**ABSTRACT**

Construction industry practices and tools are constantly evolving creating a challenge for academia to keep curriculum current, if not cutting edge. Industry must seek how to best implement new technology and tools as well as maintain a constant lookout for highly qualified next generation workers. In order for the construction industry to move forward and become more efficient Academia and Industry partnership is vital.

If Academia is more aligned with current industry trends, they can better prepare the next generation workforce for quick integration into the workplace. Industry must be aware of the next generation workforce and their skill set. Industry can influence this skill set for the next generation of construction graduates so they can become productive within a company sooner, improving the industry as a whole. Real life scenarios provide learning and application opportunities that increase critical thinking and problem solving skills. Industry also benefits from research capabilities of an academic environment as potential solutions to the challenges they are facing are explored.

These benefits are amplified through the use of Building Information Modeling (BIM). BIM is still considered a ‘new’ technology, in that a majority of companies are still working to define BIM and to sort out what it means to them individually, as a company, and as an industry. Industry and Academic partnerships will help identify and research the benefits and Return on Investment (ROI) for the Industry. This paper will discuss how this partnership, between XXX School of Construction and industry, has developed and continually improved the curriculum at XX University and can lead to significant impact on the next generation workforce.

**Keywords** – BIM Education, VDC, Collaboration, Construction Management, Undergraduate courses, industry

**1. INTRODUCTION**

The utilization and integration of technology is changing the way the construction industry conducts business. There are many tools that utilize technology to improve productivity. Industry must find ways to easily and seamlessly upgrade their processes. A large hurdle is training all of the employees to use these tools.
Additionally, the shortage of experienced personnel in the AEC industry conversant with current technology means that architecture, engineering and construction management graduates must be better prepared to enter the workforce. Because of this expected shortage of qualified personnel, academia must work with industry to support the personnel needs of the construction industry as technology, specifically Building Information Modeling (BIM), becomes a major design / contractor tool.

As new forms of collaborative tools, such as BIM, are being introduced into the construction industry, it is vital for Academia to integrate the awareness and use of the benefit of these tools into the curriculum and classroom instruction. These tools are keys to aid in better collaboration between the design and construction teams, helping drive new project delivery methods (Eastman et. al. 2008). These project delivery methodologies, such as Construction Management at Risk (CMAR) and Integrated Project Delivery (IPD), are designed to provide faster project delivery in the overall design and construction process resulting in projects with shorter installation times and more efficient construction. Students need to know how to use these tools to improve their marketability, and to be prepared to enter the workforce. Industry benefits by having new employees who are familiar with current industry practices and can engage quickly as well as a workforce that can bring a solid knowledge of these new methods and technologies to integrate into the company improving their productivity.

Since technology can be used to improve productivity, improving the skill level of new college hires through the introduction and use of newer technologies, primarily Building Information Modeling (BIM) requires new approaches to instruction in the classroom. The 2008 BIM Smart Market Report published by McGraw Hill Construction notes that greater productivity, along with improved communications, are being seen by experienced BIM users. This tool will also support the integrated project delivery (IPD) methodology which has been shown to help streamline the design and construction process by reducing rework through sharing the information throughout the entire lifecycle (Jones 2009). Educating the incoming workforce with the skills and knowledge of how to implement this technology will help prepare new graduates for the construction industry. In addition to educating the current workforce, this will create a broader knowledge base for implementation into today’s fast paced construction project.

Research done by Pavelko (2010) concerning the use of BIM tools for various tasks provided an outline for implementation within the classroom (Figure 1). The challenge for many academic institutions is how to provide the skills since many universities do not have the technical capabilities to instruct their students. Further, even though the construction industry indicated that tying estimates, schedules and information to a 3D parametric model was important, the survey results indicated that only a few schools were implementing these techniques into their curriculum. The schools which responded use BIM for 3D coordination purposes (82%), while only half (46%) tie schedules to models, and even fewer (35%) tie estimates to the models.

