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QFD AS A TOOL FOR IMPROVEMENT OF CAR DASHBOARD

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Abstract
This paper presents a Quality Function Deployment (QFD) for development of car dashboard of Toyota and Honda motor cars. A questionnaire is used for getting 'Voice of the Customer' (VOC). 'Voice of the Customer' is translated into customer needs which are then converted into technical specifications. The output from House of Quality (HOQ) is used in concept generation. Pugh chart is used for concept selection. CAD models of the selected concepts are presented.
Keywords: *Quality Function Deployment (QFD), House of Quality (HOQ), Concept generation, Concept selection, CAD models, car dashboard*

Introduction

Now-a-days cars are not only a luxury but also a necessity of life. Car industry plays the role of back bone for the economy of any country. Dash board is an important part of the car interior used for controlling different functions in the car. Mostly car dashboard is equipped with suitable functions to make the drive easy and comfortable. Common functions available in the car dashboard are: speed meters, fuels and oil gauges, navigation system, audio and video devices and control, air conditioning devices and control and holder for different attachments in the centre console.

The success of the company lies in understanding the customer needs and expectations and anticipating the changes required in existing or new products being offered (Soota et al., 2008). It is very important for any firms involved in business industry to improve their service quality by reducing the gap between internal quality and external customer satisfaction (Lin 2007). QFD is the best method to convert the customer needs and requirements into quality characteristics and develop a design quality for a product. Quality Function Deployment (QFD) is a powerful development tool, with a wide range of applications, for achieving product development, thus improving the product quality, reducing the time to market along with the design and manufacturing costs. Quality function deployment (QFD) is a well-known design method. This method has a vested reputation in industrial production as a means of systematically incorporating customer wishes and requirements in product design (Dijkstra and Bij, 2002).

Yoji Akao is regarded as the father of Quality Function Deployment whose work has led to its first implementation at the Mitsubishi Heavy Industries Kobe Shipyard in 1972. The interest in Quality Function Deployment in the West was

motivated by reports of the achievements made by Toyota through its application between 1977 and 1984. The achievements included a decrease in the development cycle by one third, a reduction in product development costs by 61%, and the virtual elimination of rust related warranty problems (Sullivan, 1986).

In 1966, Yoji Akao introduced the QFD concept in Japan (Dean 1998). Professor Mizuno first used QFD in 1972 to Mitsubishi's Kobe shipyard site to design super tankers (Martins and Aspinwall 2001). The two pioneer researchers that had developed the QFD were Mizuno and Akao. In the late 1970s, Toyota (the automobile manufacturer) adopted QFD and further developed the Quality Function Deployment concept to a detailed process (Cohen, 1995).

Quality function deployment was first put into use at Mitsubishi's Kobe shipyard site in 1972, and later in 1983 it was introduced into the USA. Since then, it has been used as a product development and quality improvement tool around the world (Akao, 1990). Quality function deployment is one of the total quality management quantitative tools and techniques that could be used to translate customer needs and specifications into appropriate technical or service requirements. This is important in order to deliver product or service that fulfills or exceeds customer requirements. According to Guinta and Praizler (1993), QFD is a customer driven tool. While Chan and Wu (2002), stated that QFD is a customer driven planning process to guide the design, manufacturing, and marketing of goods. QFD uses visual planning matrices that link customer requirements, design requirements, target values and competitive performance into one chart (Pun et al., 2000). Quality Function Deployment is a technique for "developing a design quality aimed at satisfying the consumer, translating the consumer's demand into design targets and major quality assurance points to be used throughout the production stage" (Akao 1990).

QFD is a tool that bridges the distance between an organization and its customers. To accomplish that goal it is important to know the customer's needs or requirements (Customer Voice) so that they can be involved from the early phases of the planning process. This implies implementing technological solutions by specialists (Technician Voice) to determine the customer's requirements (Day, 1993).

QFD is cited as, a key facilitating tool in concurrent engineering environments (Menon et al., 1994), and the most widespread implementation of TQM (Sage, 1992). QFD is used because of its three basic reasons: to save design time and development time, to focus on the satisfaction of customer, and to improve communication at all levels of the organization (Kasim et al., 2009).

Ford Motor Company and Xerox, in 1986, were the early users of Quality Function Deployment that started using the concept of Quality Function Deployment in the USA. Since then, Quality Function Deployment has been developed and broadly used in various industries such as electronics, automotives, aerospace, healthcare, insurance, utilities, software engineering, banking, food processing, construction and marketing (Chan and Wu, 2003). Many other multinational companies such as IBM, HP, Baxter Healthcare, Texas Instruments, General Motors, Digital Equipment, Miliken Textile, Black and Decker and Philips International have got subscription to the Quality Function Deployment advantages (Prasad, 1998).

The aim of current study is the development of car dashboard by providing improved or new functions to meet the customer needs and expectations.

The remainder of the paper is structures as follows: section 2 presents the methodology adopted for the study. Section 3 mentions identification of customer needs for car dashboard. It is followed by conversion of 'Voice of Customer' into customer needs given in section 4. Section 5 describes prioritization of customer needs. House of Quality for car dashboard is presented in section 6. It is followed by competitive benchmarking mentioned in section 7.

