

Emphasizing Quality Management in a Construction Curriculum

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Current trends in all sectors of the construction industry indicate that stronger quality management programs are important to the construction customer. While industrial firms have long since determined the applicability of these programs, the U.S. construction industry has been slow to develop quality management programs that specifically address the nature of its operations. Construction education should examine a broad range of topics and subtopics to provide background to our students in Construction Quality Management and there are several different ways in which to address these topics. The author has combined Construction Quality Management with other current topics in a seminar course, which has been an effective introduction to the subject.

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Introduction

The three greatest concerns of construction are cost, time, and quality. Although *quality* can be defined in several ways, within the construction industry “quality is simply meeting the customer's requirements.” (Oakland & Marosszeky, 2006) John R. Butler, Jr., Director of the Construction Division of the Georgia State Financing and Investment Commission states, “In Georgia, where I oversee the majority of the state’s major construction projects, general contractors are not performing their duty to provide quality construction... Almost every project we build has construction defects.” (Butler, 2002). Construction firms are certainly concerned about the quality of a project, realizing that if the project quality does not meet the customer’s approval, the project won’t be sold. However, in actuality, quality is often acquired by rework, repair, and extra effort and cost by the construction crews. For a variety of reasons, construction quality does not always meet the customer’s expectations. Although some of the responsibility for not meeting customers’ expectations lies in the design of the project, the contractor still needs to concentrate on meeting the customers’ expectations. Pressure from clients and governments, as well as commercial competitive pressures, are forcing companies in the construction sector to differentiate themselves on the basis of customer focus, overall product and process quality, and especially, service quality. (Oakland & Marosszeky, 2006).

Many construction firms use the process of inspection and repair as their primary means of quality control. This process is neither efficient nor consistent, with production costs increasing to repair the defects, but little or no effect on the defect’s recurrence. A management program specifically designed to assure consistent quality is a proven and effective way of achieving customer satisfaction with the product. The Total Quality Management (TQM) and ISO 9000 Quality Management Systems prescribe an effective way to establish, maintain, monitor, and

improve product quality. Many industrial firms have adopted these plans and have made them effective for their own products.

In the past 25 years, construction firms have watched other industries embrace TQM and ISO 9000 concepts and be transformed into market leaders. However, the construction sector has struggled to fully understand and implement these types of programs. (Oakland & Marosszeky, 2006). Compared to other industries in this country, the construction industry lags behind in the implementation of effective quality management and customer satisfaction programs. (Zheng, et al, 2006).

In 2003, a major pharmaceutical/biotechnology manufacturing company conducted a study to assess the current state of quality assurance in the construction industry, and determined: “that [only] about 50% of those contractors had program manuals for their quality management programs; many contractors did not know what a Quality Manual was and confused it with their safety manual; generally, construction contractors did not know what was expected in a quality program; and some quality plans and/or Quality Manuals were merely window dressing and were not implemented at all.” (Harrison, 2005) While industrial owners typically want the contractors working for them to match the level of management they exercise in their own endeavors, many of the construction contractors studied apparently did not have adequate quality programs, and were not on the same level as the construction owner.

Although some firms have been able to adapt to ISO 9000 or TQM programs, construction firms need to adapt those programs to the unique characteristics of the construction industry. “TQM techniques are desperately needed in the construction industry, but before the techniques can be well-applied they must be adapted for the construction industry.”(Lahndt, 1999) “Clearly for maximum effectiveness, and to meet individual customer requirements, the management system in use must be appropriate to the type of activity and product or service being offered”. (Oakland & Marosszeky, 2006) In recent years, several quality management systems have been developed that do address the unique characteristics of the construction industry.

