M.A.H.S.E.N.
Mechanically Assisted High Speed Extraction of Nails

Product development for ArcelorMittal

Edesign 100          Section 25          Prof. Sarah Ritter          May 2015
Group 3
Team Jamabo Believe

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Abstract:

Much of the equipment ArcelorMittal purchases from third parties is delivered on wooden pallets, and they have no solution for the removal of these pallets and other scrap wood. Since some of the wood is damaged or contains nails and staples, we propose that we attempt to resell the undamaged pallets, and refurbish and resell the damaged wood by first removing all of the nails and wood. We would use a two-part process that includes a drill bit to remove the tainted wood, and a wedge to then clear this tainted wood of any metal debris. This allows the company to take the majority of its wood income and turn it into profit by reselling it as pallets or clean scrap wood.

Problem Statement:

We make profit for ArcelorMittal off of their waste wood. We salvage 95% of the scrap wood right after its usage and turn it into profit while easing the workload of current employees. Additionally this process will have no negative environmental impact or safety risks.

After delivery, the wood from railroad cars and pallets is making no money for the company; it is just being burned or thrown away. Both of these current solutions have negative environmental consequences, require labor and are not bringing in any profit.

We are going to search for a solution that minimizes waste and maximizes usable output in a safe, economical, and environmentally friendly fashion, all taking place at the plant. We will brainstorm different solutions of the problem and weigh the pros and cons of each, and then select the best option for prototyping. We will build, test, and have others review our product, and then we will improve upon our idea. All will be accomplished in the next 4 weeks.

Sustainability:

Sustainability is the ability of a process to be performed repeatedly without wasting financial resources or taxing the environment.
Background:

Currently Arcelormittal is giving away unused pallets to employees to burn as fuel at their houses. We set out to find a way unused pallets could be profitable for ArcelorMittal in the long run. Our initial idea was to just hire a company to remove the pallets and refurbish them however we found that most companies like this charge for pick up. The fee for pickup tends to be about $75-$100 dollars per truck load\(^1\). With this cost, over a lifetime of recycling pallets through an outside company, ArcelorMittal would take a large loss.

The price for most of these recycling companies is so high because the recycling company still has to cover the labor costs. We needed a way to cut out the middleman and independently sell high quality pallets to outside companies. Our idea is to bring a pallet refurbishing division to ArcelorMittal by designing the tools necessary to fix any broken pallets the company could not resell.

We searched for patents to determine if there were any preexisting tool designs that would work as well as our proposed idea for a hollow drill bit but we couldn’t find any that met our exact needs. While there is an abundance of hollow drill bits, and devices for removing the cores from the bit after drilling we could not find any that would work as effectively as our proposed design. The closest patented device we found was an attachment for a normal hollow drill that removed a wood core from the inside after drilling, but this had to be installed separately\(^2\).

Our solution to this problem was to design an all encompassing hollow drill bit that will drill around a nail and then self eject the core using an interior spring as soon as pressure is taken off of the drill. Using our design ArcelorMittal would then be able to refurbish pallets in house, cut out the middleman, and sell the refurbished pallets to a company that will pay between $1.50-$3.00 for pallets in good condition\(^3\).

Customer needs:

ArcelorMittal was in search of a way to remove excess pallets that weren’t in use in an environmentally friendly way, a recycling program of sorts. We decided to create a program that would incorporate speed, efficiency, and durability all while keeping safety, ease of use, cost, and environmental impact in mind.
Table 1. The rankings in the table below were used to determine what design criteria would take precedence over others and which would go into the final design.

<table>
<thead>
<tr>
<th>Safe to use</th>
<th>Environmentally friendly</th>
<th>Quick</th>
<th>Inexpensive</th>
<th>Efficient (low waste)</th>
<th>Easy to use</th>
<th>Repeatable process</th>
<th>Durable product</th>
<th>Total</th>
<th>Weight</th>
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</thead>
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<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>0.5</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>0.5</td>
<td>5.5</td>
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<td>0.5</td>
<td>5.83</td>
<td>0.08</td>
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<td>1</td>
<td>0.5</td>
<td>0.5</td>
<td>8.5</td>
<td>0.11</td>
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<td>2</td>
<td>1</td>
<td>1</td>
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<td>10</td>
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<td>2</td>
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<td>1</td>
<td>1</td>
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<td>0.33</td>
<td>7.66</td>
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<td>2</td>
<td>3</td>
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<td>0.5</td>
<td>12.5</td>
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<tr>
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<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>16</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Grand Total: 75.49

From the data in Table 1 above it was found that the top criteria that had to be included in the final design were, durability, repeatability, efficiency, and safety. We choose these specific criteria based upon ArcelorMittal’s current methods of pallet disposal.

