

## Entrepreneurial Training for REU Students

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### Abstract

An innovative Research Experience for Undergraduates (REU) program gave engineering undergraduates an opportunity to improve their technical and professional skills while experiencing entrepreneurship firsthand. The unique learning experience embedded a six-week entrepreneurship training into the 10-week REU program to broaden learning outcomes. On questionnaires administered before and after the program, students rated their knowledge about (1) developing a business model and (2) turning a research or technology idea into something marketable higher on the post-test than on the pre-test. In spite of this increase in knowledge, students expressed some level of dissatisfaction. In response to open-ended questions and in a focus group discussion, students offered suggestions for increasing satisfaction with the contribution of the entrepreneurial program, Crimson Startup, to the research experience. We plan to improve the training and tailor it specifically to enhance the experience for REU students.

### Keywords

Undergraduate research, entrepreneurship training, I-Corps™ Site

### Introduction

Undergraduate involvement in research is considered to be one of several high-impact practices for enhancing student success.<sup>1,2</sup> In addition, undergraduate research has been useful in promoting collaborative interdisciplinary research efforts,<sup>3</sup> raising awareness of the societal context of research,<sup>4</sup> engaging underrepresented students,<sup>5</sup> and improving graduate student recruitment.<sup>6</sup> The research theme for the REU Site was renewable resources to engage students in an area with potential for broad impact. Our focus was on projects incorporating bamboo for engineering applications. Until recently, the possibility of farming bamboo as a crop in the U.S. was not possible because of a lack of an economical supply of juvenile plants to establish large bamboo groves. Scientific breakthroughs now allow for rapidly propagating bamboo through tissue culture processes.<sup>7</sup> The Black Belt, a region in Alabama and Mississippi characterized by dark fertile soil, is well-suited for cultivating temperate species of bamboo; Alabama has been targeted for industrial-scale cultivation and finding uses for this material has potential to benefit this economically-challenged part of the state. Moreover, the soil is heavily depleted from cotton farming in the 19<sup>th</sup> century, so there are few options for farming in this region. Since 2010, The University of Alabama (UA) has become a bamboo launch pad for leaders in multidisciplinary research collaboration, education, and the community at large. It has created unique

opportunities for partnerships in order to promote scientific discoveries that will lead to the creation of new applications and industries.

Economic growth is driven by innovation, high-tech employment, and new businesses; such is the case for the Black Belt region.<sup>8</sup> To bolster innovation in the region and complement the focus on bamboo, we explored translation of research into products and processes that benefit society and the economy. An entrepreneurship curriculum based on NSF’s Innovation Corps™ (I-Corps) program helped engineering students to identify product opportunities that might emerge from their bamboo-related research. This has the potential to increase economic growth and broadens students’ perspectives about societal impact of their research.

**Program**

UA hosted 10 undergraduates in a NSF REU program in 2016. Faculty-mentored projects allowed students to collaborate on socially-relevant problems; 60% were from groups underrepresented in engineering (female, Hispanic) and 40% were from institutions with limited research opportunities (lacking graduate programs). By conducting research, students improved their technical and professional skills. In addition, the REU students participated in a modified version of our UA I-Corps Site program to learn how to rapidly test business hypotheses. More than 100 teams have participated in the program, Crimson Startup,<sup>10</sup> since 2013. The most successful teams spend 10-20 hours per week with potential customers and program coaches.

I-Corps™ curriculum is based on Lean Launchpad®,<sup>9</sup> a program integrating experiential learning and feedback to improve student understanding of entrepreneurship, was adapted to accommodate REU students. Students gathered information through conversations with potential customers (at least 10 per week) to try and determine what the market truly values. The 10 REU students formed three multi-disciplinary teams to explore a bamboo product concept. They joined a cohort of 28 other participants who met weekly to exchange ideas and lessons learned. A template for the weekly presentations provided a uniform basis for team engagement. Six UA I-Corps™ Site coaches and the REU PI and/or Co-PI attended the weekly meetings. Coaches were available to help guide teams through the customer discovery process. The cohort explored viable business models that were adapted each week as they talked to more and more potential customers. At the end of the program, students created videos describing their product ideas and announced their decision about moving forward with their product concept or not.

