

PROJ_MGT 439: Integrating VR/AR/MR with Design and Construction

Spring 2023

Course Summary

The Architecture, Engineering, and Construction (AEC) industry has experienced a significant digital transformation in the last decade, transitioning from drawings to building information models (BIM) and from BIM to digital twins (DTs). These technologies, which simulate construction projects in a multidimensional digital model, present multiple aspects of a project, help tremendously in all stages of a project, and have changed how AEC professionals have created, shared, and perceived data and information. Due to the multidimensional nature of this information, new techniques are being created to interact with and visualize it in order to make better data-driven decisions. As one of the best alternatives, XR facilitates the visualization, comprehension, and communication of such complicated information for construction professionals. However, well-prepared architects and engineers are needed to properly utilize XR in construction projects and must grasp how this technology works and what to consider when applying it to this industry. Integration of BIM and XR technologies such as virtual reality (VR), augmented reality (AR), and mixed reality (MR) can develop workflow efficiency through enhanced common understanding and prepare students in architecture and engineering programs to become leaders of the AEC industry. The Master of Project Management Program at Northwestern University is one of the premier programs for developing future leaders in the AEC sector; consequently, we want our students to have solid knowledge and hands-on experience in VR, AR, and MR to apply them in their future projects. This class is going to build up a foundation for integrating VR, AR, and MR in all stages of projects, from design and construction to operation and maintenance. This course's objective is to familiarize students with the available tools and identify the current gaps in future research and development. Students will work individually and in groups to investigate the feasibility of incorporating XR technologies into AEC projects.

Course Objectives

By the end of the course, students will learn the fundamentals of XR, its applications in the AECO sector, and the skills to identify, develop, and deploy XR applications for the AECO problems. Specifically, they will:

- Gain a fundamental understanding of XR, including virtual reality continuum, characteristics of XR systems, perceiving digital information, advanced technologies of Virtual Reality, Augmented Reality and Mixed Reality. etc.
- Be able to identify the opportunities for application of XR in different stages of a project such as conception, design, construction.
- To apply Virtual Reality, Augmented Reality and Mixed Reality in the real world scenarios during the project lifecycle.
- Critically think about existing solutions and identify limitations, pitfalls, and bottlenecks in existing solutions.
- Critically think about existing solutions, limitation, and challenges of adopting Virtual Reality, Augmented Reality and Mixed Reality.
- Finally, you will explore the broader implications of XR technologies, including the new opportunities they provide, enabling you to make recommendations to clients and other key audiences.

Course Schedule:

Following is a week-by-week description of course:

Week 1: Introduction: Introduction to AEC Industry, AEC projects challenges, Building Information Modeling (BIM), Construction management technologies, Immersive technologies, and fundamental concepts of Extended Reality, Virtual Reality, Augmented Reality, and Mixed Reality.

- *Lecture, discussion, expectation of the final project*

Week 2: A Deep Dive into Virtual Reality: Learn fundamental VR concepts and characteristics, and explore basic questions regarding the nature of virtuality. You will also get introduced to VR hardware and software and learn about VR applications across different stages of AEC.

- *Demo/Hands-on Lab/Discussion*

Week 3: A Deep Dive into Augmented Reality and Mixed Reality: Learn fundamental AR and MR concepts and characteristics. You will also get introduced to AR and MR hardware and software and learn about AR and MR applications across different stages of AEC.

- *Guest Speaker from SmithGroup company about VR/AR/MR in AEC*
- *Demo/Hands-on Lab/Discussion*

Weeks 4: A Deep Dive into Mixed Reality and Metaverse: Learn fundamental MR and Metaverse concepts and characteristics. You will also get introduced to MR and Metaverse hardware and software and learn about their applications across different stages of AEC.

- *Guest Speaker from Northwestern University about Metaverse in AEC*
- *Demo/Hands-on Lab/Discussion*

Week 5: Final Presentation

- *Students' Presentations, discussion, Wrap-up*

Final Project

* The project will be done in groups of two to three people. The final project will be in two sections, and students need to present them in one presentation as their final project:

1- The first section involves selecting a published article regarding XR, VR, AR, or MR in the AEC industry and writing a two-page summary report about it. (Report needs to be submitted.)

2- The second part of the project is to define the problems of VR, AR, and MR (maybe pick one focused area) and propose or 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 a future research and development topic. The format of the deliverable is a presentation in Week 5 with PowerPoint slides plus any live demo or recorded video. (The PowerPoint slides need to be printed and submitted).

Grade Determination:

- Class attendance 15%
- Class participation: 15%
- Final project
 - Report 25%
 - Presentation 45%

Additional Information and Resources

Required Supplies (optional)

A laptop, a smartphone, a Google Cardboard kit (approx. \$20). See a list of viewers compatible with your phone here: <https://vr.google.com/cardboard/get-cardboard/>, iPad

Required Web-based Account and Software

Autodesk Revit 2022 or 2021 (free 3-year education license) <https://www.autodesk.com/education/free-software/revit>
 Enscape (Free student version) [Free Enscape Student & Educational Licenses | Enscape™ | Enscape \(enscape3d.com\)](#)

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