2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
Paper ID #40086

Introducing Entrepreneurship in Manufacturing courses: A Hands-on Project approach

Dr. Anu Osta, Rowan University

Dr Anu Osta is a Senior Lecturer in Mechanical Engineering Department at Rowan University. His teaching interests are Mechanics, Materials and Manufacturing and Design.

Introducing Entrepreneurship in Manufacturing courses: A Hands-on Project approach

Introduction

One of the driving purpose of entrepreneurship education is to enable the student community to be able to convert the idea in their minds into a thriving, growing, successful business enterprise that has products or services to offer to customers. Entrepreneurship is a powerful tool not only in developed economies but in emerging economies as well where it often is one of the leading drivers of growth and prosperity. By putting the student in a virtual manager's or a founder's position we can help them envision the entire company and the role played by all of the functions that are critical for its day to day operations, be its finance, or sales, or accounting, or product development. A well-developed strategy combining the above functions can really lead a company to success.

Among the various approaches adopted in entrepreneurship education the main ones are

(1) The Case Study Method of Harvard Business School

(2) The Research Method of Chicago Business School

(3) The Project Based Method

(4) Lectures and Group discussions

At Rowan university the Advanced Manufacturing course is an elective senior level/graduate course taught once every academic year. The course description is as follows:

This course will provide students with knowledge of modern manufacturing processes, how design is optimized for manufacture, and information on future directions of manufacturing, such as additive (3D printing) manufacturing techniques and the use of digital data across the product life cycle. The course will also discuss the taxonomy of manufacturing processes and provide an examination of current state of the art manufacturing with an emphasis on trends and directions in manufacturing, the relationship of digital data to design and production, and the impact of supply chain on production decisions. The manufacturing module introduces fundamentals of modern manufacturing techniques like advanced machining processes, advanced welding processes, rapid prototyping and additive manufacturing, microfabrication technologies, and flexible manufacturing systems.

Entrepreneurship-based projects in manufacturing courses in important in a number of ways as it serves to increase student engagement and motivation to understand the various technologies and manufacturing methods. The students are called to develop their critical thinking and leadership skills and develop their knowledge of business and markets. The project work promotes team work which help the students prepare for careers in industrial manufacturing and entrepreneurship by providing them with valuable prior experience in an academic setting.
A study by Kujala et al. (2015), provides insights into the motivation and challenges that student's face when working on such projects. The authors conducted a case study at a Finnish university of technology, where students were given the opportunity to identify and solve real-life problems using innovative approaches. The study found that students were motivated to participate in the course for a variety of reasons, including the opportunity to work on real-life problems, to develop their entrepreneurial skills, and to collaborate with other students. However, the authors also identified several challenges that students faced, such as difficulties in defining the problem, lack of resources, and insufficient communication and coordination within the project teams. Entrepreneurship-based projects in manufacturing courses can increase students' engagement and motivation. The study found that students who participated in such projects were more likely to continue their studies and pursue a career in manufacturing compared to those who didn't. In a study by Cudney and Elberfeld (2014) the authors describe a case study conducted at a US university, where manufacturing students were tasked with developing a product and business plan for an entrepreneurial venture. Such a project-based learning was helpful in developing critical thinking skills among the students. Students had to identify problems and develop solutions, which could have helped them think more creatively. Entrepreneurship-based projects in manufacturing also help students develop leadership skills (Kebabci and Sari 2017). Such projects require students to work in teams and take on leadership roles. Entrepreneurship-based projects in manufacturing courses can also help students develop their knowledge of business and markets (Arora et al. 2015). Such projects require students to identify market opportunities, develop business plans, and pitch their ideas. Entrepreneurship-based projects can help students explore the role of design thinking and develop a deeper understanding of prototyping and manufacturing processes (Dym et al. 2005). Students are required to design, prototype, and manufacture products. Framing the problem, exploring

possible solutions, making decisions, and implementing the chosen solution are the four key stages design thinking.

Entrepreneurship component in manufacturing courses can help students develop interdisciplinary skills. Students were required to integrate knowledge from various fields, such as engineering, business, and marketing, which helped them develop interdisciplinary skills (Li et al. (2018). Inorder to be innovative, adaptable, and successful in today's fast-paced and rapidly changing world 'entrepreneurial mindset' is recognized as a key trait. Entrepreneurial mindset is a set of attitudes, behaviors, and skills that enable individuals to identify and pursue opportunities, take calculated risks, and innovate in order to create value. The entrepreneurial mindset is important for several reasons. It promotes

Opportunity recognition: Entrepreneurs are able to identify gaps in the market and come up with innovative solutions to address them.

Adaptability: Entrepreneurs are often faced with unexpected challenges and setbacks, and the ability to adapt and pivot is crucial.

Risk-taking: While not all risks pay off, taking risks can lead to learning and growth opportunities, and can help individuals build resilience.

Innovation: Entrepreneurial mindset encourages individuals to think creatively and outside the box. This mindset can help individuals develop new ideas and solutions to problems.

Self-efficacy: This mindset encourages individuals to take ownership of their goals and outcomes, and to persist in the face of challenges and setbacks.

A study by Nordin et al. (2018) found that entrepreneurship-based projects in manufacturing courses can help students develop an entrepreneurial mindset. Sánchez-Gálvez et al. (2020), concluded that entrepreneurship-based projects in manufacturing courses can help students develop sustainability skills, Arvanitis and Athanasopoulos (2019) found that entrepreneurship-based projects in manufacturing courses can help students develop networking skills, Jukola et al. (2017), entrepreneurship-based projects in manufacturing courses can help students develop a sense of ownership and responsibility by taking ownership of their projects and be responsible for their outcomes.

