**FABLAB O SHANGHAI “FABO ACADEMY X CHINA”**

Fablab O Shanghai “Fabo Academy X China”, is a digital manufacturing and rapid prototyping course based on MIT’s “How To Make (Almost) Anything” class (MAS.863/4.140/6.943) and Fab Foundation’s “Fab Academy” global. The course is an overview of the tools and practices commonly used in any Fablab, with a focus on design, project development and documentation.

**COURSE CONTENTS**

The course is divided in two parts. The first one is focused on the tools and workflows of the Fablab: 3D scanning, electronic design and programming, basics of 2D sketching and 3D Modeling software, training on laser cutting and 3D printing. This first phase is important to learn the constraints and best practices to design objects for digital fabrication tools. Get used to move from design to prototype and back for improvements. Understand how the machines work, what they are used for and what are the materials available, how to adapt the design process to the machine or technique used. Also, production and programming techniques for electronics will be introduced.

**DESIGN THINKING**

Throughout the class, students will be introduced to Design Thinking techniques. First they will conduct a research about the field their product will live in, collect data and informations, interpret the research material through visual storytelling and ideate a final project proposal. At this point they will experience how rapid prototyping works, by moving many times back and forth in both the design and fabrication stage. Design Thinking will be a short module (30 minutes) during the lecture of week 2, 3 and 5.

**MODULE 1: DESIGN FOR FABRICATION**

2D CAD software, design and Laser Cut a modular construction kit.

3D Modeling software, design and 3D Print something that can only be 3D printed.

Programming: add Input & Output devices to your PCB.

Electronics: build a system to control a 2 axis machine with an actuator.

3D Scanning: scan, modify, print and animate yourself.

In the second part of the course, all the technical and practical skills studied will be applied to the design and fabrication of a small device. At first the students discuss a final project proposal with input and output capabilities using design thinking techniques. The prototyping phase make use of project development and documentation tools, to record and publish the process, experiment results, design, code and all the material related to the final project. In the end, each student present the final project to the class.

**MODULE 2: PRODUCT DEVELOPMENT**

Final Project: design and manufacture an interactive storytelling object. (Part 1)

Final Project: design and manufacture an interactive storytelling object. (Part 2)

Final Documentation & Presentation.

**FINAL PROJECT BRIEF: MAKING AN “INTERACTIVE STORYTELLING OBJECT”.**

The theme for the final project start with a *simple* question: “who am I?”. Each student will design and fabricate an object to describe an aspect of their life, their personality, or something peculiar about themselves. This object should be able to “tell a story” about its creator using shapes, images, sounds, colors, lights, movements, while interacting with the viewer or user.

**COURSE STRUCTURE**

The principal for teaching is hands-on learning: keeping the theory short but dense before continuing on practical applications. Each student is required to bring his own laptop, in good working order, **with a mouse** and basic software installed.

*Course Length*: 1 day/week, 7 days in total + 1 day for presentation of the final projects.

*On Class Hours*: 3 classes (50 min) each day.

*Off Class Exercise Hours*: 3+.

**CLASS SCHEDULE**

*15 min - Review*: Review of past week’s assignments.

*35 min - Theory Lecture*: Video/Slide Presentation.

*10 min - Break.*

*50 min + 35 min (+10 min Break) - Practical Lecture*: Machine Training, Practical Application, Software Demonstration.

*15 min - Assignment*: Overview of the weekly assignment.

## **MODULE 1****:** **DESIGN FOR FABRICATION**

A broad view on digital manufacturing techniques using 3D scanning, electronic design and programming, basics of 2D sketching and 3D Modeling software, training on laser cutting and 3D printing. Learn the constraints and best practices to design objects for digital fabrication tools. Get used to move from design to prototype and back for improvements.

## Understanding how the machines work, what they are used for and what are the materials available, how to adapt the design process to the machine or technique used. Introducing production and programming techniques for electronics.

**CLASS 1. 2D CAD SOFTWARE, DESIGN AND LASER CUT A MODULAR CONSTRUCTION KIT.**

## Introduction to the basic commands of 2D CAD sketching. Learning key concepts of designing 2D objects and understand the possibilities and limitations of laser cutting.

## 

**Assignment:**

1. Design a modular (parametric) construction kit with engraved and scored element.
2. Cut 2 modules and analyze them. Modify the design, cut an improved version.
3. Laser cut 10/20 modules and assemble them without using glue.

## **Learning outcomes:**

* Learn the basic commands of 2D CAD software.
* Know what kerf is and how to compensate for it in the design.
* Learn how to safely and efficiently use the Laser Cutter and the stock material.

