

2006-129: BRINGING "REAL WORLD BUSINESS" INTO THE CLASSROOM: INTRODUCING ENTREPRENEURSHIP TO ENGINEERING AND TECHNOLOGY STUDENTS

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Mary Finkel has acquired over ten years of manufacturing experience while working as a Manufacturing Technologist at S-3 Engineering in Ann Arbor, Michigan. She received her Bachelor of Science degree in Manufacturing Technology from Eastern Michigan University, graduating Cum Laude in December of 2004; and was awarded an Excellence in Manufacturing scholarship. She is a member of various professional societies such as Society of Automotive Engineers, Society of Plastics Engineers, the Engineering Society of Detroit and the Society of Manufacturing Engineers - from which she earned her Manufacturing Technologist Certification. She is currently a Manufacturing Engineer at Global Engine Manufacturing Alliance in Dundee, MI.

Bringing “Real World Business” into the Classroom: Introducing Entrepreneurship to Technical Students

Abstract

What is the difference between engineers and entrepreneurs? Historically, on some level, there has been a difference. However, with a growing global economy and feverish foreign competition the roles of engineer and entrepreneur have merged. For a variety of reasons many engineering and technical academic programs have not embraced the merger of engineer and entrepreneur. Consequently many engineers and technicians have a steep learning curve when they begin their careers. They do not fully understand or appreciate how the manufacturing enterprise works and how the engineering function integrates with the enterprise. As a consequence engineers become disconnected from the many non-engineering aspects of the manufacturing enterprise.

In general, new graduates lack the ability to create opportunities and take advantage of them. Climbing the “corporate ladder” is not a possibility anymore. When an organization is operating in a “lean” state, there is no ladder to climb since there is no higher level to attain. To build a successful career, engineers need to become “rock climbers”, i.e. think like an entrepreneur and adopt an entrepreneurial spirit.

The Manufacturing Engineering Technology program at Eastern Michigan University provides technical students with an education that merges engineering technology and entrepreneurship. A required three-course capstone sequence emulates the product realization journey of a small business. The first course in the sequence develops a product concept, the second course plans its production and the last course actually produces and sells the product.

The capstone sequence is a valuable experience for the students. The development of a product from conception through to production helps them realize how strongly engineering decisions affect the enterprise as a whole.

The goals of this presentation are to identify why entrepreneurship is important for engineers, discuss the pedagogy of teaching engineers and technicians about entrepreneurship, and discuss how the Manufacturing Engineering Technology Program at Eastern Michigan University merges entrepreneurship and engineering technology education.

In addition to the author, there are several coauthors, with varying backgrounds, providing their perspective of entrepreneurship in engineering and technology education.

Introduction

How entrepreneurial are new engineering graduates? Why is it important for engineers to be entrepreneurial? How can schools incorporate entrepreneurship into engineering education? How can engineers be entrepreneurial in the workplace?

The answers to those questions are fairly subjective. The following paper presents the opinions of several authors with respect to those questions.

Comments on the entrepreneurship of engineering graduates.

In 1972, the Mechanical Engineering curriculum at New Jersey College of Engineering (now the largest part of New Jersey Institute of Technology) exposed me to all engineering fundamentals. Surprisingly, one of my most used lessons right now is applying problem solving strategies that I learned with the early computer languages.

As new engineers, we were expected to move into a position with a company that would be utilizing our major in the purest sense. The mechanical engineers were looking forward to designing widgets that someone else wanted. Computer science majors would become software developers, or actuaries. Starting your own business was never discussed except by those professors who couldn't make their own commercial business work.

When I graduated, my social structure guided me toward working for someone else and being dependant upon their creative business skills. Today, personal independence is most important. Graduates need to recognize that and have the ability to execute accordingly.

There was no entrepreneurship training when I was in my undergraduate degree. NCE was pure engineering theory and practical application. I took graduate courses in business, majoring in marketing, at Seton Hall University where I was exposed to entrepreneurship training. The exposure was limited to a course that required the creation of an imaginary product and bringing it to market.

Currently, most new graduates have outstanding computer skills, but not all have the aptitude to take what information is available and assemble it into a cohesive presentation with a logical recommendation. Knowledge of problem solving techniques often is very weak. Most are deficient in their ability to convey technical messages and worse, they can not create technical questions.

A graduate with an entrepreneurial attitude seems to use intuitive reasoning for making decisions, no matter the situation. Without this attitude, their scope of observation is limited to only what they see in front of them at best. They must also be led by the hand to find their productive path. These individuals seem to be very focused on their assignment and tend to lose sight of the significance of their contribution. Those with the entrepreneurial attitude radiate confidence and seem to be more goal oriented.

The graduate with an entrepreneurial attitude nearly always takes the profitable path. Their approach seems to be more convincing during group communications. They've thought about the arguments ahead of time and came prepared to not only support theirs, but also to hear others. Those with the entrepreneurial attitude are surprisingly willing to hear dissenting opinions while the others take the naysayer's comments personally. The contrast is surprisingly apparent to even casual observers.

