2006-1462: THE BABSON-OLIN SYMPOSIUM FOR ENGINEERING ENTREPRENEURSHIP EDUCATORS: HELPING ENGINEERING FACULTY TEACH ENTREPRENEURSHIP

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1997, the Pew Charitable Trusts recognized this effort by selecting Babson for a Pew Leadership Award for renewal of undergraduate education. Dr. Schiffman holds a Ph.D. in mathematics from Dartmouth College as well as an M.S. in management from the Sloan School at MIT. He has taught at the University of Colorado and Colorado College. Prior to joining Babson, he worked at Digital Equipment Corporation.

The Babson-Olin Symposium for Engineering Entrepreneurship Educators: Helping Engineering Faculty Teach Entrepreneurship

Introduction

The pace of innovation and change is demanding that students of engineering engage in business activities that generate social and economic value. Yet, traditional engineering education is no longer sufficient in competitive, uncertain environments. For the past 15 years we have witnessed many business schools and engineering schools form partnerships – some have succeeded but many have failed or continue to struggle. Overall, most partnerships are not meeting original expectations; various constraints are limiting the impact of such partnerships. Rather than dependence on business school faculty to teach entrepreneurship to engineering students, Babson College and Olin College of Engineering developed a program with an aim of helping engineering educators better teach entrepreneurship and build entrepreneurship into their own engineering curricula.

The Babson-Olin Symposium for Engineering Entrepreneurship Educators (SyE^3) is funded by a three year grant from the National Science Foundation with additional support from the National Collegiate Inventors and Innovators Alliance. The primary goal of Babson-Olin SyE^3 is to assist engineering faculty and technology entrepreneurs in teaching and applying entrepreneurship as a core feature of engineering education. Engineering fosters innovation and is a leading source of technological progress. The collision of engineering and entrepreneurship is a value enhancing process that stimulates venture formation, economic growth, and social value.

The NSF partnership between Babson College and Olin College of Engineering is logical and both colleges have an institutional commitment to engineering entrepreneurship education. Such a commitment is marked by many shared activities and outreach development such as SyE^3. Babson College, a business school founded in 1919 by entrepreneur and financier Roger Babson, is an AACSB (The Association to Advance Collegiate Schools of Business) accredited institution and has been ranked #1 in entrepreneurship for the past twelve years according to *U.S. News & World Report*. Babson has been the standard in entrepreneurship education. The College was one of the first business schools to offer entrepreneurship courses and it hails as a benchmark for curriculum development.[1] The entrepreneurial spirit of the college is evident through our core values of integrity, diversity, innovation, collaboration, and excellence that are manifested in the mission of the college: "Babson College educates men and women to be entrepreneurial leaders in a rapidly changing world. We prepare them to identify opportunities and initiate actions that result in genuine accomplishment."[2]

The Olin College of Engineering is located adjacent to Babson College near Boston, MA. Olin was founded in 1997 and the first class was enrolled in the fall of 2002. The vision of the College and its subsequent curriculum development is a triumvirate of "superb engineering" in conjunction with the arts and business and entrepreneurship.[3] The Olin mission is one of vision and passion for change: "Olin College prepares future leaders through an innovative engineering education that bridges science and technology, enterprise, and society. Skilled in independent

learning and the art of design, our graduates will seek opportunities and take initiative to make a positive difference in the world".[4] Olin engineers have competencies in the technical and commercial aspects of innovation and are trained to assume leadership roles across organizations rather than focusing solely on technical paths of promotion. The emphasis on entrepreneurship fosters a mindset that encourages students to create for a purpose and develop skills with a mindset that views problem solving as a process of opportunity identification with a customer and/or organization focus. Olin's close proximity to Babson and its focus on entrepreneurship was a purposeful attempt to influence engineering education.

The pilot offering of Babson-Olin SyE^3 was held June 21-25, 2005, on the campuses of Babson College and the Olin College of Engineering. The purpose of this paper is three-fold. First, we highlight the need for SyE^3 as evidenced by the current literature on engineering entrepreneurship education, which includes a discussion on available programs that complement the Babson-Olin program. The addition of Babson-Olin SyE^3 fills a gap in the field that, if successful and sustainable, can add to the critical mass of programs encouraging the infusion of entrepreneurship into engineering and its many sub-disciplines. Second, we describe Babson-Olin SyE^3 in terms of content, structure, and pilot offering participants. Third, we discuss the primary learning goals and measure the accomplishment of these goals based on participant feedback. We will conclude with a brief description of future offerings.

