From Senior Design to Starting a Company-A Model for Entrepreneurship

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Abstract

Entrepreneurship and education have gotten engaged in the last few years, and will either enjoy a blissful marriage or require some counseling to prevent a breakup. Some universities might reject the idea of creating new companies or products based on faculty or student research. There could be nostalgia for pure research, where scientific research funds do not depend on business marketing success or failure. Other universities might wrongly expect entrepreneurship to be the panacea for funding ills, creating a free flow of capital into the research environment. Balancing the two, scientific research and product creation, allows a university to benefit from commercial successes and keep the focus on teaching students.

This paper describes the success of one trial program conducted at Oklahoma Christian University in Edmond, Oklahoma. The flexibility of the electrical engineering curriculum allowed students to pursue their own invention as a senior design project. The engineering faculty, intrigued with the project, allowed the students to stay on after graduation. The students cleaned out a storeroom and started a company. In return, the students signed a license agreement with the university that provides a means for profits to be shared with the engineering department. Along with the university, the State of Oklahoma helped these young engineers. They benefited from established technology commercialization centers, grants, and cooperative legislation created to keep technologies and skilled workers in the state.

The success of this project can serve as an example for universities wishing to try an informal program. With a flexible curriculum and a supportive environment, entrepreneurship can flourish even without a fully dedicated academic program.

I. Background

Oklahoma Christian is a fully accredited private university offering standard degrees in liberal arts subjects, education, music, science, and engineering. The Department of Science and Engineering offers electrical and mechanical B.S. degrees, with specialization in Computer, Controls, Communications, and DSP available for electrical engineering. The focus of the engineering department is on developing engineers with professional, ethical attitudes. The engineering professors come largely from industry, and this background carries over to the curriculum.

One key way that the professors pass on their industry experience is through mentoring design projects. At OC, no engineering student may graduate without completing a three-semester systems design project. Project teams composed of electrical and/or mechanical students work through the difficulties of planning a project. They must plan a schedule and a budget, write status memos, and present reports to the rest of the college. During their presentations, they must answer questions submitted from an audience that includes professors and their peers. This is rigorous project designed to emulate the reality of industry.

II. Introduction

The founders of the engineering program intended to prepare every engineering student to enter the workforce with the skills to be immediately productive, professional, and competent. One of the by-products of this intense program is that some of the senior projects spawn products that might be marketable. One undergraduate project showed the potential to be a success in the marketplace. Before this attempt, there was no formal program for entrepreneurship, but the cooperation and encouragement of the faculty helped support a trial program. OC is currently evaluating this effort while it considers the merits of starting a formal entrepreneurship program. The challenge presented here is that even in schools where funds, staff, or other resources prohibit a formal program, students and faculty can test the waters with a trial program. As these "garage" efforts succeed, the university administration can determine whether or not to start a directed program for entrepreneurship.

III. Engineering Curriculum

It is the fundamental approach to engineering at OC that encourages and allows projects like Commack to incubate and grow. The curriculum approach is project based rather than "text book" based. Students are assigned projects in the classes and learn the theory and technology necessary to complete the projects. Professors build in strong mathematics from the rigorous texts used in the theory portion of the courses. Laboratories projects are integrated with the courses, not taught separately. All students must take a broad spectrum of courses in electronics, microprocessors, communications, DSP, and controls. However, students also take a three-course sequence in their selected emphasis. This allows sufficient theoretical depth for the professors to assign meaningful lab based projects.

Two other O C engineering objectives are important in the development of entrepreneurial ideas: 1) Producing immediately productive engineering graduates and 2) Using state of the art industrial based equipment and software. The first demands that each professor incorporate in his courses the theoretical ideas and projects central to current applications in industry. The second ensures that test equipment, computer programs, and laboratory supplies reflect current practices. Professors must adapt and change projects and applications in the curriculum as the state of the art advances. Therefore, it is imperative that they be current in their respective fields.

As an example of the above, in the communications sequence the first course project is to design and simulate an all-digital satellite communications system. In the second, the modulation techniques used in wireless and satellite systems form the basis for the design, modeling and simulation of optimum receivers in the presence of noise. The third semester reflects the type of

project from which students can develop truly innovative applications. In the third course students design, build, and test a wireless spread spectrum radio. The radio includes message generation in a DSP, convolutional encoding and decoding, direct sequence PN spreading and de-spreading, Walsh Code multi-plexing, and binary phase shift modulation, and up conversion and amplification to the 915 MHz un-regulated band. The receiver also includes a matched filter and outputs the wireless decoded message continuously to a computer screen. In addition, this course details the theory of coding, Code Division Multiple Access (CDMA), pseudo-random noise (PN) sequences, and synchronization. Students learn and use the actual standards for the IS-95 and J-008 CDMA spread spectrum systems and industry optimization programs for the current 2nd Generation systems.

