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Study of the Effect of Customer Requirements and Preferences: Case study of Ceramics Tea Pot

Yassaman Khodadadeh*, Nargess Alanchari**, Mohammad Saleh Owlia***

*Associate Professor at Department of Industrial Design, College of Fine Arts, University of Tehran, Iran and Honorary Lecturer at Institute of Science and Technology in Medicine (ISTM), Keele University, UK, Email: khodadade@ut.ac.ir
**MSc Graduate in Industrial Engineering, Email: nargesa42@gmail.com
***Associate professor at Department of Industrial Engineering, University of Yazd, Iran, Email: owliams@gmail.com

ABSTRACT

The aim of this study was to develop a systematic method for obtaining aesthetical specifications according to the customer needs. For this aim, Quality Function Deployment (QFD) was used to study ceramic teapot. 2000 teapots were collected and 130 samples with more differences in form were selected. 30 groups were identified by cluster analysis of form factors. A sample of each group was chosen. 96 girl students aged 18 to 24 were selected randomly and were asked to weigh the 30 samples and their aesthetical factors, such as form, colour, etc. Statistical analyses were performed and the five most attractive teapots were selected. The aesthetical factors of these five samples were analyzed and translated to aesthetical specifications. According to these specifications, a new teapot was designed and a 3D model was developed and compared with the last five samples. It obtained the highest score. Therefore, it was concluded that the voice of the customer was translated correctly.

Key words: QFD, Voice of customer, Cluster analysis

INTRODUCTION

Human beings live in an artificial world, full of artifacts, tools and products. All of these products need to be designed. Designing a product is solving an ill-defined problem, which does not have a certain answer (Cross, 2000). It depends on many different factors, such as the customer, his financial circumstances, his idea, the production limitation, raw materials, production technology, etc. To take all these factors into the account, various methods have been developed, such as FMEA (Failure Mode Effect Analysis), DFMA (Design for Manufacturing and Assembling) and QFD (Quality Function Deployment) (Kitsios, 2000). In order to use a systematic method to design an object according to customer requirements, there is a need for a model. Quality Function Deployment (QFD), which is a method for translating the voice of the customer to Engineering specifications, was used as a model. Attempts were made to use this method to hear the voice of the customer regarding aesthetical factors. For this aim there was a need to select a certain product with an aesthetical function. Following an initial search, it was concluded that the aesthetical function of teapot is very important to the customer. Therefore, the study was carried out on ceramic teapot.

QFD

Many companies use standardised methods for the translation of customer wants and needs into product and process properties (Schütte, 2002). One of the most common methods is QFD.

QFD is a structured method used to identify and prioritise customer requirements, and to translate these requirements into engineering specifications for systematic deployment throughout a company at each stage of product or process development and improvement. The concept of QFD was introduced in Japan by Yoji Akao in 1966, and was first applied at the Kobe Shipyard of Mitsubishi Heavy Industries Ltd. Since that time, QFD has become the accepted methodology for development of products and services in Japan (Jackson & Frigon, 1994). In the early 1980s, QFD was introduced at Xerox, and since then American businesses have exhibited substantially growing interest in using it. According to Akao (1990), QFD is a method for developing a design quality aimed at satisfying the consumer and then translating the consumer's demand into design targets and major quality assurance points to be used throughout the production phase (Ioannou, Pramataris and Prastacos, 2004)

Nowadays QFD is a well established product development method in many countries. Western companies utilize QFD more for decision support during the product development process than as a quality assurance tool (Karsak, Sozer and Alptekin, 2002). There are several approaches to QFD; each of these approaches makes use of matrices to organise and relate pieces of data to each other (Hauser and Clausing, 1988).

In Western countries the QFD model most used is the four-phase model of Hausser and Claussing (1988). The House of Quality (I) is run first, translating customer demands into engineering characteristics and ranking them in order of their importance. These data are the starting point for the second phase, where the critical parts of a new product are identified and ranked according to their importance. In the following step the key production processes are reviewed (III) and improved if necessary. Phase four focuses on the role of the production personnel and the impact on product quality (Fig 1).

