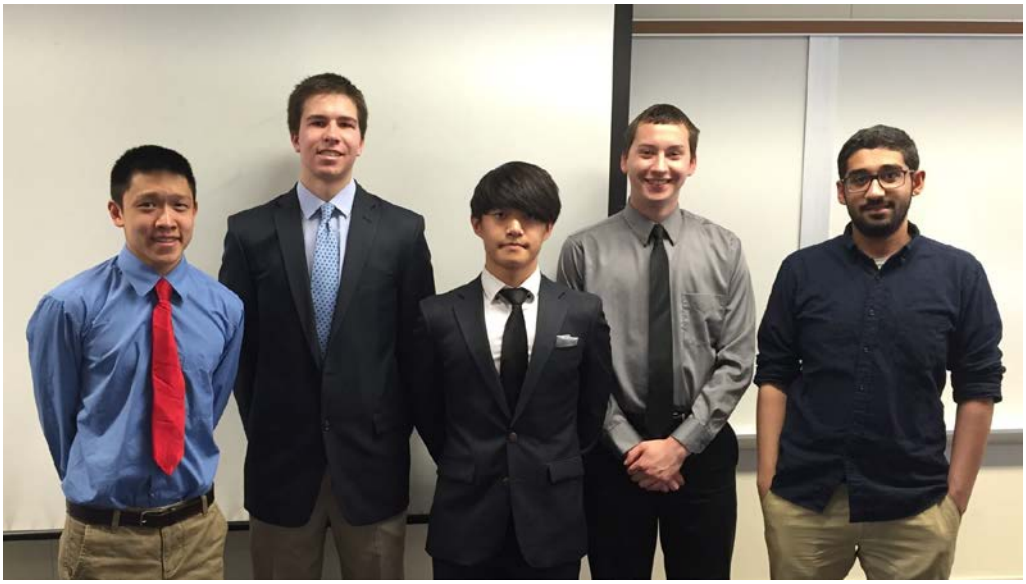
Design Project II- Recycling Wooden Pallets

EDSGN 100- Introduction to Engineering Design

Section 9, Team #8



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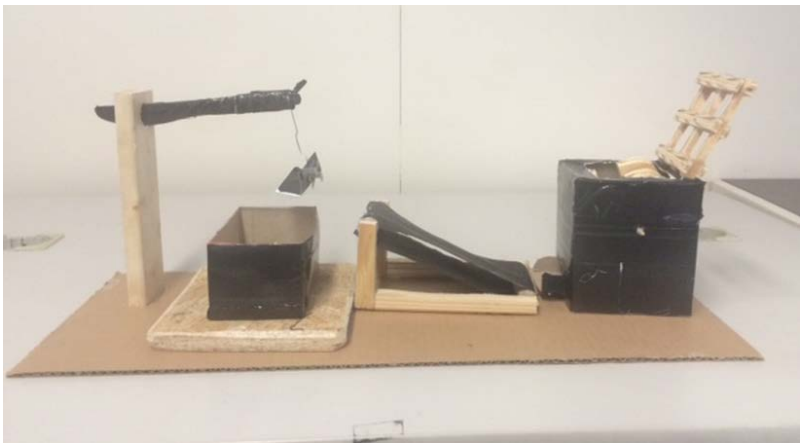

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ArcelorMittal

Abstract:

http://www.personal.psu.edu/ana5215/Project2.pdf

ArcelorMittal, a steel production factory gave us the opportunity to develop a system to reduce the waste generated in the steel production process. There are several types of waste that result in their process, broken wooden pallets, used bricks, and metal barrels. After extensive research, our design group chose to develop a wooden pallets recycling system. The recycling process consist of the following steps. First, grinding of the pallets, then use a magnet to remove the nails from the pallets, and lastly pack and ship the grinded pallets to sell. Our design group believes that our process is the most feasible and environmentally friendly, and would generate an acceptable profit.

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Introduction:

The process of production of steel may result in the generation of waste that can be problematic for the company. These wastes that are produce can take up space, slow down the production process, and cost a company a great deal of money to send to recycling facilities. Thus, companies look to develop their own system/methods of recycling to save money and space. ArcelorMittal is one of those companies. Through their process of producing steel, different types of wastes are generated or produced as byproducts of the process. The three main waste types that ArcelorMittal look to decrease are the following. First are the bricks that are used in the arc furnaces. They break-up in the process and are not usable anymore. Second are the metal drums and totes that are used to deliver chemical products, which is mostly antifreeze. The drums and totes take up a lot of space, and cannot be reused as they need to go through a cleaning process before. And the last are the wooden pallets that are included with almost every shipment they receive. Most of the pallets break during the shipment process and become unusable.

