New Orleans JAZZED about Engineering Education

Paper ID #17193

Collaborative Efforts to Encourage Entrepreneurial Mindsets

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Abstract

The goal of this paper is to discuss efforts to engage and inspire engineering students by adding entrepreneurial course content and creating relevant extra-programmatic opportunities. Three primary mechanisms discussed in this paper include 1) entrepreneurship-specific course modifications to both a first-year engineering course and to a second-year engineering design course (including collaboration with business faculty and students), 2) creation of entrepreneurially-relevant extracurricular clubs, activities, and events for students on campus and 3) introduction to extra-university interaction opportunities for engineering students interested in entrepreneurship with both the private sector and with students and mentors from other universities. It is hoped that descriptions of lessons learned and anecdotal evidence of successes may benefit other institutions attempting to more closely integrate entrepreneurial concepts with engineering education.

Introduction

There is an increasing interest and demand from students across the country for entrepreneurship education. As highlighted in a recent New York Times article[1], the number of college courses in entrepreneurship has risen from only about 250 in 1985 to so many that more than 400,000 students were enrolled in such courses by 2013[2]. According to the *Chronicle for Higher Education*, "Colleges are responding to this interest, and fueling it, by offering more undergraduate courses, programs, and extracurricular activities that promise to cultivate an entrepreneurial mind-set and develop skills needed in this start-up world. Risk taking, in a way, has become the new critical thinking. It's what colleges believe they need to teach for graduates to meet the needs of today's work force. For students, entrepreneurship offers the creativity and independence that traditional careers seem to lack" [3,4].

Integrating entrepreneurial skills and activities into the Engineering program may be one way to respond to the serious challenge of Engineering student retention, especially in the transition between freshman and sophomore years[5,6,7]. It has been reported that students may decide to leave engineering if motivation for the required hard work is not provided via engaging courses that relate engineering theory to the reasons they originally chose engineering. In other words, students need to be provided with perspective both within the classroom and through extra-curricular opportunities. It is anticipated that encouraging students to adopt an entrepreneurial approach to their coursework may increase retention, which has been shown to be dependent on student ability to relate coursework to both educational and professional objectives[5,6,7], and may help to produce graduates who are better prepared for the demands of engineering as a profession.

This paper intends to communicate successful/well-received attempts (as well as some other lessons learned) to engage engineering students via an entrepreneurial approach to two

traditional engineering courses, through connections to a campus-wide network of entrepreneurially relevant opportunities, and by linking students to a wider regional community of extra-university entrepreneurs and resources.

What have others done?

Clearly, as indicated in the previously cited New York Times article, entrepreneurship opportunities on campuses nationwide have exploded. Many exciting communications from Kern Entrepreneurial Engineering Network (KEEN) schools and others at conferences nationwide support the idea that entrepreneurship and engineering are a good fit. According to that organization's web-site[8], their network is "a collaborative network of [over 20] colleges and professors championing the entrepreneurial mindset in engineering undergraduate students" with a stated mission "to graduate engineers with an entrepreneurial mindset so they can create personal, economic, and societal value through a lifetime of meaningful work." Including an entrepreneurial mindset in an engineering curriculum, discussed more completely in a paper by Kriewall and Mekemson's,[9] is one where unmet customer needs are coupled with traditional engineering approaches to problem solving and can lead to potential benefits to both individual students and to society as a whole. Similarly, presentations from 2015's ASEE Annual Conference and Exposition concerning Epicenter[10], the National Center for Engineering Pathways to Innovation showcased another inspiring example. Their stated mission "…is to empower U.S. undergraduate engineering students to bring their ideas to life for the benefit of our economy and society" by "offering entrepreneurship and innovation programs to engineering faculty and students." These and many, many other examples make it very clear that an entrepreneurial mindset can inspire students and, in addition to a traditional engineering program, is a necessity for a subset of today's engineering students.

