ArcelorMittal Project: Recycling Pallets “Pallet Wrecker”

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Abstract

The design project is to design a system or practical way that could efficiently convert or recycle waste found in a factory. The project was brought to the team by ArcelorMittal, one of the largest steel producers in the world, regarding one of their plants based in Steelton, Pennsylvania. The company has an extreme excess of wooden pallets, refractory brick, drums, and totes, with no future of being used while at the plant. After comparing the ten concepts for the solution to the problem, the Wreck-It Ralphs chose to focus their efforts on the pallets. The team’s process for the wooden pallets involves two steps. The first step involves tearing the wooden pallets apart using a design the team brainstormed; an enhancement on a current design. After the pallets are separated, the wood would then be sent through a woodchipper and sold or donated as woodchips to local school yards, playgrounds and parks depending on their condition.

Problem Statement

The vision of ArcelorMittal is to minimize unnecessary waste of pallets from their industrial process in order to eliminate a negative impact on the environment. They also foresee the opportunity to create a system which maintains the minimal waste of pallets. Consequently, ArcelorMittal has to send these excessive pallets to landfills or have them burned, which adds to environmental and economic expenses. ArcelorMittal is currently using excessive pallets for the forklifting of drums, which is key in transportation around the plant. However, these pallets are not reused and are wasted. Furthermore, ArcelorMittal incurs transportation and other miscellaneous costs with respect to clearing the factory space of the excess pallets. The aim is to find an opportunity in the industrial process to use the engineering design process to recycle or reuse the excess pallets through the examination of the inputs and outputs. ArcelorMittal intends to reduce its waste footprint and make better use of the waste they generate. The ideal situation
would be where ArcelorMittal eradicates waste completely by finding an efficient and sustainable way of recycling the pallets. The Wreck-It Ralphs understanding of sustainable engineering is that of a design process that minimizes the use of resources in a way that future generations will not be compromised with their ability to meet their own needs.

**Research and Background**

Wreck it Ralphs researched on several aspects of ArcelorMittal’s manufacturing process to come to a conclusion with respect to the area that needed to be addressed. The team not only had to research about the Steelton plant located in Pennsylvania, but also find background related to any waste produced and methods of recycling the waste. Since pallets was an area of interest for the team, research was conducted about the number of pallets supplied to the company, the type of wood used, the amount of wood used per pallet, and the possible applications of reusing the wood. As the solution needed to emphasize on sustainability, the Wreck-It Ralphs also researched about the potential pollution and other wastes that can be produced. The last section of research included several patents were studied about such as Pallet Dismantler (US 8752457 B1) and the Pallet Recycling Device (EP 2743029 A1) as various possible solutions were contemplated through the application of these patents.

**Customer Needs**

The follow list of eight items presents the more critical customer needs geared toward ArcelorMittal.

1. The recycling of the pallets has to be cost effective, less than $50 per pallet
2. Create a process that allows for the reuse of at least 1000 pallets
3. Waste is disposed in a 100% efficient method
4. Process of reusing pallets must produce zero pollution
5. Solution can be expanded to at least three other countries
6. Solution benefits the local area by supplying to at least five local businesses
7. Solution must have at least three different applications
8. Solution satisfies its objective within two months of initiation

The following AHP Matrix (Table 1) shows the ranking of criterions in terms of their relative significance:

Table 1: AHP Matrix

According to the AHP Matrix, the most important customer needs that needed to be addressed were cost of repurposing the pallets and the number of pallets that could be recycled in a given time interval. These were the two most important criteria, since ArcelorMittal is a large business. They cannot afford to waste money on endeavors like this. If they did, they would not proceed, so the price has to be low. Also, with the large amount of pallets that they have, they need to maximize the efficiency of the process by reduce the number of pallets as swiftly as possible.
**Concept Generation**