Methodology

To identify the customer needs, the authors selected the customers from the following walks of life who have been using cars for the last few years. Teachers and students of NWFP University of Engineering and Technology Peshawar, technical staff in sales and repair center of Toyota/Honda of Peshawar, and technical staff in sales and repair center of Toyota/Honda of Islamabad.

Two surveys were conducted in the study. Survey 1 was conducted to find out functions in the car dashboard which needs improvement. The results of the survey 1 are Forced exhaust system and multipurpose cup holder. Survey 2 was conducted to know the 'Voice of the Customer' (VOC) about the functions (forced exhaust system and multipurpose cup holder) which were the result of the survey 1.

Data collected from the surveys was interpreted in terms of customer needs. Customer needs were organized according to their relative importance. Relative importance was subjectively allocated to customer needs on a scale 1-5 (where 5 indicate the most important need and 1 indicates the least important need). The ranking was carried out on the basis of customer feedback obtained from the customer survey.

In order to proceed on to the next product development stage, the information obtained from the surveys about customer requirements, technical descriptions, and relative importance was used to build the House of Quality (HOQ) for the

car dashboard. The concept generation process was based on the results of House of Quality. Pugh chart was used for the concept selection of blower of car A/C system and for the multipurpose cup holder in the car dashboard.

Identification of Customer Needs for Car Dashboard

The process of identifying customer needs is an integral part of quality function deployment (QFD) and is related to concept generation, concept selection, bench marking, and establishing target specifications. Identifying customer needs is a process divided into the several phases: gather raw data from 'Voice of the Customer' (VOC), interpret raw data in terms of customer needs, establish relative importance of needs, and reflect on the result and process. The results of customer survey for VOC **are** shown in Table 1.

Table 1: Results of Survey for Voice for Customer

CUSTOMER NEEDS	VOTES
There should be a system that can circulate the air inside the car to maintain its temperature and exhaust, the internal gases (smoke, moisture etc.)	36
Sites for different attachments like cup bottle	31
It should not effect the existing features of the dashboard	18
Operation of the system should be efficient	34
Good ergonomics	16
Easy and safe usage of the systems	21
Look nice	36
Forced exhaust system can be operated automatically	23
Good Economics	25
System should be durable and reliable	28
Cup holder can be fitted into different vehicles	23

Conversion of Voice of Customer into Customer Needs

After getting voice of customer, the data was translated into customer requirements. For the conversion, the basic guidelines are followed such as use of positive phrases, avoiding use of must and should, expressing the needs in terms of product attributes, as shown in Table 2**.**

Table 2: Voice of Customer Translated in Terms of Customer Needs

S. No.	Voice of Customer	Customer Needs
1	There should be a system that can circulate the air inside the car to maintain its temperature and exhaust the internal gases (smoke etc.)	Incorporate a forced exhaust system
2	Sites for different attachments like cup, bottle	Multipurpose container
3	It should not effect the existing features of the dashboard	Not interfere with vehicle operation
4	Operation of the system should be fast	Efficient operating system
5	Good ergonomics	Good ergonomics
6	Easy and safe usage of the systems	User friendly
7	Look nice	Attractive design
8	Systems can be operated automatically	Automatic operating systems
9	Good Economics	Cost effective
10	System should be durable and reliable	Reliable design
11	Cup holder can be fitted into different vehicles	Flexible design

Prioritization of Customer Needs

Customer needs and/or requirements, which belong to different categories according to how much they affect the degree of global satisfaction of a product or service, must be ranked according to the customer preferences. Relative importance is subjectively allocated to customer needs on a scale 1-5 (where 5 indicate the most important need and 1 indicates the least important need).

The ranking was carried out on the basis of customer feedback obtained from the customer survey. The relative importance of the customer needs is shown in Table 3. The final step in identifying customer needs is to reflect upon the results and the process. The process of identifying customer needs is not an exact science, and methods of gathering and identifying customer needs vary from product to product and also depend on the thinking approach of the product development team. The customer needs mentioned in Table 3 are comprehensive enough to proceed on to the next product development stage.

Table 3: Relative Importance of Customer Needs

S. #	Needs	Importance
1	Incorporate the forced exhaust system	5
2	Multipurpose container	4
3	Not interfere with vehicle operation	1
4	Efficient operating system	5
5	Good ergonomics	1
6	User friendly	2
7	Attractive design	5
8	Automatic operating systems	2
9	Cost effective	3
10	Reliable design	4
11	Flexible design	4

House of Quality for Car Dashboard

Toyota and Honda are selected as competitors. Competitive benchmarking was conducted by giving the same questionnaire and/or survey form to group of customers to inquire on the level of importance of each requirement. In the survey form every individual customer is requested to evaluate the degree of satisfaction obtained within his/her own company from the use of the product.

The information obtained from surveys about customer requirements (WHATs), technical descriptions (HOWs), relative importance, and benchmarking are used to build the house of quality (HOQ) for the car dashboard. Table 4 lists HOWs for car dashboard. Table 5 shows the relationship between HOWs and WHATs.