I've had the opportunity to hire newly graduated engineers for a position in manufacturing where they would be hands on with metalworking fluids, tools, machining and grinding processes, trouble shooting in the real manufacturing environment and interacting with machine operators, floor supervisors, middle and upper management. My best hires were those individuals who naturally drifted to understanding the larger business picture. Not surprisingly, those with the highest propensity to do so were those whose family operated their own business, whether it be a trucking firm, housing rental operation, a farm, or an auto repair garage, to mention a few. These individuals were an astounding find and proved to be very capable of managing the metalworking fluids for an entire transmission manufacturing plant. They could only do that by understanding the large picture of the business situation. They were exposed to the concept of being an entrepreneur early. It is becoming more apparent as I expand my business and networking efforts that too many corporate engineers just don't get what their company is all about.

It is absolutely critical that today's graduate is capable of fending for herself or himself. If nothing else entrepreneurship training provides an emergency parachute if there are no offers from existing companies. Companies prefer to hire only the highest grade graduates and not all students can be in the top 1% of their class. Those "lower" achievers will appreciate the freedom that this knowledge will give them.

The entrepreneurial education should be a fundamental requirement woven into the current required curriculum. The more exposure to the philosophy of entrepreneurship, the more realistic the parachute becomes for those graduates who will need it.

Entrepreneurship springs from a passionate idea that the student engineer has developed on his own. What can/should be taught is the enlightenment process that a college atmosphere encourages. Are networking skills taught so the aspiring student turned businessman has a feeling for where he can turn for support and insight? In the stone ages of the early 1970's my college didn't even address starting your own business. Maybe it was the school I attended, but it just was not encouraged then. I'm not sure it is universally entrenched in curriculums yet.

Comments on entrepreneurship in industry and education.

Entrepreneurship and engineering technology majors are a special breed of people. I consider them one and the same. As a student attending Eastern Michigan University (EMU) and an engineer for over 10 years, I have had the opportunity to view the world from both of these two unique perspectives at the same time. What I have experienced is that entrepreneurs and engineers are people that have a love, drive and a desire to develop a service or a product that will better human existence. There is a major difference between someone that has just an idea and someone that has an idea and wants to develop it, no matter how difficult, or how much time and money it may take.

In today's society and specifically in the industrial or technology sector, many businesses have to run their operations very lean just to survive. To do this companies have to recruit suppliers from foreign countries to build tools, assemble products, complete drafting projects etc. These available sources are replacing the need for extra staffing as well as down sizing current

staffing. In turn this is helping to jump start the entrepreneurship drive in engineers, as well as non engineers. It is very important for today's engineers to have an entrepreneurial attitude because most engineers will have to face all the aspects of what it takes to bring a product to market at some point, because of the changes I have discussed above.

Having some knowledge of what it takes to bring a product or service to market is definitely a needed set of skills in today's market. Universities can play an important role in providing these skills. A university setting would allow an up-and-coming engineer/technician the opportunity to actually develop an idea and take it to market. This would be the ultimate learning experience, in turn positioning that individual for many potential job classifications and opportunities. Though it seems like this process could lead to much work for each student who is assigned a product to develop, in today's market place it is becoming a common trend for individuals to be left alone to develop and complete an entire project with minimal assistance, and produce positive results.

I have had the opportunity to experience entrepreneurship in both the engineering setting as well as the university setting. Currently I am employed by a major tier one automotive supplier in Farmington Hills Michigan where I have been assigned projects that require the development of body control systems. The development entails all aspects that I have discussed plus such things as concept proposals, bill of material estimations, program-timing charts, design of experiment reports, etc. My drive and entrepreneur attitude have provided me with continued success in the engineering field.

At the university level I was given the opportunity to help develop a product through the Eastern Michigan University Research and Development center. The product entailed meeting with my professor and an entrepreneur who had an idea for a pet toy but needed some assistance in developing and manufacturing the design. This project taught me the struggles of entrepreneurs, especially if they have no experience in product development.

Entrepreneurial attitudes are going to be a basic requirement in engineering and with the changes in how companies are operating I can only see more individuals acquiring the entrepreneur bug and wanting to pursue the American dream.

Introducing entrepreneurship to technical students at Eastern Michigan University.

It is very important for technology students to become familiar with the various aspects of entrepreneurship. The competition facing manufacturing companies especially is so intense that the engineers need to be well versed in all aspects of the business in order to help their company improve, expand, compete, and ultimately profit. If engineers/technologists are myopic, concentrating solely on product design, they will become complacent in their position and in the end cause their company to do the same.

The expansion of the world market is causing competition to be fiercer than ever before. Our companies need to have people who are able to understand the workings of the enterprise. These days, when a company wants to improve a product or design a new product they often have teams comprised of design, production, process, and quality engineers, as well as people

from marketing, finance, purchasing, human resources and various other departments. This team structure helps the company make the part right the first time. It brings together those involved in all aspects of the project in order to make decisions that are advantageous for the entire company's well being.

In order for an engineer or technologist to work well in this type of team environment they need to understand the roles of their teammates. This is where the University education comes into play. The university should incorporate the diverse operations of an enterprise into the engineering/technology curriculum. This type of information is necessary for a new graduate to be able to relate to their co-workers and work in a unified fashion towards a company's goals.