While thinking of ideas for the design, the team kept an open mind to any and all ideas, no matter how ridiculous they may have sounded. Once all the ideas were gathered, the team then went through each idea and thought about if it was actually feasible and then from there talked about how realistic it may have been to implement. The main components that were necessary mainly focused around efficiency and sustainability. The team decided that whatever idea that was decided upon needed to be extremely efficient so that it could keep up with the constant supply of pallets that ArcelorMittal was receiving on a weekly basis. Another component that the team focused on was the environmental impact. Since this entire design was based on recycling materials the team decided that environmental factor should be extremely important. From there the team then compared all of the ideas that were left to the customer needs through the use of a concept scoring matrix, which is where the final idea was decided upon and can be found in the next section, titled, “Concept Selection.” On the next page, you can see an image of the classification tree (Figure 1) which the team made. It shows the initial issues that had to be covered when recycling the pallets, and a multitude of possible methods to solve those issues. This was one initial way to guide the project to completion.
Figure 1: Classification Tree for Recycling Pallet Process
Concept Selection

<table>
<thead>
<tr>
<th>Selection Criteria</th>
<th>Weight</th>
<th>Rating</th>
<th>Weighted Score</th>
<th>Rating</th>
<th>Weighted Score</th>
<th>Furniture</th>
<th>Rating</th>
<th>Weighted Score</th>
<th>Send back to suppliers</th>
<th>Rating</th>
<th>Weighted Score</th>
</tr>
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<tbody>
<tr>
<td>Cost</td>
<td>20%</td>
<td>1</td>
<td>0.2</td>
<td>3</td>
<td>0.6</td>
<td>4</td>
<td>0.8</td>
<td>2</td>
<td>0.4</td>
<td>5</td>
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</tr>
<tr>
<td>% Waste converted</td>
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<td>5</td>
<td>0.5</td>
<td>5</td>
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<tr>
<td>Efficient</td>
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<td>0.1</td>
<td>5</td>
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<td>3</td>
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<tr>
<td>Eco-Friendly</td>
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<td>1.2</td>
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<td>2.4</td>
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<td>Benefits local area</td>
<td>5%</td>
<td>0.01</td>
<td>0.01</td>
<td>5</td>
<td>0.25</td>
<td>3</td>
<td>0.15</td>
<td>1</td>
<td>0.05</td>
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<tr>
<td>Ethical</td>
<td>20%</td>
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<td>0.2</td>
<td>4</td>
<td>0.8</td>
<td>4</td>
<td>0.8</td>
<td>3</td>
<td>0.6</td>
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<td>Inmediate results</td>
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<td>0.25</td>
<td>0.13</td>
<td>3</td>
<td>0.15</td>
<td>2</td>
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Table 2: Concept Scoring Matrices of Initial Ten Designs

Above, the scoring matrix for the Wreck-It Ralphs can be found. Ten ideas were considered, but only three large ideas stood a chance to become the final design. First, woodchips ranked number one, since it was so eco-friendly and efficient in its design. While it lacked in cost, it transferred 100% of wood from the pallet to mulch which improved the lifespan of the wood. Next, industrial paper was an option, since it was also very efficient at converting wood to paper in its design. However, the papermaking process is not very safe for the environment. Also, the process is expensive, and ArcelorMittal could not do it on their own, and they would make little profit from the design. Lastly, furniture was a possible solution to the pallet crisis, but it was too expensive to pursue, it had no true benefit to the local area, and the results were not fast, since furniture making is a long process.

The final proposal by Wreck-It Ralphs was to separate the pallets with a modified pallet jack, remove the nails, chip the wood, and package, sell, and donate as immediately as possible.
The final design fell along well with the initial criteria. Although the design was more expensive than expected, the design was extremely efficient at converting waste to new product, improving its lifespan and also the longevity of the planet. Also, it benefits the local community, like Steelton-Highspire School District and Serb Park in an immediate way.

