

EDSGN 100: Introduction to Engineering Design
Penn State College of Engineering 2015
Waste Stream Reuse and Recycling Project
Sponsor: ArcelorMittal



ArcelorMittal

Design Project II “From Pallets to Gardens”

Section 10

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Abstract

Pallets are a common wooden product that industries and companies expend at an astounding rate when it comes to shipping, transporting, and storing manufactured products. ArcelorMittal, one of the largest steel-producing industries in the world, has a steelmaking plant located in central PA called Steelton. ArcelorMittal, as the mindful company it is, requested Penn State's College of Engineering to give Engineering Design 100 Spring 2015 Students the opportunity and task to form a system solution to their pallet waste problem. This was in finding the best way to convert the material into other uses with the environment and economy of the company in mind. The following technical report exhibits a carefully researched and designed system solution to the concern at hand. It involves the translation of lumber waste into biodegradable product that holistically improves and advances the Steelton plant with its steel-producing needs, its relationship to other industries, involvement in global efforts, and its impact on the environment.

Introduction

What is waste? What are its implications? How can waste be turned into usable material? These are the main ideas considered for the development of this project. The main purpose is to find a way in which an ArcelorMittal steel mill named Steelton can solve its current problem of accumulating, unusable wood pallets that are considered to be waste. Before developing the idea, sustainability and waste are two terms that need to be defined in order to come up with the best solution for the waste accumulation problem. According to the Merriam-Webster dictionary (2015), waste is defined as "loss of something valuable that occurs because too much of it is being used or because it is being used in a way that is not necessary or effective." Waste is usually diminished if with sustainability. Sustainability is the longevity and durability of a system or process, or a network of systems and processes working together to sustain natural resources, advance the economy, shape politics, and even develop human culture. ArcelorMittal wishes to create a more sustainable way to handle its waste. Now, it can be seen that the main purpose of this design project is to find a way for broken or inoperative pallets of ArcelorMittal's Steelton plant, so they can be used for the benefit of the company, the environment, and economy.

Problem Statement:

The problem is that ArcelorMittal Steelton disposes a large amount of wooden pallets during their steel-making process. The ineffective pallets accumulate at a fast rate and there is not an efficiently-implemented way to handle the lumber waste.

Mission statement:

The mission is to devise a system that reduces the waste of wooden pallets and other lumber material. The solution must aim to be an efficient, safe, and cost-effective manner of disposing and reusing the waste as useful resources. It is essential to focus

on finding alternative uses for the wasted lumber so it can be reused as new forms in the end of its lifecycle. In this way, external systems such as other industries, surrounding communities, and environments would benefit as a whole.

Design Specifications:

The goal is to create an opportunity to reduce ArcelorMittal's waste footprint. To do so, they require an established solution that meets all applicable requirements. The design solution must be economically viable so that it will be worthwhile and profitable to Steelton, and ArcelorMittal overall. It must be mindful of all the possible inputs and outputs such as labor, waste, raw materials, time, and investment. Lastly, the system must be beneficial to the industry and the environment as a whole.

Table. 1: Gantt Chart

TASK	4/3/15	4/6/15	4/13/15	4/15/15	4/20/15	4/22/15	4/27/15	4/29/15	5/01/15
Information gathering/ brainstorming									
Brainstormin /Concept Selection									
System Diagram /Concept of Operation									
Life Cycle Analysis									
Assessment of viability aspects									
Prototype building									
Formal oral presentation /class competition									
COE Project Showcase Spring 2015									

Rationale for Opportunity Identified

ArcelorMittal would be extending the life cycle of their materials, which means the process becomes more efficient and less waste is produced. The shredded product could be sold to other companies to create some income, therefore the price of buying new pallets slightly decreases. The benefit however, is not only economic. They will be helping the environment in several indirect ways: slowing deforestation, extending the wood's life cycle, and decreasing the pollution to the environment.

Conclusions from Research

As ArcelorMittal plants use pallets to store and transport steel blooms, billets, and slabs, they quickly go through a large amount of wooden pallets as they produce and transport steel on site. It seems that a large sum of money is wasted by the plants for not efficiently getting rid of wasted lumber while purchasing the input they get it from. (eg. the Bissen branch was paying to get rid of wooden wedges that came with the shipments of wire coils while purchasing new wedges to package their new products). The pallets may go through a similar wasteful process. This behavior has already been altered to reduce the waste of the wooden wedges, as they are currently "recovered and reconditioned on site"; there must be a similar reusing method applicable to the wooden pallets. Since waste management policy is stated to include the recycling of wooden pallets and reusing of wooden reels, the brainstorming process must include a careful consideration of alternative materials the pallets can be used for, or even initially made from.

Corrugated or plastic pallets could replace the current pallets, as they reduce freight costs, have high load capacity, and use less material—making them thinner and lighter. Apparently there are 5 basic parameters for pallet sustainability (depending on the application): "strength, stiffness, durability, functionality, and purchase price". If many of these pallets are crafted at individual plants where they are needed, they won't have to be re-produced much in the future because metal pallets last a long period of time.

This segways into the thought to eliminate wooden pallets altogether and utilize alternative pallet materials such as plastic and metal. Remaining wooden pallets would be disposed and recycled in an appropriate manner, and plastic or metal pallets would take the place of the less-effective wooden pallets. Plastic pallets made from the most appropriate polymer and shape would be less disposable. Using metal pallets is most questionable though, whether they are made of steel, carbon steel, or aluminum. Since these types of pallets would be reusable for a longer period of time they would be categorized as "returnable packaging".

Metal pallets can be made of steel, carbon steel, stainless steel, and aluminum. Steel is strong, good for heavy or high-stacking loads, long term storage away from moisture (dry storage), and rough handling. It's commonly used for military ammunition. Carbon steel has the best durability for lowest cost, but its very expensive compared to wood. Stainless steel does not require a paint coating, and its commonly used in sterile environments. Aluminum is lighter but just as durable as steel; it resists rotting/plastic creep/corrosion from the weather, is good for long term outdoor or at-sea storage. This could be ideal for outdoor areas of ArcelorMittal plants. Stainless aluminum is 2-3x more expensive than carbon steel.

When it comes to metal pallets as an alternative to wood, the long-term costs would only be lower on large scale implementation, so a switch to metal material is out of the question for one facility, Steelton. Overall, a few metal pallets could be used elsewhere with their high strength, stiffness, durability, absence of bugs, splinters; they are sanitary and recyclable. They also have much higher weight, are more slippery (less friction), may rust (ie. carbon steel), and are not expendable like wood. Unfortunately compared to wood, these types of pallet materials would yield extreme costs and they are not the most suitable for the rough use in the steelmaking industry. It would be too much of an investment for ArcelorMittal to uptake alternate pallets. It might even make sense for the plant to create their own metal pallets from their lower-quality scrapped steel, since it is already producing steel, but in reality this would be out of scope, extremely expensive. The company would probably go into debt from the initial capital spend on these pallets.

Pallets of these alternate material are price competitive. Sectors that currently use metal pallets include the automotive, pharmaceutical, lawn tractor, motorcycle, and tire industries where they are much more appropriate for controlled, clean, intricate environments. To conclude non-wood pallets are not ideal for the steel industry needing them at their disposal. It became quickly eliminated as a solution concept.

