Best practices on BIM education
Design-Construction team

I'm sure glad the hole isn't in our end...
Some Questions?

• What changes is BIM bringing to the industry and CM academic curriculum?
• How does BIM impact the development of future CM professionals?
• What are the special challenges facing educators and students?
Biography

• Education
  – Ph.D. in Architecture, Texas A&M University
  – M.S. in Construction Management, Texas A&M University
  – B.E. in Architectural Engineering, Kyungwon University

• Work Experience
  – Assistant Professor, Milwaukee School of Engineering, 2007-Present
  – Assistant Professor, Western Illinois University, 2005-2007

• Research Area
  – Building Information Modeling
  – Building Energy Efficiency
  – Construction simulation

• Teaching Area
  – Design-Build Studio
  – BIM
  – Project Management
  – Construction estimating & Scheduling
2011 BIM (Building Information Modeling) Workshop

Instructor

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Email: woo@msoe.edu

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Email: wurtsj@msoe.edu

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Course description
This course prepares the students to utilize building information modeling (BIM) as a coordinated, integrated and consistent process to a building project in design and construction decision making. The students are provided the basics and advanced techniques to produce high-quality 3D designs and construction documents using Autodesk Revit Architecture, Structure, and MEP. The second day workshop will focus on model quality control, model-based estimating, and 4D construction scheduling. The course will utilize Autodesk Revit, Navisworks, and Solibri Model Checker.
I coached numerous design-build and commercial construction competition teams at MSOE. The competitions invite students from across the country and provides them with an opportunity to apply their skills and talents in a situation that closely simulates what companies experience during the bidding and procurement phases of construction.
Agenda

- **Introduction**
  - Current Uses of BIM

- **BIM Educational Activities**
  - Approaches for BIM Curriculum Development
  - Collaboration
  - Competition
  - BIM Workshop for CM professors

- **Case Studies**
  - Auburn University
  - Colorado State University
  - Milwaukee School of Engineering
  - Texas A&M University
  - University of Oklahoma
  - Virginia Tech
Why do we use BIM?

Integrated Practice

- Integrators
- Collaboration
- BIM
- Concurrency
- Continuity
- Multi-party Agreement
Current Use of BIM

- Planning
  - Space Coordination
  - Project Scoping

- Design
  - Design Collaboration
  - Digital Fabrication
  - Environmental Analysis

- Procurement
  - Model-Based Estimating
  - Constructability Analysis
  - Logistics Plan

- Construction
  - Clash Detection
  - 4D Scheduling
  - MEP Models
  - 3D Shops
  - Visualization

- Operation
  - Facility Management

- Retrofit
  - Energy Analysis

Design BIM

Construction BIM

Operation BIM
Concurrency
Overlapping design and construction phases allows integrated practice to compress the overall project schedule and deliver a building in less time.
Integrated Project Delivery is like...

Source: AECBytes
4D Scheduling
### Model-based Estimating

![Building Model](image-url)

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Total Weight: 201318.0572

Total Length: 14264.52
3D MEP Coordination
BIM in Academia

70% integrated BIM into their curriculum

97% will have an element of BIM in the future

35% teach model-based estimating

### Learning about BIM software tools

<table>
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<th>Self Taught</th>
<th>Learned during an internship</th>
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</tr>
<tr>
<td><strong>SD</strong></td>
<td>18%</td>
<td>20%</td>
<td>14%</td>
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</table>

**Source:** Anoop Sattineti, Auburn University
BIM-Based Academic Activity

• **Fast growth in BIM education**
  – Industry demand & support
  – Currently Coursework Limited
  – Software availability by few but different vendors

• **Wide variety of academic courses and projects incorporating the use of BIM-related software**
  – Dedicated BIM courses teaching model authoring
  – Integrated into the curriculum
  – Capstone course/project

• “Silo” mentality prevails among disciplines & departments

• **Funded research conducted by a few number of universities**

• **National BIM Competition**
2011 ASC BIM Competition

1st Place
Colorado State University

2nd Place
Milwaukee School of Engineering
AGC BIMForum Academic Subcommittee

- Architectural Programs
- Engineering Programs
- Architectural Engineering
- Construction Management
- International
- Design-Build
Basic Elements for BIM Curricula

• Understanding of the lifecycle project development process
  – The role of owner, designer, builder, users & other parties associated with the project

