

## **AC 2008-600: A DECADE OF TECHNOLOGICAL INNOVATION: A RETROSPECTIVE VIEW OF THE FIRST DECADE OF THE NCIIA**

### **Phil Weilerstein, National Collegiate Inventors and Innovators Alliance**

Phil Weilerstein began his career as an entrepreneur while still a graduate student at the University of Massachusetts. He and his colleagues launched a start-up biotech company which eventually went public. This experience, followed by several other entrepreneurial ventures, brought him a lifelong passion for entrepreneurship, which he has pursued through his work as Executive Director of the National Collegiate Inventors and Innovators Alliance or NCIIA. Phil's tenure at the NCIIA is marked by his skill for network-building and expert leverage of resources. As an entrepreneur in a not-for-profit organization, he has grown the NCIIA from a grassroots group of enthusiastic faculty to a nationally known and in-demand knowledge base and resource center. He currently serves as the Chair of the ASEE Entrepreneurship Division.

### **Angela Shartrand, National Collegiate Inventors and Innovators Alliance**

Angela Shartrand, Assessment Specialist, is an educational psychologist who has experience evaluating programs in philanthropic, community-based, and higher education settings. Prior to joining NCIIA, she evaluated programs in the areas of teacher education, youth philanthropy and leadership, and community-based family support services, identifying and disseminating best practices and policies. A graduate of Williams College, she Holds an Ed.M from Harvard University and a PhD in in Educational Psychology from Boston College and has taught courses and workshops in applied research to faculty, graduate students, and undergraduates at Boston College and Wheelock College.

# **A Decade of Technological Innovation: A Retrospective View of the First Decade of the NCIIA**

## **Abstract**

The role of entrepreneurship in engineering, science and technology education has undergone a transformation over the past ten years. Experiential exposure to commercially directed innovation and entrepreneurship is now a growing part of many engineering programs and is increasingly viewed as a way to prepare students for the realities of a working world in which they will need to take control of their careers and be prepared to contribute to the commercial success of any enterprise they join or create. The National Collegiate Inventors and Innovators Alliance was created in 1996 to nurture the next generation of innovators and technology entrepreneurs by working with higher education institutions to build programs, build faculty knowledge and networks and support emerging technology entrepreneurs. NCIIA has provided funding, training and community building resources and programs to encourage the initiation of curricular programs, formal and informal networks and the launch of new products and businesses based on technological innovations by student teams known as E-Teams. This paper will review and discuss the progress and outcomes of the NCIIA programs over the past ten years looking at the impacts on participating institutions and programs, educational and entrepreneurial outcomes and the development of key networks that continue to drive progress in the field.

## **Introduction**

The role of entrepreneurship in engineering, science and technology education has undergone a transformation over the past ten years.<sup>1,2,3</sup> Experiential exposure to commercially directed innovation and entrepreneurship is now a growing part of many engineering programs and is increasingly viewed as a way to prepare students for the realities of a working world in which they will need to take control of their careers and be prepared to contribute to the commercial success of any enterprise they join or create. The National Collegiate Inventors and Innovators Alliance (NCIIA) was created in 1996 to nurture the next generation of innovators and technology entrepreneurs by working with higher education institutions to build programs, build faculty knowledge and networks, and support emerging technology entrepreneurs. NCIIA has provided funding, training and community building resources and programs to encourage the initiation of curricular programs, formal and informal networks and the launch of new products and businesses based on technological innovations by student teams known as E-Teams. This paper reviews and discusses program outcomes over the past ten years, examining institutional impacts, educational and entrepreneurial outcomes, and the development of key networks that continue to drive progress in the field.

## **History of the NCIIA**

NCIIA was founded in 1995 with support from the Lemelson Foundation, a private philanthropy based in Portland, Oregon. Lemelson's vision was to create an organization that fosters invention, innovation, and entrepreneurship in higher education, resulting in the creation of

innovative, commercially viable, and socially beneficial businesses and employment opportunities in the United States. The program was founded on the premise that invention, innovation, and entrepreneurship are essential components of the higher education curriculum and vital to the nation's economic future. The NCIIA works with colleges and universities to build collaborative experiential learning programs that help nurture a new generation of innovators and entrepreneurs with strong technical and business skills and the tools and intention to make the world a better place.

The NCIIA achieves its goals by offering a collaborative faculty network in combination with grants and resources provided through its member institutions. The Advanced E-Team and Course and Program grant programs have been offered since the NCIIA's inception in 1995. Designed to help generate and support the work of *E-Teams* (multidisciplinary teams of students, faculty, and advisors), these programs have filled a unique niche nationally and have generated significant impact in educational and commercial terms as described below.

