CSCI 8605: 3D Drawing in eXtended Reality

Graduate Studio/Seminar Course, Spring 2025

Professor Daniel Keefe (he/him or they/them). You can contact me at dfk@umn.edu.

Meeting Time 9:30 AM-12:00 PM Friday mornings

Final Exhibit & Demos 1:30 p.m. to 3:30 p.m., Monday, May 12

Classroom Regis Center for Art-West, Room W130

Office Hours Feel free to stop by my office in Keller Hall 6-211 if you have a quick question. And/or, just email me if you would like to meet outside of class. I am happy to schedule a time to meet in person or over zoom.

Course Description and Details

Important Dates

Class meets just once a week, on **Friday mornings from 9:30 AM-12:00 PM in Regis Center for Art-West, Room W130.** We will meet each Friday from January 24 to May 2, except for Friday March 14, which is during Spring Break. All class meetings will be in person.

Instead of a final exam, we will hold a **Final Interactive Exhibit and Demo Session on 1:30 p.m. to 3:30 p.m., Monday, May 12.** This is the two-hour final exam time assigned by the University to this course. The exhibit will be open to the public. So, you can invite friends and family to see your work in VR--please reserve this time on your calendar now!

Welcome and a Brief Intro to the Course

In this experimental course, you will do hands-on work with 3D mixed-reality hardware and software (headsets, 3D controllers, both commercial and custom software) to learn a style of digital free-form 3D modeling known as 3D drawing and painting. We'll study the topic from two complementary perspectives:

1. the creative art/design practice of 3D drawing, and
2. the technical interactive computer graphics tools that make it possible.

We'll engage equally with both perspectives through a format that combines in-class studio time for learning and practicing 3D drawing skills with demonstrations, readings, and presentations on the latest research in 3D drawing technologies and the 25+ year history of 3D drawing in virtual reality. Then, you will complete a final work that is either a creative exploration or a technical exploration of 3D drawing and present their your in a public exhibit/demo day at the conclusion of the semester.

Is this Course for You? (Prerequisites)

Students from multiple disciplines are encouraged to enroll! The prerequisites are graduate standing in an art or design discipline (e.g., CLA MFA students, CDes MFA, MS, or PhD in Design students) or graduate coursework or research in 3D computer graphics, HCI, or HRI (e.g., CSci-5607, CSci-5609, CSci-5619, CSci-5115, CSci-5125, CSci-5127W) or permission of the instructor. Interested students who are unsure if their experience would be a good fit for the course are welcome to contact me at dfk@umn.edu to indicate their interest in the course and background to request a permission number for registration.

Classroom and Equipment

The "classroom" for this experimental studio/seminar course will be the newly renovated and digitally outfitted ArTeS studio for Art-Technology-Science research collaborations in the Regis Center for Art on the West Bank campus. Students will have access to the lab/studio and a variety of resources for audio, sensing, projection, and XR experiences!

Planned Topics

1. Context and Course Introduction

What is a drawing tool?
Understanding the historical context of XR drawing
Setting up a mixed reality drawing space
Safe XR studio practices
Importing and exporting from 3D drawing software

2. Technical Foundation Skills 1
Background on working in virtual spaces
Human perception with perspective-tracked stereo displays

Selection, manipulation, and navigation techniques
Technologies and procedures for XR-based classroom critique

3. Technical Foundation Skills 2
Line Control
Creating smooth, intentional lines
Pressure Control: Controlling line thickness and weight
Practicing precise line connections between points

4. Mark Making in Virtual Space
Form and Physical Simulation
Virtual Color and Texture
Virtual Lighting and Shading
Perception of 3D form

5. Advanced Line Control
Understanding tool limitations and strengths relative to various drawing styles
- Quick Dynamic Styles (e.g., Gesture Drawing)
- Detailed Precise Styles (e.g., Slow Drawing, Photorealistic, Technical)
- Experimental Styles (e.g., Abstract, Minimalist, Surrealist)

Oversketching
Bimanual user interfaces
Context-aware and Intelligent UIs

6. Building XR 3D Drawing Tools
Current challenges in XR research and creative practice
How 3D drawing tools respond to various inputs (virtual and physical)
Programming a modern 3D drawing tool in Unity

7. Observational Techniques
Learning to see objects as they truly are, not as preconceived notions
Proportions and Scale
Negative Space Observation
Shape Simplification
S-Curves

8. Planning and Guides
Preliminary Sketching
Bringing reference materials into virtual spaces
Scaffolds and guides
Construction lines and layers

9. More on XR Tool Building
Designing and prototyping interactive virtual experiences
Implementing novel 3D user interfaces and features
Working with class starter code in Unity

10. Multiple Viewpoints
Understanding how 3D drawings read from all angles (360-degree thinking)
Identifying and resolving dead spots or weak views
Creating works that reward circumnavigation
Understanding how lighting affects form from different angles

11. Time and Multisensory Experiences
Recording and revealing the drawing process
Animated and interactive drawings
Engaging other senses

12. Scale and Composition in XR
Understanding human scale and body relationships to work
Considering viewer pathways and optimal perspectives
Reading and responding to site-specific features (e.g., architectural spaces)
Considering natural and virtual lighting conditions

13. Professional Practices
Documentation of XR work (form screen captures to interactive demos)
Exhibition and demo preparation

Weekly Drawing Assignments

For the first 11 weeks of the semester, you will do one drawing as a homework assignment that we will discuss during a class critique at the start of the next class. Since some of these drawings will be handed in digitally, and it will take me some effort to prepare them for class critique, these will always be due 24 hours before the next class (i.e., at 9:30am on Thursday mornings). I will announce the prompt for each week's drawing in class and also post a written description of the assignment on Canvas.

