ГОДИШНИК НА УНИВЕРСИТЕТА ПО АРХИТЕКТУРА, СТРОИТЕЛСТВО И ГЕОДЕЗИЯ
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INTEGRATION COURSE OF BUILDING INFORMATION MODELING (BIM) INTO DESIGN CURRICULUM IN SUDAN

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Keywords: *BIM, curriculum, design and integration, individual learning, collaboration*

ABSTRACT

The relevance of Building Information Modeling (BIM) is apparent in today's construction industry. Benefits of implementing BIM has been identified as real-time integration of changes throughout the model which appears both graphically in the views and numerical data in the schedule, which in turn leads to more accurate budget and cost predictions. Given these benefits, it is imperative that educational institutions start integrating BIM into their curriculum to prepare future practitioners. It can be concluded that BIM's promise to improve construction practices lies in its capability to facilitate direct inter-disciplinary collaboration throughout the design process. Furthermore, it also demands project team members to have a better understanding of a building's components, as unlike conventional 3D models, the components pertain actual as built construction information. It is crucial then that introductory courses on BIM in school stresses the importance of students having good fundamentals of designing and modeling in BIM, before proceeding to the collaborative aspect of BIM. This paper seeks to evaluate and share experience in conducting the first BIM course in architectural school, as well as exploring ways in which BIM can be further extended and integrated into inter-departmental courses.

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1. Context of bim education in higher education environment in Sudan

The Capital Khartoum is one of the fastest growing cities in North Africa, practitioners of the AEC (Architecture, Engineering, and Construction) industry in Sudan is currently facing a heightened boom of demand for construction projects, going strong despite having lost much of its traction over the past year as compared to its 1995 period [1], and taking into account the coming exaction of African Economic Community in the end of 2015, it can be expected that AEC practitioners in Sudan will face an even greater challenge in keeping up with the demand of construction projects, amongst the myriads of challenges in many other sectors of its economy.

Unfortunately, no revolution comes easy, and the implementation of BIM itself to the largely CAD based Sudanese AEC industry is by no means excluded from this fact. Clients have regularly cited the steep learning curve of BIM to be one of the main reasons for refraining from converting to BIM [2], often preferring to do projects the conventional way, while outsourcing a BIM consultant to deal with the actual construction and integration of BIM model in projects. While it is possible to execute a BIM project in this manner, it may not be entirely feasible for an AEC consultant to sustain this method in the long run, as the method will require additional consultants in the process of delivering a project, and in doing the project in the conventional manner in the first place, the consultant would lose much of the benefit of BIM's capacity for Integrated Project Delivery (IPD).

Having realized this, and given the difficulty of training their currently already experienced staffs in BIM, the demand for BIM-enabled fresh graduates (particularly those whose BIM operating platform is Revit) have been steadily increasing over the past year, from both local and international design and construction firms. It can be expected then that in the near future, as the competitive pressures from the enactment of African Economic Community makes its way into the Sudanese AEC market, the demand for these graduates will also increase in Sudan. Hence it is essential that educational institutions in Sudan also contributes in the education of future graduates who understands, and is able to operate within a BIM defined framework, if the AEC consultants in Sudan are to remain competitive in the North Africa AEC market.

It is in consideration of this increasingly global context of the AEC sector in North Africa that, University of Khartoum, Sudan; (UOK) had recently held its first fully devoted course on the education of BIM.

The recent UOK Department of Architecture accreditation from the British Architecture Accreditation Board (BAAB) had also required the department to have a course in BIM, further amplifying UOK's Department of Architecture's needs to integrate BIM in its education process. The department's commitment to integrate BIM into its curriculum was represented in its establishment of Introduction to BIM, as well as the integration of BIM in Computational Studio.

2. Class overview and course description

The course of Introduction to BIM was delivered in the span of fourteen weeks, in Gezira College of Arts & Technology's Department of Architecture computer lab, with the educational version of Autodesk Revit 2016 serving as the platform of BIM operations for the twenty-four students who took up the course. This course offers an introduction to operating in BIM both individually, and collaboratively, as well as clarification to the common misconception among architectural practitioners that BIM is just a 3D modeling software by introducing students to the proper use of tools in Autodesk Revit, and explaining how this information will be interpreted in the course of real construction projects.

