

October 2005

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### Recommended Citation

McDaniel, Dale (2005) "Developing an Integrated Curriculum Model For Construction Management Education," *Online Journal for Workforce Education and Development*: Vol. 1: Iss. 3, Article 2.  
Available at: <https://opensiuc.lib.siu.edu/ojwed/vol1/iss3/2>

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Construction Management Education

OLJ25mar05001

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## Developing an Integrated Curriculum Model For Construction Management Education

### Abstract

The issue of how to develop curriculum for construction management programs has been debated for several years by university faculty. Construction management is a recognized discipline that needs to maintain a strong identity positioned between architecture and engineering. Graduates of construction management programs should be prepared to meet the needs of the construction industry for managing complex projects. Therefore, construction management education needs a curriculum model that will help university faculty to achieve and maintain relevant construction management programs. This paper describes a curriculum model that integrates curriculum development, instructional design, and program evaluation.

## The Need

In recent years, construction management has earned recognition as a professional discipline with management professionals serving the construction industry with traditional design professions of architecture and engineering. To maintain this identity and provide the construction industry with well-prepared graduates, the intent of many construction management programs is to achieve recognition as a source for relevant construction knowledge. Most university faculty agree that the foundation for building a strong construction management education curriculum is combining practical and theoretical construction content with management principles. Practical content is generally considered to be construction technology, and theoretical content is considered mathematics, science, and engineering subjects.

The difficulty in achieving and maintaining programs with relevant content stems from the struggle to develop curriculum that meets industry needs, while satisfying requirements of accreditation bodies. The American Council for Construction Education (ACCE) is the recognized accrediting body for university programs in construction management. Current curriculum requirements for ACCE accreditation include a minimum number of credit hours in each of five categories: general education, mathematics and sciences, business and management, construction science, and construction (ACCE, 2005). While this approach to curriculum development has merit, credit hour counting is considered an incomplete methodology. University faculty tend to develop curriculum based on these numeric requirements alone, with the idea that if students complete enough courses that they will be prepared to enter the workforce. Other times faculty rely on their own experiences for determining curriculum, often

ignoring the need for establishing program goals and denying input from construction industry professionals on the necessary competencies of graduates for entry-level employment. While the establishment of formal accreditation for construction management programs was a vital step in bringing status to the field, too often requirements for accreditation are incorporated as the sole basis for developing curriculum. This paper presents a curriculum model that suggests an integrated approach to resolving this issue.

### Background of Construction Management Education

Construction education is not new. It has been a part of the practical aspects of architectural and engineering programs for many years. Likewise, vocational education and apprenticeships have, for many years, prepared people to enter the building trades as carpenters, electricians, masons, plumbers and the like. But, formal education in construction technology and management is relatively new to higher education. Although the actual time for the beginning of formal courses devoted to building construction is uncertain, Dietz and Litle (1976) recorded them as starting at the Massachusetts Institute of Technology (MIT), Union, and Yale in 1926. Courses in construction were developed that focused on the technology and processes of construction without management content.

The Depression of the 1930s greatly affected the progress of construction education. University enrollment in construction programs diminished during this time, and many activities ceased or were absorbed back into departments of architecture or engineering. Thus, only shortly after its formal beginning, construction education failed to survive on its own. Just as construction activity began to revive and construction courses gained enrollment in the late 1930s, interest in the discipline waned as our country entered World War II because emphasis was placed on education that focused on

war training (Dietz & Litle, 1976).

Oglesby (1982) noted that after the end of World War II, construction courses and departments began to grow again. During the 1950s and 1960s, construction curricula became widespread. Most construction courses were offered in the fifth year of five-year programs in construction engineering because faculty member of four-year programs would not reduce traditional requirements.

During this time of growth in construction education, courses and programs were developed in nontraditional academic departments, such as business, construction technology, industrial science, and industrial technology. These programs placed more emphasis on construction technology and management and concentrated less on basic science, mathematics, and design (Dietz & Litle, 1976).