The above depth in theory, breadth of laboratory and computer simulation experiences, and exposure to advanced applications, provides the fertile ground for students. They can then ask, "Can we use similar techniques to develop a wireless spread spectrum based system?" And, not only to answer in the affirmative, but have the confidence that they can do it themselves.

IV. Senior Systems Design Project

When the students have completed all of their general courses and are deep into their selected emphasis, they enroll in a mandatory senior design sequence. The senior design project, also called "Systems" is a three-semester capstone course designed to teach engineers how to conduct a real-world project. This project goes beyond the laboratories mentioned above by having student teams in full control of a major project. They learn quickly that in industry, engineering is more than putting together parts to solve a problem. Engineering demands abilities for professional presentation and communication, budgeting, scheduling, and the ability to function as part of a design team.

For instance, as underclassmen, students seldom worry about supply issues. There are plenty of "LM741" op-amps, resistors, and diodes in the bins, on hand and ready to use. However, in Systems, students must order their own parts, (which might not arrive for several months), construct a realistic schedule considering lead times, negotiate price constraints, and confront other real concerns.

Systems class is not the first OC course that forces students to write memos and make status reports. The underclassmen study communications skills, but in Systems, their abilities are judged more harshly. Their presentations take place in a large classroom with many faculty members who attend, other students working on their own projects, and their classmates who can be their harshest judges. They might hope that their guests miss the chance to ask a hard question. That seldom happens, because if the audience fails to catch a mistake or ask the tough question, the faculty member serving as their customer always brings up the issue.

The entire engineering faculty may ask questions, but there is an assigned "customer," usually one of the faculty or an outside sponsor with an engineering background. If the project is sponsored by donations from a business, that company might send a manager to be a real-life customer. The customer is tasked with mentoring the students, and there is a second mentor from within the faculty. The mentors guide the students and try to help them see the real issues.

In a sense, the mentors are like a board of trustees. They ask leading questions to spur the students to discover gaps in their research. If gentle prodding fails, the mentor asks the crucial question during an update presentation, and expose the problems in front of the other students and faculty.

Sometimes the end deliverable is a paper proposal, but in most cases, the students produce a prototype, or at least a functional scale model. Some past projects have also been for competitions like the IEEE fire-fighting robot or the ASME Mini-Baja car competition. In these examples, the end deliverable is a real, functioning product.

The whole process forces the students to be ready for industry. Students earn grades for their team's success, and for their individual role on the team. Like industry, not all workers receive the same grade. There have even been cases when the faculty was not convinced a student was ready to be effective in the real world, and they failed systems. Students are not allowed to graduate until their work is satisfactory.

V. Project Proposal

As a junior in the OC engineering program, David Compton was also a percussionist in the OC band and involved in some stage productions. He saw that setting up microphones for drums took a long time and that they were easy to knock over. He saw a potential to do a systems design project that would address this issue, and his original idea was to find a way to put microphones inside drums. He confided in several relatives and friends, and they all warned him against revealing too much to his professors. They had in mind professors who might be looking for an idea to steal. But from the OC professors' lessons on and concern for professional ethics, Compton knew he could trust them. He cautiously approached a few professors he trusted, and found them receptive and enthusiastic for his idea. Since they had a background in industry, they encouraged him to examine the potential market for his idea, and consider the business side of things as well.

Compton found that the market for a drum specific solution would be too small, but that wireless microphones had a rather large market. He also saw the opportunity to apply what Professor Nored was teaching in the communications courses directly to the project. Compton worked with Professor Nored to fashion a project proposal, and solicited another student to be his partner. Jeremy Emack was another junior who would be in the same class as Compton, and Compton had known Emack to be a good student. Emack also played bass guitar in the OC band with Compton.

