Visualization in Building Information Modelling (BIM) for Interior Design Education: A Case Study at Sunway University

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Abstract
The utilization of Building Information Modelling (BIM) technology has revolutionized the architecture and interior design industry globally in recent years. This technology promotes a more efficient approach in the design visualization process and it provides enhancement of productivity. Similar to other developing countries, the employment of BIM in Malaysia has presented new challenges to both the industry practice and educational institutions. The curriculums of build environment courses offered in universities throughout the world have been restructured to allow the integration of BIM. However its adoption in Malaysian higher education has been considered slow. This paper discusses on the introduction of BIM through the usage of Autodesk Revit software tool for visualization purposes to the diploma in interior design students' project at Sunway University. The research was focused on the process of parametric tools techniques used in Revit to create 3D models and the features that allow BIM to interoperate with other 3D applications. Case study methodology was used and information were gathered through variety of data sources including; observation, assessment and interview series. The result showed that although BIM has aided the students in terms of time efficiency in producing visualization, there are limitations in design freedom as well as the needs for students to be familiar with other 3D applications beforehand. Findings from this research will be among the important considerations to be taken in developing BIM and Revit as an independent module into the academic curriculum of Diploma and Degree courses in Interior Design at Sunway University.

Keywords: Building Information Modelling, Interior Design Education, Interior Visualization

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Introduction

The digital age has brought many changes in architecture industry in recent years. In relation to design production, the inventiveness of technology in architecture has been very noticeable, from the traditional drawing board to Computer Aided Design and today, with Building Information Modelling (BIM). BIM is an extensive, wide-ranging term that covers technologies and methodologies based around the creation and co-ordination of digital building data that is visually represented in "three dimensions (3D)"on a computer screen (Mathews, 2012). The Construction Industry Development Board Malaysia (CIDB, 2013) defined BIM as "a modelling technology and associated set of processes to produce, communicate and analyse digital information for building construction life cycle". It has revolutionized the architecture and design industry in terms of visualization, preconstruction simulation, life cycle analysis and enabled faster construction, thus promoting more sustainable integrated practices (Asojo, 2012). BIM is a successor to the computer-aided drafting (CAD) (e.g. AutoCAD) which started in the 1980s. With the advent of BIM, the architectural and interior design practice has gradually started changing since the beginning of the 21st century (Wong, Wong & Nadeem, 2011).

This research was initiated from an understanding of the shortages of education and training efforts provided by higher learning institutions in Malaysia towards the development of BIM. Though universities in Malaysia teach traditionally industry-standard Computer Aided Design (CAD) applications such as AutoCAD, 3Ds Max and Adobe Photoshop but has falling short of meeting the new and advanced software such as BIM (Enegbuma & Ali, 2011). The aim was to explore possible advantages and disadvantages of visualization through the use of BIM application for interior design students' project at Sunway University, Malaysia. Initiative has been taken by the faculty members of the Department of Art and Design at the university to integrate BIM as a module into the curriculum of diploma and degree programs in interior design in the near future. The researcher observed and documented a design studio project which involved the production of a 3D BIM model for visualization by students and a case study methodology has been used to examine the visualization process during the project.

BIM and Autodesk Revit

Autodesk Revit is a software that is commonly used to produce BIM models and serves as a tool for planning, designing and stimulating. In contrast to CAD in which the 3D elements or objects are made up with purely lines, the 3D models produced with BIM are actually intelligent contextual models, where objects are defined in terms of building elements and systems such as spaces, walls, beams and columns (Azhar, 2011). Although CAD has been one of the primary design tools in the industry, BIM are becoming more utilized due to its capabilities. Colleges and universities are restructuring curriculum to reflect this change from CAD to BIM (Sacks & Barak, 2010). Among the most common objectives for BIM related courses include: producing drawings from a model (Sacks & Barak, 2010) and, at the same time, developing verbal, written, graphic and electronic communication skills (Arnold, 2010). Generally in Malaysia, the built environment industry including Interior Design employs CAD with AutoCAD being the most commonly used software (Dawoud, Haron & Abdullah, 2013). Due to the benefits of BIM and its huge potential of improving the Architecture, Engineering and Construction (AEC) industry, governments of developed and developing countries around the world have started to mandate the usage of BIM in their respective countries. (Mohd-Nor &Grant, 2014).

