

Teaching Innovation to Freshmen Engineering Students

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Abstract

Companies profit and grow through the development of innovative products and designs. Thus, industries invest substantial parts of their profits into research and development, seeking the most innovative ideas and employees to find those ideas. Employees are motivated to be creative, especially when the potential for recognition exists. Engineers are often the leaders of product development teams. For product development in industry, a structured plan may be used to encourage brainstorming and help enhance creativity. This is why innovation, entrepreneurship, and leadership are critical skills for engineering students.

Keywords – Projects, Innovation, Entrepreneurship, Leadership

Introduction

Practical innovative projects help students develop their portable skills. Portable skills are skills that can transfer from one occupation to another, and from school to work. Both soft skills and hard skills help encourage mobility of employees. This paper outlines the process for teaching these critical skills in our class “Introduction to Engineering.” The steps are idea generation, market research including stakeholder analysis, evaluation, product design and development, product protection, and commercialization. This paper also talks about leadership and entrepreneurship. Through the use of these steps and skills, we give students the tools for innovation and success.

Idea Generation

During the first week, the students are told how brainstorming is conducted in the lecture part of the class. Current students were also told about the products developed by previous students. They were also told that the best ideas were those that the students had a personal interest in developing, to fill an unmet niche. Once the list of potential products is developed, as in Table 1, students evaluate each product or concept, considering student interest in the project, strengths and weaknesses of the concept, feasibility of execution, etc. Students 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. Students must also be taught to keep an accurate log book and document their work carefully to protect their intellectual property rights.

Market Research

Market research identifies customer needs and wants. This method can identify potential target groups or markets. Based on the target groups, students can identify the advertising techniques to reach each target group. Listening to customer requests for products and services is another way to develop or improve products and services. Market research can be used to determine geographic area of a business and/or

Table 1: Brainstorming Innovative Products

| PROJECTS | STUDENTS |
|-------------------------------|--|
| 1. Wi-Fi Shield | Matt, Shane, April, Xavier, and Torrey, Michael. |
| 2. Cable Management | Justin, Clayton, Cole, Russell, Ovin. |
| 3. Remote Pager | Virgil, Marcus, Justin, Udes, Liyanage. |
| 4. Knife Guard | Daniel, Bradeen, Phillip, Hamoud. |
| 5. Condensate Overflow Switch | Stephen, Omar, Joyanne, Tapiwa, William. |
| 6. Magnetic Glasses | Taris, Harley, Samantha, Asia, Jomarie, Ryder. |
| 7. Freezer Jug | |
| 8. Insulated Carts | |
| 9. Can Lid Cover | |
| 10. Headband Holder | |

Table 2: Research Selected Products

| Wi-Fi Shield |
|--|
| <ul style="list-style-type: none"> • We referenced various sources throughout the internet and were not able to find anywhere that suggested that this product had already been invented or created. • We found that a wireless network uses radio waves to transmit signals in the same way that cell phones and radios do. A router is able to receive information from the internet through a physical, wired Ethernet connection. The router then translates that information into a radio wave signal and sends it to the computer's wireless adapter. • Source: http://computer.howstuffworks.com/wireless-network1.htm • In regards to finding a material that would be suitable for our project's purposes, we were able to determine that metals, such as aluminum, will reflect radio signals that attempt to pass through them. Aluminum seems like the best option for a material because of its low cost and abundance. • Source: http://www.madsci.org/posts/archives/2002-03/1015162213.Eg.r.html • In terms of an aesthetic design for the shield, we were able to find a source that described a scenario of diminished Wi-Fi signals that was known to be caused by chicken wire that was found in the walls of old homes "because the wire is spaced in just such a way to create a perfect shield against Wi-Fi frequencies." • From this, we decided that we wanted to place a section of chicken wire on our aluminum shield in order to allow our shield to better reflect and block any Wi-Fi signals that attempt to pass through it. Chicken wire is a very cheap and abundant resource, so we don't foresee this causing a problem with budget or profit loss at this time. • Source: http://lifehacker.com/5657613/why-is-wi-fi-coverage-so-bad-in-my-house-and-how-can-i-fix-it • We found that you can purchase a 2 x 2 ft. sheet of 6061-T6 aluminum for approximately \$30. • Source: https://www.metalsdepot.com/catalog_cart_view.php?msg • We were also able to find that a 2' x 10' roll of chicken wire can be purchased for approximately \$6/roll. • Source: http://www.homedepot.com/p/HDX-1-in-x-2-ft-x-10-ft-Poultry-Netting-308400HD/204331887 |

