CHALLENGE OF TEACHING BIM IN THE FIRST YEAR OF UNIVERSITY

Problems encountered and typical misconceptions to avoid when integrating BIM into an architectural design curriculum

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Abstract. This paper presents an experience about BIM curriculum from Faculty of Architecture, Rangsit University, which has been implemented since 2010. Our approach is to introduce BIM into the first year architectural design curriculum both as a tool and as a new way to practice design. The objective of this paper is to identify problems encountered from the class and typical misconceptions about BIM curriculum based on our experience. Problems encountered are 1) The need to boost students’ attention, 2) The lack of acceptability criteria of the students’ design flaws, 3) The lack of BIM Guideline to be used in the curriculum, and 4) The need to grow the BIM thinking in other advanced studios. Typical misconceptions identified are 1) BIM is just another design tool 2) Traditional design process can be used in a BIM design studio, and 3) BIM limits creativity. Finally, we propose how to improve the curriculum and compare the BIM design process to traditional design process.

Keywords. BIM; Curriculum; Education.

1.1 DIFFERENT APPROACHES IN TEACHING BIM

Since the beginning of CAD, architectural schools have been taking very different, not to say contradictory, approaches in teaching computer-aided design. Some avant-garde schools integrate CAD teaching early into their curriculum; some others claim the computer limits the students’ creativity so they do not let the students use the computer in their early years; while some others, due to lack of instructors who understand technology, let the students pick up the tools by themselves. When BIM enters the academic picture, some schools
even hesitate to incorporate BIM into the architectural curriculum. But since professional architects begin to see the benefits of BIM, the initial resistance to this new technology has declined; “To BIM or not to BIM” in architectural school is not the question anymore because architectural education usually reflects the needs of the work market (Ibrahim, 2006). It cannot be denied that architectural schools nowadays should integrate BIM into their curriculum; thus, the questions are when to BIM and how to teach BIM?

In the introductory essay to “BIM in Academia” Peggy Deamer (Deamer & Bernstein, 2011) asks if BIM should be considered as a software/skill/tool issue (therefore a non-credit workshop, or to be placed in the structures/technology course?), a professional organizational method (part of a professional practice?) or new form of design practice (to be integrated into studio?). If the last is the case, should it be offered in the advanced studio (as an elective, or at a post-graduate level) or in early, core studios? A study by Becerik-Gerber et al (2011) shows that AEC schools and programs approach these questions differently. Also, there is a growing number of publications regarding the topic such as Ambrose (2006), Cheng (2006), Ambrose (2007), Penttilä & Elger (2008), Barison & Santos (2010), Clayton et al (2010), Barison & Santos (2011), Becerik-Gerber et al (2011), Ambrose (2012), Barison (2012), and Ibrahim (2014).

1.2 OUR APPROACH: INTRODUCING BIM IN THE FIRST YEAR AS A TOOL AND A NEW WAY TO PRACTICE DESIGN

Contrary to many other schools in the country, we believe that our students (Gen Z, digital natives) should be exposed to technologies as early as possible in their curricula, thus will be groomed to think the BIM way. That’s why we integrate BIM into the first year of the Architectural program since 2010. In Year 1, semester 1, BIM is introduced into a CAD course where the students learn how to use BIM software as a tool. It then continues in Semester 2 in another CAD course, from which the skill is used in two other related courses. In many aspects, most of the teaching is still strictly divided into teaching design and teaching computer skills (Dokonal & Knight, 2008). But in order to accelerate the learning process and gain students’ attention, our approach tries to integrate the two into a fast-paced learning process through various in-class assignments. A typical project for the first year students is a single-family detached house. At the end of the course, each student designs a building in a Community development project.

In other words, BIM does enter our curriculum at a pre-advanced studio level, first as a single course and then intra-course collaboration. It is introduced both as a tool and a new design method. The first year students use
BIM throughout the design process; from Architectural Programming, Preliminary design, to Design development, and Construction Drawings. However, in this paper the definition of BIM is limited mainly to 3D modelling, documentation tools and reported tendency depends on specific application software (ArchiCAD).

1.3 WHY TEACHING BIM IN THE FIRST YEAR IS A CHALLENGE?
Teaching BIM in the first year seems ideal for grooming the students to think the BIM way. But early in the curriculum there are design fundamentals to be covered as well as architectural vocabulary and grammar. Many think that the students should not design a home until they have acquired basic knowledge and skills. But the students want to design; teaching BIM as a tool is not enough to attract students’ attention. A teaching strategy needs to be well thought out.

Moreover, the relationship amongst these BIM related courses needs to be conceptualised and communicated, synchronised and coordinated; not every instructor can see the big picture. There are misconceptions amongst instructors that limit the growth of BIM thinking in our school.