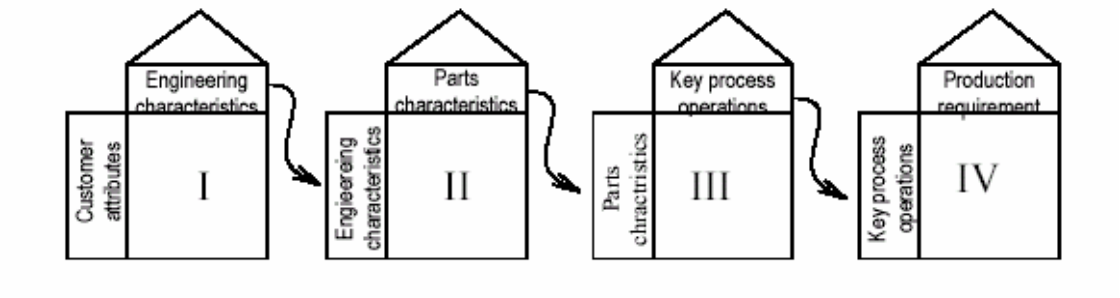

Fig 1: Four phases of QFD

The House of Quality starts with a "What-How" Matrix that identifies the wants, desires, and needs of the customer (Akao, 2004). These customer requirements are shown on the left part of the House of Quality. The ceiling of the House, the horizontal axis below the roof, shows the design or technical requirements, while the body of the House visually displays the relationships between the customer requirements and design specifications. The symbols used in each box, if any, show whether the relationship between the two corresponding elements is strong or weak, positive or negative. In this way the House of Quality quickly reveals patterns and identifies weak points in the design requirements. The Interaction Matrix, also known as the Correlation Matrix, is the "roof" of the House of Quality (Fig 2). It is established to determine the technical interrelationships among the design requirements. This information is valuable as the basis for decisions regarding technical trade-offs (Jackson and Frigon, 1994).

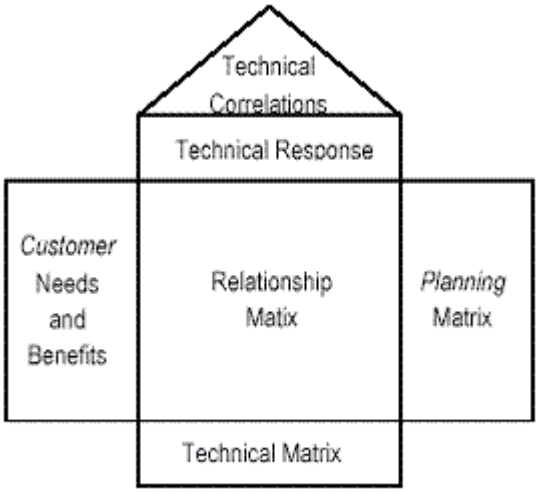

Fig 2: The House of Quality (Cohen, 1995)

METHODOLOGY

As aesthetical factors are not very clear and depend on many other factors, identifying accurately the requirements of the customer in this regard is very difficult. This study consists of eight stages. In these stages attempts are made to translate the voice of the customer to design specifications. This can help the designer to design a teapot according to the ideas of a certain group of customers.

Stage 1: Determine the Customer requirements

The initial and most critical step of the QFD process is the identification of customers' needs. In this step, customer requirements, expectations, and complaints are determined. Several methods can be used to establish the customers' requirements, including: customer panels, focused group discussions, structured or unstructured customer interviews, self-completing questionnaires, in-depth customer observation, customers' complaint and compliment database, customers' service inquiries database, front-line staff feedback.

In order to identify the important aesthetical factors in the design of teapot, a literature survey was carried out. Also a small group of customer were interviewed to help identifying these factors. The aesthetical features which were identified are:

- Form and shape
- Colour
- Pattern
- Size
- Style

Stage 2: prioritize the customer requirements

It is unlikely that an organization can satisfy all of its customers' requirements at once. Therefore it is necessary to prioritize the requirements. Using a structured questionnaire, 96 girl students between 18 to 24 years old were selected randomly from University of Tehran. They were chosen from different fields apart from art. They were asked to rank the importance of each aesthetical feature from 1 to 5. On this scale 5 indicates the most important and 1 denotes relatively low importance. The result of this study is presented in table 1. In order to deploy customer requirements to design characteristics four more stages were carried out, which are explained as follows.

Table 1: Ranking of the features

Aesthetical feature	Mean
Form and shape	4.39
Colour	4.25
Pattern	4.96
Style	3.47
Size	3.45

Stage3: design characteristics

The customer is unable to clearly describe the features that shape the design he has in mind. Therefore, there is a need to make an image for him by showing him existing products. For this aim, 2000 teapots were found from the Internet and their pictures were downloaded. This was an uncomplicated way for obtaining many samples. Due to the similarity of the samples, 130 teapots with more differences in characteristics were selected. By studying these 130 teapots and also searching the literature, the effective characteristics in shaping a teapot were identified in detail. Colour, form and pattern characteristics are presented in tables 2, 3 and 4. Also style and size were studied. Two style-groups of classic and modern, and three sizes large, medium and small, were considered.

