Recent Graduates Perspectives on Innovation and Entrepreneurship and the Creation of New Entrepreneurship Course

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Recent Graduates' Perspectives on Innovation and Entrepreneurship and the Creation of a New Entrepreneurship Course

Abstract

Many Electrical and Computer Engineering students at the University of North Carolina at Charlotte showed an interest in entrepreneurship when interviewed during their senior exit interview. Several students highlighted the existence of a taste of innovation in our capstone senior design classes (SDI and SDII) and elaborated on the mechanism of entrepreneurship in our Professional Practice course, but they all agreed that the department was missing a dedicated course on innovation and entrepreneurship.

This information encouraged us to conduct a survey to assess the true level of intensity. Two faculty from the Electrical and Computer Engineering Department interviewed students from the most recently completed Senior Design capstone course sequence to assess their perspectives on innovation and entrepreneurship. The faculty evaluated students ideas, compared the data from students who participated solely in industry supported projects versus students who worked on faculty sponsored projects. They analyzed this feedback and used it in the development of a new course for the benefit of future students. The survey was taken by thirty seven students; twenty two of them worked on an industry sponsored project, while fifteen students worked on faculty sponsored Senior Design projects. All thirty seven students were asked a specific set of questions geared toward identifying students' knowledge in identifying new business concepts, identifying opportunity, analyzing the market for a new venture; and determining the sales and market strategy for a product.

The results of the survey indicated the need for the students to learn about new venture opportunities, business concepts and strategies, and funding sources. The students also wanted to learn how to search for grant money from different sources. All these methods were incorporated into a new course "Technology Innovation and Entrepreneurship" for Engineering students that was offered in our department for the first time in the spring 2013 semester.

This course consisted of a mixture of graduate and undergraduate multidisciplinary students working on five projects; each project was unique, formed out of student or faculty ideas. Three out of the five teams projects continued working on the assigned project during their capstone senior design courses for the fall 2013-spring 2014 with a strong plan for commercialization of their product. These students were motivated, self-driven and excited about their projects and the possibility of launching a business successfully by using our program, and taking advantage of the resources available to them from our University's Office of Technology Transfer. While this course gives a chance for our students to work with a faculty on the development of a new product, it will build a foundation for our engineering students to pursue a certificate in Innovation and Entrepreneurship at our Business school, if they wish. This course helped students identify opportunities to implement all ideas; helped the individual managed business growth, and provided methods of using critical thinking. This course was designed to be valuable for engineering students who plan to embark on the process of innovation and entrepreneurship while practicing engineering.

Introduction

Faculty from the Electrical and Computer Engineering Department at the University of North Carolina at Charlotte were intrigued by the ASEE Entrepreneurship division presentations on entrepreneurship at ASEE conferences (2009, 2010 and 2011). Many presentations identified the availability of funds from National Collegiate Inventors and Innovators Alliance (NCIIA) for Universities[1,5] ; these funds can be used as seed money to support course development in entrepreneurship. Weilerstein, et al., indicated that "NCIIA alone has funded the creation and modification of over 200 new courses and programs since its inception"[5]. In the spring of 2012 the faculty researched other engineering colleges with entrepreneurship courses, prepared and submitted a proposal for a grant from NCIIA to support a new course in entrepreneurship at our department.

Research Overview

The objective of this study was to test our engineering students' entrepreneurship skills and to embark on methods and techniques to help our students improve on those skills. The faculty first research goal was to create multiple opportunities for the students to practice on the theory of commercialization while working on a real project. The methodology was to create students and faculty projects where a team of students will work together on the designs of the project in one semester, prototyping the design in the second semester and promote it for commercialization in the third semester. We have taken a look at the study done by Creed, et al.[2], in "Engineering entrepreneurship: An example of a paradigm shift in engineering education". The authors implemented a similar approach but used Industry sponsored projects for entrepreneurship instead of using faculty and students projects. The need for such a program was highlighted by Creed, et al., by saying "The environment for engineering practice will continue to undergo a significant metamorphosis, driven by international competition in high-tech markets, globalization of manufacturing and services, the impact of exploding information technology, the cross-fertilization between traditional engineering disciplines, and the complicated issues associated with environmental protection and sustainable development"[2]. Our second goal was to train students on developing a nice marketing strategy while building a knowledge base of methods and grants opportunities to support new invention fund.