History of Entrepreneurship Efforts at Pitt-Johnstown

The following brief history of entrepreneurship efforts at Pitt-Johnstown is intended to provide context, supporting the contention that a corner has been turned and that the current path has and will continue to lead to positive outcomes for our students and our region. Uncoordinated efforts in the Business program and in Engineering without sufficient infrastructure and consistent champions has led to several fits and starts. The Entrepreneurship Program at the University of Pittsburgh at Johnstown (Pitt-Johnstown) originated in the Business program and has emerged in fits and starts. In the 1990s, a local grant supported a pilot program to pair business students interested in starting companies with mentors in the local business community, but the pilot ended when the grant was exhausted. Discussions in the late 2000s between faculty in Business and English Literature about resurrecting the entrepreneurship mentoring program to support the growing number of military veterans returning to school also reached a dead end.

During this same time, the Engineering program contained the seeds of entrepreneurial opportunities but had not yet created a fertile curricular soil for those seeds to take root. Because all faculty have both appropriate education and significant industrial experience, students have been exposed to real-world perspectives on the engineer's role in business and industry across many core courses. The most directly relevant entrepreneurial content for engineering students has been provided via an Engineering Design course for Electrical and Mechanical engineers, an

Engineering Economics course required for all engineering undergraduates, a Construction Management course for Civil Engineering students, and, perhaps most importantly, capstone Proposal and Senior Project courses for all majors. The importance of understanding risk and liability, of continuous professional development including licensure, and of ethics in engineering practice, all of which are relevant concepts for an entrepreneurial approach to engineering, have been stressed. Historically, senior projects that have led to longer-term student-private sector collaborations or even student-initiated business have been rare.

Recently, entrepreneurship at Pitt-Johnstown has experienced a revitalization. A renewed push to create an Entrepreneurial Studies program came from Pitt-Johnstown President Jem Spectar in 2011. This led first to an agreement with Johnstown Area Regional Industries (JARI) to support entrepreneurial internships for Pitt-Johnstown students and, subsequently, the Business Department head and several Business faculty members drafted a proposal for a new major in Entrepreneurship to be housed in the Business department and modeled on traditional academic majors. This new major was to require at least ten 3-credit, 15-week classes in Business and Entrepreneurship; however, when one of the faculty leaders on the proposal resigned her position, the Business Department head decided to abandon the traditional curriculum proposal path and to be more nimble and opportunistic in offering entrepreneurial educational opportunities primarily to Business students. It was not yet clear who the customers for a new Entrepreneurship major would be, but several faculty members were anxious to move forward with piloting an applied entrepreneurship course.

A collaboration then emerged among marketing faculty to offer a course called "Entrepreneurs Idea Lab" (EIL) that adapted the lessons from MIT's Bill Aulet, author of *Disciplined Entrepreneurship: 24 Steps to a Successful Startup*[11]. The EIL was rolled out as a boot camp whose ultimate goal was to prepare students to pitch a business idea to potential investors. "Sharks" were recruited from among local businesses and the entrepreneurial community to provide feedback to students at the midterm and then to judge pitches at the end of the semester. The sharks were impressed with the students' ideas and the students were energized by the competition and feedback. A local supporter of Pitt-Johnstown student entrepreneurs eventually provided funding to award $1000, $500, and $200 to student pitches that judges rated as first, second, and third best in subsequent semesters.

Figure 1: EIL marketing flyer[12]

At the same time, an effort was made to create a space on campus for entrepreneurial brainstorming, idea development, and innovative collaboration (Figure 2). The University allocated a large classroom to what became the "Idea Lab" and marketing faculty secured a foundation grant to purchase a 3D printer, writeable tables, and IPads. Gift funds were used to install ceiling-to-floor white boards and cork wall boards, and creative scrounging on campus secured a large boardroom table, comfortable chairs, a smart board, computers, and a projector. The Idea Lab was designed partly after the "Innovation Floor" at the Swanson School of Engineering at the University's main campus which had been toured by the Business department head and the instructor of the EIL. For more information, see content at http://www.pittstartup.org.