Engineering Entrepreneurship Education: Change in Motion

The current state of engineering education is wrought with great challenges, which creates an immense opportunity horizon. The groundwork to explore new opportunities in engineering education has been laid by the reform of ABET criteria and calls for action by such publications as Engineer 2020.[5,6] Today's engineer and his or her technical skills are being rivaled by the globalization of the field leading to a commoditization of engineers.[7] Competition for talent with countries such as India and China is unprecedented and the field is likely to experience price wars for technical literacy. Thus, the need arises to differentiate the U.S-educated engineer in order to remain competitive domestically and globally.

Education reform is a slow process unlike the technological change the world has experienced over the past two decades. To illustrate the magnitude of technological change, consider the introduction of the telephone in 1875. It took 35 years for 25% of the U.S. population to adopt the technology, whereas, it only took 13 years for the same percent of the population to adopt cell phone technology.[8] The rate of consumer acceptance in conjunction with the pace of change demands swifter reform in engineering education in order to meet the talent pool demands of society. It has been suggested that engineering education in the United States needs to be at the forefront of cutting edge research in order to expand technological capabilities that appear to be shrinking compared to our global competitors.[9] Traditional engineering education emphasizes "design-and-build" and rewards technical excellence and solving single disciplinary problems.[9,10]

Increasing the nation's technical capability or educating for technical excellence is a necessary but not sufficient criterion for engineering success in today's competitive landscape. The process of invention is only the beginning of the innovation journey.[11] Companies of all

ages and sizes are looking for future paths to growth typically grounded in innovation activities;[12,13] therefore, the technical skill needed for invention needs to be matched by entrepreneurial acumen for commercialization resulting in start up ventures or a new ventures within existing organizations. The continued downsizing of corporations and the limited resources of start up companies require the technical and business side of innovation to be merged. A technical person with business skill and entrepreneurial experience is highly marketable both from a corporate recruiting and venture capital investing perspective.

Bjorkland & Colbeck interviewed twenty seven leaders in engineering education to determine the most significant changes over the last ten years.[14] Of the 27 interviewed, 26 indicated the change in how design is taught to be very significant. The authors noted the early exposure of design courses during the first year as well as design principles being infused throughout the curriculum. One of the interviewees expressed concern over that lack of progress on teaching design effectively and stated:

> "I don't see [changes in teaching design]. I think we're still to the stone's edge of the traditional with very little emphasis on design only because faculty do not understand design. I think we can look forward to the time that will change. I don't know how long a time we're talking about, because obviously it takes academia a while to make those changes."[14]

The need for a "new" engineer is gaining widespread acceptance[15-17] and details of innovative experiments in engineering entrepreneurship education have been published.[18-22] Organizations such as the entrepreneurship division of ASEE, NCIIA, and Stanford's REE program are developing a critical mass of resources supporting engineering entrepreneurship.

The evidence in support of entrepreneurship education is growing. Economic impact, job creation, society enhancing innovation, understanding the financial value associated with innovation and commercialization, the soft-skills of business, and the opportunity to action orientation of entrepreneurship are undeniably beneficial to engineers graduating from American colleges and universities. Is education reform so slow really? Or are the issues around adopting entrepreneurship as part of engineering curriculum similar to design teaching issues uncovered by Bjorkland & Colbeck above. Do engineering educators understand entrepreneurship? We suspect not. Can engineering educators understand entrepreneurship? Without a doubt. Are engineering educators motivated to learn about and then teach entrepreneurship? This is the aim of Babson-Olin SyE^3. Learning how to teach entrepreneurship and the motivation to engage is why the program was developed. The next section describes Babson-Olin SyE^3 and how it can help engineering educators teach and engage engineering students in entrepreneurship as well as gain support and start building an institutional commitment around entrepreneurship.

