Chopping for Change
ArcelorMittal

Cheap Chips
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Abstract:

Our motivation for this project came from ArcelorMittal and their need to find a way to reuse and recycle wood pallets that go to waste, thus creating toxic emissions. The method we chose to go about reusing and recycling these pallets was to first extract the nails with extreme heat and the use of an industrial sized magnet, then use a wood chipper to grind up the pallets. The wood chips could then be used for landscaping, playgrounds, and particle board.

The results that we obtained after the making and packaging of the product was a profit of $27 per pallet. We have also effectively reduced the amount of toxic chemicals normally released due to the pallets being burned in the past.

Introduction and Problem Statement:

ArcelorMittal would like to improve the environmental quality of the world today by reducing or reusing their major sources of waste: wood pallets, refractory bricks and drums/totes. Specifically, we would like to reuse wood pallets in order to sustain the environment. By designing an opportunity to reuse and recycle one of the largest sources of refuse, we can reduce the environmental burden of the pallets from material delivery.

As of now, wooden pallets are burned rather than reused or recycled, which wastes renewable resources that we can reuse for better purposes. Through the current processes of transportation of these materials, fossil fuels are used, and by cutting down on the use of fossil fuels, we could reduce the emission of pollution. Furthermore, forests are destroyed causing deforestation and more extinction of the wildlife. As deforestation occurs, forest takes many years to regrow and replacing all the forests would not be possible in our lifetime.

Our project would reuse the wood pallets, decrease the fossil fuels used to transport these materials and try to improve the quality of the environment. In the beginning, we had several ideas including furniture, wood pellets for gardening, wood chips (for playgrounds), pressed plywood (engineered plywood), mulch for landscaping, fire-starting logs, and paper. We moved forward with the ideas of pressed plywood, mulch, and wood chips. We chose the idea of pressed plywood because we planned on grinding the pallets into chips/shavings and then pressing the chips/shavings into an eight
foot by four foot plywood board. With these ideas, hopefully we can use this ideas so we can reuse the wood pallets. By designing an opportunity to reuse and recycle one of the largest sources of refuse, pallets from material delivery has many uses that can affect the environment positively.

**Definition of Sustainability:**

According to ArcelorMittal, sustainability in their own definition means “striving to develop a cleaner steelmaking process.” As a group we have put together a definition of sustainability. With the help of this definition we were able to put this definition towards the problem we had in order to find solutions. To us sustainability means the process of reusing and recycling waste and byproducts in order to maintain a healthy environment. Sustainability also means something that is able to produce same results multiple times and durable.

**Background:**

Wooden Pallets are usually taken apart as they are easier to handle when they are separated from each other. Our approach at first for recycling and reusing the wood pallets was to remove the nails from the wood pallets and then reuse, recycle or sell the wood that was leftover. By doing a Google patent search we were able to find out that there are many companies out there that sell particle board. Particle board is also known as engineering wood. As a result of this, there isn’t a control over particle board because many companies make the same particle board. Particle board can also be made out of shavings.[1] We also discovered that other companies manufacture wood pellets for gardening and grilling. When grilling flavors can be added to the pellets to give a smokey flavor and can select from a variety of flavors.[2] We researched a patent to see if there was any patent related to removing nails. The idea that we found was that there is a patent that heats the nails red hot in order to remove them easily. The wood becomes really charred around the nails and the nails will fall out or can be removed easily. [3] We also discovered that there is no patent for wood chips used on playgrounds considered that it is not an invention. We found out that they now have fake rubber chips for playgrounds. As our last patent research we found out that a patent for synthetic fire starting logs exists. They consist of sawdust, wood fibers, coal liquid. molasses and paraffin wax. This would be hard to compete with other companies because you have to add so many materials to the sawdust.[4] There are products that exist today that we used towards our solution. Woodchippers exist today and plywood presses exist as well. Sending the wood pallets through wood chippers as inputs, and in return as outputs you get sawdust, wood chips and wood shavings.
Customer Needs:

Through the use of the AHP matrix, our group was able to figure the most important customer needs for the project. AHP which means analytical hierarchy process is a matrix that is often used to determine what the best elements are of a products design. With the use of this chart, you are able to compare different customer needs and see what customer needs is the most important. With the information ArcelorMittal gave us, our group was able to put together eight customer needs in order to best fix this projects design. Our list was composed of 1) safe, 2) ease of use, 3) eco-friendly, 4) cost, 5) efficiency, 6) durable, 7) portable, 8) reusability. As you can see below, this was the AHP matrix we put together.

