

Improving an Existing Course in Mechanical Construction

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The Building Construction and Contracting Department required information for the development and improvement of its only required course in mechanical construction. A multi-part study was conducted to collect this information from students, placement records, construction educators, and construction industry professionals. Student career interests, and the department's last six years of placement records were studied to determine the area of industry focus for the class. Construction educators and construction industry professionals were surveyed to determine the importance of existing course topics, and to identify important course topics, which are not being covered in the class. The study indicates that the majority of students in the class are interested in general construction and construction management, and that the majority of graduates over the past six years have found employment with general construction and construction management firms. In addition, the study identifies scheduling and coordination as the only two topics which appear within the five most important topics of both construction educators and construction industry professionals. This paper provides results of the study and serves as a resource to other educators who are currently modifying their course in mechanical construction.

Key Words: Mechanical Construction, General Construction, Construction Management, Teaching, Survey, Graduates

Introduction

Depending upon the type of structure, the mechanical portion of a construction project is often a significant percentage of the total project cost. Because of this significance, it is imperative that we adequately educate our students in the area of mechanical construction. In Fall 1994, in a continuing effort to provide quality mechanical construction education, our department initiated the process of reviewing its only required course in mechanical construction to determine the most applicable topics and the overall course perspective.

The required course, BC 334 Mechanical Construction, is a three credit hour course and is taught each semester to approximately 50 to 70 students. It is an introductory course that provides a limited overview and exposure of the mechanical construction process. Course topics and expected outcomes are illustrated in Figures 1 and 2. In our efforts to improve the course, we established two objectives for the study. Our first objective was to determine the most important course topics. The second objective was to determine if our assumption on the course perspective was correct--that the course should be taught from the perspective of the general contractor/construction manager (GC/CM) rather than from the mechanical contractor.

We expected that the results of the studies would indicate the important topics to be scheduling, coordination, plan and specification interpretation, basic terminology, and methods and

materials, because they are more applicable to the perspective of a GC/CM. The perspective of the GC/CM is managing the mechanical construction work that is being performed by a subcontractor. The perspective of the mechanical contractor is one of a much higher proficiency that involves the actual performance of the work. We believed that the course should be taught from the general construction/construction manager perspective because it appeared that the majority of BC graduates have traditionally obtained such positions. According to the BC faculty "elders," the majority of our alumni over the past 25 years have traditionally entered the fields of general construction and construction management.

Table 1

BC 334 Mechanical Construction Topic Areas of Exposure

The student will be exposed to the following ten topic areas of mechanical construction:

1. The mechanical scope of work for a building construction project
 2. Interpreting mechanical drawings and specifications
 3. Application and quantity takeoff of piping, fittings, valves, and hangers
 4. Basic plumbing codes and design principles
 5. Various HVAC equipment and system configurations
 6. Components and typical system configurations of hydronic systems
 7. Basic ductwork methods and materials
 8. Rectangular ductwork quantity takeoff
 9. Computerized mechanical estimating
 10. Career opportunities in mechanical construction
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Table 2

BC 334 Mechanical Construction's Ten Expected Outcomes

Upon successful completion of the course, the student should have the skills to complete the following ten items:

1. Interpret and comprehend mechanical drawings and specifications
 2. Explain and use the basic terminology of mechanical construction
 3. Identify and describe the major components of plumbing, hydronic, and HVAC systems
 4. Identify, describe, and apply the most common piping methods and materials used in mechanical construction
 5. Perform a simple plumbing piping quantity takeoff
 6. Perform a simple rectangular ductwork quantity takeoff
 7. Perform a simple hydraulic piping quantity takeoff
 8. List common coordination and scope of work problems encountered by the mechanical contractor
 9. Describe the "typical" organization of a mechanical construction firm
 10. Describe potential career opportunities in mechanical construction
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Method

The study was conducted in four distinctive parts.

Part One

In fall 1994, eight construction educators at the ASC Region III Regional Meeting were surveyed to obtain their opinions regarding the most important topics to be taught in a mechanical

construction course. A roundtable presentation (Koontz, 1994) was conducted to state the problem to the audience who then provided verbal feedback and completed a survey instrument (see Appendix A).

Part Two

In Spring 1995, resulting from the input provided by the construction educators in Fall 1994, a telephone survey was conducted of construction industry professionals to collect their opinions regarding what should be taught in a mechanical construction course. Forty-one survey participants were selected randomly from among BC alumni who work for general contracting or construction management firms. These randomly selected alumni were chosen specifically from general contracting or construction management firms because at this point it was hypothesized that the general contracting or construction management firms typically employ the majority of BC graduates. The average industry experience was eight years. Alumni graduation dates ranged from the years 1975 to 1994.

