

AC 2007-591: CONVERTING ENGINEERING FACULTY TO EDUCATORS OF ENTREPRENEURS

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Converting Engineering Faculty to Educators of Entrepreneurs

Abstract

Including concepts of entrepreneurship in an engineering education is nothing new. It would be difficult to find a university that does not offer several courses or specific programs in entrepreneurship. However, finding large numbers of engineering programs that have fully incorporated entrepreneurship into their undergraduate engineering curricula is a far greater challenge. With the growth of outsourcing and global competition, it is imperative that engineering faculty be more than just educators of technically competent engineers. It is important that they be educators of entrepreneurs. This paper will describe a workshop that took initial steps to convince engineering faculty of the importance of educating engineering entrepreneurs and integrating entrepreneurship into an engineering curriculum. It will describe the workshop agenda, the assessment process used to measure if there was a change in faculty attitude, and the preliminary assessment results.

Introduction

How often do engineering students add features to a design because they believe the features to be innovative or important, and not because the client asked for or needed the features? Are the students encouraged to include the innovations to stretch their design skills or are they discouraged because they are not part of the specifications? The answer is probably both. Engineering faculty members want, and need, their students to demonstrate that they, the students, have learned engineering skills; that they are able to design to meet a customer's needs. Yet, should the students not be asked to stretch and explain how the client can capitalize on the new and innovative features; should the students be encouraged to be entrepreneurial? In general, engineering faculty members believe that teaching entrepreneurship is a sound idea; however, including it as an integral part of an engineering education is another story. How does one approach changing from educators of competent engineers, or what Carol Steiner refers to as "technipreneurs,"¹ to educators of engineering entrepreneurs?

Entrepreneurship in an engineering education is nothing new. Durgin and Zwiep describe the entrepreneurial aspects of the Worcester Polytechnic Institute (WPI) engineering programs dating back to 1865² and other engineering programs that integrate entrepreneurship into their curricula can be found.^{3,4} However, those programs are currently the exception, and finding an ABET-accredited engineering program that includes entrepreneurship as an integral part of its program educational objectives is unusual. A review of the program educational objectives of the 42 ABET-accredited biomedical engineering programs reveals that only two specifically include entrepreneurship as part of their program educational objectives. Only three others suggest its importance. Likely reasons for specifically excluding entrepreneurship from an engineering curriculum are the intensive requirements for mathematics, science, and engineering topics, and the need to meet university general education requirements.

On the surface, this appears to be a conundrum. Virtually any paper that describes an entrepreneur, describes her or him as someone who can formulate a problem, develop an idea

that solves the problem, can communicate his or her idea in oral and written form, and is knowledgeable in current societal and industrial practices. If you were to compare those characteristics with the outcomes listed in the ABET criteria⁵, you would be hard pressed to distinguish between characteristics expected of an engineering graduate and those of an entrepreneur.

So why is entrepreneurship not included in most engineering curricula? A likely significant reason is that most engineering programs are being pressured to reduce the number of credits in the four-year baccalaureate degree, rather than increase credits to include entrepreneurship. While 20 years ago it was common to require 140 credits for a BS degree in engineering, today many institutions will grant a BS degree with as few as 120 semester credits (180 quarter credits). Pressures from state legislatures and parents have forced engineering colleges to lower the bar on the number of credits required for an undergraduate degree. As a result, engineering faculty are reluctant to add what they consider non-engineering topics. They are educating “technipreneurs” or engineers who try to set up their own technology businesses rather than develop businesses that will profit from the technology.^{1,6} As Nada Dabbagh and Daniel A. Menascé state, “Engineering curricula have often exclusively emphasized the technical dimension of the engineering profession.”⁷

Faculty Workshop Agenda

In an effort to address the engineer versus entrepreneur conundrum, the biomedical engineering (BE) program faculty at the Milwaukee School of Engineering (MSOE) and faculty from the MSOE Rader School of Business, with the support of the Kern Family Foundation and the National Collegiate Inventors and Innovators Alliance (NCIIA), proposed integrating entrepreneurship into the biomedical engineering curriculum beginning with the 2006 freshman class. The BE program was chosen because its curriculum includes a four-year design sequence, thus allowing continual infusion of entrepreneurial principles into the design process.^{8,9} Additionally, the MSOE BE program specifically includes entrepreneurship in its program educational objectives. The four-year design program, specific inclusion of entrepreneurship in its program educational objectives, and the faculty’s willingness to participate, made the BE program the logical choice for the formal introduction of entrepreneurship in its curriculum.