In 1974, the American Council for Construction Education (ACCE) was established as an accrediting agency for college-level construction management programs. The ACCE was originally proposed by the American Institute of Constructors and the Associated Schools of Construction. Its elevation to accrediting status was an important increase in respectability of construction education (ENR, 1975). Until this time, the only accrediting agency related to construction was the Accreditation Board of Engineering Technology (ABET), which directed most of its attention to engineering and engineering technology programs. Since accreditation standards were established, the number of construction management programs has increased significantly. In 2005, there are currently 57 construction management baccalaureate programs accredited by ACCE (ACCE, 2005).

In 1994, the American Institute of Constructors' (AIC) Constructor Certification Commission (CCC) developed a written certification examination. Candidates that qualify through formal education and/or construction experience are eligible to take the Constructor Qualification Examination Level I. After completing seven more years of experience they are eligible to take the Level II examination (Hauck, 1998). This

certification process has given the professional construction manager professional status comparable to that of registered architects and engineers (Mills, 2005).

As construction projects increasingly become more complex in nature, and as more emphasis is placed on customer service, construction managers must possess the necessary knowledge and skills to meet these challenges. To this end, university faculty must ensure that programs prepare construction managers of the future.

#### Theoretical Discussion of Model Development

Tyler (1975) identified four fundamental principles to be addressed when developing a curriculum and plan of instruction. These principles are:

1. Define appropriate learning goals and objectives.
2. Establish useful learning experiences.
3. Organize learning experiences to have a maximum cumulative effect.
4. Evaluate the curriculum and revise those aspects that did not prove to be effective.

In order to plan and develop an educational program, it is vital that a goal be established to guide instructors toward the criteria for designing courses, selecting instructional materials, developing instruction, and evaluating the effectiveness of the program. Without a target, instructors may simply point their subject matter weapons and fire blindly, seeking to fortify bombard students with information.

Tyler advocated identifying effective learning experiences that support program goals and course objectives. Among these learning experiences that apply to construction management curriculum are experiences to develop critical thinking skills, acquire information, develop social attitudes, and develop interest. For each content area, these experiences may vary, but when properly designed should lead to effective learning.

After the overall curriculum has been considered, instructional design is formulated. Clark (1995) explained the instructional design process as similar to a typical business system composed of input, process, and output. Inputs for an academic program

are the students who need to acquire knowledge and skills. The process is the learning that takes place within the program. The output is a group of students that have attained knowledge and skills to prepare them for the workforce.

The Instructional Systems Design (ISD) model includes five phases: Analyze, Design, Develop, Implement, and Control (Clark, 1995).

#### Phase I Analyze

- Analyze job
- Select tasks / functions
- Construct job performance measures
- Analyze existing courses
- Select instructional setting

#### Phase II Design

- Develop objectives
- Develop tasks
- Describe entry behavior
- Determine sequence and structure

#### Phase III Develop

- Specify learning events / activities
- Specify instruction management plan and delivery system
- Develop instruction
- Validate instruction

#### Phase IV Implement

- Implement instructional management plan
- Conduct instruction

#### Phase V Control

- Conduct internal evaluation
- Conduct external evaluation



- Revise system

Kirkpatrick (1994) developed a four-level approach for evaluation that addresses reaction, learning, behavior, and results. These evaluations are ordered in sequence, with succeeding evaluations presenting more feedback information.

Reaction measures learners' perceptions and attitudes toward the learning experience. Reaction reveals what the learner thought of the program, including materials, instructor, facility, content, and methodology.

Learning is measured by the learning objectives with concern toward facts, techniques, and skills obtained. This measurement may be a written test, skill practice, or job simulation.

The third level, behavior, measures the extent to which the knowledge and skills learned in the program have been transferred to the learner, and whether the learner can demonstrate this fact. Evaluations include observations from the instructor. When graduates of the program obtain employment in the field, employer evaluations may be included.

The fourth level is results. This level of evaluation is the highest in the hierarchy. It addresses whether the instruction has met an organization's business need. Results evaluation helps determine the return on the educational investment.

The model presented in this paper combines the overall concepts of the above models to provide university faculty with a single source, systematic approach to implement when developing a program.

#### An Integrated Model

In order for construction management programs to prepare graduates to meet the needs of the dynamic construction industry, construction management education needs a curriculum model that will help university faculty to achieve and maintain relevant construction management programs. No longer should university faculty rely solely on accreditation requirements and their limited industrial experiences to develop curriculum.

