Building Tomorrow's Leaders in Biorenewable Chemicals

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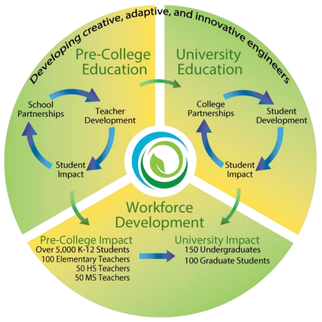
NSF Engineering Research Center for Biorenewable Chemicals

Project Goals

- The overall goal of this work is to help develop the human capital needed to transform the chemical industry into one that uses a large amount of biorenewable (rather than fossil) carbon.
- Specific objectives include: developing long-term engagement with K-12 educators and institutions; providing world-class research lab experiences for a broad group of undergraduate students; discerning the qualities of good mentoring and disseminating our learnings to our peers; providing unique, **trans-disciplinary graduate training**; using CBiRC know-how to inspire undergraduates in classrooms; and **providing entrepreneurial training to graduate students to expand their horizons and to create new economic opportunities**.
- The project supports the center's strategic plan by leveraging the CBiRC research infrastructure to produce the next generation of globally-competitive, creative and innovative engineers.

Pre-College Education Programs – Feeding the Pipeline



Program Objectives

- Provide STEM content professional development for K-12 teachers (STEM Summer Institute);
- Offer interdisciplinary research experiences for teachers and high school students centered on CBiRC related projects (Research Experiences for Teachers and Young Engineers and Scientists);
- Directly engage with 3th-12th grade students (GK12).
- *Provide STEM learning opportunities to a diverse group of participants.*

2009-2014 Pre College Impact

Schools	>120
Teachers	>200
K-12 Students	>20,000
Undergraduate &Graduate Students	>50

Vision for Sustainability

- Institutionalize the STEM Summer Institute and Symbi GK12 at Iowa State University;
- Support partner institutions with their K12 initiatives;
- Collaborate with central Iowa industry to support CBiRC K12 STEM initiatives;
- Establish more long term partnerships between CBiRC and school districts to ensure best practices are maintained.

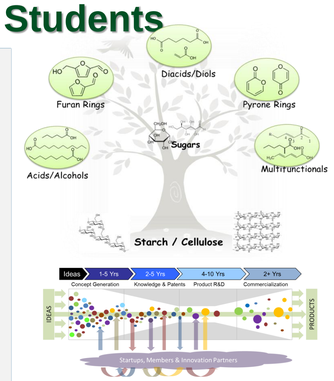
Continue to prepare a diverse set of high school graduates who are ready to meet the demands and challenges of the 21st century and are competitive in science, technology, engineering and math fields.

- Young Engineers and Scientists
- Research Experiences for High School Teachers
- Summer Academy for Middle School Teachers
- Workshops for Elementary Teachers
- Symbi, GK12
- STEM-C

Technology-Led Entrepreneurship for Graduate Students

Approach

- Leverage the talents of the ILO (Peter Keeling) and the activities in the Industrial Collaboration and Innovation Ecosystem to produce world-class opportunities for CBiRC graduate students (and now a broader audience) to learn to be technology entrepreneurs
- *Learn to think at a systems level – learn to be creative, to seize opportunities, and to understand risks and rewards and the complexity of building a solid foundation for taking a product to market.*
- Coursework supports this: ILO offers **BR C 507 Entrepreneurship in Biorenewables**, which was designed to develop an understanding of discovery research and its relationship to entrepreneurship and innovation in the broad area of biorenewables. Based on early success and interest, this course became a required part of the broader ISU Biorenewables Resources and Technology Graduate Program (and title is changing to reflect broadening scope: ***Technology-led Entrepreneurship in Biorenewables***).
- Furthermore, a mentoring component (modeled after I-Corps program) was added recently. This in turn is having extremely powerful impacts. For example, multiple other ISU startups mentored through program, and the State of Iowa now using the same mentoring program so that they can mentor startups who have requested state funding.
- Collectively the Course and Mentoring program is referred to as the **Biobased Foundry.**

