

A Systematic Process of Product Design Based on Customer Preferences

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Abstract

In the context of total quality management, customer satisfaction is a key factor of success. Customer needs have been in the past described with rather vague words. In order to lead in the competitive market, product designers must be willing to interpret and reflect customer perceptions of a product on the design. The objective of this research is to develop a systematic process capable of linking customer preferences on a product to the design of product elements or specifications. The design process consists of multivariate statistical analyses, semantic differentials, and multidimensional scaling techniques under the framework of a methodology known as quality function deployment which is frequently used to construct a quality design process. The process being established is expected to serve as an effective means to communicate between the customer and the designer through proper representational schemes of design elements.

1. Introduction

Quality is one of the very basics of customers' decision factor in various products and services. Such a phenomenon becomes more widespread regardless of whether the customer is an individual, an individual corporation, or a retail store. Consequently, to be successful in today's competitive markets, a product must be designed to ensure the high level of quality standards.

Although quality has been rather perceived as something that describes the superiority of technical specifications of a product relative to the price, and therefore, determines the added-values of the product, quality product must be defined as any product that satisfies customers' specifications and preferences. Customers are concerned with not just which is better or more expensive, but which product meets the expected level of their own explicit and implicit needs. The prerequisite to satisfying such needs would be that the supplier must understand and conform to customers' requirements.

As alluded, the success of a product largely depends on how we can devise a systematic process to meet the customers' requirements or preferences from the early stage of design. Currently, the product development process focuses more on formulating abstract customers' needs and preferences in more a concrete and expressive semantics so that designers can comprehend with ease.

This research aims to present a systematic process of product design based on customers' preferences, which consists of multivariate statistical analyses, semantic differentials, and multidimensional scaling techniques under the framework of quality function deployment technique which is frequently used to construct a quality design process. The process being built is expected to serve as an effective means to communicate between the customer and the designer through proper representational schemes of design elements.

2. A Process of Product Design

In the research, a process to transform abstract customer needs to product design factors is built on the basis of statistical inferences drawn from customer perceptions on the product, as shown in Figure 1. Such a methodology has been tested and successfully applied to the design of certain consumer products in the field of ergonomics and human factors. The process being discussed is a serious extension to existing research in terms of theoretical accuracy and applicability.

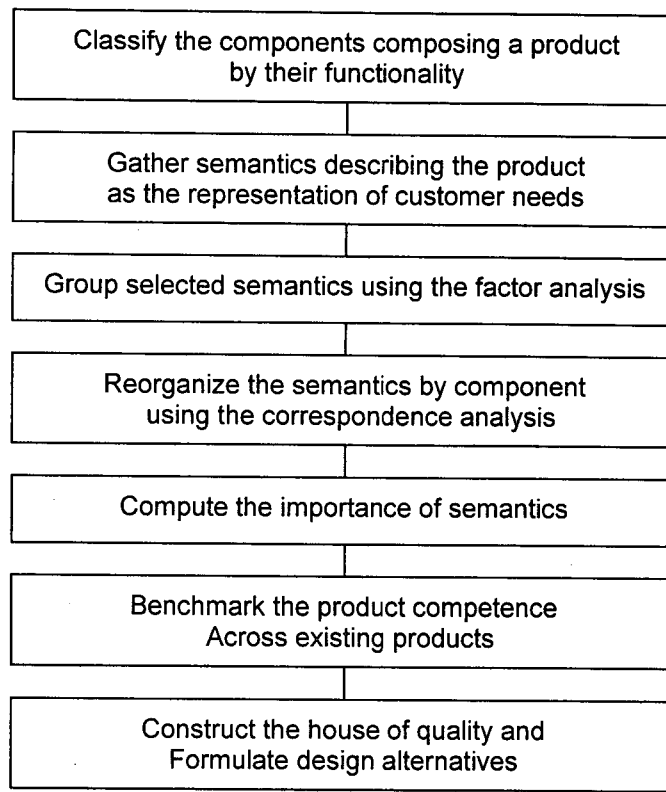


Figure 1. Product Design Process Proposed

2.1 Classifying the components of a product

Customer needs are broken down into specific needs on the parts or components composing a product, under the assumption that customer preferences or needs on the components of a product constitutes those of the product as a whole. It has been said in design theory that a product is usually designed in a way to correspond product functions to potential human needs. This implies that product design should be pursued to improve the customer satisfaction of each component with regard to its perceived importance. Analytic hierarchy process is used to draw and prioritize the perceived importance of each component from the strata of customer populations.

