

PROTOTYPE OF PROGRAM DEVELOPMENT OF QFD TOOL TO CONVERT CUSTOMERS' NEEDS INTO THE SHAPE OF A PRODUCT AUTOMATICALLY FOR SMALL AND MEDIUM SIZED CERAMIC FACTORIES

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Abstract

The research objectives of this study were (1) to study the format to convert customers' needs to a product's shape, and (2) to develop a quality function development (QFD) tool program prototype to convert a product's design shape automatically and evaluate the users' satisfaction. The research was divided into 2 parts. The first part involved collecting data from interviews using a specific sampling of each person in 5 small and medium sized ceramic factories and using visual basic for application (VBA) language to control the application working on Microsoft's Excel program and AutoLISP language to display a product's shape on AutoCAD to support product design automation. The second part involved evaluating the users' and customers' satisfaction with the QFD tool program using a closed /open questionnaire from 3 user groups in 30 factories with a total of 90 people and a 4 customer groups in 30 factories with a total of 120 people. The research results were that the QFD tool prototype has the ability to convert customers' needs into the shape of a ceramic coffee cup automatically, format the size of the coffee cup in the QFD tool program, and build and display the coffee cup automatically on the AutoCAD program. The designers do not need to waste time designing the product and the customer can see the shape of the ceramic product immediately. The results of the users' and customers' satisfaction levels using this program had an average of 3.69 and standard deviation of 0.42 with a high level of satisfaction.

Keywords: Program QFD tool, format to convert customer needs, convert product design shape automatically

Introduction

The development of sustainable small and medium sized enterprises (SMEs) needs the utilization of technology to help produce designs that are unique to their products. This is a major contributing factor for SMEs to compete on the world market in terms of quality and efficiency in production. The ceramic industry in Thailand is an increasingly competitive business, as revealed by a survey of 2470 operators of SMEs in which it was

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found that 70% of them said that their business competitors had increased in numbers. The growth of SMEs Thailand has been as a result of taking advantage of cheap labor and resources, rather than from creating quality products, and this method of growth is not sustainable (Panpiemras, 2005).

The solutions for such problems in this research have the main idea of optimizing product design and reducing the costs by applying quality function deployment (QFD) techniques used in the design of their products by converting to products being shaped automatically.

QFD is a matrix structure analysis which transforms the desires of the customer/user into the language required to implement a product. The result is a matrix structure analysis which prioritizes and links the product development process so that it assures product quality as defined by the customer/user (Dean, 1998).

The concept is to develop the QFD tool for supporting the automatic design of products that can be developed with visual basic application (VBA) language through the ActiveX interface to display the design of a product's shape via the AutoCAD program (Gulati, 2012).

The research objectives of this study were 1) to study the format to convert the customers' needs to a product's shape, and 2) to develop a QFD tool program prototype to convert a product's design shape automatically and evaluate user satisfaction.

In the first phase of this research it was found, after surveying the problems of the SME ceramic industry in Thailand, that 80% of the designers in 10 ceramic factory sample groups were not in touch with the customers' needs concerning product requirement. The researcher developed a tool to help the design of a product using QFD which helped the ceramic designers to design products that take into consideration the customers' needs and requirements. The results of the users' satisfaction level when using this program had

an average of 4.46 and a standard deviation of 0.56 with a high level of satisfaction (Intarapadung, 2010).

The second phase of this research was to study the acceptance of the software, analyze the levels of awareness and satisfaction, and analyze the relationship of the deployment software QFD tool. The researcher found that the advantages of the software QFD tool were the perceived ease of use and benefit, ability to apply, availability for use, efficiency, and effectiveness. The correlation analysis of the relationship between the software applications was at a high level (Intarapadung, 2011).

In the third phase the researcher found that ceramic factory design staff manually designed products as they lack CAD program training and must often hire outside professional designers which is not cost effective. The researcher updated the QFD tool to be user friendly so that it could design automatically without professional training. The designers set the parameter design requirements from the second phase of the House of Quality (HOQ) to design shapes automatically. The researcher updated the QFD tool with VBA and AutoLISP programs including AutoCAD-based products for the shapes of the designs.

The ceramic industry is fundamentally linked to other industries such as the construction, electronics, computer, and automotive industries and, to meet domestic and import demands, production technology is being continuously developed. In Thailand, the number of facilities that are licensed to operate ceramic factories is 813, with 47050 employees (Office of Small and Medium Enterprises, 2010). The export value of ceramic products in 2011 was 20934.99 million baht and the import value of ceramic products was 19587 million baht (Department of International Trade Promotion Ministry of Commerce, Royal Thai Government. 2011). The ceramic industry's supply chain will benefit from the researcher's design and research development and will increase production effectively.