Literature Review

Past research shows the need for an educational shift in the general engineering curricula from a purely technical focus to one that will add entrepreneurial skills to complement their undergraduate engineering major. Angela Shartrand, et al.[1], in "Technology Entrepreneurship programs in U.S. Engineering Schools: An Analysis of programs at the undergraduate level" examined programs and courses offered at 340 ASEE member schools in the U.S. Their research showed that "entrepreneurship education is available in at least half of the engineering programmed examined and has been integrated within the engineering program in approximately 25% of these programs"[1]. We asked ourselves the question "do engineer need entrepreneurship skill?" Based on the article by Ochs, et al.[4], we read that "The engineer as inventor is certainly not new. Many innovative products that we enjoy today were created by engineers"[4]; therefore

we know that our approach to create a course in innovation and entrepreneurship to our engineering students will be accepted by our students with pleasure.

Sullivan, et al.[6], indicated that a course in innovation will be considered successful if the students experience the process of invention and innovation by saying "understanding the customer and market are critical for an invention to find a niche"[6] students should understand that "their inventions must reach the market in order to have an impact on the world"[6].

The Survey

The faculty developing this course interviewed Senior Design students and students of the most recently completed Senior Design capstone course sequence. They assessed student comments and noticed the need to offer an entrepreneurship course to our engineering students. The faculty followed up by surveying students (the survey questions are shown in Appendix A) to assess their perspective on innovation and Entrepreneurship. The faculty surveyed thirty seven students; twenty two of them worked on an Industry sponsored project and fifteen students worked on faculty sponsored Senior Design projects with potential entrepreneurship idea. The faculty evaluated student's ideas and compared the data from students who participated solely in Industry sponsor projects versus students worked on faculty sponsored projects. The faculty analyzed these feedbacks and utilized the data in the development of the new course for the benefit of current and future students.

Survey Data and Results

A summary of the survey data is seen in table 1 below. We started by analyzing the data received from the survey and looked at the first question: Did COE prepared you to be an entrepreneur? We noticed that 47% of the students working on a Faculty sponsored project said yes, while only 28% of the students working on an Industry project believe the college did, the same for the question on expanding Senior Design Project to develop a business, students on Faculty sponsored project showed more confidence (80%) than students working on Industry sponsored project (53%), see figure 1 below for the chart of this analysis.

Table 1: Student Perspectives

Question #	Industry		Faculty
1. Did COE prepare you to be an entrepreneur?	28%	**Yes**	47%
	44%	**No**	26.5%
	28%	**Not Sure**	26.5%
3. Idea of Senior Project to be expanded to develop a business	52%	**Yes**	80%
	24%	**No**	13.33%
	24%	**Not Sure**	6.67%
4. Create a patent from your design	19%	**Yes**	20%
	47.6%	**No**	80%
	33.4%	**Not Sure**	
5. Starting a business is		Easy	6.67%
	95%	Difficult	80%
	5%	Very "	13.33%

6. Do you like to be your own boss?	66.66%	Yes	73%
7. Interested in starting a business at some point in life	76.1%	Yes	53%
8. Do you have enough skill to start a business	28.6%	Yes	60%
9. Can identify a good business opportunity	71.5%	Yes	86.7%
10. Can you do a good market analysis about an idea	19%	Yes	46.66%
11. Manage risks	52%	Yes	66.667%
12. Building a knowledge data base about a product is a powerful tool	**100%**	Yes	**100%**
13. Do a strong market analysis and a sales strategy enable a new business to identify the target customer?	85.7%	Yes	93.3%
14. Do you consider yourself a strong leader?	66.67%	Yes	73.3%
15. identify resources for an organization	66.66	Yes	66.66%
16. Why do you think people start their own business?	100%	Own Boss	86.67%
17. Why do you think people don't start their own business?		see(*) below	

* Fear of failure, not enough money, a steady check, and government obstacle.