Figure 2: Cook Family Idea Lab[13]

Entrepreneurial Alchemy (EA) and Pitch-Fest at Showcase for Commerce

A separate collaborative effort that has been very successful in bringing together students, faculty, and the business community is a local entrepreneur's meet-up group called Entrepreneurial Alchemy (EA).

Figure 3: Entrepreneurial Alchemy[14]

This group includes regional entrepreneurs, faculty members, Pitt-Johnstown staff, government officials, and leaders of local economic development agencies supported by a grant from Pennsylvania's Department of Community and Economic Development (DCED) that meets

monthly (since 2012) to develop programming and support for regional economic development efforts based on entrepreneurship. Among the products of its discussions was a proposal for a "Pitch-Fest"—an idea competition to be held during Johnstown's popular Showcase for Commerce, an annual event originally created by the late US Representative John Murtha and later sponsored by the Chamber of Commerce and JARI to bring Johnstown-area defense contractors together with government agencies to discuss contracts. The Pitch-Fest was intended to provide college students and local entrepreneurs another opportunity to pitch ideas to a panel of "sharks" with prize money provided by a local foundation and in-kind business development assistance offered by local businesses.

The Pitch-Fest at Showcase proved to be very popular, as pitches were made in the Stars and Stripes room of the Johnstown War Memorial Arena to an overflow crowd, nourished by a local craft brewer whose founder included a graduate of Pitt-Johnstown's Business program. The Pitch Fest competition included local entrepreneurs, graduates of Pitt-Johnstown's EIL, and, in 2014, a team of Pitt-Johnstown Engineering students who were recruited by the Business Department chair at an undergraduate research symposium where they were showcasing their senior project – a distribution device for customized e-cigarette recipes. The Engineering students were steered to a local investor to prepare for Pitch-Fest and a provisional patent was secured for an idea that originated from their Electrical Engineering Senior Project. The Engineering student team, one of four from Pitt-Johnstown, was among those to win awards (second place) in the pitch competition.

Figure 4: 2014 PitchFest at Showcase engineering team "Juice Box"[15]

This was a pivot point in the Pitt-Johnstown Entrepreneurship Program. It became clear that the Program needed to reach beyond Business students, to those from other disciplines across campus, many of whom who were required to innovate as part of their coursework. Through inclusion, divergent types of students could leverage unique domain knowledge to create unique and potentially commercially viable solutions to real problems. To make it easier for non-business students to fit an entrepreneurship class (e.g., EIL) into their schedules, the Business Department chair allowed Engineering and CS students to use the EIL to satisfy a General Education requirement. The instructor of the EIL course began making recruiting presentations to Engineering classes and distributing recruitment flyers to Engineering faculty. Faculty also sought and received assurances from the University that students would retain rights to any intellectual property produced in class. This pivot to expand the reach of the emerging entrepreneurship curriculum and to make adaptations to suit students with less flexible

schedules, especially engineering students, reflected a commitment by faculty and administrators to be entrepreneurial in seizing opportunities to develop the program.

Engineering Changes

As entrepreneurship activities proceeded in the Business Department, in the Engineering division, a first-year introductory course intended to familiarize students with computer applications for engineers was modified in 2013 to follow a new paradigm wherein course content was presented paralleling a real-world engineering consulting project. Topic-specific lectures focused on requisite computer application, analysis and writing skills were paced with periodic "business meetings." Those meetings were related to a semester-long data collection and analysis project which included a fun laboratory experiment to motivate students. Mini-companies of two students each were asked to treat the project as if they had been hired to perform a consulting job for a customer – their professor. The project provided context for the production of a series of typical engineering consulting documents: a formal introductory email, a follow-up cover letter, a meeting summary memo, a project specification document including an estimate/quote, project planning documentation, an interim technical progress report and financial summary, and a final technical report were woven through the fabric of the course.