Table 4: List of HOWs for Car Dashboard

Need No.	Metric No.	HOWs	Units
2, 3, 6, 7, 11	1	Diameter container	mm
2, 3, 6, 7, 9, 10, 11	2	No of components	Subjective
1, 8	3	Climate condition	Subjective
1, 3, 4, 6, 10	4	Area of the blower	mm^2
3, 5, 6 ,	5	Distance to access the controls	mm
1.4 , 8, 10	6	Operation time	Seconds
3, 5,6, 7	7	Dimension	mm
6, 10	8	Depth of container	mm
4, 6 ,10	9	Area of the duct	mm^2
2.5 ,6, 9, 10, 11	14	Clamping Force	Newton

Need No.	Metric No.	HOWs	Units
2, 7, 9, 10, 11	11	Adjustable base	Subjective
1, 4, 8, 10	12	Speed of the blower	rpm
5, 9, 10	13	Spring stiffness	N/m

Table 5: Relationship between HOWs and WHATs

S#	HOWs / WHATs	Diameter containe	No. of components	Climate condition	Size of the blower	Distance to access	Operation time	Area of the duct	Dimension	Depth of container	Adjustable base	Speed of the blower	Spring stiffness	Clamping Force
1.	**Incorporate the forced exhaust system**			•	•		•					•		
2.	**Multipurpose container**	•	•								•			•
3.	**Not interfere with vehicle operation**	•	•		•	•			•					
4.	**Efficient operating systems**				•		•	•				•		
5.	**Good ergonomics**					•			•				•	•
6.	**User friendly**	•	•		•	•		•	•	•				•
7.	**Attractive design**	•	•		•				•		•			
8.	**Automatic operating systems**			•			•					•		
9.	**Cost effective**		•		•						•		•	•
10.	**Reliable design**		•		•		•	•		•	•	•	•	•
11.	**Flexible design**	•	•		•						•			•

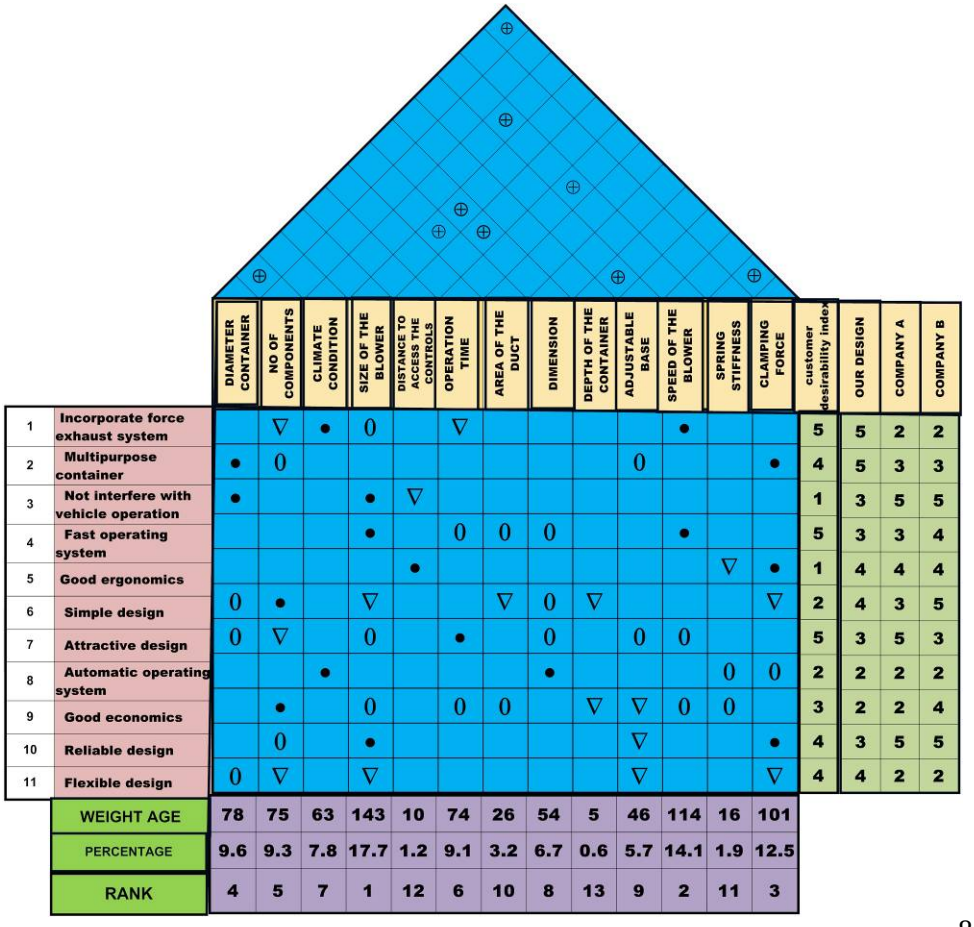
The HOQ for car dashboard **shown in figure O** shows that the characteristic of "size of the blower" received the highest score of 143. Size of the blower is related to the following customer needs: incorporate the forced exhaust system; no interference with vehicle operation; fast or efficient operating system; simple or user friendly, attractive, flexible, reliable, and economical or cost effective design.

The second highest characteristic is "speed of the blower" which received the second highest weighting of 114. Speed of the blower is related to the following customer needs: incorporate the forced exhaust system; fast or efficient operating systems; attractive design; and economical or cost effective design.

