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EVALUATION OF SOFT REQUIREMENTS DURING PRODUCT DESIGN

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Abstract

This paper presents an approach to improve current methods for dealing with customer requirements that are of a more qualitative nature than is common today. In addition, an approach to support handling of qualitative measures and to develop an evaluation method that can support dealing with these totally different kinds of demands is proposed. This method will enable a kind of multi-criteria evaluation with criteria coming from both technical and aesthetic issues. A first approach has been based on utilizing ideas from value analysis as a basis for this evaluation.

Keywords: design, evaluation method, multi-criteria

1. Introduction

The global marketplace and an increased competition have forced industry to become more efficient in development of new products. Flexibility and customer adaptation has become some of the leading strategies in order to stay in the forefront of technical development today. Consumer oriented products, but also other types of products, has to an increased degree used styling and user adaptation as a way to gain competitive advantage. This means that industrial designers have been used in the project teams, to give this aesthetics appearance and product identity.

For new revolutionary products the new technical possibilities enabled by a technical breakthrough is often enough for a successful product launch. At this time the company has a technical advantage by being the first to bring the product on the market. For the next generation of the product the technical performance may not be sufficient to guarantee a successful product launch since the competitors are now on the track and have invested a lot of money and man-time in learning the new techniques. An often-used approach is to involve industrial designers in parallel with the technical development to improve the overall performance and usability of the product.

Combining industrial design and engineering in the product development team is not easy and there are many issues that have to be considered. One main obstacle here that has to be tackled is how to deal with contradictory demands concerning technical performance and aesthetic soft demands. Many of the soft, industrial design related, product properties are not easily measurable or captured and expressed in engineering parameters.

2. Background

The method presented in this paper is a result from the Dennis project [1]. In this project we are using a research method, which is based on a combination of empirical studies of industrial designers in Sweden and theoretical studies of methods and techniques for a support method. The empirical studies are performed both as questionnaires and interviews of industrial designers. The collaborative work of industrial designers and engineers in integrated product development teams is also studied, in the companies participating in the project. Also, the method of interviews of representative customers in focus groups, on their opinion of product prototype variants concerning user interface and other soft properties, will be studied, as a means for gathering information on soft product properties. For the physical modelling of product variants and mock-ups, computer based techniques like “Rapid Prototyping” is considered.

So far the questionnaires and interviews have not been fully analysed and evaluated. The findings presented in this paper are based on a combination of theoretical studies of methods and studies of collaborative work of industrial designers and engineers in integrated product development teams. The industrial designer is penetrating a company in depth when an old product is to be given a new shape or when a new product or product identity will be developed. This involvement by the industrial designer often concerns emotional aspects within the producing company. It is then important that both parts can have a mutual respect and understanding for each other’s competence. We have to create an understanding of different ways of thinking and addressing problem tasks and to find methods for how to utilise both competences in the best way.

