Advancement in Conventional QFD Process by Integrating It with Soft Computing

Bakul .S. Chandel[1] M.Shinde[2]
[1]PG Student [2]Professor
[1,2]Department of Mechanical Engineering
[1,2]Mahakal Institute of Technology, Ujjain M.P

Abstract— As we know, in QFD planning process, the single objective point of view that focuses on maximizing customer satisfaction needs to be extended by considering the company's other design related objectives Considering the multi- objective nature of the design problem, here we propose a fuzzy multiple objective decision framework that included not only fulfilment of engineering characteristics to maximize customer satisfaction, but also maximization of extendibility and minimization of technical difficulty of engineering characteristics as objectives subject to a financial budget constraint to determine target levels of engineering characteristics in product design. The fuzziness of relationships in QFD modelling justifies the use of fuzzy regression to determine the functional relationships between Customer Needs and Engineering Characteristics (ECs), and among engineering characteristics.

Key words: Quality Function Deployment, House of Quality, fuzzy Logic, fuzzy based decision model

I. Introduction

For new product development, Quality Function Deployment (QFD) is a useful approach to maximize customer satisfaction. QFD process consists of four phases. In the new product design stage, a QFD team organized to implement the first two phases, i.e., product planning and part deployment, of QFD processes, which mirror the product design process to achieve great customer satisfaction. The two phases are closely related at the design stage, since the outcome from the latter phase should make the decisions from the former phase applicable. Hsuan Chena, Wen-Chang-Ko, proposed fuzzy nonlinear programming models based on Kano's concept to determine the fulfilment levels of Part Characteristics with the aim of achieving the determined contribution levels of Design Requirements in phase first for customer satisfaction. This model also deal with the design risk, this study incorporates Failure Modes and Effects Analysis (FMEA) into QFD processes, and treats it as the constraint factor in the models. Determining the fulfilment levels of the "how" was an important task in the first two phases of the QFD processes, when QFD is applied to the new product design. However, most related studies have only focused on the priority or achievement levels of DRs in first phase. Considering Kano's concept, paper proposed a fuzzy nonlinear model to determine the performance levels of the "how" based on the existing fuzzy linear model. The "how" can be categorized into three classes based on Kano's concept. Through the modification of the decision variables denoting the performance level, the fuzzy nonlinear models can be constructed for first phases and second phase in a fuzzy environment. Compared with fuzzy linear models without considering Kano's concept, fuzzy nonlinear models can achieve better satisfaction degree. To reduce the design risk, risk analysis of DRs, namely a fuzzy FMEA, is taken into account in the second phase model as a constraint factor.

II. Quality Function Deployment

QFD (quality function deployment) is defined as a method for developing a design quality aiming 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. QFD is a way to assure the design quality while the product is still in the design stage .It can be taken as the process where the consumer's voice is valued to carry through the whole process of services.

QFD was invented in Japan by Yoji Akao in 1966, but was first implemented in the Mitsubishi's Kobe shipyard in 1972, possibly out of the teaching of Deming. Then later it was adopted and developed by other Japanese companies, notably Toyota and its suppliers.

In the USA the first serious exponents of QFD were the 'big three' automotive manufacturers in the 1980's, and a few leading companies in other sectors such as electronics. However, the uptake of QFD in the Western world appears to have been fairly slow. There is also some reluctance among users of QFD to publish and share information - much more so than with other quality-related methodologies. This may be because the data captured and the decisions made using QFD usually relate to future product plans, and are therefore sensitive, proprietary, and valuable to competitors.

A. *House Of Quality*

Matrix diagrams, which are very useful to organize the data collected, help to facilitate the improvement process. They can be used to display information about the degree to which employee expectations are being met and the resources that exist to meet those expectations. The structure in which QFD uses to organize information is known as the House of Quality.

In its broadest sense, the QFD House of Quality displays the relationship between dependent (WHATS) and independent (HOWS) variables (Woods, 1994) [8]. Figure 1 shows the typical House of Quality.

