An Introduction to Design through Making

Tue & Thur 12:30 – 1:45 p.m.; Curry Maker Studio: Room 203 Ruffner Hall

An *Introduction to Design through Making* (EDIS 3050) provides a hands-on introduction to maker education. No previous experience is required. Participants have the opportunity to design and make jewelry, board games, musical instruments, 3D models, and mobile sculptures. Technologies used in the design process include digital design software and maker technologies such as 3D printers and laser cutters.

Course Web Site

The course web site is located at:

https://www.maketolearn.org/studio/design-through-making/

The *Make to Learn* web site provides resources that address a range of maker projects and technologies.

UVA Makerspace Agreement

Before the second week of class, read and complete the UVA Makerspace Agreement below. Not everything on it will apply to this class, but completing it will grant you access to any Fabrication Lab or Makerspace on grounds.

http://ehs.virginia.edu/Shop-Studio-Safety-User-Agreement.html

Course Structure

The course introduces design through a series of projects. Each project provides an introduction to a specific maker competency. The design projects and maker competencies have been piloted by students at the *Laboratory School for Advanced Manufacturing* in the Charlottesville City Schools. These projects are designed to be readily mastered by novice makers. They have a low threshold and a high ceiling, and can be implemented in a variety of ways.

The weekly projects lead to a midterm and final project. Any of the weekly projects can be expanded into a midterm or final project.

Course Schedule

1. **Designing 2D Objects** *(Jan 14 / 16)*

   This design activity introduces two technologies: (1) digital die cutters and (2) 2D design software.

   Assignment: Option A. Use the Silhouette Design Software to either replicate the objects in an existing board game or (optionally) create your own unique board game. Use the Silhouette Portrait die cutter to fabricate the pieces of the board game.

   Option B. Create an artistic design or pattern using the Silhouette Design Software. Then use the Foil Quill adapter for the Silhouette Portrait die cutter to emboss an art object or card.

   Design Extension: Deign and fabricate your own original board game.

(Note: Each week extensions are suggested for potential adaptation and development of a midterm or final project. Midterm and final projects are not limited to these suggestions; they are intended as a starting point for inspiration and creativity.)

2. **Designing 3D Models** *(Jan 21 / 23)*

This design activity extends two dimensional designs to create three dimensional objects..

Assignment: Option A. Select one of the models of historic homes available on the *Make to Learn* web site. Download the Silhouette file for the selected model and then fabricate and assemble the selected home. Document the assembly process, including images of each stage of assembly.

Option B. Use the Silhouette Design Software and Silhouette Portrait die cutter to design and fabricate your own three-dimensional model.

Design Extension: Design a three-dimensional model and fabricate it using chip board or plywood cut with either the Silhouette Cameo die cutter or the Affinia laser cutter.

3. **Designing with Light** *(Jan 28 / 30)*

This design activity extends the papercraft techniques developed in the first two classes and combines them with electronic circuits and LED lights known as *Circuit Stickers*.

Assignment: Option A. Use *Circuit Stickers* and an original art design created with the Silhouette Studio Design Software to develop an artistic pattern using light.

Option B. Create a light sculpture using an Arduino microcontroller and an LED strip.

Design Extension: Create an interactive art project in which LEDs light up in response to inputs from sensors.

4. Designing Toys and Creative Objects *(Feb 4 / 6)*

This design activity provides an introduction to 3D printers and three-dimensional design.

To join Tinkercad, follow this link and enter your name.

https://www.tinkercad.com/joinclass/ZZAMABWSNJ7P

Assignment: Option A. Use the Tinkercad Design Software to design a small toy. Then use the Affnia 3D printer to print the object.

Option B. Identify a need or project in your personal life that could be addressed through design of a small 3D printed object.

Design Project: Design and fabricate a motorized 3D-printed animation machine and an accompanying animation sequence.

5. Designing Laser Art *(Feb 11 / 13)*

This design activity provides an introduction to the Affinia laser cutter.

Assignment: Option A. Design a slice-form animal that can be fabricated and assembled using interleaving segments of cardboard or chipboard.

