Spring Term
Undergraduate & Graduate Levels
4.501

Tiny Fab:
Applications in digital fabrication

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

Introduction

Through making, we will explore next-generation design and construction of a single structure through digital production. We reason through design for physical products manufactured using 3D printing, laser cutting, and CNC machining.

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

Questions of Computing

The learning objective of this class is design through computational and making, a subject that must be addressed before we can ask more profound questions about AI. The core question in the course is, "Can computers design and manufacture a house without human intervention?" The class will explore this question by designing and fabricating an ADU using digital fabrication techniques.

Part 1-Digital Design of Housing

First, we 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 in three exercises. Through these exercises, you will learn to design, draw (1), 3D model (2), and 3D print (3) a small house.

Part 2-Designing an ADU

You will design and prototype an ADU (Accessory Dwelling Unit) for a specific site and client, applying the detailed information learned in part one. We use the Double Diamond design stages to develop our initial proposal. This is a four-stage approach to exploring design, allowing us to converge on a specific design idea. We will learn product discovery by physical testing.

Part 3-Digital Design in Detail

This final part of the class examines a section of the design as a physical detail and as an assembly of fabricated components. We will first learn the fundamentals of building construction and design by building prototypical models. Projects range from desktop models with innovative rain screens to novel building components.

Who should take this course?

This course is designed for advanced undergraduates in course four.

Requirements
Students are expected to complete ten assignments, participate in class discussions and reviews, and share their design ideas.

- Limited to 12; Course 4 and 4B majors and Design and Architecture undergraduate minors are welcome.
- You are expected to 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, Feb11

- 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

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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