TEACHING BIM, WHAT IS MISSING?

The challenge of integrating BIM based CAD in today's architectural curricula

MAGDY M. IBRAHIM
Faculty of Engineering, Ain Shams University, Cairo, Egypt
Magdy.mi@gmail.com

Abstract. Building Information Modeling is the technology converting the workplace in design firms around the world. Now, professionals as well as academia see the feasibility and benefits of converting to such a new technology. Therefore, it seems inevitable to start teaching BIM to architecture students. And as we keep using and depending on computers the way we are, it also seems inevitable that programming will soon become one of the core curriculum classes for architecture students. However, the same problems facing professionals in design firms are those facing academic educators in schools of architecture, but with some different aspects. The misconceptions about the reality of BIM and the lack of understanding the full potential of the applications are the common issues. Few schools have started looking at the problem of preparing their students for a career in a BIM enabled work environment. The difficulty is due partly to the novelty of the technology and partly to the dilemma of teaching one application versus teaching the technology behind it. Besides the steep learning curve there should be the early introduction to how to interact deeply with the application to edit its content. The training required for BIM based CAD should focus on the core concepts rather than the application interface and functionalities. Therefore, building a course for teaching these systems should follow a different path than with conventional CAD. The training should be tied closely to the design curriculum in the design schools. A special version with different interface might empower the user. Hence, enhancing the experience and relieving some of the concerns attached with introducing BIM in the architecture curriculum.

1. Introduction

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. It is obvious that slowly but surely, BIM based CAD is gaining more and more ground each year in the professional practice of architecture. And, accordingly, we do expect more graduates to be able to use such applications the same way we expect almost everyone to have fair knowledge of conventional CAD platforms. In conclusion to her article in the 2006 AIA's "Report on integrated practice", Renée Cheng commented on the BIM education by saying: "Regardless of the magnitude of BIM's eventual of impact on the profession, its recent rise provides the ideal catalyst for rethinking architectural education. The level of expertise required to intelligently design with BIM is significant, and serious consideration must be given to how it can be taught" (Cheng 2006).

In the light of the new paradigm shift, few schools have started looking at the problem of preparing their students for a career in a BIM enabled work environment. Many schools around the world are still sticking to the old curriculum for teaching CAD, mainly teaching AutoCAD as a general purpose drafting CAD package. The problem is due partly to the novelty of the technology as there are few people capable of teaching it, and partly to the dilemma of teaching an application versus teaching the technology concept itself.

As discussed before (Ibrahim 2006), the training required for BIM based CAD should focus on the change in the work flow rather than the application interface and functionalities. Therefore, building a course for teaching these systems should follow a different path than what it used to be with conventional CAD. The training should be tied closely to the design curriculum in architecture schools. Students should get acquainted with the application after they get to understand what design is, but before they get trained on a conventional drafting CAD application.

The same hesitation in practice to go forward and convert to BIM is equally mirrored in the schools of architecture, but this time it is not because of budget concerns or training expenses issues, they are actually deeper issues regarding the formation of the architect and developing the skills. Those issues are unique to the education realm and concern the integration with the current curricula.

This paper is a collection of observations and suggested strategies that I have acquired and thought of from design studio and CAD teaching experience in many schools of architecture, as well as practicing as a professional architect with the role of a CAD manager.

2. Observations

There have been many graduate research regarding BIM technologies in many universities and research centers around the world. Some research centers have had their BIM information available such as Chuck Eastman in Georgia Institute of Technology where the "BIM Resources @ Georgia Tech" has been created. But incorporating the technology in the core curricula is still not recognized as much.
However, there are some observations:

2.1. COMPARE CONVENTIONAL CAD TO BIM

BIM is not just another CAD; it is the shift from presenting information about the building to representing this information. What we used to use and call CAD is in its essence a neat replacement of the pencil, pen and the T-square on our desks. It is used for the production of drawings; in much the same way as a word processor is used for letters and reports. Its contribution to efficiency matches that of the word processor, a little, rising to quite a lot when a document has to be reissued with revisions (Richens 1994). BIM based CAD is different, it requires thinking behind what we draw in order to produce a correctly represented data about the building in either format: drawings, or database. It is a way of thinking before it is a program to run on a computer. Many architects used to think in the BIM way even when using traditional CAD tools, since normally the tool would not teach you how to think.

