BIM Integration in GSU Construction Management Program – A First-Year Review

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Abstract
This paper summarized the author's first-year experience of introducing BIM as a brand new ingredient into the Construction Management (CM) curriculum at Georgia Southern University (GSU). The goal, as determined by the department administration, was to reinvigorate a long-established CM program by keeping it up with the most recent industry trends, and better prepare the CM major graduates for an unprecedentedly competitive job market. The flexibility that the department gave the author in regard to designing the first-ever BIM course at GSU was remarkable and the supports from the whole faculty and affiliated academic units were tremendous. Literature of other successful CM programs were researched and referenced. The course schedule and activities were discussed, and the learning outcomes were assessed through student surveys, course evaluation, faculty interviews and general departmental feedbacks. Future improvements and action plans were also discussed.

Keywords
BIM, Construction Management, Course Schedule, Learning Outcomes

1. INTRODUCTION

As building information modeling (BIM) steadily replacing CAD as the new paradigm in the AEC industry, its pervasiveness in the academia seems to be only a matter of time. In 2005, Rundell had already discussed BIM as a conducive pedagogical tool to broaden students' vision and improve their learning outcomes in architectural, engineering and construction disciplines. Nevertheless, Sabongi and Arch (2009) conducted an exploratory study to which 45 out of 119 Associate School of Construction (ASC) member schools responded. The study reported that less than 1% of the respondents' programs taught BIM as a stand-alone class, and only 9% had addressed BIM in their curricula. Obstacles that hinder the integration of BIM into the Construction Management (CM) curricula were identified as the following:

- Difficulty in increasing volume of the existing curriculum;
- Student concerns on more course loads deferring graduation;
- Extra working loads for faculty to develop new curriculum;
- Availability of appropriate course materials, e.g. textbooks for proposed new BIM curriculum.

The slow infiltration of BIM in CM programs is exacerbated by the plummeting economy and a less motivated industry environment. On the other hand, strong programs like Auburn, Florida, Georgia Tech, Penn State (Autodesk 2011) and USC are still able to flourish and take the

leadership, attributed to factors such as long-established reputation, academic intellectual strength and affluent investments put into the BIM education of these institutions. While for the vast majority CM programs in the country, it is challenging to utilize the limited resources to establish the BIM culture into their curriculum. This paper summarized the experience of improving the CM curriculum with dedicated BIM class development in a second-tier national university. The difficulties encountered, the lessons learned and some of the strategies adopted may be of value to peer programs that are in the similar process of integrating BIM into their curriculum.

2. BACKGROUND

Georgia Southern University (GSU) is 2nd tier national university located in Statesboro, South Georgia. While it is only about 50 miles away from the famous historical City of Savannah, Statesboro is barely known as a rural farming area. Nevertheless, impacts of the university on local community are significant: the whole city's economy counts on the expansion of the university, so do construction activities. The construction management program at GSU is accredited by American Council for Construction Education (ACCE). Before the economy fell in 2008, students graduated from this program usually get 2 or 3 job offers secured, and the enrollment was rocketing to almost 500 in 2007, which was noteworthy considering it only has the undergraduate degree (Bachelor of Science in Construction Management) conferred. Due to a much lower tuition and positive industry feedback compared with peer programs in other two major universities (Georgia Tech and University of Georgia) in the state of Georgia, the CM program was one time extremely popular and attracted students from all over the state.

Closely associated with local economy, the CM curriculum had a strong focus on residential construction before 2008. Most students have a family background in residential contracting, and expect to become homebuilders after graduation. In 2008, the housing market started crashing, and the program was hit seriously. Fig.1 outlines the trends of student enrollment in the past 5 years, which clearly shows the recession of the program.