Thus, challenges of teaching BIM in the first year arise both at the conceptual level and the execution level. In this paper, what seems problematic at the execution level is called “problems encountered” and what does not seem right at the conceptual level is called “typical misconceptions to avoid”.

Our methodology is composed of two steps. First, we observe BIM courses (course structure, course syllabus, assignments, students’ works, connection between courses, etc.) and discuss with the instructors. As a result, problems encountered at the execution level are identified. Then, after an interview with both instructors and the policy maker, we will be pointing out typical misconceptions to avoid when introducing BIM early into an architectural design curriculum. Furthermore, we will suggest solutions in order to improve our BIM curriculum.

2. The BIM courses
Figure 1 shows the BIM courses introduced in the first year (left) and a triangular relationship between three BIM related courses in Year 1, semester 2 (right).
In Year 1, semester 1, BIM is first introduced as a tool in an introductory course (Computer-Aided Design I). This course begins with some technical drills where the students learn how to create basic components in architectural design (column, beams, floors, etc.) in a BIM software. Then the students are given assignments to design some basic structures (a pavilion, a bus stop, a home), even though they haven’t yet learned all the design fundamentals. We even send the students “up the elevator” to see what the second year students are doing. The freshmen design what they think a resort and an apartment building should look like, all of this to be finished within the class hours.

Later in the second semester, BIM is introduced as a design method into a continuous course (Computer-Aided Design II). The students are given one assignment per week, to be finished within the class hours. Some assignments require the students to use the design and presentation skills, while a few others are just technical drills. The course runs in parallel with two other related courses. One is the Basic Design course, where the students use their BIM modelling skills and learn the design fundamental through a community based development project (called “4+1 project”), in a collaboration with the 4th year students; another is the Building material course, where the students learn about materials and construction techniques and how to integrate them into the design, and use BIM to produce technical drawings and for document management. At the end of the first year, the students have come up with a design of a basic structure for the community development project and can manage a set of documents. At least two instructors from each course are assigned to teach in another related course in order to ensure the communication between these courses.

Figure 2 shows the development of the students’ work from the first BIM course in year 1, semester 1 (upper row) where the students simulate a type of building without prior design knowledge. Then, the design skills and BIM skills are developed in the Computer-Aided Design II course in semester 2.
Finally, the final design outcome of the first year students are shown in Basic Design course’s 4+1 project (bottom row).

3. Problems encountered

3.1 THE NEED TO BOOST STUDENTS’ ATTENTION

Students enter an architectural school with an aspiration to design something, not to learn tools. Teaching BIM merely as a tool is not enough to gain students’ attention, resulting in skipping classes. From our experience, the teaching strategy has changed from a traditional software learning function by function to learning by designing basic structures. Also, the students respond better to a fast-paced learning, which keeps them motivated. Moreover, the instructors see that the freshmen’s academic attention is different from one year to another.

3.2 THE LACK OF ACCEPTABILITY CRITERIA OF THE STUDENTS’ DESIGN FLAWS

Early in the BIM courses, the design process is introduced at such a fast pace that students may not have understood several design issues (human scale, spatial arrangement, circulation, zoning, etc.). The end products seem complete and impressive with details and rendering, but some lack of understanding in the design is shown. These mistakes in design normally decrease as time
goes by, and the students have gained sufficient knowledge in design fundamentals, but to what extent these design flaws is acceptable for each step of the course? This seems to create confusion among instructors and results in grading inconsistencies. Also, instructors who are not assigned to teach other related courses cannot see when these design issues will be covered in the curriculum.

3.3 THE LACK OF BIM GUIDELINE TO BE USED IN THE CURRICULUM

The level of detail expected from BIM models and drawings is not the same for each design studio. In the first year studio, the students need to communicate the look and feel of the building; therefore, the level of detail of construction graphics can be minimal. However, the correctness of the drawings becomes crucial in advanced construction courses, as they are more concerned about constructability of the design. There is an urgent need of a BIM guideline in order to assure the consistency of the drawings for each design studio.

3.4 THE NEED TO GROW BIM THINKING IN OTHER ADVANCED STUDIOS

Our school grows a solid thinking of BIM to the first year students, but its development is still problematic. BIM continues as a tool for structural system design and analysis in construction courses offered in Year 2. After that, the students have the liberty to use BIM or not in advanced design studios. There is no further development of BIM courses in our curriculum, which means that advanced aspects of BIM shall not be addressed (Interdisciplinary collaboration, model based estimating and cost controls, 4D scheduling, construction management, etc.). The main reason is that the curriculum structure is unresponsive to BIM (Deamer & Bernstein, 2011). Another reason is the lack of BIM literates, specialists across all the design studios.