The course was broken down into 8 bi-weekly handout modules with each module explaining specific parts of the tools in Revit, and a short introductory lecture, followed by a hands-on workshop session discussing the implementation of the specific tools being the main delivery method of the course. A rundown of the materials covered in the class can be observed from the course syllabus (Table 1).

There were no previous class requirements for students who wish to attend the course. In the future however, participants are expected to have completed the Computational Studio course in their second year to be admitted in this elective course.

Table 1. Introduction to BIM course syllabus

Week	Topic	Sub Topic
11	Introduction to BIM in the construction industry	Evolution of information technology in architectural design Design method using BIM technology Autodesk Revit's principles and workflow Autodesk Revit's user interface and key features
22	Architectural BIM: Setting up project	Topographic modeling Image references Datum: project location, grid, elevation
33	Architectural BIM: Component modeling	Basic component modeling Column, Walls, Openings: window, doors
44	Architectural BIM: circulation and roof	Circulation: Stairs, ramp Roof types
55	Architectural BIM: Family Creation and Editing	Family creation and editing System families Loadable families In-place families
66	Architectural BIM: Curtain Wall	Curtain wall system
77	Architectural BIM: Mass modeling and editing	Mass modeling and editing
88	Exercise (mid-term project submission)	Project exercise
99	Introduction to Collaborative BIM	Introduction to Collaborative Revit Setting and the principle of worksheet Project workshop in collaboration with University of Khartoum, Sudan
110	Project Workshop	Project workshop
111	Project Workshop	Project workshop
112	Collaborative Management	Introduction to Naviswork for clash detection Exercise on project and rectification
113	Collaborative Management	Project modification and elaboration
114	Project Finalization (final-term project submission)	Project finalization Course feedback

3. Course objective

The course aims to introduce students to the basics of operating in BIM, as well as its main benefits in comparison to the conventional method. These benefits were identified as: 1) Provision of accurate and integrated documentation of drawings and other information within a project, and 2) Facilitation of cooperation across teams of different disciplines by use of its work sharing feature [3]. Having these two objectives in mind, we divided the workshops into two major sessions during the course of the lecture, with the first focusing on the students' individual learning of basic element modeling, and the second focusing on the application of BIM's collaborative aspects. The method, we hypothesize, would allow students to produce a fully functional BIM model that contains accurate data, and thus would enable them to contribute in a team of inter-disciplinary consultants working in BIM, be it for future projects, or research purposes, thus achieving the two main objectives of using BIM.

4. Course implementation

Having identified the two main objectives to be achieved in the course, we accordingly divided the course materials to be covered in two distinct sections during the lecture. The first part of the course discusses the principles of BIM, as well as the proper application of its tools, including each of its relation to its respective real construction project counterparts in the first eight week of the course, and the last six weeks were allotted to the discussion and practice of BIM's collaboration capacity. Students were handed full copies of the handout for each of the two sections at the start of these two major sections to allow for self-paced learning, aside from the regular pace of the course.

It is to be noted though that during the second part of the course, we had invited Assistant Professor from UOK to lecture on the collaborative aspects of BIM. Being traditionally oriented towards the teaching of the architectural design aspects of a construction only, like most other architectural schools, we had initially found that our current pool of case studies insufficient to demonstrate the interdisciplinary capacity of BIM. Thus, we hope to make up for this by inviting an industry partner who has had experiences on the subject.

4.1. Understanding BIM, and Individual Projects

We started off the course by giving students an understanding of the term "Information Modeling" in BIM, as well as its relevance to construction projects. The following demonstration was done to achieve this.

Further addition of walls in any of the three opened views (floor plans, sections, perspective 3D) would automatically result in the addition of information in the schedule views, which is set to show the walls' area and lengths. Hence the demonstration makes its point that the term "Information Modeling" in BIM refers to the automated generation of a building's information (in this case wall area and length) in sync with the creation of its related building element (wall) in the model, as opposed to the conventional methods, where architects and engineers have to finish designing a building first, and have a quantity surveyor manually extracts these information from the finished drawings later.