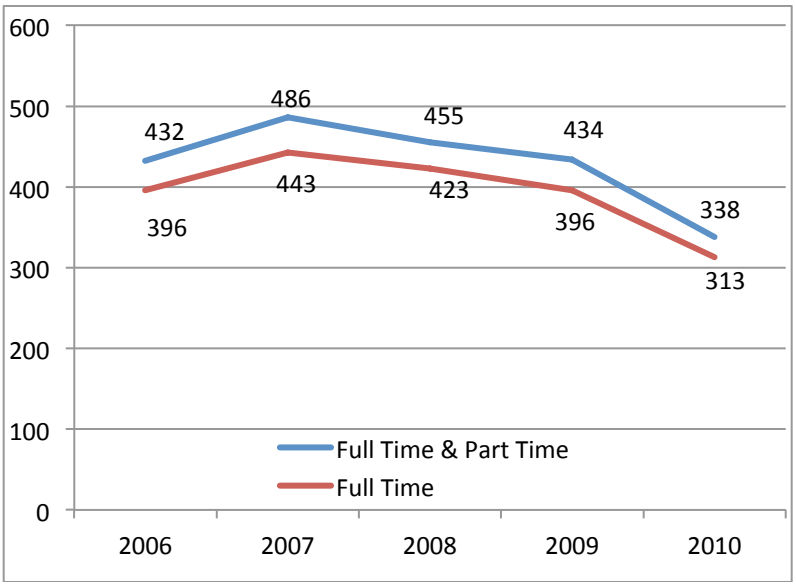

Fig. 1: Fall-semester enrollment of CM program at GSU (Source: GSU 2011).

In order to reinvigorate the program, quite a few strategic adjustments have been made over the last 3 years, highlighted by a program-wide transition from residential construction to commercial construction. In response to the most recent market trends, green building and BIM are heavily expected to keep the program updated and stay competitive with peer programs in the Associate Schools of Construction (ASC). Nevertheless, no substantial change in the curriculum has been made to accommodate the contents of BIM until the author was hired in fall of 2010. During the job interview, the search committee and the department chair explicitly referred the hiring to the author's background in BIM. A major responsibility of the new faculty is to develop a dedicated BIM course, meanwhile facilitate the possible integration of BIM in other courses in the existing curriculum. The department chair anticipated that the new BIM course would stimulate desired transition of this established program, and produce positive chemistry to boost the program's rebounding.

3. COURSE DEVELOPMENT

3.1 Methodology

A Curriculum Committee was founded to steer the endeavors in restructuring the CM curriculum. The mission of the committee was to review existing courses, assess the needs and core capacities of the program, initiate necessary changes and accomplish updates of the curriculum. Quite a few courses were removed and some were consolidated to set aside credit hours for the new BIM (3 credit hours) and green building (3 credit hours) courses. Noticeably, the Construction Graphics course was also restructured to accommodate fundamental BIM-based drafting and graphical communication in lieu of the obsolete hand-sketching.

The committee created a roadmap to foster the development of the new BIM course, focusing on the syllabus, course schedule, learning outcomes, course delivery, course evaluation and continuous improvement. The author was also required to attend a series workshops offered by the Center for Excellence in Teaching (CET) to receive training on course development.

3.2 Contents

The new BIM course is titled as "BIM for Construction Management". As stated in the syllabus, the goal of the course is to expose the students to the concept and benefits of BIM, to build up their modeling skills with cutting-edge software applications, to lead them in model-based construction analysis and management, and to cultivate their problem-solving skills. The learning outcomes, following the criteria of the Bloom's Taxonomy, were set as follows. After taking this class, the students will be able to:

- Describe the concept and development of building information modeling.
- Understand the benefits of building information modeling.
- Identify and compare mainstream BIM software applications.
- Create basic building information models.
- Conduct model based analysis.
- Evaluate real construction projects and integrate BIM in construction project management.

Course materials were prepared combining the author's previous teaching experience at University of Florida, and relevant curricula provided by Autodesk®, Inc. The course activities as

planned in the course schedule are organized into various progressive learning modules and can be illustrated using Fig. 2.