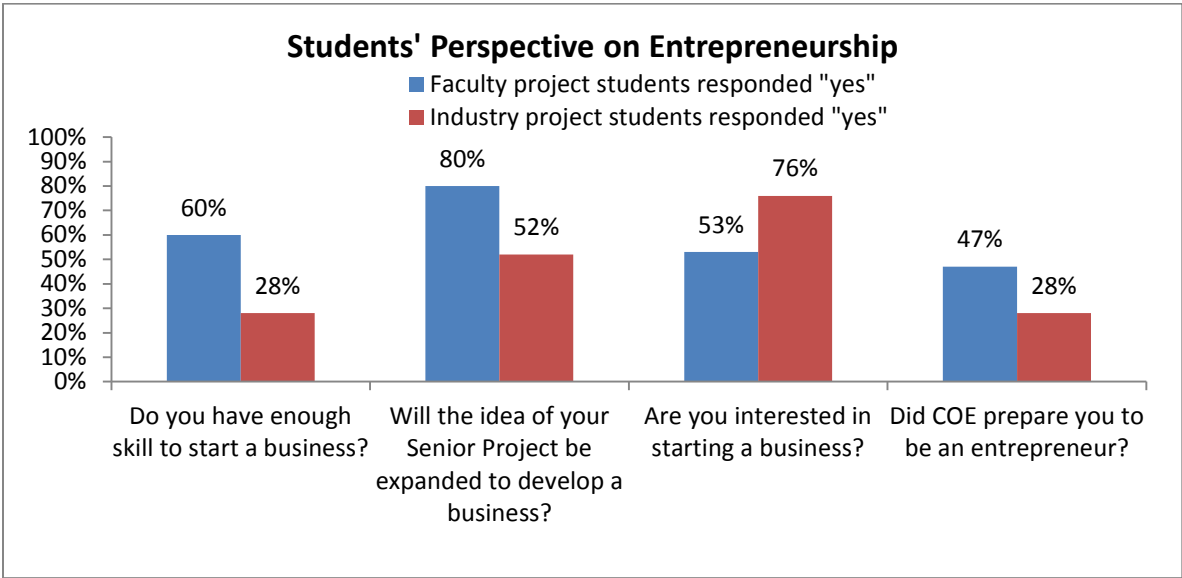Figure 1 below show the need to develop a course in entrepreneurship.

Figure 1: Survey data that indicate the need to develop a course in Entrepreneurship

When we asked "why people don't start their own business" almost all responded with fear of failure, not enough money, a steady check, and government obstacle. On creating a patent from their Senior Design a 20% of students said yes from both groups. It seems that 20% of the

