

# Use of Quality

## Function Deployment Analysis in Curriculum Development of Engineering Education and Models for Curriculum Design and Delivery

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**Abstract** — Quality Function Deployment is a management tool which is used in identifying customers' needs and to provide those requirements to them with Quality Consciousness. This modern technique is used in developing curriculum of engineering education. Two different models of curriculum design and development and curriculum delivery process is discussed. Designing an efficient curriculum with continuous improvement module in it is the need of the day.

**Index Terms**—Curriculum, Design, Quality Function Deployment, Quality.

### I. INTRODUCTION

Quality Function Deployment (QFD) is a planning tool used to fulfill customer expectations. It focuses on customer expectations or requirements, often referred as the voice of the customer. It is a team based management tool in which customer expectations are used to drive the product development process. By implementing QFD, an organization is guaranteed to implement the voice of the customer in the final product.

“Quality function” is defined as the collection of activities through which one achieves fitness for use. “Deployment” is the Japanese word, which refers to an extension or broadening of activities. Thus, “Quality Function Deployment” means that responsibilities for producing a quality item. The American Supplier Institute Inc[1] defined Quality Function Deployment as a system for translating consumer requirements into appropriate company requirements at every stage, from research through product design and development, to manufacture, distribution, installation and marketing, sales and service.

QFD is a systematic and organized approach of taking customer needs and demand into consideration while designing new products or services or while improving them. It is a methodology for planning products and services, which starts with the voice of customer. The concept of QFD was introduced in Japan. The QFD methodology was developed at Mitsubishi's Kobe Shipyard in 1972 Sunil Sharma[2].

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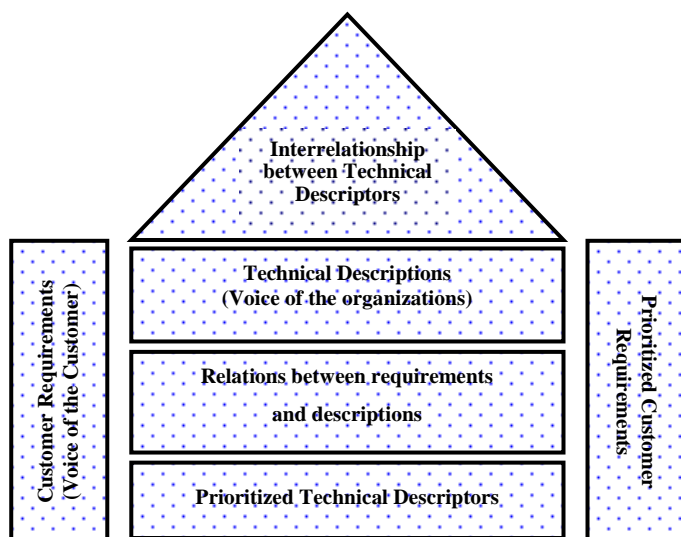
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QFD is a method for developing quality design aimed at satisfying the customer's demands into design targets. Here major quality assurance points will be used throughout the development phase. In the present scenario, the service organizations are widely adopting the concept of QFD in view of improving the service quality. Sarda and Kallurkar[3] wrote, the Mechanical Engineering Department of University of Wisconsin used QFD to obtain customers' feedback on the Mechanical Engineering under graduate course. Curriculum committee had proposed curriculum changes. But, since the department's entire faculty did not support the changes, none were made. The main external customers were determined to be full time undergraduate students, since they would be direct beneficiaries of the modern curriculum. The QFD result indicated that the Mechanical Engineering Department was not fully meeting internal and external customers' need. The faculty identified the need to redesign the undergraduate curriculum and the need for increased support and recognition of faculty members by the chairman of department. There was consensus about these improvements and improvement processes were implemented. Durga Prasad, et. al[4] suggested a Total Quality Engineering Education (TQEE) model through Quality Function Deployment, which is one of the techniques of TQM. Majid Jaraiedi and David Ritz [5] used QFD to dissect advising and teaching in education and looked for possible solution that would improve their perception in students' view. They concluded that QFD is the answer for specific design requirements and to be compared against each other to see, which satisfies the customers' requirements ideally. They used QFD to record and compare all the ideas and to highlight the valuable ideas.

The curriculum of the engineering education must be dynamic in nature. Obsolescence of technology and not meeting students' expectation will be fatal to engineering education. Therefore the modern management technique QFD is most suitable to design and develop a dynamic curriculum.

### II. THE HOUSE OF QUALITY

The primary planning tool used is the house of quality. The house of Quality translates the voice of the customer into design requirements that meet specific target values and matches those against how an organization will meet those requirements. The construction of house of quality is as follows.



