Building Inter-Collegiate Technology Entrepreneurship into the Undergraduate Curriculum at the University of Texas at San Antonio: An Historical Perspective in Effective Educational Transformation through the Center for Innovation and Technology Entrepreneurship

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ABSTRACT
The University of Texas at San Antonio (UTSA) Center for Innovation and Technology Entrepreneurship (CITE) began with the mission of establishing the context of intercollegiate technology entrepreneurship as a cornerstone of engineering and business undergraduate education. A case study of the process to create this center is presented here, including elements that have allowed for the acceleration of the program and elements that have been barriers to overcome. In three years, CITE has established an intercollegiate $100K New Technology Venture Start-Up Competition, provided training to over 200 young technology entrepreneurs, hosted 34 New Technology Venture Pitches, created over a dozen new invention disclosures, and spun off multiple new companies and technology licenses. In addition, programs implemented in the center have been coupled with studies of the young technology entrepreneurs themselves to inform a more robust decision making model for Accelerating Collegiate Entrepreneurship (the ACE model).

Introduction
In November 2008, the University of Texas at San Antonio (UTSA) applied and received NCIIA funding which supported the expansion of a current undergraduate course by combining undergraduate engineering senior design projects with graduate and undergraduate business students focused on forming new technology ventures. During the grant period, the UTSA Center for Innovation and Technology Entrepreneurship (CITE), a joint center between the College of Business and the College of Engineering, was used as a vehicle for accelerating multidisciplinary intercollegiate team formation, teaming engineering and business students with the intent of taking their senior design project beyond the classroom and into prototype and business plan development. Providing a Business Plan Competition among the teams enabled three important advancements in undergraduate and graduate pedagogy:

1) Formalization of curricular and pedagogical changes in both the colleges of Business and Engineering;
2) Development of a new venture start-up strategy for those teams with high estimated probability for market success; and
3) Academic study of the students as a basis for journal-quality articles and research.

Among the pedagogical revisions resulting from this experiential activity was an entrepreneurial focus for the senior design projects in engineering. Successful interdisciplinary teams became E-Teams geared toward launching new technology ventures. The university provides IP protection and links teams with business advisors, incubator space, and potential venture funding. For both business and engineering students, a start-up guidebook was created and given to each of the students to help train them on the process of creating a technology-based company. The guidebook saves each student the approximate cost of $150 textbook. This publicly available text has now been translated into Spanish and will be used by two universities in the Canary Islands: Universidad de La Laguna and University of La Palmas.

The following paper will present an historical and future perspective of CITE: the $100K New Technology Venture Start-Up Competition, the current results, and the future directions for this program.
The Center for Innovation and Technology Entrepreneurship and the $100K New Technology Venture Start-Up Competition

Within the present national and international conditions of business and education, we have begun to ask ourselves large-scale questions about technology entrepreneurship and its place in our society. While these questions may not be new (Gartner and Vesper 1994; Kuratko 2005), the importance and significance of the innovative and entrepreneurial spirit focused on technology in American society is emerging as a critical factor for competing in a global market (Minniti and Bygrave 2004; Rothaermel, Agung, and Jiang 2007; Schramm 2006).

From the positive impact of small techno-centric businesses on new job growth, and the apparent competitive advantage in high technology observed by the United States, one would think the status quo is working and there is little to worry about. However, given increasing trends in outsourcing from menial service centers to more skilled workforces in science and technology fields, the question remains "What will be left?" If the belief in American innovation, ingenuity, and entrepreneurial spirit is strong, then these hurdles will be overcome. However, questions are beginning to creep into our minds about how this will be achieved.

Understanding the educational system and its impact on enabling young technology entrepreneurs may be a key consideration for what is currently happening in the country and potentially what may transpire in years to come. Creating a baseline by looking at our science, engineering, and business students to understand their current beliefs and perceptions about technological entrepreneurship and their propensity for becoming technology entrepreneurs themselves may be a good indicator. This program capitalizes on the changing landscape of the university, which has proven ripe for a major project and research effort; its purpose is to understand and effect the creation of a pipeline of technological entrepreneurship in a region of the country that has traditionally not shown substantial progress in this area.

The Center for Innovation and Technology Entrepreneurship

The university has an enrollment of 30,000 students in 2010, serving a historically underrepresented minority population that accounts for over 50% of student enrollment. The city itself is not a technology-based center, such as Boston or Silicon Valley, and has traditionally been focused on tourism. In fact, the university was historically focused on teaching, and less on research, as clearly evidenced by the small number of patents awarded to the university and the almost non-existent licensing revenue in previous years.