4. Typical misconceptions to avoid

4.1 BIM IS JUST ANOTHER DESIGN TOOL

One of the most common misconceptions about BIM is to take it as another design tool. Some instructors may even hesitate to use BIM when they find that our choice of software is not well received by the industry. BIM is not just a design tool that you can take it or leave it, but a revolutionary way to design, a concept. When the students learn BIM, they do not learn only how to use a design tool, but also a nonlinear way of thinking, and how to integrate multiple facets of information. Moreover, Jacek Magiera (2013) argues that a
BIM class requires training software skills in the first place, but even more important are “lateral” skills such as communication, management, and teamwork. Our first year students have learned all these skills through various assignments and have exercised these skills in a community development project, thus thinking the BIM way.

4.2 TRADITIONAL DESIGN PROCESS CAN BE USED IN A BIM DESIGN STUDIO

Contrary to what a number of instructors believe, the architectural design process for BIM class is not a traditional design process that has been taught in design studios since the Modern days (these instructors have learned the design process when BIM did not exist). A linear thinking such as “students should get the floor plan right before they can design a facade” is a Modern design process. When designing with BIM, the students can work back and forth between the floor plans, the elevations, and the model with consistency among these representations. Allegorically, the sequence in which a design concept the student has captured can be nonlinear. In a fast-paced learning process, a student may have understood one concept, then progress to another concept and so forth. This does not affect the learning outcome at all.

4.3 BIM LIMITS CREATIVITY

BIM is often perceived as an obstacle to students’ creativity because of its instant building elements. We argue that this is not so; it all depends on how BIM is introduced. In the first year, students learn to communicate with design vocabularies (space, circulation, concept, image), using design elements (dot, line, plane, etc.). Being aware that grammar limits their creativity; the students learn to communicate with vocabularies first, and grammar is inserted later to ensure they will not be afraid to explore. In early BIM classes, there is no judgment on the design whatsoever that could frame the students’ creativity. Our students’ works from 4+1 project have shown that there is a drastic progress of the students’ works. The students have explored what they can do with BIM and come up with different interesting designs for community homes and buildings based on a modern traditional style (cf. figure 3).
In order to improve our curriculum, the following suggestions are offered:

- A fast-paced learning is not the only way to boost students’ attention. Modifying assignments every year will keep the class fresh and respond better to students’ interest,
- Acceptability criteria of the students’ design flaws should be drafted in order to keep the consistency of grading,
- A professional development program needs to be developed so that the instructors can grow their BIM knowledge. Also, the concept of BIM courses needs to be communicated across all years,
- BIM guideline needs to be developed in order to assure the consistency of the model’s the level of development in a design studio. What seem necessary for the first year students is, for example, LOD 100, LOD 200 (New York City Department of Design and Construction, 2012).

6. Conclusion and discussion

When BIM is placed in the first year, the students learn the BIM design process, which is different from a traditional one. In a traditional design process, the students have to go through a linear process (Site analysis, Bubble diagram, schematic design, Design development, etc.) otherwise they fail. If they have not cleared the first floor plan, they cannot begin the second floor. If they have not finished the floor plans, they cannot begin thinking about the facade.
However, one may argue that BIM design process is a normal design process, which is cyclical through a cycle of “seeing, moving, and seeing” (Schön & Wiggins, 1992). Here we would like to distinguish between “normal” and “traditional”. Due to limitations of traditional design tools (conventional sketching, physical modelling, traditional CAD software, etc.), interactivity of the design can become problematic such as the consequent of a change may not be accurately reflected in the model and all subsequent views of it. Chuck Eastman’s early experience in teaching BIM confirms that BIM appears fairly intuitive to students, and it more closely resembles their perception of the world (Eastman et al, 2011). Using BIM software in design, the interaction with the model improves. The students can see the models of the overall design fast and begin the refining process fast.

More importantly, in BIM design process the students can start anywhere they want, but still get the outcome. It’s like making a journey, the traveller can choose whatever mode of transportation (by bus, by car, by plane, etc.), but still arrive at the destination. Our approach of teaching BIM at a fast pace helps to boost the students’ attention. They are given a task to design every week, decide for themselves how to accomplish the task, and progress quickly. The learning outcome has proved the effectiveness of this approach.

Our decision to teach BIM in the first year turned out to be ideal since the students will be trained to think the BIM way early in their education. As a result, they will continue to use their BIM thinking in advanced design studios, even though BIM course is not there anymore. However, the misconceptions of BIM need to be avoided. Instructors in those studios still think of BIM as a tool and still use traditional design process, which is unreceptive to BIM thinking. In our Faculty, each year’s design studio is a unique school of thought. Students exposed to a variety of thinking is our strength, but it is problematic for BIM since BIM requires everybody to speak the same language.

Our future work will be focused on researching how to insert BIM design process into advanced design studios. For the time being, what we can do is to establish a BIM guideline as a drawing and modelling standard for each design studio. Advanced BIM concepts will be introduced to the students when professionals in the country are more ready.

References


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