PROJ_MGT_439: Integrating VR/AR/MR with Design and Construction
Spring 2019

Master of Project Management Program
McCormick School of Engineering
Northwestern University

Wednesday, 6:30-9:30pm (Half-course. Meets the second five weeks of the quarter)

Instructor Information

Instructor	Email	Website
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Course Summary

Virtual Reality, Augmented Reality and Mixed Reality have been adopted in the Architecture, Engineering and Construction (AEC) industry as innovation technologies but only limited in marketing and strategic level in most cases. Since the Master of Project Management Program at Northwestern University is developing the future leaders in the AEC industry, the goal of this class is to help our students to gain solid knowledge and hands-on experience of VR/AR/MR, and in return, they can apply these technologies to their future projects. This class is going to build up a foundation of integrating VR/AR/MR with Design and Construction, as well as potentially, to use it throughout the project lifecycle for Operation and Maintenance. While these emerging technologies might be intimidating, this class intends to establish a strong connection between the students and the VR/AR/MR community at early stage in order that the students can catch up with current innovations and developments outside of the classroom. The goal of this course is therefore to not only learn the available tools, but also to analyze the current gaps for future research and development in the relevant field. Students will work individually and in teams to explore the potential of VR/AR/MR.

Course Objectives

1. To understand and be able to describe the advanced technologies of Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR) and Extended Reality (XR).
2. To apply VR, AR, MR, and XR in the real-world scenarios during the project lifecycle.
3. To analyze the current limitation and challenges of adopting immersive technologies like VR, AR, MR, and XR.
4. To propose and develop a solution to overcome the current challenges. The expected result at the end of this 5-week course would be a new business case for the AEC industry or an innovative research and development topic.

Course Schedule

Week	Topic	Preparation	Activities
1	Introduction of VR/AR/MR	Online Reading (see list below)	Lecture, Discussion, Expectation of the Exercise & Final Project
2	A Deep Dive into Virtual Reality	Account: A360 Cloud Rendering, Software: Revit, Revit Live, Enscape, Iris VR, App: Roundme, Bring: laptop, smartphone, Google Cardboard	Lecture, Demo/Hands-on Lab, Discussion, "QR Code Poster" exercise due on Week 3
3	A Deep Dive into Augmented Reality	App: Augment & Umbra Composit iPad app, Bring: iPad	Lecture, Demo/Hands-on Lab, Discussion, Review QR Code Posters
4	A Deep Dive into Mixed Reality	HoloLens & Magic Leap applications for AEC industry case studies	Lecture, Demo/Hands-on Lab, Discussion
5	Final Project Presentation: Case Study and Proposal for Future Research + Unity 101	PowerPoint slides plus any live demo or recorded videos; Installed Unity	Students' Presentations, Unity Demo, Discussion, Wrap-up

Additional Information and Resources

Required Supplies

Laptop, smartphone, iPad (optional)

A Google Cardboard kit (approx. $15). See a list of viewers compatible with your phone here: https://vr.google.com/cardboard/get-cardboard/

Required Web-based Account and Software

A360 Cloud Rendering Account (3 years free for students) https://www.autodesk.com/education/free-software/autodesk-360-rendering

Autodesk Revit (free 3-year education license) https://www.autodesk.com/education/free-software/revit

Revit Live (30-day free trial) https://www.autodesk.com/products/revit-live/free-trial

InfraWorks (free 3-year education license) https://www.autodesk.com/education/free-software/infraworks

Enscape (6-month free trial) https://enscape3d.com/free-student-license/

Iris VR (1 year free for students) https://help.irisvr.com/hc/en-us/articles/230548967-Non-Profit-Educational-Users

SimLab OBJ Exporter for Revit (21-day free trial) https://apps.autodesk.com/RVT/en/Detail/Index?id=2588306018562127114&appLang=en&os=Win64&autostart=true

STL Exporter for Revit (free download from Autodesk Desktop App)

Augment (14-day free trial) https://manager.augment.com/en/free_trial/new?solution=education

Umbra (30-day free trial) https://www.umbra3d.com/industries/aec/ (with Revit and Navisworks plugin)

Unity https://unity3d.com/get-unity/download

Required & Recommended Apps for Mobile Device

Roundme App (free) https://itunes.apple.com/app/roundme/id839493812?mt=8 (iOS)
https://play.google.com/store/apps/details?id=me.round.app&hl=en (Android)

Augment App (free) https://www.augment.com/augmented-reality-apps/

Umbra Viewer App (free) https://itunes.apple.com/us/app/umbra-composit/id1292667507?mt=8

AR-media Player (free) http://www.armedia.it/arplayer

Optional Wearable Devices

Oculus Rift, HTC Vive, Microsoft HoloLens, Magic Leap, Windows Mixed-Reality HMD

Online Reading List

Virtual Reality for architecture: a beginner's guide: http://www.aecmag.com/59-features/1166-virtual-reality-for-architecture-a-beginner-s-guide

Augmented Reality for Architects and Civil Engineers:
https://www.engineering.com/BIM/ArticleID/12233/Augmented-Reality-for-Architects-and-Civil-Engineers.aspx

Augmented reality visualization: A review of civil infrastructure system applications (journal)
https://pdfs.semanticscholar.org/d7ad/e935b8539b30afff5a782a3190a760a9a7f3.pdf

A Framework for Using Mobile Based Virtual Reality and Augmented Reality for Experiential Construction Safety Education (journal)
https://www.researchgate.net/profile/Chansik_Park3/publication/276025929_A_Framework_for_Using_Mobile_Based_Virtual_Reality_and_Augmented_Reality_for_Experiential_Construction_Safety_Education/links/554e218708ae93634ec70057.pdf

Immersive virtual environments versus physical built environments: A benchmarking study for building design and user-built environment explorations (journal) https://s3.amazonaws.com/academia.edu.documents/37986809/1-s2.0-S0926580515000606-main.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1521231394&Signature=2p1DZTeupt%2BedZ47SlEfz65OzwA%3D&response-content-disposition=inline%3B%20filename%3DImmersive_virtual_environments_versus_ph.pdf

Low-cost virtual reality environment for engineering and construction (journal)
https://link.springer.com/content/pdf/10.1186%2Fs40327-015-0031-5.pdf

Assignments

Based on the course schedule, students have to do the preparation before the class, which includes the online reading (week 1), exercise, software & apps installation and cloud-based online accounts setup (week 2 to 4). Students are encouraged to practice VR/AR/MR apps during and after class.

Project

The project will be done in groups of two people. The project is to define the problems of VR/AR/MR (maybe pick one focused area) and propose/develop a solution to overcome the current challenges. The expected results could be a new business case for the AEC industry, an innovative workflow or a proposal for future research and development topic. The format of deliverable is a presentation on Week 5 with PowerPoint slides plus any live demo or recorded videos.

Grading

- Class preparation and participation: 30%
- Exercise: 30%
- Final project: 40%