

## Project Based Innovation to Improve Pallet Recycling

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**ABSTRACT:** *The main objective of this project in our solid modeling course was to find innovative ways of recycling pallets. Pallets are the single largest consumer of hardwood lumber in the United States. Recovered pallet lumber has been proposed as a potential source of material for value added wood products. This recycling activity creates jobs, decreases the volume of pallets going into landfills, and eases the demand that new pallet manufacture places on timber resources. Recycling is important due to low cost of entry into recycling, and increasing environmental concerns regarding resource use and waste disposal.*

**Keywords:** *innovation, pallets, project based learning, recycling*

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### I. INTRODUCTION

We asked students in our solid modeling course to think of innovative ways for recycling pallets as approximately 400 million new pallets are currently produced annually, and about 175 million are repaired or recycled. Annually, some 100 million pallets are estimated to be abandoned, lost, burned, or taken from the country (USDA, 2000). Pallets consumed between 34% and 38% of the total hardwood consumption in the U.S. in 1997, making pallets the single largest domestic user of hardwood lumber. Hardwood consumption for pallets was 50% greater than the second largest hardwood consumer, furniture. As many as 20% of new pallets are remanufactured (Hansen et al., 1998). Pallets are excellent candidates for recycling. They have short service lives and tend to accumulate in large quantities in central locations, such as shipping locations, retail centers, or large manufacturers, facilitating ease of consolidation and collection. They are easily disassembled due to their simple designs and standardized part sizes (Bush, et al., 1997).

Increased pallet recycling is a standard practice within the pallet industry. Among the forces driving recycling are increases in both material prices and waste disposal costs, the low cost of entry into recycling, and increasing prominence of environmental concerns regarding both resource use and waste disposal. In 1995 alone, pallet recycling firms recovered 171 million pallets (Araman, 1997). There is tremendous potential for the recovery of large quantities of valuable hardwood lumber from landfilled pallets. Over 25% of all pallet boards are oak (Bush, et al., 1998).

### II. INNOVATION

Project based learning is a good way to introduce innovation in a solid modeling course. Innovation is the exploitation of change as an opportunity for a business or service. Innovation can be taught and learned (Drucker, 1985). On the average about sixty percent of all jobs in the U.S. are generated by firms with twenty or fewer employees. Pallet recycling is largely a small business enterprise. Large firms with over five hundred employees generate less than fifteen percent of all new jobs (Birch, 1979). Students have to learn to design in a way that is ethical, socially conscious, environmentally sound, and globally aware (ASME, 1995). Education must make active learning the predominant technical student learning mode (NSF, 1995). This paper explores the idea of pallet recycling as a tool for teaching innovation in an inexpensive, sustainable, and impactful approach. Pallets can be recycled into remanufactured pallets by replacing broken pallet bars and slats. The broken pallet bars and slats can be used as a fuel. The goal of this project was to convert used pallets into other products.

### III. 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 a prototype. 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 developing their product. This will involve product specific development using engineering and business concepts. Product protection and marketing will depend on the schools existing policies and procedures.

### IV. PRODUCT DEVELOPMENT

The process of taking an idea from initial conception to market is called product development. It includes idea generation, market research, product evaluation and selection, design and development, product protection and commercialization (Grunewald, 1991).

#### 1. 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 brainstorming (Bobrow, et al., 1987). This involves students who suggest anything that comes to their mind, and feed off one another's ideas, and seeks to create a large list of potential products in an environment free of criticism. Students will then 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 should have a potentially workable project. Once this process has been completed, the student can begin their design of prototype, and preparing to present and defend their ideas before their peers.

Many wood manufacturers direct wood scrap to municipal solid waste (MSW), industrial, or construction and demolition (C&D) landfills because of a lack of local market for wood residues. Pallet manufacturing wood residues are sold as fuel, sold to pulp or paper manufacturers, sold as livestock bedding, or to bark or mulch companies. Local recycling is needed to reduce this loss because transportation over long distances makes recycling unprofitable. Wood waste only accounts for 5.8% of the material disposed on in MSW landfills, which is expected, since C&D landfills take spent wood at lower tipping fees. If landfill costs increase, a greater emphasis will be placed on recycling.

#### 2. 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 researchers 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.

