

# Research on Application System of Integrating QFD and TRIZ

Deng Chaoqun

School of Management, Wuhan University of Technology, Wuhan, P.R.China, 430070

(E-mail: dengchaoqun1988@163.com)

**Abstract** Customers are ultimate judges of products. In order to produce the world-ranking product, customer information must be embodied in the part of production and hierarchy of control. This paper firstly points out the deficiency of QFD and the superiority of TRIZ. And then it constructs the application system of integrating QFD and TRIZ based on the theoretical rationale of the integration. The main function modules of this system are also introduced in this paper. Finally it safely arrives at a conclusion as following: the integration of QFD and TRIZ can clarify the black-box process of converting the customer needs to design requirements.

**Key words** QFD; TRIZ; Integration; Confliction matrix

## 1 Introduction

QFD originated in Japan in 1960s. Two professors Mizuno and Yoji Akao compile and publish a book Quality Function Deployment, which introduces the main content of this method from the perspective of quality management. However, the deficiency of QFD in practical application arouses many scholars to add new analytical methods into QFD. Clausing and Pugh (1991) realized that the principle of innovation should be involved in the process of converting the customer needs to design requirements, and they put forward an Enhanced Quality Function Deployment (EQFD)<sup>[1]</sup>. Adiano and Roth (1994) supposed that traditional QFD can not resolve the dynamic feedback problems between customer needs and manufacturing process, thus they proposed Dynamic Quality Function Deployment (DQFD)<sup>[2]</sup>.

TRIZ was created by Altershuller, who is a patent expert in admiralty in the former Soviet Union. It is a problem solving system established on the basis of the evolution law of technology systems. TRIZ and other quality engineering technologies provide the theoretical guidance for a new product development. In recent years, domestic and foreign scholars research on the relationship and integration between QFD and other methods such as TRIZ, Taguchi methods, Design of Experiments and so on. Ross (1988) firstly identified the role of Taguchi methods and Design of Experiments played in QFD<sup>[3]</sup>. Terninko (1999) proposed a model of customer-driven produce design by synthesizing the methodologies of QFD, Taguchi methods and TRIZ<sup>[4]</sup>.

Zhao Xinjun et al (2002) put forward a design technique to resolve the contradiction or conflict of the techniques. Beginning with the House of Quality (HOQ), it firstly determined the interaction or contradiction of quality characteristics, and then made use of the conflict matrix of TRIZ to solve the contradiction existed in the roof of HOQ<sup>[5]</sup>. Ma Yanhui, Hezhen (2007) studied how to convert customer requirements into quantified design features<sup>[6]</sup>. Yu Yuanguan, Shi Guilong (2008) applied the theory of inventive problem solving into HOQ to perfect the process of QFD<sup>[7]</sup>.

This paper regards that although QFD has many advantages, it encounters several bottleneck problems in the implementation. TRIZ can solve these problems perfectly, but it can do nothing to convert customer needs. Therefore, if we combine the two methods in one organic whole, it not only can make up the deficiency of QFD, but also give full play to the superiority of TRIZ.

## 2 The Deficiency of QFD and the Superiority of TRIZ

QFD has achieved a wide range of application since the birth due to its focus on customer satisfaction, benchmarking and trans-departmental teamwork. However there are still some deficiencies requiring further improvements, which can be summarized as following: 1) It makes an inadequate consideration of product life cycle. The company should pay attention to the product life cycle when conducting a new product development in order to avoid the phenomenon that the new product may withdraw from the market soon just like a flash in the pan. 2) It proposes the question what to do, but can not answer the question how to do, the roof of HOQ analyses the correlation relationship between quality characteristics. The problem that a negative correlation is present between characteristics is defined as a bottleneck problem. Although Yoji Akao mentioned the bottleneck problems in his works, but he did not provide a train of thought to resolve these problems which only can be settled by the

experience of the staff engaging in the product design and production. 3)The process of converting customer requirements to quality characteristics is not definite. QFD may be powerless to provide concrete steps to accomplish this black-box process, which will not only restrict the popularization of this method, but also put difficulties in the way of improving the process of deployment.

