<u>Computer-Integrated Project Delivery (half credit hr)</u>
PROJ_MGT 455

Course Syllabus

Course Objectives

This class examines emerging design and construction industry technology, related work processes and the contractual relationships to enable success. It attempts to approach innovation and technology from a pragmatic, forward thinking vantage point. The topics covered will be building information modeling (BIM), virtual design & construction (VDC) and reality capture.

Computing tools have not only become essential and ubiquitous in the industry, but also are a required competency of any design or construction professional. Since the “Great Recession”, investors have poured billions into developing technologies aimed at Architecture, Engineering and Construction. In 2018 alone $3.1 billion was invested in this space. The rate of adoption, effectiveness and volume of new technologies is foreseen to only increase precipitously.

The course objective is creating a holistic understanding of design and construction technology’s role in the current and future state of the industry. The class will cover the relationship between software, the project process and the related roles and responsibilities of the talent involved. Students gain hands-on experience with key software products and the latest peripherals and hardware. By the end of the course participants will understand which technology is appropriate for each stage in the project process.

The format of each class is as follows:

<u>Lecture/ Presentation classes</u>	**<u>Computer Lab classes*</u>**
50% lecture	35% lecture
10% BIM Execution Plans (BEP)	15% BIM Execution Plans (BEP)
20% homework critique	25% homework critique
20% software instruction	25% software instruction
	**We reconvene in the computer lab after the halfway point break.*

The majority of the final grade will be driven by the Group Term Project. This project will consist of final versions of all the group’s homework and lab assignments from the 10 weeks. All assignments support and are related to a design and construction project solving for a client problem assigned by the professor. The group will present to the professor, highlighting the work in the week following the 10th and final class. The premise of the presentation will be <u>to explain to the client how the project budget spent on BIM & VDC technology added value to each stage of the project process.</u>

Schedule Overview

Week 1	**Fundamentals** What is BIM? What is VDC? What is a BEP?
Week 2	**Concept Design** Tech to capture existing conditions. Tech to decide what to build. Tech to sell the idea.
Week 3	**Schematic Design** 3D Model the final condition of the site. Use the model to calculate project metrics.
Week 4	**Design Development** Use the model to ensure the project fits into the budget and schedule requirements.
Week 5	**Permit Documents** Create deliverables from the model. Reports, sketches, drawings.
Week 6	**Preconstruction** Quantify the objects in the model. Use tech to validate the detailed estimate is in budget.
Week 7	**Construction Coordination** Progress the model from design intent to plans/shops ready for fabrication.
Week 8	**Clash Detection** Run trade contractors' 3D coordination. Navigate & query the model for issues.
Week 9	**Digital Layout** Ensure the coordinated model is what gets built at the physical, real world project site.
Week 10	**Facilities Management & Operations** Deliver the BIM data, insights and 3D visualizations to the owner enabling operations.
Week 11	**Group Term Projects due** All of the final versions of the homework assignments and the final projects uploaded. Team presents their work to the professor in a professional setting.
Week 12	**All grades released**

Text/ Resources

- Northwestern University Student Access to Lynda.com.

  The Software Instructional section of the Lectures and Labs *will only INTRODUCE* the programs, apps and features needed to complete the assignments. It is STRONGLY recommended to watch the Lynda.com video content that best aligns with the focus of the classes. Lynda.com contains a large volume of material to watch, that is updated regularly. The professor will make suggestions for video content to watch, this will not be a comprehensive or exhaustive list.

- Autodesk Education Community

  Autodesk provided active students with 1 years of access to their entire fleet of software for free. Northwestern will give students access to both the MPM Graduate Computer Lab (physical access only), as well as the Undergraduate Computer Labs in the Tech Building (physical & remote). It is recommended to also download and install the required software to your personal laptop for practice, convenience and offsite team meetings. Refer to Autodesk's system requirements for Revit & Navisworks to see if your machine meets the minimum requirements to successfully run the software required for the class before installing; see link below for current system requirements.

  https://knowledge.autodesk.com/support/revit-products/learn-explore/caas/sfdcarticles/sfdcarticles/System-requirements-for-Autodesk-Revit-2021-products.html

Software

All required software is available in one or both of the Computer Labs available to students. Purchasing and/or downloading any of the below titles is optional and not covered by any MPM program or class fees.

Autodesk's AEC Collection
    Revit Architecture, Structure and MEP toolsets, Navisworks, AutoCAD, ReCap Pro
Oracle's Primavera
Autodesk's Building Ops
Microsoft's Office Suite
    Excel, Word, Powerpoint
Adobe's Acrobat Reader

Hardware

All hardware, peripherals and equipment listed below will either be available through the main MPM offices or be brought in for demonstration purposes during the lectures. Students will not be required to purchase any of the below items.