Concept Generation

Brainstorming Ideas

Instead of being scrapped, the current wooden pallets can be sent to other companies and consumers for endless uses. Possible recycled products or uses of the pallets may include wood shavings, wood chips firewood, fuel, or converted to mulch, furniture, garden stakes, craft wood, wooden structures (temporary pre-structures for architectural and art projects), modern art, compost, and biomass reactors. The conditions of the pallets could be classified into three categories that would yield different recycling techniques and outputs: (1) rotting pallets (that contain bacteria, fungi, or termites, as a result of moisture), which could be shredded in a designated machine and sent through

a composting stream, (2) pallets with strips that are broken beyond repair can be shredded in their own machine into mulch for uses that require decent wood (no rot)--such as wooden strips, shredded wood-chips, or mulch--and (3) pallets that aren't entirely dismantled but have been used enough in the mill. They could be treated and converted into other uses such as furniture, etc., (eg. 1001 ways to reuse pallets).

Thought Process Leading to Final Solution

The initial idea of shredding wood for multiple uses was the basis for our final solution. Using an assembly-line-like procedure, the lumber would be separated. In order to guide the separation, specialized laborers would be in charge of determining which wood is suitable for reuse after treatment, and which is considered to be complete waste. "Waste" lumber would go through a different stream into a shredding process. The resulting wood particles would later be allocated for a specific use, other recycling process, or a multitude or combination of recycling and producing.

To be more specific, both the "suitable" wood and "waste" wood must have any metal debris extracted from it. The idea was originally for only the unsuitable wood to be shredded and rolling magnets would remove its metal contaminants, while the other, better wood, could be kept intact and strong plate magnets would remove metal debris. After that, these varied pieces would continue on a conveyor, onto a new separation stage, in which different sizes would be mechanically separated. Depending strip sizes, they would be stacked into designated containers according to size. After that, a wood hardening treatment would allow this wood to be usable again. The removed metal debris would then be recycled by melting down. It turns out that this was not fully the best solution because of the effort and investment to remove nails indefinitely.

Instead, the final design utilizes the same idea as just explained except no pallet separation would occur. The facility already identifies its unwanted pallets and all of those will go into the same waste stream without distinction. The pallets can be piled up close to multiple shredders. There would only be one conveyor belt with a moving band segment that facilitates feeding the machine. This waste would be converted into mulch that can be used on the land property for the flower beds and landscaping around the facility itself, or for public landscaping in the local Harrisburg community and compost needed for farms.

Since mulch beds continuously disintegrate into the soil there is an ongoing process of adding more mulch periodically as it continues to decompose as part of a natural biodegrading process. Wood as an organic material would contribute a significant amount of organic matter and nutrients to soil, benefiting essential microorganisms and fungi while decreasing plant diseases. This natural mulch would improve moisture retention, decrease compaction, and retain important soil organisms such as

earthworms. Depending on the climate and kind of mulch, the decomposition duration is about one to four years, which is a very fast process of break-down.

It is important that the pallet wood converted into mulch is confirmed to no longer have chemicals or pesticides that would be damaging to the environment, the health of the soil and organisms in it. If these chemicals expire by the time the wood results as mulch, then it is fine to use. But if not, they would have to go through a process of expiration. It must be better to do this instead of spending money on more chemicals to, further polluting, in order to neutralize the existing pesticides and preservative chemicals that were initially used to treat the pallets. Luckily, the wood used from the railroad cars is stated by ArcelorMittal as not “pressure treated, heat treated, or otherwise chemically treated”--so it can be assumed not to be contaminated with toxic substances.” This means that this wood is safe to use, meanwhile the pallets may have come from anywhere when imported to the plant, so the facility must determine whether they were chemically treated or not.

A critical factor to consider is if these pallets were previously treated from invasive species, such as bugs from China. If they are used to import raw materials to the locations in the USA, they must be strictly recycled within the plants in the USA, as in, stay within the overseas country or same country (USA) before being reused again. It is a waste of time, money, efficiency, and labor, for these pallets to be exchanged and treated repeatedly, wasting with more chemicals. This again creates unnecessary pollution. It would be best to treat these pallets once and keep re-circulating them within the USA, such as in the Steelton plant. Hopefully this is only an issue if ArcelorMittal does not know if the pallets are foreignly treated in the first place.

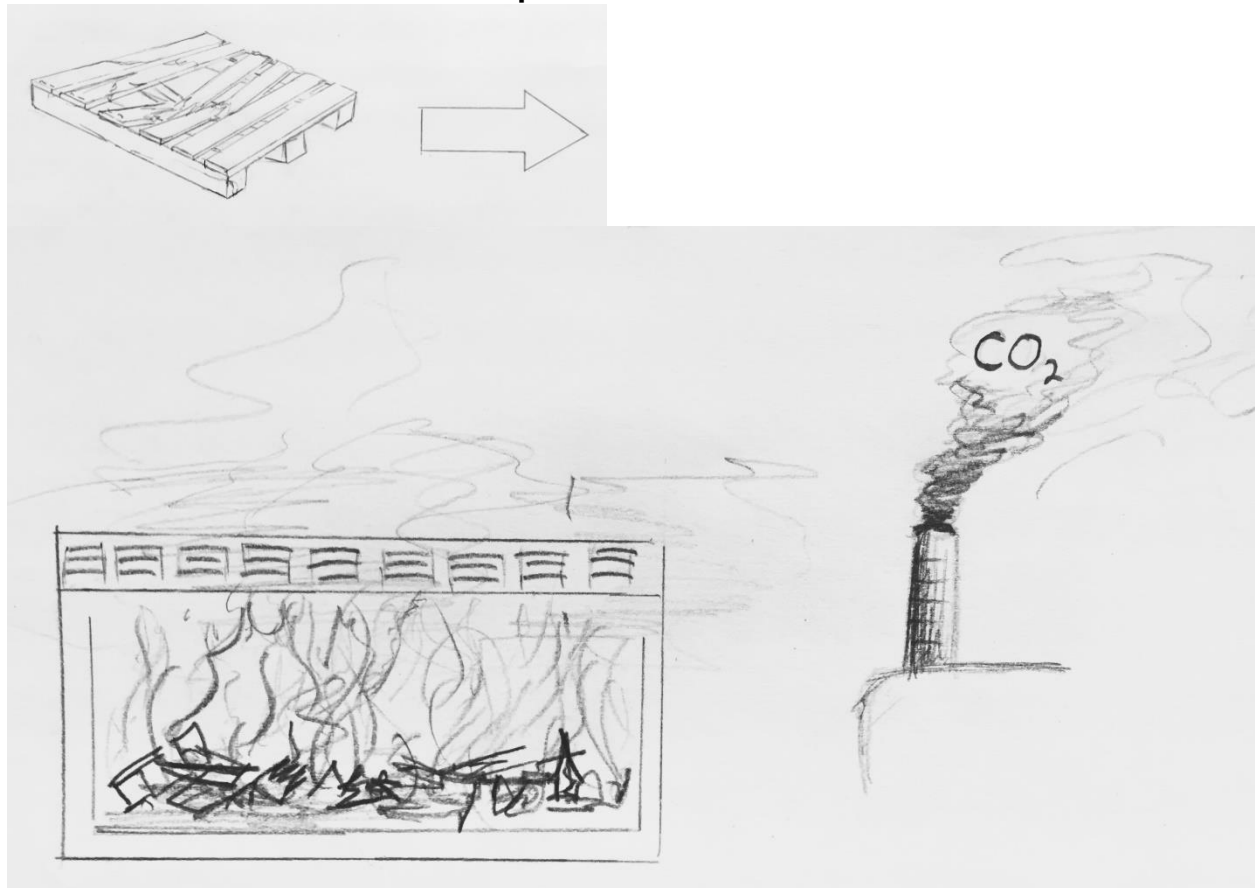
Back to the pallet recycling stream, the shredding process would require the use of magnets to collect the metal debris, which would make the most sense introduced AFTER the wood is shredded. There are specialized types of mulch shredders that can handle nails and metal pieces passing through with the wood being shredded. Besides mulch for outdoor landscaping, this shredded wood can be directly used to produce particle board and plywood by other companies, if ArcelorMittal’s Steelton plant would prefer not to produce this themselves. In that case, it could be sold or exchanged for materials with other companies that would like the mulch for particle board/plywood, or other ArcelorMittal sites that already produce these. There are plenty of companies in Pennsylvania that participate in the exchange of wood compost materials such as Mulch Works Recycling Inc., located in Delaware County, PA.