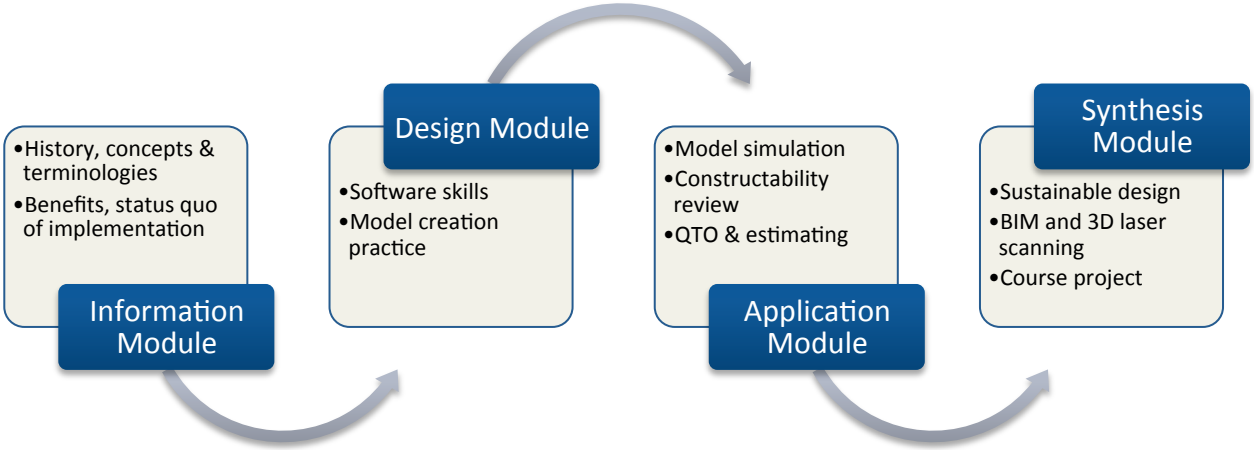

Fig. 2: Major learning modules of the BIM course.

3.3 Delivery

The first phase (Phase I) course development was accomplished within one month, right before the fall semester of 2010. Considering it was the first-ever BIM class in the program, the Curriculum Committee decided to test run the course as a 4000-level selective (3 credit hours) for two consecutive semesters (fall 2010 and spring 2011), open only to juniors and seniors that had already taken the Construction Graphics class.

In the second phase (Phase II), the course was put online in fall 2011 through a WebCT platform called GeorgiaView. All course materials have been tweaked catering to the unique online learning environment. Intensive online teaching/learning tools were reviewed and adopted, including Google Sites/Docs, Wimba Classroom, iSpring, and to name a few. Both synchronous and asynchronous online teaching strategies were examined. The instructor received $3000 stipend for developing the online BIM class, which was finally part of the compulsory major curriculum at 2000 level (3 credit hours).

4. COURSE OUTCOME

4.1 Phase I: BIM as Selective in Classroom

The department chair officially announced the new BIM selective class: *TCM4090* in fall 2010 to the entire department, including faculty members, and professionals from physical plant at GSU. A most advanced computer lab in the department was selected as the classroom for this class, with 24 desktops running 64 bit Windows® 7 OS, 6 GB RAM, Intel® Core™2 Duo 3.4Ghz CPU, 512 MB dedicated NVIDIA GPU, 500 GB 7200 RPM hard drive, and 22-inch LCD monitor. All machines were preloaded with Autodesk® Revit® Architecture, Structure, MEP, Navisworks® Manage and EcoTect™ 2011, with educational licenses procured from Autodesk® resellers.

The class met twice a week and 2 hours each time. It was compact in size with 5 students registered for each of the two semesters. There were also 2 faculty members and physical plant professionals audited the class in each semester. In the 16-week class period, students were taught software applications, conducted literature reviews, and accomplished one individual

project and one group term project. A broad spectrum of course materials was incorporated in class including most recent industry publications on SmartMarket reports and Journal of BIM. Due to the small class size, student participation and enthusiasm were beyond expectation as evidenced by the following observations:

- Almost each class period lasted more than the planned 2 hours due to students' willingness to stay for discussion, coursework, and one-on-one mentoring with the instructor;
- Intensive out-of-class commitment to BIM, as reported by the students that most of them spend 5 or more hours each week in developing modeling skills, reading BIM relevant industry news and refining their course projects in their spare time;
- Quick learning and application of knowledge from the BIM class in other courses the students were taking, including quantity takeoff, estimating, structures, and senior projects.

The highlights of the BIM selective class were the course projects. An average of 10-hour independent modeling was reported by students on their individual projects. For the group term projects, a team spirit was quick formed and leadership skills of students were demonstrated. The term project was to create the BIM model of the department building – Carruth Building, out of the original 2-D drawings and specifications, which were first produced in 1959 and modified due to frequent remodeling over the years. Challenges in print reading, communication cross disciplines and verification of discrepancies between the real building and the drawings were almost overwhelming. Couple of students from fall 2010 semester volunteered to be veterans in the spring 2010 class, and continued working on the project in their spare time. Fig. 3 juxtaposes the original project documents with the Phase I model of the Carruth Building. The Phase II model containing MEP systems is pending due to the possible integration of 3D laser scanning data captured by the surveying class.

