Teaching Innovation and Entrepreneurship Using Technology

Raj Desai
desai_r@utpb.edu
U.T. Permian Basin

John Dudley
jdudley@semo.edu
Southeast Missouri State University

ABSTRACT

The best way to equip students with the skills to survive and thrive in a global economy is to teach innovation and entrepreneurship. Students can develop the skills to identify new business opportunities and develop the tools to capitalize on these observations.

The purpose of this project was to develop an ergonomically designed shovel that had a significant impact on reducing the number of back injuries related to the roofing industry. It was determined that by reducing the amount a worker has to bend over when removing shingles would decrease the number of back relate injuries, furthermore, preventing lost workdays, increasing productivity and decreasing workmen's compensation.

INTRODUCTION

Innovation is the exploitation of change as an opportunity for a business or service. Innovation can be taught and learned (Drucker, 1985). On the average about sixty percent of all jobs in the U.S. are generated by firms with twenty or fewer employees. Large firms with over five hundred employees generate less than fifteen percent of all new jobs

(Birch, 1979). Students can also work for large companies as intrapreneurs within the large company, but must see small business as a viable option. The Engineering Design/Analysis course at the University of Nevada at Reno provides an example of what one course in entrepreneurship can accomplish (Looney & Kleppe, 1996). Student teams work during one semester to design and build an electronic device of some sort. Several of the designs were turned into real products that were sold to existing companies or formed the basis for new startups. Engineering students have to learn to engineer in a way that is ethical, socially conscious, environmentally sound, and globally aware (ASME, 1995). Engineering education must make active learning the predominant engineering student learning mode (NSF, 1995).

Roofing is a profession that permeates the United States as a result of the huge number of residential and industrial structures that possess asphalt roofs. Roofing contractors are hard pressed to keep up with the demand placed on them, which results in an extremely long lead-time. Contractors are constantly trying to devise means of speeding up the process of stripping and laying new asphalt roofs. This decrease in time has been accomplished through radical advances in technology, such as the advent of the nail gun. The nail gun allows workers to put their hammer down and drive nails by means of air pressure, in turn; dramatically increasing the number of nails they can drive per minute. Even with past advances in technology, there is one element that seems to constantly be an issue when dealing with roofing: injuries. Roofing injuries account for a large percentage of the overall number of back injuries in the nation. Due to the amount of repetition required when roofing, chronic fatigue is a common problem. According to the

San Francisco Spine Center in California, ever year 450,000 people in the U.S. work force suffer from back injuries (Martin, 1999).

THE CONCEPT

Students can develop entrepreneurial skills by working in small teams to generate, evaluate, develop, and market their innovation. Faculty members should be encouraged to participate as student team mentors.

At the beginning of the semester students in the program will generate ideas for a large number of potential products. The product ideas will then be presented to the class and their peers will rate the ideas based on various factors given by the faculty. The product has to be prototyped by the end of the semester, so it has to be a project that is doable by the end of the semester. The project has to be at the skill level of the students. Students can imagine great projects, but they have to be able to make a prototype. The project cannot be too expensive, as it has to fit the budget of the school. Several other criteria can be added, depending on the limitations of the school.

Students will then form teams based on product interest, compatibility, skills, and other factors. The teams will work together to generate marketable product concepts. Each student team will then perform a preliminary market analysis and patent search. Within a few weeks, the team must persuasively present their product concepts to their peers. As part of this presentation, each team must specify objectives to be met by the end of the

semester. These objectives will be used as grading criteria for the project. The objective of every team and every project will be to create, prototype, and market a new product. Once the team has decided on a project concept and objectives, they will work on developing their product. This will involve product specific development using engineering and business concepts. Product protection and marketing will depend on the schools existing policies and procedures.

As a result of personal experience and observation, the researchers in this study have devised a means of reducing the number of roofing injuries due to chronic fatigue through an ergonomically designed roofing shovel. The shovel is designed to minimize the amount roofing workers have to bend over when removing existing shingles from asphalt roofs. Chronic fatigue is closely associated with carpal tunnel syndrome in that both of them are a result of repetition. When specific parts of the body are worked in the same manner over and over, it creates stress. While it is difficult to reduce the amount of repetition placed on roofers, due to the nature of the work; it is possible to alter their motions to decrease stress to specific parts of the body. By diminishing the amount a worker has to bend over, the amount of stress placed on the lower back decreases.

PRODUCT DEVELOPMENT

The process of taking an idea from initial conception to market is called product development. It includes idea generation, market research, product evaluation and

selection, design and development, product protection and commercialization (Grunewald, 1991).

Idea Generation

Idea generation refers to generation or identification of potentially marketable product ideas. Highly motivated enterprising students are an ideal source of potentially marketable, creative product concepts. Students will be motivated to pursue their ideas, especially when the potential for recognition exists. The opportunity to learn real business and engineering skills while working on one's own idea should appeal to many students. Even if student's concepts fail due to weak market analysis, existing products, or for any other reason, failure can often teach much more than success.