High Performance Mobile Workstations, LiDAR Laser Scanning Equipment, Drone UAVs and Related Peripherals, Robotic Total Stations or other digital layout equipment, iPads

Group Term Project

The homework assigned each week will ultimately culminate into the Group Term Project. The software instructional section of the lectures and the labs every other week will be timed and scheduled to support the homework assignments. Each week, students will be given one point toward their final grade for submitting the homework on time and a grade for the assignment based on the rubric available on Canvas. The professor will provide a critique for each assignment. This grade is not final. As part of the Group Term Project students will be given the opportunity during their final presentations to show how they have updated, course corrected and/or progressed their work since it was originally turned in. The grade for each component of the Group Term Project given at the end of the class will be what determines the students' final grade.

Student team leaders will be chosen to be the "Project Manager" for their team. Team leaders will be considered for additional class credit. The team members are selected randomly using the tools within the "People" module in Canvas.

Class Participation

The design of this class attempts to recreate the reality of real-life vertical construction projects. In our industry we seldom are able to choose the team members we rely on. Even for team members we are able to bring into the fold, we cannot guarantee their performance, yet the project must still be delivered on time and within budget. To ensure the Group Project Teams have the greatest chance of success, and that every student has the opportunity for the best class experience possible, an evaluation of participation is weighted heavily. Evaluation of Class Participation will be based on the following criteria.

- <u>Attendance, timeliness, disruptions.</u> It is expected that all students will appear in person to class and be ready to begin at the scheduled start time. If situations arise where an absence or tardiness is unavoidable by the student, coordination with the professor via text, email or mobile phone is required. Students are expected to silence their phones, remain in class and be attentive for the class's duration. Sidebar conversations, leaving the room and other disruptive or distracting behavior will negatively impact the participation evaluation.
- <u>In class etiquette, general observation.</u> The professor will be "roaming" the class during lectures to evaluate whether electronic devices are being used for note taking and/or first hand, tactile attempts at the material being presented, versus the devices being used as a distraction from the lecture. In-class questions, clarifications and professional anecdotes will be considered as well. For online instructions, the students are expected to leave their laptop video cameras on for the duration of the class.
- <u>Messaging w/ the Professor.</u> It is understood and will be considered that English is not the first language for many of the students. If a student is uncomfortable asking a

question or requesting clarification in front of the class, emails, texts and one on one phone calls will be considered for participation and are encouraged.

- Team Leader. Additional consideration will be given to those chosen to lead their project teams.
- Team Participation. If the professor is made aware of team members not participating in project team meetings outside of class, not posting project progress for their teammates on time, or causing the team to become unproductive in other ways, their participation evaluation will be negatively impacted.
- Team Member Evaluations. You will be required to submit a completed Team-Member Evaluation Form via email to the professor 2 business days after your team's final presentation. Failure to submit these evaluations will negatively affect your participation evaluation. The default value for each student is 2 out of 4. Ultimately, only values from returned evaluation forms have an impact on the average for each student's final Team Member Evaluation value, positive or negative.
- MPM Honor Code. Any behavior or actions that are identified that fall outside of the Honor Code as written in the MPM & EMDC Handbook will negatively impact the participation evaluation at a minimum.

Grade determination

Term project ___85_____%
Class participation ____15____%
Class presentation _____(part of the Group Term Project)_____%
Homework ____(parts of the Group Term Project)____%
Other _Computer Labs____(supports the Group Term Project)____%

Class Schedule Detail

Week 1: Fundamentals.

- A broad brush overview of a typical project and the technology that will be covered throughout the course.

  Lab Work (Outside of class): login procedures, software titles.
  Homework: Write the outline of a BIM Execution Plan (BEP).
  Look ahead: Students should begin watching the instructional videos on Lynda.com for Revit Architecture specifically the massing & room object features.

Week 2: Concept Design. 3D BIM.

- Software packages that allow designers to quickly develop programs and ideas into visualizations that allow clients to make decisions and move forward.
- Tools that enable teams to communicate a client's vision into a comprehensible concept.

- Introduction to the use of Virtual Reality and Augmented Reality for Design & Construction.

  Lab work: will be focused on simple exercises around a basic building program and floor plan using Revit Architecture. (25 mins).
  Homework: Develop a building mass that fits on the site provided. Develop a simple floor plan for each floor. Students will be given (2) weeks to complete the assignment. (25 mins Printing/ Upload problems? Intro OPR). Update BEP with...
  Look ahead: Students should begin watching instructional videos on Lynda.com for Navisworks and begin to read the Help files for Revit "Quantities & Schedules"and Oracle's Primavera.

Week 3 LAB CLASS: Schematic Design. 3D BIM.

