

Engineering Student Technology Committee

<http://www.engr.colostate.edu/ESTC>

**College of Engineering
Colorado State University**

1. Title of Proposal: Lab Experience for Senior Design students

2. Proposal Participants:

Primary Contact for Proposal

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Department/Major: Electrical and Computer Engineering

Circle One: Undergraduate Student Graduate Student Faculty Staff

Additional proposal participants

Name: **Anthony (Tony) Maciejewski** _____ E-Mail: aam@colostate.edu

Department/Major: Electrical and Computer Engineering

Circle One: Undergraduate Student Graduate Student Faculty Staff

3. Proposal Abstract:

This ESTC proposal requests funds for the acquisition of equipment for PCB prototyping and 3D printing stations for all students involved in the ECE Senior Design program. Historically, ECE senior design projects have engaged students from electrical engineering, computer engineering, mechanical engineering, chemical and biological engineering and computer science, in the order of percentage of students. The aim of this proposal is to allow students to follow current trends in PCB manufacturing and 3D printing, making them more valuable for potential employers. If funded, this equipment will allow students to (1) stay current with the new technologies, (2) create prototypes much faster, without the need to send items out for manufacturing, (3) work together on different aspects of the project right here, on-campus and (3) become more marketable in the demanding job market. This ESTC project, if funded, will strongly and directly enhance educational goals and learning experience of every student working on ECE senior design projects, whether being engaged as senior design student, independent study student, or just an enthusiast helping with a project.

4. Proposal Budget

List of items to be purchased with CFT funds and cost:

Equipment	Price
PCB prototyping printer by Voltera https://www.youtube.com/watch?v=5YMJrhG6Aos	\$2,200
Compact PCB prototyping/etching machine http://www.carving-cnc.com/cnc-x4800-series/cnc-x4800usb-router-engraver-drilling-and-milling-machine.html	\$1,800
Drill setup http://www.amazon.com/WEN-4208-8-Inch-Speed-Drill/dp/B00HQONFVE/ref=sr_1_1?s=hi&ie=UTF8&qid=1426712487&sr=1-1&keywords=benchtop+drill+press	\$80
Assorted drill bits, engraver bits and end mills	\$50
LulzBot TAZ 5 3D Printer https://www.lulzbot.com/products/lulzbot-taz-5-3d-printer	\$1,650
Dual Extruder Tool Head https://www.lulzbot.com/products/lulzbot-taz-dual-extruder-tool-head	\$375
FlexyDually Tool Head https://www.lulzbot.com/products/lulzbot-taz-flexydually-tool-head	\$375
Miscellaneous Add-Ons for 3D printer	\$300
Total requested funding:	\$6,830

Dollar or percentage amount requested from ESTC:

We are requesting \$6,830, or 62% of the total budget.

Dollar or percentage amount(s) to be provided by other fund(s):

The remaining 38% of the equipment will be provided by the ECE Department or donated as listed below:

- ECE Department will participate in this proposal by providing desktop computers needed for this equipment setup, miscellaneous parts for the LulzBot clone and parts for connecting the donated 3D printer suite. Please see full description below. Estimated value is around \$1,200.
- Rocketship Systems Inc. (Coby Leuschke, coby@rocketshipsys.com) will donate parts for one more 3D printer suite. Please see full description below. Estimated value is \$3,000.

5. Full description of proposal:

This proposal requests CFT funds for the acquisition of equipment to comprehensively support and dramatically improve teaching and learning effectiveness and impact in senior design program not just of Electrical and Computer engineering students, but students of other majors that choose to join ECE senior design projects. This equipment will equally be used by ECE students that are working on senior design projects in other departments. As an example, over the past several years, ECE senior design projects have engaged students from following majors: electrical engineering, computer engineering, mechanical engineering, chemical and biological engineering and computer science, and a number of independent study students, in the order of percentage. To provide you with a better idea, this year's projects are engaging 12% ME students and 3% independent study students; 5% of ECE senior design students are working on mechanical engineering senior design projects.