students working on Faculty project had experience with creating a small business of which one consider the process an easy process while two students consider it very extremely difficult method, more procedure to create and follow. Table one provided us with a clear comparison of student's perspectives. If we analyze the data more carefully we see the need for students to learn about Technology Innovation, in order for them to identify good business opportunity, to learn how to do a market analysis for an idea, identify resources for an organization, figure 2 below shows students response and familiarity on this subject.
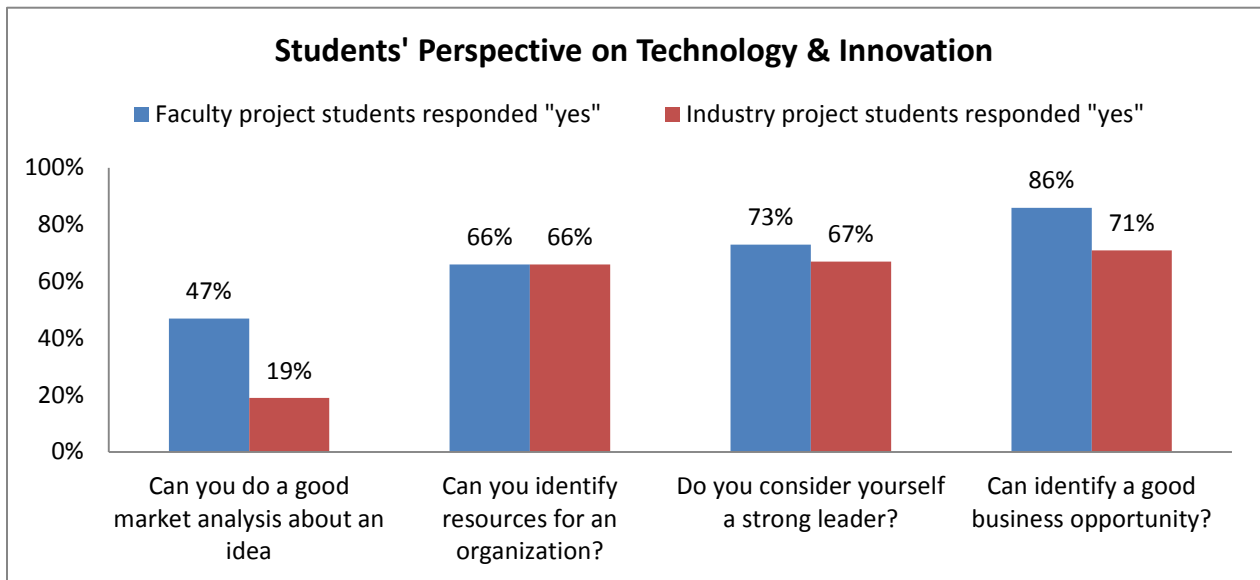

Students' Perspective on Technology & Innovation

■ Faculty project students responded "yes"   ■ Industry project students responded "yes"

	Can you do a good market analysis about an idea	Can you identify resources for an organization?	Do you consider yourself a strong leader?	Can identify a good business opportunity?
Faculty	47%	66%	73%	86%
Industry	19%	66%	67%	71%

Figure 2: Survey data that shows the need for Technology Innovation

Course and program plan of development

In the fall 2012 the faculty received confirmation of a grant approval from NCIIA to support building a course in innovation and Entrepreneurship at our engineering department.

Preparation for the course by supporting an entrepreneurship project in senior design

In preparation for the course we start looking for entrepreneurship programs in other Engineering school and we realized that in order for our program to be successful we need to consider and follow the model from Standish et al.[3] highlighted five elements that will define entrepreneurship in education they are "developing intellectual content, gaining institutional acceptance, engaging students and alumni, building relationships with the business community and lastly showcasing success"[3]. We used this model as the starting point for our plan of implementation to build our course; therefore the faculty generated and funded from this grant a senior design project starting in the fall of 2012. Two members of this team took ECGR4090 in the spring 2013 to work simultaneously with some graduate students on the business aspect of this project, this dynamic; working on the prototype and on the commercialization was a strong support to student's engagement. The design team consisted of five multidisciplinary (two computer, one electrical and two mechanical) students working together on designing a system that can create an

environment that will autonomously grow plants utilizing various types of sensors, the sensors and controls take the human factor out of the hydroponics process and allows for the plants to be grown in optimal growing conditions. The first goal of this project was to create a design and demonstrate a proof of concept of the design in the 2nd semester of this capstone sequence. This design can be utilized by a group of hobbyists (that don't have the room or time for a garden) as well as large corporation looking for more efficient, cheaper, autonomous way to monitor and grow their products. This system uses a database server, control system, and a Mobile Notification System (MNS). The server is used for data storage and hosting the MNS. The control system incorporates the Arduino microcontroller board for processing sensor measurements. Sensors are used to monitor pH, conductivity, and temperature of the environment. Peripherals attached to the control system are used to drive the sensor measurements. The mobile notification system utilizes JAVA, PACHE, and PYTHON languages. The designed control of the system uses the data reading to constantly maintain and balance the environment without any human interaction. The system incorporates a unique alert system via SMS if any sensors failed. The team completed the design by December 2012, and delivered a full prototype by the end of the spring semester of 2013 as seen in figure 3 (a) and (b) below.

