General Information

This course is the lab part of EDUC 236/CS402 (Beyond Bits and Atoms: Creative technologies for off/online learning). Both courses should be taken together.

School of Education EDUC 211 - School of Engineering CS 402L

Fall 2012, 1-3 units, Friday, 2:15pm - 5:05pm, Learning Fabrication Lab, CERAS room 102

Teaching team

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Assistant Professor of Education and (by courtesy) Computer Science
Director, Transformative Learning Technologies Lab and Stanford Makers’ Club
Lead TA: Shima Salehi (we’ll have 4 TAs in total)

Course Web Site & email lists

http://beyondbitsandatoms.stanford.edu

Email list for course instructors: bbafaculty@lists.stanford.edu
Email list for all course members (students and faculty): bba-fall2012@lists.stanford.edu

Course Description

This course is a hands-on “makers” lab for prototyping tangible technologies, with a special focus on learning and education. We will learn how to use state-of-the-art fabrication machines (3D printers, 3D scanners, laser cutters, sensors, polymer casting) to design educational toolkits, educational toys, and tangible user interfaces. A special focus of the course will be to reinvent the “offline” side of online learning: designing hands-on toolkits, wet-labs, and tangible interfaces, that could be used in conjunction with Massive Open Online Courses (MOOCs). We also focus on low-cost, appropriate technologies, particularly for urban school in the US and in developing countries.
After completing this course, you should be able to:

- Design objects and products using tools such as 3D printers, and laser cutters.
- Design and prototype educational toolkits for science, math, robotics, environmental sensing, and data-logging, as well as interactive toys.
- Design hardware at the prototype level.
- Evaluate existing educational products as for their fabrication techniques, and design quality within their target audience, content domain and deployment plan.

I can’t program or do anything technical. Should I enroll?

No previous programming, prototyping, or technology background is assumed. Even if you have never programmed in your life, you can still enroll!

This class is a good fit for people both with and without a technical background. Students with a programming or engineering background will learn how to use their skills to design meaningful tools for learning, and students with a learning sciences or psychology background will learn how to make their ideas come to life—a toy, a piece of software, or a tangible human-computer interface.

The class is structured for non-engineers to succeed. However, prototyping does take time, just like any other new skill. You are strongly encouraged to get help from your fellow students through the class email list as well as from the TA, who will hold weekly office hours designed especially for technical and programming support. We will attempt to schedule these office hours flexibly, and per special requests. In general, each class will be devoted to a particular technology, and the two last weeks will be used for the final projects.

What the deal with taking this together with EDUC 236/CS402?

This course is the lab part of EDUC 236/CS402 (“Beyond Bits and Atoms: Creative technologies for off/online learning”). Both courses should be taken together. Under very special circumstances, we allow people not to do so, but we need to discuss it before the first day of class. **Note that they are two separate classes with their own workload, so expect to work as much as you would for TWO CLASSES.**
Final Project

The final project is connected to the BBA class session. The final project is to design and implement a constructionist learning environment. There are (at least) three alternatives for this project. Typically, the final project is a toolkit (in particular, low-cost toolkits). **Toolkits can have both software and hardware – think of them as Lego on steroids.** They can also have physical and virtual elements connected in real time – so think of your toolkit as a radically multi-material, transmedia product.

Examples of a toolkit are a robotics kit, a science kit, an environmental investigation kit, a construction kit for physics, a storytelling environment, a kit for history or social science, etc. In particular, this year we will focus also on toolkit that could be connected to MOOCs, in other words, tangible kits that could be used by students going through an online course.

The first step involves writing a design specification for the toolkit that describes what it is for, who it serves, why it is needed. Subsequent to receiving feedback, you will write a functional specification: components that the toolkit will have, technologies will you use to create it, cost/fabrication issues, examples of projects that students can create with it, and what learning outcomes are expected. You are free to use any authoring tools and prototyping machines: Microworlds Logo, Scratch, GoGo Boards, NetLogo, Arduinos, iPhone/Android development platform, 3D printers, laser cutters, etc.

