Educating the next generation of architects for interdisciplinary BIM environments

Suha Jaradat

Design Innovation Research Centre, School of Construction Management and Engineering, University of Reading

Abstract

In a study of architecture and Building Information Modelling (BIM) in the UK and USA, experienced practitioners and recent graduates working on BIM projects, in internationally leading architectural firms raised issues relevant to architectural education. The design studio has been central to architectural education, evolving from a traditional apprenticeship of a designer within a master architect's studio. Much has been written about the pedagogy of the design studio. However changes in the architecture profession raise new questions. BIM is being adopted to address issues of cost, value and carbon. It facilitates collaborative design using a central model in a standard way across disciplines to create information to be used through the life cycle of building and infrastructure projects. Using BIM is shifting professional roles as it changes the mechanics of working and interacting with others. This paper uses data from the study to explore the new questions raised for educating the next generation of architects to work in interdisciplinary BIM environments.

Architectural professionals emphasize the need to teach architecture differently. Graduates are now expected to have learnt about BIM not from a theoretical perspective only but technically as well. They need to understand the professional responsibilities of the architect and the relationship with other professions to fully participate in BIM collaboration, suggesting a need for interdisciplinary design studios. They should be aware of the options of technologies available and identify BIM not as individual software packages only. Moreover the data revealed a perceived gap in architectural students' knowledge of construction. They create 3D virtual models but have no idea how they can be constructed as the focus is on the picture and technologies used not the systems.

The paper poses questions regarding individual work in design studios to facilitate interdisciplinary BIM environments. It has implications for research and the architectural pedagogy required to train the next generation of architects.

Keywords: architects, architecture, BIM, collaboration, design studio, educating, interdisciplinary.

Introduction

A number of researchers have studied architecture and discussed the relationship between practice and education [i ii iii iv]. Unlike medicine and law that are known for preparing professionals, the discipline of architecture offers a free and liberating environment as it is part of a domain that also integrates a profession [v]. The studio has been dominant in the education of design disciplines such as architecture. There is an extensive research on design studio pedagogy [vi vii viii]. The changing role of design studio has also been considered and new models have been suggested to develop collaborative design skills [ix].

Existing issues affecting architectural practices involving digital technology, globalization and environmental concerns have also been evaluated but little attention has been paid to current approaches including BIM and its wider impact on the pedagogies of architecture. BIM is being implemented in the architectural, engineering and construction organizations as a way of designing and delivering building and infrastructure projects. There have been recent international initiatives to promote the use of BIM. The UK government, for example, envisions the implementation of BIM by 2016 on all public procurement [x]. This approach creates deliverables that should be used throughout the life cycle of the assets and replaces the traditional way of working separately with a more coordinated and controlled process for sharing data.

BIM involves using new software packages and novel technologies for creating and manipulating a central model, standards and repositories for storing and accessing data by different stakeholders from various organizations. This emerging way of working has extensive effects on the dynamics of work inside contemporary organizations.

The implementation of BIM within architectural practices is a current issue that is changing the context of architecture and has implications for the architectural pedagogy and its role in preparing the next generation of architects to fully participate in future practice. This paper reinterprets a study that investigates how professional roles and interactions are being shaped and mobilized in interdisciplinary BIM environments. It draws on data collected from

interviewing participating architects and others working in internationally leading design, architecture, engineering and planning organizations in the UK and USA. It seeks to discuss the teaching of BIM in the wider context of studio learning outcomes in schools of architecture. The following sections of the paper give a brief background of the study, explain the research methods, and finally discuss the findings and implications for research and architectural pedagogy.

Background and methods

The context of this research is a set of interviews in international design, architecture, engineering and planning organizations in the UK and USA. The interviewees were mostly architects who have used BIM on several projects worldwide. Five major firms were initially identified but some interviews were also conducted in other firms.

Data collection

Data were collected by conducting 40 semi-structured interviews, as the main source of data, with 50 BIM users and experts in both the UK and USA. Most of the interviews were one to one but some people, up to four, were interviewed together. Other complimentary materials were also collected including some documents about BIM, pre interview questionnaire, observation of meetings and informal conversations.

The formal interviews were conducted between May and August 2012. Some participants provided documents to further illustrate some points like BIM definition, for example. The interviewees were asked to identify specific projects in the pre-interview questionnaire which proved to be helpful to capture initial thoughts as a starting point of the conversation and answer some of the interview questions as they were thinking of specific examples. 19 questionnaires were completed and returned.

Two of the 4 meetings observed were non BIM, one clash detection session and one weekly progress review meeting with the owner, architect and contractor to enable comparison between BIM and non BIM environments. 16 informal conversations were arranged with practitioners and academics to discuss proposals and get feedback at various stages of the research.