2.2. CAD IS EVERYWHERE, BIM IS NOT

Regardless of what we think of computers and CAD specifically, CAD is everywhere, in practice as well in academia. Almost every architecture student nowadays would learn CAD either formally through required curricular courses or on his/her own if not. Most students believe, and to some extent it is true, that they will not be qualified for getting a position in practice without high CAD credentials. As a matter of fact, many students are fluent in CAD as a drafting tool as well as three-dimensional modeling and visualization tools.

2.3. CAD SUBSTITUTES HAND DRAFTING, BIM DOES NOT

The initial application of computing in architecture has been one of substituting CAD drafting replacing hand drafting. In most offices, until recently, this has been so literal that drawing sheets and computer files have been thought of in a 1:1 relationship (Johnson 2000). It is believed that the

1:1 relationship made it very straightforward to convert to CAD platforms when it became economically viable to own a computer or more in an architectural office. There have been no radical changes in the way drawings are produced in relation to manual drafting techniques. CAD standards and best practice regulations are a byproduct to the fact that smart people are using these systems and feel the need to conform to a standard. There was no revolutionary change utilizing CAD. Teaching CAD in schools had long benefited from this relationship, making educators focus on teaching the application and not the drawing concepts which are picked up from different classes.

This is different with Building Information Modeling based CAD systems. The work flow has changed when using BIM as your CAD platform (Ibrahim 2003). Consequently, you can not depend on other knowledge of drafting techniques to build upon. In contrast, as an educator you would need to depend on all what the student have learned in order to make him/her familiar with the application.

2.4. BIM BASED APPLICATIONS LONG STRUGGLE

BIM solutions have failed to empower their users with an intuitive interface that would celebrate the capabilities rather than the functionalities. Because of this, many believe that BIM solutions are good for typical repetitive buildings. Students are no different. Today's students pick up a lot of skills on their own without training. It is very common to teach a CAD class and find many students who are forced to register to just complete their required credit hours when in fact they have very good skill in using the application and getting result out of it. This strength keeps it is momentum when using BIM application.

Students would explore, on their owns, different BIM applications, and would shape an opinion regarding this class of applications. Another application example is "SketchUP" which became very popular among students without any training. The interface is intuitive enough for a new user and the purpose is clear.

2.5. LOTS AND LOTS OF MISCONCEPTIONS ABOUT BIM

I believe personally that one of the major obstacles that delayed the implementation of BIM based CAD is misconceptions (Ibrahim 2006). Because of the three-dimensional nature of BIM application, it has always been confused with three-dimensional modeling general CAD packages. Not only students, but professionals as well in many offices use BIM based applications such as ArchiCAD for creating three-dimensional models of their designs, not paying attention to the wealth of features and

functionalities such a program is capable of. People get hired in other offices for the sole purpose of modeling on ArchiCAD to generate perspectives. Students believe it is yet another three-dimensional modeler with restriction on what they can build.

When I asked some fourth year computer savvy architecture students if they would like to get introduced to BIM based CAD applications, they did not welcome the idea. After discussing it with them, I found out that: first, they are familiar with the application, second, they already use it to produce three-dimensional models, third, they were unhappy with the fact that they should select parts from previously created content lists. It was obvious that they were not aware of the capabilities of customizing the content, and the interface didn't intuitively imply the ability to create your own content.
It was also obvious that with to this type of students, learning the insides of the application is so vital to its acceptance. They needed to feel empowered to get attracted to the application. AutoCAD as a basic modeler as it is, gives more empowerment to the user than ArchiCAD or Revit. It is obvious how to draw a line and shape some form out of that line.

Generally, lack of understanding the full potentials even with widespread application such as AutoCAD is a major issue. In architectural offices you find very few people who can customize AutoCAD, write macros, or create applications. The same applies to BIM based applications which are even harder to manipulate.

2.6. FORM GENERATION VERSUS PRODUCTION: BEAUTY AND THE BEAST

CAD is offering something to the efficiency and production quality of architectural offices, which is worthwhile. But the irritating thing is that CAD contributes little to design, and computers are not used by designers, at least not when they are designing (Richens 1994). But students tend to confuse the value of CAD when faced with its visualization capacity.