**Fig. 1:** The House of Quality

In the above Figure, the exterior wall in the left side is the customer requirements, the listing of voice of the customer, or what the customer expects in the product. On the right side prioritized customer requirements or planning matrix. The ceiling or the second floor contains the technical descriptors. The centre portion of the house is the relationship between customer requirements and technical descriptors. The roof of the house is the interrelationship between technical descriptors. The foundation of the house is the prioritized technical descriptors this is the structure for the house of quality.

### III. QFD METHODOLOGY

QFD analysis is a step-by-step process. The various steps are,

**Step 1:** Determining the voice of the customer (customer needs)

The voice of the customer is required to begin a QFD process, which can be obtained on the basis of experiences with the customer or on survey report.

**Step 2:** Determining the priority structure of customer needs and preparing the competitive evaluations of customer needs.

Pair-wise comparison of customer using Analytical Hierarchy Process (AHP) is the best way for obtaining the priority structure of customer needs. The priority structure indicates the relative importance of needs. The customer plays an important role in determining the relative position of the organization with respect to that of its competitors for each customer need. This competitive assessment of customer needs can be accomplished through survey of customers, which includes questionnaire survey, direct interviews, telephonic interviews and interaction through e-mail.

**Step-3:** Develop the customer portion of QFD matrix.

The horizontal portion of the QFD matrix is concerned to the information related to customer. The list of customer needs, priority rating and competitive assessment of customer needs are occupied with a proper order in this customer portion.

**Step-4:** Develop the Technical portion of QFD matrix.

The vertical portion of QFD matrix is related to the technical data. Once the customer needs are identified, then QFD team can establish appropriate design requirements that would satisfy those needs. The team for obtaining the target ratings for each design requirement conducts competitive technical assessment. Inter relationships for customer needs and design requirements are established, which are placed at the middle of the technical portion of the QFD matrix. The co-relationship of the design requirements can be examined. The objective is to highlight any requirements that are in conflict with each other. If action on one item will harm another item, this negative effect needs to be resolved. The triangular portion accommodates these co-relations, which gives the overall QFD matrix the appearance of a roof top. As a result, the QFD matrix is referred as the House of Quality. Column weights can be calculated, by using the customers' importance level in conjunction with weights assigned to the relationship symbols. The resultant number provides a method of judging the relative importance of each of the design requirements. Column weights can serve as an index for highlighting those design requirements that have the largest relative effect on the product. These column weights are entered at the bottom of the technical portion of the QFD matrix.

**Step 5:** Analyze the QFD matrix

Once this QFD matrix is completed, the analysis stage begins. The chief focus should be made on the appropriate design requirements to obtain the complete satisfaction of customer needs in order of final ranking. To fulfill each design requirement, all the necessary steps to carryout are analyzed.

### IV. QFD ANALYSIS FOR CURRICULUM DEVELOPMENT

The house of quality is the first name of the QFD charts or matrices, that appeared because there is a triangular shaped matrix attached to the top, sometimes called rooftop. The rooftop matrix looks just like a house, hence the name. It is a kind of conceptual map that provides the means for instructional planning and communications.

The general model for curriculum design requires 4 matrices. The first matrix is what's matrix it is also called needs matrix. Here the customers needs for the course is developed. In order to satisfy those needs, a set of required skills should be developed and the relationships between the two sets are evaluated. Once it is validated the skills can be carried into the second matrix namely skills matrix, to match a set of primary topics. On the development of topics matrix, the primary topics are broken down into secondary topics and this now creates subjects for which the instructional hours are assigned. This becomes the third matrix. The fourth matrix will be on delivery of the subjects and knowledge.

The QFD technique is used for the identification of various procedures or how's for satisfying the primary requirements' of the students and the details of QFD analysis is furnished below.

