complete design of new products requires multidisciplinary expertise and consequently it results from the collaboration of several actors (Project Manager, Design Engineers, Designers, System Engineers, Marketing Specialists, Ergonomics Specialists, Economists, End-User). It is then clear that the formalization of the design intent underlying the product specification may improve the communication quality among the involved actors, who can belong to different departments in the same company, e.g. styling and engineering, or to external suppliers. In addition the formalization of the relationships between shape and aesthetic character included in a computer system may help designers to achieve their goal more directly. In fact, even if the introduction of digital tools in the styling workflow in the last twenty years has significantly shortened the development time and costs, some critical issues have still to be faced and overcome to move towards an ideal optimized digital design process, in which the design intent is automatically communicated and preserved throughout all the process phases.

To find the relationships between geometrical elements of a product shape and its aesthetic characters is the key to innovate the modeling tools by enabling the specification of those values of shape characteristics and parameters that, once processed by a computer system, could compute the design model conforming to the original intention.

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In the first part of paper is presented the research methodology and a short description of informations model for business data processing of information provided by customer for conception process.

In the second part of paper is identify the relationships between a product's shape characteristic and its emotional message.

II. THE RESEARCH METHODOLOGY

For the development of informatics model for business data processing of information provided by customers, a multidisciplinary research was made. The research consisted in optimization of different methods and techniques, which are specific to the following domains: conception, marketing, psychology - sociology, ergonomics, etc. The main processes to develop the model business data [1] processing of information provided by customer are: Acquisition, Processing, Using-Reusing and Dissemination.

For customer information acquisition I will use a questionnaire, for which I used as informatics' support an interface HTML.

For stocking the information provided by the customer I propose the usage of a data base, for example MySQL.

The information processing will be made with StatGraphics, and for data integration in the conception process is used QFD (Quality Function Deployment).

The methods presented are not competition but complementary. With StatGraphics are processed the information provided by customer, and with QFD the customer's needs-requirements are transformed in achievable technical specifications, and so these are integrated in conception process.

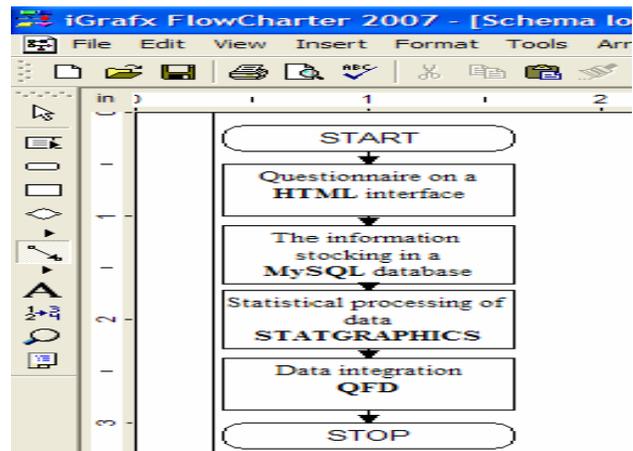


Fig. 1. The model for business data processing of information provided by customer.

The model for business data processing of information provided by customer for conception process is presented in figure 1.

The Research Methodology used was a multidisciplinary one, centred mainly on the research methods specific to marketing and mathematical statistics, with transmission and transformation of gathered information in statistical data.

The method of information acquisition used was the INVESTIGATION, and the research tool was the QUESTIONNAIRE. A HTML interface was used for the questionnaire application on an (experimental) sample made of 30 subjects.

III. THE RESULTS OF RESEARCH

It is often essential for companies today to deliver more customised products with shorter lead times, perfect quality and reliability and at lesser prices in order to maintain COMPETITIVE DESIGN. A typical design process focuses on the product's overall required functional specification provided by the customer, to produce a set of embodiment designs capable obtaining this function (El-Ganzoury et al 2006).

The "relationship" between aesthetics and engineering in design is found to be dependant on several factors: cost reduction needs, manufacturing processes, technology, customer requirements, customer satisfaction, to the value placed on emotional influence of product design, and even philosophical issues about the human condition.