Having explained the basics of BIM and its benefits, we proceeded to the introduction of building elements in Autodesk Revit, and its real-world equivalence in relation with each respective building element parameters.

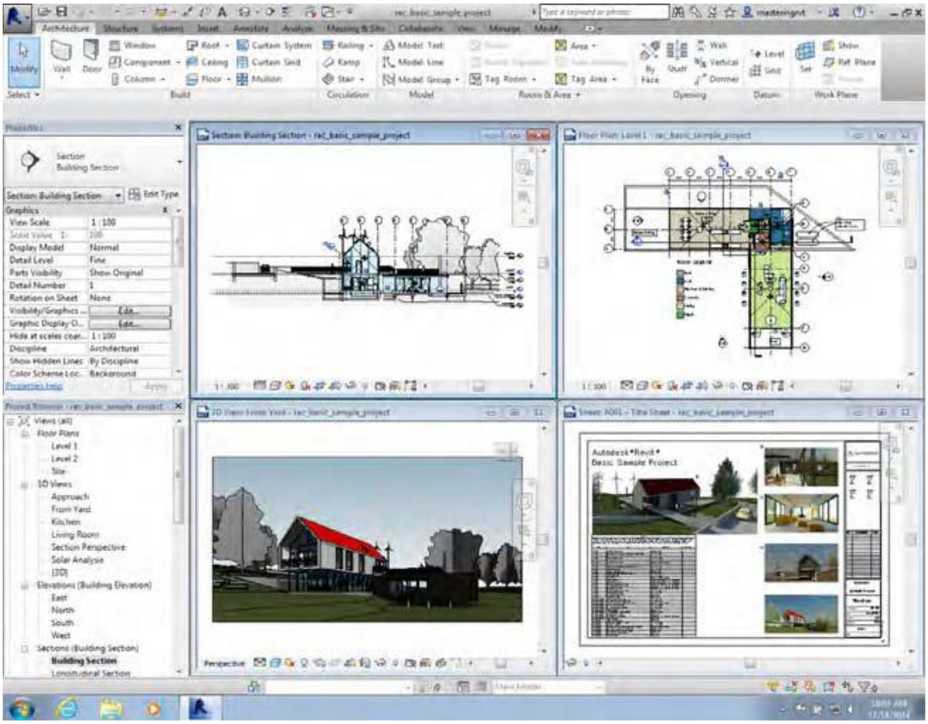

Figure 1. “Information Modeling” Definition Demonstration, Revit 2016 [4]