Data analysis

Data were collected until signals of 'saturation' [xi] appeared which include repetition of information and confirmation of conceptual categories to promote the validity of the data. The interview protocol informed early thematic coding in NVIvo to help categorize the data then a process of unpacking and interpreting the

general codes created additional codes. A theme regarding architectural education appeared despite the fact the interviewees were not asked about it. The analysis of the data set is on-going in an iterative manner between theoretical frameworks and empirical data [xii].

Summary of findings

In 12 out of 40 interviews, the participants raised issues relevant to architectural education and BIM in 16 references although they were never asked about it directly in the interview which indicates that this is a current issue that should be investigated further. The responses varied from reflecting on their personal education experience to everyday practices and interactions with new graduates and students. The general themes indicated *a need to teach architecture differently, a lack in architectural students' construction knowledge, and a need for interdisciplinary design studios*. These findings will be discussed further below.

A need to teach architecture differently

The design studio provides an open environment for the students to excel but experienced practitioners talked about their personal experience and revealed a gap between architectural education in the studio and working on real projects, a senior architectural technician and BIM coordinator in the USA explains:

'In college my needs and what I was trying to do on the projects were a lot different than what we need to do to get the buildings built and the realities of business.'

Others in the UK have indicated explicitly that architectural education should change to reflect the reality of work practices, this is what an Information Systems Applications Administrator who has an architectural background thinks:

'I think the university study has to change quite dramatically to accommodate for what is actually when you go out to work. But yeah, so that's what I think.'

So in order for newly qualified architects to participate fully in collaborative BIM environments, they have to be equipped with construction knowledge and be aware of their professional role and responsibilities, a Project Architect from the UK argues:

'People coming out of university, architects will have to know more about construction I think and they'll have to know more about their professional role earlier if they're going to work fully in BIM collaboration at the design levels.'

Practitioners in both the UK and USA have been pretty consistent in expressing their concerns

regarding architectural education and its role in preparing students for real life projects.

A lack of architectural students' construction knowledge

A gap in architectural students' education regarding some construction details and how the pieces and systems work together is noticeable as some of the participants discussed. A Senior Project Architect in the USA expressed his frustration regarding university students' lack of construction knowledge despite their exceptional computer and modeling skills:

'Universities are producing students who don't have a clue, they can work a computer like no-one's business, they can model anything, it's amazing what comes out of them. They have no idea what a stud is, they don't know what a nail is, they know nothing about what the real thing is, it's a 3D virtual model of a picture that they can do amazing things, beautiful, but it's not architecture. It's a picture, it's just a picture, you can't build it, you don't know how pieces come together and you don't know how the systems work together and you design this beautiful picture and that I say, yeah, but you can't ever build that on this planet because it's impossible! Or, what are you using for this? Oh, I don't know. How much would it…? I don't know. Come on, really?!!'

An Associate & Information Manager from the USA emphasizes the imbalance of computer skills versus construction details in architectural students' education. He recalls an earlier personal experience when he started as a junior architect, he refers to it as an *'ah ha moment'*. He was once drawing scupper details but had no idea what the scupper was until he noticed them on the side of a building while he was walking and went:

''That's a scupper' it hit me! Ah ha. That *'ah ha moment'* took way too long from the time I began drawing to the time I understood what it was I was drawing. With the BIM environment; with the 3D; with the visualization aspect that *'ah ha moment'* is happening instantaneously. You can't not know what it is you are doing while you're doing it which means - so the problem is OK we've got inexperienced college graduates who may be whizzes at software; they know all the buttons but they don't know architecture so the mentoring aspects kicks back in. This lost art of teaching what any of the processes and why - the why's and the wherefores.'

The significance of understanding what is being drawn has been frequently mentioned as this Architect & Project Manager from the USA indicates:

'But we are not always the best people to be building Revit models, a lot of time it's the people that are out of school. So you have a little bit of a gap there of taking really fresh young people from school and getting them boosted up to a 15 year level of experience and that's a lot to try to get people to do.'

So to make full use of fresh graduates' computer skills, they have to go through a steep learning journey from school to practice which is quite challenging.

A need for interdisciplinary design studios

Some participants assessed their studio setting and compared it with practicing in industry revealing that the BIM feature is not fully employed in school. This is evident in what a recent graduate says about his architectural education:

'Personally in school through undergrad and graduate, they push a lot of the computer applications. The more computer applications you can learn the better. So they don't necessarily teach any at all but it's more upon the student to learn. I didn't get into Revit until probably grad school personally. In studio setting, you are not really utilizing the BIM aspect of the Revit application, it's more of a design tool.'