SyE^3 Program Description

Babson-Olin SyE3 enters the market of engineering entrepreneurship education on the heels of pioneers. Table 1 indicates the focus of what we believe to be the critical mass of programs supporting the growth of engineering entrepreneurship education. As previously noted, many programs have been introduced by individual colleges and universities, but larger

programs fostering, supporting, and providing resources to the engineering higher education public are of particular interest in this paper. NCIIA, ASEE Entrepreneurship Division, and Stanford's REE serve to facilitate, build knowledge, and stimulate communication respectively as it relates to engineering entrepreneurship education. Babson-Olin SyE^3 is designed to train engineering educators on the process and content of *teaching* entrepreneurship.

Insert Table 1 About Here

The pilot program was 3.5 days and the structure and content mapped to the broad phases of the entrepreneurial process, which includes opportunity generation, evaluation, commercialization (launch) and sustainability (See Figure 1). Content as well as process are critical to effective entrepreneurship education; therefore, various pedagogies across content areas were experienced by participants. The first day, however, was devoted to the challenges and opportunities of teaching at the engineering entrepreneurship interface. In other words, entrepreneurship education is needed, but why and how should you execute within the walls of your engineering college?

Insert Figure 1 About Here

A key design premise of the Babson-Olin program is a requirement of team participation. This "buddy system" is composed of an engineering educator paired with a technology entrepreneur that works together throughout the 3.5 day program. Teams of academics and practitioners create dynamism and diversity in the program classroom that encourages fruitful intellectual and practical collisions. Furthermore, the team format allows for exchanges and collaborations that can enrich curricula development and course/college strategy. The structured use of practitioners in the classroom is a pedagogical innovation that started in entrepreneurship and the use of adjunct professors that are practicing entrepreneurs is commonplace in business schools.[23] Adjunct professors that are technology entrepreneurs are ideal instructors in engineering entrepreneurship with the appropriate teacher training.

Participants in the pilot symposium attracted a diverse participant pool of ten teams representing a host of different institutions including MIT, Rose-Hulman Institute of Technology, Rowan University, Florida Gulf University, Hampton University, Illinois Institute of Technology, Jackson State University, Lawrence Technological University, Polytechnic University of Puerto Rico, and Salish Kootenai Tribal College. The majority of these institutions (82%) offered courses in entrepreneurship for engineering students and 40% of the participants have been teaching for at least fifteen years. The experience of the participants, both in teaching and in entrepreneurship education, was desired in the pilot offering to better assess the potential impact of Babson-Olin SyE^3.

Program Goals – Planned Versus Actual

Babson-Olin SyE^3 was designed to assist engineering faculty in their journey to teach and apply entrepreneurship as a core feature of engineering education. The primary goals of SyE^3 (the pilot) were:

- SyE^3 seeks to raise the technology entrepreneurship literacy of engineering faculty and their students and demonstrate the importance of this literacy to economic prosperity (job and wealth creation). This includes knowledge of the entrepreneurship process and identification of relevant linkages between engineering and entrepreneurship.
- SyE3 seeks to improve the art and craft of teaching entrepreneurship in engineering schools. This includes the use of case studies, simulations, and real world projects as alternative pedagogies.
- Motivation to understand and engage in the entrepreneurship process. With a recognition that engineers foster innovation in the economy, the importance of engineering entrepreneurship is critical for economic progress and competitiveness.

A pre and post survey was conducted to capture an indirect measure of program goal attainment and impact. Survey results (See Tables 2 and 3) indicate initial evidence of program impact and success, yet class size limits our ability to interpret findings beyond simple description. In addition to pre and post surveys, participants were asked to give feedback in an electronic journal using a course management program after each session. Qualitative comments from this feedback were incorporated into our analysis.

Insert Tables 2 & 3 About Here

Entrepreneurship Literacy. As a result of the Babson-Olin program, 84% of the participants see more linkages between engineering and entrepreneurship (table 3, item 10). Prior to the program, only 34% of participants felt *completely* confident in their understanding of entrepreneurship (table 1, item 1), but this percentage jumped to 53% in the post program survey (table 3, item 1). Furthermore, all participants either somewhat agreed or completely agreed that they were confident in their entrepreneurship understanding. Finally, 95% agree (table 3, item 9) that they have a better understanding of the *opportunities* related to engineering entrepreneurship education.

