

THE APPLICATION OF QUALITY FUNCTION DEPLOYMENT (QFD) TO DESIGN A COURSE IN TOTAL QUALITY MANAGEMENT (TQM) AT THE UNIVERSITY OF MICHIGAN COLLEGE OF ENGINEERING

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Abstract

There are many pressures on universities these days to reduce costs without reducing the quality of education. The author has used Quality Function Deployment (QFD) to design a new course in Total Quality Management (TQM) that has increased the student to teacher ratio in the course, grown from one section to three, and continuously sends student teams into various departments in the University and local businesses to improve their quality programs, as well. This paper shows the step-by-step application of QFD that focuses both on external evaluators of the University (companies that hire graduates) and internal evaluators of the University (the students themselves).

1. INTRODUCTION

Quality Function Deployment (QFD) began thirty years ago in Japan as a quality system focused on delivering products and services that satisfy customers. To efficiently deliver value to customers, it is necessary to listen to the "voice" of the customer throughout the product or service development process. The late Dr. Shigeru Mizuno, Dr. Yoji Akao, Dr. Tadashi Yoshizawa and other quality experts in Japan developed the tools and techniques of QFD and organized them into a comprehensive system to assure quality and customer satisfaction in new products and services [1, 2, 3].

Since 1983, a number of leading North American firms have discovered this powerful approach and are using it with cross-functional teams and concurrent engineering to improve their products and services, as well as the design and development process itself [4, 5, 6, 7]. The author used QFD in 1985 to develop his Japanese translation business, Japan Business Consultants, and saw revenues increase 285% the first year, 150% the second year, and 215% the third year [8]. QFD was an integral part of Florida Power & Light's successful bid to become the first non-Japanese Deming Prize recipient in 1990 [9, 10]. It has been successfully applied in the U.S. healthcare industry since 1991 at the University of Michigan Medical Center [11].

2. HISTORY OF QFD APPLICATIONS IN EDUCATION IN NORTH AMERICA, EUROPE, AND THE PACIFIC RIM

QFD has been applied to university and other educational institutions in North America, Europe, and the Pacific Rim since the late 1980s. One of the earliest uses of QFD in education was by Ermer at the Mechanical Engineering Department of the University of Wisconsin - Madison in 1991 [12] where the department chairman used it to assess and respond to the needs of his faculty. Application reports began appearing at the North American QFD Symposia in 1992 with a case study for a high school guidance program [13] in which she reported outstanding improvements in student involvement in college planning activities. Krishnan and Houshmand demonstrated their use of QFD to balance between research and

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teaching at The University of Cincinnati Department of Industrial Engineering [14]. In this case, various customers such as businesses and students were identified, and their needs were translated through QFD into "product features" such as "communication skills, practical knowledge," etc. which were translated into "process features" such as "presentations, project reports, lab experiments," etc. QFD was used by Lakeshore Technical College in Wisconsin to increase the variety of course offerings and other structural issues such as parking etc. for its students [15]. Curriculum was addressed again in 1995 by Hillman and Plonka of Wayne State University [16] which portrayed the strong relationship between the needs of industry and the employability of engineering graduates. A full engineering curriculum update by Rosenkrantz led to an almost course-for-course match to SME Curricula 2000 recommendations at California State Polytechnic University [17]. A new application of QFD to strategic planning and funding was done at the University of Vermont by Hummel [18].

QFD activities to improve European institutions have also been taking place. Clayton reported on the use of QFD to build a degree program in the Department of Vision Sciences at Aston University in the United Kingdom [19]. Nilsson et al reported on the use of QFD to develop a Mechanical Engineering Program more responsive to the needs of changing industries in Sweden [20]. QFD was applied by Seow and Moody to design an MSc degree in Quality Management at University of Portsmouth in the UK [21]. Conjoint Analysis has been recently employed in the market research end of QFD and a study was conducted by Gustafsson et al at the University of Linköping, Sweden to develop a TQM course curriculum [22].

In Japan, Akao, Nagai, and Maki have systematized a process for identifying and analyzing both the internal and external evaluators of higher education and using QFD to identify and improve critical and conflicting needs [23]. Tiede polled the perception of Australian high school educators about QFD after it was used to strengthen the understanding of school policies by students, parents, and staff [24].

3. TQM 401: A SENIOR AND GRADUATE COURSE IN TOTAL QUALITY MANAGEMENT

In 1993, the College of Engineering at the University of Michigan introduced a course in TQM in the Department of Industrial and Operations Engineering. Capitalizing on many of the quality control techniques gaining popularity in the automobile industry, such as Taguchi Methods, C_pk measurements, SPC, etc. a professor assembled a course to cover these techniques. After its initial offering, the professor invited the author to take over the class. Because of my exposure to many advanced quality techniques, such as QFD, I decided to apply these to structuring the course according to customer needs.