demographics of customers (age, gender, income, etc.). Prospective customers have to be asked the right questions, and open-ended questions to get the best answers. If your product has competitors, you want to look at their weaknesses and develop a strategy to enter the market. Customer profiles will allow you to determine if the market is large enough and profitable enough to develop your product. During the second week, students will perform searches to make sure they are not duplicating products already on the market, as in Table 2. If they plan on developing an existing product they need to show how their product is better and/or different from the existing product.

Market research will let them know who their potential competition could be, and what would be an appropriate price range for the product. They should also consider demographic factors, establish timelines, and get a better estimate of the resources needed to complete their project. During the third week, the student groups make a timeline to guide the development of the product is shown in Table 3.

Table 3: Project Timeline for Remote Pager

| Task / Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| Brainstorming | X | X | | | | | | | | | | | | | |
| Research other Remote Pagers | | X | X | | | | | | | | | | | | |
| Develop Survey | | | X | X | | | | | | | | | | | |
| Administer Survey | | | | | X | X | | | | | | | | | |
| Design | | | | | | | X | X | | | | | | | |
| Team Task List | | | | | | | | | X | | | | | | |
| Gather Materials | | | | | | | | | X | X | X | | | | |
| Prototype | | | | | | | | | | X | X | X | | | |
| Complete Report | | | | | | | | | | | | | X | X | |
| Presentation | | | | | | | | | | | | | | | X |

During the fourth week students develop a survey consisting of various questions designed to retrieve feedback from possible consumers about the marketability of the product, as in Table 4. The survey also collects information about the consumers and is designed to help forecast possible retail pricing and target populations. During week five, students compile the survey results as shown in Table 5.

Project Evaluation

Evaluation is the process of identifying and collecting information to help decision makers choose among available alternatives [1]. The words evaluation, assessment, and measurement are sometimes used interchangeably. Measurement is generally used for assessment or evaluation. Evaluation is done to determine value. Evaluation is a term more common with those engaged in research and development. Good evaluation utilizes measurement and observations, gathering evidence systematically, and analyzing the results objectively [2].

Table 4: Survey Instrument for Wi-Fi Shield

| <u>Wi-Fi Shield Survey</u> | |
|--|--------|
| • Do you currently live in a house or an apartment complex? | Yes No |
| • Do you currently have an internet connection in your residence? | Yes No |
| • Do you use a router to transmit an internet connection throughout your home? | Yes No |
| • Is your router located near the center of your home? | Yes No |
| • Is having a strong internet connection something you value in your home? | Yes No |
| • Do you get a better signal in certain areas of your home? | Yes No |
| • If you could increase the connection speed in your home using the same router and service provider for a reasonable cost, would you? | Yes No |
| • How much would you be willing to pay for this convenience? Please circle one. \$25-\$50 \$50-\$75 \$75-\$100 \$100+ | |
| • Overall, how interested are you in buying this product if it were available? Please circle one. Not At All Interested Somewhat Interested Very Interested | |
| • Overall, what is your reaction to the described product? Please circle one. Poor Fair Good Very Good Excellent | |
| • For the purpose of demographics please answer the following questions: | |
| • Gender: Male Female | |
| • Age: Under 18 19-25 26-35 36-45 46-55 56-65 Over 65 | |
| • Income: Under \$20,000 \$20,000- \$35,000 \$36,000- \$50,000 Over \$50,000 | |
| • Race: White African American Hispanic Asian Native American Other | |
| • Where do you live? Country City | |
| • Do you have any suggestions that may improve the overall quality or effectiveness of this product? | |

