AC 2012-3090: THE METHOD OF COVERING MEP SCOPE IN AN ESTIMATING COURSE

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The Method of Covering MEP Scope in an Estimating Course

Abstract

Construction science and management graduates are expected to understand work scopes for all construction trades to effectively support estimating teams in their organizations. Among the various trades, having a good understanding of Mechanical-Electrical-Plumbing (MEP) scope is highly valued in construction organizations since relatively fewer construction professionals possess this expertise. Traditionally, MEP content is covered in design-oriented technical courses in construction curricula and work scope is assumed, and treated, as specialty areas to be handled through subcontracts in estimating courses. However, construction students also need to develop proper skills in estimating courses for MEP scope to eliminate the fear of dealing with technologically complex work scopes. The purpose of this paper is to present an estimating course module that addresses this current shortcoming in construction curricula. The paper presents a systematic approach on how to develop a MEP work scope which later can be used in detailed estimating process. The module starts with the introduction of MEP specification development and its presentation in construction drawings. Common characteristics of MEP drawings are then highlighted and the procedures for their analysis are presented in a systematic order including the differentiating aspects of various systems. The laboratory portion of the module concentrates on performing quantity takeoff, digital or manual, where the results are translated into work scope sheets. The paper further explains the detailed scope identification methodology for each system and their integration into estimating course context.

Introduction

Construction science and management graduates are expected to work in a dynamic work environment performing various tasks including planning, estimating, scheduling, and managing the construction process. The graduates are also expected to be familiar with work scopes for all construction trades to effectively support estimating teams in their organizations. Among the various trades, having a good understanding of Mechanical-Electrical-Plumbing (MEP) scope is highly valued in construction organizations since relatively fewer construction professionals possess this expertise.

Historically construction people come from diverse backgrounds, experiencing and learning the profession in field practices[1]. However as projects got more complex and competition tougher, the peoples' profile in the industry has changed over the years and college graduates mainly from construction, and also from architecture and civil engineering programs started to occupy professional ranks in construction companies. Most graduates joining construction companies come from those fields and fewer come from mechanical or electrical engineering. Despite the importance of MEP trades in building construction, it is not easy for construction companies to attract and retain professionals trained as mechanical or electrical engineers. In many cases, construction companies provide training for their project engineers and managers to develop understanding of MEP trades. Building systems courses in construction programs try to close the knowledge gap of future construction managers but seasoned industry professionals urge construction educators that the proper MEP skills from construction program graduates is one of

the major expectations in the construction industry. The author is able to include this comment because of his personal industry experience and working relationships with the members of the construction advisory council in his institution.

The complex nature of MEP construction is also reflected in professional development opportunities including the Mechanical Electrical Academic Consortium (MEAC). MEAC is established under the Associated Schools of Construction structure to focus on MEP education in collaboration with academia and specialty trade associations[2]. The Consortium delivers a "Mechanical and Electrical Faculty Boot Camp" to address the need and provide hands on experience in the mechanical and electrical specialties. As another example, among several organizations that offer certification for construction estimators in United States, the American Society of Professional Estimators offers specialty exams in plumbing, HVAC piping, HVAC sheet metal, and electrical subjects[3].

In today's construction industry, the challenging MEP scopes motivated contractors to use specialty expertise and consequently subcontract these trades in building construction process. These systems are challenging technologically. Many aspects, such as technical scope, expertise in timing, especially coordination with other trades, providing testing and commissioning require in depth knowledge and experience[4]. There are examples of MEP construction courses developed to address this need and these are structured as specialty courses within construction management curricula[5, 6].

Estimating and MEP knowledge and preparation are recognized as critical items for construction education as reflected in various construction science, management, and technology curricula. For example, the American Council for Construction Education (ACCE), the international accrediting body for construction higher education, defines the following subjects to be covered under estimating topical content with at least 3 semester credit hours[7]:

- Types of Estimates and Uses
- Quantity Takeoff
- Labor and Equipment Productivity Factors
- Pricing and Price Databases
- Job Direct and Indirect Costs
- Bid Preparations and Bid Submission
- Computer Application

ACCE also requires MEP content to be covered under the "Analysis and Design of Construction Systems" without defining specific contact hours for each section[7]. Traditionally, MEP content is covered in design-oriented technical courses in construction curricula[8, 9] and work scope is assumed, and treated, as specialty areas to be handled through subcontracts in estimating courses. There are several examples of estimating textbooks that follow this tradition[10, 11].