My first application of QFD to a service sector activity had been in 1985 in my private Japanese translation business [8]. I had also used QFD to design several training courses on Japanese business and in QFD itself [25]. The benefits of using QFD were that I could focus my constrained resources, in my case time, on those areas that mattered most to the customers of my course. The word "customer" must be interpreted broadly. Traditionally, instructors do not look at their students as customers, but more like "raw materials" to be molded into a "product" that industry and society will accept. A more capitalistic interpretation is that students spend money and have choice. What I expected QFD to achieve was a course that would give students marketable knowledge and skills, and would be packaged such that the best students would choose it over other course options. I knew the starting point was to identify the customer.

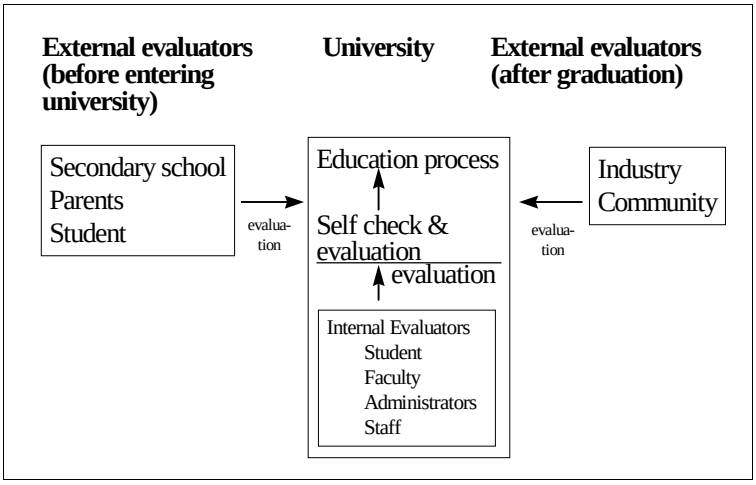

Fig. 1 Akao's concept of university evaluators [23]

3.1 The External Evaluator: Industry

Dr. Akao of Asahi University and one of the founders of the QFD methodology 30 years ago, has described two groups of customers of a university, which he calls internal and ex-

ternal evaluators [23]. See Figure 1. Since my concern was for a single course rather than a full curriculum or degree program, my customers were limited to industry as the external evaluator and the student as the internal evaluator.

TQM401, being a 400 level course, was intended for graduating seniors in Industrial Engineering who would be expected to participate in ever growing TQM activities in companies that were hiring them. Thus, it made sense to me to focus on those industries which frequently hired University of Michigan graduates and their future bosses as the customers. Since Michigan is the automobile capital of the world, I consequently spoke with a number of engineering managers in the automobile, automotive parts, and also the electronics industries. My purpose was to find what capabilities they wanted new hires have in addition to their engineering specialty. Their responses were then grouped using the KJ™ method into an Affinity Diagram which help structure the requirements from the customers' point of view. See Figure 2. When coupled with a hierarchy diagram, unspoken requirements can also be identified.

Engineering managers were also asked to prioritize their needs using the Analytic Hierarchy Process (AHP). The AHP uses pairwise comparisons that allow for an accurate measure of importance, including a ratio scale distance between values, unlike the more traditional rating scale used in QFD. The results are shown in Figure 3 using the first level of detail only.

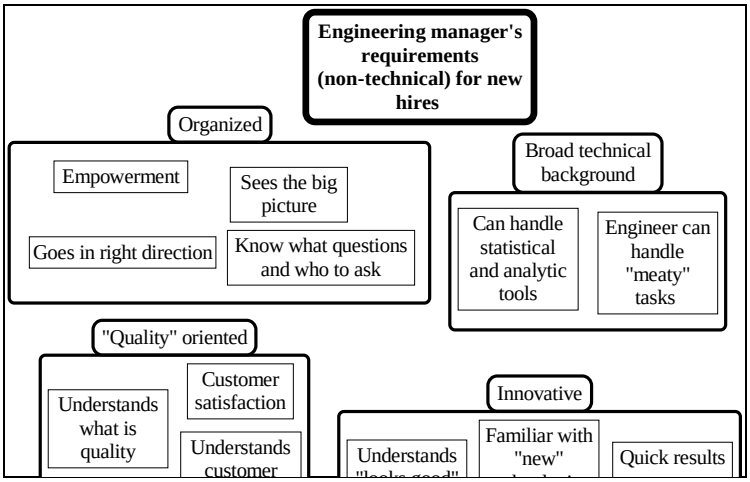

Fig. 2 Affinity Diagram of engineering managers' needs (partial)

