Course Description:
Currently, the building industry is facing enormous technological and institutional changes and challenges. Among these are globalization, socio-economic changes, sustainability, specialization, and virtual collaboration. One very important instrument to such change is the use of information technology. The 21st century engineers and construction managers must be able to deal with a rapid pace of technological change, a highly interconnected world, and complex problems that require multidisciplinary solutions.

Students will work in multidisciplinary project teams to simulate engineering and construction processes for actual projects. In one semester, students will focus on collaboratively designing and engineering optimal solutions, by utilizing information technology and their individual strengths – problem solving from engineering students, design from architecture students, and schedule, cost, quality control and overall management from construction management students. By providing a cyber-learning platform, where students from multiple disciplines can work together, students will be able to test ideas, principles, and practices in the way to become creative and innovative practitioners. In addition, students will collaborate with their peers in Virginia Tech University (VTU), exploring bi-costal project collaboration and role-based learning. Distance Education Network (DEN) will enable students from two universities to follow software tutorials, lectures and participate group discussions.

Building Information Modeling (BIM) is argued to be a catalyst for change poised to reduce industry’s fragmentation, improve its efficiency, effectiveness and lower the high costs of inadequate interoperability. Students will learn BIM authoring and specialty applications and construction management functions including construction simulation, model based estimating, energy analysis, clash detection and code compliance.

Students should have familiarity with BIM software environments or willingness to learn them. All students enrolled in the course are expected to attend special skill building lab sessions. This course is not intended to make students completely proficient in these environments. Instead, it aims to demonstrate how construction management functions are impacted by new technologies and helps students understand the fundamentals and practical uses of the state of the art information technologies and tools in the building industry. It also promotes project-based learning through cross-disciplinary, geographically distributed, virtual project team collaboration.

Objectives:
(1) Students will gain experience in how to work in multidisciplinary teams of architecture, engineering, and construction, in which they are exposed to holistic view of the building industry;
(2) Students will have hands-on experience with emerging technologies, which support collaborative and concurrent teamwork, and they will explore the issues around technology’s impact on organization behavior and performance so that they can produce better and economical building products;
(3) Students will learn different aspects of collaborative design and engineering (in the context
of multi-disciplinary and geographically dispersed teams) Building on their technical competencies, this course focuses on fostering their collaboration skills (dealing with organization, management, teamwork, and effective use of IT).

(4) Students will learn to how to integrate personal and group knowledge to achieve positive results in complex engineering and construction tasks.

**Methods of Teaching:**
A combination of software tutorials, lectures, case studies, peer-to-peer learning and discussions. Additional out of class time required for directed self learning, seminar assignments, teamwork and reviewing relevant material.

**Learning Objectives:**
- BIM skills and knowledge building
- Application of BIM skills/knowledge to construction domain knowledge
- Team work and team building essentials
- Understanding of the requirements needed for successful team collaboration
- “Learning by doing”

**Roles & Responsibilities:**
Four groups of six students will work on three projects (max 24 students). Each group will have 3 USC and 3 VT students. Each student in each group will have the following roles:
- Architect/Engineer (A/E)
- Project Manager (Owner’s Representative)
- Cost Engineer (Contractor)
- Scheduler (Contractor)
- Construction Manager (Contractor)

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<th>Role</th>
<th>Arch. Model</th>
<th>Struct./MEP Model</th>
<th>Energy Compliance</th>
<th>4D Scheduling</th>
<th>Estimating</th>
<th>Clash Detection</th>
<th>Code Compliance</th>
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- Primary role – Task leader
- Secondary role – Participates in the task; works with the task leader
- Consultant – Provides expertise/requirements

**Guest Speakers:**
Project participants of case studies and subject matter experts might participate either remotely or visit the class.

**Teaching Assistants**
USC: Farrokh Jazizadeh; jazizade@usc.edu
Office Hours: Fridays 2-5 PM
Location: KAP217
VT: Sandeep Langar; slangar9@vt.edu
Office Hours: TBD

Office Hours: Other hours by appointment only. Students are advised to make appointments with the professor ahead of time and be specific with the subject matter to be discussed. Students should also be prepared for their appointment by bringing all applicable materials and information.

Assignments:
Students will work in groups. There is no midterm assignment. Instead, there will be six assignments and three final reports due at the beginning of the class as specified in the class schedule below.

Guidelines and additional information will be developed, which will provide a common vernacular for the assignments. It is crucial that students turn in whatever they have on the due date. NO assignment will be accepted late. An incomplete grade will only be issued when a student is unable to complete the work because of documented illness. A letter from your physician will be required documentation.

