Entrepreneurship In Electrical Engineering Education

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Abstract

The program in entrepreneurship education, offered by the Electrical Engineering Department at the University of Nevada, Reno (UNR), has as one of its courses a senior-level undergraduate course, EE 491. This course takes a very "hands-on" approach to teaching electrical engineering students the concepts of innovation and entrepreneurship. The basic goal of this class is for students to experience the product development process as well as how to start a new company. To attain this goal, the students are separated into groups and form companies known as E-Teams, they generate a few product ideas, evaluate each of the ideas and choose one to explore, develop the product idea into a functional prototype, and finally perform market/financial analysis to determine if the product could sustain an actual business. Once they have completed this process at the end of the semester, the E-Teams present all of their findings at a final presentation to faculty members as well as invited guests from the private industry sector. The basic idea behind the course is for the E-Teams to experience an actual start-up process and attempt to take it to the point of soliciting financial support. While they negotiate the product development process, the E-Teams are given a wide variety of lectures that provides them with valuable insight into being both effective engineers and entrepreneurs. The class fits into the engineering curriculum by offering students a "capstone" course, i.e., one that ties their entire college education together. Student inventors/entrepreneurs from this class were recently featured as part of a program sponsored by the National Museum of American History located at the Smithsonian Institution in Washington, D.C. This class has now been extended to include MBA majors from the College of Business at the University of Nevada, Reno. This paper describes in some detail, the format, content and results of teaching the class.

Introduction

The EE 491 course at UNR takes a very unique, innovative approach to teaching senior electrical engineering students the concepts of entrepreneurship. It involves both "hands-on" training as well as interaction with a variety of experts in the field. The "hands-on" nature of the course is achieved by having the students develop an actual product/business idea as the primary project for the course. The interaction with experts in the entrepreneurship field is achieved through a special guest lecture series sponsored by the course. The course is primarily focused on teaching the students about entrepreneurship. However, they also learn how to become better engineers in the process.

Course Structure [1]

The entrepreneurship course for electrical engineering students at UNR, EE 491, teaches the students about entrepreneurship through two different types of activities. The first one involves the students starting their own business and the second one involves their participation in a guest lecture series that covers the many aspects involved with starting a successful business.

At the beginning of the semester, the students break up into groups of four to six people and form student companies, also known as E-Teams (E denoting excellence and entrepreneurship). Much like the business world, these E-Teams are required to act quickly and intelligently. Within the first week, they elect officers, develop their organizational structure, generate

several product/business ideas, evaluate each of these ideas in terms of feasibility and market potential, and select one of these ideas to develop into a business. Once the E-Teams have selected an idea, they are required to convince the professor, or management, that the idea is worthy of pursuing. This is done through the careful preparation of a proposal that covers all of the aspects involved with the business development. Such issues as the E-Team member's technical ability to solve problems, the availability of required resources, the ability to complete the development on time with tangible results, and the market potential of the idea are discussed in these proposals. Once submitted, the proposals are carefully scrutinized by the professor who looks for holes in the students' logic. If any major problems are identified, the proposals are rejected and the E-Teams must quickly improve them or select another idea. The students quickly learn that they must clearly express their ideas for them to be accepted. They also learn that the business world is driven by feasible product ideas accompanied by sound development plans, not revolutionary technological developments that have no market potential.

Once their ideas have been accepted, they begin the business development process. This development includes both product development as well as business research. During the development of the product prototype, the E-Teams are faced with a variety of problems that require quick, innovative thinking. These problems aren't always technical. The E-Teams are often faced with such "real-world" problems as locating resources. The business research includes exploring the market/financial potential of the product. This part of the development gets the E-Teams ready to sell their ideas to other people.

At the end of the semester, the E-Teams will have a working prototype of their product idea along with a significant amount of business research completed. All of this work is presented to a large audience of both UNR faculty and invited guests from the private industry sector. At this point, the E-Teams are ready to prepare a business plan and in many cases, start looking for continuation funding. The deadline of having to present tangible results at the end of the semester gives the student E-Teams a taste of the pressure they will face as either engineers or entrepreneurs after their graduation.

Throughout the semester, while the E-Teams struggle to develop their product ideas into working prototypes and viable business opportunities, the course provides them with a series of lectures that cover the many aspects involved with starting a new company. These topics, as well as the overall lecture format, vary from lecture to lecture. Some of these lectures cover very specific topics involved with entrepreneurship. The first example of a lecture covering a specific topic is the one on financial records. This lecture is given by a Certified Public Accountant representative from the seventh largest public accounting firm in the country, Grant Thornton. During this session, the students learn how to read financial records and also learn about the importance of good financial record keeping. Another special lecture topic is the legal issues surrounding patents, trademarks and copyrights. This lecture is given by an experienced patent and trademark attorney representative from the Law Offices of Graham and James. Other special topics covered by expert guest speakers include marketing, financing, product liability, ethics, and many more. Another set of lectures given by guest speakers covers high technology product development. Representatives from such prolific companies as Hewlett Packard usually give these lectures. During this special lecture series, several entrepreneurs speak to the students about their businesses and what they have done to make them successful. These entrepreneurs have started successful companies in the areas of radio frequency engineering, personal computer retail, electronic control equipment, along with several others. They talk to the students about how they have made their companies successful and what they feel are the most important aspects of starting a company. The also offer the student E-Teams helpful hints on making their specific business developments a success. Finally, the students are treated to a guest lecture by one of the most prolific inventors of all time, Mr. Jerome Lemelson, holder of over 500 patents! This series of lectures gives the students an excellent overview of practical entrepreneurship practices.