Having other uses for pallet components such as furniture and other creative projects, should be eliminated as an option. Why? Because if there are large enough pieces to be used for other projects then they must be good enough to re-build custom pallets on

site to be used over again. Steelton currently does this process of recovering pallet pieces large enough to re-make pallets. If some wood strips are too small, then yes, they may be used for small domestic creations in the home or office, or end up being shredded instead. Before this happens, consumers cannot blindly be offered scrap pallet wood that may contain carcinogenic substances from shipments or from being in the plant--they may have been treated with toxic chemicals for insecticides, weather resistance, or contain steelmaking byproducts; in that case they are NOT for domestic use unless certified. An inspecting process would be needed for this and it may not even be worth the company's efforts to send pallet waste into this type of recycling stream, since it is relatively small scale.

Eventually this process of thoughts and elimination led to the creation of 6 general system design solutions that overlap in some ways to form the final solution. The following are the concepts generated for how to recycle pallet waste and gain a utile output/product from the recycling process:

FIG. 1. Incineration or Fuel Concept Sketch

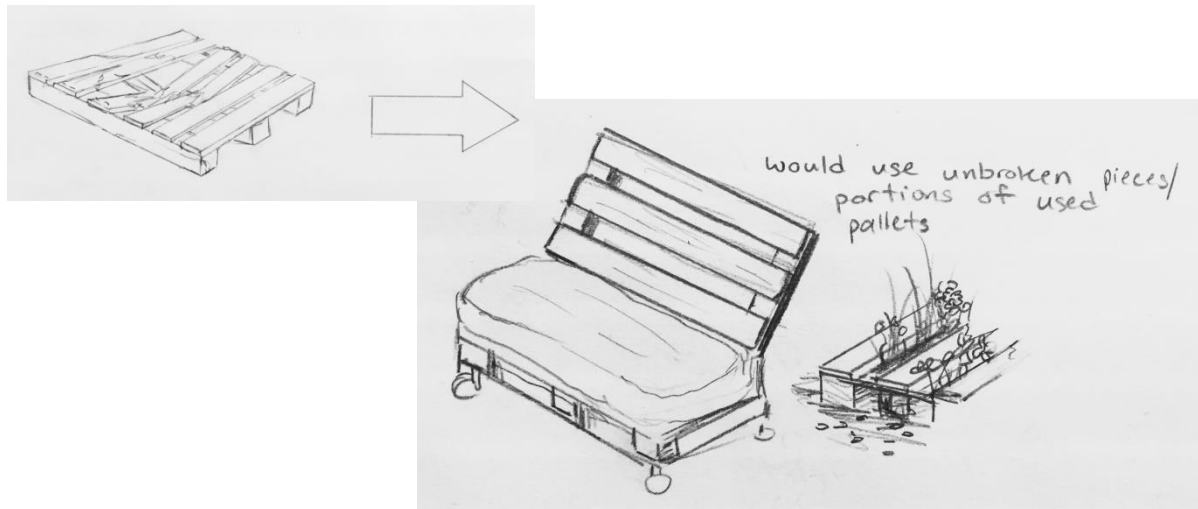


A – Incineration or Fuel

One of the most old-fashioned methods used to eliminate wood waste is to simply burn it and use it as fuel. ArcelorMittal also specified that they already have their employees take home the waste lumber to use as firewood in their homes. It may seem like a fast,

disposable way of removal, but it yields the most detrimental consequences to the environment and the atmosphere—encouraging deforestation and greenhouse gas emission. Plus this wasted wood has numerous alternative uses. When it comes to fuel, incineration would not supply sufficient energy for the plant's enormous energy needs to produce steel. Overall, it would be a wasted effort to burn such large amounts of wood that barely create enough energy for Steelton.

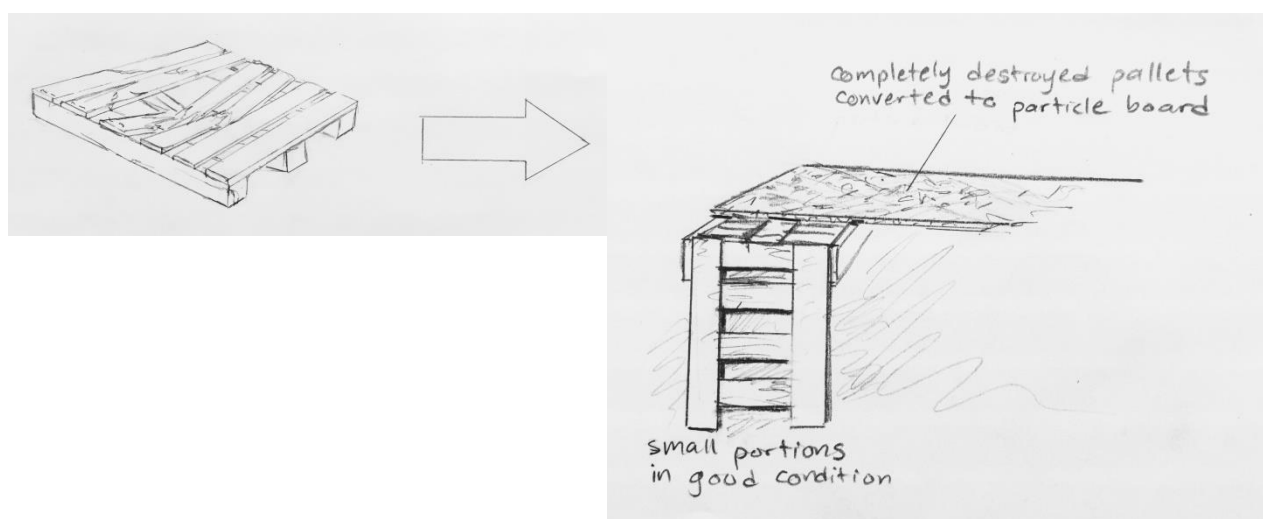
FIG. 2. Domestic Project Concept Sketch



B – Domestic Projects

Pallets that are broken beyond re-use for the plant can actually be broken down into smaller components for personal projects and domestic use. Employees could take pieces home that are appropriate in size for small-scale construction, DIY projects, woodworking, and even art. The waste output would become a creative and satisfying input for people employees and people involved with Steelton to produce their own small outputs. Unfortunately, pallets may not be the ideal wood material to be used for domestic use. They may even be possibly dangerous to users if they have been chemically treated (in this case only the wood used for the railcars is known to be safe). In addition, the consumption of the waste is not very efficient since it would take long for Steelton to rid the pallets in this manner.