A Chief operating Officer, who works closely with architects and designers in an organization that develops technologies to integrate design, engineering, construction, and development services, suggests that cross training proved to be helpful to boost the knowledge and experience of young professionals to become fully integrated, as he explains below:

'It is a real challenge. We will walk back around the office when we are done if you look at most of our people using BIM they are young people. So then the question becomes well how do they get the knowledge necessary to really build buildings? We wrestle with this; we do a lot of cross training, so we have a university programme internally where we identify career paths. The career paths are not how I want to be an architect or I want to be a builder, they are how do I become an integrated person, so there is a lot of cross training. Architects learning about construction, contractors learning about design.'

Based on the interviewees' personal education and work experience, one of the lessons they learnt and suggestions they put forward is the need for interdisciplinary design studios that facilitate and represent BIM environments in

which students from various disciplines can work together on one project and learn from each other to solve design problems.

Discussion

BIM is currently being implemented in architectural practices and is changing the context of the profession. The interviewees raised issues regarding the individual work in university design studios and their role in preparing architects to work in interdisciplinary BIM environments. There has been an indication in both the UK and USA to the need to teach architecture differently to respond to current issues arising in the industry. Working in a BIM environment requires proficiency in using advanced digital technologies as well as sound understanding of building systems, construction details and how pieces are put together. Students are also expected to be aware of the wide range of digital technologies available to facilitate the BIM process, learn about their professional roles and interactions with other disciplines to be able to participate in fully integrated collaborative environments.

Interdisciplinary design training seems to be the way to face the challenge of improving the knowledge of young professionals and prepare them to be more integrated. Table 1 below compares individual work with the interdisciplinary model in design studios.

Type of design studio	Individual work in design studios	Interdisciplinary work in design studios
Nature of work	Individual or group work with architectural students	Collaborative work across other disciplines
Purpose	Using digital technologies as design tools to produce 2D drawings and 3D architectural models	Utilizing the full aspects of BIM using different technologies
Participants	Learning from fellow students, tutors and external visitors in the architectural field	Cross learning from students, tutors and external visitors in architecture and other disciplines
Learning outcome	How to become an architect	How to become an integrated person to fully participate in BIM environments
Focus	Design development	How buildings are put together, how systems work and construction details.

Table 1: Comparison of individual work and interdisciplinary work in design studios

The interdisciplinary design studio features came out of the practitioner's critical thinking and reflection on their education and work experiences. It would be worth experimenting and testing its application in universities and value in practice to assess its role in educating the next generation of architects for interdisciplinary BIM environments.

Conclusions

The individual work in the design studio in universities is dissimilar to working on real projects in many ways. This paper focuses on one angle of the multifaceted design studio pedagogy and contributes by discussing the wider impact of BIM on architecture education. It suggests an interdisciplinary design studio model to teach students the full aspects of BIM in practice alongside the theoretical education. It is not suggesting that it will totally fill that gap in education but might help to smooth the steep learning curve mentioned earlier. This model should be put to the test in the wider context of learning requirements.

Acknowledgements

Notes

[i] Kostof, S. (ed.) 1977. *The Architect: Chapters in the History of the Profession,* New York, Oxford: Oxford University Press.

[ii] Cuff, D. (1991). *Architecture: The Story of Practice,* Cambridge, MIT Press.

iii Schön, D. A. (1983). *The reflective practitioner : how professionals think in action* New York, Basic Books.

iv Piotrowski, A. & Williams Robinson, J. (eds.) 2001. *The Discipline of Architecture,* Minneapolis: University of Minnesota.

v Anderson, S. (2001). The profession and discipline of architecture. *In:* PIOTROWSKI, A. & WILLIAMS ROBINSON, J. (eds.) *The discipline of architecture.* Minneapolis: University of Minnesota.

vi Salama, A. M. & Wilkinson, N. (eds.) 2007. *Design Studio Pedagogy: Horizons for the Future* Gateshead: The Urban International Press.

vii Salama, A. (1995). *New Trends in Architectural Education: Designing the Design Studio,* Cairo, Egypt, The Anglo-Egyotian Book Store.

viii Schön, D. A. (1985). *The design studio: an exploration of its traditions and potentials,* London, RIBA publications Limited.

ix Whyte, J. K., Ewenstein, B. & Gann, D. M. (2004). Reconsidering the Design Studio. *International Engineering and Product Design Education Conference.* The Netherlands.

x Cabinet Office (2011). Government Construction Strategy. http://www.cabinetoffice.gov.uk/sites/default/fil es/resources/government-construction-strategy_0.pdf.

xi Glaser, B. G. & Strauss, A. L. (1967). *The discovery of grounded theory: strategies for qualitative research,* New York, Aldine de Gruyter.

xiixii Orton, J. D. (1997). From inductive to iterative grounded theory: Zipping the gap between process theory and process data. *Scand. J. Mgmt.,* 13(4)**,** 419-438.