Technion Graduate BIM Course

Advanced Building Information Modeling for
Students of Architecture, Engineering and Construction

019627 – for CEE Students
209XXX – for Arch students

Goals and Outline

Design and construction of modern buildings requires not only professional skills, but also the ability to **collaborate in multi-disciplinary teams** and **knowledge of and proficiency in the use of sophisticated information technologies**. Building Information Modeling (BIM) tools are essential for **design, for engineering and management** analyses of various kinds, and for communication and management.

In this course students will learn advanced concepts of Building Information Modeling through formal lectures, but they will also have the opportunity, through **hands-on group projects**, to apply the theoretical knowledge to development of a building project from **conceptual design, through engineering and cost analyses, to detailed design and fabrication of models using rapid prototyping technology**.

On completion of the course you will have a good understanding of the capabilities and the limitations of BIM technology. You will also have first-hand experience of the ways in which BIM can be used to support professional and multi-disciplinary teamwork, and you will be competent in operation of a fairly broad set of tools appropriate for your particular profession. You will also have a detailed understanding of the ways in which other professions in the Architecture, Engineering and Construction domain use BIM.

The course is a joint offering of the Faculties of Civil and Environmental Engineering (Structural Engineering and Construction Managament Unit) and the Faculty of Architecture.

The number of students will be limited to 30, (10 from each discipline of architecture, strutcural engineering, and construction management).

Faculty

Assoc. Prof. Rafael Sacks (CEE)
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Dr. Yasha Grobman (Arch)
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Teaching Assistant

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Term Project

Each team of three to six students (one or two from each discipline) will prepare a term project. Each team will be given a brief. The project will be developed in 3D using BIM tools. At each stage of the course, the students representing each profession – architecture, structures and construction management – will model and analyze the different aspects of your building project using the tools discussed. You will be required to present in class and submit the appropriate design and analyses development of your own projects each two weeks as ongoing homework assignments, and to present your project at mid-term and at the end of the course in a studio setting. In the final two weeks you will be able to fabricate the necessary parts using NC machinery and assemble your structure.

Guidelines for the project structure

Design, plan, fabricate, and build a (model of a) disaster recovery structure that can house X people to work, collect a maximum amount of rainwater, generate maximum electricity, introduce natural light for the people to work, and have minimum cost. Only three materials will be allowed – plywood, perspex and plastic pipes. Further details will be provided at the first lecture of the semester.

Student Evaluation

Six reading summaries, each of two texts (papers/book sections)	30%
Discipline – specific project submissions – two for each discipline	20%
Project overall grade, composed of: - 10% Collaboration - 10% Result (meeting project program goals) - 10% Result (meeting predicted values from their own anaylses) - 10% Team member peer evaluations	40%
Participation in class discussions and in group work	10%

One unexcused absence will result in a grade penalty of 2%; two, a grade penalty of 4%, three unexcused absences will lead to dismissal from the course.

Syllabus

The course is 3.0 credits. In each week, there will be:

1. A two-hour lecture
2. A two-hour exercise class: usually one hour of software instruction and one hour for project consultation.

The table below outlines the course contents

Session	Lecture	Exercise	Reading Homework/Project Submission
1. Introduction Rafael	• Course discourse and brief introduction • BIM Concepts (Rafael) (Typed and untyped objects, solid modelling and CSG, parametric modelling, coordination, parametric constraints, design intent modeling) • Term Project Description	• RHINO • Sketchup • Digital Project, • Generative components Refresher – using REVIT to model buildings Tutorial – model a small building in Sketchup, import to REVIT, model and prepare schematic desing drawings. • Group project teams	Reading: Building Information Modeling: What is BIM? C.M. Eastman, 2009 http://bim.arch.gatech.edu/?id=402
2. BIM in Architectural Design and Manufacturing Yasha	• Discussion in class - The future of BIM in architectural design and structural engineering. • BIM systems, content libraries, creating new object classes, design intent • Conceptual design in Revit/Rhino – tutorial and discussion about the advantages and limitations of existing tools.		
3. BIM in Structural Engineering Israel Kaner (Guest lecturer)	• Structural analysis of BIM models with external tools • Structural analysis of BIM models with internal tools • Structural detailing (steel,precast concrete, cast-in-place concrete)	• ATIR IFC export • Robot Millenium • ETABS (Demo only) • Tekla Structures	Reading: Chapter 5, BIM Handbook Project Submission (architects): Two directions for alternatives, conceptual design proposals.