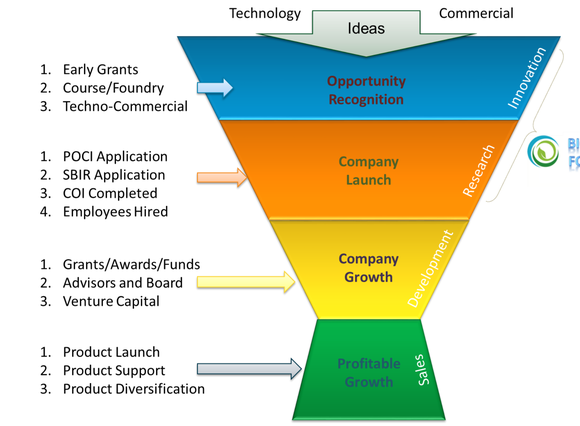


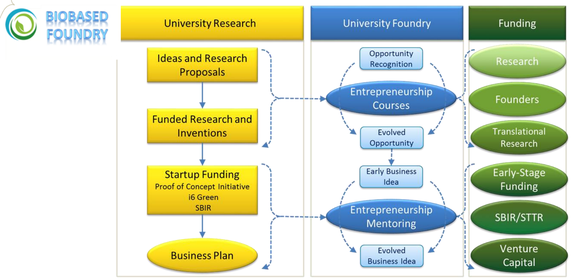
Outcomes

- **The Entrepreneurship Course**, has developed about 50 startup concepts into a first business model. The program has been very well received by the graduate students. The students all gained a deeper understanding of what it takes to build an idea into a value proposition and how this might attract funding. Importantly the concept of technical and business risk becomes part of their vocabulary.
- **The Biobased Mentoring Program** has incubated 4 CBiRC startups and 6 ISU startups. Of these 10 startup entities, 7 became formally incorporated and are in the process of seeking funding. Four of these startup entities have received phase-I SBIR or STTR funding and are now applying for phase-II funding. One of them won a SECO award.
- **The Foundry** is gaining wider acceptance at Iowa State University as a powerful addition to graduate education.

Startups fail because they don't talk to customers until they have a product.

Need to focus on Business Model Canvas instead of writing Business Plans.

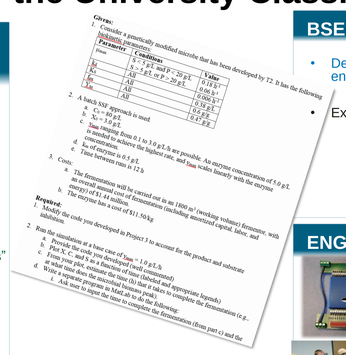




Bringing CBiRC to the University Classroom

Biol 313L *Genetics Lab*

- Dr. Alexis Campbell created a student directed inquiry based experiment module
- The module is based upon the science and bioinformatic predications that she has worked on as part of the Nikolau lab, in conjunction with the Wurtele lab – fatty acid/lipid regulation in yeast
- Class size ranges from about 180-200 students each semester – so class impacts >350 students each year
- To help with the student driven module, Dr. Campbell implemented "Learning Facilitators" who come into the class two days within the module – they help the students derive their hypotheses, work out experimental design, controls, etc. *There are about 20-25 facilitators each semester.*
- Students spend about 15 hours - this includes a presentation day at the end
- The 'top' students also have the opportunity to present to a CBiRC panel on the final class evening



BSE 380 *Principles of Biological Systems Engineering*

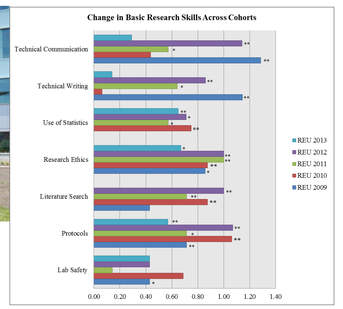
- Developed *CBiRC-based* problem in section on modelling microbial growth and enzyme kinetics
- Exploring use of pyrone-testbed-based project in capstone ChE class at ISU

ENGR 160 *Fresh. Problem Solving & Computer Applications*

- Used sensor boards to encourage tinkering and hands-on (these were core "hypotheses" we identified at CBiRC outset) – not in context of biorenewables, but general engineering
- Referred to global energy and resource use early in class to motivate study of engineering (content based on REU orientation presentation)
- First approach in particular greatly increased student ability and confidence in programming – have continued this approach and have encouraged others to adopt
- Presented this work at 2013 Frontiers of Engineering Education (NAE) conference in Irvine, California

Multi-Institutional Trans-Disciplinary REU

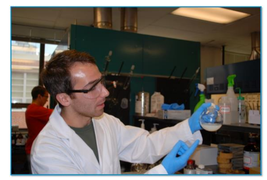
Select partner institutions → Solicit project titles and short descriptions → Advertise REU (applicants indicate top-three projects) → Send each PI three to six applicants after initial review → Take PI rankings and make cohort → Interview top selections; make offers → Sort out logistics!



[The CBiRC REU] was the first time I really felt that I had independence as a researcher. Before CBiRC, I had worked in labs, but I was more of a tech than a researcher.

Having made significant progress in a project I knew very little about 3 months prior gave me a lot of confidence in my abilities as an independent researcher.

I still keep a sample of my soybean plastic as a souvenir.



Elia Altabet: REU class of 2010; UMCP class of 2012; Fall '12 admit to Princeton CBE PhD program

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