2.2 Gathering the semantics as the representation of customer needs

In general, customer needs are not sufficiently concrete to be directly used in design. One way to resolving such ambiguity would be to extract from customers the semantics used to describe a product or their subjective preferences in the form of adjectives or modifiers. In the research, adjectives were first gathered by looking into dictionary and the journals related to the product, and were, then, surveyed from potential customers to check the adequacy of selection. These adjectives were finally reclassified and transformed to attributes in relation to the product.

2.3 Grouping selected semantics using the factor analysis

Customer needs are very complex and diverse with a great deal of redundancy. Representation of human needs, on the other hand, tends to be made with restricted adjectives. So, the grouping of adjectives is a necessary step toward fair semantic representation of customer needs. Factor analysis was performed to reduce and group adjectives related to product components. Focusing on the fact that the sum of eigenvalues pertained to each factor agrees to the number of adjectives, adjectives were grouped by factor after selecting adjectives similar to much of the eigenvalues. Factors chosen are believed to represent major streams of customer perception on the product.

2.4 Reorganizing the semantics by component using the correspondence analysis

A product is composed of numerous components with distinct characteristics. This implies that customers' perception on each component may as well be distinctly expressed. Therefore, selecting proper adjectives and attributes with regard to each component is also necessary. Correspondence analysis was employed here to match each component to the set of semantic adjectives on the correspondence graph, based on customers' responses.

2.5 Computing the importance of semantics

In reflecting diverse customer needs in product design, different strata of customer populations will have different preferences, i.e., different semantic importance. A systematic means is needed to identify what is important to customers in relation to product components and link it to the design of product. As a tool for integration, a framework of quality function deployment technique was introduced with three main characteristics; customer attributes, engineering characteristics of the components, and their relationships. The relationship matrix obtained here will be the snapshot of customers' preferences on the product.

2.6 Benchmarking the product competence across existing products

Satisfying customer needs will no doubt improve the quality of a product. However, it may not be so desirable to put equal emphases on improving every components of interest. As a way of benchmarking, comparing the customer preferences across existing products will greatly help the designer decide what components should be focused on to enhance overall competence. Semantic differentials were obtained for existing products from the survey questionnaires on the preferences on each component. Multi-dimensional scaling technique was then employed to grasp the level of competence of competing products.

2.7 Constructing the house of quality and Formulating design alternatives

As shown in Figure 2, the house of quality used in the quality function deployment was built to quantify the relationship between the customer needs expressed in semantic attributes and the

components of a product in a matrix form. Table 2 describes the key elements in the house of quality. Here, the planning matrix and target matrix are used to benchmark the customer preferences on the products and which product yields the best semantic responses from customers with respect to each component. These matrices will then form the basis of formulating design alternatives.

