CLASSNUM: **DIGITAL FABRICATION WITH ROBOTICS (2 credit)**

Room: MakerLab

Instructor: **Ian Roy**

Guest Instruction: **Hazal Uzunkaya, Tim Hebert**

Enrollment: Limit of 8.

Course dates: (seven 180-minute classes) Fall, 2018

Day/times:

Credits/Grading: 2 credit with letter grade

Required Reading: To be provided in class, as appropriate.

Course Overview

Digital fabrication methods are quickly changing the landscape of manufacturing worldwide. Access to cheap machines capable of rapidly producing high quality prototypes are spurring innovation across every industry that uses or makes physical stuff.

The goal of this course is for students to walk away with the ability to imagine a design and produce it in physical reality. Students will learn the fundamental underlying technologies in digital fabrication, 3D scanning, 3D design, and robotics. Through a combination of real world examples and hands on experiences, students will learn to take a design from concept to reality. There will be a focus on literacy of underlying technologies: how things work, what their limitations are, why they fail, and how to troubleshot or design around those limitations.

As part of the course, students will examine workflows to produce 3D designs from a variety of sources, and learn 3 avenues for having them physically produced. A variety of CAD and 3D modeling tools will be used. They will examine the inner workings of 3D printers and Robots and gain hands on understanding of the capacities and limitations of each.

Each student will assemble, calibrate, tune and operate a 3D printer from parts that they will take home at the end of the course. Each student will learn to solder and assemble an electronics kit. Each student will learn to operate the 3D printers and 3D scanners in the MakerLab and be certified to have swipe access for future use. This course will cover a lot of ground, and focus will be on digital literacy and understanding what is possible today and what the implications will be for tomorrow.

LEARNING GOALS

STUDENTS WILL:

1. LEARN THE UNDERLYING TECHNOLOGIES OF DIGITAL FABRICATION, 3D DESIGN, 3D SCANNING, AND ROBOTICS.
2. LEARN TO OPERATE 3D PRINTERS IN THE MAKERLAB AND UNDERSTAND THE LANDSCAPE OF POSSIBILITIES IN 3D PRINTING TODAY.
3. LEARN TO SOLDER AND UNDERSTAND BASIC ELECTRONICS LOGIC.
4. LEARN THE VARIOUS AVENUES FOR CREATING AND FABRICATING DIGITAL DESIGNS: FROM SELF-OPERATED, TO USING A LOCAL RESOURCE, TO THE ONLINE MARKETPLACE.
5. LEARN THE SIMILARITIES BETWEEN DIGITAL FABRICATION MACHINES AND ROBOTS.
6. LEARN TO ASSEMBLE, CALIBRATE, TUNE, AND OPERATE A 3D PRINTER FROM PARTS.
7. LEARN THE IMPLICAITONS OF DIGITAL DESIGN, DIGITIZATION, AND AUTOMATION ON OUR FUTURE.
8. BUILD LITERACY IN HOW TO APPLY A DESIGN MINDSET TO DEVELOP AN IDEA INTO A PHYSICAL PROTOTYPE - AND WHAT IT TAKES TO TAKE A PROTOTYPE TO PRODUCT.

Course Requirements

Each class will start with a full roll call and attendance of all sessions is mandatory.

Each student will be required to purchase a small 3D printer kit at a cost of $199 to participate in the course. In addition 2 books: "The 3D Printing Handbook: Technologies, design and applications" by Ben Redwood, Filemon Schoffer, and Brian Garret – and "Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution" by Liza Wallach Kloski and Nick Kloski.

As a 2 credit course, you should expect to spend 3 hours a week in class and additionally a minimum of 9 hours/week in preparation. Most work outside of class will be video based and require work with an online software platform. If students have laptops, they should bring them to class. If they do not have one, machines will be available in the MakerLab.

Grading

One third of the grade will be based on a student's contribution to class discussion and hands on workshops. One Third will be based on short in-class quizzes and short writing assignments every week based on the previous week's content and homework. The final third will be based on a final paper.

If a student has a documented disability on record at Brandeis University and wish to have a reasonable accommodation made for you in this class, please contact me immediately. Please keep in mind that reasonable accommodations are not provided retroactively.

Contact Information

Ian Roy: ianroy@brandeis.edu - Office Hours Tuesday 3-5pm in Farber2
Hazal Uzunkaya: hazalu@brandeis.edu **Tim Hebert:** thebert@brandeis.edu

Class 1: Ian Roy, Hazal Uzunkaya, Tim Hebert
Location: Gardner Jackson room

3D Printer unboxing and overview

- Each student will familiarize themselves with the parts of their 3D Printer kit
- Overview of Digital Fabrication & 3D Printing underlying technologies
- Overview of 3D Printing Workflow & Anatomy of a 3D Printer

3D Printer Assembly & Calibration

- Hands on assembly of a small 3D Printer
- Open Q&A and support through assembly process: 8 students, 3 instructors.