Final Creative Work or Programming Project

Your final product for this course will be a significant creative work or programming project that you develop over the last 4-5 weeks of the semester. The choices of the type of project

and specific topic are up to you, and we will take time to brainstorm and discuss possibilities in class. A final creative work could be a well developed 3D drawing or XR installation or a series of drawings or studies on a consistent theme. A final programming project should implement a new 3D drawing tool or feature extending the software we discuss in class.

Attendance and In-Class Participation

Our class meets only **once each week for a total of just 14 times this semester**, and the studio approach to the class means that much of your learning will come from this class time, which will include in-class drawing exercises and discussion that cannot really be made up outside of class. My rule of thumb is that you should still be able to learn the majority of the material and generally do very well in the class, even if you get sick or have other reasons to miss 1-3 class sessions. So, our policy takes this into account by automatically dropping the 3 lowest participation scores during the semester. In summary:

0-3 absences during the semester: The 3 lowest participation scores will be automatically dropped, so none of these will count against your participation grade. You are all good! You do not need to let me know ahead of time if you will miss class, and you do not need to let me know if your absence is for an official university-excused reason or not.

4 or more absences during the semester: Missing 4 or more class meetings for whatever reason means you will miss around 30% of the course content. In this case, you need to email me to setup a time to talk about your situation. I will want to discuss how we can adjust the work and expectations for the semester based on your specific needs. Also, while your three lowest participation grades will be dropped automatically, if you have more than three university-excused absences, I will need you to document those for me so I can adjust the gradebook so that these do not count against your grade. (Please familiarize yourself with the University's policy on what counts as an excused absence (e.g., sickness, bereavement, religious observation, military service).

Grade Calculation Details

- **33% Weekly Drawing Assignments** -- These will be graded on a scale from 0 to 3, and the one lowest grade will be automatically dropped.
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        - 0: You did not submit a drawing.
        - 1: You submitted a drawing with substantial deficiencies based on the criteria, including level of effort, specified in the directions OR late with minor deficiencies in terms of the criteria.
        - 2: You submitted a drawing that met all of the criteria, including level of effort, LATE or you submitted it on time but with minor deficiencies in terms of the criteria.
        - 3: You submitted a drawing that met all of the criteria, including level of effort, specified in the directions.

- **33% Weekly In-Class Participation** -- I will take attendance and notes on participation each class session and record a grade using the following 0 to 3 scale. The three lowest grades in this category will be automatically dropped.
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        - 0: You did not attend class.
        - 1: You attended class but arrived late in a way that disrupted what we were doing.
        - 2: You attended class but did not participate fully in discussion, drawing, or other activities.
        - 3: You attended class and participated fully in all activities.
- **33% Final Creative Exhibit or Programming Project** -- This grade will be based on both the quality of the work you produce for your exhibit or programming project and a short written reflection on the project and your learning during the semester:
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        - 66%: Quality of the exhibit or programming project demonstration.
        - 33%: Final written reflection.

Calendar & Course Webpages

The course webpage is hosted on Canvas, and as you have likely already found, it includes a full calendar of class meetings and planned topics and assignments for the semester. These may change slightly as we navigate the semester; we will take advantage of the digital format to always keep the course webpage up to date with our latest plans.

Inclusive Conduct within Our Classroom and the Field of Computing

At this point in your careers, we trust you are already aware that computing as a field has a huge problem with a lack of diversity. At all levels, there is an underrepresentation of populations, including women, African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians, Native Pacific Islanders, and persons with disabilities. If you are continuing on to a career in computing, we want you to know and think creatively about this problem because it is something that you have a responsibility to help change at UMN and beyond. In this course, one way we will do this is to use inclusive language and be respectful in all of our interactions, including written and face-to-face communication. This includes recognizing the diverse skills that we each bring to the course, including technical computing skills and creative art/design skills, and providing a welcoming environment for each of us to grow in our individual understandings of inherently interdisciplinary topic we are studying!

Some info on related, official university policies follows.

Equal Access and Opportunity

The University of Minnesota shall provide equal access to and opportunity in its programs, facilities, and employment without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression.

Sexual Harassment

University policy prohibits sexual harassment as defined in the University Policy Statement adopted on December 11, 1998. Complaints about sexual harassment should be reported to the University Office of Equal Opportunity, 419 Morrill Hall, East Bank.

Academic Integrity

All work submitted for this course is required to be your original work. Scholastic dishonesty includes violating the course policies outlined here, plagiarizing, or cheating on assignments. Within the course, a student responsible for scholastic dishonesty can be given a penalty, including an "F" or "N" for the course, and further disciplinary action may occur.

Student Resources

As you navigate your semester, please do not hesitate to take advantage of the many resources the UMN provides to support you. In the Computer Science & Engineering Department, we have collected many resources for students on our website. And, you can find additional info on several topics below.

Mental Health Information

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce your ability to participate in daily activities. University of Minnesota services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus
via http://www.mentalhealth.umn.edu

Disability Information

If you have already been working with the Disabilities Resource Center and have a letter from them to help direct your instructors on to set you up for success, then please send that to us, and we will make every effort to make sure this class is a good experience for you.

University policy is to provide, on a flexible and individualized basis, reasonable accommodations to students who have documented disability conditions (e.g., physical, learning, psychiatric, vision, hearing, or systemic) that may affect your ability to participate in course activities or to meet course requirements. Students with disabilities are encouraged to contact Disability Services and their instructors to discuss individual needs for accommodations. Disability Services, McNamara Alumni Center, Suite 180, 200 Oak Street, East Bank. Staff can be reached at http://ds.umn.edu. or by calling (612) 626-1333 (voice or TTY).