Teaching Entrepreneurship. Babson-Olin attendees did not have significant experience with the case method of teaching (table 2, item 2) and only 12% were completely comfortable using the case method. Post program results indicate that 89% of the attendees are more inclined to use case studies in the classroom (table 3, item 2). The case method of teaching is common place in business schools and particularly in entrepreneurship classrooms. Case studies are designed to amplify the problem-solving skills of students by encouraging students through discussion and the Socratic method to identify possible courses of action in order to address the issues of the case.[24] The discussion based approach of the case method encourages students to apply content and frameworks to a real world situation. A powerful combination used the Babson-Olin program was inviting the protagonist of the case, the entrepreneur, to address the

class after the instructor led the case discussion. Such a clash of theory and practice allows the case and the subsequent discussion to come alive.

Most participants were somewhat comfortable using project-based learning methodologies prior to the program, but their level of interest did not seem to increase as a result of the Babson-Olin program (table 2 – item 4 vs. table 3, item 3). When asked about their overall confidence level in teaching entrepreneurship, the pre survey average was 3.59 (neutral to somewhat agree), while the post survey average was 4.21 (somewhat agree to completely agree).

Participants were exposed to four case study discussions, a studio design experience, several role play exercises, and were required to make a short presentation called a "rocket pitch." Most of these alternative pedagogies were both new and engaging to the participants. Feedback from participants relative to the various pedagogies experienced included the following:

> *This was an exciting and interesting case and was one of the highlights of the program. I got some good ideas on how to get discussion on a case going and how to push the class to be decisive.*
>
> *This case is probably the most applicable case that I have seen for undergraduate engineering entrepreneurship. Many of the cases that we see (medical devices, information technology, big chemical companies...) are not necessarily something that the typical undergraduate student can relate to. I have sponsored over 50 undergraduate student entrepreneurial projects in the past 7 years and the successes, pitfalls etc. in this case study are quite similar to what my BEST students have encountered.*
>
> *[The design session was] exciting, challenging, interactive--a true learning experience.*
>
> *The Rocket Pitch activity was a follow up of the team activity at the Olin College Studio. Rocket pitch was an excellent demonstration of presentation of device/product information to an interested audience (consumer, investors, industry partners etc.).*

Motivation to understand and engage in entrepreneurship. Pre survey findings indicated some resistance to the notion that entrepreneurship should be a required component of engineering education (table 2, item 8). As a matter of fact 30% of the pre survey respondents had a neutral or negative opinion, yet 95% of the post survey respondents either somewhat agreed or completely agreed that entrepreneurship should be a required component of engineering education (table 3, item 7). These results underscore the importance of positioning entrepreneurship in the world of engineering. Preconceived notions need to be dispelled before the importance of entrepreneurship to engineering education can be embraced. The Babson-Olin program did an effective job in changing individuals' perceptions of entrepreneurship education.

The goals established for the Babson-Olin SyE^3 pilot offering were attained with 89% of the post survey respondents rating the program as "outstanding;" the remaining 11% rated the program as "good." The feedback solicited throughout the program was important as we develop the next face to face offering. As we move forward, we believe the goals of entrepreneurship literacy, excellence in teaching entrepreneurship, and motivation to engage in entrepreneurship create the appropriate purpose for Babson-Olin SyE^3.

Future Directions

In addition to the face-to-face 3.5 day program, we are currently designing an online version. We seek to build a community of practice around engineering entrepreneurship education and helping engineering educators feel comfortable teaching entrepreneurship. Our plans now include taking core elements from the face-to-face programs and providing these elements (e.g., teaching a case study, demonstrating how to do rocket pitches, defining entrepreneurship) as asynchronous learning modules coupled with synchronous events. We plan to offer online modules as way to scale up what we learn from the face-to-face events and to help build community in the knowing about and learning how to teach engineering entrepreneurship.