The average price received for scrap pallets was \$15.00 per ton delivered. The average price received for green chips was \$12.00 per ton delivered. The average price received for green sawdust was \$8.00 per ton delivered. The average price received for bark was \$7.00 per ton delivered. The average price received for coarse residue was \$5.00 per ton delivered. A tractor-trailer can haul approximately 20 tons of residue.

Wood manufacturers have to pay to get rid of wood scrap in municipal, industrial, or construction and demolition landfills. The USDA Forest Service Surplus and Scrap wood Products Exchange is designed to promote trade of wood wastes between wood product manufacturers worldwide. The EPA offers a guide to assist those wishing to invest in or start a recycling business. The guide offers information on access to capital, financing strategies, legal advice, and business planning.

### 3. Product Evaluation and Selection

Once potentially feasible ideas have been generated and market analysis has been performed students must present their concepts to their peers. Their peers will evaluate their concepts according to some established criteria. The evaluation criteria should include consideration of the product such as manufacturability, manufacturing costs, raw material availability, size, shape, material, color, price, projected sales volume, profitability, market strategy, adaptability to customer needs, and estimated cost of marketing. External factors to consider are market size, potential customers, competition, and demand. Internal factors include resources available, financing, equipment, time, and fit. This step is a filtering process in which only the ideas with greatest potential will succeed. Students will learn to evaluate potential products. Students should present reasons for selection of product ideas chosen.

Landfills are trying to reduce the volume of wood residues from being landfilled. This trend is in part due to federal and state waste reduction programs. The landfills are either reselling these items to the public or giving them away to charitable organizations. Equine, poultry, nursery, and landscaping businesses utilize substantial volume of wood residue in their operations.

### 4. Product Design and Development

The details related to the design and development of a particular product depends on the nature of the product. Students should develop a timeline to guide the development of the product. Developing product prototypes will require the use of discretionary funds to cover the cost of materials, parts, and equipment usage.

There are several dimensions available to wooden pallets. The most common one in the United States is about 48" x 40" x 5". Recycling is very important and offers a help to the environment. Recycling also makes the environment clean, conserves material, saves energy and reduces garbage at solid waste sites (Rinkesh, 2017).

The first project reuses old or used pallets to create benches (Fig. 1) and tables (Fig. 2). This project would be useful for community service projects as sustainable seating areas. By deconstructing pallets and reassembling them using pallet bars as the legs and the slats as fillers we can make the benches and tables sturdier.