Methodology

Entrepreneurship based project component was implemented in the Advanced Manufacturing course taught at Rowan University. The project contributed 10% towards the final grade. Students were grouped into 3 member teams. The project description was as follows

Project Statement

You are joining hands with 3 other class mates to embark upon a product innovation venture. Your team comprises technologists and engineers trying to break new ground and make a positive impact on the consumers' well-being and our planet. You must identify a consumer need and devise a product based solution.

Objectives

- Develop a product (Innovation) with the intent of commercialization.
- Translate consumer needs into design requirements, design specifications, and manufacturing procedures. Incorporate state-of-the-art and best practices into your proposed manufacturing process (e.g. lean methodology and quality standards). Identify the Technologies you will use for manufacturing.
- Make use of a wide range of technical tools and approaches to produce a prototype. This includes 3D CAD tools (e.g., SolidWorks), hands-on prototyping (3D printing).
- Communicate the product development, to the investors via either a project report or a short product pitch video.

Deliverables

- The physical prototype of the product (**5 points**)
- A short report or a video pitch commenting on the following (**5 points**)
  - Problem Statement – This is the consumer need that your team identified.
  - Proposed Solution: Product Design (CAD), Material selection, Manufacturing Methods adopted.
  - Production Cost Breakdown, and Marketing Strategy.

The students by now have already been trained and experienced in machine shop fabrication techniques which includes hand tools, lathe, mill, drill, saws, soldering, water jet cutter and laser cutter. They also have experienced additive manufacturing using FDM. During this course they are further trained in additional skills as part of the laboratory module. These include Stereolithography printing, CNC machining, microcontroller programming and electro-discharge machining.

Discussions

Some class project submissions are described below in Figures 1-5 and the rest in Table 1. The entire submission is summarized under five points (a) Customer needs (b) Design solution (c) Product development (d) Material and Manufacturing (e) Costs and Marketing Strategy. Identifying customer needs is a crucial step in entrepreneurship as it enables one to understand the pain points of the target audience and create products or services that effectively solve those problems. Students were asked to conduct a small market research by either surveying the existing literature or online resources where industry trends and customer feedback were available. The teams were encouraged to conduct focus groups and ideation sessions inorder to discuss their market research so as to gather customer insights and understand customer needs.

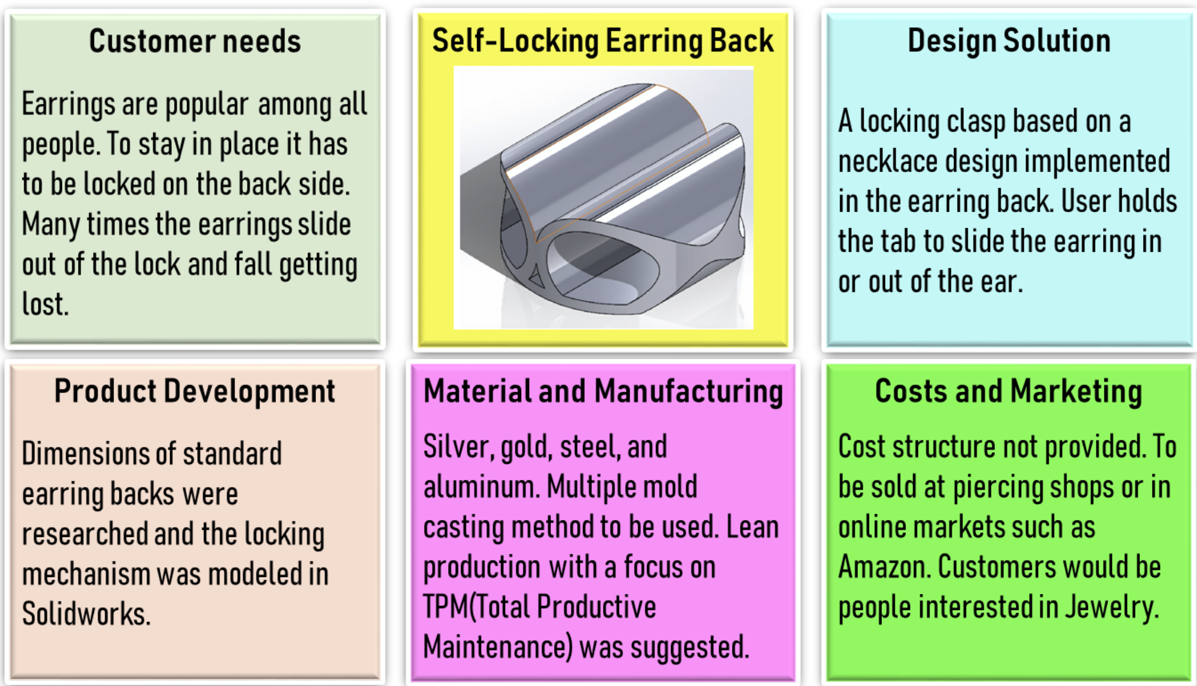


Fig 1. Self-Locking Earring Back.

