

Challenges and Resources for Teaching Mechanical Construction

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Depending upon the type of structure, the mechanical portion of a construction project is often a significant percentage of the total project cost. Mechanical systems are becoming more complicated to understand, estimate, schedule, manage, and design. Several construction management programs are teaching a combined mechanical and electrical construction course. Highly trained professional construction project managers are essential for the successful delivery of mechanical systems on a construction project. There are several challenges to teaching a mechanical construction course. However, there are resources available to instructors who teach mechanical construction. This paper will present the challenges and resources for teaching mechanical construction.

Key words: MEAC, Mechanical construction, mechanical contractors, construction education, curriculum

Introduction

The mechanical portion of a construction project is often a significant percentage of the total project cost. Typically, mechanical construction consumes 15 percent and electrical construction consumes an additional 10 of the total project cost. Both of these percentages will be much higher for buildings, such as hospitals, medical buildings, and clean rooms. Mechanical systems are becoming more complicated to understand, estimate, schedule, manage, and design. For these reasons, and due to the increased importance of mechanical systems in a building, our educational efforts in the area of mechanical construction management need to expand (Koontz and Alter, 1996). This is the only way to ensure that adequately trained construction project managers are prepared to meet the industry's demands.

Due to budget constraints, and the demands of state and university general study requirements, some construction management programs are combining their mechanical construction course content with the electrical construction course. In most construction management programs, this is the one course that teaches construction management students about the different mechanical and electrical systems. This combination creates a critical void in adequate mechanical and electrical construction management education. If this trend of teaching mechanical and electrical systems together in one course continues, the construction industry will be hard-pressed to find qualified construction project management graduates who are knowledgeable about mechanical and electrical construction.

Educational Challenges

There are many challenges in teaching mechanical construction that some faculty members do not realize until they have to teach mechanical construction. Some faculty members do recognize the challenges and avoid teaching the class at all costs. Perhaps the biggest challenge of teaching mechanical construction, is trying to find an instructor who has the proper background and education to teach mechanical construction. Complicating the problem even more is the combination of mechanical and electrical construction in one course. Another problem of a combined mechanical and electrical course is that the instructor has to be an expert in mechanical, electrical, and plumbing systems. To help combat this problem, some construction management programs will hire an adjunct and/or part-time faculty member to teach a combined mechanical and electrical construction course. This is a worthwhile idea as long as the adjunct faculty is comfortable in teaching both subjects, which is not the case in most instances. It is extremely difficult to find an instructor who can teach the management concepts of both mechanical and electrical construction. Another solution is that some construction management programs require the newest faculty member

to teach mechanical construction. This is problematic for many reasons. The instructor has to learn the university system and also teach him or herself about mechanical construction because he or she has no prior work experience with a mechanical contractor. Lack of working experience with a mechanical contractor is a problem, especially when the instructor is standing in front of a group of students trying to explain the different mechanical terms and systems.

The second challenge is trying to determine the content that should be taught in the mechanical construction course. When the instructor has no work experience with a mechanical contractor, he or she will rely on the textbook to dictate the course content. This might seem helpful, but most textbooks written for mechanical construction are engineering based and design oriented. An instructor has to be careful not to get too design-oriented, otherwise he or she will become overwhelmed, making it difficult to effectively teach mechanical construction to the students. The students have to understand the terminology and systems before design principles can be covered.

The third challenge is trying to find an adequate textbook that is not too engineering-oriented, but focuses more on explaining mechanical construction from a construction manager's point of view. There are several good textbooks out on the market, but most only cover one subject, such as HVAC or plumbing. This causes more out-of-pocket expenses for the student due to textbook cost. Though an instructor could try to teach the course by providing copies of certain chapters from different textbooks, the time required to make the copies and following copyright protection can make this difficult.

The fourth challenge is trying to obtain the educational background to teach a mechanical construction course. For a new faculty member this is extremely tough because while trying to learn a new subject, they also have to research, write papers and grants, serve on university committees, and any other responsibilities their department, college, and/or university places on him or her. If an adjunct is hired to teach the mechanical construction course, the challenge is to make sure they are teaching and not telling too many war stories from past experiences.