**Final projects in this class have become real products – so expect to make a real difference in the world with yours!**

Summary of Requirements

This course is a hands-on design lab, so the main activity will be to build projects using the available machines, and reflect about design principles. The requirements for everyone are:

- Set up your personal username on the course’s blog, and keep a media-rich log of your projects.
- Attend the lab sessions and complete the lab assignments.
- Review one product and present your review in class.
- Design and implement your final project, and present during the last week of the course.
Can I miss a class?

Due to the project-based nature of the class, and the number of group projects, attendance is very important. If you have a very good justification and email us in advance, you can miss up to one class. If you already know you will miss more than one class, you should not enroll.

Schedule

<table>
<thead>
<tr>
<th>Class</th>
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<tbody>
<tr>
<td>Class 1</td>
<td>Laser cutting/Vinyl cutter/Intro to Vector Drawing</td>
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<tr>
<td>Class 2</td>
<td>Robotics/GoGo Boards/Arduino</td>
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<tr>
<td>Class 3</td>
<td>3D modeling/3D printing</td>
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<tr>
<td>Class 4</td>
<td>Polymer casting/Vacuum forming</td>
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<tr>
<td>Class 5</td>
<td>Electronics textiles/jewelry</td>
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<td>Class 6</td>
<td>Sensor and basic electronics, reusing broken stuff</td>
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<td>Class 7</td>
<td>Haptics – remote control and feedback for physical devices</td>
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<td>Class 8</td>
<td>Biology-do-it-yourself: create your own organisms, and microfluidics.</td>
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<tr>
<td>Class 9</td>
<td>PIC, AVR, microcontroller programming</td>
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<tr>
<td>Class 10</td>
<td>Presentations</td>
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Grading

In grading the assignments, we will initially take into consideration students’ background – i.e., students with no technical background will be evaluated taking into consideration their extra effort.

All assignments will be graded as incomplete or complete. If an assignment is judged incomplete, you will have an opportunity to complete it or redo it the following week.

The grading will be 50% based on the final project, 30% based on the assignments, and 20% on class participation and overall effort.
Readings

Since this is a lab class, not much reading are required. Most of them are short papers with descriptions of cool new technologies, or papers about design and prototyping. We will choose 3 or 4 of the following papers (for the entire quarter), on top of the online documentation for the machines.

- Selections from the Interaction Design for Children Conference.
- Documentation about the machines: Epilog Laser cutter, Z-Corp 3D printer, Modela 3D scanner, and vinyl cutter.

Assignments (further details will be given each week)

- **Hardware, toy, or interface review**: an in-depth review of educational hardware or toy. A list of qualified items will be given in class. Students are expected to present their review to the class.
- **Lab mini-project 1**: Laser Cutter: laser cutting weird materials
- **Lab mini-project 2**: 3D Modeling/3D Printing
- **Lab mini-project 3**: Hacking/copying objects: Polymer casting/Vacuum forming
- **Lab mini-project 4**: Designing for real kids
- **Lab mini-project 5**: Sensors with the GoGo Board/Arduinos
- **Lab mini-project 6**: Rube Goldberg Machine: robotics/microcontrollers
- **Lab mini-project 7**: Designing an educational toolkit
Lab Fee

- **Why a lab fee?** Charging a lab fee is the typical policy in lab courses at Stanford and other schools. The lab fee ($95) will be used to buy shared materials use during lab sessions, including basic maintenance, and one microcontroller kit for each student. We will have a limited supply of acrylic, wood, 3D printer powder & binder, sensors, motors, and robotics stuff. The lab fee is not meant to support final projects, though student are welcome to use leftover materials from the appropriate bins. If students want to use materials that go above and beyond what the lab fee covers, they should be ordered directly, or reimbursed/replaced to the lab.

- **Can I buy the materials myself and not pay the lab fee?** No. We have tried it and it doesn’t work at all. Some materials can only be bought in bulk (such as 3D printer powder), and it is impossible to control individualized materials in the lab.

- **The lab fee is due on week 3.** Please write a check to Stanford University.