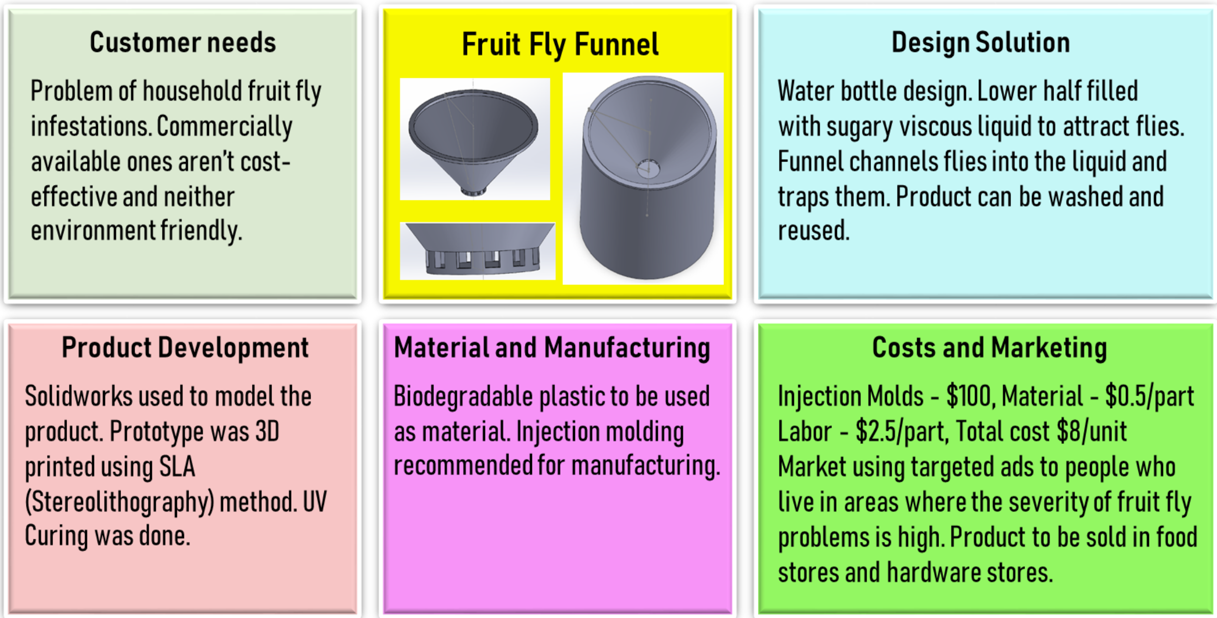


Fig 2. Fruit Fly Funnel.

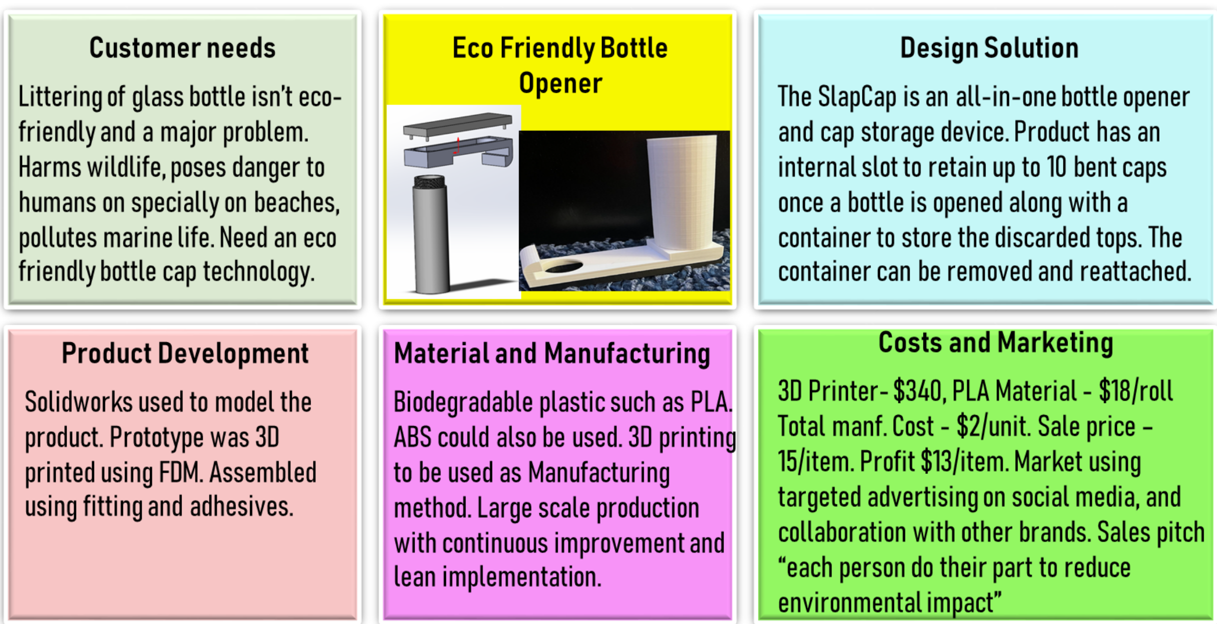


Fig 3. Eco-friendly Bottle Opener.

After identification of customer needs the team had to develop product solutions to those needs. This was the Design Solution phase. By creating sketches, CAD 3D models and analyzing their functionality. This is essential to reduce the time and cost of prototyping, and improve the overall quality of their products. Basically the students proposed their idea of solving the consumer needs.