## **Software:** Fusion 360

## **Device:** Laser Cutter

**CLASS 2. 3D MODELING SOFTWARE, DESIGN AND 3D PRINT SOMETHING THAT CAN ONLY BE 3D PRINTED.**

An introduction to the basic commands of a 3D modeling software and to the different 3D printing technologies. Learn the limitations of what can be printed and the workflow going from design to print. Analyze and debug printer errors. Design thinking, quickly going from idea to design to 3D printed prototype and then back to design.

**Assignment:**

1. Design a small 3D model and use it for testing the printer and its design rules.
2. Design and print something that could not be made subtractively.
3. Analyze your print and modify the model, print an improved version.

## 

## **Learning outcomes:**

* Learn the basic operations of 3D Modeling software.
* Learn the toolchain and workflow for 3D printing.
* Identify and solve printer errors.
* Apply design thinking to rapid prototyping.

## **Software:** Fusion 360, Slicer software

## **Device:** 3D Printer

**CLASS 3. PROGRAMMING MICROCONTROLLERS WITH INPUT & OUTPUT.**

## Learning how analog and digital ports work and how to add Input and Output (I/O) devices to a microcontroller. Make a prototype circuit using the Arduino platform and I/O devices, write or modify a program and test it.

**Assignment:**

1. Test and use many different electronic components.
2. Use the Arduino IDE to write or modify a program with I/O devices.
3. Assemble your circuit on a breadboard and test it.

## 

## **Learning outcomes:**

* Analyze a question and prototype a solution.
* Conduct simultaneous hardware and software development.

## Work with electronic components on the breadboard.

## **Software:** Arduino IDE

## **Devices:** Arduino, electronic components.

**CLASS 4. ELECTRONICS: BUILD A SYSTEM TO CONTROL A 2 AXIS MACHINE WITH AN ACTUATOR.**

## Learning how to generate, use and send Gcode to control a 2 axis stepper motor device with Arduino and A4988 stepper drivers and a servo motor actuator.

**Assignment:**

1. Assemble a 2 axis stepper motor device with an actuator.
2. Assemble the electronic control and power supply.
3. Generate gcode and operate the device with a control application.

## **Learning outcomes:**

* Understand the components of a machine.
* Learn how to create, read and modify Gcode.

## Control, test, debug, modify, automate machine operations.

## **Software:** Arduino IDE, Universal Gcode Sender

## **Devices:** Machine Kit

**CLASS 5. 3D SCANNING: SCAN, MODIFY, PRINT AND ANIMATE YOURSELF**

Learn how to digitize the physical world using the 3D scanner. Learn how to modify and repair a 3D scan model. Practice more on a 3D Modeling software and use it to modify the file. Add a servo motor to your model, print it and make one part move!

**Assignment:**

## Scan yourself with a 3D Scanner and repair the mesh.

## Modify the model and add a servo motor for a moving part.

## Print the model and check the result.

## **Learning outcomes:**

* Understand the advantages and limitations of 3D Scanning.
* Learn the basic operations of 3D Modeling software.
* Understand the difference between mesh and NURBS polysurface.
* Experience system integration.

## **Software:** Fusion 360, Slicer software, Skanect, Meshmixer

## **Device:** 3D Scanner, 3D Printer

**MODULE 2: PRODUCT DEVELOPMENT**

Discuss with the class a final project proposal with input and output capabilities using design thinking techniques. Make a prototype of the final project, write or modify a program to make it work. Complete the documentation and present the final project to the class.

**CLASS 6/7. FINAL PROJECT: DESIGN AND MANUFACTURE A PROTOTYPE.**

## Design and fabricate a final product that integrates electronics, functions and shapes. Learn the basic of spiral development. Use as many techniques learnt: 3d printing, 3D scanning, laser cutting, electronics, programming.

**Assignment:**

1. Test the electronic circuit and the program.
2. Design and fabricate all the parts of your project.
3. Assemble your project, test it, modify, improve (use spiral development).

## 

## **Learning outcomes:**

* Understand system integration, materials and processes needed.

## Manage time, break down development in simple tasks, iterate, add features.

* Solve problems and deliver solutions in a short amount of time.

**FINAL DOCUMENTATION & PRESENTATION.**

## Finish the final project and upload the documentation online. Review your work and present your website and your project to the class.

**Assignment:**

1. Complete all the work and the documentation.
2. Present your work to the class.

## **Learning outcomes:**

* Be able to talk in public and make an effective exposition of the work.