Assuming that the technical aspect of MEP scope is handled in building systems courses, the scope and provision aspects of those trades should be taught as a module in estimating courses. This way, CM students can develop proper skills in estimating courses for MEP scope understanding, and they can eliminate the fear of dealing with technologically complex work

scope when they are assigned as junior estimators early in their career. Due to limitations in credit hours, it is not always possible to launch specialty courses such as MEP estimating. The purpose of this paper is to present an estimating course module that addresses the current shortcoming in CM curriculum. The paper presents a systematic approach that is used in an estimating course on how to develop a MEP scope which later can be used in detailed estimating process.

The Course Structure and Teaching Methodology

The MEP estimating module is integrated into a third year course, CSM 4023 – Construction Estimating II, a 3 semester credit hour course (2 hours of lecture and 3 hours of laboratory work) required for all construction majors. The 2-hour lecture covers developing scopes, detailed estimate line items, bidding, pricing and subcontracting strategies for all work divisions in a construction project. During the 3-hour laboratory section, students concentrate on the use of digital estimating software and prepare detailed estimating packages. The class size is typically 20 to 22 students where they work on two commercial building projects throughout the semester. A second year fundamental estimating course is defined as a prerequisite which covers quantity takeoff, material cost, and production rates for labor and equipment.

The MEP module instruction starts with scope studies. The scope study can be accomplished by analyzing specifications and construction drawings. Therefore students are taught on how to develop MEP scopes. This applies to all trades in construction projects. In the case of MEP scopes, the first step is to highlight the differentiating aspect of MEP specifications from the architectural trades' specifications. The second step is about classifying the specifications content of MEP trades. The classification approach helps students to develop an understanding of the overall content. The third step is about MEP construction drawings. Students are taught how to analyze drawings and develop an understanding of the content for scope development. After developing a content understanding, in the fourth step students create complete MEP scope sheets. The fifth step, they use their scope sheets to perform digital takeoff. Lastly, in the sixth step they assign unit costs to scope line items (Figure 1). Below, detailed descriptions have been given for respective steps.

Step 1. Explaining the differentiating aspect of MEP specifications

The technical trade specifications of a project are composed of architectural trades' and MEP trades' work scope information. The general conditions and supplementary general conditions are part of the technical specifications. They are provided in technical specifications in addition to individual trades' (architectural and MEP) specifications.

In general, all trades' technical specifications are composed of three parts. These are (1) General information, (2) Products, and (3) Execution. When it comes to MEP trades, they have their own General Provisions section which is provided to supplement the General Conditions usually catalogued as Division 01. The explanation is provided to students for having specific General Provisions for each MEP trades.

Step 2. Classifying the information provided in MEP specifications

In order to simplify the understanding of the MEP scope, students are introduced to the standardized approach to analyze MEP specifications.

In the case of plumbing package, its specifications are mainly categorized as (1) General provisions, (2) Basic Materials and Methods which mainly includes piping and fittings, valves, insulation, support and hangers, (3) Fixtures and trim, (4) Special systems and equipment. Once this classification is given, the content and purpose of each category are discussed in the classroom. To give an example, the general provisions section is discussed by highlighting the reasons why plumbing package has specific general requirements. The factors that required the general provisions provided as a separate document are the following reasons: The need for coordination with concrete, electrical, cutting/patching, trenching/backfill, testing, and training for commissioning. All these coordination issues necessitate special coverage within a specific category in the package.

In the case of heating, ventilating and air conditioning (HVAC) package, its specifications are mainly categorized as (1) General provisions, (2) Basic Materials and Methods, (3) Equipment, (4) Testing and commissioning. As mentioned in the case of a plumbing package, when this standardized categorized list is provided, the content and purpose of these categories are discussed in the classroom. In the case of general provisions, HVAC package is subject to the same coordination issues as mentioned for a plumbing package. A very typical example for HVAC contractor is that he/she can do the installation of a boiler unit, and the power connections can be done by an electrical contractor whereas the plumbing contractor provides the water line connections[10]. One of the major categories in HVAC specifications is the equipment category. Students are informed that the information given in the specifications is only about the type and quality of the equipment. The information regarding to model number, performance requirements, sizes and number can be found in respective construction drawings. Another major differentiating category is testing and commissioning. Even though Construction Management-I course covers related topics, students are informed on pricing the management time of the testing commissioning from the estimating point of view.