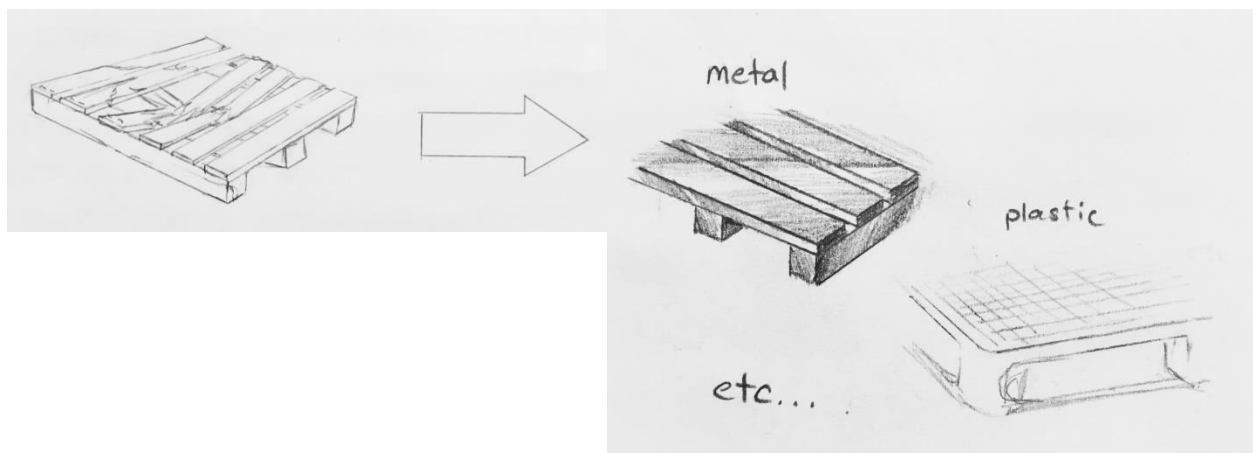
FIG. 3. Larger Construction Concept Sketch



C – Larger Construction

Another similar waste stream for the used pallets could be for any construction at plant sites. A trained inspector would be able to identify which pallets would be suitable for domestic applications versus site use. Small pieces of wood can be derived from broken pallets and converted to particle board and temporary construction fixes within or around the plant. This benefits the facility itself, but the plant may have no use for wood structures in a steel mill, or the ability to make such structures.

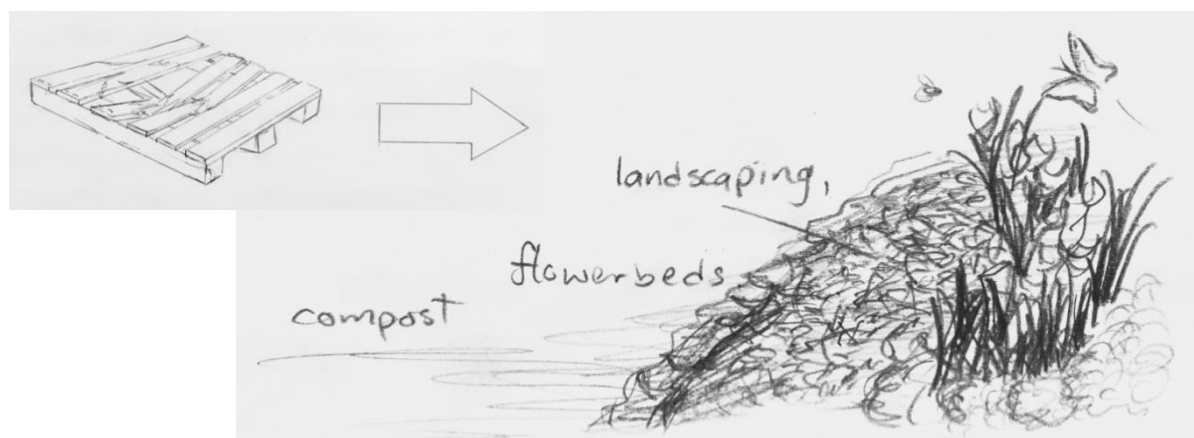
FIG. 4. Returnable Packaging Concept Sketch



D – Returnable Packaging

Returnable packaging is one of the most financially depleting investments ArcelorMittal could consider. Plastic and/or metal pallets could be used in lieu of classic wooden pallets, but may yield high costs for the company. Unfortunately, it is clearly stated that the items Steelton purchases from manufacturers cannot be returnable, but if they collaborated with these manufacturers to consider new versions of packaging, this negotiation could result in a lifecycle cooperation. They would be re-using longer-lasting pallets of new material together.

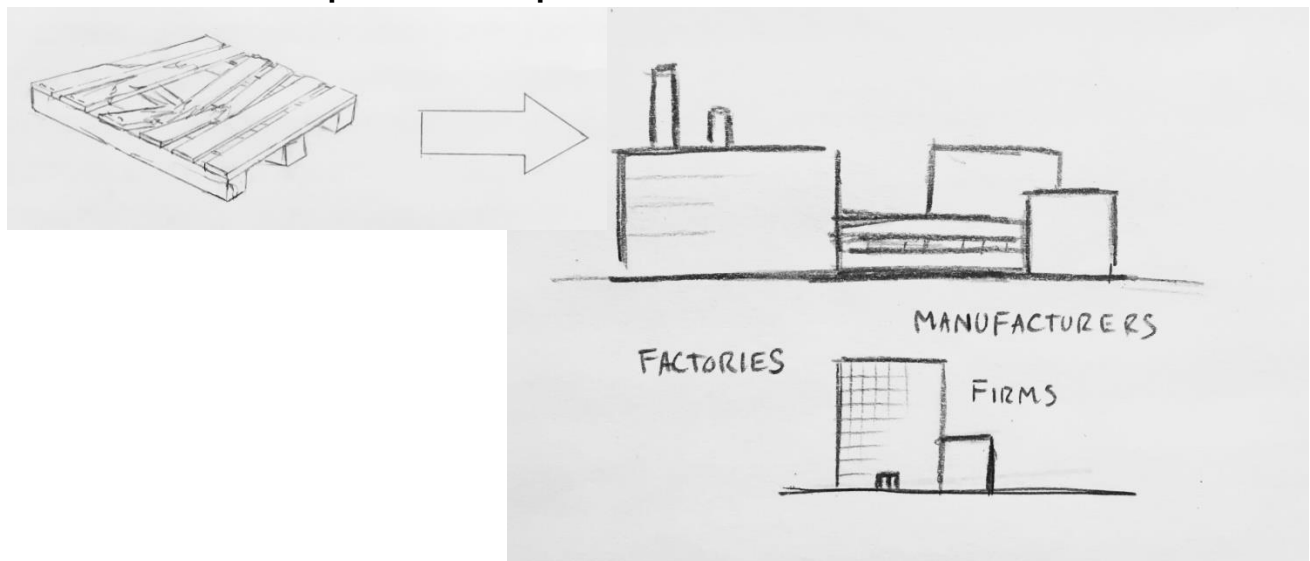
FIG. 5. Biodegradable Product Concept Sketch



E – Biodegradable Product

The solution chosen to be the best would be converting the pallets into mulch to create a biodegradable environment around the plant and in the local area, and/or to be used in creating new wood materials. This would be a fast and effective way to intake broken pallets, regardless of wood condition. Others may argue the disadvantage that this process would require inspection to determine if the wood is safe to use on the site or for the environment. Fortunately, Steelton claims that their railcar wood is free of any chemical treatment. When it comes to creating facility may not have the ability to create its own particle board and plywood, so it would have to sell the original mulch. Would pallets treated in the past kill important insects and animals of the surrounding ecosystem? Steelton employees must establish whether insecticides or treatments were used on foreign pallets from other manufacturers. An assessment would need to be made to confirm that any chemicals have expired and pose no potential harm to the environment.