Problem Statement:

The problem is that the Steelton facility of ArcelorMittal has many wastes generated in the steel production process, including wooden pallets, empty drums and totes, and waste refractory brick.

Mission Statement:

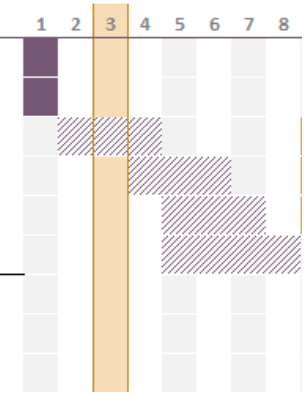
The mission is to design a system to reduce the amount of waste from the steel-producing process that ends up in a landfill. The proposed system will take into account sustainability and economic viability, as well as practicality to ultimately reduce these wastes.

Design Specifications:

- Identify and opportunity for re-use or recycling of waste materials
- Examine all inputs and outputs of the system
- The system should help ArcelorMittal reduce its waste footprint
- The system should meet all regulatory codes
- The system should be economically viable

Table 1. Gantt Chart

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Brainstorming	1	1	1	1	100%
Research	1	1	1	1	100%
concept gathering	2	3	0	0	50%
Design selection	4	3	0	0	10%
prototype/ production	5	3	0	0	10%
final sketch	5	4	-	-	0%



Concepts:

1. Burn pallets – Pallets that are unable to be reused can be given or sold to firms or homeowners that use wood-burning stoves to heat their homes.

2. Grinding pallets/railroad lumber – An industrial grinder or shredder can be used to grind the wood up into woodchips. The woodchips will have staples and nails in them that can be removed with a large electromagnet, and the metal can even be melted back down. The woodchips can be sold as mulch, playground material, kindling, etc. for profit.

3. Melt down steel drums - Steel drums that contain ethylene glycol can be melted down in the furnaces as long as they are cleaned and dried. They would have to be cut up into smaller pieces as well.

4. Crush refractory bricks – The refractory bricks can be pulverized and used as an aggregate. The iron can be pulled off with magnetic separation. Pieces of the bricks can be sold or repurposed.

5. Selling pallets-There are a number of companies that will purchase old, used pallets as long as they can be used again. ArcelorMittal could just ship them off to another company and make a profit.