Table 5: Survey Results

| <u>Survey Results for Knife Guard</u> | |
|--|---|
| • Have you ever cut yourself while cleaning a knife? | Yes: 66.667% No: 33.333% |
| • Have you ever used a knife protecting glove before? | Yes: 6.667% No: 93.333% |
| • Would you consider using a knife protective glove to prevent future cuts? | Yes: 53.33% No: 46.667% |
| • How much would you be willing to pay for a knife protecting glove? (Results are in US \$) | |
| • 1-4: 33.333% 5-10: 53.33% 11-20:13.33% 21-30: 0% | |
| • How large would you say your hand is? | Small: 33.33% Medium: 40% Large: 26.67 |
| • Do you or work for a restaurant or cafeteria? | Yes: 40% No: 60% |
| • Gender: | Male: 53% Female: 47% |
| • Age: | 18-25: 60% 26-35: 20% 36-45: 6.667% 46-55: 6.667% 56-65+: 6.66% |

Once potentially feasible ideas have been generated and market analysis has been performed student teams must analyze their concepts according to some established criteria. The students then analyze the survey results during week six, to determine their target market as shown in Table 6. 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. In practice, this step is a filtering process in which only the ideas with greatest potential proceed.

Table 6: Survey Analysis

Magnetic Glasses Survey Analysis

- Our survey showed that all of the respondents were interested in magnetic glasses.
- They were interested that they would not have to be as cautious with their glasses and are mostly willing to pay \$31-55 for a well-made pair of glasses.
- We are mostly dealing with an age group of 18-25, and prefer to add this feature with their prescription and sun glasses.
- The survey shows that both males and females are equally interested in this product.
- The survey shows that our product will be reasonably priced around \$45

During week seven, the students develop a business plan (www.sba.org), as in Table 7. An extensive business plan would be required if the group wanted to apply for a bank loan. The Wi-Fi student group found from their survey that customers were willing to pay up to \$50 for their product. Some groups decided to price their product at the maximum the customers were willing to pay.

Product Design and Development

Product development is a crucial phase in the product life cycle, because it is here that many ideas and choices come together to form one product. Product development covers design conceptualization to pre-production, to manufacture and distribution. Product development can be defined as the design and engineering required to make products serviceable, producible, and profitable [3]. User interviews can be used to generate ideas for new products. Gathering user needs information is also an essential part of the design process. Functional, expressive, and aesthetic factors are important [4]. Function needs may include variables such as fit and ease of use. Expressive needs address variables such as role or status in society. Aesthetic appearance for clothing includes durability, comfort, and fashion.

Constructing first prototype involves translating user needs and preferences into a visual model. The sketch and the specifications sheet contain information essential to the manufacturing process. Evaluating feasibility and planning production involves reviewing the prototype and determining whether it should go forward into manufacturing. A variety of activities include evaluating the design, materials, specifications, and estimation of cost.

Manufacturability of a product includes potential market, engineering and production (quality and rate of production), and financial matters (optimizing cost). During production, reevaluation could take place based on user evaluations after review of product. Marketing refers to the promotion (advertising) and distribution to the consumer. It includes brand image and response to market changes. Appropriateness of end use is inferred from user initial needs input and from evaluation of finished product. User needs

are determined from collecting information on limitations, problems, practical solutions, and style preferences. There is the constant search for affordable and cost-effective product.

Starting with week eight and until week 15, the students work on the details related to the design and development of a particular product. This will also satisfy ABET (Accreditation Board for Engineering and Technology) Criteria 2000 [5]. Developing product prototypes will require the use of discretionary funds to cover the cost of materials, parts, and equipment usage. Project based courses prompt for reflection and use of experience from learning activities in the coursework [6].