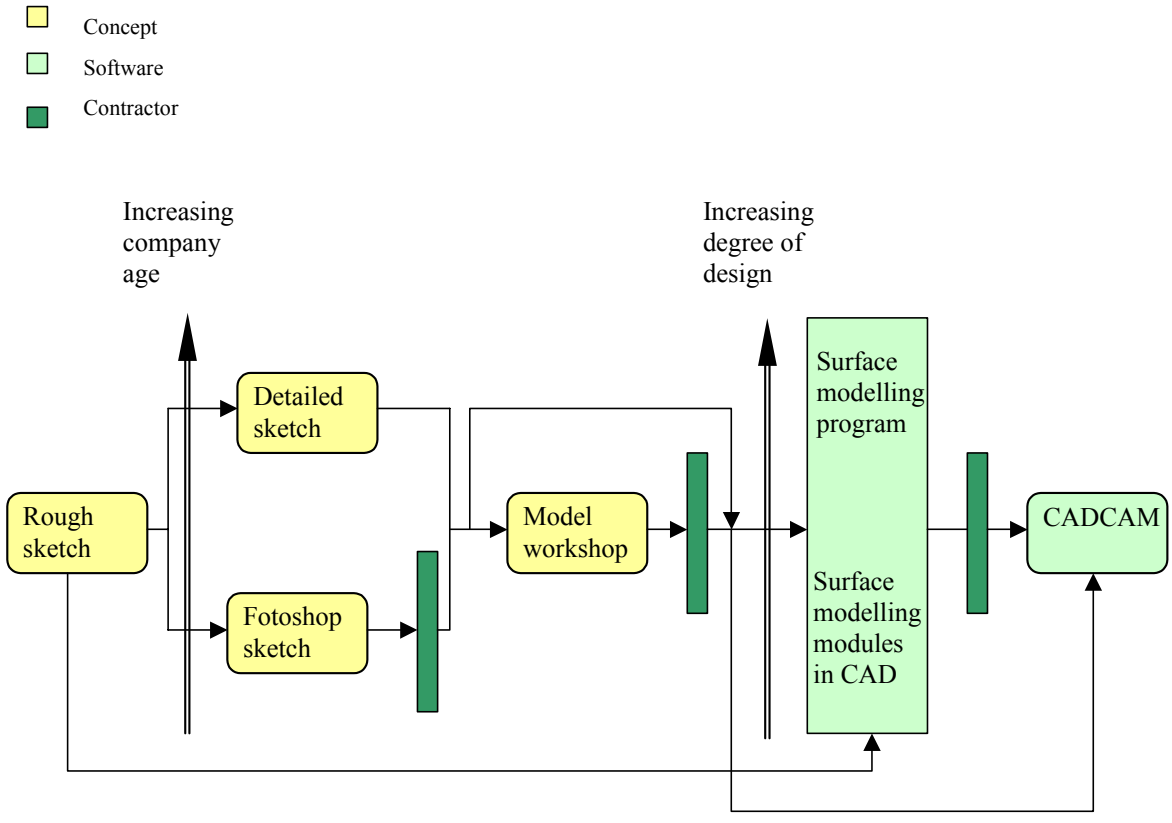


Figure 1. Workflow of a product definition project seen from the industrial designers point of view [2].

A study of the workflow of a product definition project seen from the industrial designers point of view have been made by [2]. This study has been performed in terms of visits and discussions with the producing companies Scania AB and Saab Systems and Electronics AB and the industrial design companies ErgonomiDesign AB, HotSwap and No Picnic. The workflow is illustrated in figure 1, where some of the major differences are noted concerning the age of the industrial design company as well as concerning the degree of design in the product to be developed. Another interesting this to notice is the different decision points that occur when something is presented to the contractor for input or to serve as a base for a decision. It is also at these points that an evaluation method can be beneficial.

3. Approach

The purpose of this approach is to allow booth hard technical demands to be evaluated together with soft demands in a more complete description of the product concept to be evaluated.

The approach presented in this paper is based on three main assumptions:

1. We can divide customer demands into two main categories.
2. We can use QFD as a means to illustrate relations between soft demands and design parameters as well as between hard requirements and design parameters.
3. We can apply ideas from value analysis for judging customer demands.

To start with, division of the customer demands into hard and soft ones gives a first idea of what difficulties we have to solve since it's so obvious that its hard to treat these demands in a uniform way. Some examples on what these different groups of demands can consist of are given in table 1.

Table 1. Examples of hard and soft demands

Hard demands	**Soft demands**
Max velocity	Color
Max acceleration	Shape
Noise level	Sound character
Payload (weight, volume)	Product identity
Service friendly	Ergonomics - Biomechanics - Anthropometrics - Perception
Service interval	Environment
Energy consumption	Hygienic
Life time	
Size/Batch	

The workflow is then, for each customer requirement, to investigate what relation it has to the listed design parameters and to judge how strong this relation is, e.g. a number 1,3 or 9 corresponding to a low, medium or strong relation. In this way we

can assure that also the soft requirements has been accounted for in the development of the requirement specification. We still have the problem to quantify the soft design parameters that are related to these types of customer requirements in the matrix. Some kind of qualitative value given by representative customers can probably be the best way of dealing with these parameters.