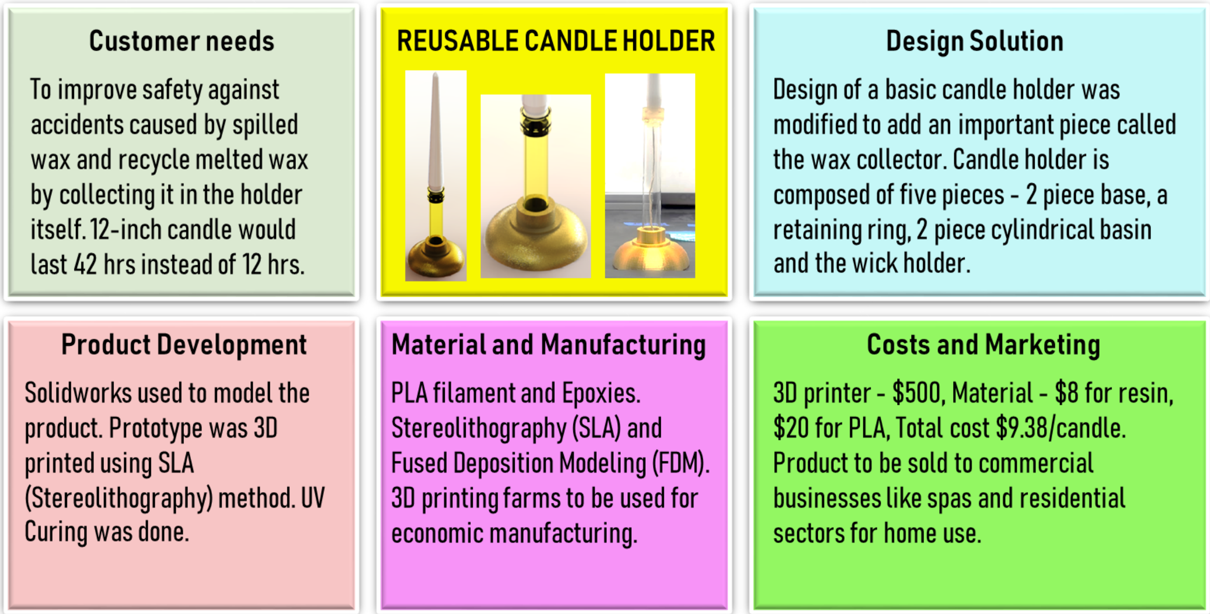


Fig 4. Reusable Candle Holder.

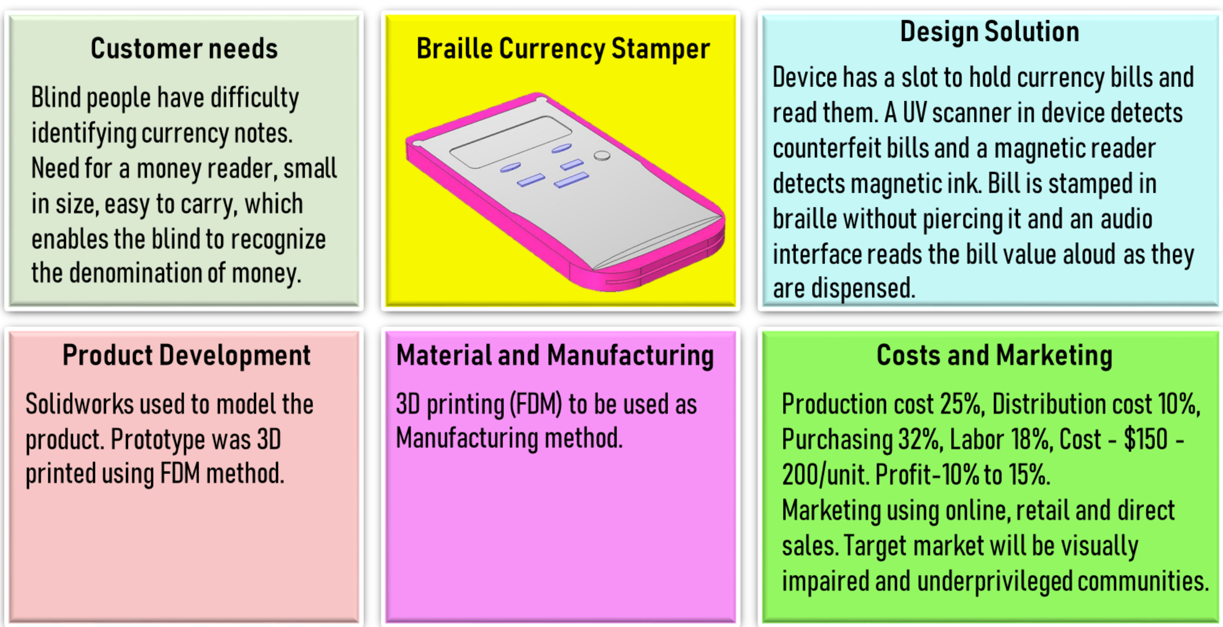
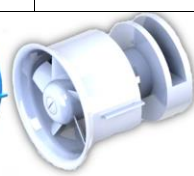
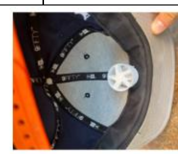
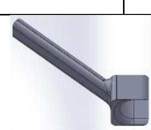
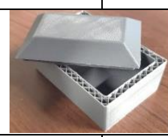
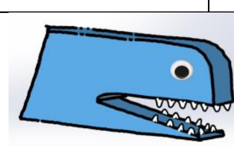
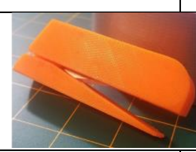
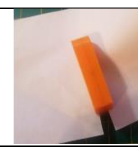


Fig 5. Braille Currency Stamper.