BIM in Malaysian Higher Education

In the case of Interior Design courses in colleges and universities, traditionally it falls under the architecture faculty, as the course deals mainly with building elements. In order for interior designers to be valued as knowledgeable and capable members of a project team, interior design curricula must incorporate industry-standard technology (Roehl & Shannon, 2013). The kind of technology and innovation offered through BIM are currently being used to shape design in the architecture community, so it will be vital for interior designers and universities to be involved in the knowledge development of BIM. The accreditation for Interior Design courses in Malaysia is partially under The Board of Architects Malaysia (LAM). The Board expects interior design students to demonstrate a clear ability to apply different tools in design, from two-dimensional (2D) and three-dimensional graphics (3D) to computer-generated and material models (Dawoud, Haron & Abdullah, 2013). According to Panuwatwanich, Wong, Doh, Stewart & McCarthy (2013), the lack of BIM training and education within educational institutions is one main barrier commonly identified across architectural studies. Research in BIM is also at a low where none of the academic institutions in Malaysia have set up a unit or department that looks into BIM matters. Mohd-Nor & Grant (2014) highlighted that while national scale reports or surveys on BIM usage has been conducted in many developed countries, it has not been the case with Malaysia.

Visualization in Interior Design

In interior design practice, the visualization and conceptualization of interior environments represent places where activity and events happen (Dohr & Portillo, 2011). It refers to the visual production of sketches, drawings, 3D imageries and multimedia to communicate ideas and concept. Generally in academic setting, studio modules for interior design curriculum will require students to demonstrate these visualizations for their project submission. Production of computer aided 3D models to facilitate the production of plan drawings and perspective views has become the common practice among students nowadays. In today's rapid advancement of technology, educators have started to show concern in the learning process of these new technologies in design production. Barison & Santos (2010) recommended that in the first two years, the focus should be on the student's individual skills of 3D modelling. Later in their academic careers when their 2D to 3D visualization skills improved, 3D modeling will allow them to more accurately "see" their design ideas" (Crumpton & Miller, 2010). This is in order to more fully integrate the learning of technology with the teaching of design." (Crumpton & Miller, 2010). For this particular research, the expectation of outcomes from the 12 weeks period of lesson on BIM would be limited to the design visualization only, which includes production of working drawings and 3D views.

Methodology

During the August 2014 semester, the Diploma in Interior Design course at Sunway University offered a studio based design module with a focus on commercial interior space to second year students. This module was supported with extra classes to provide lessons on BIM for visualization purposes. The design and visualization process using BIM through Revit software tool was documented from the beginning to the end of the project. Case study methodology approach applied in this research was inspired by Wong, Wong & Nadeem (2011) through their study on the implementation of BIM courses at a university as a case study to analyze the feedbacks from students about BIM education. Obtaining data from students will be very important in this research as part of the findings will be reflected upon

their feedbacks. Mathews (2012) stated that case study allowed researchers to capture information through a range of data sources including;

Observation of students working with Revit

The researcher spent around half an hour after lesson every week to observe and keep written records on the process of students working with Revit in building and detailing the 3D BIM model. These records provided a chronology in the development of the project.

Student's Formative assessment

The students work was assessed individually at semester end. Students were expected to produce a complete set of working drawings for the interior design project. This involved suggestions for renovations into the existing interior space. Through the assessment, the researcher could summarize whether or not BIM visualization process for the project could fulfill the assignment requirements. Assessment was conducted through Blackboard E-Learn system.

Project end interviews with students and faculty members

Interviews were conducted at the semester end and were mainly designed to obtain feedback about students' experiences and perceptions towards BIM usage for interior visualization. The interviews are to acquire their views about the strengths, weaknesses and prospects that may be developed as a result of learning BIM. Besides that, faculty members were also invited to assess the students' final projects at the end of the semester. Another round of interview with faculty members was conducted after the assessment session to view their perception towards the outcome of the students' work.

E Learning

Online tutorial series were setup in Blackboard E-Learn system by the instructor. It enables the tracking of students' views of the video tutorials posted every week. It also allowed students to communicate with the instructor through the feedback and survey system provided. The response by the students provided useful understandings to the problems encountered throughout the visualization process in Revit. Currently the Blackboard E-Learn system is being used across all faculties in Sunway University for teaching and learning.