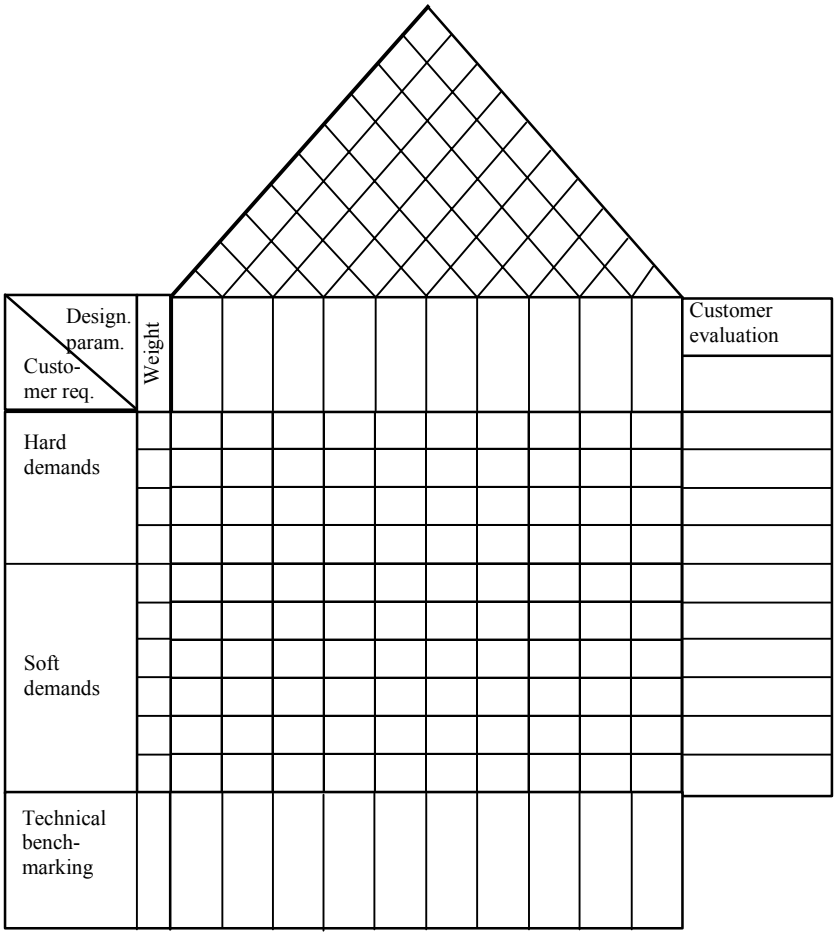


Figure 2. The house of quality adapted for dealing with soft demands.

Evaluation of soft requirements as well as for hard requirements will take place continuously during the whole development process. In opposite to the hard requirements, which can be transformed into quantitative measures, we must be able to handle qualitative measures for the soft requirements. These qualitative measures can be of different kind depending on in which phase of the development process that we are in. For early estimation and evaluation of a concepts color and shape, e.g. 3D CAD models can be used to create a number of proposals that can be shown for a representative customer group (focus group).

In later stages, physical prototypes of different kinds are preferable, e.g. clay models, FFF-models, which also are presented to a focus group as a number of concept variants. It is also important that these prototypes can be used for evaluating product function in a number of typical user sequences.

We need a similar division of design parameters into hard and soft parameters. We also need to define what demands that are mandatory and cannot be omitted. This definition is made in the requirement specification for the product. The process of establishing the requirement specification will not be discussed any further. I only

want to point out that the design parameters in the QFD chart is used as basis for this process. It is also important to point out that the evaluation method described later can only be applied on those concepts that fulfill all mandatory demands.

