

## DESIGN AND DEVELOPMENT OF AUTOMOTIVE INTERIORS USING QFD METHODS

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### Abstract

One of the methods used in products development, which is very widely used in the automotive industry, is the Quality Function Deployment (QFD) method. The purpose of applying this method is to efficiently transfer the needs and requirements of customers to the necessary technical and design characteristics of the products. It combines customer requirements, based on marketing research, with engineering recommendations and formulates them into an appropriate number of goals which be achieved in the new product.

**Key words:** QFD method, automotive interior, design, benchmarking

## 1 INTRODUCTION

Product development in the automotive industry is one of the basic directions of growth that a company in this field can choose in the process of building and maintaining its own competitiveness. In general, the process of creating a new product is a risky and potentially unprofitable business, especially in this branch of industry. Also, the activities of the research and development product generally take a long time and require higher financial expenditures, not only in the process of creating a new product, but also in modifying and improving existing ones [1]. In the pursuit of comfort, automotive interior decorators have begun to focus on the individual needs of consumers. During the 1980s, the automotive industry began to face strong global competition. Strict government regulations, growing

customer expectations, and disappointment in productivity have increased the challenge of emphasizing quality and customer satisfaction. Careful examination of Japanese management methods and practices has made significant progress [2]. Japanese processes have provided a philosophy of "total quality excellence" focused on the voice of customers. Therefore, the concept of car sales for car dealers can not merely stay on the choice of past sales strategies, but also need to be more particular and personalized, which can gain the favor of consumers before they can stand out among many competitors. The ability of consumers to buy cars is becoming more and more powerful. While buying cars, they also love to show their individuality and differentness. To prevent their cars from being similar to others, more and more people are pursuing their automotive interiors [3]. Personalized design are increasingly demanding, in the same price situation, if a brand of automotive interior personalized design does not meet consumer expectations, then consumers are likely to turn to others, therefore, companies should pay attention to the personalized design of automotive interiors. Only after fully paying attention to the personalized needs of consumers can they better meet the needs of consumers and be able to accurately grasp their Preference and buying preferences can be invincible in the fierce market competition [4]. One of the indispensable components of modern cars that brings a competitive advantage in the global automotive market, is the interior of the car itself. The interior of the automotive, according to various standards and norms, has an unavoidable role in terms of safety, reliability, user-friendliness, etc. The interior of the automotive, and especially the instrument panel is used to service and manage various technological functions in the car. The interior, as well as other elements of the car, is constantly improving and there is a lot of progress in terms of quality, additional features and materials from which they are made.



Fig. 1 Old and modern interior design

## 2 QFD IMPLEMENTATION IN THE AUTOMOTIVE INDUSTRY

In order for the implementation of this method in practice to be feasible and to give the expected results, it is necessary to establish an adequate organizational framework for its application. Some of the elements of this framework relate to the following [5]:

- the strategic management process should be based, inter alia, on the requirements of the QFD method

- the focus of management should be on users and the market
- it is necessary to provide the data and information necessary for QFD analyzes
- the focus of human resources should be on the QFD philosophy, to enable companies to develop and use their full potential to effectively deliver value to the customer
- top management should be committed to the QFD concept
- cooperation between employees and authorities in the implementation of QFD and solving quality problems.

The document that operationally monitors the implementation of this method is called the quality house. It is one of the most commonly used techniques for implementing the Quality Function Development method in the automotive industry. In practice, often one house of quality is not enough for the design and production of a complex product in this field, and especially not for the interior of cars. Therefore, a detailed analysis and iterative procedure of creating a larger number of quality houses is approached. These are usually four. At the same time, in the production of home departures from the last phase, ie. from the creation of finished products. Each subsequent house builds on the previous one. At the entrance to each of the four houses, in the left column, there is always the question: what is required?, while on the list from the house is always the answer: how to fulfill the requirements?

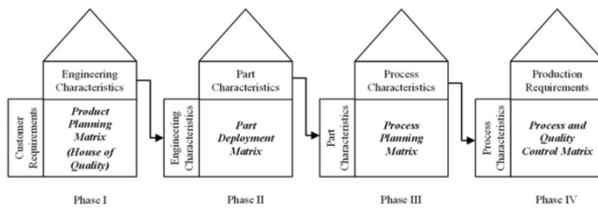


Fig. 2 Stages in the implementation of the QFD method

## 2.1 Determining product characteristics

First, the requirements are examined, that is requirements that the car or some of its components should possess (what field), then, in the how field, the characteristics of products that are important for meeting user requirements entered in the what field are defined (customer voice).