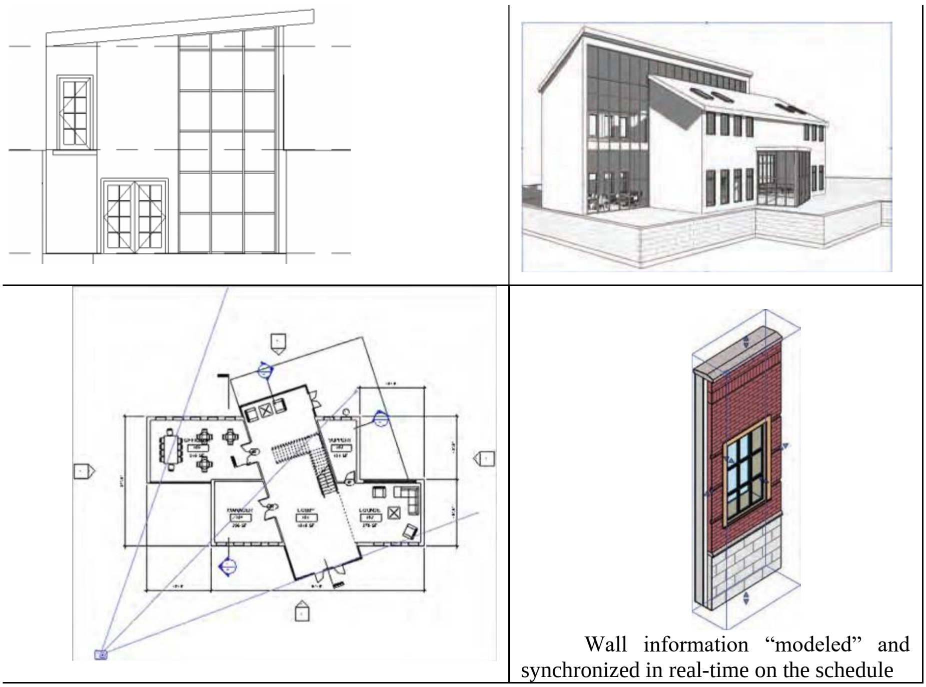

Figure 2. “Information Modeling” Definition Demonstration, Revit 2016 [4]