FIG 1. Burning Pallets Concept Sketch

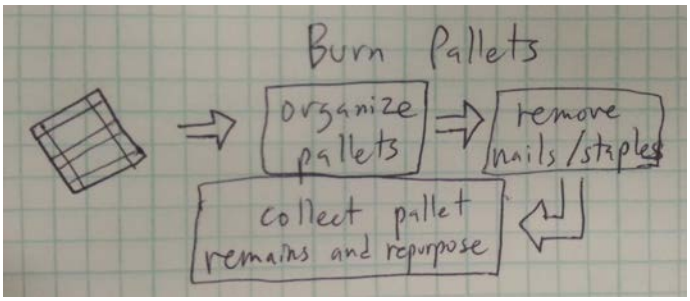


FIG 2. Selling Pallets Concept Sketch

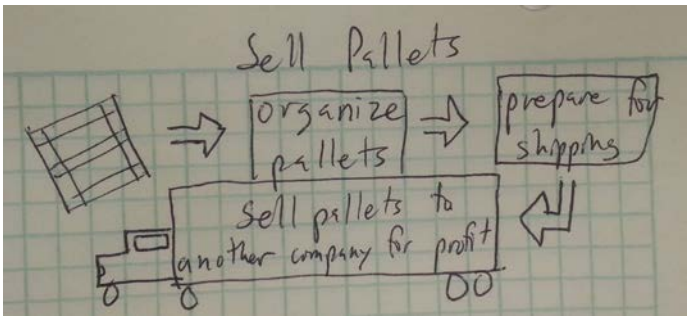


FIG 3. Melting Down Steel Drums Concept Sketch

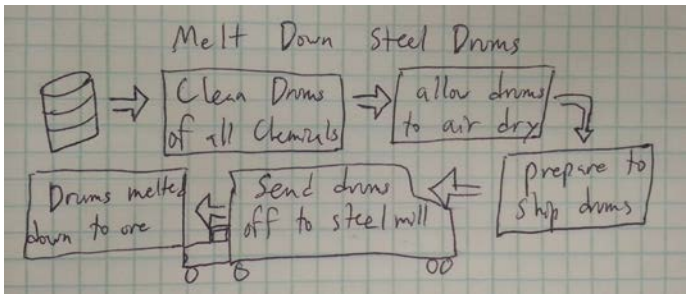


FIG 4. Crushing Brick Concept Sketch

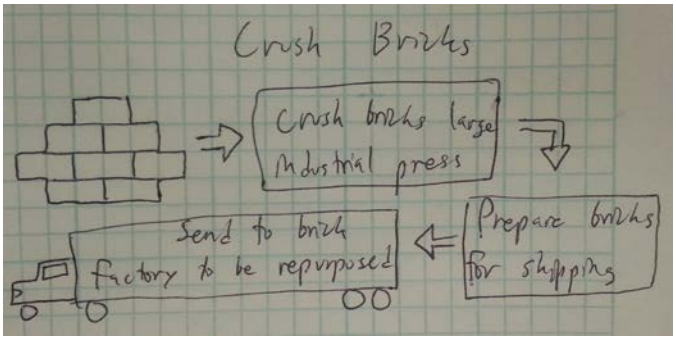


Table 2. Design Matrix 1

			Concepts		
Selection Criteria	**Burn Pallets**	**Grind Pallets**	**Melt Down Steel Drums**	**Crush Brick**	**Sell Pallets (Reference)**
Viability	0	-	+	-	0
Cost Efficiency	+	+	-	0	0
Environ. Friendly	-	+	-	0	0
Labor Intensive	0	-	0	-	0
Overall Sustainability	0	+	+	+	0
Sum +'s	1	3	2	1	0
Sum 0's	3	0	1	2	0
Sum -'s	1	2	2	2	0
Net Score	0	1	0	-1	0
Rank	2	1	2	3	0
Continue?	No	Yes	Yes	Yes	N/A

Concept 1 was not continued because of concerns that wood burning stoves are ruining the air quality, according to the Environmental Protection Agency. Wood smoke contains soot, carbon monoxide, and other pollutants can lead to asthma attacks and even cause cancer. Because of this the Clean Air Board of Central, PA is discouraging the use of wood-burning stoves.

Table 3. Design Matrix 2

		Concepts							
		Grind Pallets		Melt Down Steel Drums		Crush Brick		Sell Pallets to Another Company	
Selection Criteria	**Weight**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**	**Rating**	**Weighted Score**
Viability	20%	2	0.4	4	0.8	2	0.4	3	0.6
Cost Efficiency	25%	5	1.25	2	0.5	3	0.75	3	0.75
Environ. Friendly	30%	5	1.5	2	0.6	3	0.9	3	0.9
Labor Intensive	5%	2	0.1	3	0.15	1	0.05	3	0.15
Overall Sustainability	20%	4	0.8	4	0.8	4	0.8	3	0.6
Total Score			4.05		2.85		2.9		3
Rank			1		4		3		2
Continue?			Yes		No		No		No

Design Concept:

ArcelorMittal gave us the opportunity to choose and develop a recycling system for one of the wastes. After extensive research, our design group chose to develop a recycling system/process for the wooden pallets. Our recycling process consists of simple steps which are grinding the wooden pallets to small wood chips, use a magnet to remove the nails that are present in the grinded wood, and finally pack and sell the wood chips to any companies who are interested. The reasoning that helped us to determine that this process is the best for the company is as follows. First, it is an absolutely 100% “green” process, as there is no chemical change but only physical change of the wooden pallets. Second, our group believes this process is the most feasible.The company only needs to purchase a grinder, which costs about $15,000-$20,000. Also, the company already has electromagnets which can be used in the step of removing the nail. Finally, our design group believes that this process will generate an acceptable profit. That is because the company receives huge amounts of wooden pallets in their shipments. Forty pallets would make about a ton of wood chips, which can be sold at $100/ton.