This House of Quality should be created by a team of people with first-hand knowledge of both company capabilities and the expectations of the employee. Effective use of QFD requires team participation and discipline inherent in the practice of QFD, which has proven to be an excellent team-building experience**.**

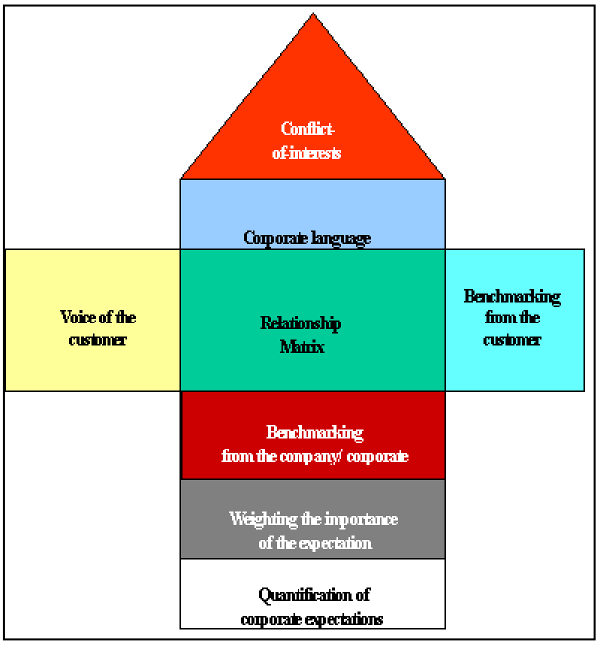

Fig. 1: The Typical House of Quality

B. *Four Phases of QFD Are*

1) Product concept planning. It starts with customers and market research with leads to product plans, ideas, sketches, concept models, and marketing plans.
2) Product development and specification. It would lead to the development to prototypes and tests.
3) Manufacturing processes and production tools. They are designed based on the product and component specifications.
4) Production of product. It starts after the pilot have been resolved

After the products have been marketed, the customer's voice is taken again

III. Soft Computing and Fuzzy Logic

A. *Soft Computing*

Soft Computing (SC) is an evolving collection of methodologies, which aims to exploit tolerance for imprecision, uncertainty, and partial truth to achieve robustness, tractability, and low cost. Soft Computing provides an attractive opportunity to represent the ambiguity in human thinking with real life uncertainty. Fuzzy logic (FL), neural networks (NN), and evolutionary computation (EC) are the core methodologies of soft computing. However, Fuzzy Logic, Neural Network, and EC should not be viewed as competing with other, but synergistic and complementary instead. Soft Computing has been theoretically developed for the past decade, since L. A. Zadeh proposed the concept in the early 1990s. Soft computing is causing a breakthrough in engineering and science fields since it can solve problems that have not been able to be solved by traditional analytic methods (tractability). In addition, Soft Computing yields rich knowledge representation (symbol and pattern), flexible knowledge acquisition (by machine learning from data and by interviewing experts), and flexible knowledge processing (inference by interfacing between symbolic and pattern knowledge), which enable intelligent systems to be constructed at low cost.

B. *Fuzzy Logic*

FUZZY logic is a form of multi-valued logic to deal with reasoning that is approximate rather then precise values .It attempts to systematically and mathematically emulate human reasoning and decision making. It provides an intuitive way to implement control systems, decision making and diagnostic systems in various branches of industry. Fuzzy logic represents an excellent concept to close the gap between human reasoning and computational logic. Variables like intelligence, credibility, trustworthiness and reputation employ subjectivity as well as uncertainty. They cannot be represented as crisp values, however their estimation is highly desirable. Fuzzy logic introduced in the 1965 by Lotfi A. Zadeh.

The past few years have witnessed a rapid growth in the number and variety of applications of fuzzy logic (FL). FL techniques have been used in image-understanding applications such as detection of edges, feature extraction, classification, and clustering. Fuzzy logic poses the ability to mimic the human mind to effectively employ modes of reasoning that are approximate rather than exact. In traditional hard computing, decisions or actions are based on precision, certainty, and vigour. Precision and certainty carry a cost. In soft computing, tolerance and impression are explored in decision making. The exploration of the tolerance for imprecision and uncertainty underlies the remarkable human ability to understand distorted speech, decipher sloppy handwriting, comprehend nuances of natural language, summarize text, and recognize and classify images. With FL, we can specify mapping rules in terms of words rather than numbers. Computing with the words explores imprecision and tolerance. Another basic concept in FL is the *fuzzy if– then rule*. Although rule-based systems have a long history of use in artificial intelligence, what is missing in such systems is machinery for dealing with fuzzy consequents or fuzzy antecedents. FL can model nonlinear functions of arbitrary complexity to a desired degree of accuracy. FL is a convenient way to map an input space to an output space. FL is one of the tools used to model a multi-input, multi-output system.

