

Projects for Waste Reduction in an Intro to Engineering Course

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Abstract

The main objective of this project in our introduction to engineering course was to find ways of reducing waste, reusing material, and recycling. Service learning is a form of experiential learning. Students use their classroom learning and apply the course concepts to address the needs identified by the service learning project. Service learning experiences are organized for students to learn and apply skills and knowledge related to course learning objectives.

Introduction

Service learning is a teaching method that combines academic coursework with practical applications to address challenges through service projects. It focuses on critical thinking to develop students' academic skills, sense of civic responsibility, and commitment to the community. Service learning promotes active learning and fosters a sense of civic responsibility¹. Service learning strengthens critical thinking, interpersonal and communication skills, and promotes student personal and social growth and leadership development. Advocates of service learning see the benefits as being similar to those of community service but with added focus and structure, elements that help make the experience more meaningful for all involved².

The students are graded on their presentation and their paper, each at ten percent of the grade for a total of twenty percent of their grade for the course. The paper and presentation are also used to evaluate ABET outcome 4, "An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts."

Research Methods

Service learning projects need to incorporate at least one service project or experience that is tied to course learning. The service learning project has to be required for all students, not just for extra credit. The service learning project must have defined project requirements or defined number of hours in the 25 to 45-hour range.

The service learning project must be a good fit with the learning objectives of a specific course. It must provide a needed service for the community or benefit some non-profit organization. The time commitment and skills needed should be aligned with the course goals and student learning objectives. We implemented service learning in the course MENG 1101 Introduction to Engineering.

Our course activities to match the course objectives are:

1. Students design a grocery shopping bag as an alternative to single use plastic or paper grocery bags to reduce waste.
2. Students design furniture from reused pallet wood.
3. Students design a 3D printer filament to recycle thrown away plastic bottles.
4. Students write a paper and do a presentation on the design by the end of the semester.
5. Students will take part in weekly activities on their project.

Service learning projects are a good way to introduce innovation in an introduction to engineering course. Innovation is the exploitation of change as an opportunity for a business or service. Courses where students solve open-ended problems can increase retention and motivation by engaging students in projects that are often the reason students choose engineering majors in the first place³. With open-ended projects, students improve their teamwork skills and report that they find the projects fun, effective, and motivating⁴. Since the project is done in groups, students will also have the chance to advance their communication and teamwork skills. Innovation can be taught and learned⁵. On the average about sixty percent of all jobs in the U.S. are generated by firms with twenty or fewer employees. Large firms with over five hundred employees generate less than fifteen percent of all new jobs⁶. Students have to learn to design in a way that is ethical, socially conscious, environmentally sound, and globally aware⁷. Education must make active learning the predominant technical student learning mode⁸. This paper explores the idea of reducing waste, reusing and recycling as a tool for teaching innovation in an inexpensive and impactful approach.

The Concept

Students can develop entrepreneurial skills by working to generate, evaluate, develop, and market their innovation. Faculty members should be encouraged to participate as student team mentors. At the beginning of the semester students in the class generate ideas for potential products. The product has to be designed and presented to the class by the end of the semester, so it has to be a project that is doable by the end of the semester. The project has to be at the skill level of the students. Students can imagine great projects, but they have to be able to design the project. Criteria can be added, depending on the limitations of the school.

Once the student has decided on a project concept and objectives, they will work on designing their product. This will involve product specific development using engineering and business concepts. Product protection and marketing will depend on the schools existing policies and procedures.

Product Development

The process of taking an idea from initial conception to market is called product development. It includes idea generation, market research, product evaluation and selection, design and development, product protection and commercialization⁹.

Idea Generation

Idea generation refers to generation or identification of potentially marketable product ideas. Highly motivated enterprising students are an ideal source of potentially marketable, creative product

concepts. The opportunity to learn real business and engineering skills while working on one's own idea should appeal to many students.

The process most often used for idea generation is brainstorming¹⁰. This involves students who suggest anything that comes to their mind, and feed off one another's ideas, and seeks to create a large list of potential products in an environment free of criticism. Students will then work to generate potentially marketable product concepts.

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

Market Research

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

The students can utilize an interest survey as a source of data collection. The survey questions are analyzed to determine the need or desire for a new product. The survey needs to provide an area for suggestions and comments. The survey questions are designed to determine specific information. The researchers are interested in determining the age, sex, race and geographical location of persons being surveyed. Also, the researchers need to determine the amount a consumer is willing to spend on this type of device. Analysis of the interest survey will indicate whether the consumers polled are interested in their product. A positive survey result can lead the student to contemplate commercialization of the product.

Product Evaluation and Selection

The details related to the design and development of a particular product depends on the nature of the product. Students should develop a timeline to guide the development of the product.



Figure 1: Grocery Shopping Bag by Daniel, Annelise, and Thad

The first product, a grocery shopping bag, provides customers with an environmentally conscious alternative to single-use plastic or paper grocery bags (Fig. 1). The use of the bags, made with repurposed clothing items, will lead to less use of common plastic or paper grocery bags which will help to protect the environment and lead to less waste. The bag comes in a range of sizes and patterns for the needs and convenience of the consumer.