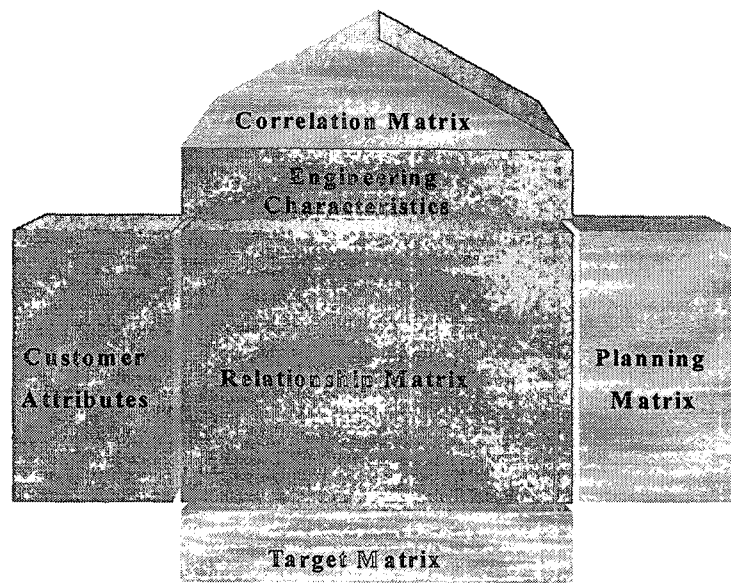


Figure 2. House of quality

Table 2. Elements in the house of quality

Element	Description
Customer Attribute	Customer attributes represent, in general, customer requirements or quality demand for a specific product or its components. Here, these attributes are used to express the customer preferences on the product in semantic terms.
Engineering Characteristics	Engineering characteristics are called design requirements or quality characteristics. These will become the measure of determining how well the product meets the customer attributes
Relationship Matrix	This is the matrix to indicate to what degree each of engineering characteristics is related to each customer attribute
Planning Matrix	This portion of the house of quality contains a competitive analysis of a product with other major competitors' products with respect to each customer need
Target Matrix	This portion indicates the summation of the effects of all prior customer attributes on each engineering characteristic.
Correlation Matrix	The correlation matrix allows the designer to identify impacts or tradeoffs between engineering characteristics

3. An Application

The proposed design process was applied to extract design alternatives for the interior packaging of a mid-size passenger car, reflecting potential customer needs and preferences. Figure 3 shows the house of quality which is a transpose of Figure 2. The column on the left represents the major components of a car interior, while the row on top lists the semantic attributes of customer perceptions or preferences with related adjectives. Data on the relationship matrix were obtained through a two-stage survey from over 150 potential customers. The first survey was performed to obtain rather generic customer preferences on the car interior components without actually seeing or test-driving the car. Second survey was later conducted again for the same subjects to see their evaluations of the five cars that were competing in the market. Both planning and target matrices that summarized the results of the second survey indicate what brand is better received by customers for a certain component and which car gives better semantic perceptions or affluence.

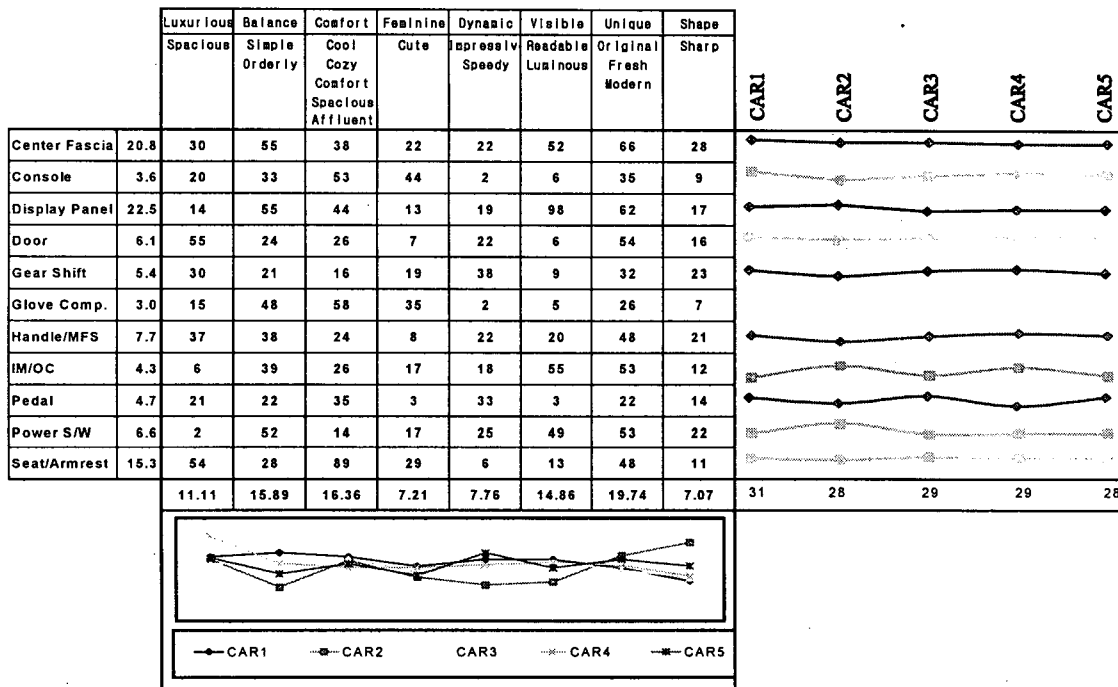


Figure 3. The house of quality for designing the interior packaging of a passenger car

For instance, the importance of customer attributes tells us that customers focus more on the center fascia and display panel among the interior parts. Especially, the center fascia plays the most important role in determining the customer perceptions on the interior, with 'modern' and 'unique' images received the best. One way to improve interior packaging design would be, therefore, to focus on designing the center fascia in a way to stress modern and unique image.