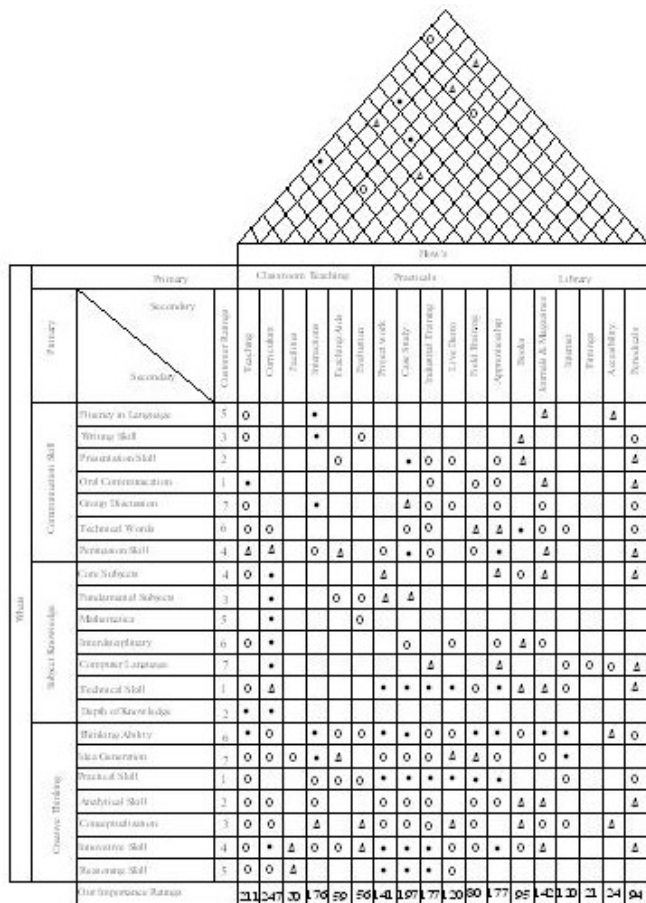


Fig. 2: QFD Model

Relationship between what's and how's

- Strong relationship – 5
- Medium relationship – 3
- △ Weak relationship – 1

Customer Importance Ratings: 1 – Highest, 7 – Lowest

The customer wants are identified and determined through the survey. These wants are the primary requirements of the customer, namely students and it is shown on the left side of the house of quality; they are communication skills, subject knowledge and creative ability. These wants are further identified through various secondary requirements. They are fluency in language, writing skill, presentation skill, oral communication skill, group discussion, use of technical words and persuasion skill in communication skill requirements. Core subject, fundamental subject, mathematics, interdisciplinary subject, computer language, technical skill and depth of subject knowledge is the requirement of subject knowledge. Thinking ability, idea generation, practical skill, conceptualization skill, innovative ability and reasoning skill in creative ability requirement.

The team determines how the organization is going to translate those customer wants into process design and process attribute targets. These are classroom teaching, practical sessions and library facility. These how's are entered across the top portion of the house of quality. These characteristics are further identified as teachers, curriculum, facilities, interactions, teaching aids and evaluation in classroom teaching. Project work, case study, industrial training, live demonstration, field training and apprenticeship is the primary procedure of practical works. Books, journals and magazines, Internet facilities,

timings of the library, accessibility of the library books and periodicals and news papers availability in the library facility.

In the next step the team evaluated each of the customer requirements against process attributes targets. In the relationship matrix of the house, the team evaluated how well its design will meet customer needs and the relationship weightage between what's and how's is given. In the roof of the house, the team developed the relationship between the attributes of process. In the next step the team developed importance ratings for its design attributes in the bottom row of the table. This was done by assigning values (5 for strong relationship, 3 for medium relationship and 1 for weak relationship) to each entry in the relationship matrix and then multiplying each of these values by customer importance ratings. These values in our importance ratings now provides a ranking of how to proceed with process design, with the highest values being the most critical to a successful process which satisfies the customer by providing their needs or requirements.

### V. MODEL FOR CURRICULUM DESIGN AND DEVELOPMENT PROCESS

The curriculum design and development model recommended for adopting in the engineering college is furnished below.

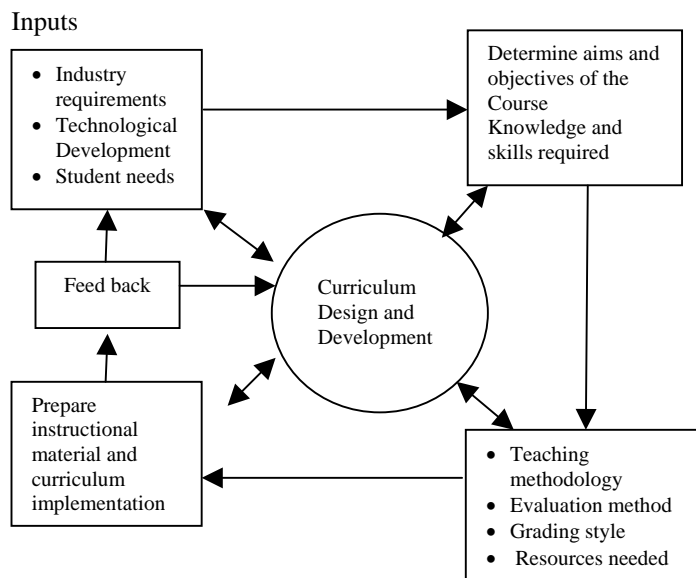


Fig. 3: The curriculum design and development model recommended for adopting in the engineering college

In the above model the activities of curriculum design and development is explained. The curriculum will be designed by considering the inputs such as industry requirements, technological developments and students' needs. After identifying this, the next step is to determine the aims and objectives of the courses and to decide about the intended knowledge and skills to be developed in the students. This would help to decide about the design of teaching methodology, students evaluation methods, students grading pattern and identify the resources needed for teaching learning process. This decision will lead to the preparation of instructional material and curriculum implementation process. A feedback will be collected from the industries and students and further the process will be continued once again from the beginning. This is a continuous improvement of curriculum design and development process.

