

Practical Innovation, Entrepreneurship, & Leadership for Technology, Business, & Engineering Professionals

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ABSTRACT--- *Corporations want to enhance the creativity of their employees. We innovate to find solutions to existing problems. Employees will be motivated to pursue their ideas, especially when the potential for recognition exists. Brainstorming helps generate more ideas and group interaction facilitates creativity. Creative products are often the source of profits and help survival for an organization. This is why industry invests substantial parts of their profit in research and development for new products.*

Keywords - Innovation, Entrepreneurship, Leadership

1. INTRODUCTION

We need to teach our technology, business, and engineering students' practical innovation, entrepreneurship, and leadership skills. In the paper below, we have outlined a process for developing these skills in our students.

2. IDEA GENERATION

During the first week, the students are told about 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.

Table 1: Brainstorming Innovative Products

PROJECTS	STUDENTS	
1. Flood Stopper	Robert, Kenneth, Johnny, Sam.	
2. Disposable Cap Liner	Larry, Vanessa, Ashley, Frankie, Daniel.	
3. Under-Wire Bra Repair Kit	Sarah, Jennifer, Kristin, Aaron.	
4. Jack-able Dolly	J. R., Roland, Rusty, Lisa, Ben.	
5. Freeze Jug/Koozie	Brian, Garetti, Tyler, Nevena, Oved.	
6. Breast Balancing Insert	Victoria, Mary, Wesley, Leo.	
7. Ball Bearing Trailer Hitch	Randy, Will, Jared, Carlos.	
8. Velcro Dog Collar	9. Child Beeper	10. Computer Strap
11. Cell Phone Capacitor Charger	12. Air Car Jack	13. Winter Jeans
14. Motion Detector Radio	15. Welder Wheels	16. Motion Capture
17. Tivo for Radio	18. Instant Omlette	19. Air Shoe Fix
20. T Post Remover	21. Dog Door Remote	22. Remote Finder

3. MARKET RESEARCH

Market research identifies customer needs and wants. This method can identify potential target groups or markets. Based on the target groups, you 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 demographics of customers (age, gender, income, etc.). You have to ask 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 or different from the existing product.

Table 2: Research Selected Products

Disposable Cap Liner - Daniel, Larry, Ashley, Vanessa, & Frank	
•	With the first reference www.halfbakery.com/idea/Disposable_20Baseball_20Cap_20Liners we discovered that the Cap Liner was already invented so we decided to improve this product.
•	We were debating on what material to use, either Velcro or Magnet for the liner to stick to the cap. After finding that magnetic therapy has been used as a natural healing technique, we decided to use magnets to appeal to certain people who believe in this. The reference is: www.magnetsandhealth.com .
•	What material to use was the next question? After researching different types of material we found that micro polyester is the best material to use because it helps keep your forehead sweat free. The web site was www.rockywoods.com/micro_polyester.htm .
•	We found that the cap liner had a patent. The patent # is 5566395. This patent had very good ideas that we did not think about like adding an antibacterial to the liner. The reference was www.freepatentsonline.com
•	Micro fiber material was found on www.reviews.ebay.com/Microfibers-materials . We decided to use this material too. It is a fine synthetic fiber woven into lightweight, washable and breathable fabrics that hold shape extremely well.

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 Ball Bearing Trailer Hitch

Task / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Brainstorming	X	X													
Research other Hitch		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.

Table 4: Survey Instrument for Product

<u>Breast Balancing Insert Survey</u>		Yes	No
• Have you had or have breast cancer?		Yes	No
• Have you had or have a family member with breast cancer?		Yes	No
• Have you had or known someone that has had a lumpectomy?		Yes	No
• Do you have one breast significantly smaller than the other?		Yes	No
• Are you unable to wear shirts because of different sized breasts?		Yes	No
• Have you tried a breast balancing insert?		Yes	No
• Do you sweat in the breast area wearing a breast balancing insert?		Yes	No
• Would you be interested in a breast balancing insert?		Yes	No
• How much would you be willing to pay for a breast balancing insert?			
	\$50- \$100 \$101- \$150 \$151- \$200 \$201- \$250 \$251- \$300		
• 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			
• \$51,000- \$65,000 \$66,000- \$80,000 \$81,000- \$95,000 Over \$95,000			
• Race: White African American Hispanic Asian Native American Other			
• Where do you live? Country City			
• Do you have any suggestions to improve the breast balancing insert?			
•			

Table 5: Survey Results

<u>Survey Results for Jack-able Dolly</u>	
• Do you know what a Dolly is used for? Yes 53%, No 12.5%, Not sure 34%	
• To move a large item, you prefer: Hand 0%, Hand truck 18.8%, Dolly 81%	
• For a Dolly built in straps is a good idea: Yes 93.8%, No 3%, Depends 3%	
• When moving which would be important:	
• Rubber corners 43.8% , Move item by hand 15.6%, Quick moving 68.8%, Wheel locks 53%, Increase height 81% , Extra help 50%	
• Use for a Jack-able Dolly for moving items: Yes 81% , No 18.8%	
• How high you need an item to be lifted: Up to 1 foot 21.9%, 1 to 2 feet 28%, 2 to 3 feet 21.9% , More than 3 feet 62.5% .	
• Interest in a Jackable Dolly: Yes 43.8%, No 12.5%, Depends 28%, Maybe 18.8%	
• Which would you prefer: Manual 12.5% , Electric 28% , Depend on Cost 50%	
• Spending amount on a manual Dolly: <\$50 18.8%, \$50 to \$100 50% , \$100 to \$200 21.9% , \$200 to \$500 3% , More than \$500 0%	
• Spending amount for an electric Dolly: < \$100 9% , \$100 to \$300 62.5% , \$300 to \$600 9% , More than \$600 3%	
• For purposes of demographics, please provide the following information.	
• Sex: Male 62.5%, Female 28%	
• Age: < 25 25%, 25-34 18.8%, 35-44 9% , 45-54 21.9%, 55-64 12.5%, >65 6%	
• Occupation: Service 18.8%, Sales 3%, Manufacturing 3%, Industry 15.6%, Government 3%, Other 40.6%	

4. 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].

