A Quality Function Deployment Framework For Planning Course Development

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ABSTRACT

We propose a Quality Function Deployment (QFD) framework for planning course development in academia and describe a case study from Florida A & M University. Utilizing a combination of brainstorming, nominal group technique and surveys, our student team developed a spreadsheet model of a House of Quality (HOQ). This facilitated identification of the teaching methodologies most appropriate for delivering critical competencies to students enrolled in our *Engineering for Business* courses. We confirm the robustness of this planning methodology via sensitivity analysis and suggest extensions to provide an integrated approach to planning course development.

1. INTRODUCTION

Program directors in academia need to adopt the continuous improvement (CI) philosophy to maintain a high quality of service to their "customers" - the students, faculty, and industry stakeholders. As proposals for curriculum enhancements are being examined, the teaching methodologies proposed should be carefully scrutinized to ensure that they are well suited to deliver the critical competencies needed by students. Quality Function Deployment (QFD) [1], a planning and design tool traditionally employed to facilitate integrated product development, can be modified to provide a flexible, integrated planning framework in this domain.

Recently, QFD has been used to facilitate planning in areas such as planning process improvement projects [2], planning for technology transfer on information technology projects [3], business planning in small companies [4], and manufacturing strategic planning [5].

In this paper, we propose a framework using QFD to provide a systematic approach for planning course development in academia. A case study from Florida A & M University is used to illustrate the application of this approach.

2. LITERATURE REVIEW

2.1 QFD - AN OVERVIEW

Quality Function Deployment (QFD) [1], a paradigm for integrated product development, was first developed and applied by the Japanese in the early 1970's. QFD helps multi-functional teams identify and prioritize customer requirements and relate these needs to corresponding product or service characteristics. The House of Quality (HOQ), a series of matrices, is used to link relationships and provides a graphical summary, making it easier to utilize, analyze, and evaluate this information. QFD has been a central feature in implementing TQM projects.

Over the years, QFD has attracted attention from a wide range of progressive industrial organizations in the USA including Ford Motor Company, General Motors, Rockwell International, AT&T, DEC, Hewlett-Packard, and Polaroid [6]. Although most of the reported applications have been in the area of product development and improvement, QFD has also been successfully applied as a strategic planning tool for service improvement projects [7].

2.2 A MODIFIED QFD FRAMEWORK

QFD can be used as a planning framework for process improvement projects [2]. However, in this non-traditional use, the interpretation of the standard QFD terms must be broadened to provide a generalizable planning framework. The three fundamental objectives of QFD [8] are to identify the customer, determine what the customer wants, and establish how to fulfill the customer's needs. In the modified QFD framework the users and stakeholders of the system are analogous to the customers in a traditional QFD framework. For example, in designing an Activity Based Costing (ABC) system, top management's needs for cost accounting information are analogous to the customer needs in a traditional QFD framework.

2.3 QFD IN ACADEMIA

In academia, decision-making must invariably be effected in groups operating in committees, task forces, or project teams. The goals of higher education are multi-dimensional, difficult to quantify, and often conflicting. Technological developments have occurred at a dizzying pace and have stimulated ongoing curriculum review and course development.

Several non-engineering programs have aggressively moved to incorporate engineering courses [9]. Among the benefits envisaged to be reaped by the students are an increased awareness of engineering and technology fundamentals, improved teamwork skills, and enhanced analytical and logical thinking. To realize these benefits, careful attention must be given to selecting the mix of teaching methodologies most appropriate for delivering the required competencies to students. Funding shortfalls at all levels have caused many institutions to rethink basic operating strategies. Society has become more aware and demanding of its institutions of higher education and students have become more discriminating in their expectations. Faced with dramatic calls for change and the need to make effective use of scarce resources while still delivering a high quality product, universities must take a careful and studied approach to planning changes.

Recently, we have seen several attempts to utilize QFD to provide a structured approach for planning in academia in areas such as developing laboratories for CIM [10], revising mechanical engineering curriculum [11], research planning [12], course design [13], and planning enhancements to computer laboratories [14]. These applications all confirm that QFD can be used to facilitate effective communication, timely information transformation, and efficient resource utilization. In the following section, we describe an application of QFD via a case study of planning course development to incorporate engineering concepts into a business curriculum.