Three iterations later, with minor continuous improvement modification based on student feedback and faculty insight, the course continues to follow the same basic approach. Seventy-seven percent of students responding to a course evaluation survey (N=58) would recommend or highly recommend this course to other students which compares favorably to only forty-seven percent (N=15) who would do so for the same course prior to the entrepreneurship modifications. To the question "What aspects of this course were most beneficial to you?" students responded:

- Everything, I will be doing this in the future.
- I enhanced my Word skills and improved my professional understanding of projects, deadlines, and how to work with a "customer" in order to make sure that they are happy.
- Learning how it will feel when we are in the real world working on a project. The interaction of consumer & client was another aspect I greatly appreciated.
- Showed me a simulation of a business project that I might have to do in the future and what exactly to do for that project and the business.
- This class introduced me to the world of engineering and got me thinking critically about how things will work after college. I have become more advanced in using Microsoft Word and Excel and Mathcad systems that I know will become relevant in the future.
- This course gave insight into the tasks that engineers complete on a regular basis. The final report and user manual truly feel like engineering consulting work.
- I learned a lot of things that pertain to the professional industry and to the real world. What I did in class will result in real world application.
- This course taught me how to communicate professionally as an engineer. The assignments required a large amount of time and effort but, in doing so, taught me how to manage my time more wisely and improved my work ethic. I believe this class

gave me a good feel for engineering and prepared me for future engineering classes/projects.

- Learning to think more outside of the box and be creative. Learning computer skills I will need in the future.
- Learning about being a professional engineer.

Hopefully, these course modifications will prepare students to take advantage of emerging entrepreneurial opportunities on campus. Collaboration among Pitt-Johnstown's Business and Engineering faculty and local business contacts as well as the success of the Engineering student team in 2014 raised the profile of the Pitch-Fest opportunity among Engineering students. In addition, a handful of second and third-year Engineering students, motivated by their first-year course experience, expressed a desire to pursue additional entrepreneurially-relevant opportunities. To meet that demand, Engineering Design, a required course for Mechanical and Electrical Engineering students was modified for the spring 2015 semester. Previously, student teams had been required to both complete a semester-long design project and to build a separate, unrelated physical prototype to compete in a "game" about half-way through the term. Those two course requirements were combined for 2015 and the "game" was changed to be a shark-tank type pitch competition for the student design projects. Course content was modified to include market and customer-specific elements using sections from *Disciplined Entrepreneurship*[11] to guide design decisions and local entrepreneurs and Business faculty were invited to lecture on relevant topics. By mid-semester, twenty-three teams had produced short "pitches" for their concepts and had competed in the course's shark-tank contest. Their efforts were scored by both a collection of faculty "sharks" and a large audience of their peers using the rubric illustrated in Table 1.

Table 1: Engineering Design Shark Tank Rubric

Item Evaluated					
Explanation of Product	1 Ill-defined product with no tie to customers	2 Mentioned the product, its need and the customers in passing	3 Attempted to explain the product, its need and the customers but information was inconsistent and/or poorly formulated	4 Explained the product, its need and the customers	5 Clearly explained the product, its need and the customers
Financial Viability	1 Did not consider or present any plan	2 Considered a plan but made a weak presentation	3 Had a plan that was not fundamentally sound	4 Plan seemed sound but not totally convincing	5 Presented a plan that convinced the audience
Questions and Answers	1 Not articulate answering questions. Team did not seem to have	2 Answered questions but it appeared that only one person knew	3 Team members involved in answering questions and	4 Answered questions well with some	5 Answered questions directly with factual information.

	fundamental knowledge of product	anything about the project	most of the answers made sense	hesitation in the replies	Did not hesitate with answers.
Overall Presentation	1 Went through the motions not at all convincing	2 Presentation was disjoint and did not cover all elements required	3 Satisfactory presentation got the idea but the presen-tation killed the deal	4 Excellent presentation but with no model	5 Excellent presentation that included some form of a model or visual representation
Would You Invest?	1 Thank you for attending	2 I'll provide 25% funding	3 I'll provide 50% funding	4 I'll provide 75% funding	5 I absolutely must have this!

