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QFD Application in an Automotive Case Study

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ABSTRACT

QFD (Quality Function Deployment) is a tool of planning that introduces the concept of quality, since the design and along all the productive and functional activities of the business, with the purpose to assure that they comply the needs of the customer. The paper presents case study of QFD application to the design of a bodywork (body car) manufactured in one car maker plant. The QFD is applied in this case to determine the priorities to be considered by the car makers in order to improve the customer satisfaction.

Keywords: *quality function deployment, body car designing, case study*

1. Introduction

The Quality Function Deployment, noted, from this point on, QFD, is a tool of planning that introduces the concept of quality, since the design and along all the productive and functional activities of the business, with the purpose to assure that they comply the needs of the customer.

QFD aims to deploy the customer's needs throughout the design and manufacture of a product and thus enhances its chances of being perceived as a high - quality product in the market place. It is also a vehicle for the simultaneous or concurrent approach to product development, where total design is approached by a multidisciplinary team usually from marketing, development, design, manufacturing, sales and services. QFD originated in the Mitsubishi Shipyard at Kobe, Japan in 1972 [1,2,3].

The QFD method relies upon a simple system of matrices to identify strong, medium and week relationships between features and attributes, with the most important performance features identified for the further consideration.

Targets to ensure a satisfactory product are thus set at a component level and potential conflicts between requirements are also identified before they become too costly to correct. Furthermore, the voice of the customer cascades down as far as operator instructions making quality traceable throughout the design process system. Indeed, the QFD maps into the "design core" of the Total Design method where customer requirements are known, offering a means of refining this stage of the design process [4]. The number of design changes and hence the design lead can be significantly reduced (up to 30%), which in turn reduces start-up costs (up to 60%).

QFD becomes a powerful technique where products have reached a conceptually static design. This is the case of the body cars in automotive companies [5,6,7].

The objectives of development of the QFD applied to the design the body car assembly are the following:

- to improve the satisfaction;
- to reduce the time limit of development;
- to discover a system that structures the planning advanced of the quality;
- to improve the internal communication;
- to gain market at the cost of the competence [8,9].

By means of the development of this QFD we will obtain an evaluation of the most important functions that should comply our product, as well as the studies whose development is indispensable so that our product comply with the requirements of the customer.

The present paper deals with one case study of QFD application to the design of a bodywork (body car) manufactured in one car maker plant. The QFD is applied in this case of

determining the priorities to be considered by the car makers in order to improve the customer satisfaction.

2. Voice of the customer

A group of 20 customers selected on the base of age, occupation, sex was interview by means of the questioners. The information were processed and the following customer needs were obtained by affinity diagram in three levels. These results are presented in table no. 1.

The needs of the customer should be translated to the technical characteristics that are measurable. These characteristics receive great variety of names, such as: requirements of design, parameters of design, characteristics of product or requirements of the product. In our case the terms used will be “internal measures” or “parameters of design”.

Translation of customer needs to objective requirements that are significant for a designer is a step of paramount importance in the QFD process that deserves considerable study and development.

If this step is carried out correctly, it will be able to ensure that the voice of the customer has not been lost. The design requirements will really reflect the needs of the customer. The tendency should be avoided of seeking one specific need of the customer and immediately decide that this is considered as satisfied by using a measure or testing method that at present is found among product specifications.

Two usual approaches for deciding “HOWs” or “INTERNAL MEASURES” are:

- Can work itself directly on the matrix? Each “WHAT” can be examined, to determine the “HOWs” that may be adequate, and to introduce them in the matrix. This is the most direct approach.
- A board can carry out a list of internal measures and to examine them set against a series of criteria. These criteria can develop so that they adapt to the most specific needs.

Independently of the continued approach, the internal measures should be:

1. Measurable (quantifiable).
2. Not imply restrictions on the design (global and not specific of a certain design).
3. They should represent a global answer to the voice of the customer.

In our case, we carry out a direct work on the own matrix. The internal measures were determined by means of the analysis of each one of the characteristics and of their possible methods of measure, as shown in table no. 2. This means that it is necessary to work side by side with the representatives of the different departments.