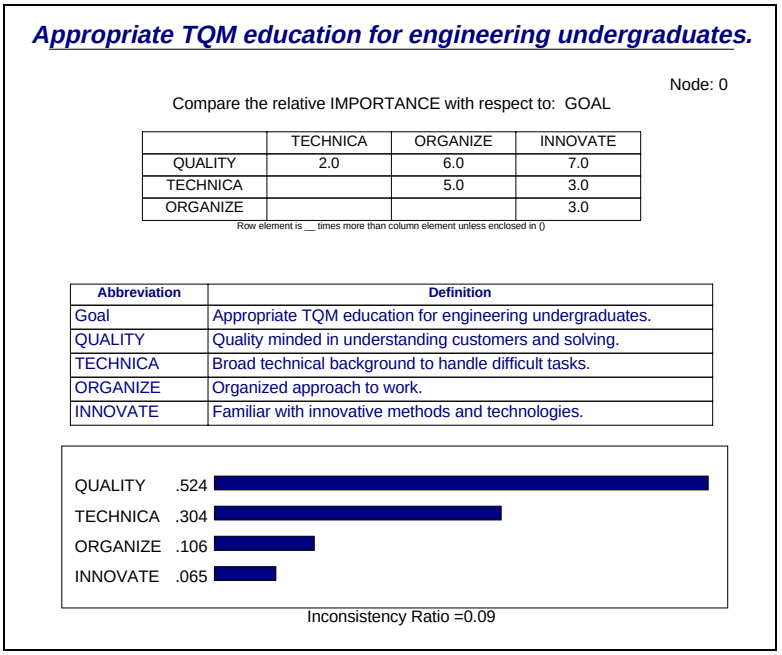

Fig. 3 AHP to prioritize engineering managers' requirements

The next phase was to translate these managers' requirements into skills and capabilities that the students must have upon completion of the course. This was done using a fishbone diagram with the need in the head as the "effect" and the skills and capabilities in the bones as the "causes." This is consistent with the earliest models of QFD developed by Akao and Bridgestone Tire [1]. These were then formed into a quality table with the managers' needs priorities developed from the AHP above being translated into priorities for the skills and capabilities. See Figure 4. These skills and capabilities were then mapped (details omitted) into subject matter, activities, and reports in proportion to the curriculum percentages in the quality table. I was surprised to see the close correspondence to the ten week JIS course for overseas students [26]. In 1995, the engineering managers' needs were prioritized again and appropriate changes were made in the syllabus. Table 1 is the 1996 syllabus. Since this pro gram has been put together, there has been increasing interest by large employers of University of Michigan engineering graduates, such as Ford Motor Co., in subjects like Hoshin Management (Policy Deployment), QFD, and TRIZ. Several companies, such as Ford, General Motors, Texas Instruments, and AT&T have students enroll via remote video classes.

3.2 The Internal Evaluators: Students

After the first year of fine tuning the course contents, it was time to focus on student needs. Since students are not in as good a position to judge the content of the course as they are the format and style, this became the focus of the next QFD study. As part of the course, students form TQM teams to work directly with real organizations; the purpose is that by explaining TQM to others, they learn it better themselves.

Fig. 4 Quality table for managers' needs vs. students' skills

Table 1 1996 Course syllabus for TQM 401

Week 1	Introduction to TQM.
Week 2	7 Basic QC Tools
Week 3	7 Management and Planning Tools
Week 4	Baldrige Award, Deming Prize, and ISO 9000/QS-9000 criteria
Week 5	The Perspectives of TQM: Overview and Daily Management
Week 6	Hoshin Management
Week 7	Cross-Function Management
Week 8	Comprehensive Quality Function Deployment for Product and Service Part 1. The Fuzzy Front End.
Week 9	QFD, Part 2. The House of Quality.
Week 10	Part 3. Beyond the House of Quality: The Design Deployments (Function, Reliability, Capability), Different Roadmaps for Different Businesses, QFD for Business Process Reengineering.
Week 11	QFD, Part 4. The Detailed Design and Manufacturing Deployments. Concept Selection, Manufacturing and process. Service Task Deployment. Includes cost deployment and process FMEA.
Week 12	Taguchi Methods for Robust Design. In-class experiment to design airplane that is robust to customer use and manufacturing noise.
Week 13	TRIZ: Theory of Inventive Problem Solving. Creativity and Innovation for product, process, service, software.
Week 14	Quality Control and plant level quality programs. Just-in-time, Takt time, TPM.

One of the projects is the TQM course itself. The course has customers (engineering managers who hire the graduates), a manager (the instructor), different functional departments (registration, library, class room and facilities), a service (teaching), a product (books, materials, visuals, etc.), and processes (lectures, projects, grades, presentations, etc.).

Unlike traditional QFD studies, the QFD team consisted of the internal customers (the students) themselves. Internal customer data was gathered from the team surveying the current students and a review of student evaluations from previous semesters. Needless to say, not all were flattering, but if improvement is to take place, than certainly a teacher of TQM should be able to demonstrate with his own program!