Having chosen where to begin, the next step was to convince the faculty of the need by presenting an entrepreneurship workshop. The goal for the workshop was to present a convincing case for either increasing content or replacing perceived critical engineering curricular material. The following specific outcomes were set for the workshop:

- Demonstrate administrative support for an integrated entrepreneurship program.
- Convince all BE faculty and other invited engineering faculty of the importance of including entrepreneurship concepts in the engineering courses.
- Present a model for how entrepreneurship can be integrated into an already overcrowded curriculum.
- Demonstrate that graduates who understand entrepreneurship are strategic assets to their employers.

The following workshop agenda was developed to meet the overall objectives:

- Lunch and with a keynote speaker:
 - The importance of private sector research and development, and patent activity in the southeast Wisconsin region.
- A presentation on the KEEN grant that described the following:
 - The KEEN entrepreneurship grant and the role of the faculty.
 - The role of entrepreneurship at the university.
 - Opportunities for faculty and students.
- The president's vision of entrepreneurship and its importance to the university.
- SBIR and STTR – current university activities and the opportunities for the faculty.
- How to make entrepreneurship work; knowing and understanding the resources.
 - Introduction to NCIIA.
 - How to write an NCIIA grant.
 - NCIIA grant requirements.
 - The KEEN grant web page.
- Invited speakers for the following topics:
 - Entrepreneurship
 - Patents and intellectual property
 - The university's patent policy
- The vision of entrepreneurship by the vice president of academics and where it is leading the university.
- Post-workshop assessment questionnaire.
- Dinner, roundtable discussions, and networking.

Assessment Process

As stated previously, the belief was that the workshop would educate faculty of the importance of including entrepreneurship in the engineering curriculum and increase support for entrepreneurship education in the engineering design programs. To assess that hypothesis, the faculty were asked to participate in an IRB approved assessment survey. The study examined whether there is a change in attitude toward entrepreneurship among faculty who attend. The specific null hypothesis was: There is no difference in faculty understanding and attitudes toward entrepreneurship as a result of participating in the workshop.

Faculty from the BE program, the School of Business, program directors from all other engineering programs, and other interested faculty were invited to the workshop. All attendees were asked to complete a pre- and post-workshop survey to assess workshop effectiveness. Participant information such as name, department, and position was not asked or recorded to satisfy IRB protocol. Although all participants were asked to complete the survey, it was not a requirement to participate in the workshop. Results are presented in Table 1.

Discussion

Four outcomes were defined for the workshop, the first being demonstration of administrative support for having entrepreneurship integrated into all engineering curricula. While

effectiveness of administrative support was not specifically assessed, the university president and the chief academic officer were both present, both gave presentations, and both expressed strong support for the program. Additionally, there have been measurable results. Efforts are currently underway to specifically include entrepreneurship in the university’s published educational objectives. Entrepreneurship will also be included in the university’s student recruitment efforts.

Table 1: Assessment results of the effectiveness of the faculty workshop on entrepreneurship. (Note: Question two was different in the “before” and “after” surveys. As a result, the responses are separated. Future surveys will reword the questions so they are the same before and after.)

Survey Questions	Agree and Strongly Agree before	Agree and Strongly Agree after
I believe that:		
1. students should consider being entrepreneurs.	87%	100%
2. there is a role for entrepreneurship in all engineering program design courses	82%	
2. all engineering program design courses should include entrepreneurship.		81%
3. teaching entrepreneurship to the engineering students in a sound idea.	91%	100%
4. the faculty member's role in entrepreneurship is important.	83%	86%
5. we can make entrepreneurship work at the university.	64%	90%
6. introducing entrepreneurship through the design curricula is a good approach	73%	95%
7. I stand to gain personally through my involvement with the KEEN program.	35%	52%
8. I will get something in return if I am involved in the KEEN program.	32%	52%
I have a good understanding of:		
9. what it is to be an entrepreneur.	87%	62%
10. how to introduce entrepreneurship into the engineering design curriculum.	19%	42%
11. the NCIIA.	33%	69%
12. grants available for student design teams from NCIIA.	36%	69%
13. how to write an NCIIA grant.	18%	23%
14. the KEEN Entrepreneurship initiative.	27%	77%
15. the goal of the KEEN Entrepreneurship initiative.	52%	92%
16. SBIRs or STTRs.	32%	75%
17. how to protect student intellectual property (IP).	39%	77%
18. university's patent policy.	45%	85%
19. where to find university’s patents policy.	45%	77%
20. the plan to introduce entrepreneurship in the BE design program.	38%	58%

The second defined workshop outcome was to convince the faculty of the importance of including entrepreneurship in the engineering curriculum. Preliminary statistical analysis of the assessment survey results shown in Table 1 rejects the null hypothesis that there was no change in faculty attitude toward and understanding of entrepreneurship at a significance level less than

0.05 using both an unpaired *t*-test and the Mann-Whitney 2-sample rank test. These results suggest that faculty attitudes toward and understanding of entrepreneurship of those who were involved in the workshop became more favorable toward including entrepreneurship in the engineering design curriculum.

