Towards Promoting A Collaborative Mindset:
Reaping the Benefits of Big Building Information Modeling (BIM) in an Integrated Real Estate Program

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Abstract

The undergraduate curricula are typically focus-oriented and are offered under different departments. These programs offer the minimum amount of integration with other relevant disciplines, and therefore, the students and faculties have limited, if any, opportunities to collaborate with scholars from other programs. The direct impact of the educational system is reflected in the industry. The industry is suffering from fragmentation and lack of collaboration among the practitioners. However, a successful practice in real world requires that professionals with different expertise work together as a team to deliver a project.

Building Information Modeling (BIM) offers a great opportunity for the integration of information and promoting collaboration across disciplines. Yet, BIM tools alone cannot solve the fragmentation issues. A social change and a collaborative mindset are needed to reap the benefits of BIM. Academia is in the best position to drive such transformation through re-visiting the curricula and making required adjustments.

This paper suggests an Integrated Real Estate Program (IREP) that will utilize BIM and integrated practice to cross traditional college boundaries and to promote integration among disciplines. The IREP will be built upon the breadth expertise of faculties in design, construction, business, economics, engineering, law, planning, property management and other related disciplines. Through taking 18 credit hours from IREP, the undergraduate student of different disciplines could achieve a declared focus area in real estate. During the senior year, two capstone labs will be offered to simulate a real-world situation for students who will be working in a multi-disciplinary team environment.

Keywords

Building Information Modeling (BIM), integrative education curriculum, real estate program, multidisciplinary teams, collaboration, capstone lab.

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Introduction

Project delivery in the real estate industry has been suffering from fragmentation among different phases and project participants of diverse disciplines. These disciplines include but are not limited to finance and business, architecture, engineering, construction, and facility operation. Lack of communication and inconsistency in information shared among these multiple disciplines often lead to inefficiencies, increased risk of errors, increased costs, and lost opportunities. According to Roberts (2010), the fragmentation falls into three categories: 1.Teams are fragmented into disconnected people, 2. Processes are fragmented into disparate tasks, 3. Fragmented tools are applied in lieu of integrated solutions.

The evolution of the concept of Building Information Modeling (BIM) is in response to the existing fragmentation. BIM offers various applications and technologies supporting different tasks such as modeling, visualization, simulation, engineering analysis, integration, and management. Finith Jernigan in his book, *BIG BIM little bim*, emphasizes that BIM is not a software, but instead it demonstrates a combination of tools, integrative processes, and collaborative culture.

The authors of this paper view BIG BIM as a combination of little bims which represents all the information about the facility in one single model. Integration capability of BIM technologies and the collaborative concept of BIM process are what differentiate BIM from the IT tools in the past. Thus, little bims alone without integrating into one single BIG BIM are no better than products generated by fragmented IT tools. BIG BIM, which is referred to as BIM in this paper, employs technologies and a process to promote collaboration and communication among parties, which ultimately leads to facility integration.

The anti-fragmentation revolution of BIM requires a new culture and vision. Full benefits of BIM tools and technologies will not be manifested until the people who utilize it adopt a culture of collaboration, trust, and information sharing. According to Ray Lucchesi, “There are different rhythms of change. Technology is faster than business. Business is faster than infrastructure or law. We’re just beginning to adjust to the technology of BIM. You can’t move to BIM without the social change. That change is one person at a time” (as cited by Miller, Strombom, Iammarino, & Black, 2009).

Academia must re-visit the curricula and make the required adjustment to support this social movement. The revised curricula would enhance the social interaction and leadership abilities of students who are the future generation of the industry. This is the gap that has been addressed throughout this paper.

Building Information Modeling (BIM)

BIM, the current buzzword in the Architecture, Engineering and Construction (A/E/C) industry, is known as a revolutionary paradigm. Various definitions have been proposed for BIM, describing different aspects of it. Some describe BIM as a parametric object-oriented digital model. The model includes different types of information such as geometry, performance, attributes of building components, construction process, schedule, cost, and information on operation and maintenance. “BIM represents buildings as digital simulations rather than just traditional CAD drawings or 3D geometric models” (Longitude Media, 2010). BIM helps users to learn about the whole building. “The idea behind a building information model is that of a single repository. Every item is described only once. Both graphical documents—drawings—and

non-graphical documents—specifications, schedules, and other data—are included. Changes are made to each item in only one place" (Cyon Research Corporation, 2003).

