Partnering with Industry and Higher Education on BIM

By
Sofia M. Vidalis, Ph.D., Penn State Harrisburg
Joseph Cecere, Ph.D., CPC, Penn State Harrisburg

Abstract
Over 2,000 commercial and industrial projects representing over a billion square feet of federal, state, and private construction in the United States, as well as in other countries, are in the process of incorporating Building Information Modeling. The cost to build with Building Information Modeling can range from 10% to 25% more, depending on the involvement in design and construction variables, including the training. Since owners see a cost benefit, they are increasingly using Building Information Modeling. Therefore, university programs must update their students in this technology.

This paper examines the factors that influence an owner’s decision. This includes enhancing the project’s coordination, addressing conflicts which reduce change orders, improving communications, and establishing a cost budget that can be better administered. The paper will also discuss the relationship between the Building Information Modeling industry and university construction programs, especially Penn State Harrisburg. This relationship results in the students becoming more aware of Building Information Modeling, its transformation and the opportunities for them. This partnering has resulted in an excellent relationship with industry and the construction program in educating its students in a rapidly changing technology.

Introduction

Building Information Modeling

Building Information Modeling (BIM) began as a concept in the early 1960s when Michigan Institute of Technology (MIT) computer design pioneers Steven Coons and Ivan Sutherland introduced the idea of modeling "real-world artifacts and phenomena" digitally.¹ With advances in computer hardware and software technology in the 1970s, design software developers produced 2-D Computer Aided Design (CAD) applications that correlated objects and properties. These products did not catch on, however, largely because they required that design professionals make fundamental changes in methodology. The construction industry also was highly fragmented, and slow to advance in areas such as higher safety standards, new project delivery methods, electronic technology, and the use of "green" building methods. As contractors adopted computerized project management, scheduling and digitized estimating software; design professionals made the move to CAD as programs became more advanced and less expensive. The ability to electronically transmit design files and contract documents was a major step for the industry and owner. This provided collaborative projects and advanced information sharing that increased the use of this technology and managed the project cost.
The adoption of BIM became heavily owner-driven. Owners saw the benefit from BIM design and construction methods through reduced claims, lower administrative costs, reduced schedule and the model's valuable information on life-cycle costs. McGraw-Hill Construction's 2011 SmartMarket Report “The Business Value of BIM: Getting Building Information Modeling (BIM) to the Bottom Line” examined the real business values that users were experiencing. Nearly half of respondents (49%) reported that they were using BIM tools, a 75% increase over the 28% BIM adoption rate measured in 2007.

Owners saw BIM offering a new way of creating and leveraging digital models for the design, construction and operation of projects, and it is revolutionizing the way firms communicate, solve problems, and achieve better outcomes. The report also showed the following:

- Half of the industries are using BIM or BIM-related tools. This is 75% more than in 2007.
- Current BIM users of all skill levels expect to double their application of BIM on projects over the next two years.
- 42% of BIM users consider themselves experts or advanced. This is three times the amount in 2007.
- Experienced users are leveraging their BIM capabilities to win new work over their competitors, and rate this as among the greatest current benefits of BIM.

The Construction Users Roundtable (CURT), an organization that includes over 50 of the largest corporations in the U.S., saw BIM as an alternative project delivery system to save billions of dollars in construction costs and add value and sustainability to capital facilities.

BIM allowed the owner and designer to easily evaluate the cost-benefit analysis of an alternate lighting or HVAC design, or explore a LEED design. Using BIM in the building project delivery system, owners could have a quality-assured product with up to 50% in schedule savings.

The General Services Administration (GSA) began slowly requiring at least a spatial BIM for concept approval. After a successful completion of 21 pilot BIM projects, the Chief Architect (OCA), Calvin Kam, the GSA's National 3D-4D-BIM Program manager, said, "When project conditions are appropriate, we encourage all projects to leverage 3D, 4D, and BIM deployments beyond spatial program validation."

The GSA cited the advantage of BIM implementation as the data generated by the model that contributes to special program validation, 4-D phasing, and improved energy and sustainability performance. As industry pushes toward greater use of BIM technology and experience the benefits of collaborative project management, they pave the way for the widespread adoption of BIM as a standard in the Architectural, Engineering and Construction industries. Design professionals, as the primary users of BIM software, have gained by the technology's growth.

