

AN INTRODUCTORY COURSE IN ENGINEERING PROFESSIONAL PRACTICE: BECOMING AN ENGINEERING ENTREPRENEUR

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Abstract: In recent years, many engineers have been involved with start-up companies. Almost all engineers at some time during their professional careers encounter activities that have very little to do with formal engineering education. These include starting a company, entering into a partnership, writing patents for their inventions, producing, marketing, licensing, or accepting a directorial or administrative role in a company. Such activities require a special understanding of legal, ethical, and financial systems, plus entrepreneurial expertise for successful leadership and decision-making. Although some of this expertise may be gained while working in industry, graduates who take on the challenge of leadership roles in companies soon after graduation may not have the benefit of such experience. While it is not possible to provide extensive coursework within a standard engineering curriculum, an introductory course helps new graduates avoid many problems. An understanding of marketing, fundraising, hiring, and venture capital partnerships may allow the development of their ideas into products or permit them to start a productive and profitable company. Such expertise, normally, would be gained through multiple courses in areas such as business law, money and banking, microeconomics, or through on-the-job experience. To provide basic expertise in these “non-traditional” skills, within the context of a traditional engineering program, requires special preparation that is compatible with the current state of economic and industrial expansion. To assist engineering students in acquiring these essential skills we introduced a course three years ago, “Professional Engineering Practice,” that is required of all seniors in the Department of Electrical and Computer Engineering. In this course, student teams (7–8 students per team) practice developing their ideas into a practical product and then develop a business plan for starting a “virtual company” to produce and market this product. Students learn how to utilize information resources related to business in databases such as *Business Source Elite*, *Academic Universe* (*Lexis/Nexis*), and *ABI/INFORM Global*.

These databases include case studies, research and development articles and industrial profiles [1]. Also, students participate in informal meetings with business leaders and visit start-up companies for first hand experience. The final requirement for this course is for student teams to prepare a comprehensive business plan for their virtual company and make an oral presentation of their

plan to the other teams and to professional societies at the end of the course.

INTRODUCTION

Although engineering tasks in industries vary over a wide range of activities, the objective of engineering education has been a matter of controversy for a long time. Should engineers be educated to function as technologists, producers, business managers, researchers, or developers. This debate may never be resolved. After all, engineers are involved with research to develop technologies that are in high demand, which may be turned into a product that can be marketed for profit. The final product, hopefully, may make life better or simplify its complexity. Students who chose engineering know, or should know, that the engineering jobs include product development for items that eventually may be sold. It would be hard to develop a product for profit without being aware of market economics, production, efficiency, cost effectiveness, product desirability, management, and effective marketing. Therefore, such topics are pertinent to traditional engineering education.

While many engineers spend a large portion of their engineering careers in production, marketing, and management, many engineering programs are specifically designed to produce graduates with expertise only in research and technological development. Although this should be the major goal of an engineering program, in reality, a large portion of engineering graduates find rewarding careers performing activities that, at best, are tangential to research and development. They may be involved with managerial, entrepreneurial, marketing, legal, and ethical aspects of engineering. Furthermore, many of those who have firm ideas about a product often accept the challenge of competition and start their own company.

According to the U.S. Census Bureau; “nearly three quarters of all U.S. business firms have no payroll. Most are self-employed persons operating incorporated or unincorporated businesses which may, or may not, be the owner’s principal source of income.”[2] This group of small businesses receives 35 percent of federal government contract dollars, while the large firms receive 26 percent of their research and development (R&D) dollars from the federal government. Small firms provide 52 percent of the private workforce, 51 percent of private-sector output,

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produce 55 percent of innovations, obtain more patents per sales dollar, and have more discoveries than large firms. [3]

Unlike many small businesses, start-up engineering companies soon encounter concepts that are very different from the typical engineering education their founders have gained from BS granting institutions. Patent rights, company secrecy, public safety, and product reliability are among the major issues that determine the success or failure of any start-up company. Many engineers who work with large companies, while starting off as technologists or product engineers, will end up in managerial or supervisory positions whose function is very different from their formal training.