• Learn the use of BIM-related software

• Incorporate multidisciplinary elements
  – Within academic units
  – With the Industry

• Teach & practice integrated behavior
  – Team members relationships & respect
  – Teamwork (trust, communication, share information)
  – Ethics

• Teach how to effectively deal with industry change
Best Practices

- Milwaukee School of Engineering
- Colorado State University
- University of Oklahoma
- Virginia Tech
- Texas A&M University
Milwaukee School of Engineering

- Professor Jeong-Han Woo
- BIM workshops for construction companies
- Started BIM curriculum in 2007
- 2 BIM courses as graduate requirements
  - Introduction to BIM
  - Advanced BIM
- Incorporate BIM into current core CM courses
  - Estimating
  - Scheduling
  - Project management
  - Design-Build Studio
### Model-based Estimating

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Design-Build Studio
Use of BIM at Design-Build Studio

• **Use BIM for design-build purposes**
  – Architectural design
  – Preconstruction
  – CM proposal development

• **CM students act as BIM managers**
  – MEP coordination
  – Clash Detection
  – Model quality Control
Model Quality Control

- Improve BIM model quality for accurate BIM-based estimating
## BIM Workshop for Professors

### Workshop Day 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
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</thead>
</table>
| 8:00 – 8:30 | Introduction to the BIM Workshop  
|          | Introduction to BIM  
|          | Sample project – Law office building                                |
| 8:30 – 10:00 | **Revit user interface**  
|          | **Revit Architecture 2011**  
|          | Architectural components  
|          | Walls, Floors, Doors and Windows, Roofs, and Interiors            |
| 10:00 – 12:00 | **Revit Structure 2011**  
|          | Adding structural grids  
|          | Adding concrete foundation elements  
|          | Adding structural steel components  
|          | Adding masonry components                                           |
| 12:00 – 1:00 | Lunch                                                               |
| 1:00 – 1:30 | **Revit MEP 2011 - Mechanical**  
|          | Adding diffusers  
|          | Adding ducts  
|          | Adding VAV boxes  
|          | Adding air handling units                                          |
| 1:30 – 3:00 | **Revit MEP 2011 - Plumbing**  
|          | Adding water heaters  
|          | Adding water pipes  
|          | Adding fire sprinkler systems  
|          | Adding plumbing fixtures                                           |
| 3:00 – 4:30 | **Revit MEP 2011 - Electrical**  
|          | Adding electrical fixtures and equipments  
|          | Power Supply Systems                                               |

### Workshop Day 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
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</table>
| 8:00 – 8:30 | Introduction  
|          | Concept of Integrated Design with BIM  
|          | Sample project – Law office building  
|          | ASC BIM Competition                                                  |
| 8:30 – 9:30 | **Revit Architecture 2011**  
|          | Importing AutoCAD files to Revit  
|          | Linking Revit files  
|          | Using Central files and Work sets for efficient BIM process        |
| 9:30 – 10:30 | **Model-based Estimating**  
|          | Creating concrete foundation schedules  
|          | Calculating steel tonnages  
|          | BIM-based estimating software applications                           |
| 10:30 – 12:00 | **Autodesk Navisworks**  
|          | Basics  
|          | Navigation  
|          | Selection Sets  
|          | Model quality control                                              |
| 12:00 – 1:00 | Lunch                                                               |
| 1:00 – 2:30 | **Model Analysis**  
|          | Clash Detection  
|          | Solibri Model Checker                                               |
| 2:30 – 4:00 | **Animation/4D scheduling**  
|          | Navisworks TimeLiner  
|          | Solibri Model Checker                                               |
Workshop Examples
2011 National BIM Competition

- California Memorial Stadium- Berkley, CA
Structural Modeling
Quality Control
Quality Control

- Compare Architectural Model (.rvt) to 2D Architectural Drawings (.pdf)
- Find Discrepancies between Engineering Model and Construction Model using NavisWorks and Solibri
Quality Control
Rapid Prototyping with BIM
Colorado State University
Professor Caroline Clevenger

Construction Management Education
• Integrating 3D Models in Construction Management Education: Masonry Interactive Homework

Interdisciplinary Education
• Interoperable Learning: Leveraging Building Information Models (BIM) in Construction Management and Structural Engineering Education

Construction Worker Training
• Using 3D Visualization to Train Hispanic Construction Workers
Colorado State University