A survey instrument was developed (Appendix B) that included a list of twenty-four topics which required a rating of DK for don't know or no opinion, or a rating of 1 through 5 for not important through *important*. The instrument topics were created from the course syllabus for BC 334 Mechanical Construction, and from telephone interviews with four alumni who are employed by three Lafayette, Indiana, general contractors.

Part Three

In Fall 1995, an informal poll of students enrolled in BC 334 was conducted to determine the number of students interested in careers in General Contractor/CM, Residential, Mechanical/Industrial, Electrical, Heavy Highway/Excavating, Government/Municipal, Lumber/Building Materials, and Other (Figure 3). It was believed that this informal study of student career interests, although relatively insignificant, would help to develop the course perspective.

Part Four

In fall 1995, 448 BC department student placement records from 1990-1995 were studied to identify types of entry-level positions obtained by BC graduates. Entry-level positions were identified as General Contractor/CM, Residential, Mechanical/Industrial, Electrical, Heavy Highway/Excavating, Government/Municipal, Lumber/Building Materials, and Other (Figure 4). It was believed that this study would support or refute the hypothesis that the majority of our students are typically employed by general construction or construction management firms, thereby determining the perspective of course instruction. Should the course be from the perspective of future mechanical contractors, or from the perspective of future general contractors/construction managers?

Results

The first part of the study was the collection of opinions from the eight construction educators at the ASC Region III Regional Meeting. The educators were asked their opinions on the importance of 17 mechanical construction topics. They were asked to assign a value from 1 to 10 for each topic with 1 = unnecessary and 10 = mandatory. The mean ratings for the top 15 topics are presented in Figure 3.

Upon review of the data from the two surveys, illustrated in Figures 3 and 4, two observations of interest can be made. Industry professionals rated scope of work issues as the most important topic (#1), while educators, on the other hand, rated scope of work issues as the least important topic (#15). Industry rated piping materials as a relatively unimportant topic (#13), and educators rated piping materials as their most important topic (#1). Both topics, scope of work issues and piping materials, indicate a strong difference of opinion between industry and educators. The results of the second part of the study regarding the telephone survey of 41 industry professionals are represented in Figure 4. The results of the third part of the study, the Fall 1995 semester informal poll of student career interests, is displayed in Figure 5. The results of the fourth part of the study, as illustrated in Figure 6, consisted of a study of 448 BC graduate records regarding entry-level placement between the years of 1990 and 1995.

Discussion

Course Topics

Regarding our first objective, important course topics, we had expected that the results of the studies would indicate the five most important topics to be scheduling, coordination, plan and specification interpretation, basic terminology, and methods and materials, because they are more applicable to the perspective of a GC/CM.

Of the top five items in each list, only scheduling and coordination appear to be important mechanical construction topics to both educators and industry. Educators ranked scheduling as their second most important topic, and coordination as their third most important topic. Industry ranked coordination as #3 and scheduling as #4. Though considered to be an important item to both educators and industry, scheduling has not been covered in the BC 334 Mechanical Construction course. Coordination, on the other hand, has been taught and will continue to be taught in the course.

Regarding the remaining three items of the top five items, educators listed: #1 Piping Materials and Methods, #4 HVAC Equipment, and #5 Plumbing Systems. Industry, on the other hand, listed as the remaining 3 items of the top five items: #1 General Contractor/Mechanical Contractor Scope of Work Issues, #2 Mechanical Construction Terminology, and #5 Mechanical Shop Drawing Review and Understanding. Though those three items of the top five items were not the same for both educators and industry, all of the top five items listed for both educators and industry have been and continue to be taught in the course, with the exception of #5 Mechanical Shop Drawing Review and Understanding.

Table 3

ASC Region III Educator Mean Topic Ratings

Item Number	Topic	Mean Rating
1.	Piping Methods and Materials	7.88
2.	Scheduling	7.88
3.	Coordination Between Trades	7.88
4.	HVAC Equipment	7.50
5.	Plumbing Systems	7.39
6.	Labor and Material Costs	7.25
7.	Ductwork Systems	6.88
8.	Basic Code Requirements	6.75
9.	Plan and Specification Competency	6.63
10.	Fire Protection Systems	6.63
11.	Equipment Applications	6.63
12.	Hydronic Systems	6.00
13.	Basic Design Concepts	5.88
14.	Shop Drawings/Submittals	5.50
15.	Scope of Work Issues	5.38

Table 4

Industry Mean Topic Ratings

Item Number	Topic	Mean Rating
1.	General contractor/mechanical contractor scope of work issues	4.46
2.	Mechanical construction terminology	4.15
3.	Mechanical construction coordination issues	4.05
4.	Scheduling mechanical construction	3.95
5.	Mechanical shop drawing review and understanding	3.90
6.	Plumbing blueprint reading	3.76
7.	HVAC piping blueprint reading	3.63
8.	Sheet metal/ductwork blueprint reading	3.51
9.	Mechanical billings/schedule of values preparation	3.44
10.	Fire protection system types and applications	3.39
11.	Understanding basic mechanical code	3.34
12.	Basic principles of temperature control systems	3.32
13.	Recognition and application of various types of piping, valves, fittings, and hangers	3.24
14.	Understanding basic plumbing code	3.22
15.	HVAC equipment types and applications	3.05