**Assessment**

The REU students completed anonymous online surveys at the beginning, beginning (pre survey), middle, and end (post survey) of their summer REU experience. They also participated in a focus group discussion at the end of the summer. Two items on the pre and post surveys addressed outcomes related to knowledge gains in the Crimson Startup program, and one item on the post survey assessed overall satisfaction with the program. Although they clearly made some knowledge gains, the REU students were not satisfied overall with the Crimson Canvas.

**Knowledge of Developing a Business Model**

	Substantial Amount (1)	Fair Amount (2)	Satisfactory (3)	Little (4)	Nothing (5)	Mean
Pre	0%	0%	10%	50%	40%	4.3
Post	0%	20%	30%	40%	0	3.1

**Knowledge of Turning Research or Technology into Something Marketable**

	Substantial Amount (1)	Fair Amount (2)	Satisfactory (3)	Little (4)	Nothing (5)	Mean
Pre	0%	0%	10%	70%	20%	4.1
Post	0%	20%	40%	40%	0%	3.2

**How satisfied are you with the following aspect of your REU experience: Crimson Canvas?**

Extremely Satisfied (1)	Somewhat Satisfied (2)	Neutral (3)	Somewhat Dissatisfied (4)	Extremely Dissatisfied (5)	Mean
0%	20%	10%	30%	40%	3.9

The focus group and responses to open-ended survey questions revealed the sources of their dissatisfaction. The primary criticism was that Crimson Startup was not well-coordinated with the REU program. Students felt they were at a disadvantage, because non-REU students had created their product concepts prior to the start of the program. REU students were asked to do so at the beginning of the program, at a time when they were busy working to figure out the direction of their research. They also mentioned that having more instructional sessions, where methods were taught, rather than observational sessions where groups presented and were critiqued, would be helpful. Additional suggestions for improvement included receiving more assistance in designing their products and being informed to begin thinking of a product before the start of the REU. The REU students were very focused on their research and saw that as their highest priority for the summer. Crimson Startup was sometimes seen as interfering with what they really wanted to be doing. Furthermore, they felt unprepared, because they did not feel they had been well-informed about this aspect of the program ahead of time. On the other hand, some students found that some of the activities provided them with useful experiences that might be beneficial in the future. For example, going out to talk to people about their concept was seen as a good experience by some of the students, and others felt that the experience of presenting their product to a group and receiving feedback was beneficial. Given the somewhat different goals of the REU students, they suggested a class tailored more specifically for the REU program.

In light of the ratings and student feedback, the Crimson Startup portion of the REU will undergo several changes next year. UA I-Corps™ Site coaches will participate in REU orientation activities and provide a lecture/exercise in a research skills workshop. A kickoff meeting will be held at the beginning of the Crimson Startup to facilitate engagement and concept brainstorming. REU student teams will be required to attend office hours with a coach for at least 15 minutes per week. REU faculty mentors will be strongly encouraged to participate in Crimson Startup as well. With these changes, we expect a fully developed REU/I-Corps™ Site blended program with potential to expand the National Innovation Network<sup>11</sup> to broaden participation of students.

**Summary**

REU Site students engaged in entrepreneurship training by participating in an innovative program, Crimson Startup, developed as part of the UA I-Corps™ Site. The activity is aligned with student's overall interest in research and commercialization. Improvements in learning outcomes are observed. However, the program does require a significant time commitment. Modifications to the program will be made next year for improved efficacy.