This research concluded that utilizing BIM as a problem based learning tool is a benefit to students and industry, but in order for it to be a true success, industry and academia must form a strong partnership. Academia should work to integrate BIM into multiple courses with qualified instructors. They also must be dedicated to ensuring students grasp the skills. Industry must be willing to invest in academia taking the time to visit the classroom and discuss current trends and scenarios. Industry could share generic models that can be utilized in a BIM curriculum providing students with current and
applicable material to implement the skills they have learned. Without this partnership it will be difficult for academia to prepare students for the challenges the students will face in the workforce.

To prepare the construction industry to be in a position to negate the effect of a shortage of qualified personnel, industry and academia must work together to train and educate the next generation workforce to take their position. Productivity increases for construction will be needed to ensure that capital projects are continued to be provided in a cost effective manner to meet the needs of owners. Building Information Modeling (BIM) is proving to be a technology that will have an impact on the delivery process of the architectural, engineering and construction community. This research explored the needs of industry related to the skills desired for new hires and how educational institutions can help. The industry is moving toward the implementation of BIM as part of a more collaborative delivery process and the educational process needs to seek ways to implement BIM into the Construction Management curricula.

2. IMPROVING INDUSTRY

Industry has a daunting task of keeping their companies current on new technologies, tools and methods to improve productivity, reduce costs, and improve project delivery. By partnering with academia, industry can have a direct impact on the skill set students, who become new hires. Being able to impact the skill set of the new hires provides companies a way to bring in skilled employees who have the knowledge and are able to implement these tools and help spread their use through the company.

![Industry Use of BIM](image-url)
Providing real job applications through case studies gives students an additional skill set that better prepares them for entering the workforce. When students are given case studies they are not just learning the material, but how to apply it. Application of the concepts to a problem has students solving problems and going through critical thinking exercises. These are skills that are vital in the workplace, but are not typically taught in traditional classroom settings. Giving students the opportunity to work through real case scenarios gives them a true view of what a job will entail before they finish school giving them validation they are in the correct field.

The academic environment allows students to research new technologies and methods that industry would not have the time or resources to explore. Academia and industry benefits from this partnership by allowing students and companies to work together to come up with some of these things to explore, but also provides an important partnership to test these new technologies in real scenarios.

Industry participation through site visits, case studies, and guest lecturing opportunities allows them to embed themselves in part of the learning process. Industry is able to emphasize the importance of material making the students better hires. Partnering with academia gives industry a good idea of the skill sets the students are leaving the university. Being involved and coming into the classroom and lab provides industry the opportunity to encourage research or education in areas that will improve the construction industry overall.

3.0 BETTER PREPARED STUDENTS

Some faculty members may have limited field experience, so partnering between academia and industry will bring a more complete package of information to the students. While faculty may have a strong knowledge of the research, theory, and methods of a topic, industry is able to bring the practical applications, current case studies, and lessons learned into the classroom. Pairing these together provides students a more complete understanding of the construction process and enables them to learn the material as well as apply it using case studies which ultimately improves the overall curriculum.

Students benefit by bringing real situations into the classroom that are close in vicinity, allowing them to see all aspects of the construction from drawings to completed building. Textbooks typically are not current and it is not feasible to visit the actual construction site or completed building referenced in many textbooks. Having a strong partnership with industry allows academics to take students to visit construction sites and gives students exposure that is not possible through just a textbook.

Bringing industry into the academic environment with real case studies gives students a hands-on learning throughout their education. These experiential opportunities add to the overall experience as well as respond to student’s desire for a variety of learning modes. (Kerka 1989). Engaging case studies from industry gives students a hands-on experience exciting them about the career they are going into which in turn excites them about learning and preparing themselves to enter the industry.

4.0 INDUSTRY INVOLVEMENT

The XXX School of Construction constructed and implemented a collaboration lab named DECIMaL, that looks and operates different from the traditional classroom setup. This lab is focused on collaboration, problem solving and realistic work environments. To motivate group work, the space was
designed to illustrate collaborative features such as co-location, proximity, visual and aural access, supported by tools and technology that can stimulate collaboration (Ghosh 2012, Herman Miller 2012). In a senior level project management class several construction companies have partnered with the School of Construction to better engage them in the material being taught, as well as to bring in real world scenarios and demonstrations.