Lastly for electrical package, its specifications' categorization is also given in the classroom. The standardized electrical work scope classification is provided as (1) General provisions, (2) Basic materials and methods which mainly includes raceways, wiring devices and other devices such as switches, circuit breakers and fuses, (3) Distribution equipment, (4) Power systems, (6) Lighting systems, (7) Fire alarm and specialty systems. Again, for electrical package, the content and purpose of this classification are discussed in the classroom. Students are informed that electrical scope will be composed of mainly high vs. low voltage systems and not always the same electrical contractor provide all services.

After each individual MEP packages' classified content introduction, the students are introduced to the respective MEP drawing set. This is explained in Step 3.

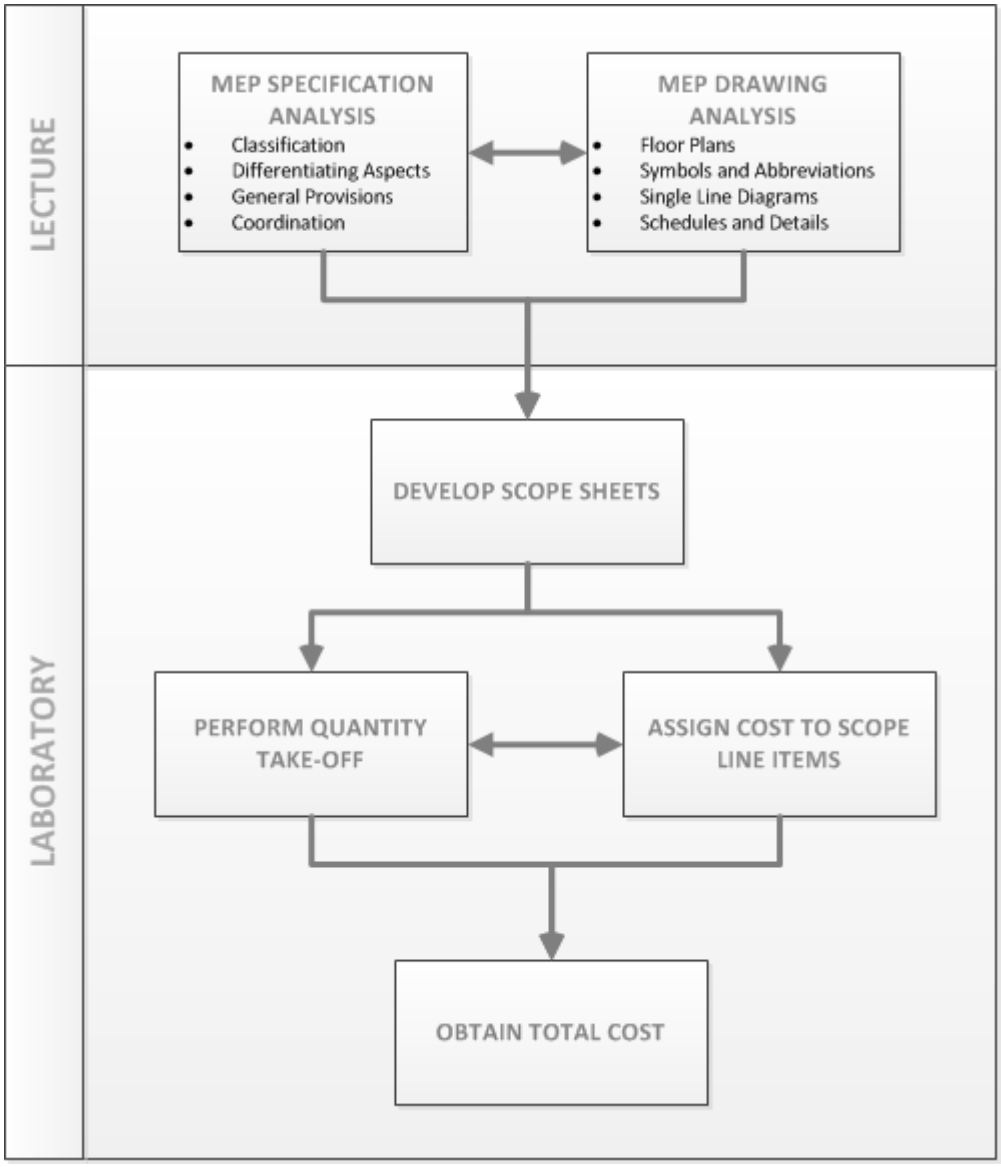

Figure 1. The Method for MEP Estimating Course Module

Step 3. Analyzing MEP Drawings

When students start analyzing MEP drawings, they are first advised to look at the floor plans. The first thing that they are encouraged is to use the symbols and abbreviations sheet to fully understand the content of the floor plans. This way, they are able to link the knowledge that they acquired from specifications to respective drawings.

In the case of plumbing drawings, after reviewing the floor plans and being familiar with the symbols and abbreviations sheet, students continue analyzing the drawings by studying the single line diagram. While studying the single line diagram they learn what type of information

to acquire from it. The major differentiation from architectural drawings is that this diagram is not to scale and it cannot be used for lineal, area, or volume calculations during the takeoff process. Students then informed about the schedules sheet(s) which provide information on equipment and fixtures. They are informed that this is critical information and it needs to be compared with the respective information provided in the specifications. Specifications may include similar, additional or complementing information. Last step is to analyze the details. Not only plumbing drawings but HVAC and electrical drawings will contain details. Students are informed why details are critical. As mentioned earlier the installation of MEP materials and equipment usually require coordination with other trades. Students are informed about the necessity of critical thinking in estimating and especially for the items that require coordination. Details provide information on other trades that the estimator must consider who (which trade) is providing what for the project.