Option B. Use the block programming language "Snap!" to design an artistic pattern. Then use the laser cutter to engrave an acrylic ornament.

Design Extension: Design a laser-cut three-dimensional model fabricated using acrylic plastic or plywood.

6. Designing Moving Objects *(Feb 18 / 20)*

The previous design activity introduced design of static 3D objects. This activity extends this competency to design of objects that move.

Assignment: Option A. Design and fabricate an electric motor. Then use the motor to power a papercraft object or mechanism that moves.

Option B. Design and fabricate a solenoid. Use the solenoid to create a working speaker.

Design Extension: Design and fabricate a high fidelity speaker with a laser-cut enclosure.

7. Controlling Objects with Computers *(Feb 25 / 27)*

This design activity extends the previous activity (*Designing Objects that Move*) and incorporates computer control.

Assignment: Option A. Design a mechanism that incorporates a LEGO WeDo motor. Write a program in the block programming language Scratch to control the mechanism.

Option B. Design a mechanism that incorporates an Arduino microcontroller and a stepper motor. Write a program in the block programming language "Snap!" to control the mechanism.

Design Extension: Design a kinetic sculpture incorporating a microcontroller, motor, and LED lights that can be operated using a battery when it is detached from the computer used to program it.

8. Midterm Project Development

9. **Designing Jewelry and Edible Art** *(March 17 / 19)*

This design activity introduces a new technology, the hydraulic press, that can be used for design and fabrication of jewelry. It also introduces the vacuform molding machine.

Assignment: Option A. Combine one or more of the following maker technologies – the 3D printer, the laser cutter, and the hydraulic press – to create a custom-designed piece of jewelry.

Option B. Design a mold for the vacuform machine. Then use the mold to create custom-designed chocolates for your family and friends.

Design Extension: Use the hydraulic press, combined with other maker technologies, to design and fabricate a personal work of art.

10. **Designing Musical Instruments** *(Mar 24 / 26)*

This design activity introduces creative technologies that can be to design musical instruments and compose music.

Assignment: Option A. Design and fabricate an electric monochord or other musical instrument.

Option B. Use the SpecDrums music rings to compose an original tune. Then create a video in which you perform the tune using the music rings.

Design Extension: Design and fabricate a multistring electric guitar.

11. Robots *(Mar 31 / April 2)*

This design activity introduces floor robots, including the Spero spherical robot and the iRobot drawing robot.

Assignment. Option A. Design a game, obstacle course, or activity that incorporates a Sphero robot. Write an accompanying program to control the robot.

Option B. Design an artistic pattern. Write a program to draw the pattern on a poster using the iRobot drawing robot.

Design Extension: Create a multi-player game that employs multiple Sphero robots in teams that oppose one another.

12. Electronic Circuits and Amplifiers *(optional) (April 7 / 9)*

In this optional activity, an electronic amplifier can be constructed to power a speaker. This final design activity in the series of weekly competencies introduces a new technology, soldering.

13. Final Project Development

The last two weeks of the semester are set aside for labs for development of final projects.

14. Final Project Development

15. Final Presentations *(April 28)*

Final presentations include presentation of a short two to three-minute video with highlights of the design process leading to the final design.

Curry Maker Lab

The advent of new fabrication technologies such as 3D printers and microelectronics gave rise to maker spaces in schools, libraries, and community centers. The current Curry School *Maker Lab* (Room 204 Ruffner Hall) was established through national and local grant support secured by Glen Bull and Joe Garofalo, co-directors of the *Make to Learn Laboratory*.

The structure and format of the *Design through Making* course is informed by an on-going collaboration between faculty and staff of the *Make to Learn Laboratory* and the Charlottesville City Schools. In 2013 the Charlottesville schools and the Curry School jointly established the Laboratory School for Advanced Manufacturing at Buford Middle School. Jointly developed activities piloted in the Lab School have been adapted for the *Design through Making* course.

The *Make to Learn Laboratory* anchors a national coalition of collaborators jointly exploring the field of maker education. Partners in the coalition include Princeton University, the Smithsonian Institution, and Midlands Technical College, among others. As new and emerging technologies are piloted and refined, they are incorporated into maker activities locally.