Today's modeling software includes powerful suites that free the designer of many of the tedious tasks associated with paper-based and 2-D CAD. Data-based 3-D CAD applications store information on building components, making the creation of a door schedule as simple as a few
key strokes. As CAD software became more advanced and functional, designers integrate many data functions thus making true information modeling a reality. With object-oriented BIM or performance modeling Virtual Design and Construction (VDC) software, designers quickly learned the benefits of fully integrated 5-D design systems. Object-based parametric 3-D modeling programs save time by generating sections, elevations, schedules, and details with the click of a mouse. One key advantage of parametric BIM software is that changes made in one view are reflected in all views, including schedules. In 2-D design, a late change can result in the need to manually update and reissue dozens of contract documents, setting the stage for confusion and error. BIM suites are also capable of quickly creating realistic renderings and animations that help the design professional sell the product. The modeling process, along with electronic collaboration, allows the design team access to appropriate components of the model. Input to the model from subcontractors and suppliers are also possible, even from firms that do not have BIM software. Today's BIM suites have import/export file capabilities that allow data to be exchanged with structural design, HVAC, and lighting analysis software. A designer can easily investigate the effects of rotating or translating the footprint of a building on its site to determine the most energy efficient placement in terms of heating, cooling and lighting requirements. Similar methods may be used to determine placement of the building footprint with respect to environmental impact and storm water pollution prevention. With today's global economy, many design firms choose to outsource detailing and drafting tasks to overseas operations. With collaborative techniques and a single model file, drafters in Europe or India can be chugging away on details while the primary designers sleep in New York. This method can drastically reduce overall design schedule, and cut costs significantly.

Partnership - Penn State Harrisburg and BIM

The goal of any educational program is to provide each student with the necessary information and skills to perform successfully in a chosen career. Yet this goal may prove difficult if the program is not striving to keep abreast of the changes and advancements being made, especially in the industrial world. The relationship with the industry, that a program develops, is a critical element to its success. Programs must strive to foster and strengthen relationships with organizations that will not only benefit the program but also the organization. The BIM industry and Penn State Harrisburg (PSH) has developed a relationship through professional associations, software vendors, and the industry. These various activities are examples of a win-win relationship for the future of both university programs and industries.

Professional Associations

The Mid Atlantic BX (MABX) trade association provides access to a suite of technology-based information including BIM and business development solutions tailored specifically to construction industry. This central Pennsylvania organization understands the importance of partnering with higher education to prepare their member’s future employees. MABX offered a series of presentations on BIM to its members including an introduction to advanced training. They partnered with PSH in offering several presentations at the university. These allow their members to learn more about the college’s construction program while learning this technology.
MABX invited students to participate in the events. Students learned about BIM and how they may use this resource in their future profession. This interaction with professionals and participants on exercises broaden the student’s BIM knowledge.

National Associated General Contractors of America (AGC), which is the largest contractor association in the United States, is a leader in BIM technology. Their national BIM committee continues to provide webinar presentations, seminars and other information about new BIM processes. AGC partners with higher education to promote BIM. University research proposals related to BIM have been initiated as well as allow students to participate in their activities. PSH students have attended their national conferences that have conducted seminars on various BIM topics. AGC also provided the program to link into webinar programs. Students are able to hear from leaders on this technology and how this is being incorporated into their future profession.

The American Society of Civil Engineers (ASCE) PSH Chapter hosts dinner meetings for the industry and students once a month. During these dinner meetings, an invited guest talks and presents a specific topic in civil engineering. There has been a couple guest speakers that were invited that talked about BIM, their experiences using BIM, what they use it for, and how useful it is to their company. These dinner meetings are also a great place for students to network with the industry and learn about new technologies that the industry is currently using.

All these professional associations give the opportunity for students to engage and network with people from the industry. In addition, students have the opportunity to attend workshops, webinars, conferences, and also professional meetings that invite guest lectures. Students that are members on any of these professional societies can also learn about new technologies being used in the construction and engineering fields from e-mails and magazines that each of these societies send out. In addition, each student can also receive news from these associations from smart phone applications, FaceBook, and Twitter. These are all very handy tools, especially when someone wants to be on top of all the technology being used in the construction and engineering fields in the palm of their hands.

