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Building Information Modeling in Architectural Education: The Case of the Middle East

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Abstract

The construction industry in the 21st century is facing a huge challenge. Building Information Modeling (BIM) is emerging as a technological, procedural and strategic new approach to the fields of Architecture, Engineering and Construction (AEC) providing a way for iterating, documenting and managing a design through most of its life-cycle from conceptual design, design development to construction through operations and management. The bulk of the time spent on a design project is in the detailed design and construction document phases of a project, while the building's general appearance, performance and cost are largely decided during conceptual design.
Since CAD easily helps visualize the design concept, where the conceptual design phase is mainly the responsibility of the architect, most curricula in architectural education are currently designed with more focus on CAD and less or no focus on BIM. As a result, most architecture graduates do not posses enough BIM knowledge or skill that is urgently needed by employers. This creates a growing gap between academia and the design and construction industry that needs to be addressed. Also, of great importance is the unique situation of each region of the world with its different infra structure and different work habits.
Through the survey of several case studies, this paper tries to answer these questions. Can BIM make the whole experience of teaching and learning architecture much simpler or more effective? When is the right time to introduce BIM to students of architecture? How should BIM be introduced to students of architecture especially in the early stages of design Studio?

Keywords

Education, Curriculum, Building Information Modeling, BIM, CAD, AEC.

1. Introduction

Building Information Modeling or shortly BIM is the technology that is currently sweeping the architectural practice all over the world. The transformation happening in the work place is no longer unnoticed in academia, with numerous research topics and teaching questions raised than ever before. Nevertheless, it is important to differentiate between the benefits gained professionally from using BIM and the education process where knowledge should be acquired in digestible doses in order to be ready for both the creative and productive parts of the architecture profession (Ibrahim 2007).

It has been noticed that in the west, BIM solutions gained significant momentum in a short time, and although this is anticipated to happen in the Middle East, it has yet to be realized for many reasons.

If looked at with a positive eye, the fact that BIM did not pick up enough momentum in the Middle East creates a unique position for the universities in the region where they can start preparing a generation of young architects who are skilled and ready when the market is ready.

From reviewing previous research, it has been concluded that the majority of architectural programs are expected to incorporate BIM into their curricula within the next two years. However, there is no agreement as to the best way to achieve this. When and how to introduce BIM are questions different programs approach differently (Gerber and Gerber et al 2011)

The methodology of this research compares several previous studies with researchers' observations and experience to measure the readiness of academia to accommodate BIM tools and technologies in current architectural curriculum. It also compares their results with an online survey conducted by the researchers to measure the interest of today's AEC firms in hiring BIM ready architectural graduates in the Middle East with a special focus on United Arab Emirates.

2. What is BIM?

Since BIM is a well known technology by today, it would be more appropriate to shorten the definition part of the technology in this paper.

According to the book "Green BIM" (Krygiel and Brad, 2008), BIM is defined as the creation and use of coordinated, consistent, computable information about a building project in design—parametric information used for design decision making, production of high-quality construction documents, prediction of building performance, cost estimating, and construction planning.

A BIM model can be holistically used throughout the design process and the construction process as well as during operation and facility management.

The model is essentially a database from which all data can be extracted smartly to meet the needs of the viewer at any time and applicable format. This model is also parametric.

However, BIM represents a design process that does not prioritize abstract representation or fragmented conventions of communication but instead privileges the contextual construction of a formal/spatial systemic intelligent simulation (Ambrose, 2009).

The possibility of starting with "building" rather than ending with "building" might radically reposition curricular goals, concepts and knowledge in the design studio. The design studio must now reflect new ways of teaching and addressing emergent digital design methods and processes, and critically evaluate their effects and possibilities in architectural production (Ambrose 2009).

3. BIM in Architectural Education:

Since BIM tools are becoming essential productivity tools in practice, the architectural curriculum should reflect this and respond to the market need.

Every architecture educator agrees on the importance of keeping the manual skills in place in the curriculum of architectural education, but not everyone will agree on when or how the new digital tools should be introduced. Partially because many faculty members are still not highly qualified in this rapidly changing field.

Generally speaking, the introduction of new tools in architectural education follows one of the following methods:

1. Creating dedicated courses to teach the new tool,
2. Or, integrate the tool in the design studio classes and depend on instructions, given through the studio course, to teach the tool,
3. Or, prepare students with short introductions to the tool in the form of workshops, short summer classes, mini courses or peer student tutoring, then require students to utilize their knowledge of the tool in the studio environment.

Each method has advantages and disadvantages, and Different schools of architecture have adopted one of these methods to introduce BIM tools in their curriculum:

The first method: the segregated method.