Table 7: Preliminary Business Plan

The Business: Wi-Fi Shield

- **Description of Business:**
- Our Wi – Fi shield will be constructed out of simple materials, such as aluminum, in order to theoretically meet a basic household need drastically strengthening your Wi-Fi signal throughout your home without having to go about changing internet service providers or buying a new router.
- **Marketing:**
- Create a user-friendly website where consumers can view our product, its benefits, and decide whether or not our product could be a beneficial addition to their household.
- Appeal to current internet service providers throughout our town to see if they see our product as beneficial to their current business plan and would consider implementing our product within their current operation.
- Pass out flyers to homes in various neighborhoods and on campus explaining our product and its benefits in order to spread the knowledge of our product. We will invite families and students to try our product to see if it could benefit them as well.
- **Competition:**
- After extensive research, we were able to determine that we are the only company, at this time, with a product such as this.
- **Personnel:**
- We, as a group, will handle all aspects of the marketing, manufacturing, and distribution of this product.
- **Financial Data:**
- In previous research, we were able to determine the cost of making our product would be approximately \$20 - \$30 with materials and time included.
- Through our product survey, we were able to determine that 86.66% of our surveyed consumers would be willing to pay between \$25 and \$75 for the luxury that our product provides. This leaves us with a very wide range of profitability. If we were to charge \$50 for our product, we would be doubling our money with every sale.

Product Protection

In order to promote wealth creation, nations have recognized ideas, creative works, and designs protected under intellectual property law. This temporary assignment of ownership over intellectual

works meets the need of finding the balance between private interests in wealth accumulation and the public interest of the product eventually being introduced in the public domain.

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. Commercialization explains the actions and decisions required in getting a product to a given market. Technological innovation must be transformed into commercially successful products and services that meet customer needs. Commercialization is the art of taking an invention or a technology and developing a product or service for either consumer or industry.

Entrepreneurship

Entrepreneurship increases people's standard of living through creation of new firms that generate value by selling new products and services [7]. Entrepreneurship can be defined as leadership that contributes to the pursuing of profit opportunities to fill currently unsatisfied needs or improve inefficiencies [8]. New venture creation can increase employment and lead to economic development. Entrepreneurial orientation is an individual's attitude towards engaging in entrepreneurial activities. Entrepreneurship is the introduction of a new good, the introduction of a new method or product, the opening of a new market, the conquest of a new source of supply of new materials and the carrying out of a new organization of any industry [9].

During week 8, students develop a table of start up costs as in table 8. Start up expenses will include the cost of obtaining the necessary business licenses, operating expense for the first three months, and any expenses needed to get the business up and running. Include your salary and taxes for the first year. The rule of three takes your desired yearly salary and multiplies it by three to obtain the total start up expenses. If you have a home business, this can be cut down to twice your salary. Remember that financing is difficult to get when you first start out. Your most common financing source will be your home equity and personal savings. You may be able to use your family members as a financing source. You must always remind them that there is a good chance that you may lose all of the money. Table 8 shows start up cost variables. You may be fortunate to get clients that will pay a small percentage up front as a down payment for your services. You may be able to pay for the expensive professional liability insurance on a quarterly basis.

During week 9 students develop an income statement, as in table 9. The income statement also goes by the name profit and loss statement. This statement is a snapshot of your monthly revenues and expenses. You can see how your company performs each month. Revenues are accounts receivable. This is what clients pay for your services/products. Outstanding invoices are not logged until the client pays them. The last part of the income statement is the subtraction of the expenses from the revenue. If this is positive, you have a net income. If it is negative, you have a net loss. Since this is a monthly picture,

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some months may have a net loss, when there is not much income coming in. hopefully by the end of the year, there are more gains than losses.