3. A CASE STUDY

3.1 BACKGROUND

The School of Business and Industry (SBI) at Florida A & M University (FAMU) has developed a suite of *Engineering for Business* courses for integration into its business curriculum. A primary concern has been to maintain the quality and effectiveness of this very innovative program. A study was initiated by the students enrolled in an undergraduate SBI course in Management Engineering I to identify the teaching methodologies most appropriate for delivering critical competencies to the SBI students. QFD was adopted as a framework for planning this course development.

3.2 THE QFD PLANNING PROCESS

The steps adopted in the first phase of this QFD process for planning course development were as follows:

Step #1- Define the customer: In this case, the customers were the students enrolled in SBI's innovative program.

Step #2-Identify the critical competencies to be delivered to the students and establish the importance of each critical competency - the WHATs: Our team conducted a survey of SBI faculty and determined ten critical competencies. Responses from the faculty survey were also used to gauge the relative importance of each WHAT.

Step #3- Identify possible teaching methodologies for the program – the HOWs. Following a review of the literature on teaching methodologies, the team identified twelve methodologies most applicable to SBI's program. These were divided into four categories based on the *Effort* (individual/group) and *Participation* (low/high) required.

Step #4- Map the HOWs into the WHATs

Using a faculty member as a group facilitator, the student team mapped the HOWs into the WHATs by assigning ratings on a 1-3-9 scale (1 – weak; 3 – medium; 9 – strong;) to indicate the relationship between each *HOW* and *WHAT*.

Step #5 - Develop a House of Quality.

Our student team constructed a spreadsheet-based model of the HOQ. This facilitated computation of the row and column totals and the ranking of the teaching methodologies under consideration. The HOQ obtained is shown as Figure 1.

3.3 ANALYSIS OF RESULTS

Examination of the results summarized in the HOQ in Figure 1 would reveal the following:

Critical Competencies

Although all ten competencies were important, faculty assigned the greatest importance to analytical ability, managerial and leadership. On a five-point weighting scale, these competencies received weights ranging from 4.5 to 5.0. Written communication, responsibility, dependability, and accountability were also quite important. These received weights of 3.6 to 4.0. The lowest importance was accorded teamwork, critical thinking, and oral communication. These received weights ranging from 3.0 to 3.4.

These results suggest that faculty demonstrated a greater preference for those competencies which were more readily correlated with student performance in the short term in the traditional academic setting. Competencies which would contribute to a student's long-term success in the work environment but would have limited impact on immediate academic performance (e.g. oral communication, teamwork) were regarded as being less important.

Teaching Methodologies

The scores obtained by the twelve teaching methodologies examined ranged from a low of 1.32% to a high of 16.17%. The highest scores (13.77% to 16.17%) were obtained by those teaching methodologies requiring teamwork and high levels of participation e.g. group projects, group presentations, computer simulation, and role playing. On the other hand, the teaching methodologies which provided limited opportunities for active student involvement (e.g. demonstrations, lectures, guest speakers, and computer laboratories) received much lower scores. These scores ranged from 1.36% to 3.04%. The teaching methodologies, which emerged as being moderately important, were case studies, individual projects, individual presentations, and class discussions. Their scores ranged from 6.11% to 8.21%.

3.4 SENSITIVITY ANALYSIS

Sensitivity tests were conducted to ascertain the impact of variations in the weights assigned to the student needs (the WHATS) and the rating scale used to map the HOWs into the WHATs. Four scenarios were investigated. Scenario 1 used the weights obtained from the original survey data collected by the student team and a rating scale of 1-3-9 to map the HOWs into the WHATs. In Scenario 2 all WHATs were assumed to be of equal importance and were assigned a weight of three (average importance) on a five point scale. In Scenario 3, all weights adopted in Scenario 1 were reduced by 30%. In the final case, Scenario 4, the weights of the WHATs were similar to those obtained in the original survey. In this case, however, a 1-3-5 rating scale was used (1 - *weak*; 3 - *medium*; 5 - *strong*;) to map the HOWs into the WHATs.

The results summarized in Table 1 confirmed that the proposed planning framework was very robust. Although the four scenarios investigated incorporated significant changes in the input planning data, there was little impact on the output - the ranking of the HOWs. In all scenarios, the HOWs that occupied the top four positions were the same, viz. Group projects, group presentations, computer simulations, and role playing. The teaching methodologies in the bottom positions also remained constant while there was slight shifting of the positions of the HOWs placed in the middle ranks.