However, the landscape at the university is changing. The president, provost, and deans are pushing to transform the university into a significant research institute, and the colleges are jointly supporting an entrepreneurship center focused on creating a pipeline of new technology entrepreneurs. Technological innovation is the foundation for creating new technology enterprises, and the spirit of entrepreneurship is the catalyst for turning these innovations into reality. Through a process of education, experience, resources, and support, the Center for Innovation and Technology Entrepreneurship (CITE) at the University of Texas at San Antonio (UTSA) is focused on fostering the growth of new technology-based ventures.

The center’s mission is to create a focal point for students, faculty, research, and education that will open a pipeline for people developing new technology ventures. It also serves as a mechanism for existing business ventures to supplement their capabilities by coordinating with faculty teams to address specific technical and business needs associated with new ventures. A graphic representation of the center’s mission focuses on four primary steps, as outlined in Figure 1.

Figure 1. Entrepreneurship Creation Pipeline

The first step is aimed at unlocking the inner entrepreneur via courses on high tech and biotech start-ups, and by featuring guest speakers representing many types and styles of entrepreneurs. Students are required to take the business plan course and a general entrepreneurship course in preparation for their final course, which teams business and engineering students. The engineers design and produce a prototype of a product, and the business students write a business plan to commercialize the product. No additional courses have been added to the curriculum. Engineering and business professors work closely to align course deliverables as required by the syllabi. Both the engineering and business students work in their teams outside of their respective classes to develop a commercialization plan.

This team process is the second step of the model—provide entrepreneurial experiences—that reinforces what Piaget terms concrete operational learners, people who learn from doing (Gruber and Gruber 1977). This step is focused on establishing new pedagogy and activities within the curriculum that give students and faculty firsthand exposure to being entrepreneurs.

The final two steps of the process are focused on coordinating existing university and external resources in a manner that will enable taking the entrepreneurial ideas from concept to market, essentially reducing barriers to entry, whether they are monetary, technological, temporal, or skills-based. These resources and support include equipment, incubator space, internships, an intellectual property office, a
Engineering and Business Curriculum at a Crossroads

The typical engineering curriculum in the US is comprised of a lot of “just in case” knowledge for analysis. It is called “just in case knowledge” because students are taught the information in the event that they might need to use it at some point (Crawley and Hallam 2002). Additionally, US institutions have trained decades of young graduates to analyze and optimize problems and designs with exact solutions. At UTSA, students are often judged as seniors on their ability to apply their skills to a design problem that results in the creation of a new product or technology, but one that largely remains an untapped resource for the country: why? Traditionally, engineers have not been trained to turn their ideas and innovations into sources of job creation. In fact, the technologies and products they often create for a grade may lend themselves wonderfully to patent protection and the initiation of new technology-based companies or new product lines within companies. However, at many schools, the creation of these new technology ventures remains an exception rather than the rule.

In the field of entrepreneurship in business schools, it is commonly mentioned that past experience plays a significant role in the decision making-process of entrepreneurs (Minniti and Bygrave 2001; Sarasvathy 2001). If one considers the importance of past experience in the success of new business ventures, it is easy to understand why financiers typically look for an experienced (and previously successful) management team. From the academic perspective, researchers have suggested that the experiential learning aspect must be included in any successful entrepreneurial program (Zeithaml and Rice 1987; Solomon and Duffy 2002; Krueger 2007). The literature goes further to suggest that concrete experiences are necessary to create successful entrepreneurs (Cromie and O’Donoghue 1992). Some have proposed simulation as a way to accelerate the experience within an academic environment, while others suggest that reality-based experiential pedagogy is necessary for truly training entrepreneurs (Plaschka and Welsch 1990). While traditional university models have pushed for the analytic, classroom-based entrepreneurship program, proponents of entrepreneurial activity complain that this model does little to encourage the “street smarts” necessary for students to actually become successful entrepreneurs (Plaschka and Welsch 1990).

The $100K New Technology Venture Start-Up Competition

Prior to the launch of CITE and the New Technology Venture Start-Up Competition in 2007, there had been no new technology ventures started at UTSA. Students were traditionally trained to finish their degrees and go get jobs; they were never given the opportunity to explore entrepreneurship. Senior engineering students would spend a year designing and building a new product. They would present it to their faculty advisors, get a grade, abandon the project, and look for work. Likewise, senior business students created paper business plans with no concrete link to a real venture start-up that they could internalize and identify with. Understanding that experiential entrepreneurship is a major element of increasing entrepreneurial intent, the single greatest predictor of entrepreneurial activity, CITE created the New Technology Venture Start-Up Competition, a collaborative program between the colleges of Business and Engineering, aimed explicitly at giving students experiential learning in the area of new enterprise formation. Business students team with engineering students to accomplish five things:

1) Create a collaborative product development team of engineers and business students.
2) Create a working prototype of the product.
3) Create a business plan for the product.
4) File IP protection with the university.
5) Compete for start-up funding with a pitch to a panel of local technology investors.