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## References

- 1 Boyer Commission on Educating Undergraduates in the Research University, “Reinventing undergraduate education: three years after the Boyer Report,” State University of New York at Stony Brook: Stony Brook, 2003.
- 2 Kuh, G. D., “High-Impact Educational Practices: What they are, who has access to them and why they matter,” 978-0-9796181-4-7. Washington, DC: Association of American Colleges and Universities, 2008.
- 3 Raicu, D. S. and Furst, J. D., “Enhancing Undergraduate Education: A REU model for interdisciplinary research,” 40<sup>th</sup> ACM Tech. Symposium on Computer Science Education, 2009, pp. 468-472.
- 4 West, M., Cross, W., Kellogg, S., and Boysen, A., “A Novel REU Program to Develop the Skills of the Engineer of 2020,” FIE Conf. Proceedings, 2011.
- 5 Kim, K. A., Fann, A. J., and Misa-Escalante, K. O., “Engaging Women in Computer Science and Engineering: Promising Practices for Promoting Gender Equity in Undergraduate Research Experiences,” ACM Trans. Computing Education, 11(2), 2011.
- 6 Pariyothorn, M. and Autenrieth, R. L., “Strategic Use of Summer Undergraduate Research Experiences,” ASEE Conf. Proceedings, 2012.
- 7 Burr, R.W. and Heinricher, J., U.S. Patent No. 8,435,789. Washington, DC: U.S. Patent and Trademark Office, 2013.
- 8 [http://www.statsamerica.org/innovation/innovation\\_index/region-select.html](http://www.statsamerica.org/innovation/innovation_index/region-select.html)
- 9 <https://venturewell.org/lean-launchpad/>
- 10 <http://icorps.ua.edu/crimson-startup.html>
- 11 <https://venturewell.org/i-corps/nin/>

## Susan Burkett

Susan Burkett is the Alabama Power Endowed Professor in Electrical and Computer Engineering (ECE). She teaches courses in ECE Fundamentals, Circuit Analysis and Integrated Circuit Fabrication. Through NSF funding, she developed a course to prepare STEM undergraduates for research experiences and she also coordinates a REU Site on renewable resources. She is the Campus Director of a NSF Louis Stokes Alliance for Minority Participation grant. She recently finished a term on the Executive Leadership Team of the ASEE Women in Engineering Division. From 2005-2007, she was a program director at NSF in the Division of Undergraduate Education promoting exemplary undergraduate research and educational programs.

## Eric Giannini

Eric Giannini is an assistant professor of Civil, Construction, and Environmental Engineering (CCEE). He teaches courses in Civil and Construction Engineering Materials, Concrete Materials, and Vertical Construction Methods. He is co-director of the NSF-funded REU Site: Innovative Engineering with Renewable Resources. In 2013, he was selected as an ASCE ExCEED Teaching Fellow. He serves as faculty advisor to the ASCE Concrete Canoe Team and the American Concrete Institute (ACI) Student Chapter, and is The University of Alabama’s representative to the ACI Faculty Network.

## Rachel Frazier

Rachel Frazier helps entrepreneurs plan viable high tech businesses as Assistant Director of the Alabama Innovation and Mentoring of Entrepreneurs (AIME) center at UA. She teaches entrepreneurship, mentors STEM teams through customer discovery, assists faculty with commercializing technologies, and plays an active role in the NSF I-Corps™ Site at UA. In addition, Rachel started a performance materials company that serves the automotive and coating

industries, and she actively encourages and supports women startups. Rachel has a B.S. in Physics (2001) and a Ph.D. in Materials Science and Engineering (2005) from the University of Florida.

### **Debra McCallum**

Debra McCallum is a Senior Research Social Scientist and Director of the Institute for Social Science Research. She received her B.S. in Psychology from Furman University and her M.S. and Ph.D. in Psychology from the University of North Carolina at Chapel Hill. She is a social psychologist interested in evaluations of education and community intervention programs and research on social issues, such as career choices related to STEM fields, social-psychological aspects of health behavior and outcomes, and safety and well-being of children and youth. She has led program evaluation activities for a variety of NSF-funded projects.

### **Stephanie Wood**

Stephanie Wood is a PhD candidate in civil engineering at The University of Alabama and is expected to complete her degree in May 2017. Her research has focused on alkali-silica reaction and test methods for determining potential alkali-silica reactivity in concrete aggregates. She received a Resilient Infrastructure and Sustainable Environment (RISE) Doctoral Research Grant in 2014 to mentor an undergraduate student in the laboratory while conducting her dissertation research. Wood has operated as president of the student chapter of American Concrete Institute (ACI) for two years and is currently an associate member of ACI Committee 201 – Durability of Concrete. She served as the graduate assistant for the UA REU Site on renewable resources.

### **Garrett Quenneville**

Garrett Quenneville is a Research Associate at the Institute for Social Science Research. He graduated with a Masters in Public Policy from the University of Michigan. He conducted research on ‘Innovation Districts’ under Bruce Katz at the Brookings Metropolitan Program. He spent six months with the University of Chicago Urban labs in New York City doing research on criminal processing and bail.