Some said that BIM is not just a tool/model; it includes processes and methodologies for creating a single repository platform to share the information among all stakeholders—referring to BIM as a verb, not a noun. "BIM describes an activity, not an object. To describe the result of modeling activity, we use term 'Building Information Model', or more simply 'Building Model' in full"(Sacks & Barak, 2010). "At its core, a BIM based methodology is built around the notion of collaboration—people and systems exchanging information about a facility throughout its life cycle" (Jordani, 2008). "BIM will push the industry forward by demanding that our teams learn to work in advanced 3D, information-driven environments, where the sharing, capture and reuse of knowledge is common practice and building performance is predictable from the earliest design phases on" (Camps, 2008). BIM without collaboration is simply a representation tool such as Computer-Aided Drawing (CAD) tool.

Through capturing information in a single database and storing it in a central platform, BIM enhances the consistency of information and greatly reduces the communication errors associated with multiple models and different databases. BIM provides excellent benefits to an integrated team, key among them are: (1)a common platform and a shared knowledge source for information; (2) a documentation tool; (3)a collaboration tool; (4) parametric; and (5) a tool for clash detection and constructability analysis (Pishdad & Beliveau, going to be published in 2010).

Likewise, utilizing BIM in education offers many benefits for process automation and integration. BIM can be applied across the spectrum of building design and implementation: conceptual design, detailed design, building analysis, construction documentation, visualization, etc. "As such, using BIM as an educational tool helps students learn about the whole building from idea to materiality. It encourages students to think beyond design, to consider cost, constructability, environmental impact, and so forth. It gives students a solid grounding in building technology, not just the manipulation of form in software" (Autodesk, 2007).

Most importantly, BIM allows integration of information from a variety of sources and disciplines into one single model. This allows the students to learn about the inputs and information shared by other disciplines and how each piece of information contributes in producing the overall project, thus, preparing students for a holistic approach to building design and construction. As John Messner, an associate professor at Penn State argues, through utilizing Building Information Modeling students would learn that a building is actually a network of integrated systems—not isolated disciplines that exist in a vacuum (As cited in Longitude Media, 2010).The students would also learn and practice soft skills such as team work, collaboration, and information exchange.

The Integrated Real Estate Program (IREP) curriculum proposed in this paper emphasizes the integration and collaboration aspect of BIM processes rather than applications of BIM software and tools.

Analysis of Existing BIM-related Courses

The students today have to learn more than what the past generations did, as they need to learn both the traditional and the latest technological tools and skills. At first, it may sound more difficult; however, current technological tools and methods eliminate manual labor works to a great extent and thus save time, offsetting the hours required for learning these new tools.

The subject of BIM education is currently a topic of discussion in many conferences, forums, workshops and academia. The key questions are to what extent BIM should be incorporated into current AEC curricula, at what education level, and how the current fairly overloaded curricula could arrange to incorporate the BIM related courses.

Many universities are considering the inclusion of courses on BIM into their current curricula. They believe BIM skills provide students with a competitive advantage in a job market. The important aspect to consider is that students would learn the BIM concept, background, and the process as opposed to just a specific BIM software application-- as the tools and technologies are continuously evolving and they usually are not difficult to learn. As Henderson and Jordan (2009) also argued, “we need programs that provide students with more than facts. While emphasizing a well-rounded curriculum that teaches students to think independently and flexibly, solve complex problems, inquire, conduct research, collaborate with others, and adapt to our ever changing world, and programs that prepares students for leadership in their chosen professions”.

Several BIM software companies have developed BIM curriculum: for example, Grafisoft created a BIM curriculum to teach BIM at University level. Also, Autodesk jointly with the U.S. Green Building Council (USGBC) Formal Education Committee developed a new Autodesk Sustainable Design Curriculum for undergraduate and graduate-level programs. The Autodesk educational curriculum is designed for architecture and engineering students. According to USC School of Architecture, professor Karen Kensek, the emphasis of the new Autodesk/USGBC curriculum is not on training students in the prescriptive use of BIM software for sustainable design; instead its main focus is to provide teaching materials for sustainable design topics and employs BIM to support critical thinking about green design (Longitude Media, 2010).

Different universities have also started to develop BIM related courses/programs based on various approaches, the learning materials of which include: (1) BIM tools, programs, and technologies, e.g. the Civil & Environmental Engineering department at Carnegie Mellon offers several short classes on BIM, data capture technologies, and data management approaches; (2) BIM concepts and processes, e.g. the Technion Civil Engineering faculty council view BIM as a skill rather than as a tool, and thus de-emphasize the learning of any particular application software (Sacks & Barak, 2010); (3) BIM from both technology and process perspective, e.g. AGC’s BIM education program offers a series of courses on BIM background, concepts, tools, BIM technology, BIM contract negotiation and risk allocation, and BIM process adoption and integration, and Georgia Tech’s BIM course teaches BIM from a technology, design and building practice perspective.