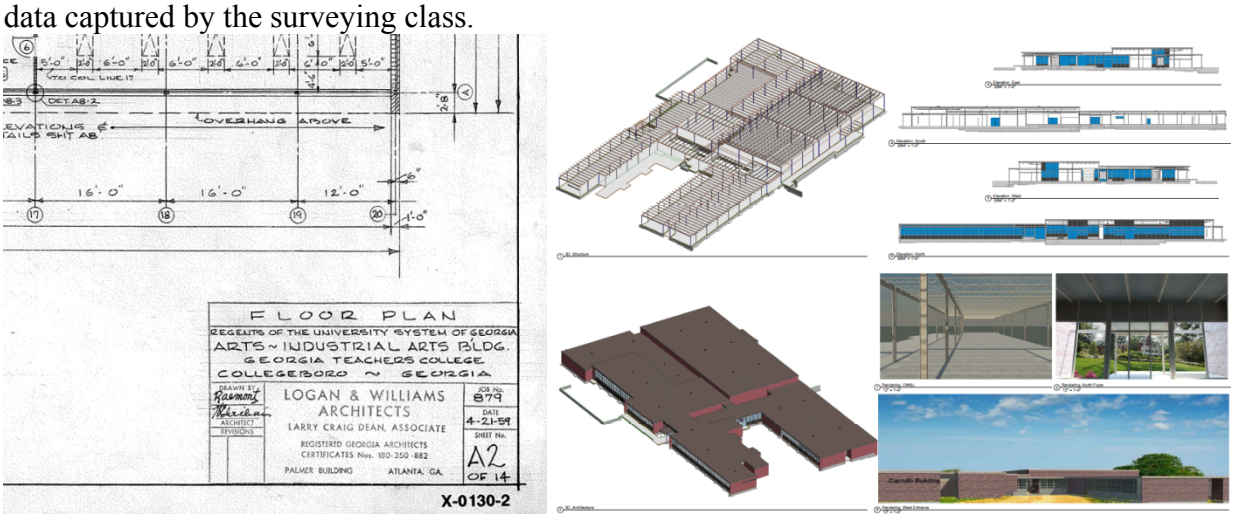

Fig. 3: Student work for group term project.

4.2 Phase 2: BIM as Compulsory Online Class

Due to budget cuts, GSU starts to encourage online classes to leverage costs of running campus facilities. The Center of Online Learning and the College of Education provided relevant training workshop of online course development and teaching. The BIM online course: *TCM2333* went

live on GeorgiaView in fall 2011, and a total of 17 students were registered, more than tripled of the previous class due to the fact that it had become compulsory.

There are pros and cons of putting the BIM course online. The biggest concern was on how to ensure the efficient delivery of the hands-on contents in the course. However, with intervention of online teaching technologies, embedded video tutorials seemed to work just fine for the students. The fact that they could adjust the learning to their individual paces, and repeat the process as many as they want is certainly advantageous over traditional offline teaching (Fig. 4). More importantly, the greatest discovery of teaching BIM online was the participation of the class. It turned out that some "quiet" students in classroom became extremely active in this online class, and conversation between each other took place almost effortlessly with the built-in "Discussion" feature in GeorgiaView (Fig. 5). The online learning environment became somewhat a comfort zone for them.