Homework

- Design Project #1: Download and remix a 3D design on Tinkercad
- Read Part 1: Applications of 3D Printing and Part 2: Hardware and Printing Choices (Page 1-114 in the MAKE: book)
- Prepare discussion questions and have 3D model ready to print

Class 2: Ian Roy
Location: Gardner Jackson room

QUIZ #1: 3D Printing Terminology

3D Printer: First Prints, intro to CAD & 3D Design

- 3D Printer test prints and calibration and CAD tools overview
- Students will learn slicing and print their first design project on their printers

Hands on 3D Scanning

- Students with 3D scan themselves and learn workflow for processing and cleaning 3D scans
- Students will begin the second design project: to remix a self-scans of themselves, add it to a downloaded element and draw something additional in CAD, and print the file on their 3D printers.

Homework

- Finish 3D selfie design project (Design Project #2)
- Read Part 3: CAD tutorials (page 119-213) in the MAKE: book

Class 3: Ian Roy
Location: MakerLab & Gardner Jackson Room

Introduction to Digital Fabrication and 3D Design (Part 1/2)

- 7 types of Traditional Machine Tools – basic history
- Digital Fabrication & 3D Printing underlying technologies
- 3D Scanning underlying technologies and applications
- How Robots Work
- The 5 avenues to design 3D content
- Binary to Physical / Analogue to Digital / Bits to atoms – design ethos and iteration

Spaces Tour

- MakerLab and Backroom tour with LaserCut and 3DPrinting demo

Homework

- Watch Wired Shenzhen Documentary (1h)
- Read chapters 1-8 : "3D Printing Technologies and Materials" in the 3D Hubs book

Class 4: Ian Roy and Hazal Uzunkaya
Location: MakerLab & Gardner Jackson

QUIZ #2 3D Printing Concepts

Introduktion to Digital Fabrication and 3D Design (Part 2/2)

MakerLab CreatorX Training

- Students will learn to operate CreatorX 3D printers and Simplify3D on the public printers the MakerLab
- Students will both 3D print their self-scans (2nd design project) in the MakerLab and send them off site to be 3D printed in color at Shapeways.
- All students will pass the MakerLab certification training in this session

Homework

- Read chapters 9-17 "Designing for 3D Printing" in the 3D Hubs Book

Class 5: Ian Roy and Tim Hebert
Location: Automation Lab & Gardner Jackson

Intro to Electronics and Soldering

- Intro to electronics Lecture
- Each student will learn the basics of soldering and assemble a small electronics kit.
- Lecture on Robotics, Computer Vision, and Automation

Robotics Demo

- Anatomy of a robot / Intro to control theory
- Hands on Robotics demo and tour of the Automation Lab

Homework

- Design Project #3: design something in CAD with an electrical component or that attaches to a digital device

Class 6: Ian Roy, Hazal Uzunkaya, Tim Hebert
Location: Gardner Jackson Room

QUIZ #3 Design and Fabrication Terminology and Concepts

3D Printer troubleshooting & advanced possibilities

- Intro to troubleshooting theory: Systemic Fault Isolation
- 3D Printer troubleshooting tactics: how do diagnose problems and what to do when things go wrong.
- Examples of common failures and their causes
- Open Q&A and support through troubleshooting process: 8 students, 3 instructors.

Homework

- Read part 4: “The Future” in the MAKE: book
- Watch Youtube playlist on design thinking and innovation mindsets (4 hours of talks from innovation leaders)

Class 7: Ian Roy
Location: Gardner Jackson Room

Tools and Mindsets for Innovation: How to Turn an Idea into a Product

- Different avenues for funding: Idea to prototype to pitch to funding to scale
- Overview of Elevator Pitch and How a Pitch Deck Works
- Project Case Studies: Local Brandeis Applications
- Brainstorm & open discussion

Design Thinking Exercise

- Students will complete a 1 hour design thinking exercise

Homework

- Final paper

FINAL PAPER (5-7 pages):
Digital fabrication methods are quickly changing the landscape of manufacturing worldwide. Access to cheap machines capable of rapidly producing high quality prototypes are spurring innovation across every industry that uses or makes physical stuff.

What is the most interesting implication or application you see for this technology in the future? How could you apply this to something in your career, or how will it influence the future of how people do business?

Approach a specific application - it could be anything from robot dogs, to consumer fabrication machines, to 3D printed organs, or simply design literacy - look into where the technology is today, describe how the underlying technology works, where it is going in the future, and what hurdles it has to overcome to get there.