The largest obstacle in establishing contractor quality management programs is the perceived impression that a quality program will increase cost without appropriate gain. Contractors typically view quality programs as leading to increased documentation and inspection, both of which relate to additional personnel and cost. “Contractors often perceive TQM as an extra cost, but they do not realize that it is not the quality that costs, but rather the non-conformance to quality that is expensive.” (Pheng and Teo, 2004) Research has shown that the cost of rectifying quality errors during and after the contract is more or less equal to the profitability of the project. (Oakland & Marosszeky, 2006) Gains, such as “happy” customers, do not have a tangible monetary impact to offset the increased costs. Safety programs finally become attractive to contractors when they realize that the cost of the safety program is more than compensated by the reduction in worker’s compensation, insurance, and the cost of accidents. Quality, too, has a measurable link to costs. Defects in construction, which result from not doing the work right the first time, cause extra work and additional warranty management overhead costs. Applying efficient work practices and task-related training can eliminate the defects and the additional work necessary to repair them. As the defects are eliminated, the warranty overhead costs should also decrease.

Quality Management in Construction

Primarily because of pressure from customers, contractors are becoming very interested in quality management programs. Once they realize that these programs can be implemented without additional cost, and possibly with increased profitability, contractors are eager to have quality management programs that address the nature of their business. To meet this growing need, several systems have been formulated specifically for the construction industry, and are gaining in popularity.

The NAHB Research Center, a subsidiary of the National Association of Home Builders, provides a quality management program in the National Housing Quality (NHQ) program for the residential construction industry. This Quality Management Program combines a construction oriented quality system directed at Trade Contractors, as well as Builders, with a certification program to assure customers that a program is in place. The classic “Plan-Do-Check-Act” (PDCA) methodology is applied to construction practices. Since Trade Contractors perform all of the construction activities in production home building, this program is primarily directed to Trade Contractor Quality Management. The NHQ program addresses the current state of quality management in the production home building industry with emphasis on:

Plan:

- Formulation of a written quality management plan and Quality Assurance Manual adopted and implemented company-wide.
- Identification of work specifications, standards, and requirements for work being done in the construction process, and addressing initial training on those specifications, standards, and requirements.

Do:

- Implementation of the program throughout the organization with necessary quality training for management.
- Implementation of a “job-ready” emphasis, where trade contractors have established job-ready conditions to be accomplished by other trade contractors prior to the start of their work.

Check:

- Increased Trade Contractor inspection of their work, as they are the experts in their own work. Identification of defects found in the inspections (e.g. through the warranty process) to develop internal training programs that will prevent future occurrence of those defects.
- Polling customers about the quality of the constructed product.

Act:

- Training on the right way to accomplish work that has been identified as defective, eliminating that defect on future work.
- Regularly analyzing the effectiveness of the quality management program and continuing to improve the program and its results.

(NAHB Research Center, 2007)

The NAHB Research Center provides training in the program along with certification audits of program. As of December 2007, the NHQ program has certified 403 trade contractors and 46 builders in this program, and has trained many more trade contractors and builders. (NAHB

Research Center, 2007) The acceptance and growth of the NHQ program in the industry indicates a demand for quality management knowledge and practices in the entire construction industry, as well as in the production home building industry. It has also been successful in increasing the quality of the products in that particular market.

Quality management in the construction industry is now an important topic to address for individuals involved in construction management, as evidenced by:

- Increased customer interest in quality, in all areas of construction
- Evolution of quality programs tailored for the particular needs of the construction industry.

Construction education, in its quest to address current and emerging issues for the industry, needs to be involved with quality management.

Quality Management Topics for a Construction Curriculum

There are many areas of knowledge that can be used to effectively manage and administer a quality management program in the construction industry. The following is a matrix of suggested topics and sub-topics that could be used in a discussion of Construction Quality Management in a Construction Management Curriculum:

Topic	Supporting Topics	Purpose
Quality Management	<ul style="list-style-type: none"> • Total Quality Management • ISO 9000 • Six Sigma • Continuous Improvement 	Overview of current quality management programs
Existing Industry Practices	<ul style="list-style-type: none"> • Sources of “instructions” for construction work • Current construction training practices • Subcontracting practices • Material procurement methods • Current role of inspection • Productivity loss due to rework • Project isolation, and practice of not transferring lessons learned 	Review of current construction industry practices relating to quality of construction and construction quality management
Implementing Change	<ul style="list-style-type: none"> • Impact of change on operations and productivity • Adapt to a culture change (Love, et al, 2000) • Management awareness and support of change adoption • Organizing change flow with the company • Introduce and promote change within the workforce 	Review of change management practices and procedures to successfully implement change