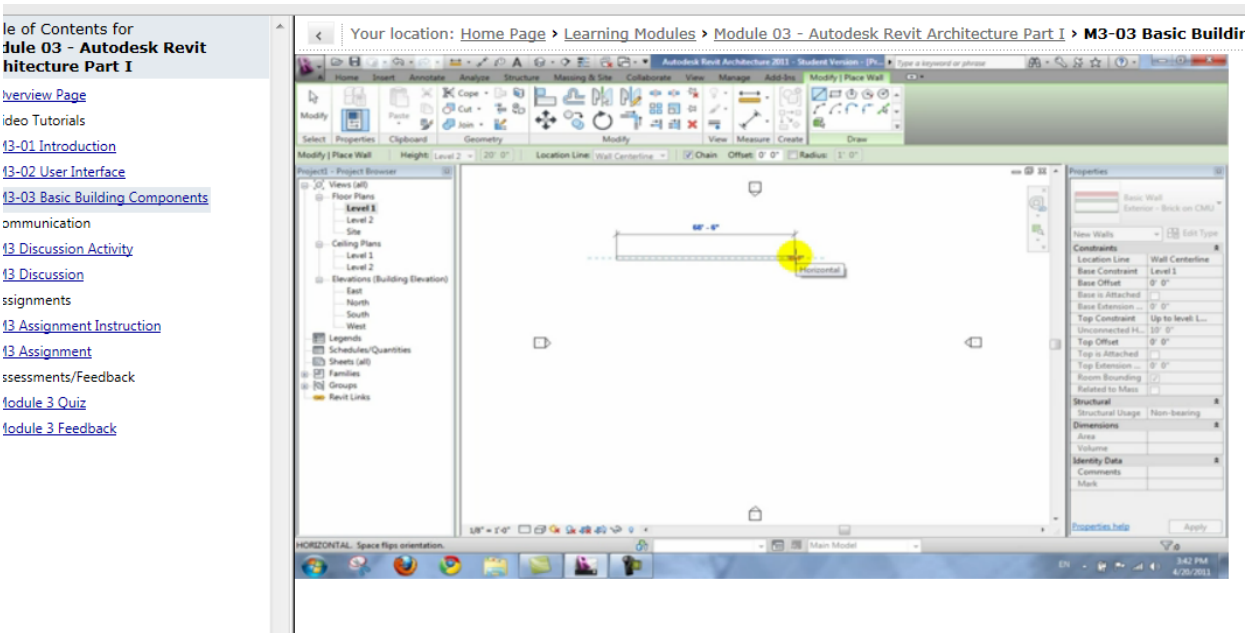

Fig. 4: Embedded online video tutorial in GeorgiaView.

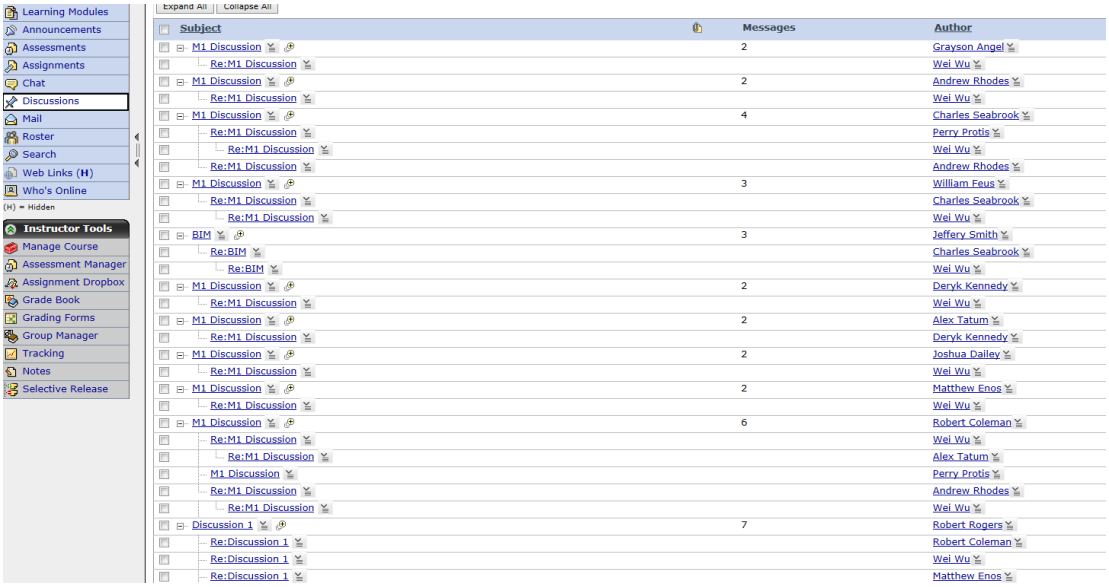

Fig. 5: Guided online discussion in GeorgiaView.

For the course project, recent industry trend shows that standalone BIM is no longer satisfactory. Cloud computing and the concept of BIM server have enabled model constructing, sharing and management over public or private clouds. Students also realize that the multidiscipline nature of the AEC industry makes it almost imperative for them to understand the network based model collaboration process. The online BIM class provides them a great platform to mimic that process. Students use Google™ apps such as Google™ Site and Google™ Docs in communication and documentation management (Fig. 6).