Figure 3: (a) Nursery of the plants   (b) The actual prototype

We met our second goal by taking a subset of students from this team and formed a new group. This new team worked on the commercializing aspect of this project while attending our new course of Technology Innovation and Entrepreneurship in the spring 2013 semester.

The Course: ECGR 4090/5090 Technology Innovation and Entrepreneurship

Two faculty developed the course material and offered the course for the first time in the spring 2013 semester; enrollment was nineteen students (sixteen undergraduate and three graduate students), we formed five project teams where each group worked on an innovative technical product. A part of the course required all teams to submit an internal NCIIA "E-Team" proposal; group presented their proposal in an oral presentation defending their approach to the faculty and class. The instructors of the class selected the three top projects and assist the teams by submitting their proposals to the NCIIA E-Team Competition in May 2013. None of these projects were funded; but the teams received positive review.

Course Objective

This course was designed to be valuable for engineering students who plan to embark on the process of innovation and entrepreneurship while practicing in the field of engineering. Entrepreneurship concepts introduced in this course helped students identify opportunities to implement these ideas. This course helped students learn how to manage business growth, and provide them with the methods and skills to use critical thinking. Through lectures, case studies, reading materials and potential projects that cover ventures growth, this course provided students with the necessary background to successfully identify business opportunity, and to embark on forming a new enterprise. In this course we introduced the students to many concepts such as identifying business opportunities, finding innovative and competitive strategies and how to submit for a small business grant or other types of grants.

Course schedule

The text book used in this course was by Dorf, R.C., T.H. Byers, and N. Andrew, Technology Ventures: From Idea to Enterprise, McGraw-Hill, and Third Edition. The class followed the schedule from Table 2 below.

Table 2: Innovation & Entrepreneurial Class – Topics and Deliverables:

Week	Topics	Assignment Due and descriptions
1	Overview, introduction and the Entrepreneur	Read Chapter one
2	Identifying business opportunity	Read Chapters 1,2,3 and 4
3	Competitive Strategy	Read and study Appendix A Sample Business Plan
4	Innovation strategies/ SBIR proposal Opportunity Evaluation	Read Chapters 5, 6 and 7. Work on the Executive Summary of the project as a group.
5	Case study 1, team executive summary The Business Model	Case study paper due on 2/11/13
6	Risk, Reverse Engineering & SBIR Budget Posted on Moodle Design presentation.	In a group work on the Executive Summary, using Chapters 2,3,4, 6,11 and 12
7	Team Presentation on Executive Summary And DOD Tutorial http://www.dodsbir.net/tutorial/tour.htm	Team Executive Summary document is due on 2/26/13

8	*Spring Break Recess*	
9	Prototype, manufacturing and distribution plan	In a group or individually work on SBIR Proposal
10	Organization and Product Prototype	Read Chapter 12
11	Marketing, Sales Plan and Team Presentation SBIR	SBIR team proposal due on 3/11/13
12	Legal Formation and intellectual property. Testimonial from a successful business owner (a previous faculty) that started his company through grants funding and an innovation idea.	Team product design/ manufacturing and distribution strategy paper due on 4/1/13
13	The New Enterprise Organization (12) Acquiring and Assessing resources (13)	Work as a group for the final Report and Presentation
14	Acquiring and Assessing resources NCIIA E-Teams Presentation for your assigned project and possible prototype	NCIIA E-Teams Paper due on Monday 4/16 Work as a group for the final Presentation
15	Management of Operations (14) Acquisitions and Global Expansion(15)	Prepare for the final Presentation using all materials on Moodle and book chapters 1 to 15.
16	Lesson Learned from a faculty that started his company through grants funding and an innovation idea.	Three teams submitted paper to the NCIIA E-Teams competition.
17	Team Presentation on assigned project and possible prototype	Final Report and Presentation