Table 5

Career Interest of BC 334 Students, Fall 1995

BC 334 Student Career Interest, Fall 1995	
General Contractor/CM	56%
Residential	23%
Mechanical/Industrial	5%
Electrical	4%
Heavy Highway/Excavating	5%
Government/Municipal	0%
Lumber/Building Materials	0%
Other	7%

Table 6

Entry-level positions among types of employers, 1990-95

Entry-Level Placement of BC Graduates Among Types of Employers, 1990-95	
General Contractor/CM	55%
Residential	14%
Mechanical/Industrial	8%
Electrical	1%
Heavy Highway/Excavating	5%
Government/Municipal	4%
Lumber/Building Materials	2%
Other	11%

In Fall 1996, scheduling will be implemented to incorporate specific instruction for mechanical scheduling into the existing BC 334 course. In addition, due to strong industry response, mechanical shop drawing review and understanding will also be incorporated into the course.

Course Perspective

Regarding our second objective, course perspective, it was found that the course should be taught from the general construction/construction manager perspective. It appears from the information provided by Part Four of the study (Figure 6) that although our students enter several areas of construction, the GC/CM interest area has been the dominating area for the last six years. With such a large percentage of students indicating career interest in GC/CM (Figure 5), coupled with such a high percentage of alumni who have entered that particular career area (Figure 6), it appears most appropriate to present material and examples that are from the GC/CM perspective. It would serve well to maintain the focus of "what a general contractor or construction manager should know about mechanical construction."

In General

For the purposes of this initial study, the information provided was sufficient, however, future studies should involve the distribution of identical lists and rating scales to both educators and

industry. This study provided appropriate information for determining course content and teaching perspective which has been implemented into the BC 334 Mechanical Construction course.

References

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Appendix A
Survey Of Educators Regarding Mechanical Construction Course Content

Please complete and forward to the presenter:

1) **Please rate the value of the following topics for their importance as a part of the mechanical construction course content:
 (use scale of 1 to 10, 1 = unnecessary and 10 = mandatory)**

-Plumbing Systems	
-Fire Protection Systems	
-Ductwork Systems	
-Hydronic Systems	
-HVAC Equipment	
-Refrigeration Systems	
-Other _____	
-Other _____	
-Other _____	

2) **Please rate the value of the following topics for their importance as a part of the mechanical construction course content:
 (use scale of 1 to 10, 1 = unnecessary and 10 = mandatory)**

-Piping Methods and Materials	
-Plan and Specification Competency	
-Basic Design Concepts	
-Basic Code Requirements	
-Equipment Applications	
-Labor and Material Costs	
-Scheduling	
-Labor Issues/Labor Jurisdiction	
-Shop Drawings/Submittals	
-Coordination Between Trades	
-Scope of Work Issues	
-Other _____	
-Other _____	
-Other _____	

Appendix B

Mechanical Construction Course Content: Input From General Contractors

COMPANY NAME: _____

CO. ADDRESS: _____

TELEPHONE: _____

ALUMNI NAME: _____

YEAR GRADUATED: _____

PURPOSE: To acquire industry input for determining course content of the BC334 Mechanical Construction course.

SUBJECTS: Purdue University Building Construction and Contracting alumni employed by general construction firms.

Please respond to each item using the following scale.

DK = don't know or no opinion, 1 = not important, 5 = important

1. Plumbing blue print reading. _____
2. HVAC piping blueprint reading. _____
3. Sheetmetal/ductwork blueprint reading. _____
4. Recognition and application of various types of piping, valves, fittings and hangers. _____
5. HVAC equipment types and applications. _____
6. Fire protection system types and applications. _____
7. Welding methods, processes, and applications. _____
8. General contractor/mechanical contractor scope of work issues. _____
9. Plumbing quantity take off and pricing _____
10. HVAC piping quantity take off and pricing. _____
11. Sheetmetal/ductwork quantity take off and pricing _____
12. Understanding basic plumbing code. _____
13. Understanding basic mechanical code. _____
14. Basic principles of temperature control systems _____
15. Mechanical construction coordination issues. _____
16. HVAC load calculations. _____
17. HVAC testing and balancing procedures. _____
18. Basic principles of commercial refrigeration. _____
19. Evaporator types and applications. _____
20. Chiller types and applications. _____
21. Scheduling mechanical construction. _____
22. Mechanical construction terminology. _____
23. Mechanical shop drawing review and understanding. _____
24. Mechanical billings/schedule of values preparation. _____