Conclusions

The importance of entrepreneurship education in engineering schools cannot be underestimated. The literature on engineering entrepreneurship education is building and the need for engineering entrepreneurship education is evident. Programs are being introduced and much knowledge is being acquired from innovative experiments and reform attempts. Accreditation criteria have been altered and reports written defining a qualified engineering graduate. However, the impact of entrepreneurship on the engineering school is not readily discussed. An engineering school producing entrepreneurs will likely attract capital (human and financial) to the region where the school operates. A study by Huffman and Quigley revealed that college graduates from the University of California at Berkeley (business and engineering graduates) foster economic development in the region through venture creation and participation in local companies.[25] Such results offer rationale behind geographic clusters such as Silicon Valley and Boston's Route 128. Similar results were found by Neck et al., in their study of the high–technology area of Boulder, Colorado.[26] It was shown that many of the largest companies that eventually spun off an exceptional number of high tech start ups would not have happened without the presence of a large research university. The research university has been a significant force in economic since Frederick Terman started of Silicon Valley after supporting Hewlett & Packard.[27,28] Companies are attracted to the talent pools provided by research universities. Neck et al. reported that 67% of the founders in their study located in Boulder for the talent pool from the University of Colorado.[26]

The engineer of tomorrow (but demanded today) is one with exceptional engineering skills and an aptitude for and abilities in entrepreneurship. Such a combination will have an economic and social impact that will be unprecedented. Imagine a world where engineering graduates not only can invent great things and solve complex problems but they can also identify the next big opportunity through a technology, customer, and market lens. The entrepreneurial engineer understands industries, markets, and the financial manifestation of their inventions.

They understand that their work, if demanded by markets, can produce jobs and impact national economies. They understand that invention is only half the battle. Commercialization is an art that requires understanding the process to market, which includes consideration of timing, strategy, resource needs, and growth opportunities. Babson-Olin SyE3 aims to train engineering educators to build the entrepreneurial mindset and skills of their students. Entrepreneurship will be the catalyst of change and progress for the engineers of tomorrow.

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Table 1
Critical Mass in Engineering Entrepreneurship Education

Program	Description/Mission	Source
NCIIA	Fosters invention, innovation, and entrepreneurship in higher education as a way of creating innovative, commercially viable, and socially beneficial businesses and employment opportunities in the United States.	http://www.nciia.org/who.html
ASEE Entrepreneurship Division	Foster and disseminate approaches to educate and stimulate faculty and students in entrepreneurship, including partnerships with business schools as well as the business and technology enterprise communities	http://www.nciia.org/asee/about.html
REE (Roundtable on Entrepreneurship Education)	Stimulate communication and collaboration between business, science, and engineering faculty who teach high-technology entrepreneurship in universities around the world.	http://ree.stanford.edu/
SyE3	Educate engineering educators about how to teach and apply entrepreneurship theory and practice as an integral part of engineering education. Babson-Olin SyE^3 Alumni will develop engineering graduates who not only have innovative ideas, but who can successfully transform their innovations into the products, systems, services, and companies that drive economic growth.	http://www3.babson.edu/ESHIP/outreach-events/symposia/babson-olinsye3.cfm

Figure 1
SyE3 Program Map

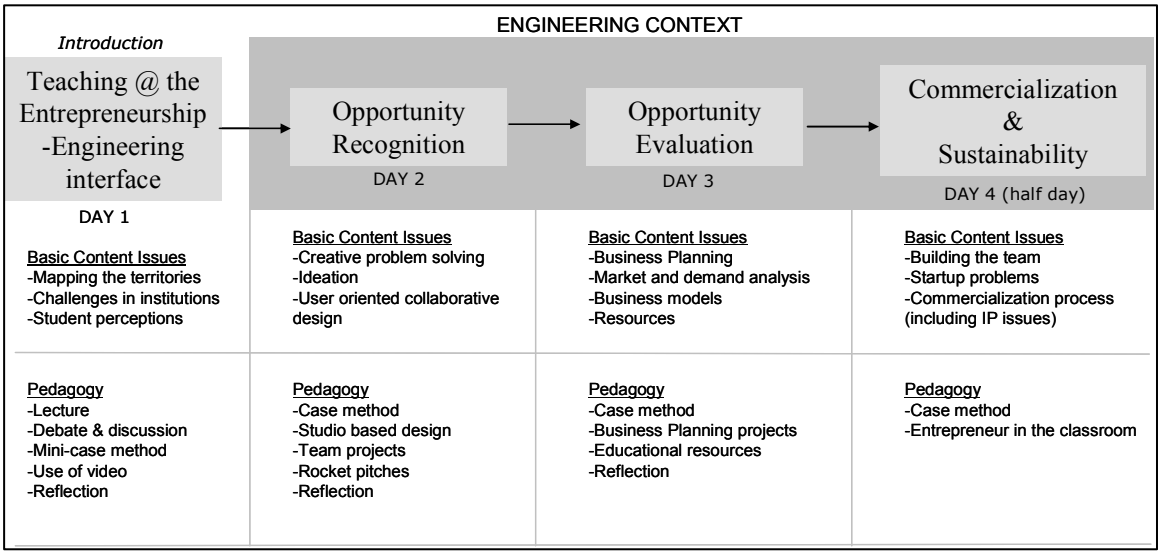

Table 2
Pre Survey (n=17)