Future plan

Sustainability is a key element for our success; we would like to continue developing new ideas and projects that will inspire new students participating in this course. We plan to continue forming teams per NCIIA guideline and objectives: "the NCIIA objective of having students focus on projects that have real impact and commercial potential, not just assignments for school"[10], this will bring strong quality results. We would like to embark on a new collaboration with our Business School Entrepreneurship Program to make it feasible for our engineering students to pursue a certificate in entrepreneurship from the business school. In the fall 2013 semester the engineering faculty offering this course attended several meetings with faculty from

the business school; the goal of these meetings was to mix business students with engineering students to work on individual teams in the spring 2014 semester. We feel this will strengthen our projects. The faculty submitted a request to our business school entrepreneurship program[8] for them to allow our engineering students to earn a certificate in entrepreneurship if they take the following 4 courses:

1. Technology Innovation and Entrepreneurship course ECGR4090/5090
2. Senior Design I course ECGR3253
3. Senior Design II course ECGR3254
4. Managing the Start-Up (ENTR 3101) from our business school.

This course and the certificate will empower our graduates to confront challenging business cases and to seek solution from a business perspective. Our goal is to get our Engineering students to work with business students from the inception of an entrepreneurship project until commercialization (from ECGR4090/5090 to ENTR 3101).

Conclusion

In summary, the offering of this course allowed some of our students the opportunity to explore innovation and entrepreneurship. These students will start their career with an edge over other engineering students because they will be able to launch businesses successfully by using our program and taking advantage of the resources available to them from our University's Office of Technology Transfer[7]. We strongly believe that we will create a number of startup companies through this program. Digital Optics is one example, it was founded in 1994 by a professor from the Electrical and computer Engineering department from UNC Charlotte; the company was sold in 2006 to Tessera technology for a sum worth of 59.5 million dollars[9]. With this new certificate, and the new courses, we will establish a foundation for a small business incubator in the region.

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8. UNC Charlotte Certificate in Business Entrepreneurship at http://belkcollege.uncc.edu/undergraduate-programs/entrepreneurship-certificate/curriculum

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10. Weilerstein, P., Ruiz, F., and Gorman, M. "The NCIIA: Turning students into inventors and entrepreneurs." *Proceedings from the American Society for Engineering Education Conference,* June 1999.

Appendix (A) Survey Questions to students

1. Do you think the College of Engineering at UNC Charlotte prepared you to be an entrepreneur?

        Yes   No   Not Sure

2. Is your senior Design Project?

   Faculty sponsored   or   Industry Sponsored

3. Could the idea from your senior Design project be expanded to develop a business?

        Yes   No   Not Sure

4. Do you plan to create a Patent from your design?

        Yes   No   Not Sure

5. Do you believe starting a business is

      Very easy   Difficult   Very difficult

6. Do you like to be your own boss?

        Yes   No   Not Sure

7. Are you interested in starting a business at some point in life?

        Yes   No   Not Sure

8. Do you have enough skill to start a business?

        Yes   No   Not Sure

9. Do you think you can identify a good business opportunity?

        Yes   No   Not Sure

10. Do you think you can do a good market analysis about your idea?

        Yes   No   Not Sure

11. Do you think you can manage risks while achieving good results for the business?

        Yes   No   Not Sure

12. Do you think building a knowledge data base about a product is a powerful tool for the entrepreneur to design innovative products?

        Yes   No   Not Sure

13. Do a strong market analysis and a sales strategy enable a new business to identify the target customer?

        Yes   No   Not Sure

14. Do you consider yourself a strong leader?

Yes   No   Not Sure

15. Will you be able to identify resources for an organization built around a strong idea?
    Yes   No   Not Sure

16. Why do you think people start their own business?
- Independence (Be your own boss)
- Unable to find a job
- Not Sure

17. Why do you think people don't start their own business?
- Not enough money
- Stability (A steady check)
- Fear of failure
- Don't know
- Government obstacle
- All of the above

18. Do you believe there is more job security in owning your own business or working for an established company?
- Working for a company
- Owning own business