The electrical engineering professor in charge of the System I course that semester was Art Sheldon. Professor Sheldon helped get the approval for Compton proposal, but saw that it was overly ambitious for the three-semester project. Professor Sheldon made sure that Professor Nored was the "customer" and mentor for the project. They revised the scope from a full product development to a proof-of-concept design. The aim was to force the students to thoroughly examine the technology, and to give them an achievable objective. They also assigned two more members to the team, believing that the project was too big for just two people.

The four students had to develop a mission statement, a project plan, budget, and schedule. They also conducted interviews with musicians, sound engineers, and other end users of the product to further their understanding of the issues. All of these steps came before the science and research so that the product would address real consumer concerns. Also, the initial research helped shape the form of the solution, instead of the science dictating the solution. This approach was borne of the industry experience of the faculty, and their approach to research.

VI. Commack LLC

As Compton's team neared completion of their design project, they were encouraged by their results. Professor Nored had driven their schedule very hard and insisted on spending a large part of their last semester testing. He had seen too many student teams, no to mention teams in industry, plan only a week or two to test the end deliverable, with the result that teams procrastinate and miss the end deadline. Also, they leave inadequate time for testing. Because he wanted this team to have something tangible at the end of the project, he demanded a couple of months of test time. The students were behind schedule, but at least they had a couple of months to make up time.

The deliverable was a proof-of-concept prototype. It showed that the product could work according to theory. The students were excited to have something that worked, but there were many issues to resolve before the model could become a prototype. The other two members of the team were happy with their grade on the project, and decided to pursue regular engineering careers. However, Compton and Emack were encouraged by this success, and expressed their desire to possibly take this project a step further. Some of the faculty members suggested that the students use the OC engineering building as a home base and try to start a company. There was no formal "incubator" program at OC designed to encourage entrepreneurship. There was simply the desire to see these students try something bold and succeed.

So Compton and Emack met with a few businessmen and lawyers, filed the papers to start a company, and founded Commack in April 1998. Their office was a defunct lab-turned-storeroom, which they cleared out and cleaned up. Professor Nored found a couple of old lab benches and offered to let them use test equipment from the communications lab. They soon agreed to a schedule that put students as the first priority. Compton and Emack could use what they needed after hours or on weekends. The arrangement with OC allowed Commack to function with limited capital while they searched for a sponsor. In return, Compton and Emack signed a contract with the school specifying a donation to the engineering department in case of success.

Over that first summer, Compton searched for financial backing while Emack worked on refining the prototype. These engineers soon learned that more went into entrepreneurship than just engineering. Also fortunate was the climate for small businesses in Oklahoma. There has been a growing interest in technology-based businesses. Oklahoma has been suffering from a "brain drain" from their universities. Neighboring states lure top students and businesses by offering tax breaks or state assistance. To combat this, the Oklahoma Technology Commercialization Center (Tech Center) provides start-up companies with business support, and

Tech Center agents help students and inventors become businessmen. Commack benefited from this agency and others like it, which encouraged them to do market studies, patent searches, and business planning.

The Experimental Program to Stimulate Competitive Research (EPSCoR) is a NSF funded program to help businesses and universities work together. Their goal is "to develop technology and knowledge transfer by fostering and facilitating individual relationships between the research scientists and industry. This is accomplished through early industry involvement, workshops and industry travel funds, individual technology plans, outreach short courses, and competitive applied research projects."[1] Since Commack was a entrepreneurial business founded to take academic research into the real world, they found a friend in EPSCoR. Compton also located a private investor who bought shares in the company. The university also agreed to put up matching funds for an EPSCoR grant. This allowed Commack to hire two students as interns. So during the first year, Commack found that their idea was patent-able and they continued to improve the proof of concept prototype.

During the third semester of Systems, Compton and Emack had taken a trip to the National Association of Music Merchants trade show in Los Angeles, California. Their goal was to see if any company was offering a wireless microphone like theirs, and they hoped to meet potential customers. They made contact Bill Thompson, president of a manufacturing company called Ashly. After their first year in business, Compton connected with Bill Thompson and invited him to visit OC, after which Mr. Thompson became a partner in this venture.

They proposed a joint venture in which Ashly would provide funding and some assistance and Commack would build a marketable prototype. The Oklahoma Center for the Advancement of Science and Technology (OCAST) offered a matching-fund grant for research done in cooperation with a university. The OCAST office "develops, implements, evaluates and modifies programs and services designed to encourage small Oklahoma firms to develop, apply and commercialize technology" and "facilitates associated technology transfer and commercialization activities."[2] Professor Nored and the Dean of the college of science and engineering, Dr. Ben Hutchinson, agreed to bring in OC to co-sponsor the grant. So Ashly's funding was essentially doubled, and the university had an oversight role to help Compton and Emack. Professor Nored was the Principal Investigator of the grant, which gave Ashly confidence that these two young entrepreneurs would have an experienced manager.