## Grants Programs

Course and Program grants strengthen existing curricular programs and build new programs in invention, innovation, and entrepreneurship. They encourage development of creative pedagogical approaches that generate and deploy E-Teams, bringing real-life applications and opportunities into the classroom setting and beyond.

Awarded twice yearly to faculty at NCIIA member institutions in the United States, Course and Program grants range in size from \$2,000 to \$50,000 with a grant period of one to three years. Since 1996, the NCIIA has awarded 243 Course and Program grants to 128 different US institutions, totaling \$4,258,621 awarded. The resulting courses and programs have served to date approximately thirty-six thousand students.

Advanced E-Team grants provide E-Teams with the support they need to bring an innovative product or technology from idea to prototype in the educational environment with a clear intention to reach the market. Proposals are evaluated on criteria that take into account the level of innovation and commercial potential of the idea as well as the resources, environment, and mentors that will support the team as they move an idea toward commercialization. E-Team grants are awarded to student-faculty-industry teams that can demonstrate an idea's technical feasibility, social value, and potential for commercialization. Awarded twice yearly to faculty and students at NCIIA member institutions in the United States, Advanced E-Team grants range in size from \$1,000 to \$20,000; the grant period is twelve to eighteen months.

Examples of successful E-Teams:

AnemiCAM from Brown University won a \$20,000 grant from NCIIA in 2006 to develop and commercialize an inexpensive, handheld device that enables physicians to quickly and non-invasively assess hemoglobin levels in the blood. Since receiving the grant, the team has launched a company, applied for two patents, and raised over \$300,000 in funding, including two SBIR grants. While anemia affects an estimated 3.5 million Americans, in some developing countries it is an epidemic that affects 50% of the population that can cause medical complications such as organ dysfunction, poor

pregnancy outcomes and, impairments in children's physical and mental development. Screening for anemia is a significant challenge in the developing world because physicians lack facilities for blood testing and problems with needle reuse. With the Lumen device, medical personnel can easily diagnose this highly treatable condition, leading to significant improvements in health outcomes for those affected.

Polytorx, LLC from Georgia Tech received an NCIIA \$7,750 grant in 2003 to commercialize a U. of Michigan patented technology for strengthening concrete. Since then, the company has raised over \$2.3 million in funding, is manufacturing and distributing the product nationally and internationally, and is rapidly expanding to keep up with demand. Social Impact: The company estimates that its growth has led to the creation of over 100 jobs. Environmental Impact: Polytorx uses recycled and recovered steel to fabricate its product and results in concrete that is lighter & stronger using as much as 40% less concrete, substantially reducing the carbon footprint of the project.

Over the past decade the NCIIA has strengthened its focus on stimulating the development of socially beneficial and globally focused applications of technology. In 2007 a new program known as the Sustainable Vision grants program was created to stimulate and support the development of collaborations between US university programs and international partners from higher education, NGO or commercial sectors. These collaborative initiatives develop innovative applications of technology for the benefit of people living in poverty and/or to address environmental sustainability in their communities. Sustainable Vision Grants support programs that move ideas to commercialization while addressing basic human needs such as health, food, security, clean water and affordable energy for people living in poverty in the U.S. or abroad. Grant recipients partner with a non-profit, for-profit educational or governmental organizations to plan and implement products or services in an economically sustainable entrepreneurial model. Sustainable Vision grants range from 20 to 50 thousand dollars with a grant period of twelve to eighteen months.

## **Conferences and Workshops**

NCIIA has developed a variety of resources to support curricular development and informal education as well as advance product development and commercialization.

**Conferences.** NCIIA annual conferences for entrepreneurial educators are a keystone of NCIIA programming. At the conferences, educators from around the globe share ideas, resources, and cutting-edge entrepreneurial curricula. They network and advise each other about new technological developments and entrepreneurial models. Through these interactions the educators are able to stay abreast of their colleagues' research and innovations and can take new information back to their respective campuses to share with their students. NCIIA publishes a peer-reviewed proceedings focused on pedagogy and best practices in technological innovation and entrepreneurship education.

The networking, educational presentations, and supporting materials create and support an expanding and well-functioning multi-disciplinary national network of people engaged in various activities related to entrepreneurial education and innovation. The Annual Conference is a

unique resource that has been critical to the initiation of many highly successful entrepreneurial programs in universities and colleges, supported in part by NCIIA curricular and E-Team awards

***Invention to Venture Workshops.*** Beginning in the fall semester of 2003, NCIIA has supported a series of intensive, one-day workshops at host universities or colleges that focus on processes of technology commercialization and new venture creation. NCIIA provides host institutions with small seed grants, which the host institutions augment with additional internal or sponsor funds and workshop registration fees. NCIIA provides additional non-financial support to host institutions for planning, managing, and running the workshops. NCIIA intends that workshops “take root” in host institutions and be conducted on an annual basis. To date, 37 institutions have hosted 67 workshops, some offering the workshop year year for several years. A total of approximately 4,000 people have participated in these workshops.