IV. Methodology

(Based On Literature Review)

Qi Wu a fuzzy measurable house of quality (FM-HOQ) model was proposed to provide measureable engineering information. Quality function deployment (QFD) was combined with a mapping pattern of ''function →principle →structure'' to extract product characteristic from customer demands. Then, a Fuzzy Support Vector Regression Machine (FSVRM) model was built to use data and realize the estimation of Product Development Time (PDT), which makes use of fuzzy comprehensive evaluation to simplify structure. Whole estimation method consists of four steps: time factors identification, product characteristics extraction by QFD and function mapping pattern, FSVRM learning, and PDT estimation. Based on procedure of the estimation method, the case of injection mold design is studied. The results of experiments show that the fuzzy method is feasible and effective.

Figure 2 Shows the original factor set affects the PDT target indirectly via a transitional factor set. The transitional factor set is composed of some factors that are unobvious and difficult to be measured or evaluated. Therefore, only the original factor set is acquirable and will be taken into account in this paper. The original factor set can be sorted into four main subsets: product characteristics, design process, design condition and design team. Here the nonlinear mapping relationship between the original factor set and PDT is realized by a fuzzy support vector regression machine, Liang-hsuan Chen and Ming-chu Weng[19], fuzzy approaches are applied to represent the relationships between Customer Requirements (CRs) and engineering Design Requirements (DRs) as well as among the DRs . A new measure for evaluating the fuzzy normalized relationships was derived. The relationships between Customer Requirements (CRs) and DRs in QFD are represented in the matrix form, which is also called the house of quality (HOQ). The matrix has two dimensions, i.e., customer wants and engineering design requirements. A triangular-shaped matrix placed over the engineering design requirements corresponds to the correlations between them. . A point system was applied to evaluate the relationships between CRs and DRs, as well as among the DRs based on the strength of relationship in the existing approaches.

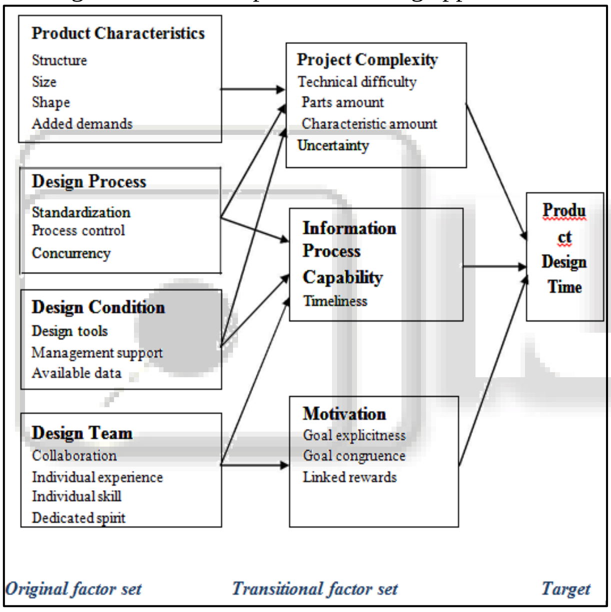

Fig. 2: Conceptual model of factors that influence design time

A fuzzy model was formulated to determine the fulfilment level of each DR for maximizing the customer satisfaction under the resource limitation and the considerations of technical difficulty and market competition. The producing ranges of fulfilment level of each DR and those of customer satisfaction can provide the QFD team with more information. Based on the fuzzy technical importance ratings of DRs, this study formulated a fuzzy linear programming model to determine the fulfilment levels of DRs for finding out the maximum level of customer satisfaction

V. Result

A. Modified Fuzzy Model Over Conventional QFD

Conventional QFD approaches focus on increasing customer satisfaction level. A modified fuzzy normalization relationship measure is derived to obtain more meaningful representation of fuzzy technical importance ratings of DRs.