Through a well structured course syllabus, a dedicated focused learning outcomes of the technology is delivered which usually insures consistent instructions and dose control over the content of the course to all students; insuring the overall quality, but in the same time, students are in a sterile environment protected from real problems that might emerge during spontaneous use of the tools.

> "Many Faculties of Architecture have a single professor for CAAD or a designated person who is the "computer" person. This ignores the fact that we are all computer people now. As such, the use of computers must finally be integrated into the curriculum. This means finding time, people and resources to teach our students the skills they need – these are not necessarily the ones we as older practitioners have". (Russell and Elger 2008)

The case of the University of Sharjah, BIM tools are less integrated into their curriculum since established programs find it difficult to sacrifice other courses in order to free credits for the introduction of such classes. In their study (Techel and Nassar, 2007) concluded that in the Department of Architectural Engineering students learn best in a segregated-integrative approach where learning material or topics are split into separate courses that try to cooperate with each other as much as possible. The separate courses ensure that certain topics are handled while the commitment towards cooperation ensures that. (Techel and Nassar, 2007)

The same applies to the review of the curriculum at the department of Architectural Engineering, Faculty of Engineering at the Arab Academy for Science, Technology & Maritime Transport in Cairo. The curriculum has electives for BIM tools, but no direct integration with the studio courses.

The department of Architecture Engineering, Faculty of Engineering at Ain Shams University in Cairo has even less integration since no such dedicated elective courses are offered, the subject is covered only in an advanced CAD course among other topics.

By interviewing faculty members, the same scenario has been found repeating in the American University in Sharjah where an advanced CAD course serves both function with no dedicated course for BIM.

The second method: the fully integrated method.

This is the absolute opposite of the first method, where students learn the tools by using it for developing and presenting their studio work (or may be technology assignments). The advantage of this method is that students learn in more realistic situations and use the tools when they need it. The disadvantage comes from the unexpected problems emerging that have to be solved with different levels of expertise. This creates differences between the expected learning outcomes for each student, also requires very strong command of the tools from the instructors.

Very scarce documentation of this method has been found in research for the Middle East region. Although undocumented, some design studio professors have tried to integrate directly BIM tools into the design studio.

The third method: the hybrid method.

This method can solve many of the problems of the previous two methods, since it provides a controlled instruction environment in the beginning then opens up to the adventurous real problems of the individuals later.

The main disadvantage for this method is the required time, since organizing workshops would require extra time during regular semesters or during off periods.

The Georgia Institute of Technology has worked to realize this solution by creating a resource center; they created the Digital Building Lab @ Georgia Tech[1], which is a web based resource center for their students to get the required help on picking up new tools. The lab does not only provide information about BIM tools, but it helps in building the knowledge regarding many other CAD tools as well. The school of architecture at Georgia Tech uses the third method of providing CAD tools. Short structured introduction to the tool, then hands on experience through design studios.

Another example, Auburn University introduced BIM by way of a one-week tutorial, followed by a semester-long introductory course (Taylor, Liu and Hein, 2008). The New Jersey Institute of Technology introduced BIM several years ago in various upper-level studios, and they now offer a BIM class and use it as the main tool in a design studio. (Rudesill, 2007)

By surveying several architectural schools around the world and in the Middle East region, it has become clear that the introduction of BIM tools in the curriculum has different strategies.

Many previous studies have concluded that the most significant obstacles to including BIM at the undergraduate level are the already-existing requirements for graduation, the absence of room in the curriculum for additional elective courses and the lack of reference materials and established curricula (Sabongi, 2009).

Teaching BIM is not only about using the tools in a dedicated CAD course, it is also about using the tools that relate through BIM to other disciplines such as model building, acoustical analysis, energy consumption analysis, building thermal behavior analysis, project management, cost estimate, etc. for the

[1] http://bim.arch.gatech.edu/

first time it is imaginable that one tool might lead us to think about all aspects of the design of a building and all the courses related to this in the curriculum.

BIM instruction should include the following: (Sabongi, 2009)

1. Technical skills in handling the respective application
2. Basic knowledge of aesthetic, functional and structural aspects of design
3. Ability to synthesize these skills and knowledge into the shaping of more complex objects
4. Ability to formulate a spatial hypothesis
5. Skills to generate respective views of the design as a basis for criticism
6. Ability to criticize the respective design hypothesis
7. Ability to repeat these steps in an iterative process

Since an application like SketchUp can be introduced very early to architecture students, tools like dynamic components, can be used as a precursor to using a fully fledged BIM solution. First, model and create kits of parts, then assemble parts in that digital environment. Later, students can compare what they created in SketchUp with a real BIM solution. Eventually, students can move to real BIM solutions.

Basic modeling techniques and concept can be discussed first in SketchUp. Custom created objects in SketchUp and the use of dynamic components can then be approached to introduce students to the concept of parametric design.