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

Koozie Survey Analysis

- Our survey showed that 92 percent of the respondents knew what a koozie was and only 8 percent didn't.
- They are interested in a koozie that would keep their drink colder, for longer and are willing to spend from \$0-5 for a koozie.
- We are mostly dealing with an age group that ranges between 18-25 years of age and prefer purchasing a koozie with their team's logo.
- The survey revealed that we are dealing with 76 percent white, 80 percent male, and 96 percent living in the city.
- Our survey clearly reveals that our product would be reasonable priced at around \$4.50.
- If we stay within this price range, we can expect to sell 50 a week at \$4.50 and maximize our profit.
- Our expense to make this product would be \$2.00 leaving us with a profit of \$125 per week.

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 trailer hitch student group found from their survey that customers were willing to pay up to \$300 for their product. Their product was a ball bearing trailer hitch for motorcycles, which would not topple the trailer during sharp turns. Some groups developed a more elaborate business plan, and others decided to price their product at the maximum the customers were willing to pay.

Table 7: Preliminary Business Plan

The Business: Ball-Bearing Trailer Hitch

- Description of Business: Ball bearing trailer hitch for motorcycles and ATVs.
- Marketing: Create a website where customers can buy the product.
- Appear at bike shows and rallies.
- Advertisements in Gold Wing magazine and an ATV magazine.
- Competition: None
- Personnel: We will handle the manufacturing, marketing and distribution of the product.
- Financial Data (Prototype Cost):
 - The total cost would range from about \$32-\$70 plus tax (8.25%) would equal \$34.64- \$75.58
 - The work would be done by us (for prototype). Since the cost is roughly \$75.58, if we charge triple since we are trying to turn a profit. The price we would charge is estimated at \$229.99.

5. 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].

6. 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.

7. 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.

8. 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].

Table 8: Start up costs

	Cost
Advertising	
Business state licenses	
Computer equipment	
Office furniture	
Office supplies	
Professional liability insurance	
Professional organizations	
Rent	
Three months of pay	
Web development	
Other expenses	
Total start up expense	

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, 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 9: Pro Forma Income Statement

Gross Sales/Revenues				
Less: Returns and Allowances				
Net Sales	a			
Less: Cost of Goods Sold	b			
Gross Margin		a - b = c		
Operating Expenses				
Wages				
Fringe Benefits				
Utilities				
Supplies				
Depreciation				
Office Supplies				
Freight				
Travel				
Miscellaneous				
Total Operating Expenses		d		
Earnings before Interest & Taxes			c - d = e	
Less: Interest Expense			f	
Earnings before Taxes			e - f = g	
Less: Income Taxes			h	
Net Income (Loss)				g - h = i

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.

During week 11 students develop a balance sheet, as in table 11. The balance sheet is one of the major corporate financial statements for companies. It provides the book value of assets, liabilities, and equity, and its preparation is according to Generally Accepted Accounting Principles (GAAP). Since market value keeps changing, the numbers shown on the balance sheet could be different from actual market capitalization. Although the balance sheet is essential to understand the company’s financial structure, it has limitations for providing information since it is a book value based statement. Investors read balance sheets to make investment decisions. Off balance sheet items, such as operating

lease expense, do not appear in the balance sheet and account for an important portion of the company’s financial structure. Therefore limitations remain for obtaining information only from balance sheets when seeking to understand the financial structure of the company.

Table 10: Pro Forma Cash Flow Statement

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Cash Inflow					
Cash Sales					
Credit Sales Receipts					
Other Receipts					
Total Cash Inflows	a				
Cash Outflows					
Materials					
Wages					
Fringe Benefits					
Utilities					
Supplies					
Office Supplies					
Freight					
Travel Expenses					
Principal					
Interest					
Income Tax					
Other Expenses					
Total Cash Outflows	b				
Net Cash Flow	a - b = c				
Beginning Cash Balance	d	e			
Ending Cash Balance	d + c = e				

During week 12 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 13, 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.

Table 11: Pro Forma Balance Sheet

	Assets			
Current Assets				
Cash				
Accounts Receivable				
Prepaid Expenses				
Inventory				
Supplies				
Total Current Assets			a	
Non Current Assets				
Land				
Buildings				
Less: Accumulated Depreciation				
Machinery & Equipment				
Less: Accumulated Depreciation				
Total Non Current Assets			b	
Total Assets				a + b = c
	Liabilities & Owners Equity			
Current Liabilities				
Accounts Payable				
Wages Payable				
Taxes Payable				
Principle Due, Land & Building				
Principle Due, Machinery				
Interest Payable				
Total Current Liabilities			d	
Non Current Liabilities				
Remaining Principle, Building & Land				
Remaining Principle, Machinery				
Total Non Current Liabilities			e	
Owner's Equity				
Contributed Capital				
Retained Earnings				
Total Owner's Equity			f	
Total Liabilities & Owner's Equity				d + e + f = g

During week 14 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 15, students complete a five minute presentation of the business plan (10 to 20 slides). This should be a comprehensive presentation of the paper done in week 14.

9. 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].

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.

10. CONCLUSION

Innovation, entrepreneurship, and leadership are critical skills that we need to develop in our technology, business, and engineering students. This paper has outlined the process for teaching these critical skills in our programs.

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