

ArcelorMittal
EDSGN 100, Section 20
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Abstract:

Over time, especially within the past few decades, Earth's natural resources have been used and wasted quickly. Consumers are using these resources at an alarming rate without thinking about the consequences. Many trash landfills have been filled with items such as plastic and glass that can be reused and recycled. If no action is taken, there will soon be no more resources to use. Large companies have been spotlighted with the amount of waste they go through. Many of these companies have been tasked with changing this and becoming more eco-friendly.

Introduction:

ArcelorMittal, the largest steel producer in North America, reached out to our EDSGN 100 class to find a way to reduce their carbon footprint. We were tasked to find a way to recycle wood pallets used for delivering material, empty plastic and metal barrels used for delivering liquids, and/or refractory brick. This task proved to be harder than imagined because of the toxins that come into contact with the three materials. Some, if not all, of the wood pallets were chemically treated, some of the barrels transported toxic waste such as antifreeze or water treatment chemicals, and the bricks were already broken down through their use with the company as well as being produced with toxins that can cause diseases like cancer when burned. After much research, our group decided to work with the barrels.

Mission Statement:

Our mission statement is to find a way to safely reuse or recycle the plastic and metal barrels in an environmentally friendly way.

Customer Needs:

Legend		
⊖	Strong Relationship	9
○	Moderate Relationship	3
▲	Weak Relationship	1
++	Strong Positive Correlation	
+	Positive Correlation	
-	Negative Correlation	
▼	Strong Negative Correlation	
▼	Objective Is To Minimize	
▲	Objective Is To Maximize	
X	Objective Is To Hit Target	

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Image 1: House of Quality

The house of quality is a very important part of the design process. This allows one to see all of the customer needs, as well as the characteristics. By seeing these two components, one can easily determine which customer needs are the most important while also seeing correlations

between the customer's needs and the characteristics. For this specific project, the customer needs include recycling plastic and steel barrels, helping the environment, saving space in landfills, and of course saving money. In order to determine what our idea was to help fulfill the customer needs, we needed to rank their importance. By doing so, we say that saving space in landfills and recycling barrels were the most important, so we needed to come up with a way to recycle the barrels. Also, we were able to see some characteristics that are needed for the customer needs. For example, the solutions cannot cost too much, and they have to be feasible. This is just the beginning of the design process, and it is very important to become familiar with the house of quality.

Recycling Plastic Barrels:

As the largest steel producer in North America, ArcelorMittal works its way through many tons of plastic barrels. They create a huge amount of waste if not recycled. One fraction of the barrels the company uses up can be returned to the manufacturer. The manufacturer then cleans them out and reuses them. The other fraction of the barrels are not recycled as easily and can cause harm to the environment if not handled properly. This is because these barrels contain water treatment chemicals which are toxic. This dilemma was tough to solve but we stumbled upon a company named Vikoz, one of the largest plastic recycling companies¹. This company handles all of the recycling work and ArcelorMittal does not have to do anything. Vikoz comes to ArcelorMittal's headquarters, loads the empty barrels onto their trucks, and recycles them. Best of all, Vikoz pays ArcelorMittal.

This plan seemed too simple so we looked into it even further. We were worried that the water treatment chemicals would be a problem, and that ArcelorMittal would have too many

barrels for Vikoz to handle, and that Vikoz would be too far from ArcelorMittal. These problems were all solved when we contacted Vikoz. It turns out that the water treatment chemical are not a problem for Vikoz and they still take the empty barrels. Although they did not go into too much detail in their email because we were just asking hypothetical questions, the company usually goes through a detailed version of how they are going to recycle the plastic brought in to the companies they purchase the scraps from. The next concern we had was the volume of barrels ArcelorMittal would have to recycle. This was certainly not a problem for Vikoz. They take pride in recycling and the less waste material in the landfill, the better. Lastly, location is not a problem. Because both companies are so large, they have many locations across the country. Some of these headquarters are close in location to each other. Even if they were not, Vikoz is willing to help companies recycle no matter where in the United States they are.

The best part about Vikoz taking and recycling the plastic barrels is that after they clean the plastic, they then turn around and sell the plastic to other companies. This makes the original plastic last longer, which is the whole point of recycling.