In the product development stage the students produced a prototype of their design solution. Since most of them were already trained on the commonly used prototyping tools such as 3D printing; machining using mills and lathes; laser cutting and engraving; water jet machining; welding and soldering; and some basic electronics with arduino programming; this was the most important learning stage of their entire project. Each failure of producing the intended prototype was a learning opportunity for the students.

Table 1. Student project submissions

Customer needs	Design Solution	Product Development	Material and Manufacturing	Costs and Marketing
Hat pins				
Fitted baseball hats with hatpins for personalized look. Need for customizable hat pins. Die stamping is costly so 3D printing can be used instead.	The design features text on the front and a pin with a clasp on the back.	Solidworks used to model the product. Prototype was 3D printed using SLA (Stereolithography) method. UV Curing was done.	Pins would be printed in a DLP printer because of its speed and accuracy. Injection Molding could also be used. Different metals and plastic.	3D DLP printer - $10,000-$20,000; plastic resin-$14.99/500g; 125-130 prints/ 500g bottle; Cost-11.53¢ to 11.99¢ /piece. Targeted Ads on Facebook and Tiktok. Partnering with LIDS Hats and MLB franchise.
The CapCooler				
Cap wearers experience sweaty head, heating, un-pleasant odor and discomfort. Need a cooling device that can fit into any cap, can be switched on/off and is battery powered.	A miniature fan with a digital thermal sensor that stays between wearer and cap. Fan has a flip switch and is charged via USB-C charger. Battery can power fan for 8 hours at constant operation. Charging port, circuit board and motor present.	Solidworks used to model the product. Prototype was 3D printed using FDM.	Plastic parts can be injection molded. Electronic components sourced through vendors. Assembly and packaging by hand	After acquiring patent for device design the company could partner with large hat brands to sell and promote the product. Product could also be sold at baseball games.
The Wire Loom Tool				
In industry, wiring is often contained inside split looms to protect them. For long lengths it is difficult to get the wire inside the loom. Need a tool to hold the loom open while the wires are being fed.	Simple compact tool design features round edges in key areas to help with ergonomics as well as protecting wires from being damaged.	Solidworks used to model the product. Prototype was 3D printed using FDM.	PLA and ABS to be used as materials. Manufacturing to be done by injection molding, blow molding, and polymer casting, FDM and SLA 3D printing.	1 million units to be manufactured each year. 25 CR-30 3D printers-$27500. Filament cost of $95,000. Production cost estimate ~ $122,500. Target customers would be electricians, automotive technicians, and/or hobbyists. Sold as 5/pack for $2.50. Revenue of $500,000 and a profit of around $377,500 if one million units are sold.

Customer needs	Design Solution	Product Development	Material and Manufacturing	Costs and Marketing
Analog Joystick Redesign	 			
Video game joystick suffer from controller sticking and drift due to incorrect reading of potentiometers that measure the joystick position. Need to redesign the joystick.	Joystick with a redesigned spring and sphere assembly. This helps push the joystick back to a neutral position and prevents shifting.	Solidworks used to model the product. The prototype was made using an SLA printer. UV Curing was done.	Acrylonitrile butadiene styrene /polycarbonate (ABS/PC). Plastic parts can be injection molded.	Marketing by partnering with Microsoft and Sony, as well outside controller manufacturers, like Scuf Gaming.
Innovative Urn	  			
To preserve the memories of loved ones, a vessel that could hold ashes of the cremated along with some memorabilia.	A rectangular urn with either a screen or QR code in front that could display videos and pictures of the loved or link to memories online by scanning the QR code.	Solidworks used to model the product. Prototype was 3D printed using FDM.	Cultured marble made by combining marble particles, pigment, and resin into a mold TO BE used as material. Resin Casting process to be used for manufacturing.	Production cost of urn without QR code ~ $25, urn with QR code ~ $30, urn with screen ~ $125. A pathos heavy marketing campaign will be used to appeal to their humanity and tap into their emotions. Ads on TV and social media platforms. Sample products sent out to funeral homes in local areas.
Scissor Shark	  			
Teaching kids how to use scissors is challenging and dangerous as they often cut and hurt themselves. Need a tool that doesn't expose the entire cutting edge to the kid's fingers.	Scissor Shark is a small plastic shark with an open mouth that looks as if shark is "eating" the paper. The opening is able to allow paper to be cut while its rounded shape and filleted edges fits well in a child's grip.	Solidworks used to model the product. Prototype was 3D printed using FDM. Current model was printed in two parts and heat welded together to keep the blade in place	PLA to be used as material if 3D printing. Injection molding of thermoplastics could also be used to manufacture the product. Blades to be manufactured by steel sheet working. Googly eyes outsourced. Assembly done by robots in flow lines.	3D printed process: PLA-$0.38/part, One blade - $0.20, Googly eyes-$.02, tooling- $0.60 per/part, selling price-$5/part, Production may have 2% defect rate. Profit-88%. Injection molding process: Machine- $5,000-$10,000; Steel-$40/kg. Final cost $125/pack. Product marketed to kindergarten teachers. Attractive packaging with animal designs. Could also be marketed as office product along with a stapler, a tape holder, and a mouse

Customer needs	Design Solution	Product Development	Material and Manufacturing	Costs and Marketing
Kids Water Bottle	 			
More than 2 million tons of used water bottles are clogging up landfills in the United States. Need a kid-friendly, reusable fun creating maze water bottle that they will want to use on a daily basis	Design a plastic bottle with maze pattern, 15 cm height and 8 cm diameter with cap. The maze resembled a tree with branched path-ways pattern. The outside surface was transparent plastic sheet and a plastic bead was placed inside the maze.	Solidworks used to model the product. Prototype was 3D printed using SLA. UV Curing was done.	For mass production injection molding is preferred. For low volume production SLA printing. Standard photo polymer resin for SLA printing. Thermoplastics for injection molding.	500 ml of Standard Photo Polymer Resin bottle we can get it for 18$. For injection molded product 0.3$ per bottle

The students were required to develop a manufacturing plan which would include,

(a) identifying the materials required for the product: This includes raw materials, components, and any other inputs required for production.