However, this endeavor can be accomplished by using a curriculum model that integrates curriculum development, instructional design, and program evaluation.

The intent of an integrated model is to provide a single source, systematic approach for university faculty to implement when developing a program. Because most construction management faculty do not formally document and employ systematic methods of curriculum development, instructional design, or program evaluation, the model combines these important phases. The phases are independent, yet are sequential. The model sequence is Goal Definition, Job Description, Competency Identification, Course Design, Instructional Development, and Program Evaluation. Figure 1 illustrates the integrated model.

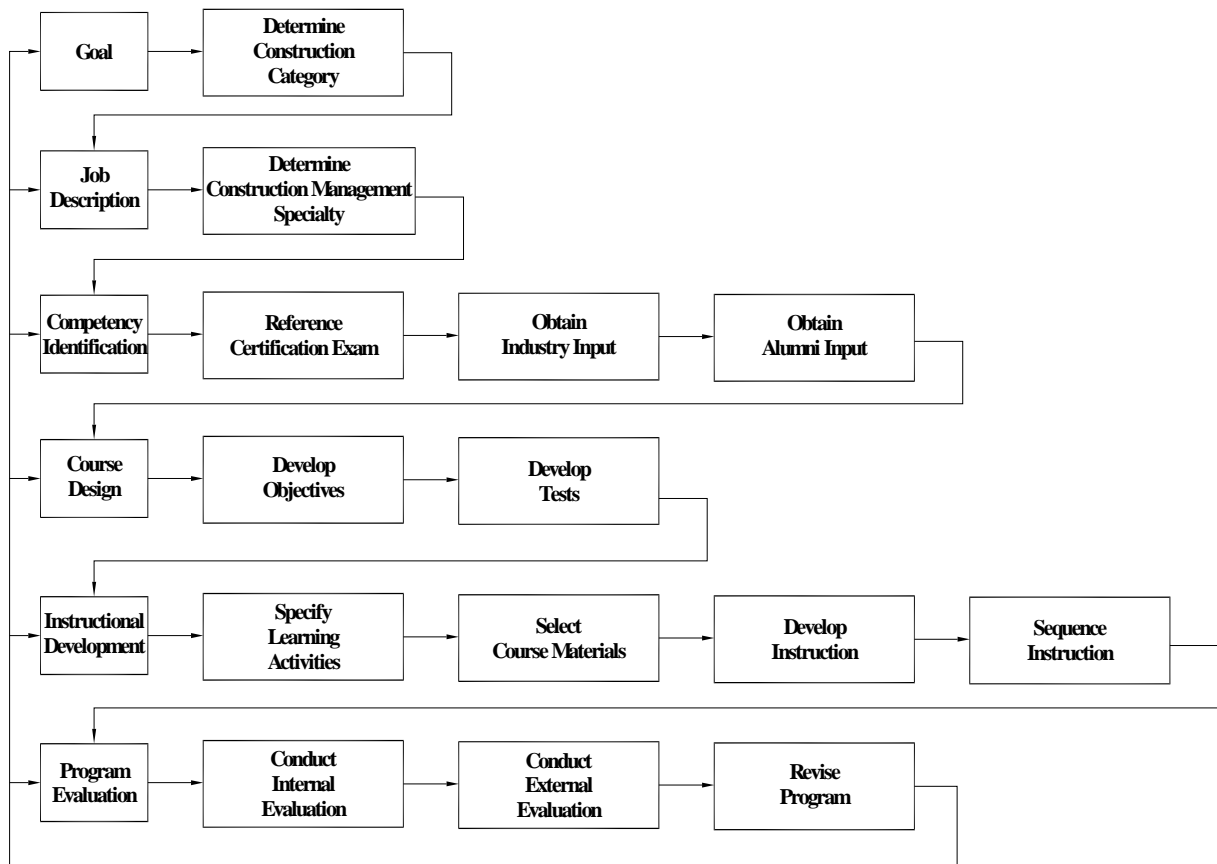


Figure 1. Integrated Curriculum Model

*Goal Definition*

The goal of most construction management programs is to prepare graduates with the requisite knowledge and skills for entry-level employment in the construction industry. While this goal is a good beginning, further goal definition leads to the intended construction category on which the program will focus. These generally accepted categories are residential construction, commercial building construction, industrial construction, heavy construction, and highway construction. The program goal serves as a map to guide faculty through the remaining phases.