- Masonry Interactive Homework
- Developed by CSU & Mortenson BIM managers
BIM Teaching Modules

- Animated using Adobe Captivate
- Stand-alone platform simulating use of BIM
- Annotated and narrated lectures
- Intended to remove software burden from IT and faculty
- OSHA Example
University of Oklahoma

• Professor Tammy Mcquen
• Teaching Philosophy: BIM is two part
  – BIM is a methodology – integrated team approach
  – BIM is a technology – interoperable approach
• BIM for Constructors
  – Goal is to provide industry with graduates that are literate in various BIM applications, experienced working in teams, and prepared with the fundamental technical construction knowledge essential for the BIM environment
• Integrated Team Approach
BIM Courses at OU

• Computers in Construction
  – Revit
• Print Reading
  – AutoCAD & Revit
• Cost Estimating
  – Revit & WinEst
• Scheduling
  – Revit & P6
• Preconstruction Services
  – Dprofiler
• BIM for Construction
  – Navisworks
• Capstone
Concept

The articulation of the exterior closure in order to produce passive offsets for mechanical systems is fundamental to achieving environmental goals and producing aesthetic results. Exterior closure constitutes approximately 10-20% of the project budget and the understanding that a verifiable, sustainable and feasible concept design as developed during the charrette process was the focus of this interdisciplinary course. An immersive, eight day course was designed to successively develop team building skills; convey an operational understanding of the sustainable design strategies utilizing the U.S. Green Building Council’s LEED criteria; software training on the development of concept modeling techniques utilizing AutoDesk REVIT; and finally training on the interoperability of REVIT models with the DesignEst estimation interface and Primavera scheduling support software.

Multiple tasks were assigned to reinforce and apply these techniques in a simulated charrette environment through the development of: 1) a concept design for a small design-build office and 2) the modification of a prototypical retail development model to achieve a LEED Certified rating. The course was designed to enable students to better understand Building Information Modeling in a hands-on, collaborative environment. The roles of the architect and contractor, and their coordinating role in project design and construction, were explored throughout this process. Each session utilized case study reviews to help the students assimilate and apply the information learned. Pre-testing and Post-testing were conducted to evaluate course effectiveness. The knowledge outcomes of the class enabled students to critically contribute to the development of environmentally responsible projects.
Once again, the results of this task were remarkable. The sustainable design strategies that each team employed demonstrated a thorough understanding of the application of LEED principles. The sophistication of the designs was enhanced by the capabilities of the software and made the final presentations a huge success in terms of student satisfaction and ultimately increased the understanding of the projects’ direction.

It is important to note that, with the exception of one of the construction students, none of the participants had any experience using REVIT and the DesignEst interface and only one construction science student was familiar with P6. Furthermore, the construction science students had not participated in an interactive conceptual design process with an architectural designer. Conversely, the architecture students had not had the opportunity to test their concepts with a feasibility analysis. This immersive program, with its emphasis on interdisciplinary team development and, through the utilization of BIM, has had multiple outcomes. The least of which being the use of the BIM software suite to achieve a more sustainable and economically feasible design solution.
Virginia Tech

• Virtual learning
  – work efficiently within multicultural and geographically dispersed environments
Virginia Tech

- Industry mentors help facilitate class functions
- Sponsorship from various software and consulting companies, which contributed free software, training and technical support
Virginia Tech
Collaborative BIM in Construction Management

Architectural

Structural

MEP

Worksets
Texas A&M University

• Julian Kang, Associate Professor, Construction Science

• Independent BIM course
  – COSC 461 – Building Information Modeling System
  – Learn how to use Autodesk Revit, Google Sketch-Up, Google Earth, Autodesk Navisworks, and Microsoft Movie Maker collectively in order to produce a 4D computer model explaining a construction project
  – Understand how BIM applications can advance construction management practices
Student Examples
Challenges and Future Directions

• Most BIM courses are at the pilot state
  – Accreditation

• Use multiple BIM applications in one course would be challenging
  – Interoperability
  – BIM knowledge base

• Hardware capacity challenges
  – IT support for BIM server
  – Cloud computing

• Require Interdisciplinary research & support
Acknowledgement

• Anoop Sattineti, Auburn University
• Caroline Clevenger, Colorado State University
• Ki-hong Ku, Virginia Tech
• Tammy Mcquen, University of Oklahoma
• Julian Kang, Texas A&M University
Q & A

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