Some companies were able to assist during the lecture period to share their processes on a certain topic. For example, one exercise that was done was the utilization of sketch-up as a tool to aid with site logistics. Students are not only learning about a variety of methods and tools but students are able to learn more about the participating companies and their methods which could be beneficial as they decide where they would like to work after graduation. Seibert and Sypher (1989) and Baker, et. al (1991) documents the benefits of experiential learning for student career decision making and for development.

Other companies volunteered to help in the lab by demonstrating a variety of technology tools they use in the project management process. Having a wide variety of tools being shown, by a mix of levels within the companies, exhibits for the students the wide range of possibilities for careers. Although there are other channels to potential gather this information, having live demonstrations provides a better understanding of each technology. Providing this wide variety better directs the students to the best fit for a successful career based on their talents and interests. Having a better understanding of the position and having a clear idea what it entails leads to greater overall success for both the student and their employer.

Recognizing that not every company is able to send someone to help during the lecture or lab sections, companies are involved in the learning process by sharing construction drawings, project case studies, and site visit that can be used for classroom materials and lessons. Sometimes it is a challenge to convey the importance of learning if students do not perceive the benefit. Giving the students the ability to see new technologies, tools, and methods being used and benefitting the construction industry gives them an added incentive to learn.

5.0 CLASSROOM IMPLEMENTATION

Engaging Industry in Academia has allowed students to learn BIM tools and their benefits through the use of real world scenarios. Industry participation has enabled students to experiment and learn with examples that have been completed or are currently in progress allowing students to visualize the end product and work with tools as they would in the field and how they assisted with the project management. Several examples of the different scenarios that have been used in the classroom follow:

a. Site Logistics Planning: A major general contractor is rebuilding the end zone at XYZ University to provide new offices, concessions, and stadium suites. The contractor provided a Sketchup model of the structural portion of the project and the model components (tower cranes, office trailers, dumpsters, portable toilets) that needed to be arranged on the site to efficiently support the labor force during construction. The contractor also defined the constraints of the site, such as the restriction on the site entry to avoid the University traffic and the requirement for a clear area for “Game Day Operations.” At the end of the lab period, the students presented their solutions to the contractor who provided insight for the students on their presentation and helped them to understand the importance of the site logistics plan. This illustrated to the students how the tools being taught in class were important during the prosecution of the project.
b. Schedules – Students are expected to understand how to create a visual representation of a project to demonstrate the construction sequencing. Using TimeLiner in Navisworks®, the students to import schedules, manually create tasks in the schedule and attach model objects to those tasks in the schedule to create a 4D simulation. A major general contractor provided a model of a bridge project that was currently under construction to allow the students an opportunity to sequence the construction of the bridge structure and to visualize the logic that the teams had developed. The contractor was then able to work with the students to help them understand the scheduling process and how this had helped them to reduce time in the schedule. Students were able to connect with this project because it was an actual project under construction.

c. Clash detection – another construction company who had recently completed the College of Nursing facility at the downtown XYZ campus provided several models of the project that were actually used during the interference checking sessions to discuss and demonstrate the benefits of Navisworks® as a tool to assist in the detection and then reduction of clashes that would become problems and/or change orders later. Through this lab, the students learned to create collision reports, how to review the results, suggest corrective action, provide the report complete with viewpoints. A second round of clash detection was then completed based on the suggestion and implementation of the collision reports offered by the students to allow them to understand that a solution to a clash may in fact create other collisions. Using this real facility and actual construction models, in addition to having the contractor participate in the class showed the students how the BIM tools are used to actually solve problems and improve the project. Involving the contractor allowed students to hear what actually happened and discuss the impact on cost savings, schedule reduction, and improved quality.

6.0 CONCLUSIONS AND FUTURE WORK

The partnership between industry and academia is one of growing importance as technologies and new methods continue to be developed and need to be implemented into the classroom as well as industry. The utilization of these new methods and technologies will be a moving force in improving the construction industry as a whole. The future benefit of forming more partnerships between academia and industry are endless. Academics must be willing to think outside the box of traditional methods while industry must make a commitment to be more involved. The current bridging efforts done between industry and the XXX School of Construction at XYZ University are a small start to the vast potential needed to strengthen the academic and industry partnerships.

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REFERENCES