### *Job Description*

The job description is a general explanation of what a person does and in what environment that person works. The job description phase involves specifying the type of construction profession for which the program will prepare graduates. Within the general construction categories are various groups of construction professionals, including general contractors, design-build contractors, specialty contractors, and construction managers (ENR, 2005). Because construction firms tend to provide more than one service and perform multiple types of projects, programs should prepare graduates with the knowledge and skills to function in a variety of construction groups. The fundamental duties of a construction manager are similar regardless of the specific group, so programs that prepare graduates in the basic principles of managing construction projects will fulfill their goals.

### *Competency Identification*

Developing a program of study for a technical area based on competencies is a technique that has been used for many years. Selvidge and Fryklund advocated this analysis approach in the 1930s. The first step is to determine the goals of the program, which comprise “the information skills, attitudes, interests, habits of work we expect the boy to have when he has completed his period of training” (Selvidge & Fryklund, 1930, p. 36). Although Selvidge and Fryklund were concerned with trade and industrial training, their approach to work education is an effective method for planning

construction education.

Competency identification forms the cornerstone on which objectives are developed for individual courses designed. Competencies serve as the basis for developing certification-type examinations, measurable through pre-tests and post-tests. Competency statements need to be specific and measurable, which enable them to be used later in evaluation. Competency statements should also be realistic related to what can be attained in a program (Ossinger, Goldblatt, Rolfe, Adams, & Varey, 1991).

To avoid the common quantitative approach of creating courses forced to fit into predetermined categories created by accrediting agencies and establishing a minimum number of credit hours for each (Ossinger, et al., 1991), the model guides faculty to develop competency statements according to the ten Duties outlined in the American Institute of Constructors' (AIC) Skills and Knowledge Survey (AIC, 1997). The ten Duties are described in Table 1.

Table 1

Ten Duties of the AIC Skills and Knowledge Survey

Duty 1:	Plan Project Execution
Duty 2:	Establish and Maintain Systems and Procedures to Operations
Duty 3:	Establish Responsibility for Operations and Communicate Relevant Information
Duty 4:	Determine and Procure Physical Resources for the Execution of the Project
Duty 5:	Develop Staffing and Subcontractor Requirements
Duty 6:	Monitor and Control the Use of Project Resources
Duty 7:	Monitor Project Costs
Duty 8:	Create, Maintain, and Enhance Effective Working Relationships
Duty 9:	Develop Teams, Individuals and Staff to Enhance Performance
Duty 10:	Solve Problems and Make Decisions

Competency statements are grouped by Knowledge Areas of the American Institute of Constructors' Constructor Qualification Examination Level I (AIC, 1997). The Knowledge Areas are described in Table 2.

Table 2

Knowledge Areas used for Grouping Competency Statements

Knowledge Area 1:	Communication Skills
Knowledge Area 2:	Design/Engineering Concepts and Associated Mathematics and Sciences
Knowledge Area 3:	Management Concepts and Philosophies
Knowledge Area 4:	Construction Materials and Methods
Knowledge Area 5:	Estimating, Plan Reading, Bid Process, Codes, Insurance, and Ability to Establish Work Methods
Knowledge Area 6:	Budgeting/Cost Accounting, Cost Control, and Cost Closeout
Knowledge Area 7:	Scheduling and Schedule Control
Knowledge Area 8:	Safety
Knowledge Area 9:	Construction Surveying and Project Layout
Knowledge Area 10:	Project Administration

Additional competency statements will be collected from practicing construction professionals through Delphi technique surveys and targeted focus groups. This partnership not only serves to strengthen industry-university relationships, it also ensures that the program maintains a dynamic, pragmatic relevance. Program alumni working in the construction industry, when applicable, will also provide input in developing competency statements. These individuals are in unique positions as they are graduates of the program and employed in the construction industry. The involvement of these two groups is often assumed; however, much research on construction management curriculum targets only university faculty members.