In this way the following board was completed in which the different internal measures for the different functions of our product are specified. This board contains the most general internal measures but, subsequently, we will see that possible relations will be possible. In what follows we will be able to see the degree of satisfaction of the board.

2. Using a matrix to determine priorities

For the lake of simplicity, the customer needs list was greatly reduced from the original list and was entered into the planning chart matrix. The group then listed the product features and engineering terms that were required to address the customer’s needs. A consensus was reached on importance ratings and correlation values.
The way of determining the technical characteristics is an important task that is briefly presented in this paper due to the large amount of the data that are involved in this procedure.

The prioritization of the customer requirements is calculated after a survey inside the plant, considering the departments of the plant. Each department will give some levels of priorities to the customer requirements. After this, according to the internal measures of each car producer, the technical characteristics are definite. Thus, the result is the house of quality shown in figure 1. In this paper, the concept selection process was considered as an integral part of quality function deployment

3. Completing the matrix of relations among what’s and how’s

This is an important step in the process QFD. The final phase of the analysis is based on great measure in the use of symbols for the relations in the intersections of needs and measures.

In this step, there are established the relations between the internal measures and the needs of the customer. It is determined the direct relations, in which the HOW (Internal Measure) satisfies the need of a form STRONG ● (9 points), AVERAGE ○ (3 points) or WEAK △ (one point). Many teams have discovered that they work better when they fill the matrixes by columns. This itself due to that, once definite the measure, is established if this helps to satisfy each one of the needs of the customer.

In the phase of analysis, the matrix of planning was revised to determine the specific objectives of quality of the business and the priority areas of investigation. A key factor in this analysis was assigning the level of difficulty according to the internal measures.

The decision of the degree of difficulty has to be made to measure for the problem that is studied. Each study represents an unique situation. In some cases, the difficulty is mainly in the design. In other cases, the problem will be found fundamentally in the manufacturing capacity. The analysis can imply suppliers, time limit, prices, competitive pressure etc. Each team should develop its own approach of the question. In general, the difficulty is assigned by means of a scale from 1 to 5 (1 = Easy; 5 = Difficult).

In our case we have carried out the decision of the degree of technical difficulty, basing on virtual suppositions of the different departments for the development of this QFD.

The last step of the process QFD subject is the calculation of the indices of importance or weights of the internal measures. These indices of importance are a combination of the degree of importance for the customer and the force of the relation between the internal measures and the needs of the customer. These weights are calculated by means of the multiplication of the factor importance for the customer by a value assigned to the relation among WHAT and HOW. The weight is assigned to the symbols.

4. Analyzing and interpretation of the matrix results

In this section we will treat how to analyse and to diagnose a Product Planning Matrix. The team has adjusted to a plan or basic purpose, and has consumed many hours of work along the necessary steps to complete the “House of Quality”.

They have been discovered and explored more details, trying to determine the nature of the desires of the customer and of the product that themselves. The sections of the House of Quality we have focused them to:

-to understand and to organize the desires of the customer.

-to identify and to organize the internal measures of the business to satisfy to the customer.

-to determine key relations between desires of the customer and internal parameters.

-to make commitment bureaus decisions.

-to carry out competitive studies among the different possible designs for our product.

-to establish objective values for the elements that will be controlled and they will measure to satisfy the needs of the customer.

We tried to determine an own transaction between the customer and the business in its constituent parts, such as the discovery of the nature of the customer satisfaction and its relation with what the business offers to satisfy its customers.

The following steps summary some “final verifications” for the matrix of planning of the product. Each one it will be described in greater detail.

1.Blank lines. Requirements of the customer with little or any relation with the parameters of design. We want to satisfy these requirements? If it is thus, to identify the requirements of design. Otherwise, it be left blank. There is not any in the matrix.

2.Blank columns. Parameters of design that do not have a strong relation with some requirement of the customer. Generally, it appears a series of measures that the businesses have developed based on the experience, technical analysis and functional decisions. It is necessary for the product, but frequently doesn't have relation with the voice of the customer. When the design of the product is undertaken, these elements will be combined with the internal measures to direct the development of a complete assembly of requirements of design. Elements of this type, that do not respond to different voices of the customer, should be eliminated from the matrix, maintaining them aside for their subsequent use.