TRIZ is the prefix of Theory of Inventive Problem Solving in Russian. The founder Genrich. S. Altshuller defined the inventive problems as problems which contain at least one contradiction. He maintained that the contradiction means the improvement of one characteristic will lead to the decline of the other characteristic in the system. A case in point is the speed and the fuel cost of a car. If we accelerate the speed of a car, we will reluctantly increase the fuel cost. Altshuller refined 39 prominent parameters which will lead to the system conflict and 40 pieces of inventive principles resolving the conflict by analyzing more than 1.5 million pieces of patents for invention. What's more, he developed the 39th-order conflict matrix to solve the inventive problems. In the conflict matrix, the row represents the characteristics requiring improvements, whereas the column represents the aggravated characteristics. The intersection between each row and column is filled by serial numbers which stand for recommended inventive principles. It is defined that each intersection contains a maximum of 4 principles. However, these principles can not solve the problems directly, they can only provide the most possible direction of solutions. When solving the practical problems, we should put forward the specific solutions by combining the objective conditions with the principles.

TRIZ includes a series of logic methods such as Inventive Principles, Algorithm for Inventive Problem Solving and Standard Techniques. The general principle of the application of TRIZ is that it firstly transforms the common problems into TRIZ problems, and then takes an advantage of tools such as Inventive Principles, Standard Techniques to find the analogous solution. The specific process is shown in figure 1.

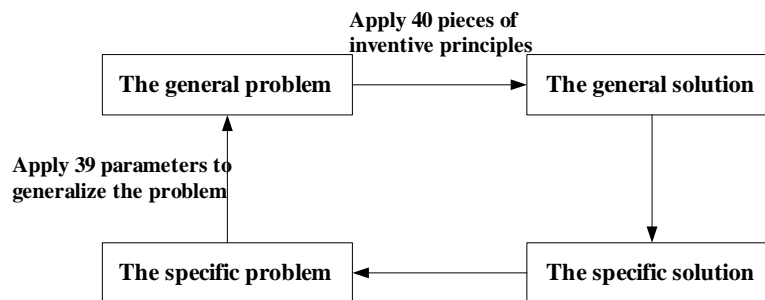


Figure1 The Simplified Process of TRIZ

### 3 The Theoretical Basis of Integrating QFD and TRIZ

The deficiencies of QFD mentioned above can be made up by TRIZ. For instance, we use the sigmoid curve to determine the life cycle of the designed product. If there is no market prospect in this product, we should research and develop a new product in a higher technical level according to the evolution law of the technique system. What's more, TRIZ collects and analyzes the related information (mainly the technical information) of products or patents combining with the product which is remained to be designed, it uses the idea and method of analogy to transform the conflict or the contradiction in the process of product design into the general engineering parameters, and then according to corresponding inventive principles provided by the conflict matrix of TRIZ, the specific programs for the design of a new product can be determined. Beyond the shadow of doubt, it is obvious that TRIZ can be utilized to determine the information of product planning, the information of customer demand, the information of choosing the concept, the information of choosing the parts and the information of production planning and so on, while QFD just points out the direction of the specific application of TRIZ. Therefore, the combination of QFD and TRIZ is the perfect complement for one another in the process of developing a new product.

This paper mainly studies in what way TRIZ can settle a negative relationship between quality characteristics in the correlation matrix, that is how these conflicts can be transformed into what is in accordance with 39 technique parameters in the conflict matrix. We can relate the interaction of quality characteristics to the conflict matrix of TRIZ.

Therefore, we design an application system of integrating QFD and TRIZ to realize the

above-mentioned process: input a pair of contradictory parameters into the system, search the inventive principles in the conflict matrix and find the creative solutions combining with actual conditions. The specific process is shown in figure2.