After analyzing HVAC specifications, students are introduced to HVAC drawings. When it comes to analyzing HVAC drawings, students are informed that the process will not be very different from the plumbing drawings analysis process as explained above. The scope of equipment schedules will be more complicated and they will contain more information such as operating weight and power requirements. Again, students are warned that the given information needs to be compared with the one that is given in specifications in order not to have scope gaps during the estimating process. Students are also warned that the drawings are mostly diagrammatic in nature that requires careful consideration and critical thinking skills during the estimating process. Same issues apply for HVAC details as mentioned for details in plumbing case.

Students are introduced to electrical drawings after covering the content of electrical specifications. The most remarkable aspect of electrical floor plans is that they are classified as power drawings, lighting drawings and fire alarm drawings. The content of power drawings are covered followed by lighting drawings. By analyzing lighting drawings students find out about different types of light fixtures, their switching and panel requirements. The purpose of electrical single line diagram is explained. The power provision (distribution) for the building is illustrated in this diagram. Students develop an understanding on how various electrical distribution equipment are connected. By understanding the logic of power distribution, they learn about the scope of electrical package. Students develop an understanding of various electrical equipment and materials such as raceways types and sizes, transformers, switchgear, and distribution panels. In addition to information they get from specifications, studying the drawings boosts the understanding, consequently it helps developing meaningful scopes. Single line diagram is followed by schedules. Schedules provide information on electrical panels and distribution equipment. These equipment also provide power for HVAC equipment therefore students are informed about the scope coordination between electrical and HVAC contractors. The fire alarm and some other specialty systems' input are given via different drawings as they are usually called low voltage drawings. Students are informed that the low voltage package can be provided by a different or by the same electrical contractor. This means coordination between electrical and low voltage contractor may be considered as part of the work scope.

Step 4. Developing Scope Sheets

Students are introduced to a scope sheet concept during the estimating class. This considered as the start process of a detailed estimate package. The purpose of scope sheets in bidding process was introduced to students in previous classes. Students are provided a sample project and they are requested to develop MEP scope sheets. At this time, students perform the tasks in the laboratory portion of the class. By having the complete scope sheets, students then proceed to the digital takeoff phase.