In this paper, we present the results of an effort to introduce graduating electrical and computer senior engineering students to entrepreneurship and to the processes of starting a company via a formal course. This is not a course in microeconomics or business law. Our efforts are primarily focused on the strategies by which an idea can be transformed to a product, marketed successfully, and the management of a start-up business. In this course, teamwork, leadership, ethical and legal aspect of a successful operation, and the expansion of a business are introduced and experienced.

Introducing Engineering Entrepreneurship

In the early 90's, it was realized that a large portion of graduating students eventually achieve the level of manager, or higher, in the company for which they initially started working. During this period, substantial numbers of students from this and other universities in the U.S were able to start an engineering company immediately after graduation with a B.S. degree. Often students developed their senior capstone projects into products that they could market. This led to developing other products and finally to start-up companies. All this clearly enforces the idea of introducing topics into our curriculum to provide the necessary education to assure that students who graduate with engineering degrees have some fundamental experiences in entrepreneurship. This prompted us to introduce a course in "Engineering Entrepreneurship", ECGR3159, in 1998. It is currently available for our students in their senior year. Since, in the initial offering, the exact nature of such a course was not well established, its content and format have gone through many changes and evolved in a way that requires participation and input from students, faculty, industrial liaisons, and local start-up companies. The fact that our region has been the breeding ground for numerous start-up companies has been very helpful to our course.

The basic structure of the course is to start with a team that chooses a hypothetical project with potential for commercialization and develop this project into a hypothetical product that needs to be marketed. Marketing requires a business plan for a start-up company. Such an endeavor requires patent applications, finding venture capital

for initial fund raising, licenses to open a business, and a series of other legal and financial activities that are here collectively referred to as the initial parameters. These initial parameters, depending on the way that they are applied, can easily lead to the success or failure of such an operation. Therefore, students are required to proceed through every step that is needed, recognize approaches that may lead to failure, and become aware of the databases and resources that are available to assist in these activities.

After organizing student teams, the projects were assigned in three different formats. Each of these formats has been taught to a graduating senior class. The formats were:

1. The same project is assigned to all teams
2. Each team is allowed to choose its own project
3. Different projects are assigned, by the instructor, to each team

Each of these approaches has produced results that are quite different. The first approach allowed for a comparison of each team activity but did not stimulate a high level of creativity. The second method, while allowing for greater creativity, resulted in some projects that were unreasonable, unrealistic, and not viable as marketable products. The third approach provided reasonable projects that were viable for commercialization and allowed for a high level of creativity. In this latter approach, the projects were chosen from recently developed high tech devices that have been successfully marketed. Students are asked to follow through all steps that are required to turn an idea into a product and form a business centered around this product that can yield a profit. Team members are required to get in touch with designers, developers, producers, managers, and marketing agents to trace the product from start to finish and follow all the required complexities that lead to the success, or the failure, of the product.

To expose students to the available resources, lecture/seminars from representatives of the small business administration, patent office, chamber of commerce, and other speakers were arranged. Students were asked to visit companies in the region to gain the experience necessary in their quest to develop a business plan for their product. Such direct contacts sparked many discussions that clarified the many details needed for a start-up business. Furthermore, this interaction provided the students with an overall view of engineering enterprises, which is a valuable experience in itself.

Student performance is evaluated at various stages of their developing a business plan during the semester. These evaluations included:

1. The submission of a mid-course preliminary business plan
2. Attendance and participation in seminars offered by business leaders

3. A presentation by each team at mid-semester with an evaluation of the presentation by other student teams
4. An evaluation of each student in the group by other team members

Results:

The students' awareness of the business legal, ethical and entrepreneurial aspects of engineering organization excited their interest and allowed them to choose where in the hierarchy of an industry they wish to position themselves. Therefore, including seminars from business, financial, and legal authorities is an important feature of this course.

Providing several different projects (one project for each team) allowed addressing a wider spectrum of experiences associated with a start-up business or business management. Furthermore, students are exposed to a greater variety of resources that are available in the literature.

We now plan to teach this course in the second semester of the junior year in order to prepare students to better plan their senior project, to be more protective of their intellectual property, and consider patent searches and patent applications for their projects. We also plan to allow some student teams to choose their own projects that will be linked to their senior design course in the subsequent year. This will allow more room for creativity and innovation. In summary, this exposure to non-traditional engineering topics, within the context of traditional engineering education, will help our students develop into potential entrepreneurs.

References:

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