The process most often used for idea generation is brainstorming (Bobrow &Shafer, 1987). This involves students who suggest anything that comes to their mind, and feed off one another's ideas, and seeks to create a large list of potential products in an environment free of criticism.

Students will then form teams based on product interests, personal relationships, skills, or other factors. These teams will then work together to generate potentially marketable product concepts. Surveys or interviews with potential customers could be useful in generating relevant product concepts. Students must also be taught to keep an accurate log book and document their work carefully to protect their intellectual property rights.

Once the list of potential products is developed, each product or concept should be evaluated, considering student interest in the project, strengths and weaknesses of the concept, feasibility of execution, etc. By the end of this process each team should have a potentially workable project. Once this process has been completed, the student teams can begin their market and product research, preparation of prototype, and preparing to present and defend their ideas before their peers.

The ergonomic roofing shovel with adjustable pitch has been designed with the roofer in mind. The adjustable angle plate of the shovel was developed to allow the roofer to adjust the pitch of the shovel allowing him to remove shingles from any roof pitch by positioning the plate to the proper associated angle. This results in faster shingle removal with less effort. The ergonomic design of the handle will lessen back fatigue caused by the position the roofer must be in to operate conventional roofing shovels. All of these factors combined result in a tool that is a pleasure to use, gets the job done in less time and over time results in less lower back injuries.

Market Research

During this phase students will perform searches to make sure they are not duplicating products already on the market. They should also consider demographic factors, identify competing products, establish timelines, and get a better estimate of the resources needed to complete their project.

The review of literature indicated that nineteen percent of all roof work injuries are the result of overexertion and repetitive stress primarily in the form of back sprains (Parsons, Pizatella, & Collins, 1986 and Personic, 1990). In Illinois and Missouri, hundreds of thousands of dollars were awarded to individuals in the roofing industry mostly due to back injuries received on the job (Levenhagen, 2002). In Washington State between 1987 and 1995 there were 1,332,703 compensation claims accepted. Of these 228,500 were back injuries. These injuries resulted in an estimated $1.4 billion in medical claims and 12.3 million lost days (Silverstein, Welp and Kalat, 1998). Martin (1999) writes that back injuries cause 149 million lost workdays throughout the United States annually.

The problem being investigated in this study is that back injuries within roofing industries account for a significant portion of the overall number of back injuries in the nation. While evidence of this problem has permeated the nation's industries, no attempts have been made to alleviate the problem. To continue utilizing a system that results in injuries is not wise, not to mention extremely costly.

There are numerous advantages to decreasing back injuries within roofing industries. A few of these are:

- Prevention of lost workdays
- Decrease in the amount of workmen's compensation paid out by contractors
- More productive workers
- Decrease in lead-times
- Increase in customer satisfaction

Product Evaluation and Selection

Once potentially feasible ideas have been generated and market analysis has been performed student teams must present their concepts to their peers. Their peers will evaluate their concepts according to some established criteria. The evaluation criteria should include consideration of the product such as manufacturability, manufacturing costs, raw material availability, size, shape, material, color, price, projected sales volume, profitability, market strategy, adaptability to customer needs, and estimated cost of marketing. External factors to consider are market size, potential customers, competition, and demand. Internal factors include resources available, financial, equipment, time, and fit to program. This step is a filtering process in which only the ideas with greatest potential are allowed to proceed. Students will learn to evaluate potential products and develop valuable entrepreneurship skills. Students should present reasons for selection of product ideas chosen, as well as recommendations for improving ideas not chosen.

The results of this project can be utilized as a viable means of assisting roofing contractor's in the daunting task of reducing work related injuries. The focus of the study was to determine whether or not the ergonomically designed shovel has a positive influence in decreasing back injuries.

Product Design and Development

The details related to the design and development of a particular product depends on the nature of the product. Students should develop a timeline to guide the development of the product against which the team can be evaluated and graded at the end of the semester. Developing product prototypes will require the use of discretionary funds to cover the cost of materials, parts, and equipment usage.

The conceptual stage is easy in that you can see the product and its usefulness very clearly in your mind. During the design phase several models are created, and finally you settle on one that works. The final shovel design is shown in Figure 1.

Figure 1: Ergonomic Shovel

In the prototyping portion of the product, since the metal of the shovel was full of carbon it was very hard to weld, and the original foot on the shovel was hard to remove. However, a working prototype was created as shown in Figure 2.

Figure 2: Adjustable Pitch

Product Protection

Protection of products and intellectual properties by patenting or copywriting of new products are essential for long term survival and growth. However securing a patent can take up to two years and cost up to $10,000 in legal fees. Intellectual property policy protects the rights of all co-inventors. All participants must keep careful records of their activities in the form of engineering log books.