	Completely Disagree (1)	Somewhat Disagree (2)	Neither Agree Nor Disagree (3)	Somewhat Agree (4)	Completely Agree (5)	Not Applicable (6)	Do Not Know (7)	Avg. Response
1. I feel confident in my understanding of entrepreneurship.	0% (0)	6% (1)	6% (1)	65% (11)	24% (4)	0% (0)	0% (0)	4.06
2. I have significant experience using the case method.	18% (3)	41% (7)	12% (2)	18% (3)	6% (1)	6% (1)	6% (1)	2.71
3. I am comfortable using the case teaching method.	0% (0)	35% (6)	12% (2)	29% (5)	12% (2)	0% (0)	12% (2)	3.65
4. I am comfortable using project-based learning methods.	0% (0)	0% (0)	6% (1)	53% (9)	35% (6)	6% (1)	0% (0)	4.41
5. I feel confident in my ability to teach entrepreneurship.	0% (0)	24% (4)	12% (2)	47% (8)	18% (3)	0% (0)	0% (0)	3.59
6. I would prefer to teach an entrepreneurship course with a practicing entrepreneur.	0% (0)	6% (1)	12% (2)	47% (8)	18% (3)	12% (2)	6% (1)	4.35
7. I believe entrepreneurship can be learned	0% (0)	6% (1)	6% (1)	41% (7)	41% (7)	0% (0)	6% (1)	4.41
8. Entrepreneurship should be a required component of an engineering curriculum.	6% (1)	6% (1)	18% (3)	24% (4)	47% (8)	0% (0)	0% (0)	4.0

Table 3
Post Survey (n=20)

	Completely Disagree (1)	Somewhat Disagree (2)	Neither Agree Nor Disagree (3)	Somewhat Agree (4)	Completely Agree (5)	Not Applicable (6)	Do Not Know (7)	Avg. Response
1. I feel confident in my understanding of entrepreneurship.	0% (0)	0% (0)	0% (0)	47% (9)	53% (10)	0% (0)	0% (0)	4.53
2. I am more inclined to use the case teaching method.	5% (1)	0% (0)	0% (0)	5% (1)	84% (16)	5% (1)	0% (0)	4.79
3. I am more inclined to use project-based learning methods.	6% (1)	6% (1)	11% (2)	22% (4)	56% (10)	0% (0)	0% (0)	4.17
4. I feel confident in my ability to teach entrepreneurship.	0% (0)	0% (0)	16% (3)	53% (10)	26% (5)	5% (1)	0% (0)	4.21
5. I would prefer to teach an entrepreneurship course with a practicing entrepreneur.	0% (0)	0% (0)	16% (3)	21% (4)	53% (10)	11% (2)	0% (0)	4.58
6. I believe entrepreneurship can be learned	0% (0)	0% (0)	5% (1)	42% (8)	53% (10)	0% (0)	0% (0)	4.47
7. Entrepreneurship should be a required component of an engineering curriculum.	0% (0)	5% (1)	0% (0)	32% (6)	63% (12)	0% (0)	0% (0)	4.53
8. I have a better understanding of the challenges related to engineering entrepreneurship education.	0% (0)	11% (2)	0% (0)	26% (5)	63% (12)	0% (0)	0% (0)	4.42
9. I have a better understanding of the opportunities related to engineering entrepreneurship education.	0% (0)	0% (0)	0% (0)	26% (5)	68% (13)	5% (1)	0% (0)	4.79
10. As a result of the Babson-Olin program, I see more linkages between engineering and entrepreneurship.	0% (0)	0% (0)	5% (1)	16% (3)	68% (13)	11% (2)	0% (0)	4.84