The second product aims to provide customers with modern and unique furniture from repurposed pallet wood to reduce waste and ease cost. The company's main product, shoe racks, will provide customers enough storage for shoes and extra storage for additional items while taking less space in the room (Fig. 2). They also plan to sell detailed instructional construction videos that teaches consumers how to do it themselves. The mission is to provide customers with modern and unique furniture from repurposed pallet wood and creating sustainable future, one pallet at a time.



Figure 2: Shoe Rack by Vincent, Jordan, and Mmesoma

The third project makes recycled 3D printer filament from thrown away plastic bottles (Fig. 3). Most single use plastic bottles are made with a plastic known as PET and as the 3D printing industry also uses PET, there is potential for recycled bottles to be reused as filament for rapid prototyping. The area of use for recycled rather than new filament is by using it in high tolerance or early prototyping 3D prints. By using it, a customer can save high quality filament for late design low tolerance 3D prints.

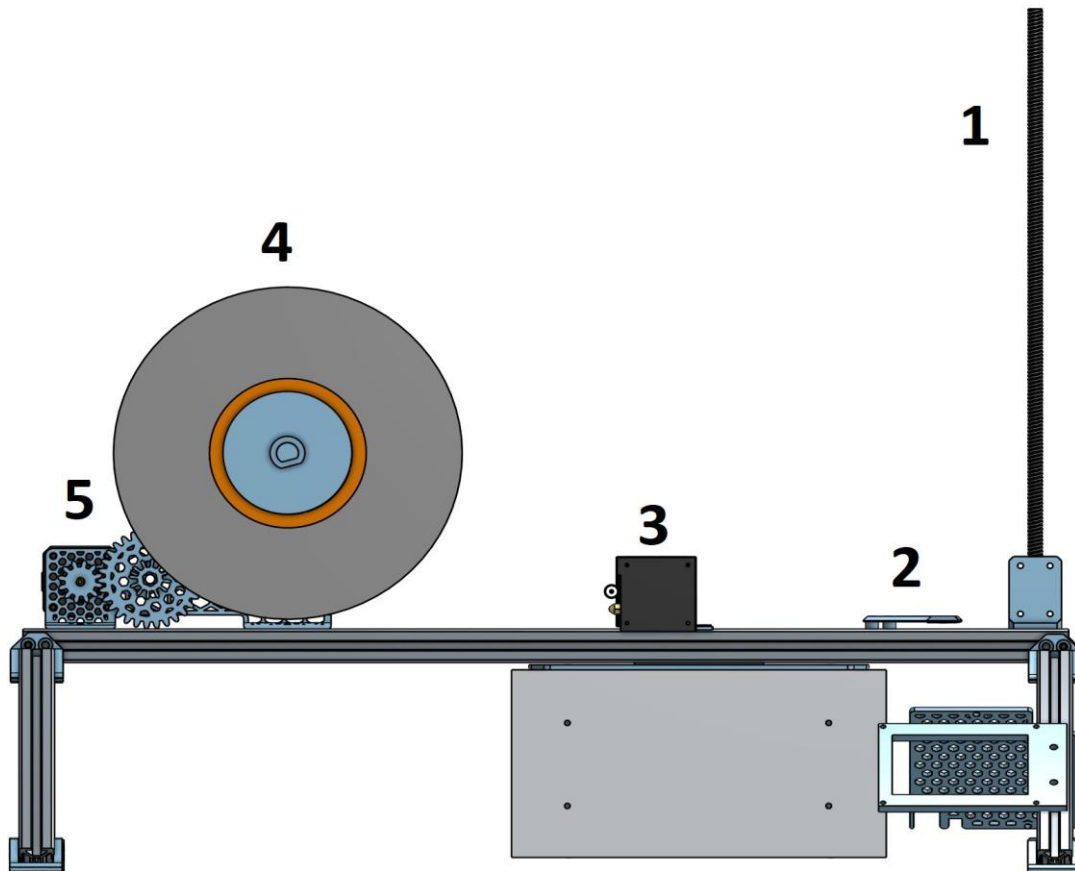


Figure 3: Recycle plastic bottles to 3D printer filament by Sergio, Gabriel, and Aidan

Summary and Conclusions

Protection of products and intellectual properties by patenting or copywriting of new products are essential for long term survival and growth. 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. Once products have been conceived, selected, developed and protected, they must be successfully commercialized. Commercialization requires consumers who are willing to buy the products at the price and quality that make these products economically profitable. As each of the above steps is accomplished, every student should submit a brief informative report summarizing their activities. A formal presentation must be done at the end of the semester to develop their oral communication skills. The students are graded on their paper and presentation of the project. The author uses the paper for evaluating criterion 4 of the student outcomes for ABET accreditation.

Through our example, we have shown how a project can be taken from an idea to design of the product. We hope the background information and examples will be useful to other schools in development of innovative service learning projects in an introduction to engineering course. Service learning projects are a student-centered pedagogy that can increase learning, interest, and

retention of diverse students. Today's industry needs a talented new generation of employees possessing a strong knowledge base and social and technical skills. Without these abilities, students may find themselves entering a complex workforce without the tools necessary to be successful.

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