Figure 1 - AHP Matrix
Looking at this AHP matrix, we were able to tell what requirements were most important to us. As you can see the last two columns, is the total and the weight. The weighted column lets us know which requirements are the most important, and we were able to rank them from 1-8. The list goes from most important to least important:

1) Reusability
2) Portable
3) Eco-Friendly
4) Safe
5) Efficient
6) Ease of use
7) Cost
8) Durable
After analyzing the results from the AHP matrix, the most important criteria is reusability, portable and eco-friendly. We wanted our solution to revolve around reusability, portable and eco-friendly because we wanted to cut down on the impact ArcelorMittal had on the environment. With these criteria, we are able to ensure that the environment isn’t harmed as much.

**Concept Generation:**

At the start of brainstorming ideas we generated several ideas including mulch for playgrounds, addition of manure to woodchips for gardening, press the wood chips into plywood for construction, stain and sand pallets to be used for furniture or paneling or flooring, compact sawdust to make wood pellets for gardening and grilling, create fire starter logs out of sawdust, burn pallets in order to smelt nails on pallets, and moisten sawdust with water to make a floor cleaner.

We then reevaluated our ideas and chose a select few to be our top ideas that we would pursue due to the easiness of production and complete reusability of the pallet, them being press wood chips to make plywood for construction, press sawdust to make wood pellets for gardening and grilling, burn pallets in order to smelt nails in pallets, use wood chips for playgrounds, and add kerosene to sawdust then pressing it to form fire starting logs. We stuck to these ideas because overall we thought that as long as we stuck to this ideas, the reusing and recycling of wood pallets

**Concept Selection:**

**Figure 2 - Concept Selection Matrix**
The choices that were available for the final design were wood shavings/chip plywood, wood pellets for gardening, and the design that we thought that would be the best was used the wood chips/mulch for playgrounds. Overall, the three designs were totally safe, portable and were easy to use. The cost of woodchips for the playground was the best because it was relatively cheap and by producing wood pallets into wood chips, we were able to get the most out of the pallet due to the amount of wood chips received. As for design 3, using woodchips for playground was able to meet the customer needs and the design requirements perfectly and had the highest total value in order to satisfy both the customers and ArcelorMittal. Design 3 was the most efficient solution in the end so we stuck to this design as our final solution.

Usually after ArcelorMittal is done with their wood pallets, they are not reused or recycled. Some of the wood pallets are also not in great condition and quality so by processing them through a wood chipper would reduce ArcelorMittal’s footprint. By processing the pallets through a wood chipper, ArcelorMittal is able to make use out of their wood pallets by creating woodchips for playgrounds that could be sold for profit.

For our process to be implemented, ArcelorMittal would have to first heat the nails and remove them using a magnetic nail remover. The nails would be discarded and melted, so that ArcelorMittal could further use the melted nails if needed. This would make the wood pallets processable to be crushed up and put in the wood chipper. After processing the wood pallets in the wood chipper, you would get woodchips that would be converted into mulch. Bags of mulch would then be packaged and would be shipped off. This mulch could be used for playgrounds and landscaping.
**Design Review:**

We attended a design review with Team 7. The group lacked beneficial feedback, but we did conclude that the improvements that we must work on were to limit the risk of fires when heating the nails for removal. This can be accomplished by separating the processing buildings for the nails from the wood chipping buildings. ArcelorMittal, one of the largest steel manufacturers in the world would have some suggestions as to fire reduction and fire safety. We also concluded that we must take into account the cost of shipping the wood chips as well as the amount of emissions that would be produced by the wood chipper.