- VDC tools that assist in developing a Cost Model for a project budget.
- Tools for planning spaces.
- Using BIM to calculate Floor to Area Ratio

  Lab Work will be to complete assignments from the previous week.
  Homework: Complete Lab assignment from previous week. Update BEP with...
  Look ahead: Students should continue to watch instructional videos for Revit MEP on Lynda.com specifically topics related to single line ductwork and piping.

Week 4: Design Development. 5D BIM.

- Validate that all of the client's requirements fit in the space.
- How to analyze deltas in project cost.
- How to represent a high level construction schedule using the data available at early stages of the project.

  Lab Work will be focused on using Navisworks and On Screen Take-off to generate simple Cost Models in Excel from their Revit models. In addition, students will use Primavera to generate a simple high level schedule to envision how long the project may take to build. They will also have to use pre-populated Revit templates to generate for all disciplines, including the Mechanical, Electrical, Plumbing and Fire Protection, sheet sets.
  Homework: Students will be given (2) weeks to complete the assignment. Update BEP with...
  Look ahead: Watch the Autodesk YouTube series on ReCap, as well as any Help documentation related to ReCap. Continue to view the Lynda.com content related to Navisworks.

Week 5 LAB CLASS: Bidding/ Permit Documents. 2D BIM.

- The requirements of a Construction Document set
- AHJ requirements of the document set such that a permit will be granted.
- Page through real Construction Documents and talk about what needs to be included and how items might exist in a Design Intent model.

  Lab Work will include assembling the beginnings of the 4D Federated Model using Photogrammetry provided, the students' Design Intent model(s) and the high level schedule. Publish an NWD (Navisworks Document file) including the 4D (timeliner) information from the lecture. Export NWC (Navisworks Cache file) of their assigned building system. All major components in each system need to have metadata present in the NWC.
  Homework: Develop the sheets of the discipline assigned to each group. Update BEP with...
  Look ahead: Students should begin to view the Lynda.com videos related to Revit MEP.

Week 6: Preconstruction. 4D BIM.

- Begin analysis & <u>coordination</u> of subcontractors' proposed means & methods.
- Validate project phases & milestones can be built within the contract schedule.
- Reality Capture for site survey at post-demolition.

  Lab Work will be to complete assignments from the previous week.
  Homework: Students will be given (2) weeks to complete the assignment. Update BEP with...
  Look ahead: Students should continue to view the Lynda.com content related to Navisworks.

Week 7 LAB CLASS: Coordination/ Construction. 3D BIM.

- Explanation of the concept of "means and methods". Opportunities for Prefabrication.
- Explanation of submittals.
- Explanation of shop drawings.
- Technology tools used to generate the 3D models subcontractors use to illustrate to the team how they plan on delivering the project.

  Lab Work: will complete assignments from the previous week.
  Homework: Complete the assignment from the previous week. Update BEP with...

Look ahead: Watch the Trimble YouTube series on using the Total Station. In addition, watch the Autodesk YouTube series related to Autodesk 360 Point Layout solution.

Week 8: Clash Detection. 3D BIM.

- Explanation of interstitial space.
- Explanation of risers and chases.
- Learn the process of clashing systems against each other
- The hierarchy of building systems in terms of the ability to adjust.
- See a live clash detection coordination session of their work.

Lab Work will include the students adjusting the model based on the assignments generated out of the coordination session. Export an updated NWC (Navisworks Cache) of the assigned building system. Finish Permit Set for review.
Homework: Students will be given (2) weeks to complete the Lab assignment. Update BEP with...
Look ahead: Continue to view the Lynda.com content related to Navisworks. In addition view the Autodesk YouTube series related to the new Building Ops solution.

Week 9 LAB HOUR: Digital Layout. 3D VDC.

- How the contents of the model find their way into real life.
- How the field team ensures that the means and methods signed off on in the model are built correctly.
- Introduction to the variety of devices used to layout systems in the field from the model; Trimble Total Stations, Autodesk 360 Point Layout and others.

Lab Work will be to complete assignments from the previous week.
Homework: Update BEP with...
Look ahead: Students will be given the opportunity to have the instructor review and provide input on their final group presentation before the final deck and deliverables are submitted.

Week 10: Facilities Management (FM). 6D BIM.

- What the building owner can do with the as-built model information.
- Current solutions to access data contained within the model objects.
- Introduction to industry standard data exchange formats such as COBie and IFC.
- They will see what their class project looks like in these forms.

- Discussion of current FM solutions such as attaching links in Navisworks, Autodesk Building Ops cloud service and IBM's Maximo Add-In to Revit.

  Lab Work will be to set up Autodesk Building Ops accounts for the owner and ensuring their assigned building system components appear as expected. **Homework:** Send in Work Order ticket from the project's Building Ops account related to the building system they have been assigned. Update BEP with...