Integrating BIM into mechanical, electrical and plumbing (MEP) construction management curriculum

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Abstract

The most common use of building information modeling / management (BIM) in the current construction industry practices is in the mechanical, electrical, and plumbing (MEP) systems of a building. These systems make up as much as 50% of the project value and represent the major challenges when it comes to project coordination, overhead coordination, and clash resolutions. Construction managers (CM) face various challenges throughout the stages of the project. At the preconstruction stage, the CM major challenge is the visualization of the MEP components in order to schedule workflow and develop accurate quantity take-off. At the construction phase, the CM major task is jobsite coordination and quality control. During the post-construction stage, CM is responsible for commissioning, maintenance, and warranty work related to the MEP systems. In this paper, the authors present their experience and challenges in integrating BIM in a mechanical and electrical construction management course. The students approached BIM from both the modeling and management perspectives. The 3D BIM model helped the students visualize the MEP systems and their components as they relate and fit into the building, as well as the relationship to the other building systems. On another level, the students took a CM approach to collect the information needed to carry on the work throughout the various phases of the project. Findings from this exercise proved very helpful to engrave the student's learning and understanding of the MEP systems, therefore serving as a great methodology to complete the objectives of this class. In addition, the students developed a plan to manage and share MEP information from a life cycle point of view.

Keywords: BIM, MEP, Construction management, Construction visualization, MEP coordination

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Introduction

At one Midwestern University an undergraduate program in Building Construction Management (BCM) has begun to integrate Building Information Modeling / Management (BIM) across the curriculum. The first step in the successful implementation of this was to hire BIM faculty member. This was completed in 2009 with a dual hire in BCM and Computer Graphics. Since the implementation of BIM originates with the implementation of computer graphics software, it was a logical collaboration. Multiple courses are utilized across two departments to expose students to a variety of levels demonstrating the use of BIM. This paper will outline one course and assignment which has initiated BIM into Mechanical, Electrical and Plumbing (MEP) curriculum.

History

In the 1990's one construction management curriculum chose to add an areas of specialization related to Mechanical and Electrical construction. The core courses in this program were to produce students who were job ready to enter the construction industry and work for general contractors in commercial construction. Since approximately 50% of commercial buildings are made up of MEP systems, it seemed appropriate that some students would be needed to specialize in that area. Collaboration with industry developed additional class in MEP estimating, MEP design build, and MEP construction management as requirements to concentrate in the MEP area.

Early architects probably drew sketches it he dirt, but now all drawings are electronic and have the ability to update all drawings with one change. Initial Computer Automated Drafting, often reference to as CADD or AutoCAD allow trained computer operators to provide electronic drawings to represent the designs of architects and professional engineers. The most current development in construction design is the ability to apply not only a three-dimensional representation of a building, but also attaching a database to the structure that would allow the tracking of schedule and cost (Koo & Fischer 2000; Chau, Anson, & Zhang, 2004). BIM has the ability to detect clashes during the design process allowing better decision making to occur rather than costly rework during construction (Tanyer & Aoudad 2005). The National Institute for Building Science has produced the United States Building Information Modeling Standard. They define BIM as a collaborative process which will provide a transformation of the construction industry through the optimization of the design and construction process (National Institute, 2007).

Course

Over the next 3 years, all students in this curriculum will be introduced to BIM. As entry level students are taught the computer graphics applications, junior and senior level students are introduced to ways to apply BIM to problem solving in the total project. The course chosen to

begin this collaboration is an upper level course titled “Mechanical and Electrical Construction Management.” This 3 credit course meets 4 hours per week, 2 hours of lecture and 2 hours of lab. The class is made up of approximately 30 students, most with at least 400 hours of work experience. Some with over 800 hours of work experience under the employment of mechanical or electrical contractors. The course is offered as an elective one per year in the spring semester. Most students taking this course are getting a MEP concentration as part of their degree program.