These design findings from our design review helped us to tweak and modify our final design. We reevaluated the heating of the nails and considering the fire safety risk. We then decided to relocate the machine that would be at risk of causing a fire to a building made out of aluminum metal. This would be away from the storing of wooden pallets, as well as the processed pallets. We as a group also decided to look into shipping costs, we found a broad range of numbers depending on where we decide to ship the chips too, also depending on growth of the design we could send wood chips around the world. After the design review we also sat down and looked at the emission rate of wood chippers and found a wood chipper made in Japan called the RX3000 which produces low emissions considering it runs on electricity.
3D Model/Prototype /Images of process, etc:
Our solution was mostly based on present day uses of wood. Since wood pallets can be turned into anything related to a wood product we decided to send the wood pallets into a wood chipper. The process can be broken down with the following:

1) Applying high heat to the nails which causes them to loosen up so they can be removed easily. The wood becomes really charred around the nails and the nails will fall out or can be collected with a magnetic device.

2) The nails would be removed magnetically and would be recycled or discarded. If recycled for further use, the nails would be melted and sent back into the factory to be reused.
3) The wood pallets would then be sent into a wood chipper. On the wood chipper, there are three options that can be selected: 1) Sawdust 2) Wood Chips 3) Wood Shavings. By selecting one of these options, the blades adjust, thus creating the desired output.

4) A worker will be overlooking the process and selects the process that best suites the current situation environmentally, economically and community wise.

5) The outputs in this process are sawdust, wood chips and wood shavings. The sawdust can be turned into wood pellets. The wood chips could be turned into mulch. The wood shavings would be turned into particle board using the plywood presser.

**Systems Diagram:**

**Figure 3 - System Process**
The connection between plant and system diagram is that the plants provide the pallets and then they are reused for the cities benefit. Wood chips can be given to schools for playgrounds. Construction companies would benefit because the price of particle boards would decrease due to the reusability of scrap wood pallets. Deforestation wouldn’t occur because through reusing and recycling wood pallets, trees wouldn’t be cut down in order to create wood chips, sawdust and wood shavings. As the wood chipper has three options to choose from, them being sawdust, wood shavings and wood chips. Generally speaking, you would select the one that is beneficial for the environment meaning giving off the least emissions, but also brings in the most profit for ArcelorMittal. You would also take into
consideration what is in high demand and what other companies are paying for the outputs created. Sawdust and wood chips are needed by the community most because people do gardening work around the house. Mulch for landscaping is required for yard work and playgrounds in schools. Using mulch for playgrounds in community areas, public parks and school playgrounds would be beneficial because by reusing and recycling the wood pallets which can be made into mulch can be quite cheap. ArcelorMittal would generally be not reusing/recycling any of their wood pallets so by reusing and recycling the pallets into mulch, the community would benefit. Arcelormittal could resell their mulch to communities and schools for a cheaper price than what you would buy at Lowes or Home Depot.

**Cost and Feasibility Analysis:**

To convert our process and our solution into a cost analysis, we broke down the costs into initial startup costs and the profits that would be calculated after. The initial startup costs was composed of any required machines, material or service that was required to make this process work. All the costs and the reasoning behind this are below:

**Startup costs:**
- Wood Chipper - $700-800
- Plywood Presser - $40,000-$100,000
- Nail Remover (Magnetic) - $400-500

Estimated about $27 profit per pallet.

- A cubic yard of mulch weighs 600-800 lbs
- Mulch costs about $20.00 per yard
- On average, a wooden pallet weighs about 70 lbs
- One cubic yard of mulch is 13.5 bags
- On average, 10 wooden pallets would weigh 700 lbs, one cubic yard weighs 600-800 lbs (700 on average), and one cubic yard of mulch is about 13.5 bags of mulch. Since mulch costs about $20 per yard, you multiply $20.00 by 13.5 bags in order to receive $270.00. This number is then divided by 10 to receive a profit of $27.00 per pallet.
An accurate cost analysis couldn’t be determined since the prices of shipping vary due to many different factors. The amount of mulch, wood pellets or even particle board shipped has a big impact on the amount of profit that ArcelorMittal is able to bring in. ArcelorMittal would have to sell their products cheaper than what Lowe’s and Home Depot sell their mulch, particle board and wood pellets for. To initially start up this process, an estimated amount of $1,000,000 to $2,000,000 is required simply due to the costly initial start up costs. This startup cost is derived from the additional wood chippers, plywood pressers and magnetic nail removals required in order to have an efficient system running in a factory. Several machines and devices would be required. Along with the price of these machines and devices, workers would have to pay paid also for their work in the factory. It would take about 50,000 wooden pallets to recover from the initial startup costs but in the long run, the profit collected by ArcelorMittal would be beneficial to the company. Overall, profit is possible with this process and this solution has little to no impact on the environment.