The I2V program is intended to help realize the untapped potential resident in U.S. colleges and universities by means of creating an accessible, shared, and consistent approach to the introduction of the vocabulary and process of technology entrepreneurship to a large and diverse number of university participants. Workshops are intended to engage university administrators and faculty directly in activities, broadening the reach of entrepreneurship programs within the university and create outreach to the surrounding business community. Workshops are expected to involve and impact students and faculty, members of the university community interested in entrepreneurial activity, local businesses seeking university connections, local investors seeking promising investment opportunities, and companies seeking university-based commercial opportunities. Host institutions that are successful in promoting these goals are expected to institutionalize the workshops so that their impacts on participants, hosts, and sponsors continue to grow.

### **Outcomes: Institutional, Educational, Community, and Economic**

NCIIA’s programs, grantmaking, and community-building efforts have produced impacts that can be described readily in four areas: educational, institutional, community, and economic.

***Institutional Impact.*** NCIIA grants have resulted in institutional impacts such as the formal adoption of new courses into the engineering curriculum, addition of entrepreneurship certificates or minors for engineering students, and the establishment of infrastructure to support entrepreneurial activities of students. Student venture funds, business plan competitions, web resources, and rapid prototyping services are examples of infrastructure improvements that have resulted (both directly and indirectly) from NCIIA funding. In particular, faculty members have attributed additional support from university and college administrators (e.g., deans, presidents) and university funding to their NCIIA award and resulting activities. Finally, some institutions are holding Invention to Venture Workshops annually in an economically sustainable way.

***Educational Impacts.*** One of the main goals of the NCIIA grants is to increase student awareness of entrepreneurship as a potential career path, and improve students’ entrepreneurial competence through real opportunities (via the E-Team model) to innovate and commercialize products and technologies of their own creation. Grantees have reported engaging more than 17,000 students in entrepreneurial courses and programs, E-Teams, and I2V workshops since the program’s inception. Taking into consideration that many of these courses and programs have

continued beyond the grant period, we estimate that more than 50,000 students have been reached to date.

***Community Impacts.*** Two main areas of community impact have been identified. First, the impact on the technology entrepreneurship community via the NCIIA conferences, workshops, and other outreach activities, is evidenced by a growing membership that now includes 157 institutions. Collaborations with other professional engineering divisions and conferences, including ASEE, ASME, and BMES, have helped integrate entrepreneurship education as an important topic within the engineering profession. As a result, a strong interdisciplinary community of scholars, faculty, and industry leaders are now committed to promoting technology entrepreneurship teaching and research, and mentoring student led companies. Another area of community impact is on the intended end users of technological innovations. NCIIA has supported the development of technologies targeted to the poor and underserved, which has led to improvements in economic and health conditions here and abroad. We anticipate that these community impacts will be further realized with the establishment of our new Sustainable Vision grants program.

***Economic Impact.*** The economic outcomes of E-Teams have been impressive so far. The successful commercialization of student innovations and launching of new start-up companies have led to licensing revenue of intellectual property, additional investment, grants, awards, and contracts, new ventures and jobs, and product and technology sales. An external evaluation of the NCIIA grants program for years 1997-2005 reported that 17 “high impact” grants produced the following outcomes:

- \$40 million through leveraging NCIIA awards, attracting venture capital to NCIIA-fostered start-ups, and generating sales in start-up companies.
- Start-up companies generated at least 700 jobs locally, which corresponded with an estimated \$35 million annually in regional economic impact.<sup>4</sup>

Our own assessment data show that at least 30 of the student ventures funded by NCIIA have brought at least one new product or service to the market, and an additional 15 projects are actively pursuing commercialization. In addition, NCIIA-funded projects have led to \$36 million in additional leverage (\$1.6 million from awards and competitions; almost \$3.7 million in private and federal contracts; almost \$9 million in grants; and \$23 million in additional investment).

## **Conclusions**

NCIIA’s mission has focused on expanding opportunities for engineering students to engage in entrepreneurship by supporting curriculum, projects, and complementary activities that geared toward commercialization outcomes. The outcomes of the past decade provide strong evidence that engineering faculty are successfully preparing their students to develop commercially viable innovations, and that student entrepreneurs are successfully launching technology ventures. We plan to continue our efforts at tracking longer-term outcomes of NCIIA-funded companies and E-Team members, which will continue to enrich our understanding of teaching and learning technology entrepreneurship.

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