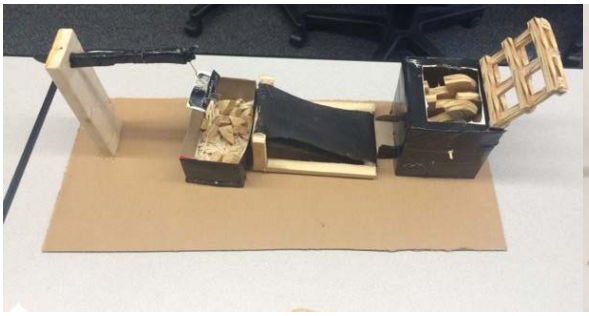


FIG. 5. Prototype

FIG. 6. Prototype Side View

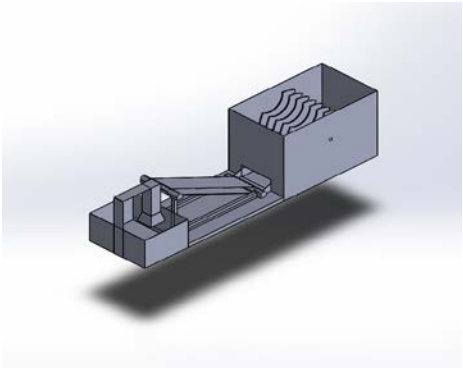


FIG 7. Solidworks Model

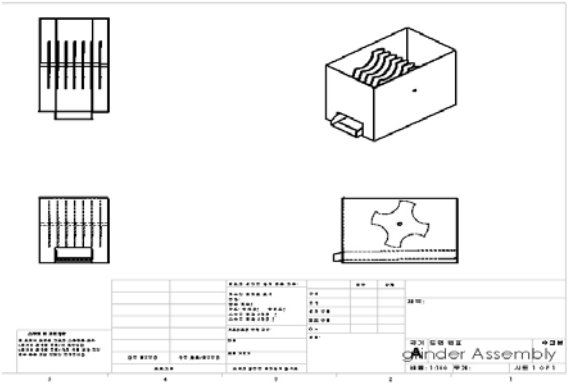


FIG 8. Solidworks Detail 1

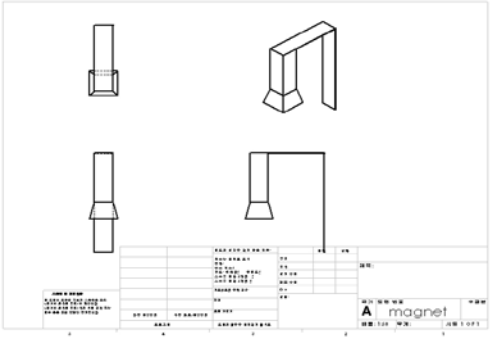


FIG 9. Solidworks Detail 2

FIG 10. Shredder Example

Environmental Analysis:

Essentially, our system will result in almost all of the waste being diverted from the landfill. All the extra wood from the pallets will be converted into wood chips to be used over again and to be sold to another company for profit. The only impact on the environment is the use of energy needed to run the machinery to shred the wood.

FIG. 11. Concept of Operations

Life Cycle Assessment:

Extraction:

1. Order received, and customer information is pulled up which contains pallet measurements and requirements.
2. Trees are cut

Manufacture:

1. The appropriate material is selected and the deck boards and stingers are all cut to fill the order
2. Some secondary process may be applied such as cutting 4-way notches in stringers to allow access from all 4 sides of the pallet.
3. It is assembled using high volume nailing machines that are fully automated are used to mass produce the pallets

Sale:

1. Pallets are shipped to the customer
2. Sold at $7/piece

Use:

1. Steel company uses them
2. They are transported to the area for recycling

Recycling process:

1. Pallets are shredded
2. Nails are removed from shreds using a magnet
3. Final product is sold

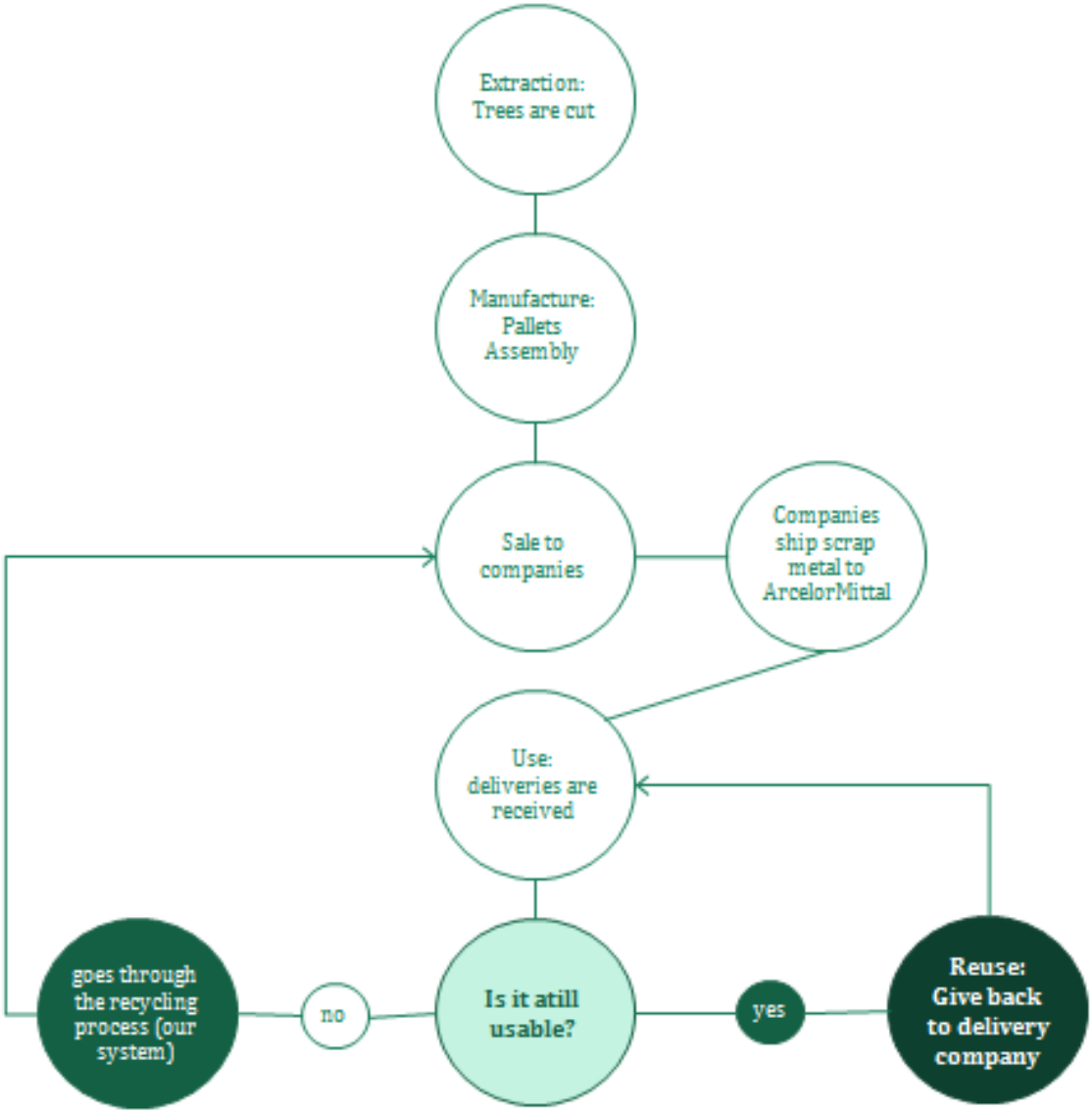


FIG. 12- Life Cycle Assessment

Sustainability: A balance of social, environmental, and economic factors that create the ability to meet the needs of the present without compromising the needs of future generations.