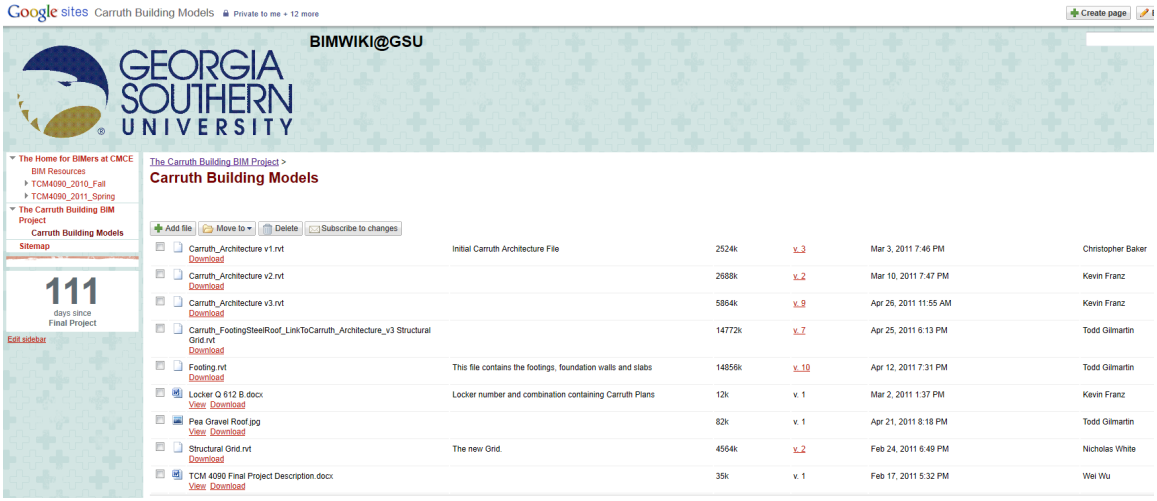

Fig. 6: Implementation of cloud based tools in TCM2333 course project.

5. COURSE IMPACTS

Within a year, this class brought the program up with the most recent development of BIM. Through students' evaluation, their interests in BIM increased exponentially with their learning experience in this class. The instructor started to get emails inquiring about the class, as well as encouraging feedbacks from colleagues on students applying BIM skills in their classes. To further promote the education on BIM, some extra-curriculum strategies were also implemented.

5.1 Departmental BIM Competition

This competition was open to students in both the Construction Graphics class and the BIM class. Students were required to build their dream houses using Autodesk® Revit®, with prescribed project requirements and specifications. After the first-round prequalification by the instructor, 6 candidates went to the final stage open to the 10-day public voting (Fig. 7). The 1st and 2nd place were given certain cash prize sponsored by the foundation funds of the department. It turned out that such a small event engendered unexpected momentum of BIM inside and outside of the department. The university provost, the dean of the collage and other department chairs actually visited the competition exhibits. After the competition, the instructor started to get inquiries about possible external training and consulting with companies on the industry advisory board of the CM program.

5.2 BIM Internship Program

The eventual goal of BIM education in the CM program is to better prepare the students for a much more competitive job market. With the apparent impacts of the BIM class, industrial recruiters made corresponding adjustments. A long-time industry partner of the CM program sent the instructor recruiting plan on BIM internship. Quite a few companies also approached to discuss about possible collaboration in future BIM classes including guest lectures and field trips. At the end of the academic year of 2010, two students were hired as BIM interns for two big general contractors in the southeast region of the States.

Fig. 7: Departmental BIM competition in fall 2010.

6. CONCLUSION AND DISCUSSION

BIM education at GSU is barely getting started. The number of students that attended the BIM class remains disproportional to the total population in the CM program. Students still have the tendency to focus on BIM software applications instead of the BIM facilitated working process. The online BIM class has quite a few uncertainties, especially on how to bridge the gap between the teaching resources and the real industrial work environment. More experiments and resources input are definite desirable.

Nevertheless, the experience gained over this year might offer peer CM programs as a good reference, especially the holistic education strategy adopted. Classroom tutoring is indisputably

important but mentoring to change students' mindsets and the outreaching to the industry for more pragmatic and best practices are even more critical. Through engagement with industrial recruiters, BIM education will be much better oriented. With a clearer target, students will be easier to motivate, and a well-rounded BIM culture can be soon established.

7. REFERENCES

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