Workforce Training Practices	<ul style="list-style-type: none"> • Initial training techniques • Training for construction trades • Inclusion of all project requirements • Training diverse and multilingual workforces • Short period training • Effective training • Consistent training throughout workforce 	Best practices to incorporate training of the workforce into construction companies
Material Control	<ul style="list-style-type: none"> • Interaction with suppliers for proper material consistently • Assurance of manufacturers' quality process • Subcontract control of material • Material inspection at jobsite 	Overview of control of material quality and delivery
Teaming and Partnering	<ul style="list-style-type: none"> • Teaming and partnering with subcontractors and suppliers • Building cohesive teams (Zheng, et al, 2005) 	Overview of teaming and partnering techniques to provide consistent performance on the project
Inspections and Documentation	<ul style="list-style-type: none"> • Detailed trade inspections • Superintendent-level inspections • Types and uses of recorded information • Consistent inspection techniques • Record of defect and repair • Checklists and pitfalls of long checklists • Organization and compilation of all relevant inspections and documentation • Photographs, videos, PDA inspection forms 	Overview of inspection techniques, recommendations, and documentation
Customer Surveys	<ul style="list-style-type: none"> • Quality survey methodology • Methods of obtaining feedback from construction customers • Determination of participants and appropriate survey questions • Statistical analysis of survey data • Use of survey information 	Compiling effective customer surveys to determine the customer's response to project quality
Quality Program Review	<ul style="list-style-type: none"> • Necessity to periodically review effectiveness of program • Techniques for review and analysis 	Overview of quality program review and audit

Quality Program Analysis	<ul style="list-style-type: none"> of program effectiveness Analyze and compare quality program costs (Thorpe & Sumner, 2004) Reinforce support and continuance of program Use of third party quality audits “Key Performance Indicators” (Thorpe & Sumner, 2004) Identification of goals and objectives Relating measurable indicators to goals and objectives Methods of obtaining relevant data Periodic accumulation of data Comparison techniques, such as graphs and other communications Evaluation of the impact of indicator results Effect of constant measuring and analyzing to performance improvement (Strange and Vaughn, 1993) Implementation of conclusions from analysis 	<ul style="list-style-type: none"> techniques and analysis
		<ul style="list-style-type: none"> Analysis techniques and Implementation of Conclusions

Accommodating Quality Management Concepts into a Construction Curriculum

Quality Management needs to be examined in the context of other courses in the construction curriculum. We need to determine whether the subject has enough content to justify an entire course, and if quality management is considered as a major topic by construction employers. Clearly, there is a trend to increase practical quality management and customer satisfaction. The ACCE standards list “quality control philosophies and techniques” as “fundamental topical content” that each program needs to include. ACCE allows each program to determine the curriculum location of the topical content and the appropriate extent or depth of coverage on the topic. (American Council for Construction Education, 2006)

Quality management may be included in curricula in a variety of ways:

- It may be a part of a “core” course in the curriculum, such as Project Management. Quality control is a subject typically covered in Project Management, and the entire quality management area could be included in this course. Project Management courses, however, have a large amount of material to cover, and quality management will probably receive only a brief overview. Other courses that might include at least some quality management discussions are: construction methods, construction materials, and Mechanical-Electrical-Plumbing. These courses, too, have a large amount of material within them and cannot accommodate much discussion on quality management.