A fifth challenge is trying to obtain class resources such as blueprints, real objects, and/or pictures to use as an aid to teach mechanical construction. It is important to teach to the different learning styles, i.e. visual, auditory, and tactile/kinesthetic of the learners. Therefore, the instructor needs to obtain items such as blueprints to help students visualize and better understand mechanical construction. It might involve a trip to Lowe's or Home Depot where certain items such as valves can be purchased and used as a class display. However, it is important that the instructor knows the different types of valves and when they would be used. Once a student is given an object to observe, they will definitely ask questions that will require the instructor's knowledge about the item. This is where the experience of working for a mechanical contractor is extremely beneficial.

Mechanical Construction Educational Resources

There are several resources, some free, available to instructors who teach mechanical construction to help combat the aforementioned challenges. These resources need to be utilized to teach students about the principles of code, design, methods, and materials as applied to mechanical systems for buildings.

The first and perhaps most important resource is contacting a local mechanical contractor who is associated with the Mechanical Contractors Association of America (MCAA). MCAA is a professional organization that serves approximately 2,300 firms involved in heating, air conditioning, refrigeration, plumbing, piping, and mechanical services. MCAA has approximately 35 student chapters across the nation. If a university does not have a MCAA student chapter, one should be established. By establishing a student chapter, the instructor has access to any publication that MCAA publishes. Most publications are free for an established MCAA Student Chapter. If a cost is associated with a MCAA publication, generally the local MCA chapter will pay the fee on behalf of the institution.

MCAA can also help the instructor connect with local mechanical contractors, vendors, and suppliers. Most mechanical contractors, vendors, and suppliers have individuals who are willing to help students in several ways. They may even allow students to take a field trip to their office, invite them to sheet metal and piping fabrication facilities and include an occasional job site visit. Field trips are an excellent way for students to encounter mechanical construction topics or processes that cannot be brought into the classroom for assessment (Heinich et al. 1999). They provide the students an opportunity to walk around the building and observe the various mechanical

construction items and activities. Additionally, the students are able to see what mechanical construction entails and learn more detail about pursuing a career in mechanical construction management. Furthermore, a mechanical contractor, vendor, and/or supplier can be invited to guest lecture on a particular topic.

The use of mechanical construction drawings will aid in teaching the students about mechanical construction. Construction drawings can be obtained from a building on campus or from a local construction project. Another excellent way to get access to construction drawings is to subscribe to <http://www.isqft.com> iSqFt provides an Internet Plan Room for contractors, suppliers, and professional estimators to view and print project information, plans, specifications and addenda for construction projects, which is an excellent way to access a variety of mechanical construction drawings for sharing in class. Educators in construction management programs can acquire free access to the Internet Plan Room by contacting iSqFt.com.

A helpful assignment is to discuss the mechanical system on a particular project and have the students color all the mechanical items such as ductwork, diffusers, equipment, etc on the project drawings. This technique will help the students understand the mechanical construction terminology and systems as well as improve their blueprint reading skills. After the students thoroughly review these mechanical drawings, take them on a field trip so they can now see the mechanical equipment installed. This author was fortunate enough to obtain drawings of the university physical plant facility building. This building was completed in four phases with three different sets of mechanical drawings. Therefore, the mechanical system can be discussed in the different stages with the students, fulfilling 3 semesters worth of material content before a system must be repeated. Field trips to the building supplement the course content because the building is open and functional, with visible mechanical equipment.

A second resource is to join the Associated Schools of Construction (ASC) Mechanical-Electrical Academic Consortium (MEAC) committee. MEAC was formed in order to create a quality pool of university educators to teach in the areas of mechanical and electrical construction. Its members include educators from various ASC academic institutions, professional construction associations, contractors, foundations, and manufacturers. MEAC meets once a year during the ASC National Conference. MEAC has a link on the ASC web site that contains information to help instructors teach a mechanical construction course. Some of the information included on the web site is mechanical construction drawings, photographs of mechanical equipment, and a core body of knowledge for mechanical construction. Additionally, this web site contains information for instructors of a mechanical class such as sample lectures, quizzes, assignments, and exams. These mechanical resources are free to educators who register online, and they can be downloaded and modified for free.