The basic idea with the evaluation method (illustrated in figure 3) is that all solutions are of equal weight concerning hard and soft demands in the beginning. Based on the structure of customer demands made in the QFD chart a value analysis division is performed and the demands are assigned different scores, see figure 3. These assignments of scores are made by the development team and can be seen as a balance to the weighting made by the customer.

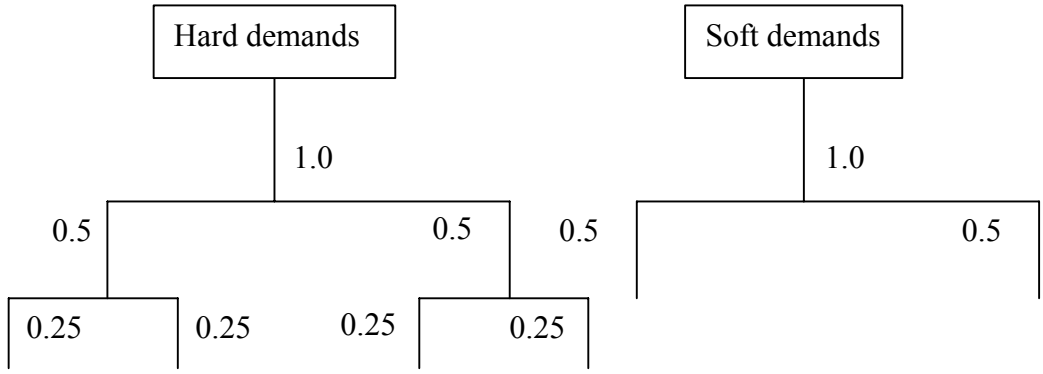


Figure 3. Illustration of value analysis applied on the structure of hard and soft demands.

The customer when evaluating different concept proposals should assign a third rating score. Depending on in which phase the project is in the development different media are used to present concepts to the customer, se figure 1. The scale to be used can e.g. be integers, 0-3, where 0 stand for “not applicable” and 3 for the best concept with respect to the actual criteria.

The total score, *S* for a concept can then be expressed as:

$$S = \sum_{i=0}^{n} C_h \bullet V_h \bullet \quad J_h + \sum_{i=0}^{m} C_s \bullet V_s \bullet \quad J_s \qquad \text{Eq. 1}$$

Where:

C_h = *Customer weighting of hard demand*

V_h = *Value analysis weighting of hard demand*

J_h = *Customer judging of hard demand*

n = *number of hard demands*

C_s = *Customer weighting of soft demand*

V_s = *Value analysis weighting of soft demand*

J_s = *Customer judging of soft demand*

m = *number of soft demands*

4. Example: Design of a bicycle

As a means to illustrate the ideas with the presented approach, I will use the design of a bicycle as an example. First of all I start with the assumption that we have made a market analysis and investigated what major demands that the customer have on a bicycle to be used in terrain and on slippery trails.

Figure 4. Example of bicycle from Skeppshult, Sweden.