Case Studies [2]

There have been many interesting developments in the history of this course. Such products as acoustic snow depth sensors and automated chemical mixture equipment are examples of products developed by E-Teams in the past. Recently, the course has had several developments that have received a great deal of interest from the business community. The first one is the Improved Metropolitan Area Transportation System (IMATS). This development has involved several E-Teams over the past three years of the course and has grown into a real business. The primary component of this system is a vehicle known as the Instant Rent A Car (IRAC). This is a car that can be located anywhere on the streets and easily rented for short trips around densely

populated areas. A potential user simply inserts their credit card, enters a Personal Identification Number, and upon approval, is granted access to the car. The IRAC's on board computer system reads the customer's credit card information, reports it to a central dispatch computer that will check the person's credit record, and open the car's doors if the person is a registered user. Once they are done using the vehicle, they may park it wherever safe and convenient, and leave it for the next user. By using Global Positioning Technology and Cellular Communications, the IRAC is able to report its location to a central dispatch computer. By keeping track of the location and usage of each IRAC, the central dispatch computer may be easily accessed for the purpose of reserving a nearby IRAC.

The IRAC was primary developed by several different E-Teams in EE 491 with the assistance of two experienced engineers that donate their time to the E-Teams in the course. Each E-Team involved with the IRAC development contributed one piece of the system as well as a significant amount of market research. Once the system development was complete, several of the students joined the two engineers to form the IMATS Corporation. Since it inception, IMATS has developed several new features into the IRAC system along with several related products. They are also currently under contract to develop an IRAC system for the San Francisco Bay Area Regional Transit System. The IRAC system has recently been featured in several different well-know publications, including GPS World [3]. Also, the Discovery Channel aired a segment on the IRAC system during its Invention series.

Another recent example of an excellent development is SmartBlinds, developed by the E-Team, Modern Technologies. This product can best be described as a automatically adjusting window covering system. It consists of a regular set of adjustable window blinds that have been equipped with a solar sensor and microcontroller system. The primary function of SmartBlinds is to automatically adjust the window blinds. It has two modes of operation: summer mode and winter mode. While in summer mode, the blinds will automatically adjust themselves to allow a maximum amount of light to pass through a window while at the same time, minimizing the heat radiated through the window. While set in the winter mode, the window blinds will automatically adjust themselves to allow a maximum amount of heat to radiate through the window. During the development of SmartBlinds, Modern Technologies discovered a unique market niche. They found that people are interested in making their homes more energy efficient. They also found that most people do not have the patience to maximize the energy efficiency afforded to them by their window coverings. It is just simply too much work to adjust the blinds as the sun moves throughout the sky. Due to the convenience and potential energy cost savings, this product has already received a great amount of interest from the public. After their final presentation for the course, the members of the Modern Technologies were approached by building contractors that wanted to know where they could buy their product! SmartBlinds was also featured on a local television new broadcast later that same day.

Both of these products, IRAC and SmartBlinds, were featured at the Natural Museum of American History, located at the Smithsonian Institution in Washington, D.C. last November (1995). During this visit, they had a tremendous amount of exposure to potential customers as well as potential financial sources. Both of these products appear to be on their way to great success.

Course Impact [2]

In general, this course seems to have a great impact on all of the students. Even those who have no interest in becoming entrepreneurs welcome the opportunity to learn more about the world in which they will use their engineering skills. Many of the course's recent graduates have gone on to fill management positions at high technology firms in a short period of time. They are given a head start on those students who have no exposure to the business world prior to graduation. They are better organized and more focused towards developing marketable products. Although they are still very interested in fascinating technological developments, they are not wrapped up in them. Those students who are interested in becoming entrepreneurs are given a great start towards having their own company. Even if they don't continue the company they start for the course, they have a good idea how to start another one when they feel they are ready.

Integration of MBA Students [4]

In the past two years, MBA students from College of Business have been invited to take the course with the senior electrical engineering students. Several students have taken this opportunity and thus far, have had a positive impact on the course. They are able to experience the technical side of product development, something that they would not otherwise be able to do in a traditional business curriculum. Conversely, the engineering students are able to learn more about the

business side of product development from the MBA students. It is believed that more MBA students will begin taking the course in the future and, due to the diverse nature of entrepreneurship, will surely add to the future success of the course.

Lemelson Center

Generous funding from the Lemelson Foundation has allowed the entrepreneurship program to grow a tremendous amount over the past couple of years. The establishment of the Lemelson Center for Invention, Innovation and Entrepreneurship has provided the E-Teams with both financial and professional support during their product/business development processes. Due to the success of the Center up to this point, a small business incubator will most likely be added to the Lemelson Center for the purpose of helping these E-Teams reach the next step, the marketplace. This will be accomplished by providing the students with office space, a shop containing necessary equipment to be used in developing products, and assistance in locating seed capital for exploiting the opportunities presented by these ideas.

Conclusion

The students in the course seem to learn a tremendous amount of useful information during their own product development process. They also learn a great amount from the many guest lecturers that share information with them throughout the semester. Many of them take their experiences in the course and put them to good use when they graduate and become engineers. In general, this course prepares the senior electrical engineering students for what they will be facing as both engineers and entrepreneurs in the business world. Many of the course's graduates come back to talk to current students about how the class helped them succeed in whatever they chose to do. Future experimentation with the course will include different methods of getting more of the E-Team businesses out of the class. Most of the businesses stop at the end of the semester, leaving many worthwhile product ideas to waste. A great amount of effort will be made to find out what might make the students try to further develop their businesses. Many private sources have offered financing to help support the students if they want to try turning their class project into a successful business. Only time will tell if this generous support will make the difference. This course has become a great success and with further growth of the Lemelson Center, will continue to succeed in producing well qualified engineers and entrepreneurs.

References

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