FIG. 6. External Companies Concept Sketch



F - External Companies

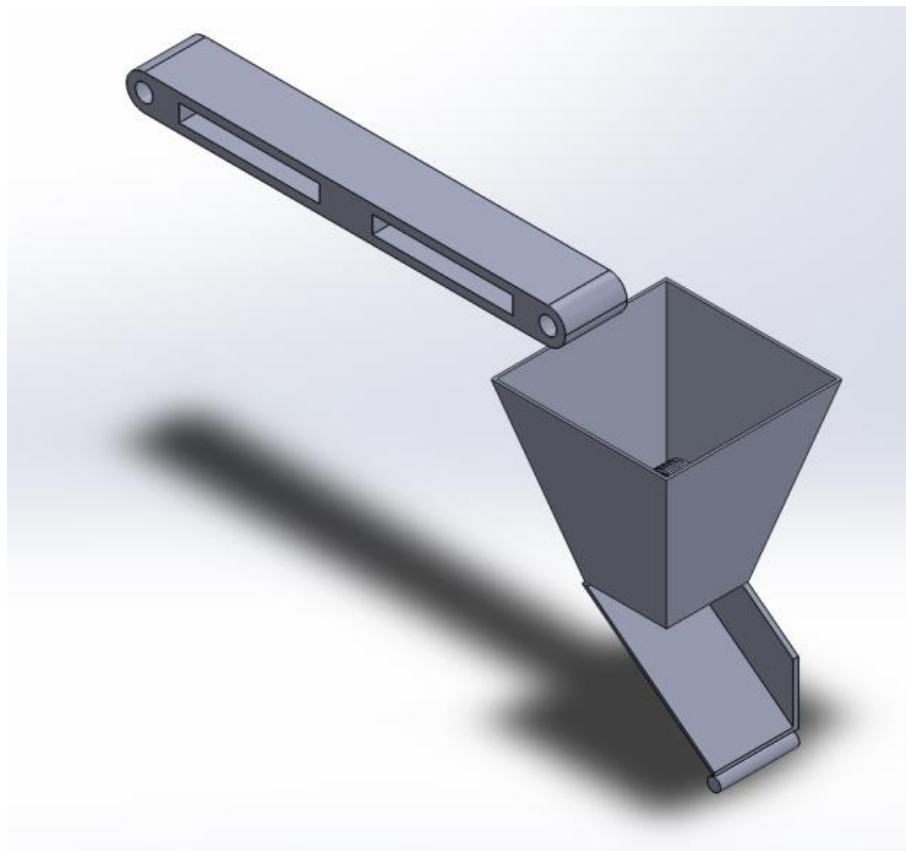
The last possible solution would be for ArcelorMittal Steelton to export the wood waste to external industries. This is based off of the chosen solution in that the wood chips from shredded wood waste would be sent to companies that use this material for multiple uses. Since it is considered as waste for the steel industry, the original waste would even be distributed for free if the external manufacturers take care of the entire recycling process. This idea can be highly unrealistic since other manufacturers (such as mulch-making companies) may not prefer to purchase wood waste from a steel company.