Table 8: Startup costs – Remote Pager

| | Cost |
|----------------------------------|-----------------|
| Advertising | \$3,086 |
| Business state licenses | N/A |
| Computer equipment | \$500 |
| Office furniture | N/A |
| Office supplies | N/A |
| Professional liability insurance | \$3,000 |
| Professional organizations | N/A |
| Rent | N/A |
| Three months of pay | \$4,500 |
| Web development | \$250 |
| Other expenses | \$500 |
| Total start up expense | \$11,836 |

Table 9: Pro Forma Profit/Loss Statement – Magnetic Glasses

| Profit/Loss Forecast Worksheet | Magnetic Glasses | | | | | | | | | | | | Year Total | |
|--|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|
| | Jan | Feb | Mar | April | May | June | July | Aug | Sept | Oct | Nov | Dec | | |
| Sales Revenues | | \$125,908 | \$129,600 | \$129,600 | \$129,600 | \$129,600 | \$129,600 | \$129,600 | \$129,600 | \$129,600 | \$129,600 | \$129,600 | \$129,600 | \$1,421,908 |
| Gross Profit Percentage | 53.00% | 53.00% | 53.00% | 53.00% | 53.00% | 53.00% | 53.00% | 53.00% | 53.00% | 53.00% | 53.00% | 53.00% | 53.00% | |
| GROSS PROFIT | \$0 | \$66,731 | \$68,688 | \$68,688 | \$68,688 | \$68,688 | \$68,688 | \$68,688 | \$68,688 | \$68,688 | \$68,688 | \$68,688 | \$68,688 | \$753,611 |
| Fixed Expenses | | | | | | | | | | | | | | |
| Office rent | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$14,400 |
| Salaries | \$10,752 | \$10,752 | \$10,752 | \$10,752 | \$10,752 | \$10,752 | \$10,752 | \$10,752 | \$10,752 | \$10,752 | \$10,752 | \$10,752 | \$10,752 | \$129,024 |
| Utilities | \$130 | \$130 | \$130 | \$130 | \$130 | \$130 | \$130 | \$130 | \$130 | \$130 | \$130 | \$130 | \$130 | \$1,560 |
| Telephone service | \$40 | \$40 | \$40 | \$40 | \$40 | \$40 | \$40 | \$40 | \$40 | \$40 | \$40 | \$40 | \$40 | \$480 |
| Office supplies | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$180 |
| Postage | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$15 | \$180 |
| Website hosting | \$12 | \$12 | \$12 | \$12 | \$12 | \$12 | \$12 | \$12 | \$12 | \$12 | \$12 | \$12 | \$12 | \$144 |
| Insurance | \$42 | \$42 | \$42 | \$42 | \$42 | \$42 | \$42 | \$42 | \$42 | \$42 | \$42 | \$42 | \$42 | \$504 |
| Professional services (accountant, etc.) | \$0 | \$5,000 | \$0 | \$0 | \$0 | \$5,000 | \$0 | \$0 | \$0 | \$5,000 | \$0 | \$0 | \$0 | \$15,000 |
| <enter other fixed cost> | | | | | | | | | | | | | | \$0 |
| <enter other fixed cost> | | | | | | | | | | | | | | \$0 |
| <enter other fixed cost> | | | | | | | | | | | | | | \$0 |
| Miscellaneous | | | | | | | | | | | | | | \$0 |
| TOTAL FIXED EXPENSES | \$12,206 | \$17,206 | \$12,206 | \$12,206 | \$12,206 | \$17,206 | \$12,206 | \$12,206 | \$12,206 | \$17,206 | \$12,206 | \$12,206 | \$12,206 | \$161,472 |
| NET PROFIT (LOSS) | (\$12,206) | \$49,525 | \$56,482 | \$56,482 | \$56,482 | \$51,482 | \$56,482 | \$56,482 | \$56,482 | \$51,482 | \$56,482 | \$56,482 | \$56,482 | \$592,139 |

During week 10 students develop a cash flow statement, as in table 10. This is a good planning document. This statement estimates how much money flows in and out of your business during a specific period. The cash flow statement reflects when your company expects to receive income, and when the company expects to pay bills. This is an extremely valuable tool to ensure that your company will have cash on hand to pay for its obligations. You can do cash flow statements quarterly.