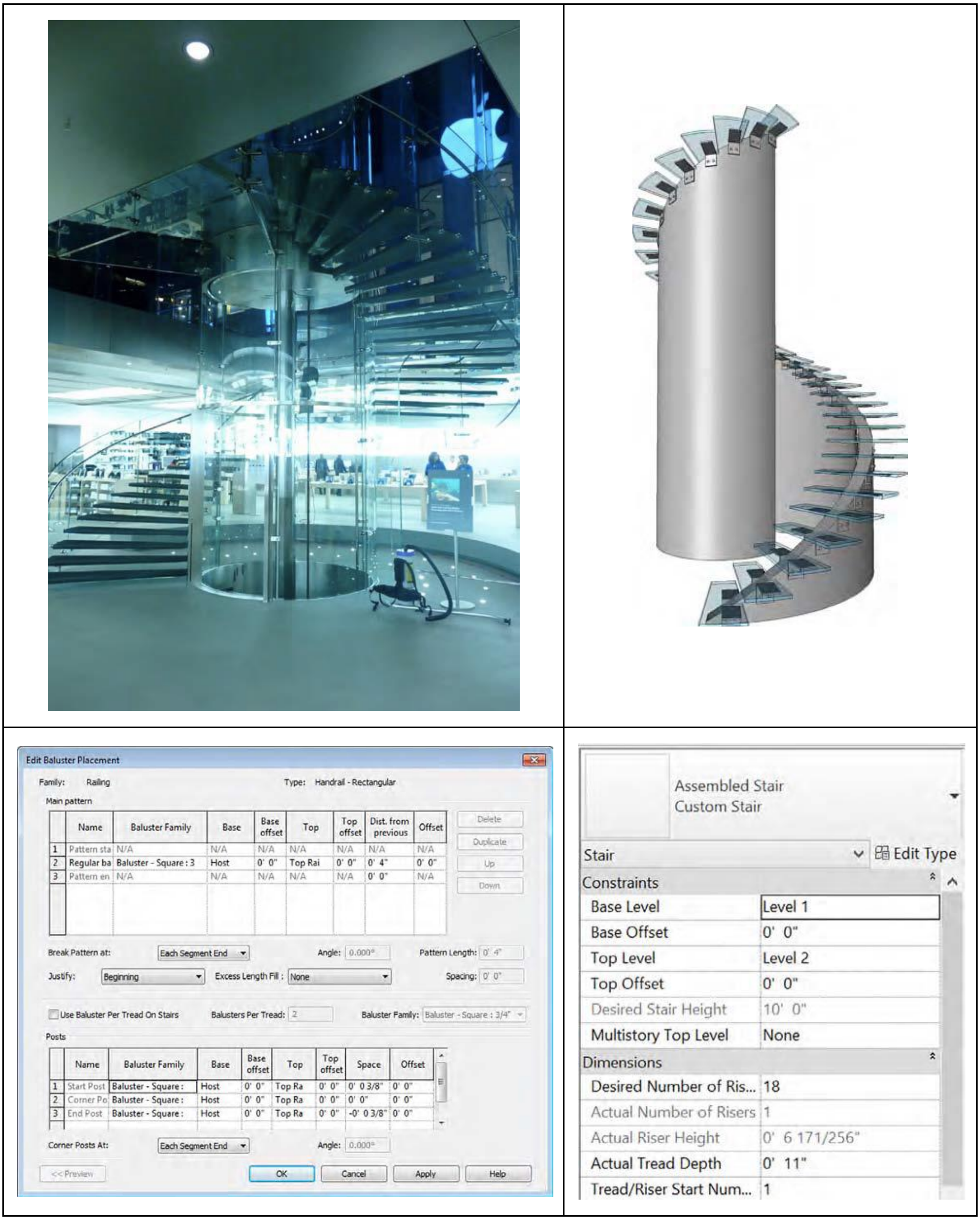

Figure 3. Example of explanation on railing baluster parameters and samples of real-world application, Revit 2016 [4]

Detailed explanations of each building element parameters and its real world sample applications were given, up until the eight week of the lecture, where the students are then asked to submit their personally modeled version of the case study given after receiving the CAD version of the model, with grading assigned based on the accuracy of their building information as compared to the information of the original BIM model.

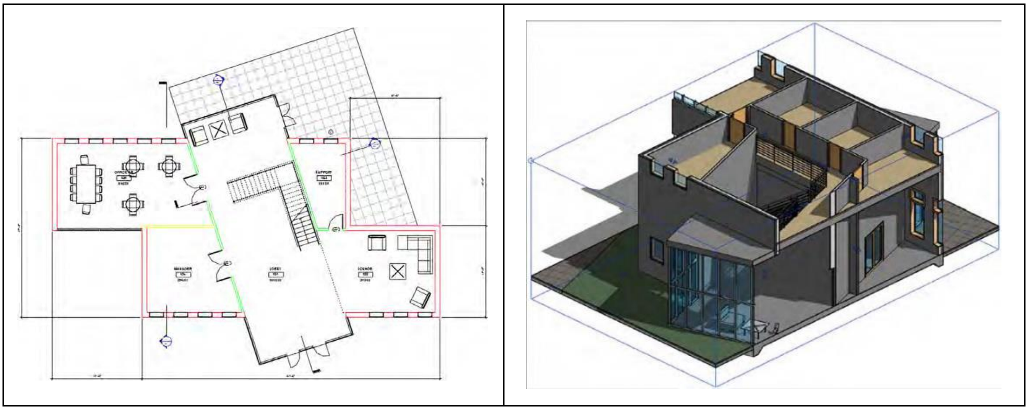

Figure 4. Sample case study of individual project assignment (inset shows the 3D Perspective View), Revit 2016 [4]

4.2. Collaborative Projects

By the start of the second part of the lecture, which focuses on the teaching of the collaborative aspects of BIM, students are expected to have a solid understanding of basic element modeling in BIM, so as to function in a team of BIM enabled consultants. The lecture started off with representatives from UOK explaining the current application of BIM in their Institution.

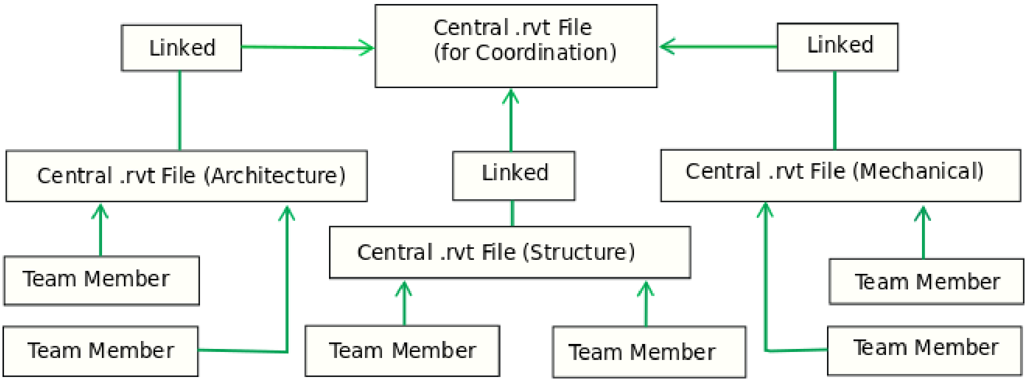

Figure 5. University of Khartoum BIM Collaboration Scheme

5. Conclusion/future integration development-collaboration/research opportunities

We realized that there are many aspects of BIM we have yet to cover in our course. Further iteration of the course syllabus will need to be made for the future, especially considering that UOK have previously integrated the basics of element modeling in BIM into the second year course of Computational Studio. By doing this, we are hoping that we can allocate more time to teach additional features of BIM such as energy, and lighting analysis in our future BIM course.