The third highest characteristic is “clamping force” which received a score of 101. The clamping force is related to the following customer needs: multipurpose container; good ergonomics; simple or user friendly, flexible, reliable, and economical or cost effective design.

The forth highest characteristic is obtained by “diameter of cup holder” which received a score of 78. The clamping force is related to the following customer needs: multipurpose container; not interfere with vehicle operation; simple or user friendly, attractive, and flexible. There is a positive correlation between diameter of the container and clamping force. Similarly, there is positive correlation between size of the blower and area of the duct. Also, positive correlation between spring stiffness and clamping force exists. The above analysis reflects the usefulness of the QFD analysis in identifying those product characteristics that should be changed in order to offer a compact design for exhaust system and multipurpose cup holder that meets the customer needs and expectations. Results of the QFD analysis are used in the concept generation and concept selection phases.

Figure O: HOQ for Car Dashboard



Existing Designs in the Car Dashboard

In this section, the already existing designs in the car dashboard are discussed.

1. Existing Exhaust System in Car

Air conditioning system of car has blower that is used to circulate the air in the cabin of car through evaporator and also used to intake the fresh air. To exhaust the internal gases from car cabin A/C is shut down and blower is started in such a way that it intakes the fresh air and slightly pressurizes the car cabin. The dampers which are tired in back bumpers of car open and exhaust the gases. Fig. 1 shows the air flow of car A/C system. Fig. 2 shows the working of the blower with the direction of air flow. Fig. 3 shows the dumper in the back bumper used for exhaust of gases. They are too sensitive to open with vibration caused by sound.

Figure 1: A/C system of car

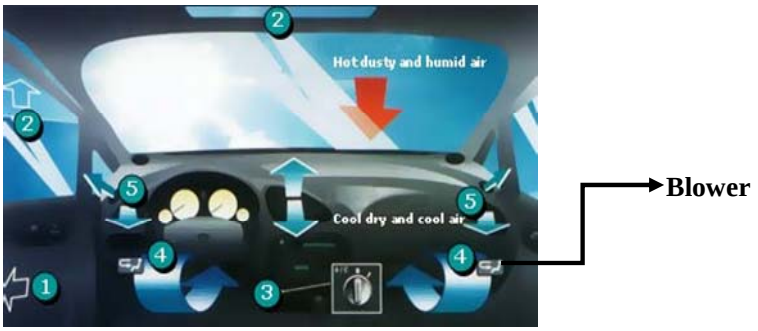


Figure 2: Blower of the car

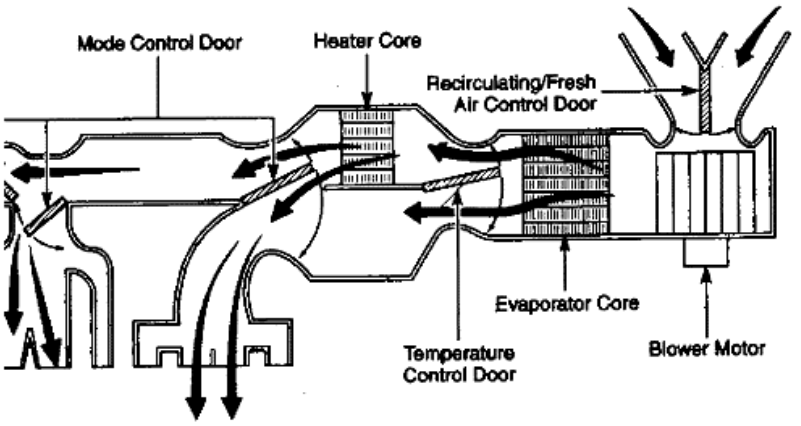


Figure 3: Dumper of the car

Customers are not happy with the existing exhaust system in car because of its limitations that include: there is no specific process to exhaust the internal gases, the blower only intakes fresh air, it takes long time to exhaust the internal gas like smoke odor etc., due to switching off the A/C for long time and opening the car windows, loss of cooling occurs.

2. Existing auto air vent

In the solar-powered automatic air vent shown in Fig. 4 the vent is used to remove hot air and replaces it with fresh and cool air. It removes nasty odors from tobacco and pet etc. away form the vehicle. It can be attached to any car window in seconds. It is with solar powered cell with no need of batteries. However, there are several limitations of this system which include: it is expensive, loss of cooling due to opening of the car window glass, risk of security, and slow air removal.

Figure 4: Auto Car exhaust vent

3. Existing Cup Holder

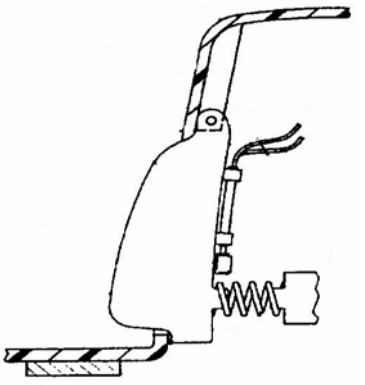
Now-a-days cup holders are essential requirements of the customer due to excess use of fast food and drinks. Drinks are available in different types of cups, tins and bottle. Cup holders can be placed in two general categories: permanent and temporary. Permanent cup holders are available for use at any time, while temporary cup holders can be thrown away when not in use. To accommodate the variation in diameter and height Honda Accord has the adjustable cup holder design. But its limitations are: small water bottle is not gripped by the tabs and will easily tip the cup back and forth within the holder, tabs are very tight, causing styrofoam cups to become grooved by the tabs.