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Table 10: Pro Forma Cash Flow Statement – Wi-Fi Shield

| | January | February | March | April | May | June | July | August | September | October | November | December |
|-------------------------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Profit | | | \$22,388 | \$44,770 | \$67,155 | \$91,540 | \$113,925 | \$136,310 | \$158,695 | \$181,080 | \$203,465 | \$225,850 |
| Total Cash Available | | 4,885 | \$27,270 | \$49,655 | \$72,040 | \$96,425 | \$118,810 | \$141,195 | \$163,580 | \$185,965 | \$208,350 | \$230,735 |
| Cash In: | | | | | | | | | | | | |
| Sales | | \$30,000 | \$30,000 | \$30,000 | \$30,000 | \$30,000 | \$30,000 | \$30,000 | \$30,000 | \$30,000 | \$30,000 | \$30,000 |
| Loans | \$15,000 | | | | | | | | | | | |
| Total Cash In: | \$15,000 | \$34,885 | \$67,270 | \$79,655 | \$104,040 | \$126,425 | \$148,810 | \$171,195 | \$193,580 | \$215,965 | \$238,350 | \$260,735 |
| Cash Out: | | | | | | | | | | | | |
| StartUp Costs | \$2,500 | | | | | | | | | | | |
| Inventory | \$3,000 | \$3,000 | \$3,000 | \$3,000 | \$3,000 | \$3,000 | \$3,000 | \$3,000 | \$3,000 | \$3,000 | \$3,000 | \$3,000 |
| Rent | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 | \$1,200 |
| Utilities | \$150 | \$150 | \$150 | \$150 | \$150 | \$150 | \$150 | \$150 | \$150 | \$150 | \$150 | \$150 |
| Phone/Internet | \$65 | \$65 | \$65 | \$65 | \$65 | \$65 | \$65 | \$65 | \$65 | \$65 | \$65 | \$65 |
| Employee Wages | \$2,000 | \$2,000 | \$2,000 | \$2,000 | \$2,000 | \$2,000 | \$2,000 | \$2,000 | \$2,000 | \$2,000 | \$2,000 | \$2,000 |
| Insurance | \$300 | \$300 | \$300 | \$300 | \$300 | \$300 | \$300 | \$300 | \$300 | \$300 | \$300 | \$300 |
| Printing | \$30 | \$30 | \$30 | \$30 | \$30 | \$30 | \$30 | \$30 | \$30 | \$30 | \$30 | \$30 |
| Office Supplies | \$200 | \$200 | \$200 | \$200 | \$200 | \$200 | \$200 | \$200 | \$200 | \$200 | \$200 | \$200 |
| Online Website Fees | \$50 | \$50 | \$50 | \$50 | \$50 | \$50 | \$50 | \$50 | \$50 | \$50 | \$50 | \$50 |
| Computer Software | \$120 | \$120 | \$120 | \$120 | \$120 | \$120 | \$120 | \$120 | \$120 | \$120 | \$120 | \$120 |
| Loan Payment | \$500 | \$500 | \$500 | \$500 | \$500 | \$500 | \$500 | \$500 | \$500 | \$500 | \$500 | \$500 |
| Total Cash Out: | 10,115 | \$7,615 | \$7,615 | \$7,615 | \$7,615 | \$7,615 | \$7,615 | \$7,615 | \$7,615 | \$7,615 | \$7,615 | \$7,615 |
| Cash After Expenditures | \$4,885 | \$27,270 | \$49,655 | \$72,040 | \$96,425 | \$118,810 | \$141,195 | \$163,580 | \$185,965 | \$208,350 | \$230,735 | \$253,120 |

During week 11 students develop parts of a business plan: Introduction, industry overview, products & processes, marketing, operating plan, and financial plan. The introduction gives a brief overview of the company’s purpose and financial summary. The industry and its current status are reviewed and its products and processes are described. The marketing plan consists of a market analysis, marketing survey, marketing strategies, and sales forecasts. The operating plan describes the company’s location, employees, raw material, and production. The financial plan includes financial statements, the capital requirements, and an economic analysis.

During week 12, students complete the executive summary. The executive summary should be a clear, concise summary and should be able to stand alone. Some of the topics discussed are the type of business, services provided, form of ownership, the company’s principles, how much money is required, and the utilization of the money. The executive summary is the first section of the business plan, but is written last. The section also includes the company’s objective and mission statement.