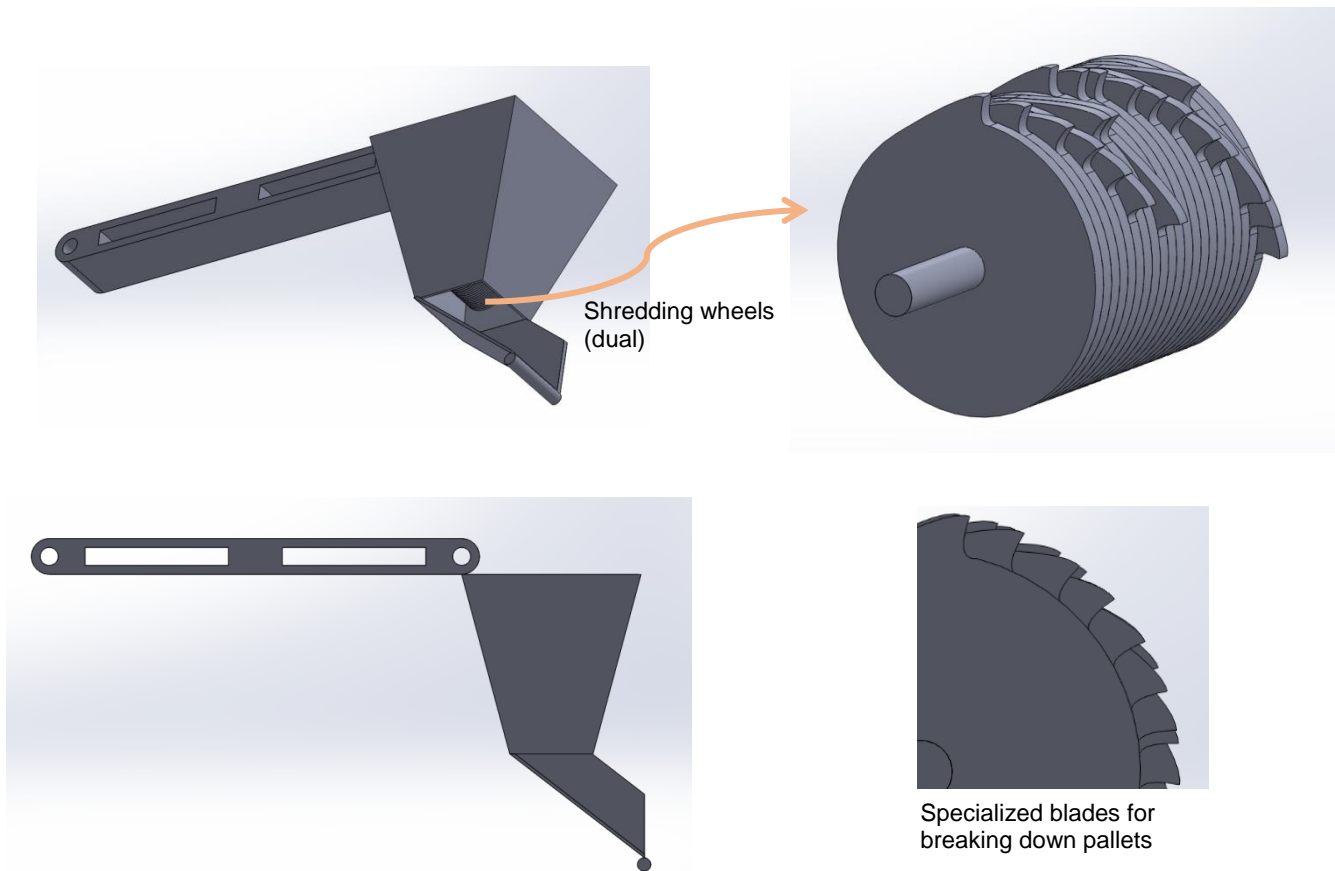
Table 2. Decision Matrix

		Concepts											
		A		B		C		D		E		F	
		Incineration or		Domestic		Larger		Returnable		Biodegradable		External	
		Fuel		Projects		Construction		Packaging		Product		Companies	
Selection Criteria	Weight	R	W	R	W	R	W	R	W	R	W	R	W
Sustainability	5	-	-5	0	0	0	0	+	5	+	5	+	5
Efficiency	5	+	5	-	5	-	-5	+	5	+	5	0	0
Environmental Consciousness	5	-	-5	0	0	0	0	0	0	+	5	0	0
Energy Use	5	-	-5	+	-5	0	0	0	0	+	5	0	0
Lifecycle Length	4	-	-4	0	0	0	0	+	4	+	4	0	0
Economic Viability	4	-	-4	-	-4	0	0	+	4	0	0	+	4
Overall Investment Cost	4	+	4	+	4	0	0	-	-4	0	0	0	0
Low Expense of Materials Needed	4	+	4	+	4	0	0	-	-4	-	-4	0	0
Disposal & Re-use Simplicity	4	+	4	-	4	-	-4	-	-4	-	-4	-	-4
Effect on Surrounding Community	3	-	-3	+	-3	+	3	+	3	+	3	0	0
Less Required Labor	3	0	0	0	0	-	-3	-	-3	-	-3	-	-3
Space Occupancy	3	-	-3	+	-3	-	-3	0	0	0	0	0	0
Possible Revenue	2	-	-2	-	-2	0	0	+	2	+	2	+	2
	Sum +'s	4	17	5	17	1	3	6	23	7	146	3	11
	Sum 0's	1	1	4	4	8	8	3	3	3	3	8	8
	Sum -'s	8	136	4	14	4	15	4	15	3	11	2	7
	Net Score	-4	-119	1	3	-3	-12	2	8	4	135	1	4
	Rank	6		4		5		2		1		3	

The Final Design

FIG. 7. (5 sub-figures) Shredding Processor SolidWorks Model





Initial Disintegrating Process

The final design is less stemmed from the idea of an assembly line type system, but more resemblant of a recycling stream. Ineffective pallets and other waste lumber would first be identified through overuse, the same way Steelton personnel currently identify and confiscate exhausted pallets from the rest. All of these would be transported to one of multiple recycling stations. No matter if the pallets are completely mutilated or in a few intact components, all will be placed onto a conveyor belt that would gradually bring the lumber to a wide chute that intakes the wood components. The chute would feed into a shredder and exit the other side through a duct that guides the wood chip particles past a rolling magnet. This rolling magnet would remove the nails, staples, and remaining metal debris from the wood particle mixture. It spins so that the ferrous material is scraped off, dropped into an adjacent container separate from the area the wood chips would reside in.

---Prototype Images on following page---

FIG. 8. Design Prototype Image (Symbolic Physical Representation of Process)

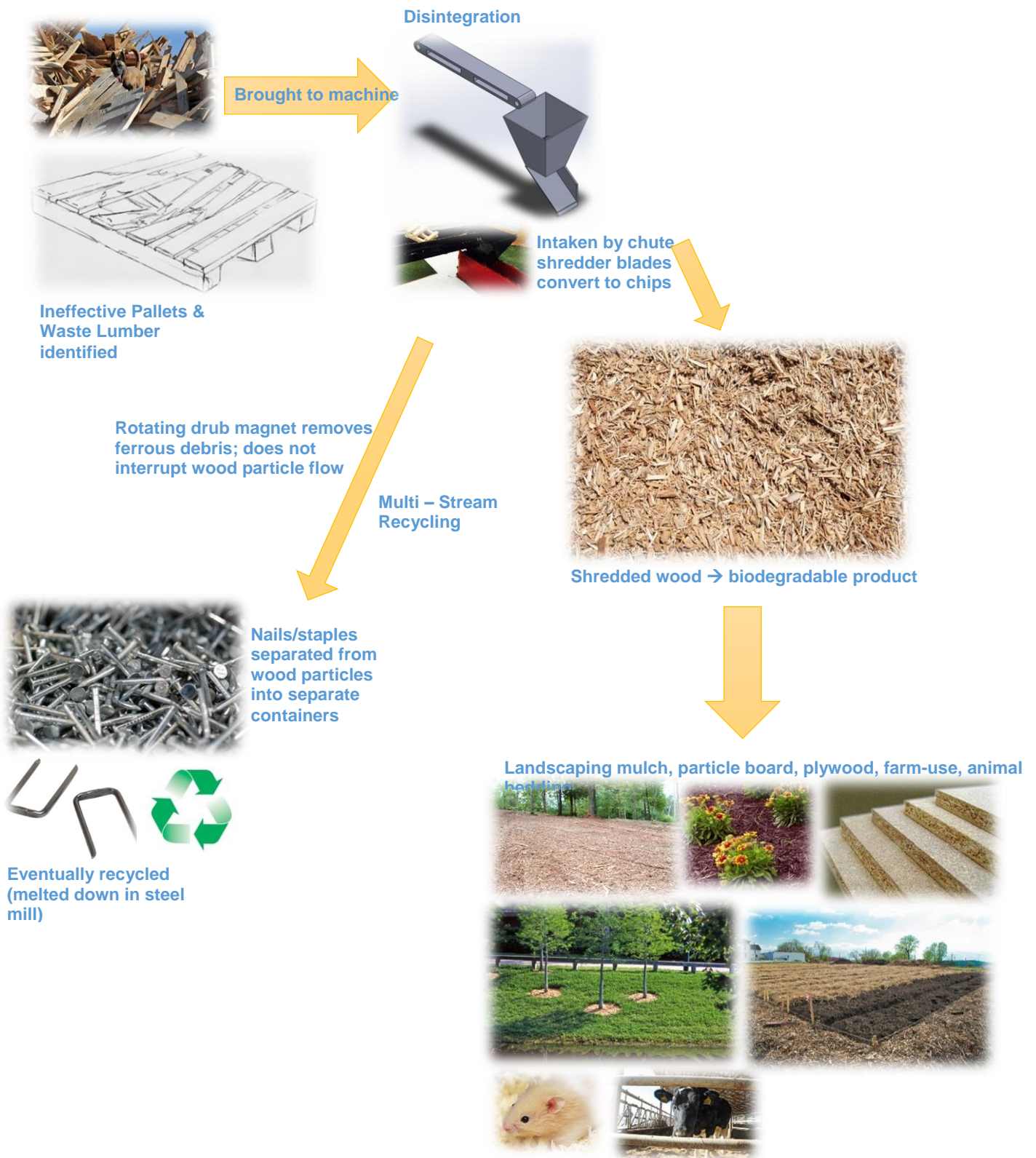


Recycling Streams that Follow

After this process, the shredded wood will be used for different purposes. Since this is a design of a whole systematic process, not just a contraption, the pallet waste in the end serves as a usable material that Steelton can either profit from or simply utilize independently for good purposes. This system will not only benefit the company, but also the environment and local community since it will follow a path of multiple recycling streams. Nearly all the shredded wood product produced would serve as material input for biodegradable product that is replenished at a fast rate. This is one of the best ways for wood to be re-used since it extends the life cycle of wood as a raw material, as waste quickly accumulates and decomposition occurs quickly.