Table 1- Customer needs from the survey

Customer needs ( <i>what</i> )	Importance(1-5)
Luxury plastic material	5
Attractive design	3
Good ergonomics	3
Less vibration and noise	4
Solid and durable material	3
Plastic texture and color	3
Wear and scratch resistance	2
Custom dashboard for users	3
Practical usb ports	5
Flexible design	4
Updated interior	1
Efficient operating system	5

The results of survey show that there are differences in the needs for automotive interiors among people of different types [2].

To be specific, group 1, the discerning and intellectual pleasure seekers, who are engaged in the medical and electronics industries, pay the most attention to safety, cleanliness, and digital device needs. Group 2, the regular and easy-going-life seekers, who are engaged in public education, the financial industry, and traditional industries, pay most attention to the needs of comfortable feeling. Group 3, the modern information seekers, who are engaged in service and design industries, pay most attention to the needs of functional storage, spatial aesthetics, digital devices, safety, and cleanliness [3].



Fig. 3 High-brightness car interior color



Fig. 4 Low-light automotive interior color

Also one of the key factors in the design of automotive interiors and one of the frequent customer requestsd is the color. Automotive interior designers have also found the important role of color in the interior configuration, belonging to the spiritual consumption of car buyers, they also began to realize that from the color point of view Better car interior design with people oriented. In general, the visual sense of the public is different, so the love for color will also be different. This difference is generally from the age, gender, occupation. Solid color car interior is more suitable for owners with children, this color matching to take care of the hearts of minors, seems relatively single, bright. For adult color selection, the brightness is generally lower, purity is relatively lower, and dark colors are matched [4].

## 2.2 Identification of critical parts and processes on the car interior

For all product characteristics that are entered in the what field, the characteristics of critical parts of the product in the how field are determined. These are the characteristics of the parts of the product that are important for the realization of the previous characteristics of the product.



Fig. 5 Decomposition of interiors

This phase is made as needed, if the product can be decomposed into components. Critical parts of products and their characteristics are transferred to the field of the third house, where for all critical parts of products and their characteristics, critical processes are determined, ie operations that achieve the characteristics of parts of products. The process of identifying critical parts of products and processes on all cars is basically the same, to make it easier for drivers to adapt to new vehicles. In essence, in addition to the design, there are differences in the layout and choice of certain instruments for engine control.



Fig. 6 Some of the critical components

## 2.3 Establishing procedures

For all critical processes, entered in the field of what is determined, in the field of how, measures to be taken, in order to improve the process and proceed with as few shortcomings as possible, which includes process quality control. Defining a measure goes up to the levels of work instructions. The car industry is a branch that is developing at a high speed and there is a constant improvement of

production processes and the interior of the car. The goal of the automotive industry is to create new types of smart cars that will make our daily lives easier.

## 3 COMPARISON INTERIORS OF DIFFERENT CAR MANUFACTURES

Just looking at and analyzing the voice of customers today would be a good basis for creating new solutions, if the market is not perceived and monitored globally. Large companies in this area leave nothing to chance, and every small change in the main competitor is closely monitored and prepared a right answer.

Only after fully paying attention to the personalized needs of consumers can they better meet the needs of consumers and be able to accurately grasp their preference and buying preferences can be invincible in the fierce market competition. Throughout this story, benchmarking plays an important role because it provides guidelines on how to look at a competitor's product and how to use its solutions in the right way.

### 3.1 Benchmarking the interior characteristics

All three luxury limousine feature a lot of innovative materials, systems and technologies. As for the interior itself, a high level of comfort and quality is expected in this class of car. They all provide an attractive design, durable and quality material as well as a reliable and efficient system. But they still differ in certain characteristics. Some of the characteristics evaluated by customers: attractive design, durable and quality material, reliable and efficient system, width of passenger space, trunk volume, hi-tech option, navigation system, number of usb ports, the strength of the inner plastic, wide adjustable seats, steering wheel settings, imperceptible noise and vibration.



Fig. 7 BMW interior

The A6 provides the least legroom for passengers in the rear seat, while the rather high seats reduce headroom. Thanks to the longer wheel bases, BMW and Mercedes provide plenty of space. However, the large transmission tunnels in all three models result in the passenger in the middle not feeling as comfortable when traveling as these two by the window. Audi lags behind when it comes to passenger compartment space, but is the only one whose the rear seats can be folded as a standard option. For BMW and Mercedes, this is charged extra. The Audi A6 has the

largest boot, with 546 liters of volume, which is 6 liters more than the E-Class and 26 liters more than the BMW.