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4. BIM in Construction Management Rafael	• Concept stage estimating • Target Value and Target Costing • QTO and Estimating • Construction Planning • Production management	• Dprofiler – live demo • Innovaya (Demo) Tutorial – take the building from last assignment from REVIT, import to TEKLA, model structural frame (columns, slabs, beams, etc.)	Reading: Castro Valley case study and Crusell Bridge case study (BIM Handbook) Project Submission (structural engineers): Structural analysis optimization
5. Parametric Design Yasha	• Introduction – parametric tools and ideas in building industry. • Discussion on the article "Parametric design in the building industry." • Presentation of architectural precedents • Design - presenting the initial alternative and choosing one direction.	• IFC, model view definitions, model server databases, model checking and program validation • Navisworks, Solibri, BIMsight Tutorial – take the building from REVIT (architecture) and from TEKLA (structure) using IFC into VICO Office, and prepare a cost estimate	Reading: Sacks et al. (2004), 'Parametric 3D Modeling in Building Construction with Examples from Precast Concrete', Automation in Construction Project submission (construction managers): Initial cost estimates
6. Collaboration and Inter-operability Rafael	• Different representations in BIM software • Define the interoperability problem • Collaboration tools and IFC Viewers • IFC Schema and exchanges • US National BIM Standard • COBIE (http://www.wbdg.org/resources/cobie.php#ar) •		Reading: Chapter 3, BIM Hanbook Project Submission (architects): sun/shade simulation

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7. Engineering Analyses and performance simulation, code and rule checking Guest lecturer	• Introduction - performance analysis, code and rule checking • Lighting analysis • Energy analysis • Handicap access	• Ecotect • Green Building Studio • Energy Plus • Solibri Model Checker Tutorial – work on term project	Reading: text about BIM and performance simulation.
8. Interim Project Presentations Rafael and Yasha	• Meeting in the Virtual Construction Lab to present models in 3D		Project submission (structural engineers) : structural details of joints
9. Quantity take-off and Cost Analysis, 4D and scheduling. Rafael	• Introduction - Quantity take-off and Cost Analysis • 4D CAD concepts • Target Value Design	• Innovaya, Autodesk QTO, Timberline, VICO Office, Dprofiler • Synchro, VICO Office, Tekla Manager • Rebar, piping, HVAC and other detailing • Tekla, CADduct, CADPipe, Revit MEP, Quickpen Tutorial – add piping and HVAC to the REVIT model; export house to Synchro, prepare 4D schedule	Project submission (construction managers): Updated cost estimate and assembly schedule (5D) Reading: construction budgeting and control - Chapter 6, BIM Handbook
10. BIM contracts and detailing Rafael	• Introduction – BIM contract and detailing • BIM contract forms, IFOA (integrated form of agreement), Integrated Project Delivery, Level of detail		Reading: AIA IPD contract form; AGC BIM contract form

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11. Fabrication Detailing and Computer-based fabrication and manufacturing Yasha	• Introduction – BIM and computer based manufacturing in architecture. • CNC, rapid prototyping, contour-crafting, Loughborough IMRC research. • Steelbuildings.com • Precast detailing http://www.idat.de/download/betonfertigteile/ • *http://aucache.autodesk.com/au2011/sessions/4030/class_handouts/v1_SE4030-Lackner-Handout.pdf*	• Prepare STL model and DXF plans for 3D printing and laser cutting Tutorial – work on term project	Reading: Computer based manufacturing in architecture, contour crafting,
12. Fabrication and CNC (hands-on) Yasha	• Meeting in the digital lab for printing and laser cutting • Prepare 3D physical model		
13. Final Project Presentations Rafael and Yasha	• Assemble Models • Studio and judging Presentation material: 1. Slide show presenting all aspects of the project 2. Booklet presenting the entire design/analysis/management process 3. CD with a digital version of all presented material		
14. Summary and Conclusions Rafael and Yasha	Summary of lessons learned		Submit final project summary, inlcuding analysis of shortcomings Project and peer evaluations

Bibliography

Becerik-Gerber, B., et al. (2011). "**Bim-Enabled Virtual and Collaborative Construction Engineering And Management**" University of Southern California.	
Eastman, C. M., Teicholz, P., Sacks, R., and Liston, K., (2008). **BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Architects, Engineers, Contractors and Fabricators**, ISBN: 978-0-470-18528-5, John Wiley and Sons, Hoboken NJ, 495 pages. Second edition April 2011, ISBN: 978-0-470-54137-1, John Wiley and Sons, Hoboken NJ, 626 pages	
Eastman 1999. **Building Product Models**,CRC Press.	
Ruschel, R., Celani, G., Guimarães, A.B.J., Righi, T.A.F., "**Collaborative Design in Architecture: A Teaching Experience**", Department of Architecture and Construction, School of Civil Engineering, Architecture and Urban Design, University of Campinas, Brazil.	
Sacks, R., Eastman, C.M., and Lee, G., (2004), 'Parametric 3D Modeling in Building Construction with Examples from Precast Concrete', Automation in Construction, Vol. 13 No. 3 pp. 291-312.	

525 Golden Gate - 4D CAD and Structural videos
http://continuingeducation.construction.com/article.php?L=5&C=799&P=4

Example building models

http://buildingsmartalliance.org/index.php/projects/commonbimfiles/