In terms of evaluating the center fascia, Car 3 is perceived by customers as being the least unique, when compared to other cars. Figure 4 depicts an idea sketch that improves the image of 'uniqueness' from the customer preference point of view, whereas Figure 4 shows the simplified sketch of the center fascia of Car 4.

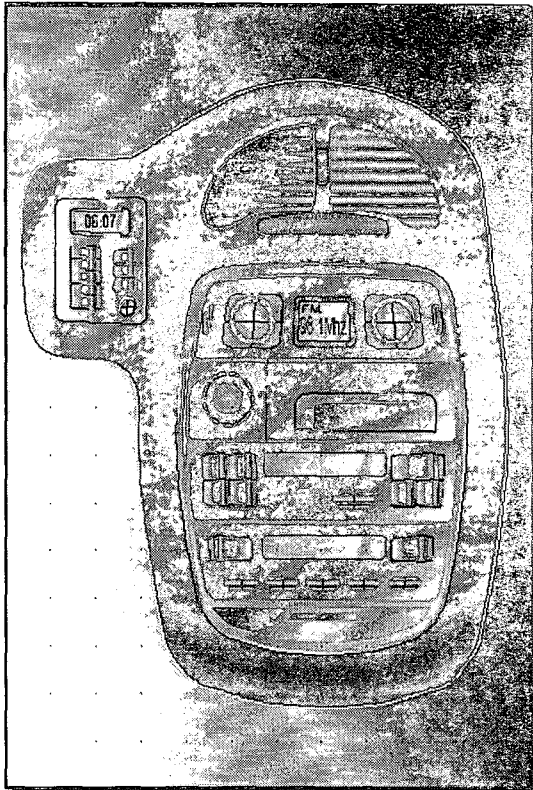


Figure 4. An idea sketch of the center fascia stressing the image of uniqueness

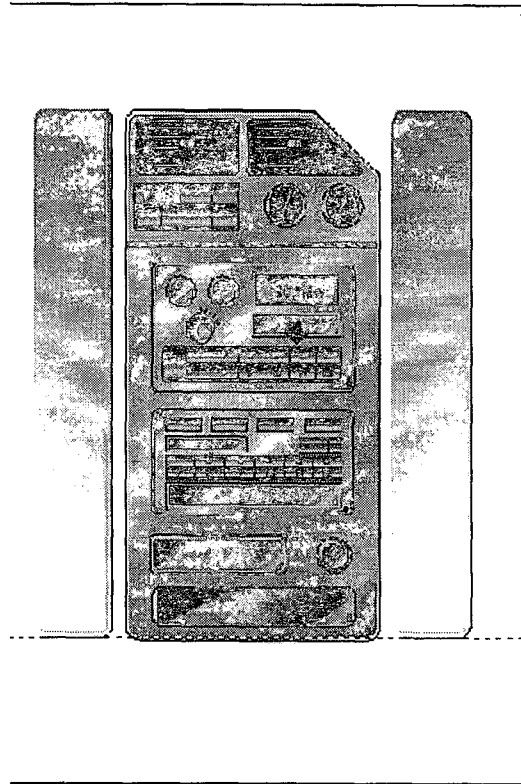


Figure 5. The simplified sketch of the center fascia of Car 4, being the least unique

4. Conclusion

This study focused mainly on developing a systematic process of product design that is capable of reflecting customer preferences on the product during the design process. With a straightforward two-stage survey, this process will greatly help the designer understand what should be done to improve customer images and preferences and in what way a design change will affect its image. The process involves multivariate statistical analyses such as factor analysis, correspondence analysis, and multi-dimensional scaling, embedded in the context of quality function deployment. It also provides a means to translate abstract customer needs and

preferences into quantifiable semantic attributes, and subsequently link them to design components. Applications of the process to automobile interior packaging were well received by the designers and it is expected to effectively aid the designer in product design to improve the overall level of quality.

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