Figure 5: Honda accord cup holder

4. Self Adjustable Cup Holder

A self-adjustable cup holder, US patent # 6,637,709 is another solution to cup size variability, a side view of this cup holder mechanism shown in Fig. 6. The sides of the cup holder expand when a larger cup is sliding into the cup holder.

Figure 6: Self adjustable cup holder



Concept Generation Phase

The concept generation process is based on the results of house of quality. Concept generation for force exhaust system in the car dashboard is presented which is followed by concept generation for multipurpose cup holder.

The following criteria are selected for the concept generation phase.

- Clarification of problem
- Development of design criteria
- Schematic diagram of the concept
- CAD models of concepts

1. Concept Generation for Forced Exhaust System in the Car Dashboard

a) *Clarification of problem*

The clarification of the problem is done by the functional decomposition of the system. There should be a system in car dashboard that can exhaust the internal gases like smoke, odors etc.

b) Design criteria for forced exhaust system

The following criteria are kept in mind during concept generation of forced exhaust system in the car dashboard.

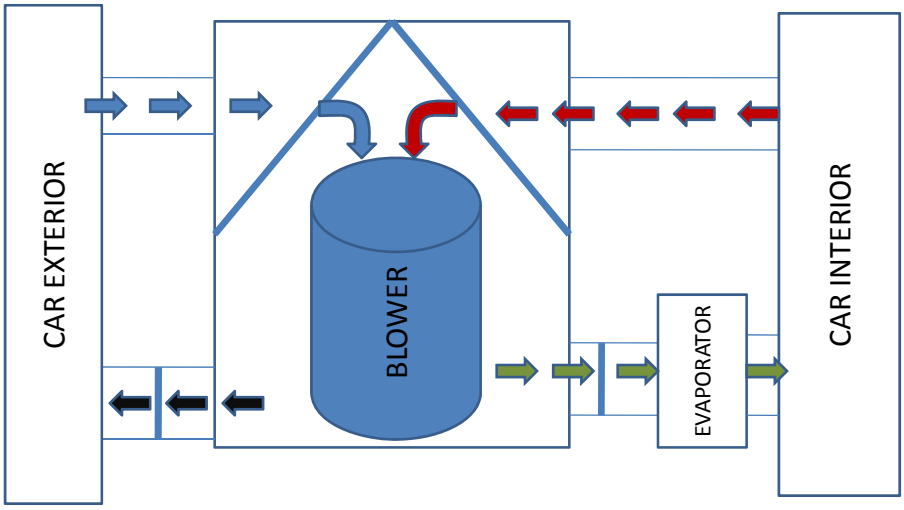
- It should be automatic; automatically sense, should be motorized
- Efficient operating system: no interfere with existing features
- Easy to use
- Minimum number of parts
- Easy to manufacture
- Do not effect the energy requirements and performance of vehicle
- User friendly
- Low operation cost
- Low cost to manufacture

c) Schematic Diagram of the Concept # 1

Figure 7 shows the schematic diagram of concept # 1. A shutter is inserted in the exhaust duct of the blower to direct the exhaust from the blower. The suction duct had a shutter and now the exhaust port also has shutter. The proper positioning of both shutters make the blower to exhaust the air from the interior of the car as shown in Fig. 7 which shows the working of the exhaust system for concept #1. The arrows in the diagram show the flow of air. The combinations of red and green arrows show the circulation of the air in car cabin through evaporator. The combination of green and blue arrows show the suction of fresh air while shut off the shutter in exhaust and evaporator direction, and open in car cabin side. The combination of red and back arrows show the exhaust of car

cabin gases (smoke and odor etc.), while the shutter is shut off in fresh air and room side direction.

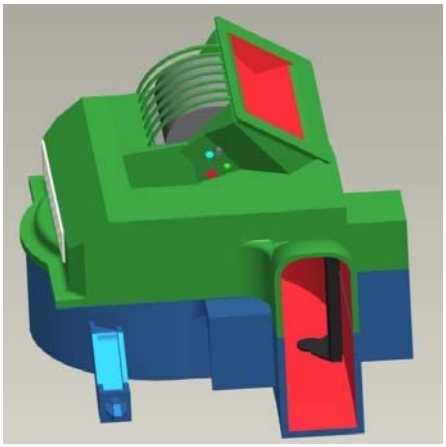
Figure 7: Schematic of the working of the concept # 1



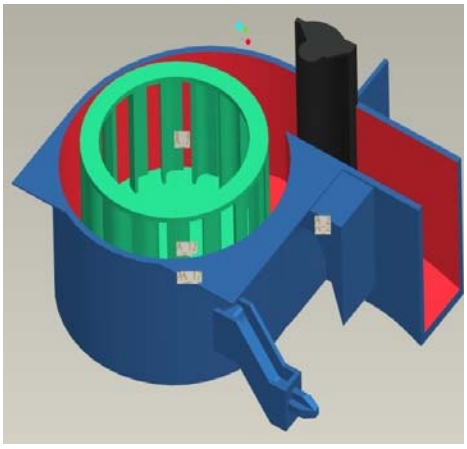
d) CAD models of the Concept # 1

The CAD models of concept # 1 are shown in Fig. 8. These models show the modification in the blower of the car A/C system.

