

Spring Term
Undergraduate & Graduate Levels
4.501/4.511

Tiny Fab: **Applications in digital fabrication**

Prof. Larry Sass
Tuesday 9:00-12:00 AM
(2-3-7) Credits
Room - TBA

Introduction

The need for affordable housing throughout North America is a never-ending problem. This is especially the case with the growing need for replacement, rescue, and replenishment of housing. The greatest need, at the moment, is in rural and suburban environments. Labor shortage and low interest in the construction industry means we must discover new ways to deliver products. Digital fabrication and robotics offer many opportunities for digital design and delivery of affordable.

Questions of Computing

The learning objective of this class is computation. This subject must be addressed before we can ask more profound questions about AI. We want to learn how to generate information with the computer and manufacturing wooden houses with computer-controlled machines is possible. The core question is, "Can computers manufacture a house without human intervention?" The class will explore this question by designing and delivering an ADU with digital fabrication.

1-Design Modeling

Part One of the course will explore, document, and discuss the housing industry through the reconstruction of ADUs, Tiny Homes, and Huts. We will also examine the fundamentals of computation and design in class. These exercises will provide entry points toward a deeper understanding of surface, mesh & solid modeling, and machine control. You will learn to design, draw, model, and 3D print a small house.

2-Digital Fabrication in Detail

Part Two of the class will explore digital fabrication of an ADU in detail. We will fabricate full-scale (1:1) mockups of building sections using CNC technology. We will explore ways to compute and design building elements. We will first learn the fundamentals of building construction and design by building prototypical models. Then, we will build full-scale using the CNC machine and some traditional tools. Using a computer-controlled router, you will learn how to design and draw details, model materials, and digitally fabricate a building detail.

3-Design and Prototyping of an ADU

In the last third of the class, you will design and prototype an ADU for a specific site and client, applying the detailed information learned in the first half of the class. You will learn the full extent of home design within a particular context using advanced computational and fabrication techniques.

Who should take this course?

This course is designed for advanced course four undergraduates, MArch students in their first or second year of core.

Requirements

- Students must complete ten assignments, participate in class discussions and reviews, and share their design ideas.
- Limited to 10; Course 4 and 4B majors and Design and Architecture undergraduate minors are welcome.
- You must know 2D drafting, 3D Solid Modeling, laser cutting, and 3D printing.

Week 1 - Part 1

Tuesday, Feb 4

- Introduction to Design Fabrication
- Handout: Assignment 1 (Analysis in 2D-Handout)
- How to Draw
- In-Class-Drawing
- Designing Home

Week 2

Tuesday, Feb 11

- Assignment 1 (Analysis in 2D-Due)
- Assignment 2 (Analysis in 3D-Handout)
- Assignment 3 (Analysis 3D Printing-Handout)
- (4) How to Model
- In-Class-Modeling
- (5) Prefabrication

Week 3

Tuesday, Feb 18

No Class

Week 4

Tuesday, Feb 25

- Assignment 2 (Analysis in 3D-Due)
- Assignment 3 (Analysis 3D Printing-Due)
- Assignment 4 (ADU Functioning Handout)
- (6) How to Design Functioning
- In-Class-Design Functioning
- (7) Computation

Week 5 - Part 2

Tuesday, Mar 4

- Assignment 4 (ADU Functioning-Due)
- Assignment 5 (ADU Forming Handout)
- (8) How to Form
- In-Class-Forming
- (9) Manufacturing

Week 6

Tuesday, Mar 11

- Assignment 5 (ADU Forming-Due)
- Assignment 6 (Framing-Handout)
- (10) How to Frame
- In-Class-Framing
- (11) Digitally Fabricated Housing

Week 7

Tuesday, Mar 18

- Assignment 6 (ADU Framing & Finishing-Due)
- (12) Digital Finishing

Spring Break March 24-30

Week 8 - Part 3

Tuesday, Apr 1

- Assignment 7 (ADU-Mockup Design-Handout)

Week 9

Tuesday, Apr 8

- Assignment 7 (ADU-Mockup Design)
- Assignment 8 (ADU-Prototyping)

Week 10

Tuesday, Apr 15

- **No Class (Holiday)**

Week 11

Tuesday, Apr 22

- Assignment 8 (ADU-Prototyping)
- Assignment 9 (ADU-Full-Scale)

Week 12

Tuesday, Apr 29

- Assignment 9 (ADU-Full-Scale)
- Assignment 10 (ADU-Design Synthesis)

Week 13

Tuesday, May 13

- **Final Review**

Learning Objectives

- Small Building Design and Digital Delivery
- Advancing skills in 3D surface, mesh and solid modeling
- Lightweight building construction
- Mastery of CNC technologies

Instructional Material

Students are charged to learn design and computation as the system of production with each exercise. We follow a five-step process to solve a problem or task for each of the 10 exercises, leading to a functional chair at the end of the term. In each exercise, students learn a new method of modeling, rendering, or machining a chair. The five steps for each exercise and tool are listed below:

- a) *Assign a Problem:* A problem related to one aspect of designing a chair is presented, for example, how a chair should be designed structurally to support a person.
- b) *Review:* We reviewed a variety of existing chairs as a way to learn how three- and four-legged chairs are supported.
- c) *Demonstration:* I demonstrate how to draw, model, render, or fabricate a structurally sound chair in class; for each class, they can download and copy a 3D model that I post on the class site in order to guide them through the process. Class.
- d) *Homework:* Students are provided with instruction through steps and manuals. Tools for homework are graphical manuals with steps, animations, and links to Youtube in support of CAD modeling & technical methods.

Grading

- Quality of design products
- Completion of 9 Exercises and the (10) Final Project
- Time to complete assignments & attendance.

Assignments

- Final grading is an average of the Exercises + Final Project

Course Fee

- All students will be charged a fee for materials.
- \$100

Course Information

- Tuesday 9:00-12:00 AM PST
- Larry's Office Hours by Email lsass@mit.edu

Class Norms

- Class Notes found on Canvas.
- Attendance
- No Zoom

Class Project

- Tiny Home Design

What will you learn?

- Design Processing - Steps in Production, Principles & Presentation
- 3D Modeling - Surface, Solid & Mesh
- Macro/Micro Design and Detailing with CNC Fabrication

How will you learn?

- Learn by repetition.
- Learn by doing in class - We work in class during Lectures and Lab. They are the same
- Short Assignments - A new assignment is due every week (mostly)

Grades

- Completion of all 10 assignments is needed.
- Assignments are graded as 100, 90, 80 or incomplete.
- Class Admin
- The course is 12 Units.
 - 2 Hours Lecture
 - 2 Hours Lab
 - 8 Hour Assignment