The core body of knowledge on MEAC's web site is a compilation of information collected from MCAA members and an excellent way to develop the content for a mechanical construction course. This core body of knowledge contains nine major categories: air conditioning systems, control systems, fans and air distribution systems, physical systems, heating and cooling loads, mechanical systems management, psychometrics, pumps, and plumbing systems. Each category is further broken down into specific topics for that category and weighted by percentage for importance of teaching. For example, the category air conditioning systems is further defined in the areas of system classification, methods of dust removal, concepts of zoning, indoor air quality standards, HVAC design processes, all water systems, air-water systems, variable air volume systems, and air handling units. Based on the teaching weight percentage for each subject, one can see that the method of dust removal is not as important to cover as the HVAC design processes. This information can help professors develop the course topics and determine how much time should be spent on each topic for a mechanical construction course.

The other information on the web site such as the drawings, photographs, and sample class content is an excellent resource to help an instructor develop the content for a mechanical construction course. There is also a complete set of Wendy's Restaurant drawings available for download. This is a great set of drawings to use because just about every student can walk into a Wendy's Restaurant to get a feel for the drawings and help them better understand mechanical construction. The photographs are of general mechanical construction items and are labeled so that students and teachers can identify the mechanical equipment in the picture. These photographs can easily be incorporated into Microsoft PowerPoint for a well informed lecture format. The sample class content is from an instructor at an ASC member school who volunteered to make all of his class materials available for use by fellow ASC instructors. The MEAC web site even has a link to a mechanical/electrical textbook that is published by American Technical Publishers (ATP). ATP allowed MEAC to take certain chapters from the textbooks of Swenson's *HVAC: Heating, Ventilating, and Air Conditioning* and Ripka's *Plumbing: Design and Installation* to

create a customized textbook that meets the needs of instructors who teach mechanical and/or electrical construction courses. The drawings, photographs, and sample class content are excellent resources for anyone who has taught or is planning to teach mechanical construction.

A third resource is to attend the MEAC Mechanical Faculty Boot Camp, held on the three days preceding the ASC National Conference. The training camp is funded by MCAA's Mechanical Contracting Education and Research Foundation (MCERF). MCERF provides a stipend to the attendees to cover hotel, food, and transportation expenses to and from the hotel. Travel to the conference is not covered because the attendees would need to provide travel to attend the ASC National Conference. Attendance by faculty shows MCERF that the university is dedicated to improving education in the area of mechanical construction. This is an excellent way to learn more about mechanical construction and to speak with the experts who are either currently teaching or working in mechanical construction. The topics covered at this boot camp are psychometrics, air conditioning systems, temperature controls, testing and balancing, system commissioning, mechanical estimating, and planning and scheduling mechanical construction. The participants receive a three ring binder including all of the presentations and a CD ROM that containing all PowerPoint presentations of the presenters. This information can also be downloaded from the MEAC web site.

A fourth and final resource is to subscribe to magazines such as *Contractor and Contracting Business* and newsletters published by MCAA and the Plumbing, Heating and Cooling Contractors. These are a sampling of sources that publish the most current information about mechanical construction. In addition, the professor can increase his or her own comprehension of mechanical systems by working for a mechanical contractor. This experience would be especially helpful for mechanical estimating, scheduling, purchasing, and design.

Conclusion

A university construction management program cannot dedicate 25 percent of its degree program to teach mechanical and electrical systems. However, university construction management programs need to be aware of the growing importance of mechanical and electrical systems and begin offering more than one mechanical and electrical course. In addition, ACCE needs to call for universities to require at least one-three credit hour mechanical construction course be taught and one-three credit hour course on electrical construction.

Today, there are several resources to help instructors teach students about the principles of code, design, methods, and materials as they are applied to mechanical systems for buildings. Teaching mechanical construction is always a challenge, but it is easier today due to the number of readily accessible resources. Highly trained professional construction project managers are essential for the successful delivery of mechanical systems. The construction project manager is responsible for equipment selection, purchasing, delivery, installation, integration into other systems of the building, and commissioning. However, students are only as good as those who teach them. Therefore, highly qualified construction educators are required to be student-oriented and experts in their fields.

In most construction management programs, students only receive one course in the area of mechanical and electrical construction. This creates a critical void in adequate mechanical and electrical construction management education. There are many challenges of teaching mechanical construction that some faculty members do not realize until they have to teach mechanical construction. However, these challenges can be overcome by taking advantage of numerous resources that are made available to construction management educators.

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