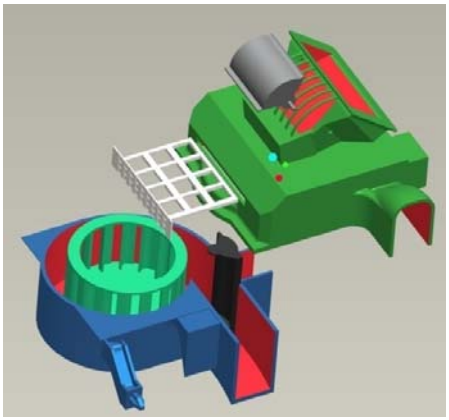
Figure 8: Cad Models for the Blower of Car A/C System According to Concept # 1



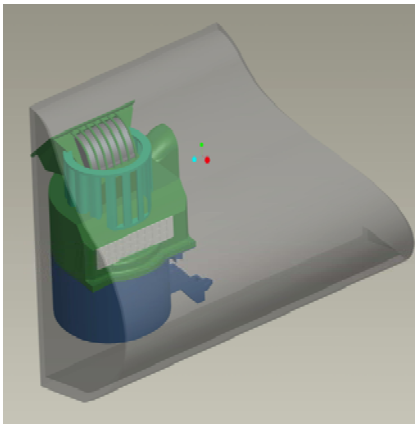
CAD MODEL 1.1



CAD MODEL 1.2



CAD MODEL 3

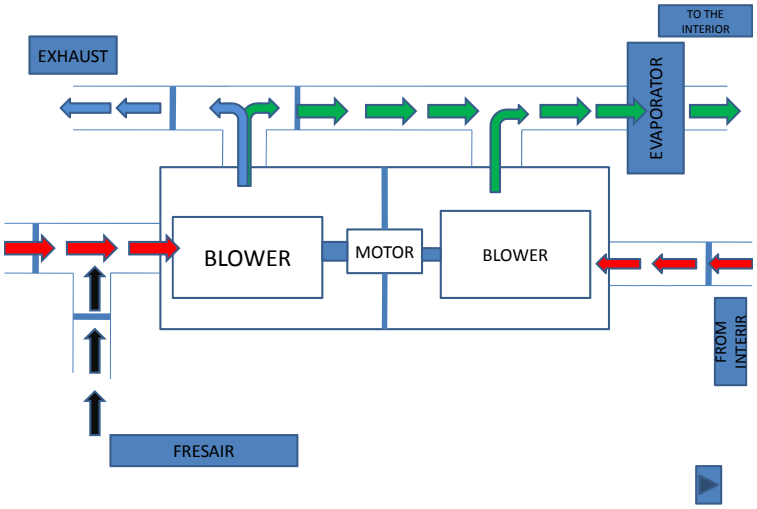


CAD MODEL 4

e) Schematic diagram of the concept # 2

Figure 9 shows schematic diagram of concept # 2. This concept also uses the blower of the car air conditioning system. The blower used in this system is double blower. It has two fans in the single blower casing. This blower also has arrangement of shutter which makes it to exhaust the internal air from the car cabin. The schematic shown in Fig. 9 shows the working of this concept. The combinations of red and green arrows show the circulation of the air in car cabin through evaporator. The combination of green and blue black arrows show the suction of fresh air while shut off the shutter in exhaust and evaporator direction, and open in car cabin side. The combination of red and blue arrows show the exhaust of car cabin gases (smoke and odor etc), while the shutter is shut off in fresh air and room side direction and open in intake and exhaust direction.

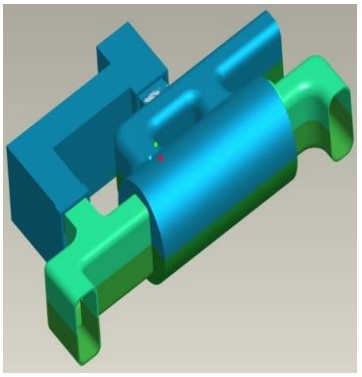
Figure 9: Schematic of Concept # 2 for Exhaust System



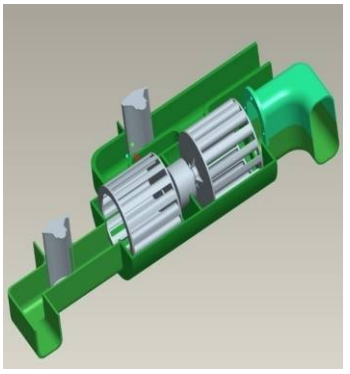
f) CAD models of the concept # 2

Figure 10 shows the CAD models of the concept # 2. These models show the use of double blower in the car A/C system.