Recycling Metal Barrels:

The metal barrels proved to be more of a challenge to recycle than the plastic totes. The metal barrels are used to store antifreeze which is needed in the steel refinement process as heat transferring agents. There are two types of antifreeze, both of which are used by ArcelorMittal. They are ethylene glycol and propylene glycol². Propylene glycol is nontoxic, and can be safely consumed by humans (in moderation). Fumes that may result from this antifreeze are not hazardous to the lungs, and as such the FDA has approved it for food processing plants. Ethylene glycol on the other hand, is considered a toxin and must be treated as such. It cannot be disposed

of in the environment and it is costly to dispose of. As such, no company we contacted was willing to take the metal barrels and recycle them, unless the antifreeze was completely cleaned out of the barrels.

We then began brainstorming ideas for cleaning the antifreeze efficiently, and completely, out of the barrels. Our first idea was to evaporate it out and collect the vapor in a condensation collector. The boiling point of antifreeze is much lower than the temperature needed to melt steel, so it would be possible to use the heat needed to melt the steel, and use it to evaporate the ethylene and propylene glycol. Unfortunately, there are several problems with this plan. One of the first ones we thought of was the fumes of the ethylene glycol. Though, they should be condensed relatively quickly, if any were to escape the condenser, they'd be out in the atmosphere, harming it and those who breathed the fumes in. The other problem we foresaw was that if the temperature was hot enough to melt steel, the barrels would probably start melting and so would the condenser. We were forced to scrap this idea, and move to a new one.

Our next idea was to buy a machine to wash the barrels. As we researched the different machines out there to wash barrels, it was clear to us that many washers used too much water to be an efficient and ecofriendly way to clean the barrels. We decided to design our own barrel cleaner, one which would be water efficient, energy efficient, easy to maintain and use.



Image 2: Barrel cleaner designed in Solidworks.

To use this machine, it must be placed on a stand (not pictured) and filled approximately sixty percent full of water. Metal barrels often have caps on the lids of barrels, so the caps must be taken out of the bottom, placed on top of this cleaner, and clamped in place. The cap from the top of the barrel must also be removed before the nozzle can be placed inside and the machine turned on. The nozzle shown here would clean the barrel with the cascading effect, but other companies have designed nozzles, that act like a sprinkler and spray the barrel³. The water containment unit

holds approximately 60 gallons of water. On the side of this machine is a device similar to that which measures the chlorine in a pool which will measure the amount of antifreeze in the water. At a certain point, when the antifreeze to water ratio is equivalent to that of the antifreeze water ratio seen in cars (40% antifreeze, 60% water is a common ratio), the machine alerts the operator that it cannot clean any more barrels with this water. The operator then attaches a hose to the bottom of the water containment unit into a new barrel. This barrel now contains antifreeze that is of the right ratio to use in cars, trucks, and diesels⁴. Since the antifreeze was residue antifreeze, it was never used and therefore does not need to be recycled. New water is pumped into the top, and the process repeats. The metal barrels can now be recycled for steel by ArcelorMittal itself or sold to another company for recycling.

Economics of Proposed Recycling Plan:

One thing we had to consider while doing this project was the economics of having ArcelorMittal recycle the plastic barrels and making a machine to clean the metal barrels. Vikos did not explicitly state how much they pay for each plastic barrel. However, according to plasticsnews.com, HDPE plastic, the type of plastic that the barrels are made from, is worth about 69 cents per pound. Assuming Vikos will pay ArcelorMittal around 65 cents per pound of plastic given to the company and assuming that ArcelorMittal uses at least 50 tons of barrels per year, ArcelorMittal could potentially make anywhere from \$65,000 per year and up, depending on their barrel usage.

The price of the machine we designed is based on similar machines used to clean barrels. Barrel cleaning machines that do not have a tank cost around \$2500, but our machine costs about \$3000 since our machine comes with a tank to reuse the water. Since it would not be economical

the buy just one barrel cleaning machine, ArcelorMittal would have to buy two or three to speed up the barrel cleaning process. ArcelorMittal would also have to hire someone who runs the barrel cleaning machine. Since this is a very basic job that needs little to no training, the hourly wage could be comparable to that of a crane operator. ArcelorMittal pays their crane operators about \$20 per hour, so this is the expected salary of the barrel cleaning machine operator. This expense is still less than the profit of recycling the plastic barrels through Vikoz. ArcelorMittal's investment in the barrel cleaning machines would pay off over time, especially if they are able to use the metal to melt down to extract steel.

Conclusion:

For this project, we were able to come up with a solution for ArcelorMittal to use in order to recycle plastic and steel barrels as well as to reduce space in landfills. We were able to use the design process as well as trial and error to come to the eventual final solution. We found a company that takes the barrels, as well as created a system that washed any potentially harmful chemicals out of the barrels. Overall, the project was a success, because we were able to create solution for ArcelorMittal that also helps the environment.

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