The Audi A6 has the largest trunk, with a volume of 546 l, which is 6 l more than the E-Class and 26 l more than the BMW.

All three models have plenty of hi-tech options in order to provide maximum passenger satisfaction while driving. It should be mentioned that the only Audi in this case has a navigation system as standard.



*Fig. 8 Mercedes interior*

The BMW 5 Series doesn't disappoint at any point when it comes to the strength of the interior plastic. The well-known "minimalist" form and simplicity, with top quality, simply captivates. BMW also leads in terms of material quality and final treatment. Wide adjustment of the seat and steering wheel allows you to find the perfect position while driving, and great visibility. Unlike the BMW, the upright dashboard of the E-Class and the sharp angular lines of the cabin make you not feel comfortable in the way the Bavarian model provides. The Audi A6 is a bit "spent". The driving position is slightly higher than the rivals, and the dashboard seems "overcrowded". In terms of materials and finishing, everything is at Audi's level, but it was not enough to win in this category.

In the interior evaluation, BMW received a mark 5, and Mercedes and Audi a mark 4.



*Fig. 9 Audi interior*

When we talk about styling, buyers of such cars usually belong to the "managerial" population, where good looks mean a lot, as well as a renowned badge of course. The phenomenon seeks "maturity", and established values, so that design exhibitions are not common when we talk about the E segment. However, there are always exceptions, such as the last generation of the Series 5, whose appearance

caused a lot of confusion at the time. The sixth generation of the "five" is somewhat more conservative, which may be more appropriate for it. She didn't get "on the first ball", rather it could be said that she is slowly getting "under the skin". The E Class next to the Series 5, as far as the profile is concerned, looks a shade "more square". The character is especially pronounced through the front of the car, unlike the rear which is not so recognizable. Although the dose of luxury is there, the E-Class lacks the appearance of the Series 5 in direct comparison. Still, Mercedes seems to follow its philosophy of "exaggeration" in detail, which usually makes it the most conservative in the segment where its competitors are the 5 Series, A6 and Jaguar XF. As for the A6, it must be taken into account that it has been on sale since 2006, that it underwent a restyling in 2008, which means that it is nearing the end of its "lifespan", so its evaluation must be taken with a grain of salt, although good looks can never be denied.

In this category, BMW took the victory with mark 4, while Mercedes and Audi follow it with mark 3.

Everyone knows that BMW is a class in itself, but the eternal question is who is the best in interior design and cars in general when it comes to the "big three" that still consists of Audi and Mercedes-Benz. The BMW 5 Series easily won in the previous comparison. Five "is not revolutionary, but it is modern. The cabin space is a winning combination of functionality and style. Numerous usb ports have also contributed to such high ratings, as it is one of the most sought after features at the moment. Even without the intelligent Adaptive Drive system, BMW provides the driver with the most enjoyment but also driving comfort. In fact, it was much harder to announce the runner-up than the winner. Audi is more expensive than Mercedes in this case, but it is also better equipped. Although it already shows its "years", there are no problems with the quality of work man ship and image, but a more comfortable ride, more space and easier use of individual switches have for a little ahead put the E class in second place.

This comparison tells us what requirements and characteristics some of the car companies must meet when designing, designing and interior design in order to be competitive in the market in this class of car. As the above mentioned companies and models have a long tradition and are widely known for their quality and comfort, "newcomers" must follow and take the best of them. Thus, they would probably take a well-quoted place in the market of this class if they left an excess of free passenger space, with as large a trunk as possible, a practical and simple navigation screen.

The upright dashboard with additional functions as well as sharp corner lines of the cabin should be avoided, it is also not desirable to put numerous switches and follow the logic that quantity is equal to quality, but following the example of Mercedes vehicles that luxury and elegance can be achieved with fewer components. What customers pay a lot of attention to is the quality of the interior material itself, ie. its wear resistance with as little vibration and noise as possible, so a good example can be taken from the Munich BMW.

## 4 CONCLUSION

The success or failure of a new product on the market depends on how well the needs and desires of the customers are met. The implementation of the QFD method, and the analysis of house quality diagrams provides a structured methodology for translating the customer's voice into design and technical requirements, directing product development and increasing the chances of success. The application of four iterations of the QFD method, the creation of four quality houses, enables the analysis of the challenges of product development and design, as well as production processes.

According to the above comparisons and analyzes, BMW clearly shows the greatest commitment to the potential buyer. In the same class of cars, BMW has invested more effort to recognize the latest needs, but also to implement the latest technical and information and communication systems that leave the younger generations speechless.

This is the basis for achieving greater profitability and business competitiveness of companies from the field of car industry.

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