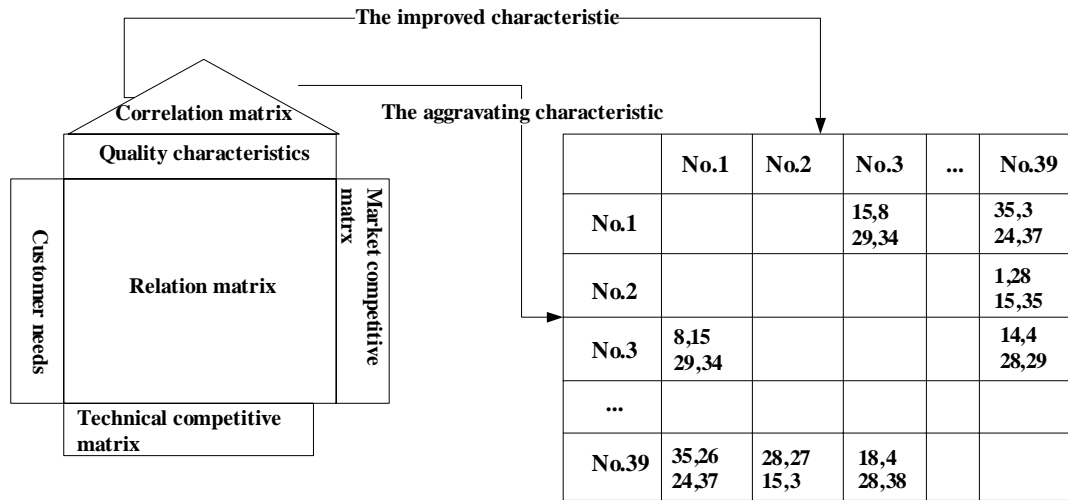


Figure 2 The Principle of Integrating QFD and TRIZ

#### 4 The Introduction of Application System of Integrating QFD and TRIZ

##### 4.1 Requirements analysis

The system software is required to be designed as an integrated system as well as separate sub-systems for QFD and TRIZ. It is required to construct the HOQ, evaluate the competitive ability of a new product, discover the conflict in the HOQ and give rapid feedback to the conflict matrix in order to find a solution. It is necessary for users to maintain the database of inventive principles including addition, modification and deletion. Besides, the user can print the report to get an ocular acquaintance of various analysis results. The detailed introduction is made as following.

##### 4.2 The main function modules of the system

The system is mainly divided into three modules: the module of constructing the HOQ, the module of solving the conflict and the module of engineering reports.