Currently the company is taking a loss on their unused pallets. We wanted to fix that and potentially turn our process profitable for ArcelorMittal. Our product being durable is important if this is going to happen. Ideally, our design will not break during the lifetime of its use; this means ArcelorMittal will be able to continually use the product without any repair costs, and in the long run this would minimize their net losses.

We also wanted the process of using our product to be easily repeatable, meaning that every time you have to drill out a nail it can be done in just one or two simple steps. Having a repeatable process would allow for copious amounts of time to be saved, meaning the job could be finished quickly, ergo minimizing labor costs.

Also, we needed the product to be efficient and safe. We defined efficient as wasting as little as physically possible. Compared to ArcelorMittal’s current method of disposal we needed our process to be 95%-97% more efficient.

The product also had to be safe for the employees to use. We figured that with minimal training we could minimize the risk of injury while using this product. This would in turn lower the risk of medical costs associated with injuries at the company’s expense.

Concept Generation:

From the beginning of the design challenge we had leaned toward finding a solution to ArcelorMittal’s pallet dilemma, but at first we weren’t sure how to tackle the problem. We came up with multiple ideas that would potentially work as solutions to their excess pallet problem.

One idea we came up with was to use a strong magnet to pull the nails and staples out of the pallets, however this would take a massive amount of strength and probably take a long time as well so we set this idea aside.
We had also discussed the idea of just mulching everything and then selling the mulch to outside companies but it would be bad for a wood chipper to have nails and staples run through it so that idea was also set aside.

We tossed around the idea of redesigning the pallets to make them easier to disassemble. This would entail creating some kind of device that would go under the nail before the pallet was put together, that way, after the pallet has been used the nail could just be pulled out.

Our last idea was the idea of a hollow drill bit that would drill around the nail or staple. This technique sounded the most promising and it was the one we eventually took to the next stage in development. We had originally intended to combine the magnet and drill bit idea into one component and use the magnet to keep the drilled core and nail in place after it had been extracted but it was determined that this would be inefficient because it would make it difficult to remove the core from the bit.

With this new problem we decided to install a spring into the drill bit so it could push the core out as you lessen pressure on the drill. Now, with this bit being able to get all of the metal out of the pallets we choose to implement the shredding/ selling idea we came up with in order to make ArcelorMittal profit. This would shred about 95% of the wood but we still had the problem of the metal in the drilled core.

For a solution to this we jumped right to the idea of a log splitter, however because this core is so small a normal log splitter wouldn't work. We then designed a miniature one that operated on the same principles of an actual log splitter. In the end we combined all of these concepts to create the Mechanically Assisted High Speed Extraction of Nails process (MAHSEN).

**Concept Selection:**

The three most promising solutions were to drill out the nails, feed the entire piece of wood (nails included) through some sort of grinder or chipper, or separate the wood from the nails by hand with a saw and hammer.
Table 2. The rankings in the table below determined the design concept we selected

<table>
<thead>
<tr>
<th>Feature/Requirement (weight)</th>
<th>Safety (0.13)</th>
<th>Environmentally Friendly (0.07)</th>
<th>Quick (0.08)</th>
<th>Inexpensive (0.11)</th>
<th>Low Waste (0.13)</th>
<th>Easy to Use (0.10)</th>
<th>Repeatable Process (0.17)</th>
<th>Durable Product (0.21)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drillbit</td>
<td>5 (0.65)</td>
<td>4 (0.28)</td>
<td>5 (0.40)</td>
<td>4 (0.44)</td>
<td>5 (0.5)</td>
<td>5 (0.85)</td>
<td>4 (0.84)</td>
<td></td>
<td>4.84</td>
</tr>
<tr>
<td>Woodchipper</td>
<td>4 (0.52)</td>
<td>3 (0.21)</td>
<td>5 (0.40)</td>
<td>3 (0.33)</td>
<td>4 (0.52)</td>
<td>5 (0.5)</td>
<td>5 (0.85)</td>
<td>3 (0.63)</td>
<td>4.32</td>
</tr>
<tr>
<td>Separate by Hand</td>
<td>2 (0.25)</td>
<td>5 (0.35)</td>
<td>1 (0.08)</td>
<td>4 (0.44)</td>
<td>1 (0.13)</td>
<td>1 (0.10)</td>
<td>2 (0.34)</td>
<td>1 (0.21)</td>
<td>1.93</td>
</tr>
</tbody>
</table>