By the semester end, the data gathered were analyzed. The qualitative data provided testimony on the significance of using BIM for visualization within the context of interior design. It also revealed the drawback and weaknesses of BIM usage in the design stage.

Settings

The extra classes dedicated to the teaching of BIM were offered to students who had completed AutoCAD and 3ds Max course in the previous semester. 20 students participated for the particular semester. As a part of the project requirement, students were expected to develop a 3D BIM model of their individual project. Students were first introduced to the concepts of modelling and the fundamental differences between BIM and CAD. Concepts for students to develop an accurate representation of BIM include parametric objects and relationships; model categories; annotation categories; families, modelling basics, modifying

elements and presentation graphics (Asojo, 2012). At the end of the semester, they are required to produce graphical presentation boards and to give verbal presentations about their project (See Figure 5).

Phase 1: Introductory Stage

At the early stage, the instructor gave introduction to the concept of BIM in Autodesk Revit and made students to familiarize themselves with the interface and concept of "families". Families are components used to build the 3D models such as walls, floors, roofs, ceilings, curtain walls systems, fixtures and partitions. Each family contains its own information, such as size, materials, parameter and variables. Any change to a family is reorganized in every order throughout the project.

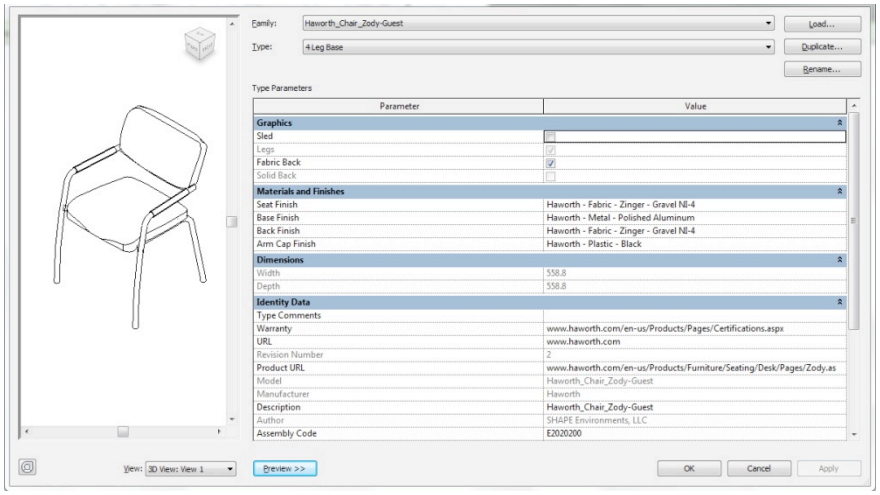

Figure 1: Furniture family of a chair with its detailed information in Revit.

Phase 2: Working with CAD files

Students started their design by importing a 2D plan from AutoCAD into Revit software as primary guide on which to base the foundation of walls. With the guide from the CAD plan, it was easier for students to decide the type of wall family to be used, its height, its thickness, width, materials and on what level, etc., from the beginning of the design development. The researcher noticed that at this stage, BIM has developed the students' understanding from software skills to a more scientific thinking. As students progressed with their BIM models, they encountered various construction implications of their design choices. They discovered that a lot of considerations need to be taken of the entire building rather than individual spaces.