- Quality management could be offered as a single topic in a technical elective. There is enough material to be covered for an in-depth quality management course. Many construction curricula include a range of business administration courses, including “Management”. Quality management may be a topic included in that course, and may affect the amount of course information available for a sole-topic Quality Management course.
- Quality management may also be considered as part of a graduate-level course in construction management. This may be the logical place for Quality Management, although the number of graduate programs and the number of graduate students limit the exposure to quality management principles. In a graduate program, statistical analysis can be associated with the quality management steps and procedures.
- Quality management could be combined with other production topics, such as lean construction, for a technical elective in an undergraduate program. Some of the topics can also be covered in other courses, such as business management courses and project management courses. As there is a fairly close association on the jobsite between safety management and quality management, quality management could be combined in a “programs” management course.
- If a curriculum has an elective for subcontracting or the trade contractor, quality management could be a major portion of that course. Since subcontractors accomplish the majority of the jobsite work, quality management is the responsibility of each subcontractor. The management of quality and minimization of defects and warranty repair should be a major business goal of trade contractors.
- Quality management and subsets of quality management also lend themselves well to continuing education seminars, symposia, and outreach education to the practicing construction industry.

Pilot Study: Implementing Construction Quality Management in a Construction Management Course

The author realized the value of including quality management within an undergraduate Construction Management program. Evaluating the above alternatives, it was apparent that neither incorporating quality management into existing courses nor providing a specific single topic Construction Quality Management course was feasible at the current time.

The study was conducted at South Dakota State University (SDSU), using two different formats for incorporating quality management into the curriculum. Special topics courses, such as technical electives, are available at SDSU and it made sense to add quality management to a current topics course, which also included change management, lean construction, and sustainable construction. Because each of these topics could fill an entire course, this was intended to be simply an introduction to the four subjects. Change management constituted about 15% of the course, with the other three topics being equally divided for the remainder of the semester. The discussion about Lean Construction included a discussion about customer satisfaction and efficiency of operations, which was a good introduction to quality management. In addition, subcontractor management was a major topic in the Lean Construction discussions, which also connected well with quality management.

The first version of the course was conducted as an on-line summer program, with 15 students. This course consisted of several reading assignments, “written lectures”, and daily online chat sessions. Although the session was slightly compressed, adequate discussion was available in the chat sessions. The quality management section consisted primarily of daily “written lectures” that addressed quality management to construction. Examples of quality manuals, customer surveys, and analysis methods were also provided online. Some articles were referenced about quality management; however there is not much introductory level written material available for construction quality management in the U.S.

The second course was a “hybrid” that contained the same readings as the online course, and had a weekly face-to-face discussion session. This was an experimental seminar format course, with ten students, which worked very well. The students were seniors, all with construction experience. One student worked full-time for an asphalt paving company, and related the quality management information directly to his firm’s operations.

The discussion about Construction Quality Management established the value of such a program, relating it to efficient operations, and “doing it right the first time”. The discussion then concentrated on feasible ways to accomplish the “Plan-Do-Check-Act” plan for TQM. Discussion of a Quality Management Plan and its elements used examples of trade contractor plans. Training methods were briefly discussed, although crew training could be a much larger topic. This section of the course also discussed defect elimination by training (continuous improvement), customer surveys, and program evaluation. Although this was mostly introductory material, the students were able to understand the intent and application of a quality management program. A full semester of Construction Quality Management may be too much for an undergraduate course, but the four weeks of study and discussion about the program was well received.

The Construction Quality Management portion of the course could easily have been expanded into additional areas concerning subcontractor management, training, customer surveys, and analysis, but this introduction should serve the students well when they become involved in a Construction Quality Management program.

Formal evaluations for the course were very positive, with a 4.6 out of 5 overall average for the summer session online course, and a 4.2 out of 5 overall average for the hybrid course. The evaluations were for the entire course, though, and did not isolate the Quality Management portion of the course.

Conclusion

A need has clearly developed for stronger quality management programs in the construction industry. The industry needs to identify the areas that they can address and strive for better quality in the constructed product. As the emphasis on quality management is increasing, there are opportunities for construction education to emphasize topic areas that will facilitate the construction manager in increasing both quality performance and customer satisfaction. Academic construction programs need to consider how best to provide education in the quality

management area, whether by combining quality management with other topics in existing courses, or creating new technical elective courses in undergraduate and graduate curricula. In the author's experience, combining this material with other topics was a good way to introduce Construction Quality Management to the students. Ultimately, of course, a comprehensive Construction Quality Management training will be needed to prepare the student to implement and operate a Construction Quality Management Program.

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