(b) determining the labor required for production: This includes the number of workers required, their salaries, and the time required to produce each unit of the product.

(c) identifying the overhead costs: Overhead costs include expenses such as rent, utilities, insurance, and maintenance.

(d) determining the cost of equipment and machinery: This includes the cost of purchasing or leasing the equipment required for production, infrastructural setup costs such as setting up a 3D printer farm or an injection molding facility, etc.

(e) considering any additional expenses: These may include shipping and handling costs, packaging costs, and any other expenses required to bring the product to market.

After analyzing the student submissions the following observations were made and based on them certain inferences could be drawn.

(1) Missing important details: In the Braille Currency Stamper the team did not mention the semiconductor among the material or what kind of sensors and electronics would be needed as components in manufacturing the product. That means discussing about the hardware and firmware. Since the project definition was not specific about the requirement to provide complete information on every material and component to be used, the student team skipped what may be

considered an integral part of that component. While the project scope was broadly discussed in the class, the specific outputs expected from the project weren't defined in detail. The students may have assumed that the functional and non-functional requirements of the project such as features and capabilities that the product should have, as well as its performance, usability, and limitations were all that was needed. The evaluation criteria was also not specific with regards to the technical specifications.

(2) Some teams such as the Capcooler did not describe in detail the material for manufacturing, or the design process. Marketing description was sort of generalized. They also did not present a cost estimate. This brings forth two interesting conclusions. First is that the level of detail in the product description report should be appropriate for the audience. For example, if the report is intended for investors or stakeholders, it may need to include more detailed financial information and market analysis. On the other hand, if the report is intended for the general public or customers, it may need to focus more on the benefits and features of the product in a way that is easy to understand. While assigning the project the instructor could specify who the target audience is. Secondly the quality of teamwork such as communication, division of tasks, and coordination among team members greatly impacts the quality of work produced. Some student teams tend to take their work more seriously than others. Their quality of the deliverables is often high, in terms of the accuracy, completeness, detail and clarity which is clearly evident in their written reports or presentations. An inference can be drawn here that it may be helpful for the students if the instructor of the course presents examples of similar project submissions, one of very high quality, one mediocre and one of low quality along with their grade distributions. This would help the students get an idea about the quality of work expected from them.

(3) While most of the teams estimated the cost of equipment and materials they did not factor in man-hours or labor cost, salary, overhead, and other contingencies, e.g. Analog joystick redesign. As a future course of action the students can be asked to build in some of the following cost components into their cost structure while reporting such as direct materials costs, direct labor costs, manufacturing overhead costs, shipping and handling costs, administrative and marketing costs. Asking entrepreneurship students to project costs out 1 year can be a rather challenging task without broader understanding of general business skills. Students are taught cost estimation for Bill of Materials in one of their second year courses called Manufacturing and

Measurement techniques. The students could be directed towards some resources, like case studies, short videos and literature for building the rest of the cost structure.

A few of the reports are worth mentioning in some aspects. For example the Wireloom tool team compared the costs between 3D printing and Injection molding and factored in the time component as well. What will take a 3D printer ten minutes, an injection mold can get done in less than one minute. While this is a great advantage, the labor cost to accomplish this is usually high. They thought that it would just take too much time and/or money to make injection molding more feasible for their design over 3D printing. The degree of automation that a 3D printer provides and the flexibility to sudden change in design makes the 3D printing preferable over injection molding. In this way the instructor could ask the student teams to make a comparative evaluation of the various manufacturing techniques that could be employed for producing the same product. Another project worth mentioning here was the Water bottle. The team explained how multiple objectives could be achieved with the same product. Water bottle for carrying water and a maze game to help kids develop their problem-solving abilities, patience, and tenacity. Students use their spatial awareness and ability to visually map out their path to determine whether it is clear or blocked as they make their way through a maze and so it helps develop their ability to analyze information, generate creative solutions, hand-eye coordination, memory and critical thinking.

Since the students had an option to make a short video in lieu of the report some teams made interesting video submissions. Two of the submissions are shown below. Screen grabs of the timeline has been taken and the pictures put together.

In Fig 6 the product was a Cap Cover. The story presented was as follows.

Scene 1 – shows a student spray painting a surface

Scene 2 – shows paint getting sprayed on to his fingers as a result and causing inconvenience

Scene 3 – shows his friend suggesting he use the Cap Cover. It is a spray cap with a nozzle which is designed to have a lip on the top which prevents the paint from reaching the forefinger pushing onto the cap.

Scene 4 – The product features and how to use it is explained.

Scene 5 – The design, cost structure, manufacturing and marketing strategy is explained.