The improvement in attitude and understanding is likely the result of the presentation of an overview of the KEEN Entrepreneurship Grant and the role of the faculty in the grant. Other topics believed important include presentations on the role of entrepreneurship at the university, opportunities for faculty and students, current SBIR and STTR activity at the university and the related opportunities for the faculty. The workshop also introduced the NCIIA, discussed how to write an NCIIA grant and NCIIA grant requirements, and the MSOE KEEN grant web page.

An even more striking change is seen in faculty understanding of various concepts of entrepreneurship. Statistical analysis of survey responses specifically addressing faculty understanding of entrepreneurial concepts rejected the null hypothesis that there was no change in faculty understanding of topics relating to entrepreneurship at a significance level less than 0.01 using an unpaired *t*-test and the Mann-Whitney 2-sample rank test. These results strongly suggest that faculty who were involved in the workshop gained a greater understanding of entrepreneurship and why it is important in the engineering design curriculum.

A third objective of the workshop was to convince attendees that a graduate who understands entrepreneurship is a strategic asset and adds immediate value to employers. This objective was addressed through anecdotal presentations from regional industrialists. Individual corporate leaders who believe in the importance of entrepreneurship were invited to present their visions of entrepreneurship. The hope was that attendees would be convinced of the importance of entrepreneurship and what is referred to as “intrapreneurship.” The keynote speaker presented the importance of private sector R&D and patent activity in the southeast Wisconsin region, several graduates who became entrepreneurs spoke of their experiences and the need to understand entrepreneurship; and MSOE’s dean of applied research encouraged innovation and entrepreneurship. While not directly measured in the survey, a positive change in attitude can be inferred.

The final program objective was to present a model for how entrepreneurship can be integrated into an already overcrowded curriculum. The proposed model includes curricular and extracurricular approaches. In the curricular approach, modules that introduce key concepts of entrepreneurship would be strategically incorporated into the biomedical engineering design sequence. The long-term goal of the KEEN project is to develop 10 to 12 lectures and laboratory activities that can be incorporated into a design program, thus capitalizing on the four-year design curriculum.

The first four “entrepreneurship” modules have been developed for the freshman design course. Topics include intellectual property, IP protection, market and customer needs, and entrepreneurship. Future modules are still under development. A pre- and post-course student assessment survey developed by the NCIIA KEEN project team will be administered and analyzed upon completion of the freshman course. While introduced in a four-year design

curriculum, it is believed that the entrepreneurship modules will be useable in any design sequence.

The extracurricular activities were initiated by the School of Business in cooperation with the various engineering programs. Over 40 students attended the initial meeting in the fall 2006-07 academic quarter. The organization has been active and growing since its inception. A measure of success is seen in a team of MSOE engineering and business students who finished second in the 2007 Chicago Entrepreneurs Quest held February 16, 2007.

Conclusion

The workshop assessment survey results clearly demonstrate the success of the workshop. Additionally, there has been significant progress in introducing entrepreneurship into the biomedical engineering curriculum. Survey results clearly demonstrate that the faculty who attended the workshop believe entrepreneurship should be included as part of an engineering curriculum. The results also show a significant increase in understanding by attendees of various concepts that workshop planners believe are important. A particularly interesting data point is seen for the survey question "I have a good understanding of what it is to be an entrepreneur." Responses to this survey question suggest that participants had preconceived ideas of what it is to be an entrepreneur and the workshop changed their understanding. This response also suggests that additional resources need to be applied to educating faculty on what it is to be an entrepreneur.

In summary, approximately 40 faculty and staff attended the entrepreneurship workshop, believed it was worthwhile, and believe that future workshops should be planned. Those attending received clear statements of support from the university's administration for an integrated university-wide entrepreneurship program. The assessment survey results strongly suggest faculty who attended were convinced of the importance of including entrepreneurship concepts in the engineering design curriculum. Additionally, a model was presented describing how entrepreneurship can be integrated into an already overcrowded engineering curriculum. The faculty learned how graduates who understand entrepreneurship are immediate strategic assets to an employer.

Recognition

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