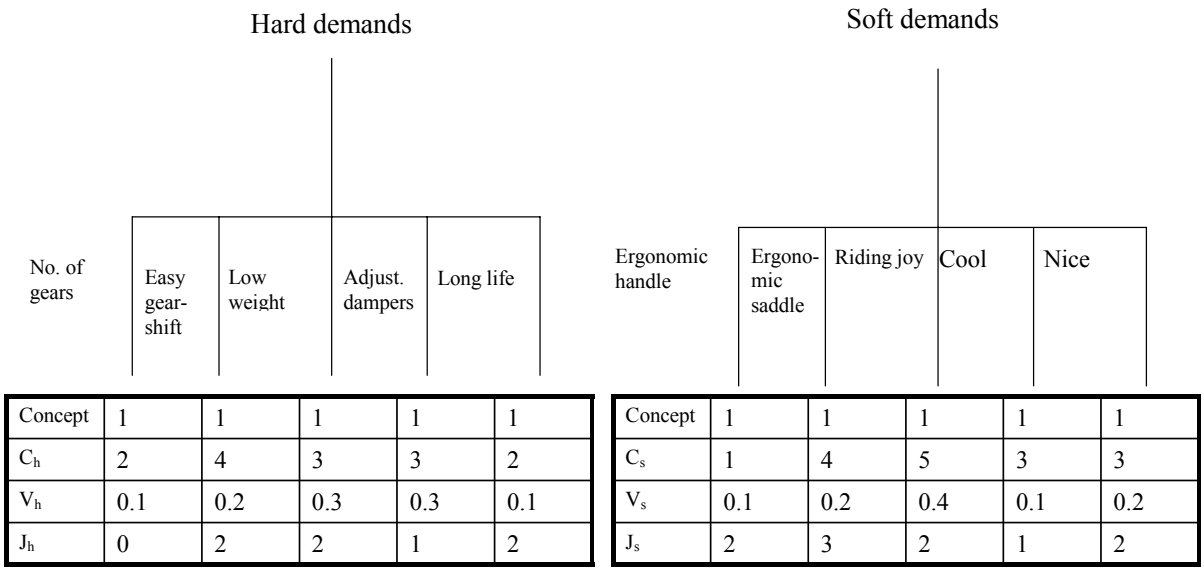
The result of this market analysis will result in a QFD matrix where soft and hard demands are listed at the left side together with the corresponding customer weight factor. These demands are then translated into design parameters and the processes of developing concept solutions take place.

Here we will focus on the handling of soft and hard demands and how these can be used for evaluating a concept with the proposed method. Therefore we are focusing solely on the hard and soft demands with corresponding customer weight factor as shown in table 2.

Table 2

C_h	**Hard demands**	C_s	**Soft demands**
2	Number of gears	1	Ergonomic handle
4	Easy gearshift	4	Ergonomic saddle
3	Low weight	5	Riding joy
3	Adjust dampers	3	Cool
2	Long Life	3	Nice

Next I simply calculate the score for a fictive concept with the proposed method. In this example the evaluation with this method will result in a total numerical value for the total score of the concept. It is also important to stress the idea of the method to serve as a means to gather and present the evaluation information for the project team hopefully consisting of both industrial designers and engineers.
For a number of concepts of different possible bicycles that fulfil the mandatory demands of the requirement specification we shown and tested by a representative customer group. These concepts were then judged according to the earlier described scale from 0-3, where 3 is the top score. The customer judgement together with the value analysis rating by the design team for one of these concepts is shown in figure 5.



Concept	1	1	1	1	1
C_h	2	4	3	3	2
V_h	0.1	0.2	0.3	0.3	0.1
J_h	0	2	2	1	2

Concept	1	1	1	1	1
C_s	1	4	5	3	3
V_s	0.1	0.2	0.4	0.1	0.2
J_s	2	3	2	1	2

Figure 5. Illustration of the different scores for a bicycle concept

The total score for this concept calculated with the equation;

$$S = \sum_{i=0}^{n} C_h \bullet V_h \bullet \quad J_h + \sum_{i=0}^{m} C_s \bullet V_s \bullet \quad J_s$$

gives $S =$ 12.8

5. Conclusions

In current product development, the products technical performance can often be seen as a constraint – i.e. necessary requirements to be met. The products soft requirements related to industrial design, e.g. user interface, ergonomics, aesthetics, and product semiotics, will then be decisive for the customer. The proposed method to evaluate the soft properties, as well as for assessment of soft requirements and translation of these into engineering specifications will then represent an important generic contribution to the product development process. This method also aim to support engineers to study trade-offs between issues related to industrial design and issues related to more traditional product development. In addition will also serve as a communication media between the industrial designer and the rest of the product development team. Further development of the method includes dealing with a more comprehensive example as well as alternative ways to present the total score, e.g. using some kind of symbols instead.

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