Instructors

The course has three instructors, each of whom have different roles.

- Sally (Luotong) Yao serves as coordinator of the Curry Maker Lab and provides oversight for on-going activities in the Maker Lab, including labs for the *Design through Making* course. Sally took the course as an undergraduate in Spring 2019. After graduation, she joined the *Make to Learn Laboratory* in Summer 2019, developing additional activities for the course throughout the summer. After entering graduate school in Fall 2019, she continued as coordinator of the *Maker Lab* and served as lead instructor for the *Design through Making* course, providing instruction for the activities that she developed.

- Jo Watts is the manager of the *Make to Learn Laboratory* (Room 203 Ruffner), coordinating on-going research and serving as liaison with collaborative partners at other institutions. Jo will serve as lead instructor for maker activities involving the hydraulic press such as jewelry making.

- Glen Bull is co-director of the *Make to Learn Laboratory*. In 1976 he collaborated with the chair of electrical engineering to develop the Curry School's first microcomputer and subsequently used it to teach the University's first educational computing course. He later collaborated with Virginia's Department of Education to develop the nation's first state-wide public school internet system, Virginia's Public Education Network (PEN), linking all 2,000 of Virginia's schools. His current work in maker education is an extension of prior work with new and emerging educational technologies. In that role, he provides oversight for the long-term direction of the Curry *Maker Lab* and the *Maker to Learn Laboratory*, including research into new and emerging maker technologies. He serves as principal investigator for grants that cover the cost of all materials and supplies for the *Design through Making* course for the Spring 2020 semester.

Assessment

Design through Making includes the following elements:

- 9 Weekly Projects
- 5 Quizzes
- 1 Midterm Project
- 1 Final Project

Weekly Projects (45 points)

Each weekly project introduces a maker technology and / or a design method. Weekly projects include two components: (1) the physical project and (2) project documentation. Project documentation should provide sufficient information to allow another person familiar with the project technologies to replicate the project.

Project Choice. Weekly projects are designed to develop competency with a range of maker technologies and design principles. There are an infinite number of maker projects that can be completed with any maker technology. To provide choice, an alternate project utilizing similar maker technologies and design principles can be proposed in place of any weekly competency. Alternate projects must be approved by Sally Yao prior to development.

Project Resubmission. Iteration and refinement are important elements of maker design. To encourage iteration and refinement, projects may be revised and resubmitted a second time if full credit is not awarded after the first submission.

Sally Yao and Jo Watts, co-instructors for the course, will independently evaluate each project based on the assessment criteria described below. The separate assessments by each co-instructor will be averaged to provide a final total for each weekly project.

- *Project Assessment* (0 to 3 points)

  3 Points – Exceeds expectations: incorporates additional functionality or demonstrates exceptional craftsmanship.

  2 Points – Meets expectations: demonstrates effective use of technology and design principles.

  1 Point – Fulfills some but not all expectations for the project, including use of technology, design principles, and basic craftsmanship.

  0 Points – Did not submit project

- *Documentation Assessment* (0 to 2 points)

  2 Points – A knowledgeable person could use the documentation to replicate the project.

  1 Point – Insufficient information provided to replicate the project.

  0 Points – Did not submit documentation

Due dates. All weekly projects are due at the beginning of class on the Tuesday after assignment of the project. One point will be deducted for late submission.

Quizzes (5 points)

A total of five quizzes will cover assigned readings. The quizzes will collectively be worth a total of five points.

Midterm Project (25 points)

Midterm projects demonstrate mastery of maker competencies, incorporating two or more technologies covered in the first half of the course. Examples of past projects are provided on the course web site.

All midterm projects must be approved by Sally Yao prior to development. The midterm project includes three components: the physical project, project documentation, and a video.

- Maker Project
- Documentation
- Video

The physical project and project documentation will be assessed using the same criteria as weekly projects. In addition, a third component of the midterm project involves development of a video. The video should document the process of making the project and its final outcome. Videos documenting midterm projects will be shared on the class web site.

Final Project (25 points)

The final project should demonstrate mastery of maker technologies and design principles across the entire span of the course. The final project involves the same components and assessment criteria as midterm projects.