The goal of this project is to make new technologies available to all of the above groups of students in the environment accessible to senior design students 24/7. This would mean that all students engaged on the above mentioned projects will have unlimited access to the PCB prototyping and 3D printing stations. By doing so, we would allow students to work together on all aspects of the project, and not just separate in smaller sub-groups, prepare codes or layouts and send them out for manufacturing. Students will have to go through all phases of the project from the beginning to the end, including the manufacturing process and procedures that go along with it.

Choosing the correct type of PCB layout technique (printing vs. etching) and the correct type of 3D printer that will be available will require that students go through the decision-making process related to manufacturing: how precise they want their product vs. the technologies, vs. the price and material availability. By having this equipment on-hand, students will work together to manufacture parts, they will have all testing equipment available in the same lab and be able to re-design and re-test their product quickly without having to wait long times between different phases. Having equipment available will allow them to make prototypes much earlier in the design process, instead of waiting to make sure that it will work before sending it out and paying an outside company to do part of the job.

Partners in this project are ESTC, ECE Department and Rocketship Systems Inc., as outlined in the following paragraph.

Realizing the need for the lab that will be available to senior design students 24/7, ECE Department has dedicated C11 in the basement of the Engineering Building as The ECE Senior Design Lab. Department has worked over the past year to setup four testing stations commonly available to students in C105 and C107 (which are closed during evening and weekend hours). After making this lab space accessible at all times, students have started spending more time in this lab, designing and testing their products. Department has setup four computer stations and soldering station, a total estimated value of \$29,950. During last academic year, department has received multiple donations totaling around \$55,000 in highly specialized test equipment and miscellaneous small components that are available free-of-charge for project use.

This Senior Design Lab has become a space that students feel as their own, available at all times, closed for their group and secure, such that most of the teams have decided to store their projects in the Lab, and not carry them around.

Currently, Lab has enough resources for computer programming, PCB layout, soldering and testing. With this proposal, we hope to bring even higher educational value to this Lab, by providing students with enough equipment to manufacture PCB boards and 3D print designs.

The proposed PCB manufacturing and 3D printing addition to the C11 Lab consists of:

- One PCB printer that would be used for creating PCB's for low-current applications, purchased with CFT funds.
- One compact etching machine that would be used to create general-purpose PCB's, and complete additional smaller etching tasks, purchased with CFT funds.
- Drill station to be used to create holes for component mounting and smaller holes needed

- for the hardware assembly (for screws, connectors, etc.), purchased with CFT funds.
- CubeX Duo 3D printer, UltiMachine RAMBoV1.3 Arduino-based controller, spare extruders, spare heads and multiple boxes of CubeX PLA material cartridges, donated by Rocketship Systems, Inc. This donation will come in parts; printer will not have heating bed installed.
- LulzBot 3D printer, purchased with CFT funds that will be available for immediate use.
- Two desktop computers needed for design and controls of the PCB manufacturing and 3D printing stations, purchased with the ECE Department funding.
- If currently available PCB layout software proves not to be sufficient, Department has committed to purchase a better version for students' use.

While choosing PCB manufacturing equipment, all care has been taken to propose purchase of the safe equipment that does not use dangerous chemicals and requires minimal training.

Donated CubeX Duo and RAMBoV1.4 will be donated as parts, so our department is planning to propose a **student project next year** which will engage electrical, computer and mechanical engineering students and one computer science student. This team will have a task of setting the equipment, creating CSU's own open-source software to run the whole equipment suite. This software should be easy to operate, user-friendly, self-explanatory, and might be shared with other departments on campus that could benefit from it. The idea of remotely accessing 3D printers and PBC machines is another option that student team will be asked to consider and any funding needed to make this part of the project possible will be provided by the ECE Department. LulzBot 3D printers have the option to print their own clone of somewhat smaller size, so the additional task for this student team will be to create a second printer. ECE Department has committed to secure funding for parts that need to be purchased to complete the clone.

As explained, this proposed ESTC project will directly and substantially benefit education of undergraduate students in the College of Engineering. The list of requested laboratory equipment and computers is in compliance with the allowable expenditures described in the CFT manual.