**Software Vendors**

Software vendors offer universities significant discounts on their products. This allows universities to purchase current software so the students are exposed to these applications prior to future employment. BIM related vendors such as AutoCAD and Microsoft have hosted presentations to the program on this technology. The presentation made the students aware of BIM, its future, the educational requirements involved, and opportunities for students. The students were also given the opportunity for special software student purchases. In addition, AutoCAD/Revit allows students to download a free trial on the most recent software program for educational purposes. Moreover, students learn other software programs that can be used as a part of BIM such as Primavera 6.0 for planning and scheduling and also Heavy Bid or Sage Timberline for estimating. The program felt that making the students aware of all the software programs in BIM, this educational exposure provided an excellent foundation for the students with this technology.

**Industry**
The BIM industry is committed to its future. They continue to be invited as guest speakers to various classes and student organizations in the program to demonstrate and inform students on the use of BIM. Some of these classes included design integration, estimating, scheduling, graphic communications, structures, and project management. Figure 1 shows an outline from PSH Construction, which was used as a handout to be handed out to students during the guest lecture. The outline, shown in Figure 1, was actually customized differently, depending on the class. For example, the estimating class handout on BIM would only include Roman numerals II and III, whereas Graphic Communications would only include Roman numerals I and II. This made it even more specialized for each course so that when a student is taking each of these courses, they would learn something new in BIM and Revit relating to that course he/she is taking. The guest speaker would go through a step-by-step introduction of how to use Revit and who uses Revit. In addition, the guest speaker would also go through a BIM example from a recent project that their company has constructed. Through the lectures, presentations, handouts, and step-by-step introductions, students learned not only the subject, but advances in BIM usage in these subjects.

Conclusions

The various activities on and off campus such as networking events, guest lecturers, conferences, webinars, and professional associations, demonstrate the partnerships universities can have with the industry to learn the latest technologies from BIM. In addition, the vendors also help students by offering them a free trial of the latest software programs that BIM uses. The university and industry partnership is a successful relationship because at the end, they both help each other. They also both realize the need to work together for the betterment of the students and the construction industry’s future. The programs that foster and strengthen these relationships will not only benefit, but will give the students a better feel about their education.

References:


Figure 1: BIM Lecture Handout for Courses

I. **Drafting in the Third Dimension**
   a. **Software:** Autodesk Revit Architecture (*Demonstration*)
b. When drafting with AutoCAD, the user would have to draw not only the floor plan, but also the interior and exterior elevations.
c. Using Autodesk Revit Architecture, the user is able to apply heights to items such as walls and doors to generate the elevations as the floor plan is drawn.
d. A multitude of Families are available in Revit to draw the different components of a building, and additional software, such as Revit Structure and Revit MEP, is available to render the building systems.

II. Estimating & BIM

a. Software: Autodesk Quantity Takeoff and Sage Timberline Office
b. Model Takeoffs (Demonstration)
   i. It is not uncommon to walk into an Estimator’s office and find a digitizer with rolls of drawings stacked up on it.
   ii. To reduce the dependence on paper plans and promote the use of electronic files, on-screen takeoff software, such as Autodesk Quantity Takeoff, has been developed. This allows Estimators to be more mobile, and even bring their takeoff information into meetings with Architects and Clients.
   iii. Not only can Autodesk Quantity Takeoff be used to determine quantities on two-dimensional PDF and DWF drawings, but it can also be used to determine quantities in a model created in Revit Architecture.
c. Autodesk QTO / Timberline Estimating Extended Integration (Example)
   i. Sage Timberline Office Estimating Extended is a very popular estimating program in the construction industry.
   ii. While other on-screen takeoff program do integrate with Timberline, Autodesk Quantity Takeoff took the integration to the next level by replacing a dimension list with a direct export to an estimate.

III. Construction Management & BIM

a. Software: Autodesk Navisworks Manage
b. Time-Lapsed Construction (Example)
   i. To aid with safety and logistics planning, the project schedule can be attached to the model in Autodesk Navisworks Manage.
   ii. This is done using the TimeLiner tool, and is helpful for not only the project team, but also the Client who may be trying to work around the new construction on an existing site.
c. Coordination (Example)
   i. Whether a project is drawn in 2D or 3D, the building systems must be coordinated to reduce, and hopefully eliminate, conflicts in the field.
   ii. Two-dimensional plans are overlaid using software or by placing the hard copy prints on a light board. However, three-dimensional models can be overlaid using Clash Detection in Navisworks Manage.
   iii. This tool helps to identify where two systems occupy the same space, and through coordination meetings with subcontractors, the most cost-effective solution can be determined.

_Demonstration_ – To be shown live using the software in class.
_Example_ – Will show an example of this software/feature already complete or mostly complete.