To explore the possible relationships between product shape and aesthetic character, it is first necessary to identify a common language based on proper words and definitions used by designers in their daily activity, able to cover the description of aesthetic aspects beside the emotional reactions of a generic observer. The analysis of the relation between terms describing aesthetic properties of lines and shapes, and terms describing emotions associated with geometric elements has been conducted through a three-steps process:

- identification of a vocabulary of terms actually used to describe shapes of industrial products;
- verification of the usability of the vocabulary to properly identify the aesthetic and emotional character of product shapes;
- identification of terms adequately associating aesthetic and emotional character with specific lines or shapes.

First, a large set of internal documents, brochure and papers describing industrial products from an aesthetical point of view, has been supplied from the industrial partners. It allowed to collect the proper words and definitions currently used by the designers in their working activity, representing the first vocabulary. A refinement of the vocabulary has been achieved by processing the results of different kind of interviews, structured in order to collect a number of data as large as possible.

Table 1 provides example questions and responses from the questionnaire. It is found by this research that the aesthetics input is an increasingly important aspect and must take place at the start of the design. This process is inspired by

requirement from company, end-user and design shows. It is further enhanced by an awareness of the market and associated tools for such awareness. The aesthetics become iteratively developed as the designers sits and works through the design. Important inspiration from a process of LIFESTYLE ANALYSIS leads to appreciation of aesthetics and development of a desirable product.

TABLE I

No.	Example Questions	Example Responses
1	What do you believe is the difference between aesthetic and engineering design?	They are both part of the same goal but they are different goals for each one.
		Aesthetics comes from engineering as much as engineering comes from aesthetics.
2	What is your definition of a good aesthetics design or product?	Does the job with a degree of style to it.
		Generates an emotion in some one.
		Gives them passion or enjoyment rather than being a lifeless lump of materials.
3	How do you find maintaining aesthetics through the design life cycle?	Often very time consuming.
		Constant contact with the engineering sector via e-mail and phone.
		Sometimes things have to be changed to make it work better in production.

A significant observation made was that during projects the aesthetic appeal could possibly come from another product or designer in a cross fertilization process. This was useful because it allowed the incorporation of the latest technologies and materials in all of the design projects. However there is always a lot of aesthetic input from past experience, which can be through everyday life or specific situations that spur the designer towards preferring one design decision to another.

Design processes are different between companies and also projects. This is significantly more apparent for the companies which prefer to promote the brand of the product as their identity. In such an instance the brand can be aesthetic aspect or quality of the product, making it prominent on the shelf in comparison its competitors.

Manufacturing of today's products is increasingly based offshore resulting in several communication challenge between the design companies, the end-users and the manufacturers. This is often do not approach the product from the same direction as the designers.

Sometimes it was observed that engineering analysis activity provided several alternatives for material weight reduction or redistribution. In this case the alternative which was most aesthetically pleasing was taken. Clearly in these cases engineering design took priority during optimisation.

A problem found was that it is not easy to demonstrate the immediate advantages of the aesthetics for the product as a total when faced with the resulting engineering changes they cause. Problems can be caused because the engineers are often not open to the new techniques and ideas presented by the designers. Due to tradition and lack of up-to-date knowledge the result is a knock on effect for the designers in terms of time-to-market and therefore product development. This is a potentially important area which might be addressed in further work.

A preferential product has been described as a product which satisfies requirements with a degree of style, so that appropriate emotions can be generated in the user. It can be contended that one of the most important realisations is that preferred product must push design forward and challenge the industry, not just accept the boundaries.

In order to achieve this, research has identified from the literature and also a semi-structured interview, an apparent “Relationships” between the main areas of aesthetics and engineering design in the product development life cycle.

It has been found that aesthetics is an integral part of the process of designing a product. In order to design a competitive product it is necessary to have a familiarity with the engineering and complexities it involves. Once these complexities are understood it is possible for the designer to challenge them and so to improve the aesthetics.

The aesthetics are informed by the technical aspects of the product and in the some situations this can be vice versa. It is important to remember that the function and aesthetics of the product paramount, resulting in some design which work well but appear dull and some beautifully designed products which do not work so well.