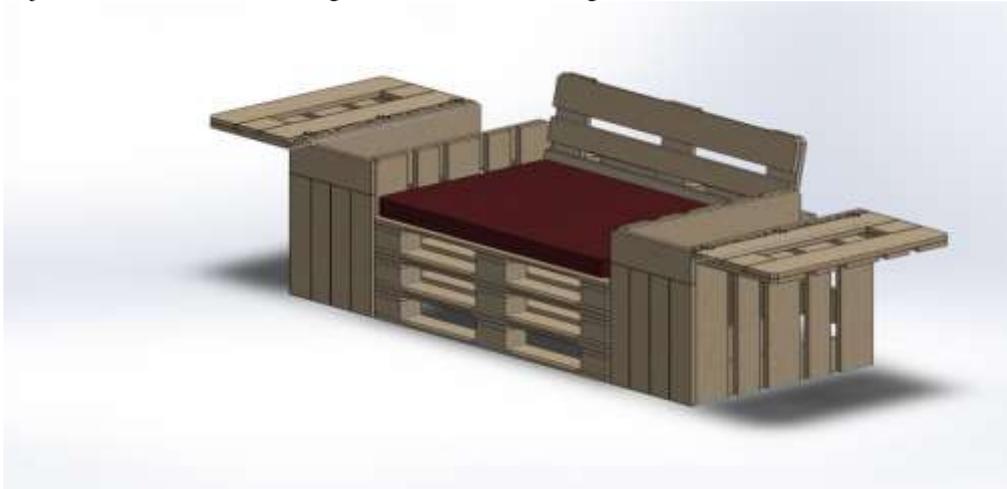


Figure 1: Prototype Pallet Bench



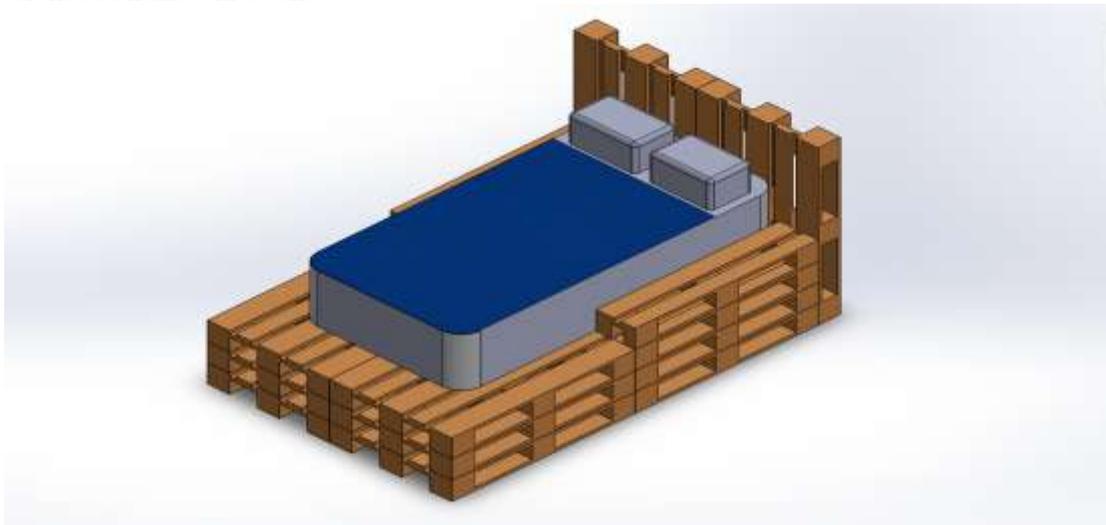
Figure 2: Prototype Pallet Table

The second project was a sofa. The sofa's design incorporates two storage units under the left and right arm rest for convenient and practical storage (Fig. 3). While this design is for a single seat sofa, the design can be easily adjusted to accommodate designs for additional seating.



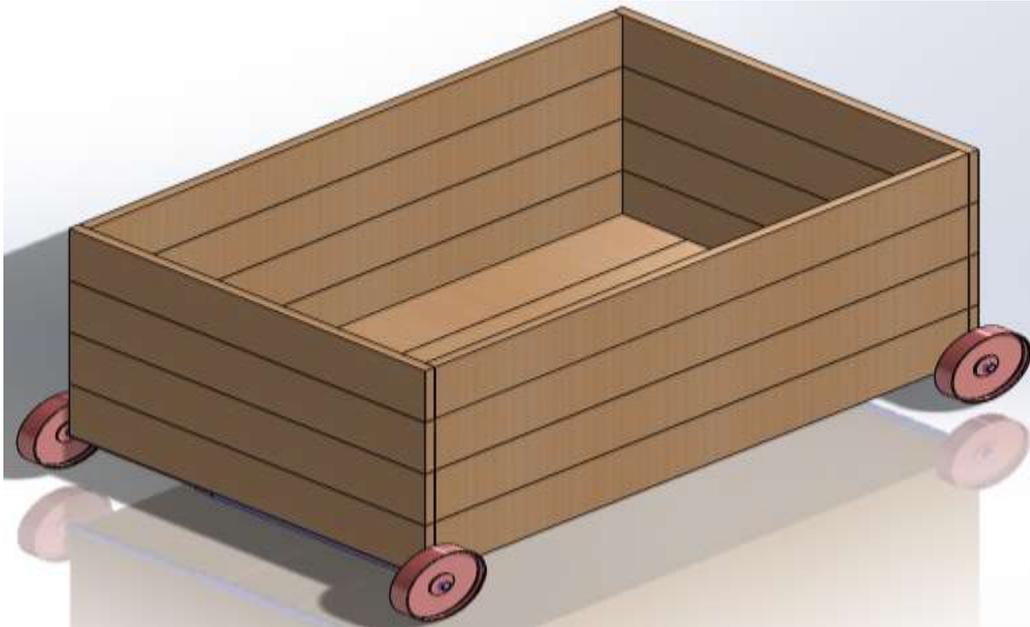
**Figure 3:** Prototype Pallet Sofa

The third project is a bed frame. It would be difficult to try and make the bed frame and then transport it into a bedroom. The construction is quite simple and it can be built inside the desired room. If the bed frame is needed to be removed from the room, the deconstruction process is just as simple as the building process (Fig. 4). There are several different sizes of pallets that can be used. When building, make sure you have all the same sizes or the bed frame will be off.