Table 2: Colour characteristics

Hue	1. Hue 2. Warm-cool of hue
Value	1. Light and darkness
Intensity	1. Primary colours 2. Secondary colours 3. Tertiary colours
Contrast	1. Value contras 2. Warm-cool contrast 3. Complementary contrast
Sleek and opaque	1. Sleek and opaque

Table 3: Form characteristics (Chen and Chuang, 2004)

Form Characteristics	Level
A. Shape of Spout	a1: tube merged with body, a2: beak, a3: tube
B. Shape of handle	b1: rectilinear shape, b2: curve, b3: complex form
C. Type of handle	c1: closed shape, c2: opened shaped
D. Type of handling	d1: up type handle d2: side type handle
E. Shape of bottom merged into body	With e1: the same level, e2: different levels, e3: legs
F. Shape of body	f1: sphere, f2: cone-like cylinder, f3: cone, f4: oval shape, f5: half sphere, f6: tetrahedron, f7: cylinder, f8: cube, f9: body with neck f10: complex form, f11: sphere and cylinder merged.
G. Ratio	ratio of width/height of teapot samples calculated
H. Axis of body	g1: vertical, g2: not vertical
I. The composition of handle and spout	The end points of handle and spout, i1: aligned, i2: not aligned
J. The composition of handle and body	j1: right-top, j2: top, j3: right, j4: front
K. The composition of spout, handle and body	k1: aligned, k2: not aligned
L. Joining relationships of body merged with	l1:same level, l2: different levels

Table 4: Pattern characteristics

Pattern	Level
Edges motif	Edges motif (presence or absence) Mono colour or multi colour Sleek and Opaque
Motif	Motif (presence or absence) Mono colour or multi colour Sleek and Opaque
Texture	Texture (presence or absence)
Golden or/and silver line	With or without line

Stage 4: Classifying the samples

In order to classify the samples, the cluster analysis method was used. Cluster analysis is a statistical method which identifies groups of samples that behave similarly or show similar characteristics. There groups are also called look-a-like groups. The clustering algorithms are broadly classified into two, namely, hierarchical and nonhierarchical algorithms. In the hierarchical procedures, a hierarchy or tree-like structure is constructed to see the relationship among entities (observations or individuals). In the non-hierarchical method a

position in the measurement is taken as the central point and distance is measured from such a central point (seed). Identifying an appropriate central position is a big challenge and hence non-hierarchical methods are less popular (Sambamoorthi, 2003).

Out of the 130 chosen samples, 30 groups were made by using cluster analysis with binary variables of form factors. The focus was on the greatest similarity of the items. These variables were defined based on the presence or absence of a factor. For instance, if a sample had a cylinder shape its variable (f7) was given one. If it didn't it was given zero. The data were analysed with the SPSS statistical software and 30 groups emerged. The number of samples in each group was different. Some groups had just one sample and some had many. These groups were presented to a number of customers. They were asked to choose the most beautiful sample in each group. As a result, 30 samples were selected for the next stage.

Stage 5: Selecting the samples by the customer

The customers (96 samples) were asked to evaluate the beauty of 30 teapots by considering all characteristics like form, colour, pattern, style and size. A nine-point scale was used for evaluating each item. As each item was weighed before in stage 1, the statistical analyses were performed based on these evaluation and those weights. Table 5 presents some of the results of the evaluation in the form of the House of Quality.

Table 5: Matrix of evaluating the samples

	Weight of Factors	Sample 1	Sample 2	……	Sample 29	Sample 30
Form	4.395833	2.2	7.466667		3.066667	4.666667
Colour	4.25	3.466667	5.6		2.133333	2.333333
Pattern	3.96875	1.333333	5.2		2.266667	2.133333
Style	3.479167	2	5.8		2.333333	2.133333
Absolute weight		36.65417	97.43889		39.66111	46.31944
Relative weight		2.27754	6.054455		2.46438	2.878101

As a result of the statistical analyses, five samples that had the higher score were chosen as the most attractive samples.

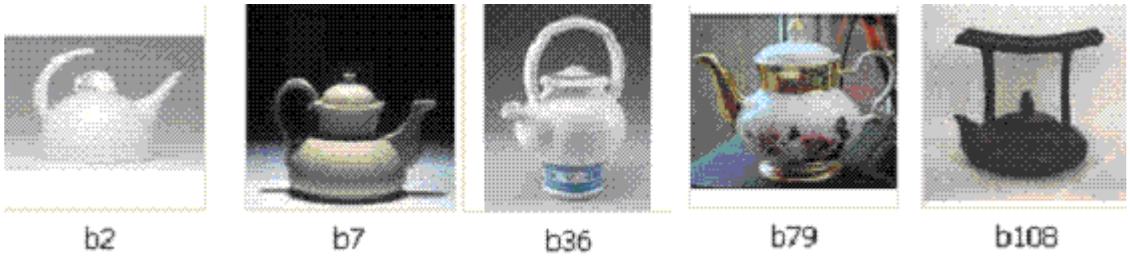

Fig 3: Five most attractive samples

Stage 6: Recognizing the effective parameters in customer choice

Attempts were made to specify the characteristics of form that were important to the customer by analysing the five most attractive teapots. This task was performed by using a matrix (Table 6). The weights of the characteristics of form were specified in terms of the relation between the characteristics of form and the chosen teapots. Each characteristic of form was defined in terms of zero or one, based on the presence or absence of a factor as explained before. Therefore, absolute weight of each characteristic was calculated as follows:

$$wj = \sum_{i=1}^{n} Wi\,dij$$

Wi= Weight of Beauty of the teapots

Dij= Relation between the characteristics of form and the teapots

Table 6: Matrix for obtaining form characteristics

	Weight of Sample	X_1	X_2	X_3	X_4	X_5	…….	X_{27}	X_{28}
Sample 1	6.05	1	1	0	1	0		1	1
Sample 2	4.54	1	0	0	0	1		1	1
Sample 3	5.1	1	1	0	0	1		0	1
Sample 4	4.71	1	1	0	1	0		1	1
Sample 5	4.57	1	1	0	1	0		0	1
Absolute weight		24.97	20.43	0	15.33	9.64		15.3	24.97
Relative weight		0.999	0.817	0	0.613	0.386		0.612	0.999

Stage 7: Designing a new teapot according to the voice of customer

The form characteristics were specified in stage 6. Other characteristics like colour, pattern, style and size were determined by interviewing the customer. A new teapot was designed according to the obtained data and a 3D model was developed.

Fig 4: The newly designed teapot

Stage 8: Evaluating the newly designed teapot

In order to examine the popularity of the new design, it was evaluated in comparison with the other five samples. 30 customers were questioned. They were asked to choose one

teapot as the most preferred sample. The frequency of the chosen sample is shown in table 7. The newly designed teapot has the highest frequency. Therefore, it can be said that is chosen as the most attractive one.

Table 7: The Frequency of the most preferred teapot

Teapots	Frequency
Sample 1	5
Sample 2	6
Sample 3	4
Sample 4	7
Sample 5	0
Sample 6 (The newly designed teapot)	8
Total	30

Conclusion

In today's highly competitive and diverse market, it's difficult to analyze users' desires and preferences by applying conventional marketing techniques. A well-designed product should not only satisfy users' physical requirements but also satisfy their psychological needs. In particular, for some of the functional products, form may play a key role. Although form is a very important factor for the customer, it is difficult for him to talk clearly about it. In other words, most customers are unable to explain their wishes and demands regarding the form and shape of a product. It is much easier for them to talk about the quality and function of a device. Therefore, designing a form according to customers' requirements is very difficult. Finding a systematic method to translate the voice of the customer to a design was the main objective of this research.

In this research, Quality Function Deployment (QFD) has been used as a tool for listening to the voice of customers. Cluster Analysis has been selected to show how customers' requirements and preferences could be linked to design parameters. The research has been applied to ceramics teapot to show how product aesthetics can be considered in the QFD process. The study included eight stages of operating to translate the voice of the customer to a design and evaluate the new design.

The model developed in this study can be very useful for designers. They can use this model to hear the voice of the customer clearly and translate it to a design.

REFERENCES

Akao,Y. (2004) Quality Function Deployment: Integrating Customer Requirements into Product Design, Productivity Press

Akao, Y. (1990) Quality Function Deployment, Productivity Press, Cambridge MA

Chen, C. and Chuang, M. (2004) A Users' Kansei Evaluation System Based on Product Form Features and Feature Composition, Institute of Applied Arts, National Chiao-Tung University, Taiwan

Cohen, L. (1995) Quality Function Deployment: How to Make QFD Work for You. Reading MA, Addison Wesley Longman, Inc

Cross, N. (2000) Engineering Design Methods: Strategies for Product Design, Third Edition, John Wiley & Sons LTD

Hauser, J.R. and Clausing, D. (1988) The House of Quality. Harvard Business Review, 3, May-June, 63-73

Ioannou, G. Pramataris, K.C. and Prastacos, G. (2004) A Quality Function Deployment Approach to Web Site Development: Applications for Electronic Retailing, Management Technology, 13(3), Athens, Greece

Jackson, H.K.J. and Frigon, N.L. (1994) Management 2000: The Practical Guide to World Class Competition, Van Nostrand Reinhold, NY.

Karsak, E.E., Sozer, S. and Alptekin, S.E. (2002) Product Planning in Quality Function Deployment Using a Combined Analytic Network Process and Goal Programming Approach, Computers & Industrial Engineering, No. 44

Kitsios, F. (2000) Product Design and Development, Technical University of Crete

Sambamoorthi, N. (2003) Hierachical cluster ANALYSIS: Some Basic and Alghorithms, CRMportals Inc., Englishtown

Schütte, S. (2002) Designing Feelings into Products- Integrating Kansei Engineering Methodology in Product Development, MSc thesis in Quality and Human-Systems Engineering, Sweden