--Final System Flowchart on following page--

FIG. 9. Final System Design Flowchart



Particle Board, Plywood, and other Applications

Particle board, plywood, and animal bedding are some major products that can be directly made from wood chips. Steelton may have the option of manufacturing their own particle board and plywood for construction purposes if they consider sending the chip material to other branches of ArcelorMittal that have the ability to intake the material and send it back in the form of construction wood. When it comes to creating derived construction material, the facility or other branches may not have the ability or finances to produce their own particle board and plywood from the wood chips. Steelton would therefore have to sell the chip material to other firms that intake that as a material for their own processes. Another interesting use for the wood chips would be animal bedding. Wood chips should be simple to directly used for this purpose, requiring minimal converting effort other than transport. Pennsylvania has a significant amount of farmland and this would prove to be a great material to be used on the floors of barns that house cattle and horses. Farmowners would gladly accept and purchase any wood compost they can somehow utilize. Even further, can be used as cage litter you see lining the base of rabbit, mice, and hamster cages. In this case, another client would be pet supply manufacturers.

Safety and Unwanted Contamination

Others may argue the disadvantage this process would require inspection to determine if the wood is safe to use on the site or for the environment. Fortunately--as mentioned earlier--Steelton's wood from their railroad cars is not chemically treated. But would pallet lumber with past treatment contain harmful substances that kill important insects in the soil and harm animals of the surrounding ecosystem? Would it be appropriate to introduce this wood product to the living space of pets and farm-life? Steelton employees must establish whether insecticides or treatments were used on foreign pallets from other manufacturers. An assessment would need to be made to confirm that any chemicals have expired and pose no potential threat to the environment.

The Major Stream Result: Mulch, an Essential Landscaping Material

The wood chips would be directly used as mulch that would provide landscaping to the surrounding land of the Steelton plant. Applying mulch beds to tree bases, flowerbeds, and woodsy regions of not only creates a healthier land and atmosphere surrounding the plant, but also for neighborhoods and the Harrisburg community around the plant. It also contributes to forming a more aesthetically pleasing land around the plant, which is visually therapeutic and beneficial to humans as residents of the region or employees of the plant.

Thus, it can be seen that with this multi-stream recycling system, ArcelorMittal will be able to solve the wooden pallet waste problem with a very environmentally-conscious and economically stimulating solution.

--Analysis on following page--

Analysis

The operation system proposed will work in the following way in terms of the amount of work and material needed, and how the current operational system will be affected by the new proposed system. The amount of pallets that the company is currently using will remain the same. However, there will be a change in the amount of waste the company currently has. This change in waste will be close to 100%, (but realistically 98%) meaning that this waste will virtually nonexistent in the facility. It will be used for novel purposes that will bring waste to use. The wood is going to pass through multiple steps or stages up until it gets completely shredded with no residues (nails, staples, or other metal particles). Once shredded, there are going to be three different uses for this wood with the following distribution of material per use:

1. Wood chips: 40% of the shredded wood will be used as biodegradable product: mulch for landscaping surrounding site and the local community, animal bedding (pet cages, agricultural use, farm use)
2. Sellings: 30% determined to be sold as raw material for other companies that need wood chips to manufacture their products. In this case, the company will make profit out of these sellings. This retail will be reflected when they purchase new pallets since the amount of money needed for them will turn out to be less, as some of it will be covered by the profits made from selling shredded wood. Moreover, this will increase the amount of money that can be invested for the development of the company, which in the long term will make the company to increase its production. Eventually the revenue and profits will be higher so the company will grow
3. Particle Board: 30% of the shredded wood converted to particle board for many purposes. Steelton would either manufacture its own/the material would be exchange with other ArcelorMittal Branches to manufacture it, or it would be sold to other external companies that manufacture particle board/plywood materials.

Converting the pallets into mulch to create a biodegradable environment around the plant and in the local area while simultaneously used in creating new wood materials would be a fast and effective way to intake broken pallets, regardless of wood condition.

Concept of Operations

This set of operations would explain how Steelton can begin implementing this system and what goals need to be met:

- Steelton must re-calculate the amount of pallet waste they currently produce and projected amount for the future, so they can determine how many pallet shredders would need to be invested in to operate
- Pallet waste must continue to be identified
- Lumber waste stream must be entirely eliminated (Steelton must civilly sever its connections with landfill companies and destinations)

- Employee/personnel distribution must be re-assessed and those who were assigned to collecting and exporting the waste would instead be carrying out tasks of the the new recycling stream
- Pallet and lumber waste must be congregated in one general area in proximity to the designated shredding site
- Steelton must establish new connections with possible clients that would accepted the shredded material as a product to purchase for their needs
- The facility must negotiate with the executive leaders of Harrisburg and surrounding counties to determine the extent to which they can contribute to enhancing the environment with biodegradable product to be used in parks, public forests, highway medians, construction work, etc.
- Steelton must coordinate with other branches of ArcelorMittal to gain approval of this system and see if it can be facilitated with the help of other ArcelorMittal complexes

Life Cycle Assessment

The waste output is pallets, the input is material to create woodchips as an output. This serves as a new material that is ready to be used for a variety of purposes that all result in creating a biodegradable result in the end. The cycle of a pallet's life begins with trees being cut down on a large scale at lumber-harvesting locations. Pine, birch, and oak wood are typically used as pallet wood. The wood is cut to specific dimensions, and threaded nails and staples are introduced (they have their own lifecycle background) to fasten the pallet structure. They are purchased by companies that utilize the pallets for their product transporting, mobility, and shipment purposes, resulting in the pallets being exchanged multiple times within their own facilities or multiple interconnected companies and plants. They may be loaded into trucks, shipped overseas, or sent through trains. Eventually the originally intact pallet may break and is repaired multiple times until it is rotting or useless for its original purpose. A repaired pallet has the average industrial lifecycle of 3 to 5 repairs. In Steelton's case, the unrepairable pallets would typically be sent to a landfill in which they would rot and break down relatively slowly. Their life would terminate right there when they are disposed of forever.

With the new system implemented, the lifecycle of the pallets lifecycle would actually be extended to an additional one to four years! If they end up as mulch for the soil, the decomposition process will prolong the life of the pallet for a naturally efficient amount of time. Smaller particles of wood decompose more quickly, and this alternative would intake waste lumber more quickly and decompose it at an ecologically healthy rate. If the pallet-derived woodchips are converted into particle board or plywood, the lifecycle would be extended to several years depending on the climate in which the material is used, and presence of other deteriorating factors such as termites. These construction materials would eventually become biodegradable product themselves. With farmland use, it usually depends on how the wood product is utilized. After serving its purpose in a cow barn for example, it would be tossed elsewhere nearby to decompose into farmland soil or be used as fertilizer.

Nearly no damaging emissions or pollutants would result from the extension of the pallet life cycle. all exchanges would stimulate the economy, and benefit wood as a material while sustaining the source of its resource in the environment by giving back to the soil.