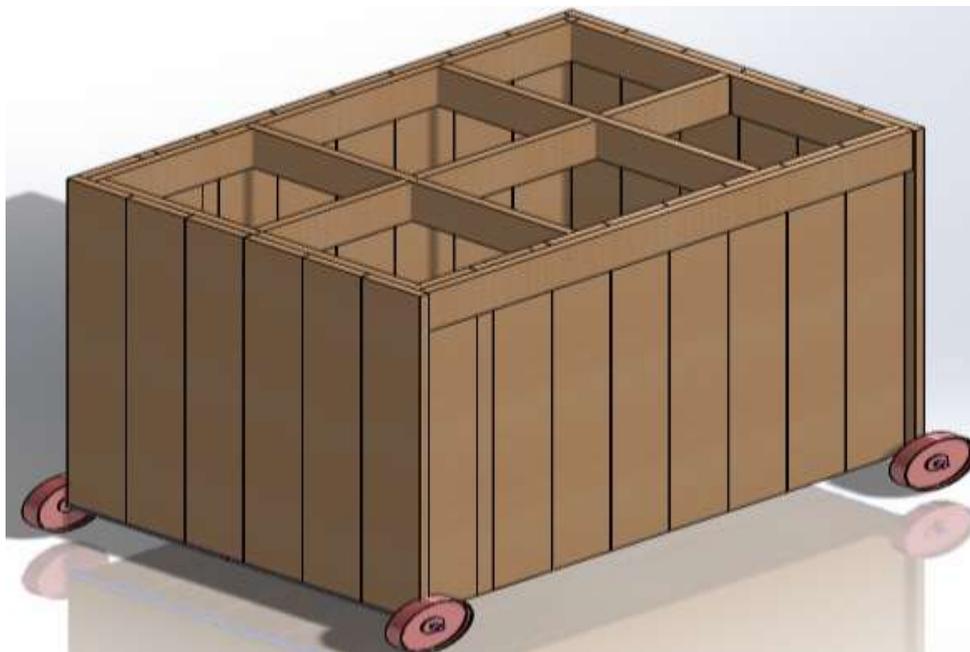


**Figure 4:** Prototype Pallet Bed Frame

The next project is a pallet garden bed. Wooden pallets provide better control over the soil, and you also have better drainage. With the wooden pallet garden bed, you can increase drainage by increasing the spacing between the boards at the base of the bed. Raised beds can be used for crops such as lettuce, peppers, tomatoes and cabbage. Pallet Garden beds can also be used for hydroponics technology (also known as water farming), by simply placing a plastic sheet on the inside of the bed and filling it up with water rich in nutrients instead of soil. You can have raised bed gardening of any height, anywhere from 4 inches to 3 feet (Fig. 5 and Fig. 6).



**Figure 5:** Prototype Pallet Garden Bed



**Figure 6:** Prototype Pallet Garden Bed for Tall Root Systems

The pallet design can also be applied to making small houses that have two doors or a small housing complex with 4 doors (Fig.7). Screws are recommended for fastening instead of nails because they are easy to remove, and mistakes can be fixed without having to pry out a nail. All fasteners must be corrosion resistant. Safety should be a priority with this type of temporary housing. The top and sides will have to be covered by tarp to prevent exposure to weather conditions.



**Figure 7:** Prototype Pallet Housing

Finally, a recycled pallet coffin provides inexpensive burial for people that needs to be performed by state or local entities (Fig. 8). This will reduce the burden on their expenditures.



**Figure 8:** Prototype Pallet Coffin

#### **5. Product Protection**

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

#### **6. Commercialization**

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 (Jensen, et al., 2003).

## V. EVALUATION

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.

## VI. PRODUCT DEVELOPMENT

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 recyclable products in a solid modeling course.

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