Considering fuzzy cost parameters, business competition, and technical difficulty of elevating quality, a fuzzy model is formulated to determine the fulfilment level of each DR in order to obtain the maximum total customer satisfaction level at each possibility level. The membership function of fuzzy customer satisfaction is then determined.

Unlike the existing QFD approaches, the proposed approach can allow the QFD team to assess the relationships between CRs and DRs as well as that among the DRs by linguistic terms for dealing with the uncertainty in the stage of product design.

The fuzzy numbers are applied in the resolution processes. The possible ranges of the fulfilment levels of DRs and the resulting ranges of total custom satisfaction level can provide a QFD team with more useful information.

VI. Conclusion

In QFD planning process, the single objective point of view that focuses on maximizing customer satisfaction needs to be extended by considering the company's other design related objectives. Considering the multi-objective nature of the design problem, the decision framework(based on fuzzy logic) proposed in this paper enables the highest possible fulfilment of ECs to maximize overall customer satisfaction as an objective to be satisfied along with other enterprise related objectives such as minimizing technical difficulty and maximizing extendibility of Engineering Characteristics subject to a budget constraint. Another contribution of the proposed approach is that one can distinguish between the importance of the objectives that are taken into account in QFD planning process by integrating the objective's membership function and the membership function corresponding to its importance degree employing the composing operator.

VII. Future Scope

Fuzzy approach based QFD, would allow a design team to reconcile tradeoffs among the various performance characteristics representing customer satisfaction as well as the inherent fuzziness in the system. In addition, the modeling approach presented makes it possible to assess separately the effects of possibility and flexibility inherent or permitted in the design process on the overall design. Knowledge of the impact of the possibility and flexibility on customer satisfaction can also serve as a guideline for acquiring additional information to reduce fuzziness in the system parameters as well as determine how much flexibility is warranted or possible to improve a design.

References

[1] Akao, Y., ed. (1990). Quality Function Deployment, Productivity Press, Cambridge MA.
[2] Clausing, D., (1994). Total Quality Development, ASME Press, New York, NY.
[3] Day, R. G. (1993). Quality Function Deployment: Linking a Company with Its Customers, ASQC Quality Press, Milwaukee WI.

[4] Dean, E. B. (1998). Quality Function Deployment from the Perspective of Competitive Advantage, http://akao.larc.nasa.gov/dfc/qfd.html
[5] Hutton, D. (1997). Quality Function Deployment (QFD): The House of Quality, http://www.dhutton.com/samples/sampqfd.html
[6] Lockamy, A., and Khurana A., (1995). Quality Function Deployment: Total Quality Management for New Product Design, International Journal Quality and Reliability Management, Universal Press Ltd. (UK) 1995.
[7] Terninko, J., (1996). Quality Function Deployment (QFD) http://www.dnh.mv.net:80/ipusers/rm/qfd.htm
[8] Woods, R. C., (1994). Managing to Meet Employee Expectations: Quality Improvement Tools Narrow the Gap Between Employee expectations and Company Resources, Human Resource Planning, Volume 16 number 4.
[9] H.Chena, W.Ko, Fuzzy approaches to quality function deployment for new product design, Fuzzy Sets and Systems 160 (2009) 2620–2639.
[10] Q. Wu, Fuzzy measurable house of quality and quality function deployment for fuzzy regression estimation problem, Expert Systems with Applications 38 (2011) 14398–14406.
[11] L.Chen, M.Weng, A Fuzzy Model for Exploiting Quality Function Deployment, Mathematical and Computer Modeling 38 (2003) 559-570.
[12] Z.Sener, E.Karsak, A combined fuzzy linear regression and fuzzy multiple objective programming approach for setting target levels in quality function deployment, Expert Systems with Applications 38 (2011) 3015–3022.
[13] K.Kim, H.Moskowitz, A.Dhingra, G.Evans, Fuzzy multicriteria models for quality function deployment, European Journal of Operational Research 121 (2000) 504-518.