3.Conflicts (the roof of the House of Quality) between the competitive evaluation of the customer and the technical competitive evaluation. The objective is to eliminate conflicts. If the customer evaluates the product as good, the technical evaluation of the parameters that be hardly related to this requirement should give also a good evaluation. Otherwise, three reasons of the existing conflicts could be: the customer need has not been understood totally and its importance for the competitively of the product; another is that doesn't exist a strong relation between the need of the customer and the requirement of design; finally, can be the bad interpretation of the technical evaluation.

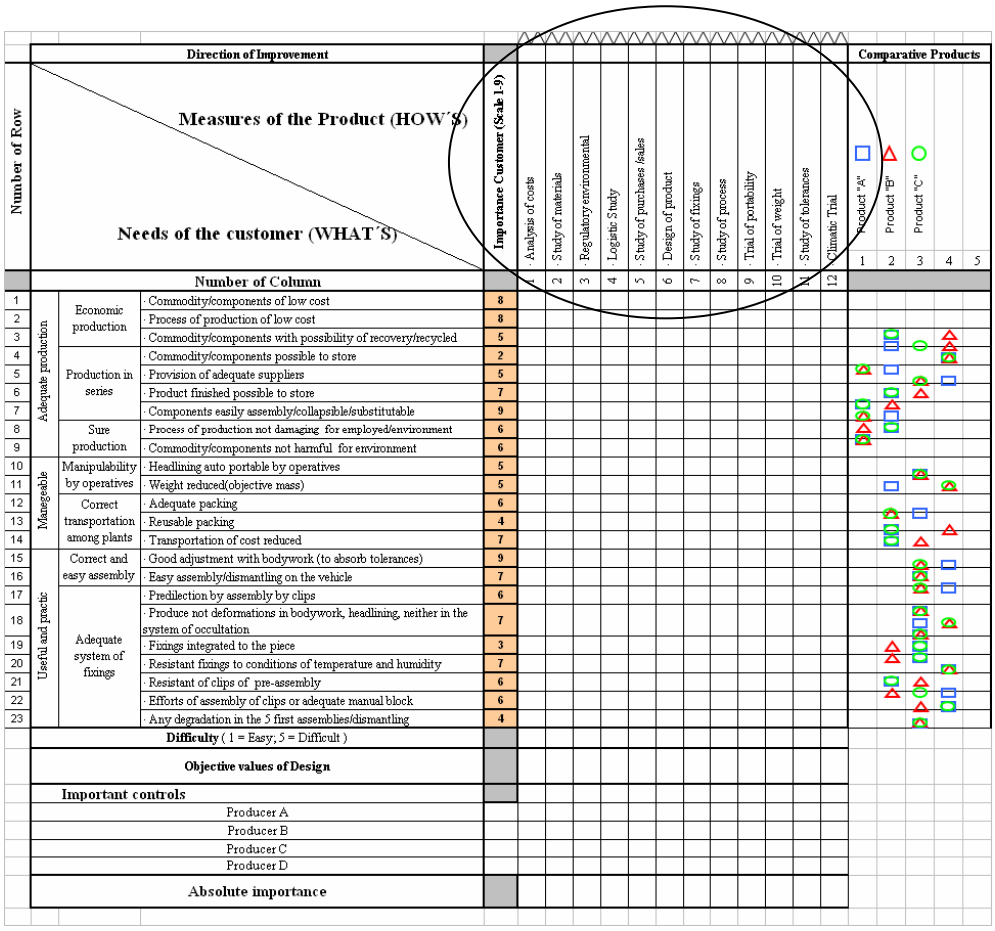
4. There is no restrictions of design. The requirements of design should be at global level. This doesn't intend to restrict the designers of components or processes. The requirements of design should guide the designers, but giving them creative opportunity of being.