Materials and Methods

Quality Function Deployment

QFD is a means of allowing designers to decide on the ways to meet the needs of their customers by using the best available resources (Sasananan, 2007). The results from the QFD are the HOQ as shown in Figure 1. To create the HOQ the real customers' requirements are analyzed (Sayapun, 2010). The steps are as follows:

- 1) Identify the needs of the client or the customer's quality requirements through interviews or questionnaires and the customer's complaints by writing the needs of the customers in the far left side of the HOQ.
- 2) Assess the needs of each client.
- 3) Make a comparison of the products from the perspective of its customers.
- 4) Evaluate the strengths and weaknesses of competitors and then fill in the boxes on the right side of the HOQ with the needs of each client.

5) Specify the technical requirements of the quality or composition to meet the needs of each client in the HOQ.

6) Evaluate the relationship between a customer's needs and technical requirements

7) Show the relationship between the technical requirements for each section of the roof of the HOQ with the technical specifications.

8) Identify the degree of importance of each technique based on the priority needs of customers, and comparisons with competitors.

9) Specify the technical requirements that will be used to design the final product, the target of the operation

Phases of QFD

QFD has 4 phases consisting of 4 HOQs (Creative Industrial Research Institute, 2012) and 2 phases are used with each phase resulting in a HOQ that reflects the specific needs of the customer. The relationship between components of an HOQ is an

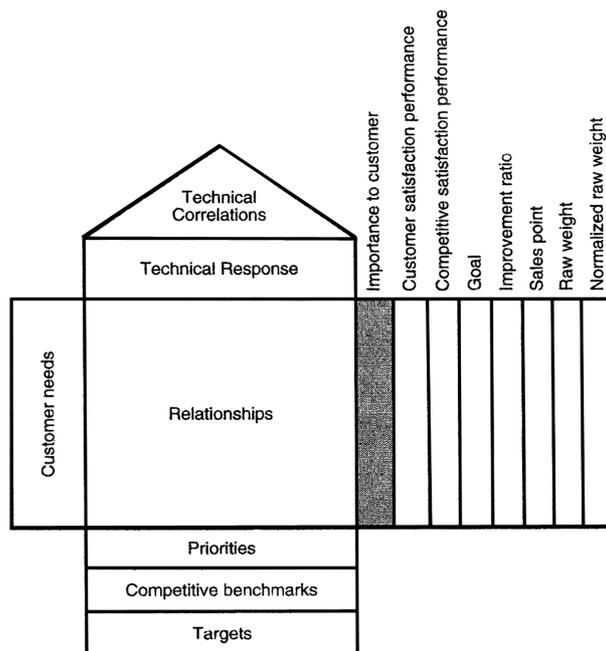


Figure 1. House of quality

important part in building an HOQ, as shown in Figure 2.

Phase 1 consists of the production plan where the customers' needs from the ceramic factory and market are taken into consideration when making the production plan. In phase 2 the product design is considered and the design requirement is inputted into the second HOQ.

Principles of Conversion to the Product Shape

This computer program has been developed using QFD for analyzing the real needs of customers from a second HOQ using the data to set the size and shape of the products. The program can be offered as a user friendly tool to design ceramic products and display the shape of products via the AutoCAD program automatically. The

computer language is used to develop the QFD Tool by connecting the AutoCAD to work together with a VBA and AutoLISP language. The program converts the AutoCAD-based products into the required shape using the information of the needs of the client using the application of the QFD tool. Conversions range from 2-phase parameters of a product shape in 2-dimensional and 3-dimensional product displays.

Software Development Process

Requirement Specification and Analysis

A structured interview is used to collect the users' requirements from ceramic factory owners, managers, and designers to analyze the function and non-function requirements in order to meet the customers' needs. A unified

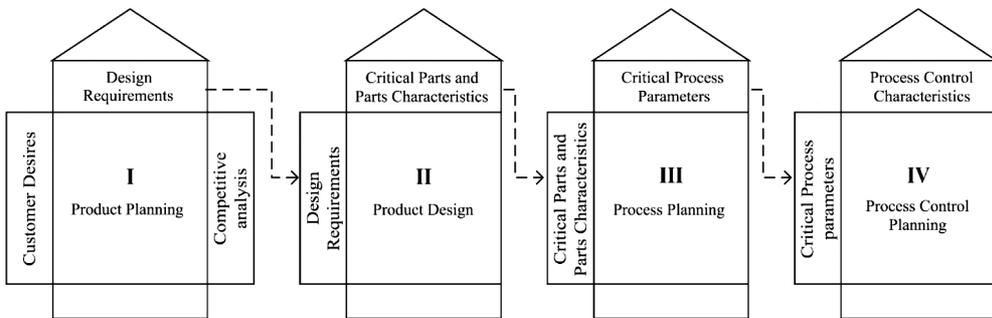


Figure 2. The 4 phases of QFD

Source: Cohen (1995)