Assignment

The assignment was given as a group project. A lecture was given to the students with an example of how a MEP component can be integrated into a BIM model. The lecture explained how the students can connect equipment over the Preconstruction, Construction, and Post construction phase by storing information in the model. Table 1 is an example of the lecture information which was provided to the students.

Table 1
Matrix for Boiler in MEP model

	Preconst. Phase	Const. Phase	Post Const. Phase
Specifications	X		
Manufacturer	X		
Codes	X		
Storage	X		
Weight	X	X	
Size	X	X	
Delivery Method	X	X	
Installation	X	X	
Safety		X	X
Wiring Diagrams		X	X
Operating Voltage		X	X
Operating Amps		X	X
Maintenance			X
Adjustments			X
Shut Down Procedures			X
Warranty			X

During the lecture, the students were assigned to groups by the instructor. The groups were made up of a cross experience with each group including students with a high level of MEP experience partnered with students will less experience. The teaching style used is to general natural peer teaching as the students’ research an equipment example. The objectives for the assignment include:

1. Identify a construction component of your choice in the MEP area

2. Analyze what kind of information is needed to successfully complete the construction of this component (information pertinent to code, site supervision, site coordination, long lead item, description, delivery logistics, etc.)
3. Categorize this information by pre-construction phase, construction phase, and post-construction (maintenance and de-commissioning).
4. Develop a schematic approach demonstrating how to link and manage this information from a life cycle approach point of view.

Assignment Deliverables

Utilizing Learning Systems Blackboard Course Management software, an assignment drop box was set up for the students to post their work. They were given one week, including a 2 hour lab period, to research and develop the assignment. The deliverables which were required included:

1. A presentation including visual aids (Power Point or other presenting aid), that will be a minimum of 5 minutes and a maximum of 10 minutes.
2. All group members must be a part of the presentation
3. It should include a graphical representation of the component
4. All information from listed in the objectives should be included
5. The visual should show the schematic approach. How would you track this information and document using BIM?

Samples of the student schematic layouts are shown in Figures 1 and 2. Figure 1 is very basic approach to visually showing that a manufactures 3 D model of equipment can be used to connect the database of information for each phase of a project. Figure 2, demonstrates a broader understanding of the capacity of information that BIM can manage during the life cycle of MEP equipment.