This competition changed the context of both the engineering and business programs, giving students an opportunity to experience entrepreneurship firsthand without changing the fundamental requirements of their existing classes. At a minimum, the students gain their first hands-on experience at starting a high tech venture, and for those who select the option to pursue the start-up, we provide incubation space, a mentor network, IP protection, access to seed capital, and assistance from the local SBDC.

Thus, the competition teams the two groups in a combined activity that requires the presentation of the prototype technology along with the business plan. This experience helps reinforce the concept to engineering students that being an entrepreneur is truly a career option for them, with inspiration being a major planned outcome per the literature (Souitaris and Zerbinati 2007; Wani and Garg 2004; Johansson, et al. 1998; Home-Douglas 2005).

As part of the experience, students engage the patenting process and the LLC formation process until the competition, where they pitch their ideas to a panel of financiers, angel investors, engineers, entrepreneurs, lawyers, and faculty. The carrot at the end of the stick is a cash prize to the winning team, and potential funding and start-up space to any team that achieves a prerequisite level of tech-venture readiness. While participation is voluntary, the work level is comparable to the traditional path, as they have the same deliverables and requirements to pass their individual courses, yet the context is what has changed. The program is no longer just a grade, but a chance to win money, experience the pressures of putting a start-up business plan together, securing IP for the company, and ultimately convincing...
a panel to fund the venture—the main requirements of any technology venture start-up.

From a pedagogical perspective, the goal of fostering technology entrepreneurship is to focus on the students early in their formation. For students that have high entrepreneurial intent, we have constructed a program that gives them the experience they need to achieve early technological entrepreneurial success. For those that exhibit high entrepreneurial traits, but currently show low intent, we need to unlock their inner entrepreneur through experiences like the New Technology Venture Start-Up Competition. From the standpoint of an educational model, the real goal is to develop a pedagogical framework that both raises entrepreneurial intent and provides necessary tools, skills, and experiences that enable entrepreneurial success, barring major deleterious exogenous factors.

Building on Shapero’s model of the Entrepreneurial Event (1982), in consideration of results of its use in analyzing senior university students (Krueger, Reilly, and Carsrud 2000), the goal is to establish a pedagogical model that ties to the theoretical framework for increasing entrepreneurial intent via perceived desirability, propensity to act, and perceived feasibility. Combining this with Luthje and Franke’s (2003) model that includes contextual factors as antecedents to entrepreneurial intent, a framework begins to emerge. This framework has been coined the ACE (Accelerating Collegiate Entrepreneurship), as shown in Figure 2, below.

![Figure 2. Accelerating Collegiate Entrepreneurship](image-url)
The realm of pedagogy we typically associate with case study, or the review of historical events, leads to the understanding of the potential for success and failure, and thus influences the individual's expectation of outcomes. The development of specific skills and their application in an entrepreneurial environment leads to a better understanding of one's abilities and thus influences perceived self-efficacy. The creation of support mechanisms for funding, mentoring, and incubating companies can be perceived as support for new business ventures, and will thus influence perceived feasibility. Exogenous factors such as market conditions are not considered controllable in this model, but the perception of the barriers the market creates can also influence perceived feasibility. Finally, some measure of personality traits underlies the individual's propensity to act, and may (or may not) have influence on the individual's perceived self-efficacy and expectations.

The goal with pedagogical change is to see some increase in entrepreneurial intent. A significant outcome from the New Technology Venture Start-Up Competition, beyond the student experiences and the possibility of starting a company, is the fact that the university system generates more intellectual property. Thus the realm of outcome scenarios is a win-win, in which students that do not choose to pursue their inventions further hand over their business plans to the university's technology licensing office, which can then decide to market the IP; in turn generating revenue for the university and royalties for the student-inventors.

Outreach and Economic Development
From a recent white paper by the Small Business Administration Office of Advocacy (Clark and Saade 2010):

> In the late 1990s, writings of Professor Michael Porter and more recently Karen Mills and others support a belief that perhaps cluster economic development or regional industry clusters—geographic concentrations of interconnected firms and supporting organizations—represent a potent source of productivity at a moment of national vulnerability to global economic competition.

CITE nurtures a growing entrepreneurial ecosystem in the San Antonio area. It coordinates activities that link early phase technology companies with class projects in the Management of Technology program. Graduate students in this program experience a real-world context for applying sound fundamentals in a consultant-client relationship. The results are better prepared graduates that have contributed to the success of local companies in San Antonio and Austin. Three local companies involved in this program have been awarded over $3.65 million from the state’s Emerging Technology Fund.

CITE also hosts a semi-annual Technology Entrepreneurship Boot Camp for the region, which targets new and emerging technology entrepreneurs. Attendance at the day long boot camp is required of all business and engineering students participating in the competition, and offers participants an intensive crash course on the commercialization of new technologies. Expert presentations on fundamental technology entrepreneurship skills include opportunity identification; business planning and pitching; IP and business law; social media, public relations, and branding; and funding a technology start-up in San Antonio.