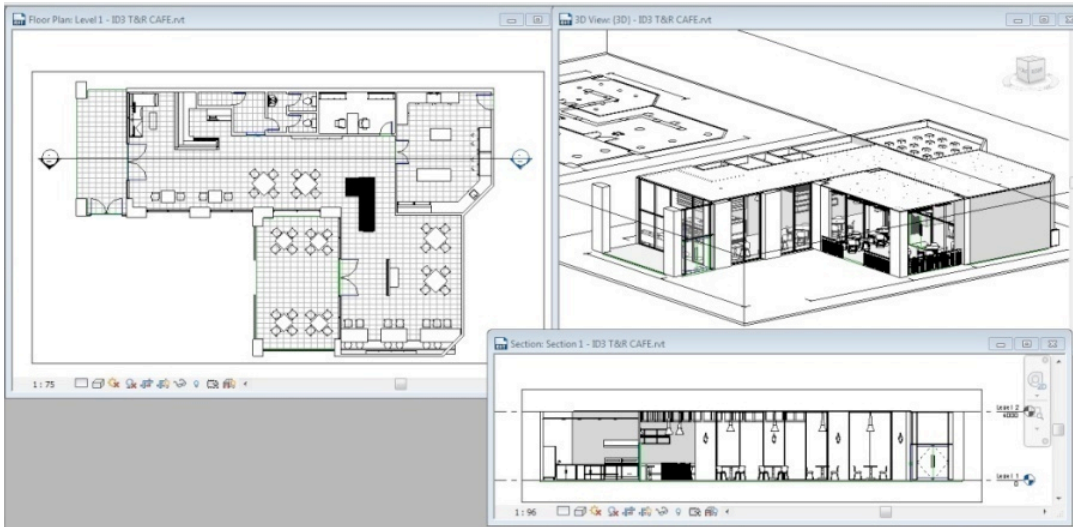

Figure 2: The modelling process of the building from an AutoCAD plan using parametric families in Revit.

Phase 3: Customization of 3D models and Massing Tool

Students had to learn the creation of customized building components and non-standard objects in order to accomplish their intended design. This includes the creation of expressive forms and complex geometry components. At this point, they were introduced to the massing tool in Revit. "Massing" tool allows a designer to perform basic geometric explorations in BIM. It will invite more designers to employ BIM at an early design stage while providing more freedom in the form making process (Park, 2008). However the massing tools in Revit will also require some time to be fully familiarized by the students. This parametric tool technique used to produce non-standard objects in BIM have led the students to a new approach of building and working with 3D models, with most of the time requires intricate level of detailing and this has brought some confusion and awkwardness in 3D modelling process among them. One reason is because they have familiarized themselves well with the more fluid and lesser numerical data input of 3D modelling techniques in CAD software such as 3ds Max, which they have learned in previous semester.

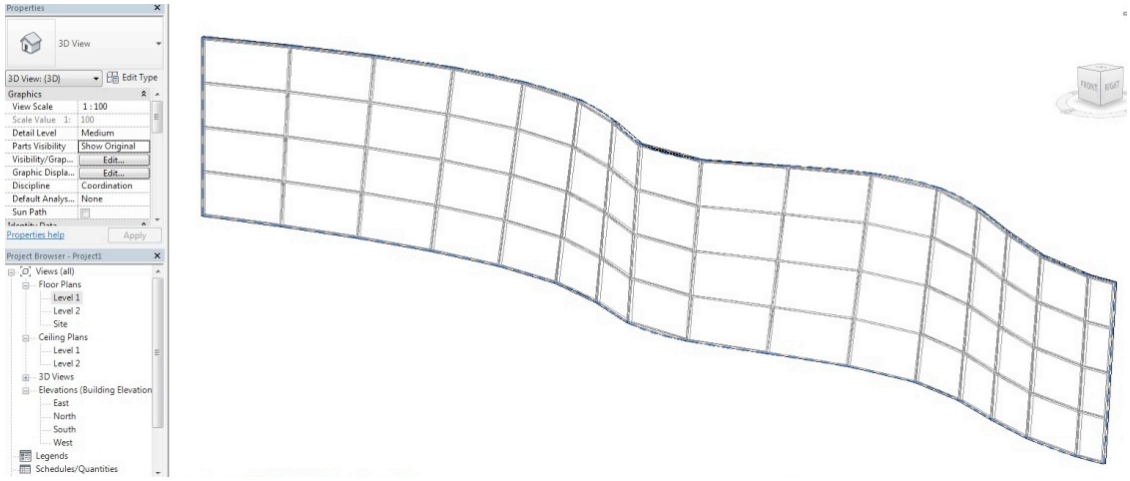

Figure 3: Mass model of a curved wall created in Revit.

Phase 4: Interoperability

To maximize the quality of visuals produced, 3D models produced from other CAD application such as Autodesk 3ds Max were used to ensure that the students can achieve their design ideas. Besides that, a good reason to interoperate Revit with other 3D applications was to improve the rendering works in order to produce realistic 3D imageries. Having prior knowledge of geometric modelling in 3ds Max has aided the students in producing non-standard geometric models. These models with custom geometry which were more time consuming to model in Revit were then integrated into the BIM model. This BIM model was then exported back to Autodesk 3ds Max as an Autocad DWG file format. Materials and lighting were applied within 3ds Max by using accessible materials in the 3ds Max library. The lighting was generated mainly from sunlight available from Vray plug-in, which is used together with the software. Once all the model content, materials, lighting and camera were in place, the model was rendered using Vray plug-in render engine.