Figure 1: Schematic layout and visual of Boiler

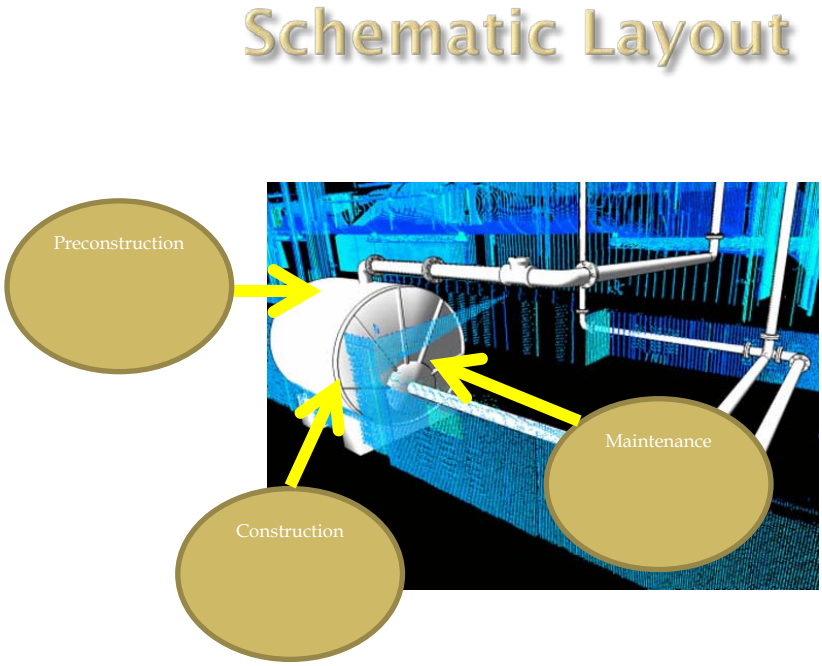
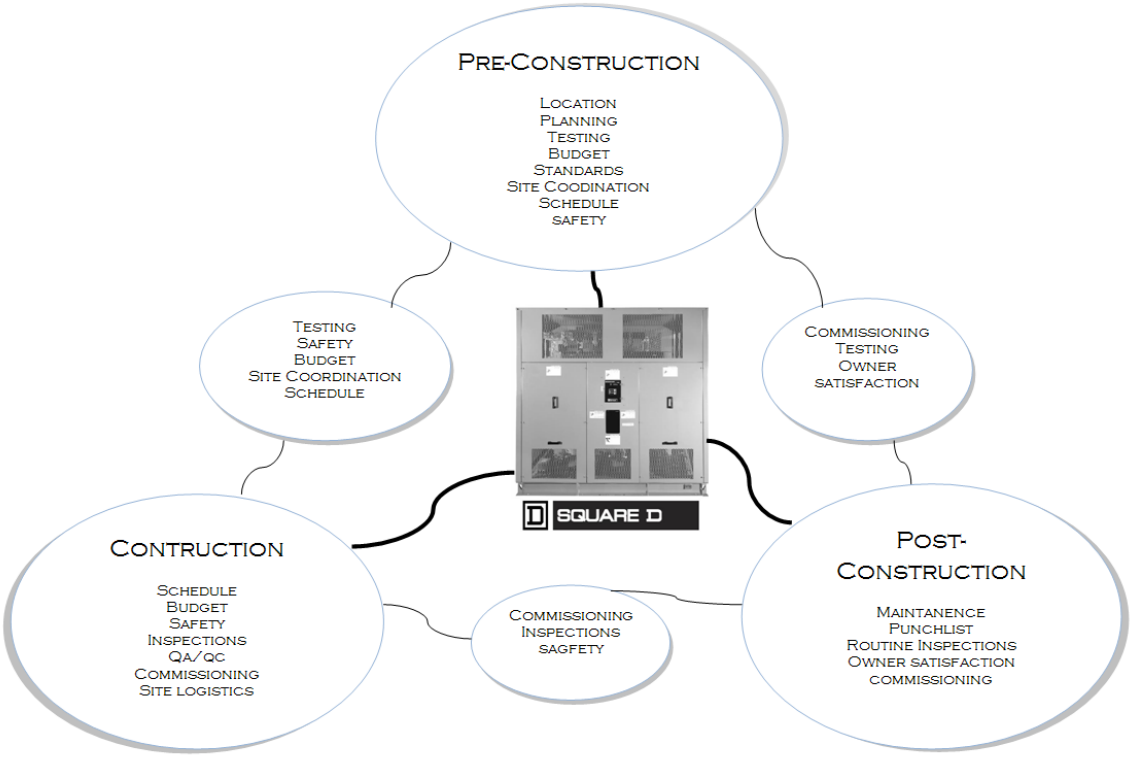


Figure 2: Schematic model of dry type transformer



Conclusions

The presentations of the students' MEP BIM assignment demonstrated that the students could connect data (information) to MEP equipment. This generation of student has been exposed to new technology every year. They are very accepting of technology and value the power of computer graphics. Since this is the first year of integration, the students did not have the software knowledge to produce the BIM module. Over the next 3 years, this assignment will grow from not only theorizing about the data, but a project will be developed to expose the students to the collection of data and manipulate a BIM model. The challenges of implementing BIM into a curriculum is the level at which students should be proficient in the manipulation of the BIM model. What is the expertise of the MEP project managers of the future? How much time should be spent in this curriculum on software training versus model manipulation? These are all questions and concerns which will be answered as trial and error of assignments and the input from industry towards the implementation of BIM.

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