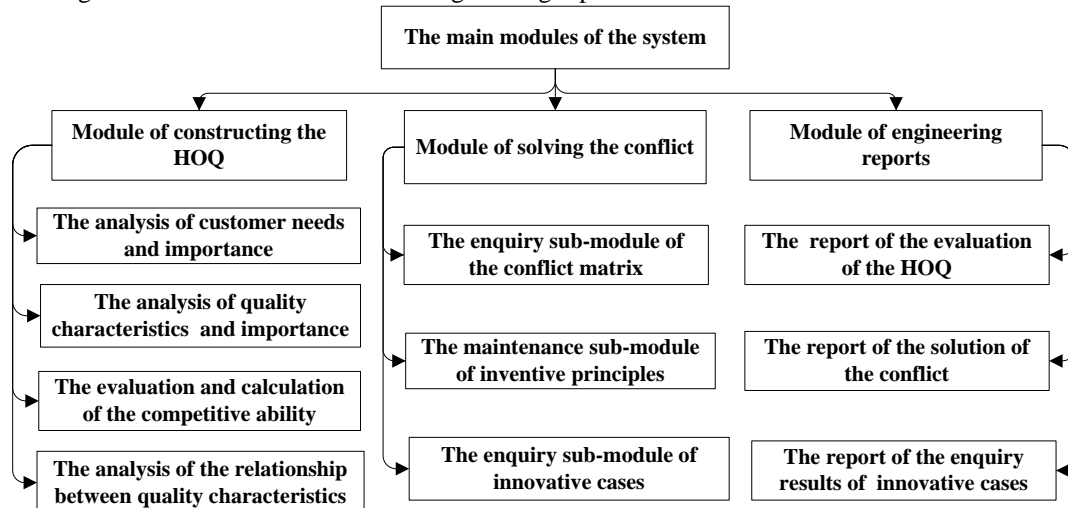


Figure 3 The Structure Diagram of the Main Function Modules of the System

##### 4.2.1 Module of constructing the HOQ

(1) Input the targets of customer needs of a product, and the system will calculate the customer importance  $k_i (i=1,2,\dots,n)$ ;

(2) Input the targets of quality characteristics of a product, and due to the fact that the ceiling of the first-level HOQ is the left wall of the second-level HOQ, the input data will automatically be addressed

into the database as the input data of the second-level HOQ.

(3) Input the matrix  $r_{ij}$  between the targets of customer needs and quality characteristics, and according to the formula (1):

$$h_j = \sum_{i=1}^n k_i r_{ij} \quad (j = 1, 2, \dots, m) \quad (1)$$

The system edits the function to calculate the technique importance  $h_j$ .

(4) This sub-module includes the evaluation of the competitive ability of the market, the technology and the comprehensive competency. According to the formula (2):

$$\mathbf{M} = \frac{\sum_{i=1}^n k_i m_i}{5 \sum_{i=1}^n k_i} \quad (i = 1, 2, \dots, n) \quad (2)$$

The system edits the function to calculate the index of the market competitive ability,  $m_i$  represents that to what extent products of our own and competitors are satisfied with customer needs.

According to the formula (3):

$$\mathbf{T} = \frac{\sum_{j=1}^m h_j t_j}{5 \sum_{j=1}^m h_j} \quad (j = 1, 2, \dots, m) \quad (3)$$

The system edits the function to calculate the index of the technique competitive ability,  $t_j$  represents the competency of each targets of quality characteristics.

According to the formula (4):

$$\mathbf{C} = \mathbf{M} \times \mathbf{T} \quad (4)$$

The system edits the function to calculate the index of the comprehensive competency.

(5) Finally we analyze the dependence relationship between quality characteristics. If there is a negative or strong negative relationship, we will enter into the module of solving the conflict in order to settle the technique conflict. Besides, the physical conflict can be solved by separation principle.

#### 4.2.2 Module of solving the conflict

(1) Enquiry sub-module of the conflict matrix: choose the improved parameter and aggravated parameter, search in the conflict matrix and find a commended solution.

(2) Maintenance sub-module of inventive principles: the user can add, modify, delete and inquire about inventive principles according to industrial classification. As a result, the inventive principle will become more reliable, feasible and applicable combining with specific conditions.

(3) Enquiry sub-module of innovative cases: successful cases of developing a new product are stored in the database, the user can inquire about cases according to industrial classification in order to broaden his horizon and find innovative thinking and inspiration.

#### 4.2.3 Module of engineering report forms

It is convenient for users to make or print the analysis results in the form of reports such as the evaluation result of the HOQ, the enquiry result of the conflict matrix, the enquiry result of innovative cases and so on. What's more, the user can output 39 technique parameters and 40 inventive principles in the form of Excel.

### 4.3 Development tool and operating environment

The system chooses Microsoft SQL Sever 2005 as a backend database, adopts an object-oriented development language C#. The system is in possession of good compatibility and scalability. And from the perspective of the application and development of the database, the system has taken into account the effectiveness and practicability.

## 5 Conclusion

In conclusion, the application system of integrating QFD and TRIZ can implement QFD effectively in the process of the development of a new product. And it can settle the technique conflict by means of 40 pieces of inventive principles of TRIZ. Besides, it can provide a great variety of innovative cases as

references for users. However, this paper scarcely details specific steps of designing this system, only introduce the overall framework of the system. The system design is remained to be further researched.

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