Aesthetic and engineering have the same ultimate goal of succeeding; however there may be different sub-goals for each in the same product. Ultimately the two should work together and therefore this is a potentially significant area.

The engineers need the support of the design engineers and the design today are bridging the gap between the marketing and the engineering teams aiming to produce a desirable functional product.

Finally some example generic responses from the interviews are found below:

- “It is very important that life style analysis leads to aesthetic appreciation and the development of a desirable product;”

- “The brand can be an aesthetics aspect or quality of the product, making it prominent on the shelf against its competitors;”

- “The aesthetic input is a vital aspect and must take place at the start of the design;”

- Aesthetic appeal may come from another product or designer in a cross in a fertilization process”

The aim was to take a product completely through from the sketch and initial ideas stage, to the latter prototyping stages whilst aiming to maintain the aesthetics initially defined in the product. Maintaining the aesthetics definition was deemed to be important since this was highlighted by the company interviews. For example as the product passes along its design lifecycle it is adjusted and changed for numerous reasons.

These adjustments are not always sensitive to the aesthetics and without close observation and checking by the design teams, there is a possibility that the final product would finish in a very different form from that of the initial concept.

The first step used was in defining the product requirements, recorded in a Product Requirements Specifications Documents. Example categories for the product design requirements were: economical, functional, ergonomic, ecological, AESTHETICAL, emotional (Table 2).

- The economical requirements are those which impose the quality of the product at the minimum cost.

- The functional requirements refer to what is expected from the product, which are the global function and the service functions that have to be carried out by the product.

- The ergonomic requirements refer to the characteristics of the product which bring about additional comfort in usage.

- The ecological requirements refer to the product manufacture, use and integration within the natural environment, as well as its recycling when is no longer used.

- The AESTHETICAL [3] requirements refer to the impact of the product over the customers senses (subjectively expressed), the most remarkable being the visual effect correlated with the product market image. These needs generally aim at the form, color, surfaces texture and the overall dimensions of the product.

- The category of emotional needs is considered the most difficult category to be defined and evaluated, because it refers to the product impact over the customer’s emotional side. For example, various characteristics of the product may create the feeling of luxury, wealth, safety, etc. to the customer. An important aspect of the emotional needs is the fact that they are difficult to be measured and almost impossible to be predicted.

The second step was the conceptual design.

Once de concepts were sufficiently developed, a Design Weighed Matrix [4] was used to directly compare concepts via de chosen requirements. The Design Weighed Matrix is shown in Table 2.

TABLE II

Requirements	Symbol	Importance Rating	Concept 1	Concept 2	Concept 3
Economical	R ₁	5	+	+	+
Functional	R ₂	5	+	+	+
Ergonomical	R ₃	5	+	#	#
Ecological	R ₄	2	#	#	#
AESTHETICAL	R ₅	5	+	/	+
Emotional	R ₆	3	/	/	/
Performance Ranking			1	2	3

The Design Weighed Matrix is a simple but systematic method which precludes a designer somehow “falling in love with his design”, as observed by a respondent to the questionnaire earlier employed. It was found that aesthetics and function were concurrent considerations. The rating of aesthetics was found to be highly subjective and in need of a systematic approach to preclude the effect of personal preferences.

IV. CONCLUSION

Activities such as structural analysis and development of function are linked with concepts of look, feel, emotion and subjective appreciation of the product.

The extraction of customer satisfaction and requirements only represents the first step of an extensive integration process. Without the purposeful forwarding and application oriented preparation the customer information for the enterprise is worthless. Effective use of customer information is only possible by its systematic, context-oriented integration into the working environment of the product developer.

The integration of customers into product development must not be seen as a single project, but as long-term, continuous management task. Customer orientation as part of the enterprise strategy will, in the coming years lead to a transformation of the enterprise organisations from a traditional, monolithic organisation form to a customer-driven organisation form. This organisation form will be characterized on the one hand by an intensive cross-linking of the relevant knowledge carriers for the product development and by the integration of the customer knowledge into the product development processes.

The "Relationship" is found to be a potential area for development in new value adding for products and is also motivated through philosophical debate.

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