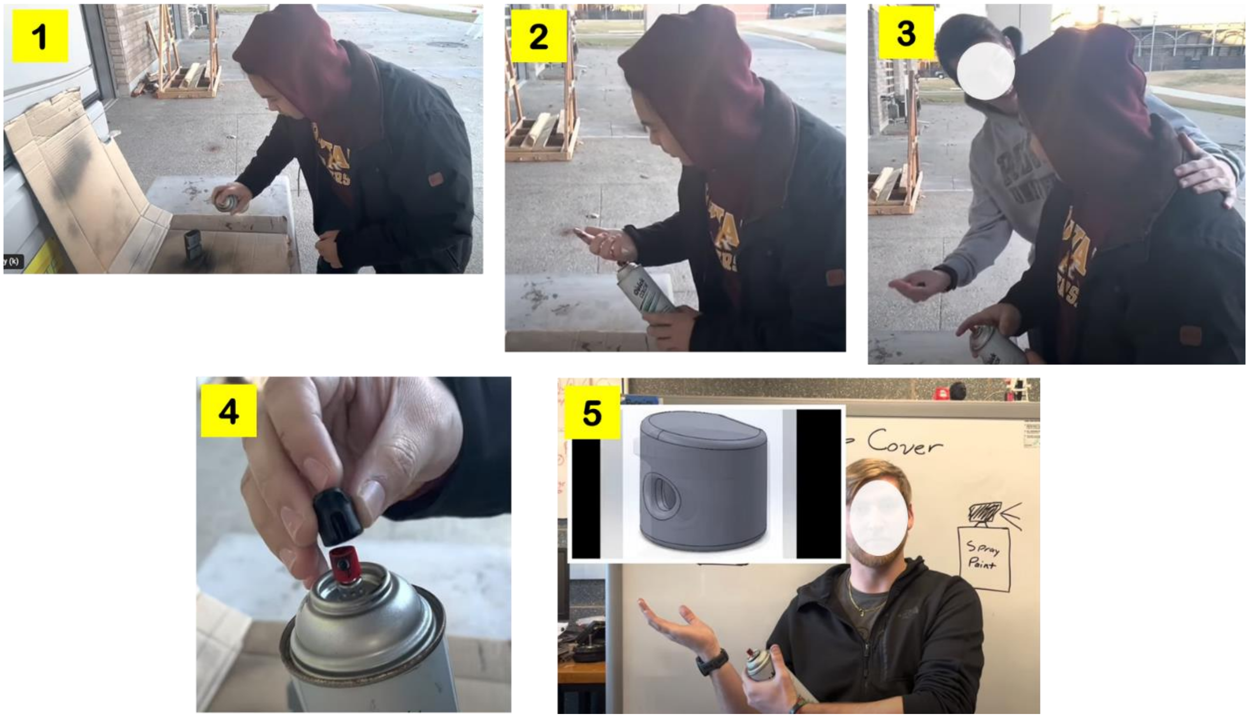


Fig 6. The Cap Cover:

Another product with video submission was the RFID Sometimes shown in figure Figure 7.

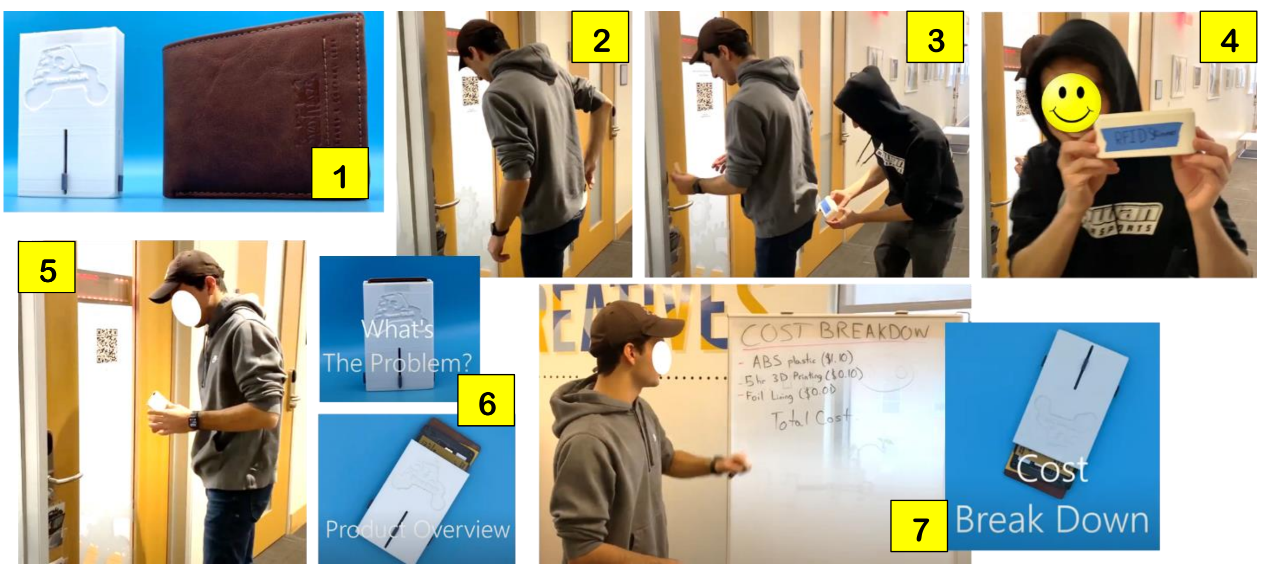


Figure 7. RFID Sometimes

Scene 1 – shows the product and how it could be used in place of the wallet

Scene 2 – shows a student trying to use his id card to open the lock on the door inorder to gain access to the classroom.