*Course Design*

The concept of designing courses is familiar to any faculty member. All faculty have become accustomed to designing courses around a set of objectives. To avoid designing courses based blindly on past practices, the course design phase uses the competencies determined during the previous phase. Competency statements guide faculty to develop individual course objectives that result in students being able to meet

the competency statements. Objectives should be specific, measurable, and realistic given the time allotted to a course offering. Based on the instructional systems design (ISD) model, objectives are composed of three parts: task or observable action, standard/criterion, and conditions.

To measure the accomplishment of objectives, tests will be developed. Test formats may be written tests, performance tests, or a combination of the two types. To truly measure the impact of the learning process, both pre-tests and post-tests should be developed. The Knowledge Areas previously discussed serve to guide faculty in developing courses.

#### *Instructional Development*

The instructional development phase involves specifying learning activities, selecting course materials, developing the instruction, and sequencing. Learning activities should be selected to best assist learning and to fulfill objectives. A variety of activities should be developed to address the competency statements, dealing with knowledge areas and skill areas. Activities should include those that students perform individually and in teams in order to best reflect the multidisciplinary nature of the construction industry. Learning materials should reflect recent advancements in technology, materials, and management practices. Because printed textbooks are quickly outdated, learning materials should include periodicals, web based sources, and case studies which are timeless. Particular care should be taken to select the best materials. Too often faculty have been accused of poor teaching and students of inadequate learning when the cause was actually inadequate materials (Dick, Carey, & Carey, 2005, p.277).

When developing the instruction, a variety of courseware types and delivery methods should be included, incorporating classroom lectures, instructor-led demonstrations, and learning experiences that simulate the work environment (Mager & Beach, 1967, p. 56). For example, in an estimating and bidding course, students may obtain current pricing from subcontractors and material suppliers that participate in

industry-university partnerships. When estimating assignments are to be submitted, students will undergo a typical bid day environment, complete with last-minute addenda and delivery of their bid to a centralized location away from campus.

This phase also will include sequencing of courses. Construction, construction science, and mathematics are specific areas that should follow a sequence that enables students to gradually progress their learning. Well-developed objectives support this function in that duplication and omission of competencies can be reduced or eliminated by coordinating the design of each course within the overall program.

#### *Program Evaluation*

In recent years, industries have embraced the concept of continuous improvement. Coinciding with this business concept is program evaluation, as the purpose is to improve the program from effectiveness of instruction and effectiveness of materials. Internal evaluations will be conducted to monitor the instructional process, which infers that the evaluation will be performed during the instructional process. Data will be collected on pre-test and post-test results, inadequacies of the instructional materials, and the time required by learners to complete various learning activities. This data provides opportunity to make revisions to the instructional process prior to delivering the course again.

External evaluations are included to provide feedback on the results of the level and quality of learning. Tests will be given in individual courses. At the completion of the program, students will take the AIC Certification Examination or similar instrument to assess effectiveness of learning because the examination content served as the basis for identifying competency statements. This concept is often referred to as *closing the loop*, and is lacking in many university programs.

The third component of the evaluation phase is revision. Construction management programs need to provide relevant education that keeps pace with the dynamic construction industry. There are many sources of change in the industry: new

technology, innovative practices, new materials, computer software advances, project delivery methods, and increased focus on quality and customer satisfaction. At frequent time intervals, the entire program should be analyzed for areas needing change.

### *Summary*

This integrated curriculum model is based on proven, time-honored models and research. The intent of a new model is to bring together appropriate development models for construction management education. An integrated model provides a single source, systematic approach for university faculty to implement when developing a program. This model is unique in that it provides for the combined input from practicing construction professionals, program alumni, and national certification examinations in determining the competency statements that the instruction will be designed to address. If a national certification exam is not appropriate, faculty can team with construction professionals to develop such an exam. This input will relieve faculty from believing that they must predict what knowledge and skills that employers expect from entry-level employees. The dynamic nature of the construction industry and advances in technology and processes will require construction management programs to be revised in order to achieve continuous improvement. This model can be used to revise programs, or to develop new programs.



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