Commercialization

Once products have been conceived, selected, developed and protected, they must be successfully commercialized. Once a product is out in the market, other manufacturers can make slight changes to the product in order to circumvent that patent. Fighting cheap

knockoffs can be a lengthy and expensive process. It is better to be ready with your next improved model as soon as you roll out your first model, in order to keep one step ahead of the cheap knockoffs.

Evaluation

As each of the above steps is accomplished, every team should submit a brief informative report summarizing their activities for the current step, as well as laying out the goals for the next step. The report should be a flexible document, varying greatly from team to team, because it ultimately depends on the product. The key element in each report must be a summary of the work done to complete each step, broken down by team member, and a brief explanation of work to be done in the coming step. A formal presentation must be done at the end of the semester to develop their oral communication skills. Each team must also submit a final report outlining the development of their product and ideas for future development of the product. Another component of the final work is the product prototype. At the end of the semester, all groups should submit peer evaluations. This will allow students to comment on the behavior, contribution, and people skills of their teammates.

The trial portion of this product was done through the construction of small roof replicas (figure 3). These replicas had different roof pitch angles. The variation in pitched allowed the test of the shovel on different angles and also demonstrate how it helps reduce strain in all situations.

Figure 3: Shovel in Action

CONCLUSION

The project will satisfy most of the skills of ABET essential summary of critical skills for engineering graduates in Criteria 2000 (ABET, 2000). Motivated students from any department should be permitted to participate. Having a wide diversity of students participate broadens the perspective of students by exposing them to think differently. It develops development of communication and interpersonal skills.

This product was found to be very user friendly. The shovel achieves this through its simplistic design. It does not require any special training or instructions to use. It is very straight- forward and can be used by anyone. The shovel achieved the goal set forth at the beginning of the project by reducing back strain. A very noticeable difference in back strain can be detected with very minimal use. By enabling the shovel to be adjusted to the pitch of the job at hand the operator uses less effort remove unwanted shingles. This

product proves to be a very viable and needed tool in the roofing Industry. It does this while giving the consumer the added advantage of stress and strain reduction.

The recommendations or changes that need to be made to the prototype shovel include going to a lighter weight handle and adding ergonomic hand grips to the handle. A shovel head that would have a hinge bracket formed into the shovel head would eliminate a welding step and reduce the production cost. The slide mechanism can be made out of a material that is cheaper and lighter than aluminum. The last change that can be made is the addition of pitch setting marks to the handle. This will allow the shovel to be easily set on the desired angle/pitch.

Through this example we have shown how a project can be taken from an idea to the design, prototype development and commercialization of the product. The information and example will be useful to other schools in the development of a practical course on innovation and entrepreneurship.

BIBLIOGRAPHY

ABET. (2000). Engineering Criteria 2000, Engineering Accreditation Commission, Accreditation Board for Engineering and Technology, 2nd Ed.

ASME. (1995). Integrating the Product Realization Process (PRP) into the Undergraduate Curriculum, Mechanical Engineering Curriculum Development Initiative, A Curriculum Development Project of the ASME Council on Education, New York, NY.

Birch, David L. (1979). The Job Generation Process, an MIT Program on Neighborhood and Regional Change, Cambridge, MA.

Bobrow, Edwin E. and Shafer, Dennis W. (1987). Pioneering New Products: A Market Survival Guide, Dow Jones-Irwin, Homewood, CA.

Drucker, Peter F. (1985). Innovation and Entrepreneurship: Practice and Principles, Harper and Row, NY.

Grunewald, George. (1991). New Product Development Checklists, NTC Business Books, Lincolnwood, IL.

Levenhagen, F. T. (2002). Settlements & Verdicts. Retrieved from http://www.levenhagen.com/verdicts.html.

Looney, M.S. and Kleppe, J.A. (1996). Entrepreneurship in Electrical Engineering Education, ASEE Frontiers in Education Conference Proceedings, Vol. 26, pp. 707-710.

NSF. (1995). Systematic Engineering Education Reform: An Action Agenda, Recommendations of a Workshop Convened by the NSF Engineering Directorate, Renaissance Hotel, Arlington, VA.

Martin, J., (1999). The Basics of Back Injuries. Professional Roofing Magazine, October 1999, 78-81.

Parsons, T., Pizatella, T., & Collins, J., (1996). Safety analysis of high risk injury categories within the roofing industry. Professional Safety, 31, 13-17

Personick, M. (1990). Profiles in safety and health: roofing and sheet metal work. Monthly Labor Review, 113, 27-32.

Silverstein, B., Welp, E., & Kalat, N. (1998). Claims Incidence of Work-Related Disorders of the Upper Extremities: Washington State, 1987 through 1995. American Journal of Public Health, Vol. 88, issue 12.