This paper suggests that academia must embrace the BIM process and the opportunities it offers for the integration and unification of different participants involved in project delivery. While it is beneficial to introduce students to different BIM applications and tools, it is more important that academia actually employs BIM to integrate the various disciplines involved in the real estate industry and simulate a real-world practice. Finally, this paper suggests the development of an IREP that bridges the boundaries of disciplines and unifies them under one program to practice the art of collaboration, communication and information sharing. Through IREP capstone labs, multi-disciplinary teams of students will work collaboratively on a single project and simultaneously gain hands-on experience with the BIM process, concepts, and applications.

Suggestions on Implementation of BIM in Academia

BIM education could be provided through various forms of lectures, seminars, discussions, studios and workshops. BIM as a standalone course may only make sense if it is to teach the students about the background and fundamental information about BIM, the process, latest technologies, computer programs, the adoption process, legal and risk management perspectives. These courses could be based on lecture notes, present PowerPoint presentations, and case studies of BIM implementation in project delivery.

Authors believe that teaching the BIM tools, software and programs should not be an academic concern. In fact, students could learn the program tools on their own through the tutorial provided by software providers. Students could get hands-on experience of working with the BIM tools through applying them to deliver their assignments for their course where those particular programs apply.

It is recommended that BIM education is integrated into current undergraduate AEC curricula. Authors believe that potentially BIM as a standalone curriculum can be considered as a graduate major of study as well. The graduates of such programs would be individuals with Building Information Management skills which to some extent replicate the construction/project management skills for the virtual environment; as there might be potential need for creation of a new career opportunity as IT or Builder Information (BI) managers. Such position will be in charge of administering the BIM process, contracts, risk management, standards, supervising the information exchange, interoperability management, coordination of participants, maintaining and managing the model.

BIM Provides the Opportunity to Cross the Boundaries of Disciplines in Academia

"Historically, most departmental-based courses of study at the university level have emphasized a narrow curriculum. Typically, each department owns and teaches a separate knowledge set and each member of that department owns and teaches an even more narrow knowledge subset" (Henderson & Jordan, 2009). However, a successful practice in real life requires that practitioners work together as a team to accomplish a goal and deliver a project.

Concepts of Integrated Project Delivery (IPD) and BIM offer opportunities for integration across disciplines in academia. IPD process and BIM tools and technologies can be employed to connect and integrate different programs, disciplines, and ultimately their students and professors to work together in a team to deliver a project that includes all the systems and components to be actually built.

This paper proposes the development of an IREP program that is built around both the concepts of IPD and BIM. IREP would be an umbrella program and a center of integration for various disciplines contributing to real estate industry: business, finance, architecture, construction, engineering, landscape, law, natural sciences, building science, and any other related program.

Towards Promoting a Multi-Disciplinary Team Collaboration: A Proposal on Integrated Real Estate Program (IREP)

The idea of development of the IREP comes to the authors in respond to the current challenges of the real estate industry. Real Estate industry is run by a broad range of professions specializing in different areas including architecture, engineering, construction, finance, economics, marketing, law, etc. The great numbers of professionals involved in this diverse

industry makes the coordination efforts a challenge; especially when one looks at the current fragmented industry resulting from the isolated silos of professions mirroring individual focus-oriented educational programs.

Due to the accreditations requirements, academic education curricula and models are generally focused on the specific disciplines. Thus, the graduates from these programs are individuals with specialized information on the field of their studies. There is limited integration among different disciplines and thus students have minimum exposure to other programs. Students leave the programs and enter into the industry with the minimum skills of communication and collaboration in a team-based environment consists of individuals with various specializations.

The real-estate industry is more than ever fragile, and academicians and researchers should develop programs and enhance current educational models to educate more collaborative individuals who are willing to cross the boundaries of disciplines, and freely share knowledge and expertise with other professions to reach excellence.

The proposed IREP could be offered both at undergraduate level and graduate level. However, the undergraduate level is the target, as at this stage the students are less likely to act focus-oriented and are more flexible and open to collaboration with students from other programs. The IREP is designed as a declared area of focus for undergrads interested in the real-estate industry and majoring in any of the following fields of studies: business, finance, accounting, architecture, construction, civil engineering, mechanical engineering, electrical engineering, landscape architecture, planning, agriculture, natural sciences, building science, information management, property management, and any other related field of study.

The suggested program will provide an overview to the interdisciplinary and multi-phases process of real estate development. It will cross the boundaries of different disciplines and integrate them into one program. The vision is to educate students on the core values of team building, trust, collaboration and integration to successfully deliver projects. It is envisioned that IREP program will ultimately result into a social change and transformation in the industry to save it from fragmentation and resulting inefficiencies.