Student and faculty response to the shark-tank game was so enthusiastic that this same model will be followed in 2016. Feedback provided during the game helped teams iterate on their designs for their final projects and several groups were so inspired by the process that they decided to continue their efforts after the course ended. When asked "What aspects of this course were most beneficial to you?" in a post-course evaluation, students responded with comments such as:

- I enjoyed and was glad to learn about the patent process and legal aspects of design. It is information that is not always clearly presented or easily accessible.
- It was different from what engineering students do every other day.
- Learning a little more about the business side of engineering.
- Taking one project and using it through the whole class.
- The engineer's week shark tank contest!
- The shark tank was the most beneficial part of the course.
- Understanding the needs of the customer's requirements for a product.
- The similarity to FIRST [FRC]. I found it interesting that what we learned was applicable to building robots. I think the house of quality and work breakdown structure could also help decide how to build the robot, how long it would take, and what sub-teams to make.
- The professor gave students great opportunities to learn from more experienced people from the local business community.
- Entrepreneurship lessons!

Inc.U

In 2014, as a result of faculty networking surrounding regional entrepreneurship opportunities, Pitt-Johnstown was invited by Engineering faculty at Penn State to collaborate on a grant proposal with Bucknell University to support student entrepreneurs and undergraduate entrepreneurship education. Pennsylvania's Department of Community & Economic Development awarded $500,000 to the three-school partnership called Inc.U. The grant allowed Pitt-Johnstown to expand the opportunity for students to compete and win investment support in the pitch at Showcase, subsequently rebranded as "PITTch-Fest" and embedded within a broader Makers Fair (Figure 5) on campus.

Figure 5: PITTch Fest and Makers PREMIER[16]

Student-businesses from Pitt-Johnstown, Carnegie Mellon, Bucknell, Indiana University of Pennsylvania, and Penn State competed in the University Division in May 2015 at PITTch-fest with the best of them going head-to-head against entries in the Open Division the next day. A team from Pitt-Johnstown made up of students in Marketing, Information Systems, and Computer Science, Healthponics, won first place in the student division (Figure 6).

Figure 6: Healthponics - a Pitt-Johnstown student team prize-winner at PITTch-Fest 2015[17]

The Inc.U grant also provided investment funds for student companies, to be awarded through a series of local shark tank-style competitions and culminating in a championship final round featuring two teams from each campus, hosted at PSU, to kick off Global Entrepreneurship Week in November 2015. Inspired by the Healthponics team example and the 2014 Electrical Engineering student Pitch-Fest award winning group, a student business from 2015's modified Engineering Design course decided to take their design, a motion-activated brake light for motorcycle helmet, even further. They worked independently through the summer and attended monthly entrepreneurial meet-ups held at the Cook Family Idea Lab at Pitt-Johnstown and sponsored through Entrepreneurial Alchemy. They networked with local professionals and, nurtured by those contacts, applied for a provisional patent by the beginning of the fall semester. This group attended "Boot Camp" pitch preparation sessions (which were supported by the Inc.U grant) in the fall of 2015 with Pitt-Johnstown's Marketing faculty, and competed and ultimately won the Pitt-Johnstown regional competition in November[18]. They then moved on to the three-university Inc.U finals (with the Healthponics team) and ultimately finished second at Penn State (Figure 7). According to members of team BrakeSafe, the following led to their pitch success[19]:

1) The inclusion of customer/market concepts in the Engineering Design course forced them to change their perspective from what they initially thought was important to what a customer/end-user would likely consider to be important.
2) They learned that there was more than one way to solve problems and that including the customer in evaluating a solution led to things they might not have considered on their own.
3) The opportunity to meet and interact with local entrepreneurs, both through the Design Course and via Meet-Ups and Entrepreneurial Alchemy meetings provided them with a network that helped them navigate the intellectual property protection world and helped them form a real business via legal and accounting help.
4) The Boot Camp sessions really helped them to prepare their winning "pitch-deck" which they believe made their idea stand out. It strengthened their technical content (the how) and highlighted the market potential for their idea in a relatable manner for investors.

Figure 7: Inc-U contest winners at Penn State, November 2015[20]

In addition, they suggested that even more outside experts should be brought to campus to provide entrepreneurial insight to engineers, either as part of a course or in conjunction with club or professional networking meetings.