Figure 10: CAD models for the blower of car A/C system according to concept # 2



CAD MODEL 2.1

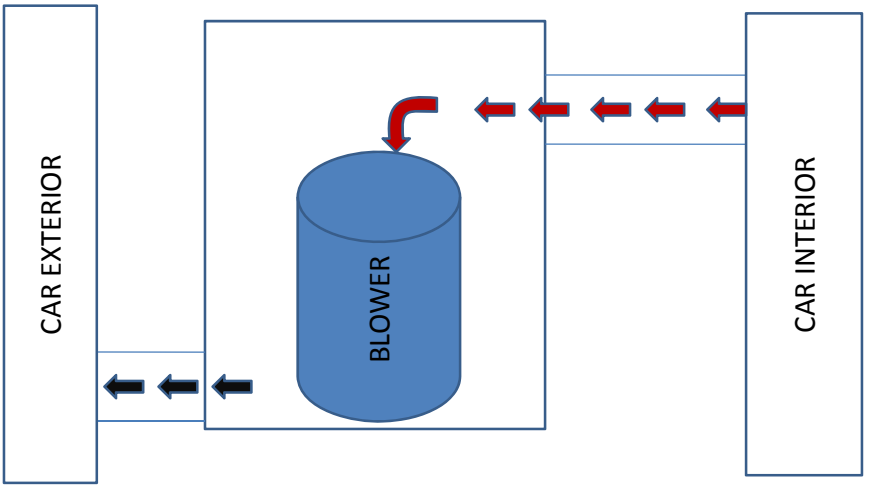


CAD MODEL 2.2

g) Schematic Diagram of the concept # 3

Figure 11 shows schematic diagram of concept # 3. This concept is the simplest of all the concepts discussed above. In this concept, instead of car A/C blower, two separate blowers are used. These blowers take the air from inside and then exhaust it. Separate ducting is also required for this system. It uses the energy from the system which may be an extra bourdon on the system. The direction of arrows shows the flow of air.

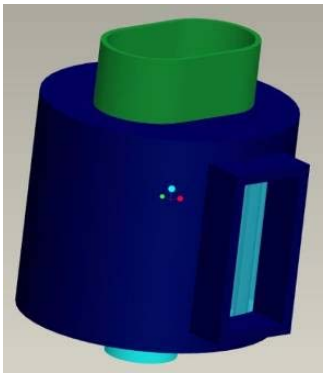
Figure 11: Schematics for concept # 3 of forced exhaust system



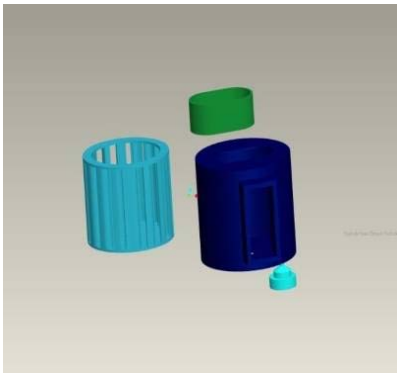
h) CAD models of the concept # 3

Figure 12 shows the CAD models of the concept # 2.

Figure 12: CAD models for the blower of car A/C system according to concept # 3



CAD MODEL 3.1



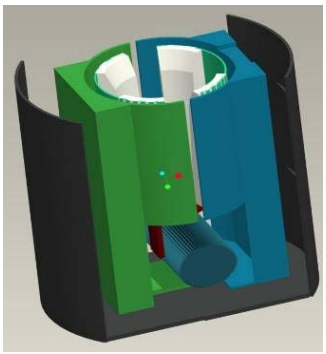
CAD MODEL 3.2

2. Concept Generation for Multipurpose Cup Holder

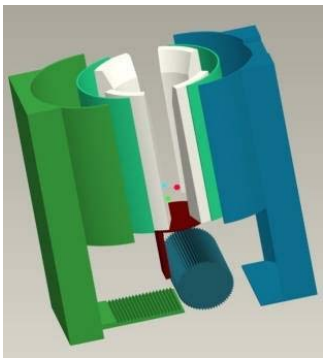
a) CAD models of the concept # 1

Concept # 1 is generated by keeping in mind the flexibility in diameter and variation in height. Griper is made up of flexible material which provides some variation in diameter. When something is to be placed in it, move the supporting parts through roller and apply force to grip the part. It is also spring loaded which increases its ability towards flexibility in diameter. There are two gripers. Supporting sides are also movable. The variation in height is provided by mechanism which has teeth shown in Fig. 13 and a roller also has teeth and spring is fixed under the movable base plate.

Figure 13: CAD models for the multipurpose cup holder according to concept # 1



CAD MODEL 1.1

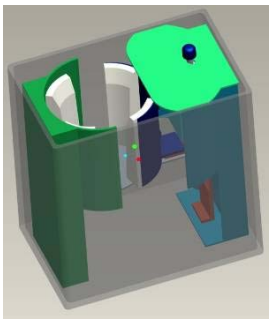


CAD MODEL 1.2

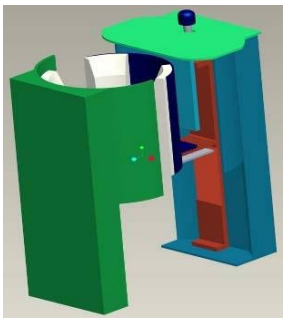
b) CAD models of the concept # 2

This concept has two gripers. One griper is movable and one is fixed on plastic sheet. It also has a movable base which is spring loaded. The movable jaw has a strip upon which teeth are cut. The movable base also has a strip with teeth. These two things move on a strip which has also teeth in respective direction for proper working of the griper and movable base. The strip is provided with the bottom for it's up down and horizontal motion. Pressing the bottom releases the base and the griper. Figure 14 shows the CAD models for the multipurpose cup holder according to concept # 2.