Eastern Michigan University has a Manufacturing program that integrates the operations of an enterprise into the engineering or technology curriculum of a student. The core classes give the student solid background knowledge to refer to when the more specialized or capstone courses are reached.

The core classes include, of course, the math and science background which is always necessary for a technology student but also includes such courses as accounting, statistics, micro and macro economics, and technical writing. These classes teach some very basic business concepts that are essential to the success of a student when they pursue a career such as, how to measure assets and liabilities, writing budgets, reading and comprehending annual reports, and knowing the concepts of markets, competition, supply and demand, taxes, revenue, capital, costs and profits. Learning how to write a proper memo, email, resume, business letter and report as well as recognizing the differences in cultures in order to ensure accurate communication are also important skills to acquire.

With this core background as a resource the students are then immersed into a selection of specialized classes "capstone courses" which build on these basic concepts. This is where we see a great deal of originality in the curriculum when compared with the manufacturing programs of other institutions.

As the students approach their final training in machining, electronics, CAD, materials, plastics production, quality management, etc...they are required to take a three-course capstone sequence that follows a product's development from conception through production. The first class, develops the product concept, the second course, takes that concept and plans its production and the final course produces and sells the product.

The first class, MFG 316 Design for Manufacturing and Tooling, is where the product design is born. Students generate product concepts they think are marketable. By a majority vote, the class selects the product they want to develop further. The faculty member in charge acts as a facilitator.

The class forms a company and divides into three basic engineering departments, product design, process engineering and tooling engineering. These three departments have team leaders and are given a list of required activities and paperwork necessary for completion of the class.

They hold team and company-wide meetings and are required to submit meeting minutes, Gantt charts and updates to the Company CEO on a regular basis.

Each team has their own separate list of requirements in which they must fulfill. The design team must submit various drawings with GD&T (Geometric Dimensioning and Tolerancing) information as well as work on packaging, labeling, advertising, and a web page. The process team works on operation sheets, facility and machine layouts, cost analysis, purchase requisitions and work orders. The tooling team creates or purchases the tools, jigs & fixtures and gages as well as creates work order logs, tool record logs and purchase requisitions.

This first class introduces the students to a company setting which includes teamwork and the responsibilities of an engineer. The second and third classes are where the students learn more about the diversity of a business as each student is assigned a different job title based on their resumes.

These last two courses are certainly the most exciting and interesting part of the curriculum. The students actually get to produce the product they have created in the first class. This is where they experience some of the real life problems and situations as well as learn the necessity for the integration of engineering and entrepreneurship.

In the second class, MFG 421 Manufacturing Engineering Analysis, they must survey the potential customers and see if the product is marketable. Change the product to incorporate the customer's taste, produce and follow a business plan, make production and process plans, being sure to design-in quality, purchase all the materials necessary for the production and be sure all the fixtures and special tooling is made and ready for production. Team meetings are especially interesting because of the many different departments represented. They help a student understand what is truly involved in producing a product.

The third class, MFG 490 Manufacturing Enterprise Capstone, is where the product actually gets produced and sold. The production and quality plans are implemented and the students are trained to perform certain parts of the production process. Inventory is controlled and the problems that arise during production must be solved. The product is sold and the profit is divided among the members of the company. It is a very intense and rewarding time for students. The end product is a true sign of their accomplishments and makes the students feel more confident in their knowledge and abilities when inquiring for a job.

Being an older student returning to college to finish my bachelors after working in the manufacturing industry for approximately ten years; I definitely see the need for incorporating the qualities of entrepreneurship into the engineering/technology fields. The program at Eastern Michigan University is surely a winning program. They are continuously updating their curriculum to include the industry's new standards and incorporating all the necessary entrepreneurship skills students need to become familiar with when working in the industry.

Conclusion

Technical students such as engineers perceive an entrepreneur as a business person who starts his or her own small business. They think learning about entrepreneurship is limited to business students. This narrow perception commonly causes engineers to become disconnected from the many non-engineering aspects of the manufacturing enterprise. Requiring students to function as a small business in the capstone classes helps diminish the entrepreneur stereotype.

The Manufacturing Program at Eastern Michigan University, specifically the three-course capstone sequence, addresses many of the issues discussed by Mr. Rodak and Mr. Pollock. The design and manufacture of a competitive product requires students to work in teams and exercise problem solving skills. The teamwork and weekly meetings requires students to demonstrate effective communication skills, make cohesive presentations, and listen to criticism from fellow team members. Essentially by forming a small business and manufacturing a product, the students in the capstone sequence realize the significance of their contributions to their business and learn to view the “big picture”.

In the future, the capstone courses will work more closely with entrepreneurs. In an effort to manage the projects the University is currently considering developing an Enterprise Center (EC) to be housed in the School of Engineering Technology. The EC will serve as an interface between the Manufacturing capstone courses and entrepreneurs. The EC will also serve as an interface between the Manufacturing capstone courses and the University. The Center will be managed by faculty and operated by students in the capstone courses.