4. The Work Market Relationship to Education

Architectural education usually reflects the needs of the work market. Therefore, it is very important to understand the needs and identify the directions where the architectural education should go if the current trend of implementing the new technology will grow (Ibrahim 2007).

From observations, there has not been any notable demand for BIM savvy fresh graduate in the Middle East nor the UAE market. The major demand, as it has always been, is the general CAD savvy young architects.

Realizing this oddity, this research surveyed a number of Middle East based AEC firms in order to understand the reasons behind it.

5. The Unique Situation of the Middle East and the UAE in particular

Our current students who will graduate in 2014 will be facing a new market with new requirements. Did the market in the Middle East change? Is it willing to change?

With the introduction of BIM, the required skill of the “operator” of the CAD system has risen dramatically. Only a well trained architect is capable of handling a BIM platform. Also, there is no easy way to describe a task to a draftsman who would model it on a BIM platform.

From observation of the market, this has led many firms who adopted BIM to give up the role of draftsman. This is not the case in UAE in particular. UAE is one place where the draftsman job has not eroded the way it had in other countries. However, the image is different in other surrounding Middle East countries.

It is clear that every region of the world has different situations and circumstances of its application of any technology and that the North American model is typically different from the European and consequently from the Middle East. Brazil, as an example of South America, has a unique situation as well (Pupo and Celani 2007). According to their survey, Brazilian architects developed a skeptic view of the role of IT in architecture; they saw CAD software mainly as a representation tool and called for a new agenda of CAD education in Brazil.

Many issues are playing for this to happen, one of them is the current profit margins of architectural consultations after the market crash in 2009.

Consultants are still in the denial phase and think that a move to BIM tools has to be enforced not volunteered. Many believe that the market in UAE in general, is not ripe enough to accommodate introducing new technology such as BIM in main stream practice.

The survey conducted by the authors has revealed some of the contradictions of the local market AEC firms positions toward BIM solutions.

A collection of professional AEC firms in the Middle East has been sent an invitation to respond to an online survey. Through professional organizations and groups such as CNBR (Co-operative Network for Building Researchers), ASCAAD (Arab Society for Computer Aided architectural Design), Linked-in service and via email lists, the researchers approached as many as 200 local consultants with 10% response rate. The low response rate was interpreted by the researchers as lack of interest in the subject and contributed to the conclusion that the professional market in the region is not yet ready to use new tools and is facing hurdles in implementing them.

The survey is composed of a group of questions designed to show their commitment to CAD tools in general and to BIM tools in particular. The result of that survey is as follows:

Question: What type of CAD systems are you using currently?

- Drafting CAD packages such as AutoCAD 93%
- BIM Solutions such as ArchiCAD or Revit 0%
- Advanced BIM systems such as Tekla Structures or Gehry's Technologies 0%
- A mix of all of the above 7%
- Not at all 0%

Question: Do you require young architects joining your firm to know CAD?

- Yes, it is a must 93%
- No, we train them anyway 0%
- No. 7%

The answer percentages clearly show that all current firms use CAD which is very expected. However, all responses indicated that new hired architects without CAD skills are not welcomed and that they do not train their new employees for this particular skill.

However, when asked about BIM tools, only 8% indicated that they used a mix of the different available tools where 92% indicated sole dependency on drafting CAD packages. Given the very small usage percentage of BIM or other tools, the response for the young architects joining the firm is:

Question: Do you require young architects joining your firm to know BIM?

- Yes, it is a must 20%
- Recommended only 33%
- No, we train them anyway 7%
- No, we do not use BIM 40%

6. Conclusion:

All indicators in research and in professional practice show an increase in the dependency of the BIM tools all over the world. Universities around the world are converting their curriculum to meet this change. Architectural graduates with BIM background are more preferred than those with only CAD abilities.

The universities in the Middle East are currently in a unique position since the market has not yet initiated the demand for the caliber of graduates with BIM knowledge. If we start immediately and pave the road for such a goal, we will be ready to provide the market with the right type of graduate by the time the demand has been created.

With all the available research and experiments to introduce such tools, a wealth of information has been generated that could help in making the right decisions and choosing the right method to implement the BIM technology in today's curriculum.

Universities should allocate enough time in the curriculum for the topic and recognize the importance of the early introduction by either increasing the credit hours of their programs or reducing other irrelevant courses to make room for the new courses. However, more creative approaches to solve this problem should be sought.

Since digital tools require both architectural knowledge and digital experience to teach, universities should work on attracting more faculty members who are capable of integrating the digital tools in the curriculum as well as providing more training to those faculty members who are not well qualified for this. This should be an orchestrated effort on all levels to prepare architectural programs for a new era where working separately and in parallel with digital and physical media is no longer acceptable.

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