Figure 14: CAD models for the multipurpose cup holder according to concept # 2



CAD MODEL 2.1

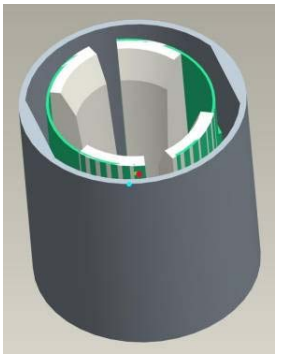


CAD MODEL 2.2

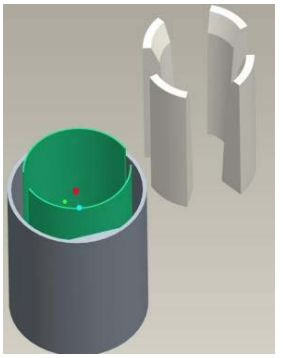
c) CAD models of the concept # 3

This is a simple concept which provides flexibility only in diameter of the thing which is to be inserted in its gripers. It has two gripers made of flexible material. It is also spring loaded. It gives flexibility in two steps, one by the material used and other due to the motion of the spring loaded gripers. Figure 15 shows the CAD models for the multipurpose cup holder according to concept # 3.

Figure 15: CAD models for the multipurpose cup holder according to concept # 3



CAD MODEL 3.1



CAD MODEL 3.2

Concept Selection Phase

Pugh chart is developed by comparing different concepts using rating scale shown in Table 6. Pugh matrix for forced exhaust system and multipurpose cup holder are produced as shown in Table 7 and Table 8 respectively. Concept # 1 is selected for the modified blower of the car A/C system. CAD models of the blower are shown in Fig. 8. Concept # 2 is selected for multipurpose cup holder the CAD models of which are shown in Fig 14.

Table 6: Rating of the Criterion

Relative performance	Rating symbol
Worse than reference	-
Same as reference	0
Better than reference	+
Much better than reference	++

Table 7: Pugh chart for Force Exhaust System

Design Criteria	**Weight**	**Concept #1**	**Concept #2**	**Concept #3**
Ease of manufacturing	2	0	-	++
Cost effective	2	0	-	-
Speed of operating system	1	0	++	0
User friendly	2	-	-	+
Performance	2	++	++	+
Compact	2	+	0	-
Easy to operate	2	0	+	0
Interference	2	+	-	-
Reliability	1	+	+	+
Maintenance	1	+	0	+
Universality	1	+	0	-
+		11	9	10
0		7	4	3
-		2	8	7
Total points		9	1	3
Rank		1	3	2
Continue		Yes	No	No

Table 8: Pugh chart for multipurpose cup holder

Design criteria	**Weight**	**Concept #1**	**Concept #2**	**Concept #3**
Durability	2	+	+	+
Cost	2	-	-	0
Ease of manufacturing	2	-	0	+
Universality	2	+	+	0
Adjustable	1	++	+	-
Required user interaction	1	0	0	0
User friendly	2	-	-	+
Versatility	1	++	++	-
Reliability	2	-	+	+
Cup hugging ability	2	+	+	-
Quality feel	1	0	0	+
+		10	11	9
0		2	4	5
-		8	4	4
Total points		2	7	5
Rank		3	1	2
Continue		No	Yes	No

Summary and Conclusions

In today's global and highly competitive market, it is essential for the survival of any organization involved in the business industry to be adaptive, proactive, responsive to changes, and has the capability to provide high quality products according to the diverse customer expectations. The success of new products in the market depends on how well they meet customer needs and requirements. Quality Function Deployment provides a structured methodology for translating the 'Voice of the Customer' into design requirements, guiding the product development process and improving the success rate for new products. This paper shows how QFD improves the car dashboard development process by focusing on customer needs and expectations. Two important developments, in the car dashboard, the forced exhaust system and the multipurpose cup holder are made according to the customer's expectations. For the product development, the customer needs are identified by market survey. 'Voice of the Customer' is

converted from market survey into customer requirements (WHATs). Product characteristics are developed to achieve the customer needs in technical descriptions (HOWs). House of quality is built by developing the relationship between WHATS and HOWS. The result of house of quality is used in concept generation. Pugh chart is used for concept selection. CAD models of the selected concepts are presented.

In the current study, relative importance is allocated to the customer needs on a scale of 1 to 5 (where 5 indicate the most important need and 1 indicates the least important need). A finer scale such as 1 to 10 is suggested for relative importance in the future research. Also in future research, Concept Classification Tree and Concept Combination Table are recommended to be used in order to produce better quality concepts for the forced exhaust system and the multipurpose cup holder. Furthermore, the Concept Selection in the current study is based on Concept Screening (Pough Chart) only. It is recommended to consider the Concept Scoring stage too in the Concept Selection phase so that high quality concepts may be selected.

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FIGURE CAPTIONS