Assignment #1:
- Preliminary review of campus projects’ scopes: PDF drawings and design data/program
- Establish group roles and responsibility; team charter; communication/collaboration procedures

Assignment #2:
- Create a digital model
- Prepare/compile schedule/cost data for the building
- Presentation: Teams present their models: comparable case and expected differences

Assignment #3:
- Complete BIM based cost estimate and scheduling
- Presentation: Teams present findings

Assignment #4:
- Complete energy analysis
- Presentation: Teams present their energy simulation findings

Assignment #5:
- Complete clash checking and code compliance
- Presentation: Teams present their findings

Assignment #6:
- Refine final project model, estimate, schedule based on findings
- Produce 3D marketing documents/videos
- Final presentations

Final Report #1:
Each group will establish their communication/collaboration procedures and choose the tools to facilitate/support their procedures. Below is a list of suggested communication and collaboration tools. Each group may test different tools at the beginning of the semester but must choose at least one tool from each category and use them for group, vendor, and mentor communication/collaboration throughout the semester. Each group must deliver a report at the end of the semester. The report must include the following as a minimum requirement:
- Basis/justification for choosing one tool over another
- Pros/cons of each tool they have chosen
- Frequency and method of use and reasoning for it (how much they used and what they have done and why)
- Unique ways of use
- Use by participants (who used what feature, who initiated the use, for what reason)
- Detailed description of the communication and collaboration procedures established by the team
- Explanation of how selected set of tools supported the team’s procedures
- Lessons Learnt: what are the organizational, procedural and technological requirements for collaborative project development; what has worked and what haven’t and why?

**Suggested Tools:**

**Synchronous Collaboration:**
- http://tinychat.com/
- http://www.tokbox.com/
- http://www.dimdim.com/
- www.huddle.net
- www.centraldesktop.com
- www.yuuguu.com
- http://presentlyapp.com/Skype
- MSN messenger
- AOL Instant messenger
- Yahoo messenger
- Google voice and video chat
- http://www.icq.com/
- Google Wave – not available yet but might be soon

**Asynchronous Collaboration:**
- http://www.ning.com/
- www.Zimbra.com
- www.meetheboss.com
- http://www.groupsite.com/
- http://secondlife.com/
- http://www.facebook.com/
- http://www.youtube.com/
- http://twitter.com/
- Bluestreak – Autodesk
- http://labs.autodesk.com/technologies/bluestreak/

**Related Software:**

**BIM Authoring:**

**BIM Specialty:**
- NavisWorks - http://navisworks.com/ (model review & clash detection)
- Solibri - http://www.solibri.com/ (model review & clash detection)
- Horizontal – http://www.horizontal-llc.com/ (collaboration, estimating, 4D simulation, clash check)

- Ecotect - http://ecotect.com/home (energy & performance analysis)
Final Report #2:
Students will develop case studies of campus projects. Campus case studies may focus on new construction or remodeling/expanding existing buildings, and study the lifecycle implications of the various project phases from design to construction, and facility management. Working in teams and with industry mentors from actual projects, students will explore how BIM impacts design, construction, procurement, commissioning, and maintenance and operations, and explore process issues such as planning the BIM process or defining BIM requirements. At the end of the semester, each group will deliver a report that is supported by a thorough analysis of the case study project. Some of the questions that will be reported in a document as well as incorporated into the project are:

- What level of information is needed at each stage (design, construction and operations) and who is responsible for it?
- Definition of “what is needed” for and from each discipline area
- What is the level of detail?
- Who generates, produces, and organizes the effort?
- What are some of the liability issues and how to overcome them?
- Who owns the coordinated model?
- Who is responsible for quality control?
- What are some of the standards needed to integrate all discipline's analytical and physical objects for simulation and performance?

Final Report #3:
Building on the results of Report #2, each group will integrate/implement their case study findings to their group assignment projects and deliver a report on two categories: technology and process. Some of the areas (for both technology and process) that should be covered in the report are:

- Interoperability
- Enhancement list
- Value proposition
- Best practices for “how to work collaboratively” on the model
- ROI metrics development (from Owner’s point of view)

Surveys:
Students will fill out surveys for the class to provide feedback on teamwork and the course.

Class Communication:
Scholar will be used for class communication, assignment submissions and reading materials. Adobe Connect will be used for sharing presentations and desktops. Each lecture will be recorded by DEN and streamlined via Scholar. https://scholar.vt.edu/portal

Grading Schema:
Software Assignments: 60% (10% for each assignment)
Final Reports: 30% (10% for each report)
Participation: 10%
Recommended Readings:
Web Sites & Blogs:
Analysis, Research and Reviews of AEC Technology - AECbytes - http://www.aecbytes.com/
Building Smart Alliance - http://www.buildingsmartalliance.org/
FIATECH - http://www.fiatech.org/
Eat your CAD - http://www.eatyourcad.com/
BIM Forum - http://www.bimforum.org/
All Things BIM - http://allthingsbim.blogspot.com/
All Roads Lead to BIM - http://www.digitalvis.com/allroads

Books:
Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors, and Real Estate Asset Managers - Dana K. Smith and Michael Tardif
Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations - Willem Kymmell
BIM and Construction Management: Proven Tools, Methods, and Workflows -Brad Hardin

Class Structure & Schedule:
Class sequence, dates topics and guest speakers are subject to change as the semester proceeds. Any revisions will be noted and announced in class.