To determine which of the concepts we would move forward with, we used the concept selection matrix above and created a weighted scale from 1-5 to determine how each concept would perform given the desired customer needs. A “1” would mean the concept would perform poorly in a specific category, and a “5” would mean the concept would be the absolute best fit for a specific category. As shown in Table 2, the concept for a drill bit scored slightly higher than wood chipping, and significantly higher than separating it by hand, due to its promising speed, durability, and safety.

The other two methods would just be too slow and even dangerous. The possibility of cutting fingers with a saw was a large problem with the hand separation. Feeding the wood through anything that would chip or grind it was also a problem because when the grinding wheel or blade would hit a nail or staple it could either destroy the metal blade, or the blade would turn the nail into a high speed projectile that could endanger employees well being.

However, if we could somehow remove the nails and then put the wood through a wood chipper, this would maximize the efficiency of our product. Because of this, we decided to combine the two top ideas to create our final concept. We also added the idea of making a wedge to remove the nail from the wood core after being removed from the drill bit.

This maximized the quality of our concept by making it fit the majority of our customer needs. It is a safe, environmentally friendly, efficient, and durable process. By doing this we can help ArcelorMittal reduce its footprint exponentially, as 100% of the wood and nails will be separated and ready to be recycled. It would also be an easy process to implement, as all we would have to do is supply workers with custom drill bits and wedges, which will not be that much of a monetary investment. Then we would have to buy one wood chipper that all of the scrap wood could go into.

Design Review:

The feedback from the initial design review was mostly positive, the main concerns being what to do if the width of the staple is too wide for the drill bit, and what to do if we can’t sell the excess refurbished pallets. The staple problem is difficult to solve because we have not been given exact dimensions on the staples in the pallets. If
we were to come up with a solution for the staples in the pallets we would use a crowbar for large staples in order to pry them out. If the staples are small enough we would just use the drill bit and the splitter to extract them just like the nails. As for the excess pallet problem, we could buy a cheap wood chipper, chip the pallets after the metal was removed, and we could use the mulch around factory property, sell it, or donate it to a greenhouse to ensure there is no surplus at the factory. This entire process is very safe with proper training, so employees must be trained before using these tools. Training would minimize the risk of injury as well as maximize employee productivity.

Process/Model:

The M.A.H.S.E.N process begins with the delivery of raw materials on pallets. The pallets in good condition after delivery will be collected and sold in bulk to another company. The broken and defective pallets will then be separated into their raw materials using the M.A.H.S.E.N process. Our specialized drill bit seen in Figure 1 will remove a cylinder wood with the nail or staple inside the core. The spring inside of the drill bit seen in Figure 2 will work to remove the core from inside. Next the core is manually hammered through the core splitter seen in Figure 3 and Figure 4 to remove the metal in the center. The metal from the core could then be used in steel production. All of the now scrap wood will then be fed through a small wood chipper purchased by the company. The mulch created could be used around the property, given to employees, or donated for community projects. The chipper has much fewer emissions compared to burning the wood, the process currently being utilized by ArcelorMittal. This process will incur some initial costs, but the total efficiency and ability to greatly reduce ArcelorMittal’s economic footprint will make the investment worth it.

Figure 1: Outside view of the drill bit
**Figure 2:** Drill bit spring

A 2.9 inch interior spring will allow for the easy removal of the wood core after drilling.

**Figure 3:** Overall view of the wedge

The 1 inch diameter mouth fits the drilled wood core perfectly.

