

Beyond Bits and Atoms Lab

Fabrication and Physical Computing for Education

Prof. Paulo Blikstein

General Information

School of Education EDUC 211X

School of Engineering CS 402L

Spring 2011, 1-3 units, Friday, 2:15pm - 5:05pm

Learning Fabrication Lab, CERAS Building, 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

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Office hours: Tuesday, 4-5:45pm (CERAS 102 or 232)

TA: TBD

Course Web Site & email lists

<http://beyondbitsandatoms.stanford.edu>

Email list for course instructors: bbalabfaculty@lists.stanford.edu

Email list for all course members (students and faculty): bbalabsp2011@lists.stanford.edu

Course Description

This course is a hands-on “makers” lab for prototyping and fabrication of 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, routers, sensors, polymer casting, robotics) to design educational toolkits, educational toys, science kits, and tangible user interfaces. A special focus of the course will be to design low-cost, appropriate technologies, in the US and abroad.

After completing this course, you should be able to:

- Design and prototype objects and products using tools such as 3D printers, laser cutters, and routers.
- Design and prototype educational toolkits for science, math, robotics, environmental sensing, and data-logging, as well as interactive toys.
- Design simple 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.
- *Maybe we will also (collectively) build an open source 3D printer!*

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. Some very light reading will be suggested – typically 3 or 4 papers for the entire course, on top of documentation for particular machines.

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 blog for the course, 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

Class	Class
Class 1	Laser cutting/Vinyl cutter
Class 2	Robotics/GoGo Boards
Class 3	3D modeling / 3D printing
Class 4	Polymer casting/Vacuum forming
Class 5	Electronics textiles/jewelry
Class 6	Sensor and basic electronics, reusing broken stuff
Class 7	3D scanning/milling
Class 8	Making printed circuit boards/Fritzing/ Arduinos
Class 9	Netduino, Propeller, PIC, AVR, microcontroller programming
Class 10	Presentations

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 many readings 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.

- Papert, S. (1980) *Mindstorms*. Basic Books, NY.
- Resnick, M. et al. (1998) *Digital Manipulatives: New Toys to Think With*. CHI 98.
- Eisenberg, M. (2002). Output Devices, Computation, and the Future of Mathematical Crafts. *International Journal of Computers for Mathematical Learning*, 7(1), 1-43.
- Eisenberg, M. (2003). *Mindstuff: Educational Technology Beyond the Computer*. Convergence.
- Eisenberg, M. (2007). *Pervasive Fabrication: Making Construction Ubiquitous in Education*. Fifth Annual IEEE International Conference on Pervasive Computing and Communications Workshops.
- Raffle, H. (2004). *Topobo for Tangible Learning*.
- Selections from the *Interaction Design for Children Conference*.
- Selection from *Physical Computing*.
- *GoGo Board Documentation*.
- 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
- **Lab mini-project 6:** Rube Goldberg Machine: robotics/microcontrollers
- **Lab mini-project 7:** Designing a toolkit for SLATE.

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.