As of the writing of this paper, the OCAST grant is in its final month, and the marketable prototype is nearly finished. If it performs according to specifications, Ashly will pick up the project and manufacture and market the end product. This project has come full circle from a student's proposal to a potential marketable product. The university has used the experience to gauge the success of research for the purpose of entrepreneurship. Commack is hoping to build on the success of this project to become the "customer" for a few more systems design projects. This project has not yet brought hundreds of thousands of dollars back to the engineering department as profit, but the school benefited from new relationships with state agencies, experience with an internship program, and other intangible benefits.

VII. Some Stumbling Blocks

Although this senior project became a company without the benefit of an established program, there were some setbacks that slowed the projects progress. The first year progressed very slowly as Compton and Emack struggled to learn how to run a business. In fact, in the first six months of operation, they had to spend almost all their time on writing a business plan, writing a grant proposal, and learning what it meant to "run their own business." If it were not for assistance from OCAST, that stumbling block would have been a major blockade. They expected to launch into refining their design, but they soon learned that businesses require cash flow. Their experience in systems taught them about part lead-times, scheduling conflicts, and time management, but now Commack had to buy its own inventory of parts.

Along with the worries of generating a salary, Commack's owners had to learn how to manage employees. When their EPSCoR Grant was accepted, the grant money helped pay for two interns. With the help of the professors, Compton and Emack interviewed interns (who had previously been their classmates). Then after selecting two very good candidates, the two young employers had to exercise authority over their two younger friends. This age differential led to a common problem with small companies. The familiarity between the partners and the employees made it very difficult to drive the pace that the company needed. Compton and Emack had to rely solely on their own self-motivation, because they were equal owners. They did not feel comfortable giving orders to each other or their younger friends. They solved this problem by putting the interns under the direction of Professor Nored. The interns respected his authority.

There was also a bit of confusion in the business office. The engineering department had to be very careful to distinguish between parts orders addressed to Commack, because they used the same suppliers. When parts suppliers received an order with the University's address on it, they automatically billed the school. Keeping the bills and parts separate was a difficulty that was only overcome because the director of the business office was cooperative.

These problems could have been eased if there was an established entrepreneurship program. Compton and Emack could have benefited from some business courses on writing business plans, capturing seed capital, and management. Fortunately, the faculty offered insights from industry to steer the venture in the right directions. Commack navigated those problems. However, they could have refined their design sooner if they learned their business lessons while still students. The fact that the engineering curriculum is technically challenging and time consuming limits engineering student's access to business classes. There is not enough time to do it all.

The lessons learned because of Commack LLC might someday lead to a formal entrepreneurship program that brings engineers and business students together. Several professors from Engineering and Business colleges have discussed pairing business students with engineers on projects. This would help fill the knowledge gap and encourage more engineers to venture into business. It would also show business majors what engineers go through to develop a product.

VIII. Conclusion

A traditional entrepreneurship curriculum might include classes aimed at the business side instead of the product side. One institute for entrepreneurship at Colorado University, the Bard Center for Entrepreneurship Development, has specific courses designed to shown potential business owner how to operate a successful venture. The courses include: Fundamentals of Entrepreneurship, Business Plans and Seed Financing, Entrepreneurial Financial Management, Business Consulting, Leading Entrepreneurial Ventures, Corporate Entrepreneurship, New Product Development and Growing Your Venture.[3] The engineering curriculum, including both core classes and Systems address some similar issues, namely, financial management, leading ventures, and product development. The owners of Commack were able to fill their knowledge gap during the first months of business, but they would have benefited from these business courses.

Entrepreneurship does not just happen. It takes the right combination of inventive dreamers, solid business advisors, charitable encouragers, and above all, a healthy environment that fosters experimentation. The students at OC not only receive an education that prepares them to be immediately productive in the workplace. Other universities lacking the resources to build a formal program can learn from this experiment at Oklahoma Christian University. It takes students ready to venture into business, professors willing to bend their curriculum around student projects, and a local business environment able to offer support. But most importantly, the university faculty and administration must have the mindset and flexibility to encourage entrepreneurs to give it a try.

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