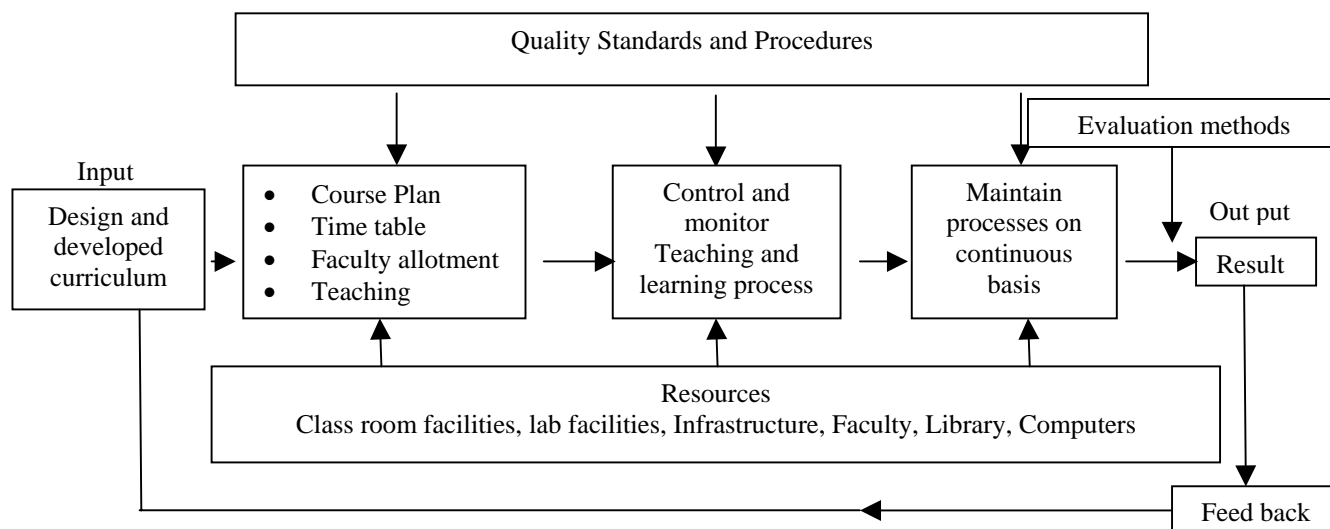


Fig. 4: The model of curriculum delivery in the college

## VI. MODEL FOR CURRICULUM DELIVERY PROCESS

The model of curriculum delivery process helps in providing exact framework for the delivery of the newly designed and developed curriculum in the engineering college.

The above model explains how the curriculum is delivered in the college. The input of the system is designed and developed curriculum. First block of the model houses the course plan, time table, faculty allotment and teaching materials. The next step or block in the model is controlling and monitoring of teaching and learning process. After establishing excellent teaching and learning environment the next step is to maintain the process on a continuous basis. These three blocks are executed under the supervision and guidance of standards and procedures of quality management objectives of the organization. These three blocks are supported with various resources such as classroom facilities, laboratory set ups, infrastructures, faculties, library and computers. The output of the model is the results achieved. The loop of the model is closed with a feed back to the input.

## VII. CONCLUSION

Globalization and liberalization of economy has intensified competition in various sectors such as industry, agriculture and services. However, the educational institutions, which cater to the human resources development component of the above sectors, have yet to realize the impact of market forces. Especially, the technical institutions are expected to set an example in propagating quality consciousness, teamwork, and optimization of productivity and manage the competitive environment and encourage team spirit among all concerned.

QFD can help to identify key product or process concerns with respect to customer requirements. QFD uses the work "backwards" towards design specifications. This is different from the current means of designing, where specifications are usually set first and then the process advances forward until the product is formed. Sometimes the end result is functional, but not necessarily what the customer wants. QFD is simply a planning tool. It begins with market research that identifies

just what the customers like, which is called the Voice of the Customer (VOC). It is through the QFD process that the VOC is translated into system and curriculum requirements. QFD is a tool for continuous improvement and problem solving.

The QFD analysis in curriculum development of engineering education and the models of curriculum design and delivery will definitely help the academic administrators to implement in their curriculum development process.

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