The 5 inch tall core splitter will allow for efficient removal of nails from the drilled wood core.
Figure 4: Inside of Wedge

Two interior wedges will allow the wood core to split around the nail at its center.
Cost and Feasibility Analysis:

With this specialized design of the drill bit and wedge we would expect the manufacturing cost to fall in a range between $60 and $80. In addition to the drill bit component of this solution, there is also a need for a wood chipper to mulch all of the scrap wood that cannot be refurbished which would cost approximately $1000. There would also be the cost of labor for a person to do this job at the factory. The cost of labor would be $12 an hour. The number of hours would be determined by the number of incoming broken pallets. There will also be a small cost for fuel to operate the wood chipper. However this overall process is much more efficient and environmentally friendly than ArcelorMittal’s current method, and its costs are not extremely high. All costs can be covered by pallet resale estimated at $2 per pallet\(^4\), and depending on how many pallets are brought in per day, we see ArcelorMittal breaking even just a few
months after the initial implementation, while they will create a more positive image of their company immediately.

**Life Cycle Analysis**

The greatest thing about our design is the fact that there will be no waste. The pallets that aren’t severely damaged will be refurbished and sold back to pallet manufacturers for a profit. The broken pallets will be broken up into its basic parts. The wood will be mulched and put back into the earth, which is good for the environment. The nails and staples can easily be melted down and added into the steel making process. Therefore, no parts will be thrown away into landfills or burned, which was a big problem for ArcelorMittal in the past, and if any inputs are not turned into a profit, they will be recycled back into the earth.

**Conclusion:**

Our process starts with the delivery of raw materials on pallets. The pallets that remain in good condition after delivery will be collected and sold in bulk back to the pallet manufacturer or another company. The broken and defective pallets will be separated into raw materials. The drill component will remove a cylinder wood core with the nail or staple inside. Next the core is hammered through the splitter to separate the wood core from the nail. The steel nail can be added to the scrap used by ArcelorMittal to make new steel. The scrap wood from the core and remaining pallet will then be chipped in a small wood chipper purchased by the company. The chipper will have some emissions but be much better for the environment than burning the wood. The mulch created could be used around the property, given to employees, or donated for community projects. This process will incur some costs. The main cost is for labor to recycle the broken pallets and collect and export the usable pallets. There will also be a small cost for gas to operate the chipper. Overall the process is extremely green and environmentally friendly. All costs will be cover by pallet resale estimated at $2 per pallet.

The pallet recycling process we have created has many positive implications. Firstly the pallets can be completely recycled. If the nails and wood cores are reused the process is 100 percent efficient. The process also has a lower environmental impact than burning the wood. ArcelorMittal can create a positive image in the community by donating mulch. Another upside is the nail extraction process is quick and easy and labor costs are reduced because most pallets are resold and not disassembled. The last and perhaps one of the most important aspects of the process is it makes the company profit quickly and continuously after it is implemented. The resale of pallets good condition should cover all costs.

The process also has some shortcomings. The first is that although the process does make a net profit there are start up costs, like the wood chipper and custom
drill bit, as well as continuous costs like labor to separate the pallets and transportation to the pallet buyer. There are also some environmental impacts. The emissions from the transportation vehicles as well as the wood chipper would have a negative environmental impact. Lastly like any job involving power tools this process invokes some safety risk for employees.

If this process were to be implemented it would be expanded upon. The next step would be to contact the pallet manufacturer or local pallet purchasing company. The price, volume, and transportation arrangements could then be negotiated for resale. The next step would be the purchase of a wood chipper and manufacturing of the drilling components. Workers would have to be periodically assigned to the task of exporting or disassembling pallets. Projects or organizations that would like a mulch donation could be located in the community. The recycling process would assimilate into the daily routine of the factory.

Our group learned many valuable lessons while completing this project. The first skill we learned was time management. Throughout this project there were deadlines to meet and we learned to use our time wisely both as individuals and as a group. We also learned teamwork skills. From generating ideas to choosing our final process we learned to cooperate with each other and voice our own opinions. Lastly we learned how to tailor a product to a customers needs. We used selection matrices to weight various customer needs and worked with a common goal of providing ArcelorMittal with exactly what they requested.
Works cited

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