Scene 3, 4 – shows an id theft being committed where the 'bad guy' scans the magnetic strip on the id card using an RFID scanner.

Scene 5 – shows the same student now using an RFID proof wallet to store his credit cards and student id card.

Scene 6 – shows the product over view and the problem it solves

Scene 7 – shows a student explaining the manufacturing process and the cost structure and marketing strategy.

A final point worth mentioning here is that students could be given some advice and tips on how to present some specific information to make it more readable as in the case of the Braille Stamper. By presenting their entire budget structure or the revenue model over a 12 month period they would have been in a better position to convince the investors regarding the investment figures.

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Leads												
Google	300	306	312	318	325	331	338	345	351	359	366	373
TV Ads	400	408	416	424	433	442	450	459	469	478	488	497
Billboards	200	204	208	212	216	221	225	230	234	239	244	249
Newsletter	100	102	104	106	108	110	113	115	117	120	122	124
Total Leads	1,000	1,020	1,040	1,061	1,082	1,104	1,126	1,149	1,172	1,195	1,219	1,243
Product												
Price	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00
Beginning Customers	1,000	1,020	1,040	1,061	1,082	1,104	1,126	1,149	1,172	1,195	1,219	1,243
Conversion %	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
Ending Customers	700	714	728	743	758	773	788	804	820	837	853	870
Revenue	$ 140,000	$ 142,800	$ 145,656	$ 148,569	$ 151,541	$ 154,571	$ 157,663	$ 160,816	$ 164,032	$ 167,313	$ 170,659	$ 174,072

Figure 8. Revenue model and cost structure for Braille Stamper

Conclusions

Entrepreneurship based project component was implemented in the Advanced Manufacturing course taught at Rowan University. The objective was to educate the students in the field of entrepreneurship by encouraging them to develop a product with the intent of commercialization. They would learn how to translate consumer needs into design requirements, come up with a design solution which would be this product and identify the technologies they could use for manufacturing it. Along the way they would make use of prototyping tools and eventually communicate the product development, to the investors via either a project report or a short product pitch video. Based on the outcomes the lessons learned inorder to successfully conduct a project component as in the present case were as follows

1. Be specific about the requirements. In the project definition provide as much information as possible regarding the level of details needed and amount of information to be provided on every material and component that will be used. The specific outputs and evaluation criteria need to be defined clearly.
2. While assigning the project the instructor could specify who the target audience is investors/stakeholders or the general public/customers. It may be helpful for the students if the instructor of the course presents examples of project submissions, one of very high quality, one mediocre and one of low quality along with their grade distributions. This would help the students get an idea about the quality of work expected from them.
3. Be specific to the students about how they should build their cost structure. Provide the specific cost components such as direct materials costs, direct labor costs, manufacturing overhead costs, shipping and handling costs, administrative and marketing costs.
4. Encouraging the student teams to make a comparative evaluation of the various manufacturing techniques that could be employed for producing the same product expands their ambit of thinking.
5. Encourage the team to think beyond the immediate need. Ask them to explore the possibilities of fulfilling multiple objectives with the same product.
6. Provide guidance on how to present easy, organized information. For example presenting their entire budget structure or the revenue model over a 12 month period.
7. Opening the submission format to include videos enables the students to visualize their product pitch and thus reflect and improve on their presentation skills. They could be encouraged to view similar real life pitches as in ‘Shark Tank’ to gain further insights into the art of making compelling pitches.

References

1. Kujala, J., Väänänen, M., & Lönnqvist, A. (2015). Entrepreneurship in engineering education: A case study on motivation and challenges in student-driven innovation projects. International Journal of Engineering Education, 31(1), 313-324.
2. Cudney, E. A., & Elberfeld, J. L. (2014). Developing critical thinking skills in manufacturing students through an entrepreneurship-based project. International Journal of Engineering Education, 30(1), 235-247.
3. Kebabci, D., & Sari, R. (2017). Entrepreneurship-based projects in engineering education. Procedia Manufacturing, 11, 1613-1620.
4. Arora, M., Youtie, J., & Shapira, P. (2015). Learning to become an entrepreneur through an entrepreneurship education program: A case study from the Indian Institute of Technology Delhi. Technology in Society, 42, 101-111.
5. Dym, C. L., Agogino, A. M., Eris, O., Frey, D. D., & Leifer, L. J. (2005). Engineering design thinking, teaching, and learning. Journal of Engineering Education, 94(1), 103-120.
6. Li, L., Hu, Y., & Gao, M. (2018). Promoting interdisciplinary innovation and entrepreneurship education: A case study of the manufacturing industry. Frontiers of Engineering Education, 3(2), 137-146.
7. Nordin, N. M., Abdullah, R., & Sipon, S. M. (2018). Developing entrepreneurship skills through project-based learning in manufacturing engineering education. Journal of Technical Education and Training, 10(1), 1-10.
8. Sánchez-Gálvez, V., Ordoñez, J. J., & Ríos, J. A. (2020). Entrepreneurship education in engineering: A systematic literature review. Sustainability, 12(9), 3583.
9. Arvanitis, L., & Athanasopoulos, E. (2019). Entrepreneurship education and manufacturing innovation: A case study. Journal of Entrepreneurship, Management and Innovation, 15(3), 23-44.
10. Jukola, S., Kujala, J., & Käpylä, J. (2017). Implementing entrepreneurial mindset in engineering education through product development projects. Journal of Engineering Education, 106(1), 96-117.