Economic Viability:

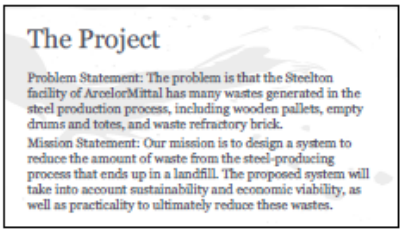
Shredding the pallets is particularly economically efficient. An initial idea was to make the pallets and lumber blocks into specific products such as pellets or mulch. However, having an extra process to refine the wood chips into products not only used up more time, but also required more machinery. This system is designed so that Arcelormittal does not need to spend any money on unnecessary new equipment. The only machinery Arcelormittal needs to buy is the wood grinder with a conveyor belt. The corporation has most of other expensive utilities like the electromagnet. Additionally, just grinding the pallets and lumber into wood chips will give

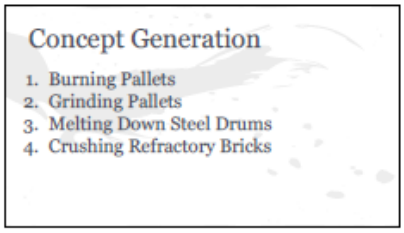
ArcelorMittal more customers. When companies start to refine raw materials into products, they decrease number the consumers who will buy their products. Simply grinding the residues to wood chips will let ArcelorMittal to not worry about having leftovers since variety of factories will buy the wood chips. This system is definitely profitable. It requires some startup investments, but with in couple years, all the beginning costs will be covered. About 40-50 pallets will make a ton of wood chips that can be sold for 100 dollars. They can use the nails and staples to make more steel with their utilities they have.

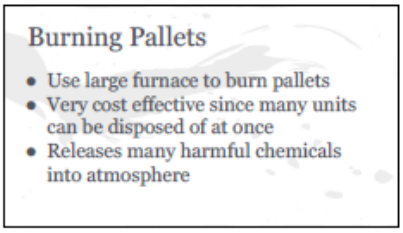
Conclusion:

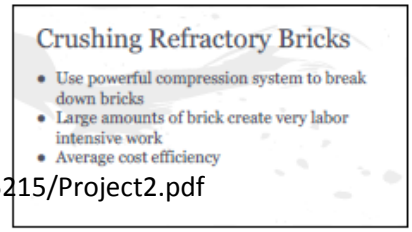
ArcelorMittal is a company that strives to make a positive impact on the environment. Since they are committed to helping the communities and areas around them, our team believes our design is well in their interest. Our recycling pallet system would remove a 100% of the waste that would normally go into a landfill while also resulting in a decent profit. The system itself would be fairly easy to implement since the Steelton facility already has an industrial sized magnet. All that would be needed would be a wood chip shredder which could be payed off easily over time with the selling of the wood chips. Our design is economically viable, sustainable, and most importantly environmentally friendly which is why ArcelorMittal should pick our design.

Presentation Slides:









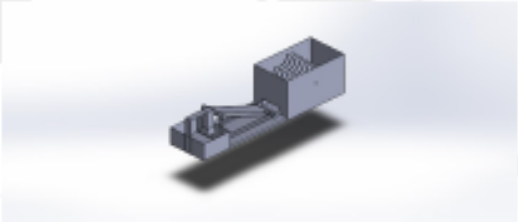
http://www.personal.psu.edu/ana5215/Project2.pdf

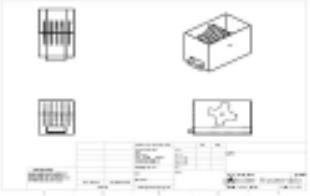
Selection Criteria	Burn Pallets	Grind Pallets	Melt Down Steel Drums	Crush Brick	Landfill Reference
Viability	0	-	+	-	0
Cost Efficiency	+	+	-	0	0
Environ. Friendly	-	+	-	0	0
Labor Intensive	0	-	0	-	0
Overall Sustainability	0	+	+	+	0
Sum +'s	1	3	2	1	0
Sum 0's	3	0	1	2	0
Sum -'s	1	2	2	2	0
Net Score	0	1	0	-1	0
Rank	2	1	2	3	0
Continue?	No	Yes	Yes	Yes	N/A

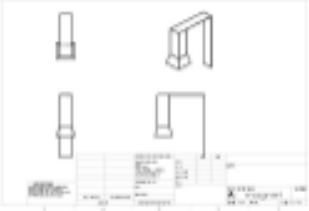
Design Concept

The design requires a wood shredder that would grind the pallets up into chips. The ground up wood would then move down a conveyor belt and be separated from the nails with an industrial magnet.

Prototype Model







Cost Analysis

- $15,000-$20,000 for shredder
- Woodchips sold at $100/ton
- About 40 pallets make a ton of woodchips
- ArcelorMittal already has electromagnet

http://www.personal.psu.edu/ana5215/Project2.pdf

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