Figure 4: The 3D rendering produced by inter-operating Revit with 3ds Max application.

Figure 5: A student presenting his visualizations to faculty members.

SWOT Analysis

At the end of the semester, students were requested to explain their understanding in operating BIM model in Revit to produce visualizations for their project through interviews. SWOT-analysis has been used to list strengths, weaknesses, opportunities and threats, in order to identify aspects concerning the design process when using BIM for visualization in interior design education. The SWOT analysis focuses on the aspects related to BIM based on the qualitative data gathered from both students and faculty members.

Strengths

Majority of the students stated remarks about the smart features in BIM in detecting errors on construction detailing. They were very positive towards the working process in Revit, as it managed to reduce the time needed to produce a complete set of working drawings (plans, sections and elevations) and 3D visuals. 3D model produced in BIM has managed to simplify the process of producing quality visualization within the context of interior design.

Weaknesses

As a parametric objects modelling tool, there are difficulties in creating custom made, complex models and non-standard objects using BIM. The 3D modelling methods in Revit are different from the traditional architectural design procedure, which is based upon a form-making process that the students are accustomed to. This can be a major challenge to those with limited knowledge of construction method and materials. Learning curve is steep in order to fully understand and to be able to handle the design tools in BIM effectively.

Opportunities

Faculty members unanimously agreed that the outcome of visualization from the students' project reflects better quality compared to when it was done in CAD previously. They saw potentials to develop and integrate BIM into other supporting modules in the diploma and soon the degree programmes such as Building Construction and Building Services, considering the unlimited capabilities of BIM to perform tasks beyond visualization such as building analysis, scheduling and estimation.

Threats

Response from the faculty members highlighted that there are still too much of the efforts which are supposed to be taken by the students were done by the system in BIM. Consequently, it reduces the students' creativity and their thinking process. Below is one of the statements made by the faculty members during the interview:
As much as we agreed that Revit and BIM has aided a lot in terms of understanding building construction, we still feel that the students' reliance on the software is very high, leading to limitation of visual exploration and studies.

Conclusion

The comments and responses from students and faculty members have inspired analytical thoughts and it also offered useful understanding for the growth of the interior design curriculum at Sunway University. Feedbacks received have indicated that BIM has its own benefits and restrictions in the stage of design visualization.

Integration of BIM into the curriculum of interior design programmes will require a well-planned strategy to ensure a success, especially when the integration involves other supporting modules like Building Construction, Lighting Design and Building Services. Based on the aspects listed in the SWOT-analysis, a strategy map has been developed by the faculty members to integrate BIM into the curriculum. The SWOT-strategy-map supports the development of a strategy, based on the aspects listed in the SWOT-analysis (Thomassen, 2011). Strengths and weaknesses are combined with opportunities and threats to locate how the different aspects can affect each other (Thomassen, 2011). Among the important factors that were taken into account in planning the strategy include the time frame to teach BIM; how many semesters needed and how soon should BIM be introduced.

The main benefit of using BIM for an interior design project is definitely the efficiency of the system in the production of visuals, besides its intelligent features to detect errors and clashes in construction. However due to the complexity of the software, steep learning curve is expected to master BIM, mainly to Diploma level students, where their knowledge and exposure to construction methods and materials are still within the most basic level. This has led to limitations of visual and design freedom, where students tend to ignore potentially innovative ideas that they have in mind when they start to think about the possibilities of building them in Revit. Therefore, having earlier skills and understanding in other 3D modelling software is important before students can start to learn BIM. It is suggested to incorporate the design process from several 3D applications with BIM application, rather than using BIM application single-handedly in the design process.

Lastly, through this case study, the researcher acknowledged that as much as BIM has given an impressive paradigm shift in architectural design process though its advanced and sophisticated features, a worrying trend existed among design students through the heavy reliance to software tools provided by today's technology. This could potentially limit their creativity and restrict their imagination in building construction detailing, when every building component is 'made-ready' for them by the system. For that reason, it is recommended that every design school should maintain the strength and appreciation of traditional education and to always consider multi-disciplinary approach when developing a curriculum with technology integration.

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