During week 13 students complete the business plan (10 to 40 pages). This should include: 1. Cover sheet that includes company name, address, and phone & email. 2. Executive summary. 3. Company description (structure, ownership, location, business, growth of company, industry). 4. Company services. 5. Market analysis (competition). 6. Financial analysis (income, cash, flow, and balance sheet).

The company description section should include the company’s structure, ownership, and other basic information such as location. Even though this section seems obvious to the owner, remember the target

audience for the business plan is investors and/or lenders. With this in mind, include a brief description of the business industry that your company is in to help lenders know what your company does. Also include the current economic health of your company, and the projected growth of the company and industry.

Your company service includes details of the services you will be providing. You want to research these services to include competitive pricing. Your prices will ultimately depend on what your client is willing to pay. Explain any unique advantage your company has over your competitors, and explain why your client needs to choose your firm over the competition. If you can identify ways to capitalize on your competition's mistakes, your company will benefit. By finding unique market niches, your company can survive and thrive.

Market analysis includes understanding the market and finding opportunities in the marketplace. It is the best way for your company to grow and thrive. Find your market niche, based on your experiences and expertise. Use the internet for your research. If you have expertise in your field, then you know your targeted clients. If you do not, then research will help you find your targeted clients. Once you know your clients, you have to know your competition. You need to pick the competition that is your size, and has your capabilities, so that you can compete with them. Bigger firms will have capabilities that you do not possess, so it will be difficult to compete with them. You also have to know the business environment for your market area, as its health and vitality will affect your clients and their needs, and thus your company.

The financial analysis will help you project your company's revenue, financial state, and future financial goals. The first step is to forecast your company's sales for the first year, and then for the first five years. This will require you to figure out what you are going to do, how much can you make/complete in a given time, and how much can you price your product/service as shown in Table 9. During week 14 and 15, students complete a presentation of the business plan (10 to 20 slides). This should be a comprehensive presentation of the paper done in week 13.

Leadership

Leadership is the demonstrated ability to set goals, get commitment, and build capability. A leader is someone who leads an organization strategically in alignment with the organization's goals, so that it is successful. Leaders influence others (followers). Leadership traits may include extreme intelligence, good memory, persuasiveness, and unlimited amount of energy. Leaders care about their followers. Production oriented behaviors involve completion of tasks. Employee oriented behaviors include skills and relationships with their employees.

In both the public and private sector leadership is perceived as a critical requirement for organizational success. We need people who are willing to take a risk, to innovate, and to create a new way of thinking. Leaders of tomorrow will have to help people see the possibilities that exist beyond what they know today. Leadership is the behavior of an individual when he/she is directing the activities of a group towards a shared goal [10]. True leadership is leaders and followers working together to achieve mutual goals [11]. Leadership requires the ability to understand and deal with complexity, long time horizon, integrative skills, system design skills, and conceptual ability [12]. Traits such as drive, the desire to

lead, honesty, integrity, self confidence, cognitive ability and knowledge of the business make it more likely that a leader will be successful. By formulating a vision, role modeling, and setting goals, a leader can use his or her talents to build a successful organization. The purpose of leadership is to enable all organizational members to choose to move in a common direction and accomplish the organizational tasks successfully [13].

Coopetition is the simultaneous pursuit of collaboration and competition to generate competitive advantage [14]. Competition is particularly important in high-tech industries where products have short life cycles and massive R&D costs [15].

During week 16 students can explain the leadership structure of their business. They can also explain the strategy that the organization will follow, so that the employees know the core values and practices that will guide the business.

Conclusion

Practical innovative projects help students develop their portable skills. Portable skills are skills that can transfer from one occupation to another, and from school to work. Both soft skills and hard skills help encourage mobility of employees. This paper outlined the process for teaching these critical skills in our class “Introduction to Engineering.” The steps are idea generation, market research including stakeholder analysis, evaluation, product design and development, product protection, and commercialization. This paper also talked about leadership and entrepreneurship. Through the use of these steps and skills, we give students the tools for innovation and success.

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