In fact, the Winter 1995 semester was able to solve the over-enrollment problem, the highest priority issue that year. The problem of over-enrollment occurred after the first semester I took over the class due to rising popularity of the subject. Due to the projects and audit style of the course, only 30 students could be accommodated in each section. After the first semester, Fall 1993, the number of sections was increased to two, which immediately filled up. As Figure 5 [25] shows, by winter of 1995, the demand was approaching 100 students demanding to take the course but the university was not able to add a third section so quickly. From the QFD study, the team changed the University's standard override procedure and put up a World Wide Web Site [28] so that

prospective students could review the course and confirm their interest prior to enrolling. By fall of 1995, however, demand exceeded 120 students, and so a third section has now been added.

The Fall 1995 team began their team work in much the same way, except that now there were other priorities to improve. As a part of their Deming Prize Criteria Report [27], the following quality table was included.

From this study emerged a new graduate feedback process to help continuously upgrade the course content based on changing requirements in industry. This new process will be implemented by the next semester's team

4.0 CONCLUSIONS

Quality Function Deployment can be used to improve all levels of university education activity, from degree program design, to curriculum, to specific courses. As Akao has shown, both external customers and internal customers should be considered. For this course, it was possible to use the internal been expanding popularity of the course among employers and students alike. Future plans include ongoing training of local businesses and university departments in TQM by these student groups, and to develop stronger ties to graduated students, local employers, and other professors in the University

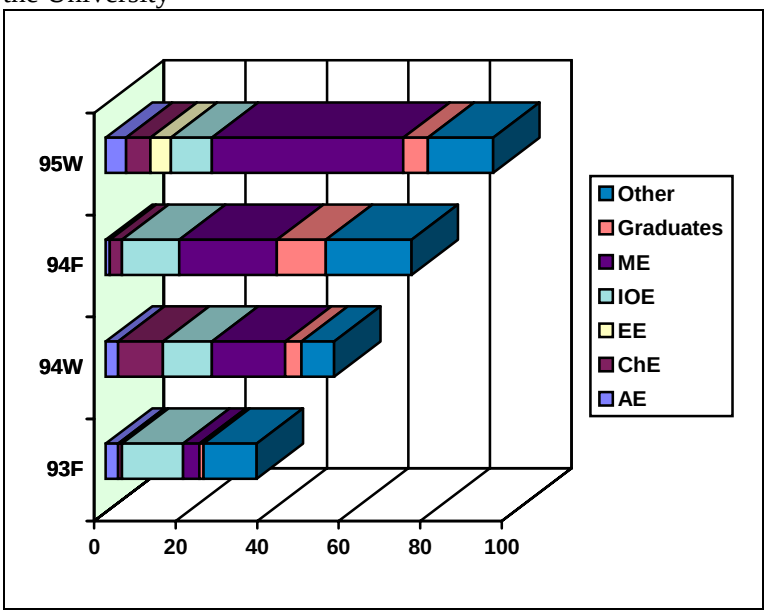

Fig. 6 Growth in students studying TQM 401at University of Michigan.

HOUSE OF QUALITY RELATIONSHIPS MATRIX

STRONG RELATIONSHIP: ◎
MEDIUM RELATIONSHIP: ○
WEAK RELATIONSHIP: △

	Aesthetics	Mobility of Instructor	Level of stage fright	Size of charts, data, etc.	Attire of Instructor	Example freedom	**Volume**	Number of anecdotes	Number of pages of reading	Number of repetitions of keypoints	Number of breaks	Number of digressions	Number of concepts	Number of steps in H.W.	Number of examples	**Time**	Time given to complete assignment	Lag time	Class length	Length allotted to given topic	**Accuracy**	Completeness of course pack	Publishing date	Complexity of steps in H.W.	Clarity of lesson	Topicality of examples	Relavancy of materials	**Convenience**	Number of places available	Interface with team sponsor	Number of team members	Timeliness of updates	Time needed to access
I want better instruction																																	
Remain interested for entire class period		○		△		○		◎			◎	○	△		◎			△	◎	○					△	○	○						
Easier to understand				◎		△		△	△	◎			○		◎					○		△		○	◎	△	△						
Smaller workload									◎				◎	◎			◎							◎	○					○	◎		△
Casual Environment		◎	◎		○	○		○				○	△		○			○															
I want better materials																																	
Up-to-date materials																						◎	◎			◎	◎						
Coursepack always accessible																													◎			◎	○

Fig. 5 House of Quality for TQM 401

customers, the students, themselves to do the QFD and make improvement suggestions to the instructor, which are carried out the following semester by a new team. The result has of Michigan College of Engineering and the School of Business.

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