According to a recent book “The Commercial Real Estate Revolution” by R. Miller, D. Strombom, M. Iammarino, and B. Balck, nine transforming keys to lowering cost, cutting waste, and driving change in a broken industry are: 1. Trust-Based Team Forming, 2. Early Collaboration, 3. Built in Sustainability, 4. Transformational Leadership, (Five tools), 5. Big BIM, 6. Integrated Project Delivery, 7. Trust-Based Agreements and Client-Centered Incentives, 8. Offsite construction, 9. Workplace Productivity. These nine keys are the primarily ingredients elements upon which IREP curriculum will be developed.

The students from each discipline entering the IREP should take extra 18 credit hours from this program in addition to their major field of studies requirements to earn a focus declared area of Real Estate. As shown in table 1, the 18 credit hours composes of two 3 credit hours courses at the freshman year, two 1 credit hour at the sophomore year, two 1 credit hour at the junior year, and two 4 credit hours Capstone labs at the Senior year.

Table 1: Proposed curriculum for an Undergraduate declared focus on IREP

Year	18 IREP credits	
	Fall semesters	**Spring semesters**
Freshman	3 credits lecture	3 credits lab
Sophomore	1 credit seminar	1 credit seminar
Junior	1 credit seminar	1 credit seminar
Senior	4 credits capstone lab	4 credits capstone lab

Freshman Level: During the first semester of the freshman year, throughout a 3 credit hours course, the students will be introduced to the principles of real-estate practice, project delivery concepts, different phases of a project life cycle, activities, project participants, roles and responsibilities, overall process, collaboration tools such as BIM, and integrated practice. Throughout the second semester, the students will take a 3 credit hours lab. The students in lab will work in a multi-disciplinary team environment to collaboratively deliver their assigned projects. Case studies will be used to provide students with information on how projects are delivered in the real world. The lab will be designed to promote and strengthen the students' collaboration and communication skills. Furthermore, students will gain hands-on-experience working with different BIM tools. The concepts of trust, collaboration, sustainability, leadership, and integrated practice are the key learning topics in this lab.

Sophomore and Junior Level: At sophomore year and junior year, one-credit hour seminars where the students will be exposed to BIM processes and technologies in more advanced level. The seminar courses are designed to keep the students current with the latest trends and practices and they follow collaborative teaching philosophy. Thus, the seminar series will be the place of inquiries, where students of various majors share and discuss their perspective on the topics and learn from the diverse points of views. Experts from various relevant disciplines, such as finance, architecture, engineering, construction, management, and Law either from academic departments or industry will participate in the development of course syllabuses and materials. BIM adopting process, IPD, BIM standards, contracts, various BIM applications, ownership of document, BIM best practices, risk management, and interoperability are some of the sample topics of discussion.

Senior Level: During the senior year, a two-semester series of 4 credit hours capstone labs will be devoted to expose the students to real-world practice. The vision behind capstone lab experiments is to mimic a real world situation where different professions with various backgrounds collaborate to deliver a project. Thus, the students in capstone labs will work in a multi-disciplinary team environment to collaboratively deliver their assigned project. Assigned projects should be designed to include different phases of a project delivery from early programming, planning and conceptualization phase all the way to project implementation and information on project operation. BIM is a good median to be used as the primary integrating tool and platform.

The key purposes of the capstone labs are for students to: (1) implement their knowledge and skills acquired in different courses through years of studies; (2) practice team work, collaboration, and information sharing; (3) become prepare for real-world multidisciplinary practice; (4) practice integration principles and leadership; (5) utilize different BIM applications and experience little bims integration into a single BIG BIM; and (6) to understand the overall

challenges associated with the real estate practice. Ultimately, the IREP will prepare the students for entering into the industry which is based on the broad knowledge sets and required integrity to sustain.

Conclusion

The highly focus-oriented educational curricula offered by different departments have led to graduates who are highly specialized but lacking the collaboration skills and ability to work in a multi-disciplinary team based environment. The current educational system is known as a major cause of the industry fragmentation. In respond to the identified gap, the IREP is proposed to overcome the major barrier towards integration and collaboration among different disciplines.

The IREP is designed as a declared area of focus for undergrads interested in the real-estate industry and majoring in any of the following fields of studies: business, finance, accounting, architecture, construction, civil engineering, mechanical engineering, electrical engineering, landscape architecture, planning, agriculture, natural sciences, building science, information management, property management, and any other related field of study.

The IREP will be developed based upon the key principles stated in "the Commercial Real Estate Revolution" book including BIM, IPD, sustainability, and transformational leadership. The goal of the IREP is to create a multi-disciplinary program where the students, faculties, and practitioners from different fields of study will interface, inter-relate and interact as a unified program. The program will be designed to educate the undergraduate students on the value of trust, collaboration. Latest BIM tools and process will be utilized to facilitate integration among the involved disciplines.

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