To many, using CAD is about getting a pretty image out to their teacher that might insure better grades for their work. A major motive for learning CAD is to be able to produce such appealing presentation drawings to insure higher grades. One can observe many illogical use of CAD and digital technology in general that exhibit this behavior, for example, scanning hand drawn sketches, adding color in Photoshop, then printing them on glossy paper for effect.

The ability to twist solids and create wavy surfaces such as NURBS is another major motive where the appeal to use CAD is prominent. Mistakenly, this practice is sometimes considered form generation from students and faculty as well. Very few students will get into breaking down

their AutoCAD files into layers or thinking of utilizing external references for work minimization and organization.

It is again the 1:1 relationship with using the pencil and paper to produce architectural drawing, only a little different pencil. CAD has not changed the way students think about their buildings, it rather sophisticated their product in a way that is not proportioned to their real knowledge. BIM applications are production and optimization tools, and with this sense, they do not possess the same appeal to students.

2.7. ARCHITECTS ARE NOT VERY FOND OF COMPUTERS AFTER ALL

The education of architects is not very much similar to the education of engineers. Computers are core tools for engineers; they get to learn this very early. On the other hand, architects are always looked at as artists who should not be bothered with lots of mathematics, calculations, and other engineering chores. The tendency even to join architecture schools between students is sometimes influenced by the desire to stay away from heavy studying of mathematics in other engineering disciplines. Computers are logical machines based on the language of mathematics, and without the natural love of these subjects, many architects and architecture students flee away from computers. The only exception is when computers give them beautiful imagery which they like.

This translates into more desire to learn how to achieve goals with applications and less desire to learn what is behind the application or application customization. Seletsky (2006) has defended the introduction of BIM in education by stating that some students already have the courage and creative tendency to write their own scripts, combine their own variety of pre-existing tools, or even go so far as to modify existing application interfaces to suit their own particular needs when the design challenges posed to them mandate "outside-the-box" thinking. But in fact, and through observations, this is the exception and not the rule. Using CAD is a requirement to all students, but customizing an application is a privilege to those who dare. Very few students would sign up to a CAD programming class if offered and small percentage of architects will pursue the CAD manager roles in architectural firms.

2.8. THE “RUSH” VERSUS “WAIT” DEBATE

The Building Information Model represents a fundamentally altered medium from the traditional representation in contemporary practice of architecture (Ambrose 2006). Ambrose has summarized the need for transformation of profession and academia due to the new framework of BIM. Ibrahim and Krawczyk (Ibrahim and Krawczyk 2003) identified six concerns that would

affect the profession and the education with the implementation of BIM based CAD systems: the master apprentice relationship, the customization issues, the objects creation inside the system, the impact on innovation and creativity, the dependability on the software industry and last but not least, the change in the architectural education. The argument is that the more knowledge implemented into a system the more dependable the user becomes on that system.

For a skilled architect who is familiar with concepts, codes, assemblies and specifications as well as the notion of drawing a building, using a BIM application would be a productivity boost that is very welcomed. However, the same application used by a junior architect, or a student who does not have the same knowledge, would put them in a different position.

Paul Seletsky (Seletsky 2006) argues, from an idealistic point of view, that BIM should be immediately implemented in schools as it will revolutionize teaching architecture, ignoring the fact that learning is a process of adding up knowledge in a layered manner. Renee Cheng (Cheng 2006), on the other hand, is asking to slow down the implementation of BIM to insure the proper introduction of the tool and what it will be used for, but in the same time, underestimating the rapid conversion of the workplace into BIM.

The risk is that dependence on the system drafting capabilities might reduce the drafting skill of the student user, and might institutionalize the format given by the application leaving little space for improvement.

2.9. THE BOTTOM UP ATTITUDE

Martinez and Vigo, has documented the bottom up attitude toward using the computer in the design studio (Martinez and Vigo 1999), where students would be faster than their teachers to comprehend and implement the digital tools. This was very clear through the last decade of the twentieth century, but started to fade with more faculty members joining who are younger and more capable of using the same tools with even better proficiency. The problem will surface again with the BIM tools.