Research
As CITE develops a focus on entrepreneurship at UTSA, the colleges of Business and Engineering are working together to scientifically study the changing pedagogical and curricular landscape. Experiments are currently being conducted that link the undergraduate senior design courses in the Mechanical Engineering and Electrical Engineering Departments with the Small Business and Entrepreneurship practicum course in the College of Business. These linkages are bringing a business focus to the engineering product design process, while providing new and novel tangible technologies around which business students can build their business plans.

The study of these experiments will be used to further refine the approach to entrepreneurial education at UTSA and provide new knowledge for the study of technology entrepreneurs in general. Other areas of research include entrepreneurial personality traits, entrepreneurial intent, business incubation, technology transfer, policies for accelerating technology commercialization, microfinance, and venture finance.

The creation and validation of a simple instrument forms the basis of this work, and will lead to the creation of new knowledge as the study continues to unfold with the growth of the New Technology Venture Start-Up Competition for undergraduate students. The data suggests that the engineering students lean toward being entrepreneurially minded in the long-term, but have little short-term intent. The business students tend to have positive short-term and long-term intentions, but again, the data suggest much stronger intentions in the long-term. The anecdotal evidence indicates that there is an underlying interest and perhaps passion for experiential entrepreneurship as part of their educational process. The growing results of this longitudinal study will help direct the pedagogical changes used to create a pipeline of successful technology entrepreneurs. As this research database grows, the ACE model will be improved in order to structure and guide the delivery of technology entrepreneurship education for a generation of future technology creators, innovators, and managers at the university level.
Results/Discussion
Between Spring 2008 and Spring 2010, 108 business students and 100 engineers participated in the $100K New Technology Venture Start-Up Competition, comprising 34 teams. Four teams have proceeded to work on their new ventures after the semester ended.

This past year was a tremendous period of growth for the UTSA Center for Innovation and Technology Entrepreneurship. Through CITE, seniors in the colleges of Business and Engineering teamed their skills to solve a major roof and gutter problem for a national builder: ice buildup. Combining the technology development and prototyping skills of the engineers with the business acumen of the business students, the final product (IceGuard®) was presented at the UTSA New Technology Venture Start-Up Competition in 2009. Beldon Roofing, a $50M+/year Texas-based company with national sales, is licensing the technology and sponsoring research to further develop the product at UTSA with the 12-month goal of commercial launch as a $5M-$10M per year product line. This is the first student invention to be licensed from UTSA.

With the support of our sponsors, including founding sponsor Texas Research and Technology Association, we have built a prize pool of over $100K, offered twice a year in the technology venture competition. Sponsors also include a law firm, who provides legal assistance to all teams who wish to proceed with business formation. Grants from SBA and NCIIA have helped solidify the process. Interested entrepreneurs in the city make up CITE’s advisory board, which supports and helps develop CITE’s activities. With the help of the Harvard Business Club of San Antonio, we have introduced a mentoring program for our start-up teams, pairing each team with a mentor for the semester.

With grant funding, we initiated an outreach program for our students involved in technology entrepreneurship to visit and inspire middle and high school students in the region. Through a connection the university has had for several years, we launched our New Technology Start-Up Guidebook in English and Spanish draft versions in the US and Spain. This text was an assignment created by graduate students working under faculty supervision. Finally, we have integrated the Technology Entrepreneurship Boot Camp into the broader San Antonio entrepreneurial ecosystem as the real starting point for any student thinking about taking his or her first step into technology entrepreneurship.

In three years, CITE has established an intercollegiate $100K New Technology Venture Start-Up Competition, provided training to over 200 young technology entrepreneurs, hosted 34 New Technology Venture Pitches, created over a dozen new invention disclosures, and spun off multiple new companies and technology licenses. With strong support from the community, CITE will help feed the pipeline of technology entrepreneurship, fueling the growth of the San Antonio ecosystem.

Recommendations

$100K competition
We will continue to hold this competition and seek external funding. The deans of both the Engineering and Business schools are kept apprised of each step and are completely supportive. We will consider a statewide venture competition in the next five years.

Boot camp
We will continue to host the Boot Camp, as this has been very successful in motivating the student entrepreneurs in their semester work.

Global technology start-up
We are collaborating with the Canary Islands and have begun a discussion of matching our students together for an international competition in 2011.

Company partnerships
We are building experience, cases, projects, and hands-on education and are reaching out to accelerate the success of regional technology companies.

Mentors
The mentor network has been exciting and fruitful, and having a lead mentor from the Harvard Business Club of San Antonio helps coordinate, recruit, and monitor the program.

Seed funding
Our next major project is to build seed funding for the viable projects from interested individuals through our advisory board connections.

References