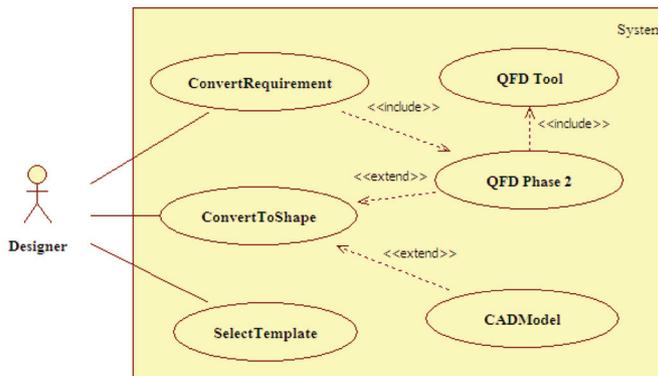


Figure 3. Use case diagram of QFD tool

modeling language tool is used to analyze function requirements, as shown in Figure 3.

In Figure 4 the QFD Tool has 3 functions: 1) to convert a customer's needs from QFD phase 2 (ConvertRequirement); 2) to convert requirements to shape (ConvertToShape); and 3) the user selects a coffee cup template from a dialog template (SelectTemplate).

Analysis and Design

A 3-step conversion process of the customers' needs is used in shaping the coffee cup product automatically.

In the first step, the customers needs are converted using the HOQ in phase 2 to determine the quality of the product shape, which consists of the width, the height of the cup, and the width of the handle of the cup in a 2-dimensional display, and to determine the thickness of the cup in a 3-dimensional display.

In the second step, the coffee cup, consisting of the 2-dimensional shape parameters, lines, arcs, and circles included in the design, is converted into the 3-dimensional display with the extrude and revolve commands.

In the third step, programming is used with the VBA and AutoLISP controls and AutoCAD to design a 3-dimensional shape of a coffee cup from the dimensional parameters from step 2. In this step it is necessary to program the VBA language to make a connection between the plug-in Microsoft Excel program to collaborate work with the AutoCAD program.

Application Development

The researcher developed the interface of the QFD tool program from the parameters of the QFD phase 2 converting the desired shape automatically using the VBA language that can create a 2-dimensional and 3-dimensional image via the AutoCAD program (Contract CADD Group, 2012).

This work has been implemented in AutoCAD under the ActiveX Automation interface and VBA programming environment. AutoCAD is customized for the coffee cup design automation through the ActiveX Automation interface which manipulates AutoCAD programmatically using VBA. Programming is used to manipulate shapes produced in 2-dimensional and 3-dimensional form for AutoCAD objects (lines, circle, arcs, view, viewport, extrude, revolve, etc.) described by the AutoLISP object model that can be created, edited, and manipulated by VBA programming environment.

Testing and Evaluation of User Satisfaction and Acceptance

In testing the QFD tool program follows the principle of software engineering with black box testing and white box testing. Black box testing is used as the test case method of the function of the QFD tool program. White box testing is used as the unit's test method.

For evaluating the QFD Tool program a sample group consisting of owners, managers, and product designers was used. A questionnaire was used as a tool to collect information and

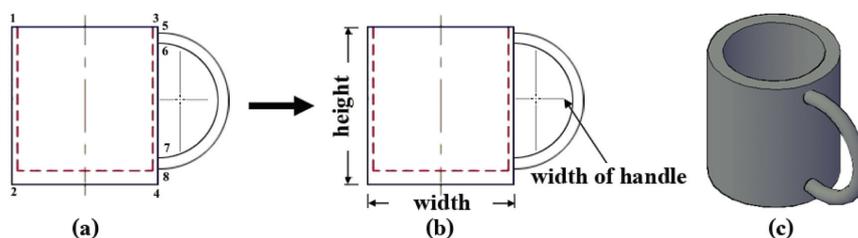


Figure 4. The parameters of a coffee cup

evaluate the users' satisfaction with the program using the statistical data analysis by the mean and standard deviation. This questionnaire was examined by three experts and the consistency of the contents of more than 0.6 can be used as a tool to collect data and evaluate user satisfaction with sample group in this research.

