Building Information Modeling Curriculum at Virginia Tech

Kihong Ku, Doctor of Design
Assistant Professor of Building Construction

Structure of Presentation

- Department of Building Construction & School of Construction
- BIM in the Undergraduate Curriculum
- BIM in the Graduate Curriculum
- Pedagogy for tomorrow’s Construction Professionals
Building Construction Undergraduate

- 4 year program, ACCE accredited
- Technical and managerial
- Construction and Design track
- Development, Real Estate, and Construction track
- Vertically integrated lab (2\textsuperscript{nd}, 3\textsuperscript{rd}, 4\textsuperscript{th} year)
- Integration with architecture
Construction Engineering & Management Undergraduate

- 4 year program, ABET accredited (in progress)
- Engineering, construction theory and business management
- Integrated lab with BC
Previous Approach vs. Modified BIM Approach

- Technological Performance
- Human Performance
- Ecological Performance
- Economic Performance

Modified from Annie Pearce 2006
Slide 9

BC BIM Curriculum (Undergraduate)

- Start in 2006 as online tutorial/workshop at 1st year: construction, structural components, quantification, pricing, scheduling
- 4th year: modeling from existing project documents, structure, mechanical clash detection, 4D scheduling
- Goal to comprehension and operational fluency in manipulations of the data, including inputs/exports during procurement/performance area
- Software: Revit, Navisworks (Commonpoint)
CEM BIM Curriculum (Undergraduate)

- Intro at 2nd year focus on CAD, schedule impact analysis
- 4th year: modeling from existing project documents, structure, mechanical clash detection, 4D scheduling
- Goal to comprehension and operational fluency in manipulations of the data, including inputs/exports during procurement/performance area

Crane Coordination

- Location
  - From S team
- Integrated Schedule
  - Input Crane location into overall schedule
Structural Schedule

- 3 Phases
  - Col Line 17-9
  - Col Line 9-5
  - Col Line 5-1

n Logic
  - Columns
  - Beams
  - Metal Deck
  - Concrete
Mechanical Logic Per Floor

Floor Logic
- Ductwork
- Machines (HX, Hydronic Pipes, etc.)
- Attenuators, Diffusers
- Filters, Hoods

3 D Model
**Overall Coordination Strategy**

- Coordination Based on S and J given Schedule:
  1. Structural sequence
  2. Mechanical sequence
  3. Matching schedule
  4. Items being brought on site

**Original Schedules**

A) Schedule Coordination

Schedule Coordination of G21 will be based on selected J and S team’s structural and mechanical report

B) AON Analysis

Part of creating a uniform G team schedule for the 4D model is through the analysis of J and S teams’ AON

C) Total Derived Duration

Steel Duration: 70 days  
HVAC Duration: 109 days
G21’s Schedule

A) Schedule Modification

- Steel Duration: 98 days
- Added 28 days
- Concrete Curing
- No weekend work

- HVAC Duration: 88 days
  - 21 day difference
  - Non-modeled components/activities

HVAC Non-modeled Components

- Other Examples
- Heat Exchangers
- Sound Attenuators
- Exhaust Hoods
4D-Sequencing - Phase 1

Slide 23

4D-Sequencing - Phase 1

Slide 24
4D Simulation Issues

- Areas of Concern
  - Software Compatibility
    - Layering of Objects
      - Rhino to Common Point
    - Schedule
      - MS Project to Common Point
  - Visual Restrictions
    - Structural Obstruction of HVAC Installation

Collision Detection

Areas of Concern:
1. 1st floor; page M1.4
2. Clash detection indicated in 4D model.
Collision Detection

Areas of Concern:
1. 2nd floor; page M1.8
2. Clash detection indicated in 4D model.

Architecture BIM Curriculum (Undergraduate)

- 5 year program, NAAB accredited
- BIM curriculum by spring 2010
- Modeling/rendering course and Building structures course
- Application at 3rd year for building assemblies, environmental systems analysis
- Digital fabrication & 3D imaging
- Solar Decathlon
Graduate Courses incorporating BIM

- Construction Integration I, II
- Information technologies in Construction
- Facilities Integration
- Building Systems integration

---

CYBERTECTURE EGG, MUMBAI, INDIA

- 32,000 sq.m. Egg-shaped building
- 13 floors of office spaces
- James Law Cybertecture International

VISION

Cybertecture Egg will combine "iconic architecture, environmental design, intelligent systems, and new engineering to create a landmark in the city."

The egg is orientated and skewed at an angle to create a strong visual impact.
• Visualization of the building envelope as a 'cocooon'
• Array of parametrically increasing circles
• Formation of a multi-section surface

• Intersecting surfaces cutting through the multi-section surface
• Formation of the base surface and the sliced profile

• Initial structural system thought as the circular profiles used to model the surface
• The shaft as the main support to floors and the glass envelope

• Primary structural system aligned to the floors of the building
• Secondary ribs running perpendicular to the horizontal ribs
**Project Purpose**

- Troubleshoot post-processing software to produce as-built documentation of the Catawba Hospital Farm

**Introduction**

- Catawba Hospital Farm
Scenarios are developed by creating virtual model in SL.
**Proposed Scaffold Safety Prototype in SL**
Scaffold Erection scenario

Trainees will be provided with planks, brackets, supports etc.
- Users need Install scaffold
- Follow proper installation sequence

**Tower Crane Safety training**
- Optimization of crane usage can reduce cost, safety issues and scheduling delays
- Training operators can reduce fatalities

---

*Crane accidents.com*
*“Towards Fully Automated Robotic Crane for Construction Erection, SHIHCHUNG. KANG and EDUARDO. MARANDA,” Stanford University*
• RSS Scripting - Methodology

Slide 45

BI M Pedagogy

• Goal: Cultivate an environment for creative team-based problem solving
• Focus on process innovation and digital documentation
• Learn cross-cutting analytical tools & methods such as life cycle costing, construction & building simulation, process modeling, etc.
• Provide opportunities and guidance for immersion with real world stakeholders

Slide 46
Core Competencies

- Systems-based conceptualization and analysis of built facilities (integrated practice)
- Evaluation of contextual sensitivity / appropriateness of solutions and tools
- Identification, comparison, and evaluation of goals, metrics, project value, design options, etc.
- Understanding the interaction of multidisciplinary knowledge domain including architecture, engineering, construction, computing, sustainability, etc.

Essential Skills

- Cross-functional process modeling
- Ability to...
  - Collaborate and control processes
  - Integrate and validate models
  - Specify levels of detail and/or development
  - Articulate costs and benefits from multiple perspectives
- Parametric modeling and data specification skills
- Experience in interacting with real world stakeholders, and sensitivity to their needs
Discussion

- Gaps in the current approach
- Learning/pedagogy evaluation opportunities
- Sequencing of curriculum