Entrepreneurship Club

Unfortunately, not every collaborative effort to inspire students via entrepreneurial concepts and opportunities has resulted in stellar results, even given the resurgence of interest and allocation of resources. As an example, a faculty mentor for a student entrepreneurship club formed in the fall of 2014 reported[21] that the club currently falls into "this approach didn't work" category indicating that:

> *"…every meeting we had last semester was in response to an email sent to students asking if we were going to meet. If I didn't send something, the meeting didn't happen, even if it had been discussed in a previous meeting. We had several meetings whose purpose was to come up with a plan, but the students didn't follow through. Although a lot of students were initially interested in the idea of being entrepreneurial. They appeared to fall into three categories:*

1. *Those who were already participating in entrepreneurial activities and who ultimately didn't have the time or need to participate in another club. Many of them had taken [the EIL class] already and were actively pursuing their own projects.*

2. *Those who thought that being entrepreneurial sounded like fun, but didn't know how to contribute and faded away. There was at least one enthusiastic freshman in this category. I believe that with some guidance he could still be a real asset, and I'm sure there are others who can be cultivated, but without a clear mission for the club, it might be difficult to hold their interest.*

3. *A few wildly enthusiastic individuals who envisioned working on a community service/entrepreneurship project through the club. Unfortunately, the club lost momentum after several of these students graduated. One in particular graduated but expressed a willingness to continue working with the club for a specific service project.*

I believe that a combination of structured, generic activities (e.g. forming teams to create elevator pitches), talks by local entrepreneurs, and the opportunity to play a part in a larger project could generate the enthusiasm and continuity the club needs. Realistically, the club is ultimately the responsibility of the students and, although a mentor can be a coach/sounding board/cheerleader, it can't be done without student engagement.

With additional planning effort, the Entrepreneurship club may yet prove to be successful and faculty mentors will continue to provide guidance to students interested in proceeding. Local business advisors to the club have suggested that students first write a mission statement to define the club's purpose and to potentially create a document approximating a business plan to better define leadership responsibilities. In addition, Pitt-Johnstown's Concrete Canoe team, a model successful student club on Pitt-Johnstown's campus, suggests that the Entrepreneurship Club modify their by-laws such that club leaders be elected from first, second, and third year members. Then, after serving for a year, "retired" club leaders can pass their knowledge on to the next leadership class during their senior year.

Final Thoughts

Pitt-Johnstown is now in the final stages of receiving approval to offer an 18-credit minor, through the newly-formed Division of Business and Enterprise[22], in Entrepreneurship. This is another step toward creating a more robust Entrepreneurship Program on campus. Unlike the early false start with the proposal for an Entrepreneurship major, the minor has been developed with more awareness of the need to serve entrepreneurial students who remain interested in their chosen majors. A major challenge to Engineering students interested in entrepreneurship is that the requirements of their Engineering curriculum leave little flexibility to complete the additional six course minor as it is difficult for many to fit even the 3-credit EIL course in as a free elective. Therefore, the Entrepreneurship Minor will allow engineering students to count their 3-credit senior engineering project, and perhaps one additional 3-credit engineering course, toward the minor.

Pitt-Johnstown continues to develop an Entrepreneurship Program to meet the demands of all its students. In the *Higher Education Research Institute* (HERI) survey[23] that is administered annually to incoming freshmen, 30% of incoming Pitt-Johnstown freshmen indicated that "becoming successful in a business of my own" was "essential" or "very important" to them. Since Engineering students learn and practice making, building, and innovating to solve problems, they are obvious prospects to participate and excel in the Entrepreneurship Program. Pitt-Johnstown Engineering faculty are seeking to incorporate opportunities to develop entrepreneurial skills directly into Engineering courses and have championed efforts to offer both local and regional outlets for interested students. The administrators of the campus Entrepreneurship Program also intend to support Engineering students' entrepreneurial aspirations with outside-the-classroom training and support to better position those students to realize their entrepreneurial goals.

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