As far as feasibility for this process, stakeholders would not have any issues accepting this process. This process is used widely throughout the world and is already incorporated into the process of how wood is used today. This process would only require permission of the patents as listed and described in the background. This process however has some safety concerns. Urea-formaldehyde is dangerous can cause watery eyes, coughing, skin rash if exposed. Urea-formaldehyde is used as an adhesive in this process for some of the outputs. Another safety precaution would be the nails. Nails can sometimes set off a fire and can be hazardous. This process would have to be done in a separate factory and would have to have different conditions compared to the steelmaking factories as of now.

**Life Cycle Analysis:**

Our main goal of the system was to extend the life of the wood pallets. Wooden pallets that had nails embedded inside them made it tougher to extend the life of the pallets. In order to send wood pallets into a wood chipper, nails had to be removed before hand. After removing the nails by applying heat to the nails and using a magnetic remover, the nails would have two possible uses. The nails could be both recycled/reused and discarded. By discarding the nails, the nails can be melted and can be sent
back to the factory further its use in many different ways. It can be used in steelmaking process and other products that ArcelorMittal produces. This process for nails would be turned into a cyclical process. The wood pallets can be sent into a wood chipper to be turned into sawdust, wood shavings and wood chips. Furthermore, the sawdust can be turned in wood pellets for gardening and grilling, wood chips can be transformed into mulch for landscaping and playgrounds. Finally the wood shavings could be turned into particle board for construction work.

By using the Life Cycle Analysis this let us create the opportunity to further the wood pallets use in the form of wood pellets, wood chips, and mulch while the output is still a wooden product that has advantages for both ArcelorMittal and the environment. With this process, ArcelorMittal is able to profit off the wood pallets instead of it going to waste and also the customers are satisfied with the quality of the wooden product they bought and the overall price of it also.

Conclusions:

In conclusion, our system that we have created would not only help ArcelorMittal but would make the environment healthier. Through this process, little to none pollution is released. Since ArcelorMittal simply doesn’t do anything with their wooden pallets and lets the pallets collect dust, this process would bring in extra profit that they did not see coming. This system is totally 100% reusable, decreases deforestation as trees wouldn't have to be cut down in order to create sawdust, wood chips, and wood shavings from tree logs. As this process develops and if actually took into consideration, this process would initially have a expensive startup fee. Looking at a range from about $1,000,000 to $2,000,000, this process may be too pricey as a startup cost. Since being one of the biggest steelmaking companies in the world, this is totally possible for ArcelorMittal taking into consideration the amount of wood pallets that are discarded and thrown out from this company. By reusing and recycling wood pallets, ArcelorMittal could develop a nice profit margin on the sides as they are making use out of the wood pallets. As this design develops more, some possible substitutes could be made in this system. This system can be turned into 100% machine ran and no human workers would be needed. With the technological advances today, this process can easily be made efficient and the amount of profit that is accumulated by ArcelorMittal would be a great source of income. The main lessons that my team learned from this project is that one small idea and some strict guidelines could be turned into
something that actually applies to the real world today. With the guidelines given to us, we had to compose an solution to the problem ArcelorMittal has. Wood pallets are widely used throughout the world and since ArcelorMittal simply does not focus on what to do with their wood pallets, they are gone to waste. ArcelorMittal has something more important to worry about such as the steelmaking process, thus being said we discovered that anything is possible in the real world and with the process of brainstorming as a group. All the ideas that we presented to each other after brainstorming them made us realize that something small can lead into an actual project.

References:


30 Apr. 2015.