**Systems Diagram**

![Systems Diagram](image)

Figure 2: Systems Diagram for Final Pallet Design

As one may notice, the systems diagram (Figure 2) repeats after determining if the pallets are in good condition. This is because the wood chips are packaged and distributed based on their condition. Chips from good pallets are sold, while the chips from poor pallets are either sold or donated.
Model

The prototype was designed considering the requirement to break down the pallet into wood pieces that could be easily chipped by the wood chipper. The design allows this product to separate the pallet using hydraulics that, although are not depicted in the images, would enable the jack lever to pull up the extended part of the prototype that would be placed under the upper part of the pallet, hence separating it. Once the pallet is separated, the metal nails would be removed manually to prevent any damage to the wood-chipping machine. Finally, the woodchipper would convert the wood into wood chips. Without this new product, the design would be virtually impossible. To remove pallets by hand is a tedious process. This product allows the process to occur nearly spontaneously, helping to solve the problem of excess pallets.
Life Cycle Analysis

The team’s design improves the straight line problem very well. Instead of going right from cradle to grave there now is an entire step in between there that takes many years to complete. The pallets are no longer just being used once but instead, once they are ground up into wood chips, are used day after day in various locations whether that be at playgrounds or used for gardens. These chips can stay there for multiple years and as more chips get added every year, the old ones will rot away underneath, completing its cycle. This process could be done in ArcelorMittal’s factory and would save all of the pallets and pallet from either taking up space in the factory or taken away to landfills, basically wasting the tree from which it came from.

The fact that the pallets are made of wood allowed this design to work. Since the wood has many uses, and also is a natural resource which cannot harm the environment, it allowed the wood chips to be used nearly anywhere, whether local or across the state.

Implementation Plan, Feasibility and Cost Analysis

The Pallet Wrecker would approximately cost $750, including the hydraulics system, the steel assembly and labor costs. However, the design process also requires a wood chipping machine that would have an add-on cost of about $1500 at the current market price.¹ This brings the total investment to up to $2250 for at least 3 years of usage of pallet “wrecking,” as per the warranty given by the wood chipping machine. Therefore, the cost for ArcelorMittal would be around $750 plus minimal maintenance costs. The primary goal of the Wreck-It Ralphs was to minimize unnecessary waste of pallets. Therefore, the main focus was not to generate a revenue,

but to only make the entire process of recycling sustainable. However, wood chips - the final product of the recycling process - has several practical applications. Wood chip are sold in the market for around $3.00 per pound, depending on the quality and ArcelorMittal may be able to do the same. Moreover, wood chips can also be used as mulch for agricultural purposes as it helps to retain water and keep plants at an optimum temperature for growth. Also, wood chips can be used to make industrial paper, or to generate energy by using it as a fuel. These applications satisfy one of the customer needs, which was to have at least three different uses for the final product.

Overall, this option of wood chipping serves as feasible option due to minimal investment by ArcelorMittal for implementing added sustainability at their Steelton plant, PA. Furthermore, this design process is applicable at any ArcelorMittal plant around the world and is not location specific. As the design process in 100% efficient, since all the wood from the pallets is converted to wood chips, the government would not need to further regulate any cultural, privacy or legal issues either.

Conclusions

In conclusion, the team’s design for this project involved taking apart the pallets and then making wood chips out of them, which would then be sold or donated to the local area. The positive of this design are: that the wood is completely recycled and there is no wasting wood, it increases the lifespan of the wood, it can make money for ArcelorMittal, it frees up space around the factory. Some drawbacks are: they necessity to manually take out the nails of the wood, the need to by a woodchipper and the price of chipping per pallet is a decent price when chipping tons of pallets. From here the teams design could go one of two directions, each having to do with a different step. The design could be improved by creating a better and more efficient way
of tearing the pallets apart or it could be improved by finding a better way to sell the chips. Both are areas that would the team would focus on if they had more time for more prototypes and testing. The main lesson that the team learned as a result of this project is that recycling is much harder than expected. Typically people just think to just reuse it but sometimes finding a way to reuse is the problem, which is exactly what the team learned in this project.
References

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