Our future plans for the course include having a joint class between our department of architecture, and UOK's department of civil engineering to enhance our intention of pursuing interdisciplinary studies on BIM. We have found that not only collaboration process gives our student a better understanding of construction process and BIM, it also provides a scaffolding opportunity in our class, allowing students who are behind in the course to catch up to their peers when collaborating for a project.

There is definitely still room for improvements in the design of our BIM Education course, and we would welcome any additional inputs and discussions to better ours, as well as other's future efforts to integrate BIM into their curriculum.

Acknowledgements

The Project in Figures 1,2,3,4 are taken from the book "Mastering Autodesk Revit Architecture 2016", James Vandezande and Eddy Krygiel. 2015 by John Wiley & Sons, Inc., Indianapolis, Indiana. All the drawings in 2D and 3D are chosen by the Assistant Professor from UOK to match the students' handout.

REFERENCES

1. African Economic Community (AEC), 1997 – 2018 Pan-African Perspective.

2. *Abdirad, H. & Dossick, C. S.*, 2016. BIM Curriculum Design in Architecture, Engineering. // Journal of Information technology in Construction.

3. BAF. Embedding Building Information Modeling (BIM) within the taught curriculum, The Higher Education Academy Innovation Way, Heslington, York, (2013).

4. E-book "Mastering Autodesk Revit Architecture 2016". James Vandezande and Eddy Krygiel. 2015 by John Wiley & Sons, Inc., Indianapolis, Indiana.

5. *Eastman, C. et al.* 2011. BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, 2nd Edition. New Jersey: John Wiley & Sons Inc.

6. Education in Sudan, By Tore Kjeilen.

7. Sudan – Educational System – overview, www.stateuniversity.com.

8. *Wang, L., Leite, F*. Process-Oriented Approach of Teaching Building Information Modelling in Construction Management. // Journal of Professional Issues in Engineering Education and Practice, 2014.

ИНТЕГРИРАНЕ НА ДИСЦИПЛИНА ЗА СТРОИТЕЛНО ИНФОРМАЦИОННО МОДЕЛИРАНЕ (СИМ) В УЧЕБЕН ПЛАН ПО ПРОЕКТИРАНЕ В СУДАН

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Ключови думи *СИМ (BIM), учебна програма, проектиране и интеграция, индивидуално обучение, сътрудничество*

РЕЗЮМЕ

Значението на Строително информационното моделиране – СИМ (BIM) е очевидно за днешната строителна индустрия. Предимствата от внедряването на СИМ се определят поради едновременните промени в целия модел, както в графиката, така и в цифровите данни, което от своя страна води до по-точни прогнози за бюджет и разходи. Предвид тези предимства е наложително образователните институции да интегрират СИМ в учебните си програми за подготовка на бъдещите специалисти. Може да се направи изводът, че прилагането на СИМ ще подобри строителните практики поради улесняването на междудисциплинарно сътрудничество по време на процеса на проектиране. СИМ изисква членовете на проектантския екип да познават добре компонентите на сградата, тъй като за разлика от конвенционалните 3D модели те следва да съдържат точна и пълна информация за изгражданата конструкция. Важно е началните курсове по СИМ при обучението да подчертават важността на придобиването на умения за проектиране и моделиране, преди обучаемите да се запознаят с аспекта на сътрудничество чрез СИМ. Тази статия има за цел да оцени и сподели опита ни от провеждането на първия курс по СИМ в архитектурно училище, както и да покаже начините, по които СИМ може да бъде допълнително разширен и интегриран в интердисциплинарни курсове.

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