The Beuax Arts school method relies on learning skills of drafting and presentation while working on project design with no particular subjects or courses for a particular skill developing. Such a strategy might benefit the introduction of BIM in schools, by merging the design studio and the CAD courses together. Ironically, training for BIM based CAD is still structured around understanding the interface and utilizing the tools the application provides, where the proper attitude should focus on the concept of data modeling, and the content creation process, then move to the details of utilizing the application.

3. Strategies

3.1. THE THREE PHASES OF LEARNING CAD: DRAFTING, SCRIPTING, DATA MODELING.

It has become very clear that learning drafting on CAD is just one step of the three steps to getting the full benefit of such a technology. First, is drafting, second, is programming, third, is data modeling.

A curriculum of CAD course should include the three steps. The second step is to empower the student with the ability to change, and create from scratch the tools needed. The third step is about clarifying the fundamentals behind the data modeling concept.

For example, Robert Krawczyk was able to use the computer as a designing tool by enabling the programming part of it on the basis that programming itself is an act of design: “The discussions at the end of the course clearly indicated to me that the students now consider the development of programs as their own personal expression of an idea, that CAD systems could be used to investigate ideas and not only document decisions already made. They began to understand the feedback their rules created and how it could be used to clarify concepts.” (Krawczyk 1998)
Streich also concluded that computer aided designing ends up in programming because only in this way new and original design concepts can be transferred from the designer’s mind into the instrument computer (Streich 1992).

And with BIM based CAD, the ability to create and model what the user want and not what the application is capable of is a pivotal point in getting students to appreciate, understand and use the technology.

3.2. UTILIZING THE DIGITAL DESIGN RESOURCE CENTER CONCEPT.

Building on the observations that indicate the ability of student to comprehend and use newer applications by themselves, a digital design resource center would fit perfectly.

By being able to test and try several platforms, students and teachers could escape the problem of confinement with a particular platform. Not only students will be exposed to more applications, but the interactivity between those applications can also be examined. More application than just BIM based CAD systems should be provided, such as energy analysis, database tools as well as specifications and cost estimate utilities. This should constitute a bigger sphere than just learning CAD. With this approach student would be learning using the digital tools in general. I think it has been an honest mistake that we have classified computing for architects as CAD only.

3.3. A DIFFERENT INTERFACE: EMPOWER THE USER

In fact, software vendors should seriously consider developing versions of their BIM based applications that are much easier to use. Those wonderfully developed, full fledged suites are suitable for professional practice, but do not have the same value as teaching tools. If a stripped down version of a particular package could get the attention of the students during school years, it is more likely that they would be using the professional version of it later on. The focus of the simplified version should be the core concepts of content creation and data modeling about buildings. A very thoughtful development process should create a more focused, less featured versions that relates to the architecture student needs.

Software should change to fit the way architects think. While some architects advocate changing how we think about our work in order to use computers, interface experts tend to disagree with that opinion. Donald Norman, for instance, writes, “Make the task dominate; make the tools invisible.” We must be careful to distinguish between thinking differently to do better, more efficient work, and thinking differently to use a tool. The first is admirable, but the second is the sign of a faulty tool (Johnson 2000). It is usually better to adjust the tool to fit the user, rather than trying to adjust the user to fit the tool, in this case it is the student rather than a professional architect.

4. Conclusion

Regardless of the approach, it is clear that addressing BIM teaching problems is inevitable. Today, it might be hard to advocate against the use of BIM CAD platforms in architecture schools when it is gaining more acceptance due to the benefits it provide. However, the issue of teaching BIM is not equal to the issue of teaching general drafting CAD. A deeper approach to the implementation process has to be taken into consideration. There is still the question of how much knowledge required for a student to construct a BIM model.

Also, we have to consider the nature of the architecture students as a special group. Although, they are so smart when using computer tools, we should not assume that they are as capable when customizing applications or handling data modeling issues.

We should differentiate between the benefits we gain professionally from using CAD in general and the architectural education process where knowledge should be acquired in digestible doses but without undermining the necessity to learn the tools, CAD tools in particular, in order to be ready for both the creative and productive parts of the architecture profession.

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