Table 1 – Customer requirements (WHAT) derived from the voice of the customer

	Level of detail		
	Primary	*Secondary*	*Tertiary*
Functions/Customer requirements	Adequate production	Economic production	Components of low costs
			Process of production at low cost
			Materials easy to be recycled
		Production in series	Components easy to be stored
			Providing of adequate suppliers
			Possibility to store finished products
			Interchangability of the products
		Safety production	Production non damaging the environment
			Components not aggressive for the environment
	Easy control of the process	Flexibility of manipulation the parts	Modularity of the parts
			Weight reduced (mass objective)
		Correct transportation of the parts	Adequate packing
			Re-utilisable packing
			Transportation at reduced cost
	Adequate system of assembling	Adequate fixing systems	Good adjustment of the assembled parts (fit the tolerances)
			Easy assembly
			Easy to be fixed

Table2 – Technical characteristics derived by analysing the customer requirements and based on internal measures (HOW)

Functions of the product (Customer needs WHAT)	**Internal measures**	**Technical characteristics (HOW)**
Components of low cost	Analysis of costs	Analysis of costs Study of materials Environmental regulation Logistic study Study of purchase / sales Design of product Study of fixing Study of process Trial of portability Trial of weight Study of tolerances Climatic trial
Process of production of low cost	Analysis of costs	
Components with possibility of recycling	Study of materials Environmental regulation	
Components with possibility of storing	Study of materials Logistic study	
Components not harmful to the environment	Environmental regulation	
Headlining auto portable by operatives	Trial of portability	
Weight reduced	Trial of weight	
Adequate packing	Logistic study	
Provision of adequate suppliers	Study of purchase / sales	
Re-utilisable packing	Logistic study	
Transportation of cost reduced	Logistic study	
Good adjustment with bodywork	Study of tolerances	
Easy assembling	Study of fixing	
Predilection of assembling by clips	Study of joining	
Not producing deformation in the bodywork	Study of joining	
Fixing integrity of the parts	Design of product	
Fixing resistant to the conditions of temperature and humidity	Climatic trial	
Resistant pre-assembly clips	Trial of traction	
Components easy to be assembled	Design of product Study of joining	
Good adjustment among the components	Study of tolerances	
Process of production non damaging the environment	Study of process Environmental regulation	
Adequate efforts of clips or manual block	Trial of insertion	
Any degradation in the first 5 assemblies	Trial of fatigue	



Number of Row				Direction of Improvement / Measures of the Product (HOW'S) / Needs of the customer (WHAT'S)	Importance Customer (Scale 1-9)	1 Analysis of costs	2 Study of materials	3 Regulatory environmental	4 Logistic Study	5 Study of purchases /sales	6 Design of product	7 Study of fixings	8 Study of process	9 Trial of portability	10 Trial of weight	11 Study of tolerances	12 Climatic Trial	Comparative Products: Product "A"	Product "B"	Product "C"	4	5
				Number of Column		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
1	Adequate production	Economic production		· Commodity/components of low cost	8																	
2				· Process of production of low cost	8																	
3				· Commodity/components with possibility of recovery/recycled	5																	
4		Production in series		· Commodity/components possible to store	2																	
5				· Provision of adequate suppliers	5																	
6				· Product finished possible to store	7																	
7				· Components easily assembly/collapsible/substitutable	9																	
8		Sure production		· Process of production not damaging for employed/environment	6																	
9				· Commodity/components not harmful for environment	6																	
10	Manageable	Manipulability by operatives		· Headlining auto portable by operatives	5																	
11				· Weight reduced(objective mass)	5																	
12		Correct transportation among plants		· Adequate packing	6																	
13				· Reusable packing	4																	
14				· Transportation of cost reduced	7																	
15	Useful and practic	Correct and easy assembly		· Good adjustment with bodywork (to absorb tolerances)	9																	
16				· Easy assembly/dismantling on the vehicle	7																	
17		Adequate system of fixings		· Predilection by assembly by clips	6																	
18				· Produce not deformations in bodywork, headlining, neither in the system of occultation	7																	
19				· Fixings integrated to the piece	3																	
20				· Resistant fixings to conditions of temperature and humidity	7																	
21				· Resistant of clips of pre-assembly	6																	
22				· Efforts of assembly of clips or adequate manual block	6																	
23				· Any degradation in the 5 first assemblies/dismantling	4																	
				Difficulty (1 = Easy; 5 = Difficult)																		
				Objective values of Design																		
				Important controls																		
				Producer A																		
				Producer B																		
				Producer C																		
				Producer D																		
				Absolute importance																		

Figure 1 –Technical characteristics of the body car according to the customer requirements from table no. 1

5. Points of sale: It should be kept in mind and account the opportunity that will give us to offer somewhat unique character in the market. In the same way, we will seek in the Comparative Evaluation of the Products points in which a product could be worst then the other. When all these points are bad, can be assumed that the reason is a neck of bottle (lack of technology) in the technology and therefore is necessary a technological advance to improve the product.