3.5 FURTHER WORK

The QFD *Course Planning* matrix shown in Figure 1 is the first phase of an integrated three-phase QFD methodology proposed for planning course development in academia. In the subsequent phases, a *Course Design* matrix and a *Course Implementation* matrix will be developed to provide a structured approach to realizing these proposed developments.

4. CONCLUSION

QFD has proven to be an effective tool in managing product/service development in manufacturing industry, in software development, and in service industries. It can provide a powerful framework for enhancing effective communication, defining clear and accurate tasks, and achieving effective resource utilization. This makes the technique attractive for adoption as a planning tool to enhance any group decision-making process. The findings reported in this case study emphasize the adoption of teaching methodologies which encourage active student participation. This is consistent with those recommendations in the literature [15]. However, the paper's primary contribution is in illustrating the flexibility of the QFD process in providing a methodology for planning course developments in academia.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the contributions made by the industrious students enrolled in undergraduate course *Management Engineering I* at SBI, FAMU during the Summer 1997 semester.

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Factor #	Description	Scenario #1 Base - Orignial Data		Scenario #2 *Equal Weights (3)*		Scenario #3 *Weights Reduced 30%*		Scenario #4 *Use Scale of 1-3-5*	
		Relative Importance (%)	Rank	Relative Importance (%)	Rank	Relative Importance (%)	Rank	Relative Importance (%)	Rank
1	Case Studies	8.21	*5*	8.46	*5*	8.26	*5*	9.12	*5*
2	Demonstrations	1.36	*12*	1.35	*12*	1.37	*12*	2.09	*12*
3	Guest Speakers	3.04	*9*	3.08	*9*	3.04	*9*	4.65	*9*
4	Individual Projects	7.76	*6*	7.69	*6*	7.77	*6*	8.38	*6*
5	Lectures	2.15	*11*	2.12	*11*	2.15	*11*	3.28	*11*
6	Individual Presentaion	7.76	*6*	7.69	*6*	7.77	*6*	8.38	*6*
7	Class Discussion	6.11	*8*	6.15	*8*	6.15	*8*	5.9	*8*
8	Group Presenation	16.17	*2*	16.15	*1*	16.24	*2*	14.11	*2*
9	Computer simulations	15.18	*3*	15	*3*	15.25	*3*	13.61	*3*
10	Computer Laboratories	2.27	*10*	2.3	*10*	2.27	*10*	3.47	*10*
11	Role Playing	13.77	*4*	13.85	*4*	13.83	*4*	12.88	*4*
12	Group Projects	16.22	*1*	16.15	*1*	16.28	*1*	14.14	*1*

Table 1: Summary of Results of Sensitivity Analysis

The "How's" Teaching Methodologies	Indiviudal Effort/Low Participation			Individual Effort/High Participation				Group Effort/High Participation				Group Effort/ Low Partici- pation		
The "What's" Critical Competencies	Case Studies	Demonstrations	Guest Speakers	Individual Projects	Lectures	Individual Presentations	Class Discussion	Group Presentation	Computer Simulations	Computer laboratories	Role Playing	Group Projects	Weights	Row Totals
1. Leadership	1						3	9	9		9	9	4.5	180.0
2. Managerial Skills	1			3		3		9	9		9	9	4.9	210.7
3. Accountability	3		3	3	1	3	1	9	9		9	9	4.0	200.0
4. Responsiblity	3		3	3	1	3	1	9	9	1	9	9	4.0	204.0
5. Dependability	3			3	1	3		9	9	1	9	9	4.0	188.0
6. Critical Thinking	9	3	3	9	1	9	9	9	9	3	3	9	3.3	250.8
7. Team Work	3							9	9		9	9	3.0	117.0
8. Written Communication	3		3	9	3	9		3	3	3	3	9	3.6	172.8
9. Oral Communication	9	1	1	1	1	1	9	9	3	1	9	3	3.4	163.2
10. Analytical Ability	9	3	3	9	3	9	9	9	9	3	3	9	5.0	390.0
Absolute Importance	170.5	28.3	63.1	161.2	44.5	161.2	126.8	335.7	315.3	47.1	285.9	336.9		2076.5
Relative Importance	8.21%	1.36%	3.04%	7.76%	2.14%	7.76%	6.11%	16.17%	15.18%	2.27%	13.77%	16.22%		
Rank	5	12	9	6	11	6	8	2	3	10	4	1		

Rating Scale:
1 - Weak
3 - Medium
9 - Strong

Figure 1: House of Quality (HOQ)
(Course Planning Matrix)
Florida A&M University - Scenario 1

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