Results and Discussion

Results

The principles of converting a coffee cup-shaped product uses a set of parameters consisting of the coffee cup model design. The user inputs the configuration parameters

in the model, which consist of arc, width, height of the cup, and the width of the handle of the cup, as shown in Figure 5.

The results of this study showed that the QFD tool program supports the modular design of a coffee cup automatically. The user selects the coffee cup template by setting the width of the mouth, bottom, height, and size of the handle of the cup, putting the modeling parameters through a user interface, as shown in Figure 6. The user uses the QFD tool program to convert those parameters in order to design the product displayed in AutoCAD, as shown in Figure 7.

The results of testing and evaluating the QFD tool for users' satisfaction and acceptance are summarized in Table 1. Table 1

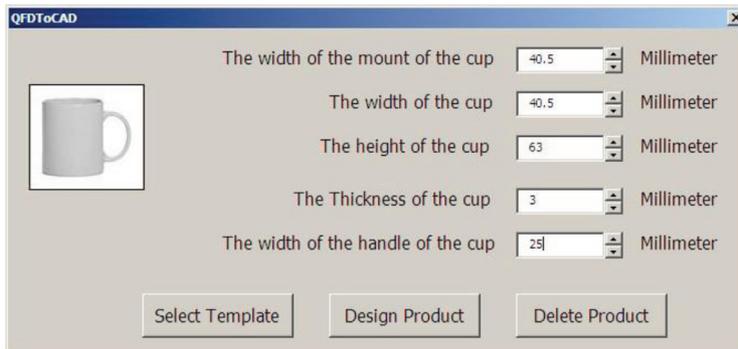


Figure 5. The user interface to define the shape of a coffee cup

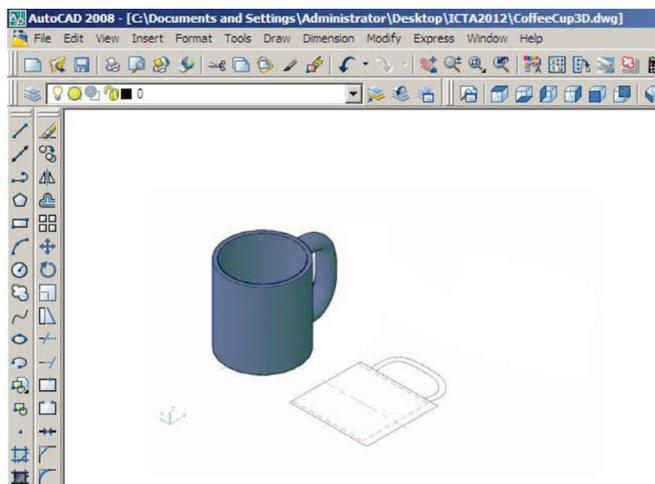


Figure 6. The modular design of a coffee cup automatically produced

Table 1. Analysis of the mean and standard deviation

No.	Questions	\bar{x}	S.D.	Interpretation
11	Design and layout of the screen. Can be easily used.	4.42	0.69	agree
22	The apparent size. The color of text and graphics.	4.30	0.77	agree
3	The program is easy to learn.	3.77	0.76	agree
4	The program is easy to use and uncomplicated.	3.64	0.75	agree
5	The program is easy and quick to use.	4.06	0.65	agree
6	The program has the right function.	3.43	0.70	average
7	Results that meet customers' needs.	3.28	0.67	average
8	The program can be customized according to size.	3.38	0.75	average
9	The program has helped support the work for the designer's products.	3.17	0.78	verage
10	The overall program actually works and performs well.	3.48	0.82	average
Total		3.69	0.42	agree

analyses the satisfaction level of the users and the average total of 3.69 and a standard deviation 0.42, which has a high level of user satisfaction and acceptance.

Discussion

The development of the QFD tool program is used to convert the customers' needs into the shape of the desired product design. The design parameters of the components of the product shape are set and a user friendly interface is developed to input the parameters automatically producing a graphic product design via the AutoCAD program using the VBA language. The AutoCAD program can create a Standard Template Library file to support the production design.

The results of the research integrating the QFD technique and computer software created a QFD tool program that can be used in the ceramic industry to increase efficiency without the reliance on outside designers

Conclusions

The QFD tool prototype development program helps to convert customer needs into a desired product. The QFD tool was developed using the QFD technique in phase 2 and the design of user interfaces with the VBA language that creates a product shape automatically.

The QFD tool gives the user the ability to design a product without prior skill or training. The ceramic industry will benefit from the QFD tool program by not having to rely on manually designing products or hiring outside professional designers which will result in a more efficient production process.

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