6. Opportunities to copy: Those requirements that in some product well are evaluated for the customer, seeking cases in which other products they be judged lower. If this it is the case, the design of the other products can be studied to carry out something it more seemed possible. Copying is more economic than the Investigation and Development.

7. Determining the Quality Planned: Establishing what results are desired to obtain in the competitive evaluation of the customer. This Quality Planned constitutes the objective for the new product or improved that we are going to remove al market. Is necessary to be realist on this point if there are restrictions of time limit and budget.

8.Resolving the negative correlation identifying necks of bottle to diminish the conflicts, or well adjusting the objective values for measure two parameters of design correlated negatively.

9.Adjusting the objective values in the parameters of design that are hardly related to our Quality Planned. Valuing the technical difficulty.

10.Identifying requirements of design that should be detailed or unfolded to the following phase (Unfold of Components). These they should be the parameters that be new, difficult or highly praised.

These ten analytic steps and of diagnosis they can carry since some minutes to several days. The same principles are applicable to any of the matrixes that can be utilised for a Planning study case of the complete Product.

Subsequently we will carry out the analysis and study of the results obtained in our QFD, with the purpose to extract the conclusions referred to the different possible designs for our body car modulate with system of occultation.

5. Conclusions

Thanks to the execution of this QFD we have guaranteed that the most important functions to

guarantee the customer satisfaction are polite by our product. Otherwise it should be carried out and redesign of our product.

The fact that our products comply happiness functions has been thanks al Functional Analysis carried out previously al design, since in said Analysis we have obtained some guidelines on the fundamental characteristics that should require our product.

Also we have established the diverse internal measures that should carry out on our product so that said functions are polite. As we have been able to observe some already they had been carried out and other they should be carried out in following enlargements of this project.

These internal measures to carry out in next enlargements of this project are the following: Analysis of costs, Study of price Logistic, Study of purchase/sale, Study of Tolerances, Trials in prototypes.

This QFD will serve for subsequent phases of the project; as in the prototype to carry out a control on the compliance of the objective values established for this through the corresponding trial, and for carry out a comparative one from of the behaviour before you said trials of each one of the designs presented. In this way we will determine the points to improve being able to base on the behaviour of the other solutions.

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Das Auftragen des QFD im der Kraftfahrzeugtechnik Des Fallstudie

Zusammenfassung

Qualitätsfunktionsaufstellung ist eine Methode für die Strukturplanung der Produkte. Es ist im Stande, die Kundenbedürfnisse mit den technischen Eigenschaften der Produkte aufeinander zu beziehen und den Einfluss des Produktes auf den Kunden zu bewerten.

QFD baut matrices genannt Tabelle der Qualität. Die wichtigsten von diesen sind Haus der Qualität. Das Papier präsentiert eine Fallstudie der QFD Anwendung in der Bodycar-Herstellung. Im Anschluss an den QFD und das Analysieren der gegebenen Ergebnisse, werden dort gegründet die Vorränge mussten in der Herstellung des bodycars so dass die zu vergrößernde Kundenbefriedigung betrachtet werden.

Aplicarea conceptului QFD in proiectarea unei caroserii auto. Studiu de caz

Rezumat

QFD (Quality Function Deployment – Implementarea functiei calitatii) este o metoda pentru planificarea structurala a lansarii unui produs, fiind capabila sa coreleze necesitatile beneficiarului cu dorintele acestuia despre produs si sa evalueze impactul produsului asupra beneficiarului.

Procesul QFD presupune construirea mai multor matrice (numite tabele ale calitatii). Prima dintre acestea se numeste Casa Calitatii. Lucrarea prezinta un studiu de caz al aplicarii QFD la proiectarea unei caroserii auto. In urma construirii si analizei etapelor QFD sunt determinate prioritatile ce privesc proiectul realizarii unei caroserii auto care sa satisfaca intr-o masura mai mare cerintele beneficiarilor.