Step 5. Perform Digital Takeoff

In the beginning of the semester students learn how to use On Center Takeoff software. By using their scope sheets they start using the software and perform quantity takeoff for the items listed in their scope sheet.

Step 6. Assigning Unit Costs

When they finish digital quantity takeoff process, students assign unit costs by using cost databases (RS Means) to the quantified line items and obtain the total costs for MEP packages. This finalizes their MEP estimating project.

Course Evaluation and Assessment

The University of Texas at San Antonio follows a two-tier course evaluation procedure. Students complete an online evaluation measuring the effectiveness of each class and its instructor. This evaluation is used for administrative review purposes as well as assessment. In addition, students are asked to complete a hand-written evaluation as a supplemental measure that is viewed only by the instructor at the end of the semester.

The online survey provides a general measure in a quantitative form however, does not specifically provides an opportunity to evaluate specific course modules. The hand-written supplemental evaluation affords the specific comments on different aspects of the course. Although some students do not provide detailed feedback on individual modules, the MEP portion of the project usually receives positive feedback. Their notes indicate that the MEP module in the estimating course compliments the design oriented coursework in other building technology courses.

Conclusions

Developing full scopes for trades is critical in estimating. When it comes to MEP trades, the handling of the scopes can even be more critical for building general contractors due to its technologically complex and costly nature. General contractors value the professionals who possess good skills in MEP trades' management. They constantly recognize the need for educated personnel in MEP. It is important for construction students to develop skills in MEP estimating. Recognizing the importance of the issue, this paper presented an approach for covering MEP scope used in an estimating course.

Since the scope of MEP differs in many ways from architectural trades, the differentiating aspects of the MEP specifications are highlighted. Coordination requirements are the major factor creating the differentiation from architectural trades. In order to approach in a systematic manner, the author presented the classification used for each MEP scope. The method of analyzing the drawings and using them along with specifications are also presented. The main idea is to show students that they need a method when approaching the MEP documents. Once they captured this idea, the practice part in the laboratory portion did run smoothly while using the takeoff software.

Due to credit hours restrictions it is not possible to launch specialty courses such as MEP estimating. Because of this reason integration of special modules becomes critical. In fact, students recognized the effectiveness of important content delivery which was accomplished in a short amount of time.

Bibliography

1. Gould, F. and Joyce, N. (2009). Construction Project Management. Prentice Hall, NJ
2. MEAC (2011). Mechanical Electrical Academic Consortium, Associated Schools of Construction, Ft. Collins, CO. Information available at meac.ascweb.org
3. Remer, D., Ahle, K., Alley, K., Silny, J., Hsin, K., Kwitman, E., and Hutchings, A. (2007). Cost Estimating Certificates Offered by Professional Societies in the United States and Abroad. Proceedings of the 2007 American Society for Engineering Education Annual Conference & Exposition, Honolulu, HI
4. Gunhan, S. (2012). Builders' Role: Innovative Green Technologies' Integration Process to Construction Projects. Proceedings of the International Conference on Sustainable Design and Construction 2011, ICSDC 2011: Integrating Sustainability Practices in the Construction Industry, Kansas City, MO.
5. Korman, T. M., Simonian, L., and Johnston, H. (2008). Design and Implementation of a Specialty Contracting Construction Management Course. Proceedings of the Associated Schools of Construction 2008 International Conference, Auburn, AL
6. Orth, D. L. (2004) Utilizing Educational Delivery Systems in a Mechanical Construction Course. Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition, Salt Lake City, UT
7. ACCE (2010). Standards and Criteria for Baccalaureate and Associate Programs. American Council for Construction Education, San Antonio, TX
8. Oppenheim, P., and Walters, R. (2011). The Evolution of the Laboratory Component of a Climate Control Course in a Construction Management Program. Proceedings of the Associated Schools of Construction 2011 International Conference, Omaha, NE
9. Orth, D. L. (2007). Utilizing Educational Delivery Systems in a Mechanical Construction Course. Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition, Salt Lake City, UT
10. Dagostino, F.R. and Feigenbaum, L. (2003). Estimating in Building Construction. Prentice Hall, NJ

11. Patin, J.W.P, and Rosso, L. (2010). Plan Analysis & Cost Estimating for Construction - Edition II, Dalrymple Press, Baton Rouge, LA