Cost Analysis

Since the only new expenses being introduced with this design would include the wood processing machine itself, possibly a few additional personnel, and a rearrangement of truck use for transporting pallets, virtually no other new costs will be present. One machine would range from anywhere between 20,000 and 100,000 dollars depending on its output ability and other accessories present (such as a conveyor). Since the components that comprise the machine come in such a wide variety of forms and prices, it is difficult to pinpoint an exact price range for the shredding machine. Some marginal investments may have to occur in order to rearrange employees and vehicles to switch from the waste stream to recycling stream effort, but no physical capital will be spent by Steelton in that aspect.

Economic Viability

This system will help the company in different ways such that the company will lower its costs for new pallets, which will leave more money to produce what they actually produce which is steel. The system is based on how to use the wood pallets waste in order to get some profit out of it to lower the costs for new pallets. This allows Steelton to produce more steel, increasing its long-term profits and revenue. The shredded wood will be used for different purposes that will generate some benefits for the company in both direct and indirect ways. First, the shredded product that is sold to other companies is the best representation of a direct output of this system. Profit made out of this selling will lower the companies investments when buying new wood pallets, further promoting an increase the steel production. Eventually this sequence will generate more profit in the end. Second, the shredded wood used for the landscape as recycled material is the example of the indirect output of this system. Steelton would progress its sustainability and relationship to the environment. Biodegradable product will benefit Steelton indirectly by eventually earning the facility higher regard as a green operating process. With a higher status, more economic exchanges will occur with the plant to grow the industry. Third, some of it will be used to make construction materials like particle board, which has many different uses for the company itself, and a small percentage of could be sold to other companies. Basically, this output can be used for a variety of possibilities: most commonly, division of space, portable set ups, provisional constructions, and other extents.

Conclusion

In Conclusion, it can be seen how this system based on an assembly line process can be very beneficial for the company, also solving the company's waste accumulation problem. Due to the expansive ways in which the proposed system can benefit the company, a very deep study of the implications and the procedures was be taken into account for the development of the project. It was determined that ending with a

recycling stream that ends with a biodegradable result would be the best approach that the company could take in order to be well-advantaged by the results that the system has. The main goal of the system is to aid the steel company with the pallet waste accumulation in such way that the results will help the company to keep doing what they do which is producing steel, in a more efficient and facile way. There are many ways in which wood can be used to generate profits, but since ArcelorMittal is a steel company, working with wood will represent an unnecessary cost for them--damaging the company's sustainability.

The facility's focus to produce steel means that the wood's end result will not be fully dealt with by Steelton. Instead, the wood would be sent to other companies that deal with this type of material, automatically generating profit for ArcelorMittal. Since a comprehensive amount of wood would be used for environment restoring purposes, this technique will also indirectly help company by building their reputation of becoming a more green and sustainable system as part of the economy. Eventually this increase in sustainability will cause others to think highly of the Steelton plant. ArcelorMittal as a whole will benefit with increased economic development and interaction within its own branches and other sectors in the United States and overseas. Local communities, farmlands, and surrounding neighborhoods would ultimately benefit from a cleaner environment that is tended to—a global operation that all companies and institutions are adopting. Thus, this recycling stream system was determined to be the best approach that the company could take in order to not only solve the wood pallet accumulation problem, but to ensure the durability, sustainability, development, economy, and the reputation of the company. Investing in sustainability now will yield great global economic and environmental benefits for the future of this industry and the world.

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--Presentation slides and Tri-Fold brochure are on the following pages--

Presentation Slides:



Introduction

- Main ideas for development:
 - What is waste?
 - Its implications?
 - How can it be turned into usable material?
- Main purpose of design project: find a way to recycle broken/inoperative pallets of ArcelorMittal's Steelton plant, for the benefit of the company, the environment, and economy.

Description of design task

Problem statement

- The problem is that ArcelorMittal Steelton disposes a large amount of wooden pallets during their steel-making process.
- The ineffective pallets accumulate at a fast rate and there is not an efficiently-implemented way to handle the lumber waste.



Design Task

• Mission:

- Devise a system that reduces the waste of wooden pallets and other lumber material.
- The solution must aim to be an **efficient, safe, and cost-effective** manner of disposing and reusing the waste as useful resources.
- It is essential to focus on finding alternative uses for the wasted lumber so it can be reused as new forms before the end of its lifecycle. In this way, external systems such as other industries, surrounding communities, and environments would benefit as a whole.



Design Task

- **Design Specifications:**

- Create an opportunity to reduce ArcelorMittal's waste footprint
- Design solution must be economically viable
- Must be mindful of all possible inputs and outputs (eg. labor, waste, raw materials, time, and investment)
- System must be beneficial to the industry and the environment as a whole.

Approach

- Extend life cycle of materials
- Recycled product could be sold to other companies
- Environment in mind



Final Design

Disintegrating Process

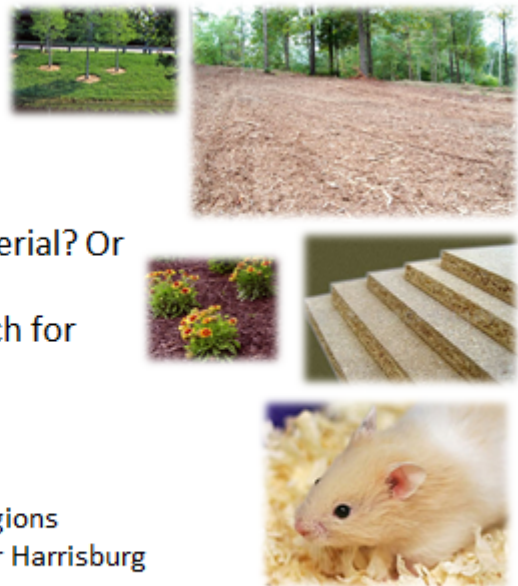
- Recycling stream
- Ineffective pallets + waste lumber identified
- Transported to recycling stations
- Regardless of how broken
- Placed onto conveyor belt – enters a chute that intakes wood components
- Chute fees into shredder
- Rolling/rotating drum magnet – removes ferrous debris & does not interrupt flow of wood chips
- Nails/staples separated from wood particles into separate containers



Final Design

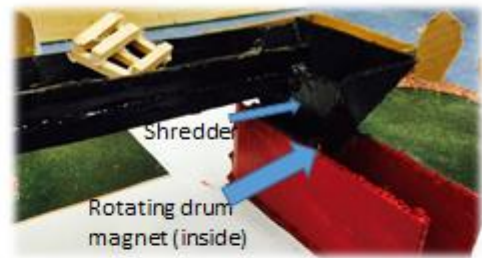
Recycling stream

- Shredded wood → biodegradable product
- Particle board, plywood, animal bedding
- Ability to manufacture own construction material? Or exchange with other firms?
- Main result: wood chips directly used as mulch for landscaping
 - Minimal conversion
 - Mulch = essential landscaping material
 - Decomposes quickly as soil renews
 - Flower beds, tree bases, gardens, and woodsy regions
 - Healthier land/atmosphere around Steelton & for Harrisburg community
 - Aesthetically pleasing/therapeutic result
- Overall, multi-streamed recycling system



Pet/animal bedding

Prototype



ANALYSIS



DISTRIBUTION OF MATERIAL

- Mulch:
 - 40%
 - Landscape surrounding site and the local community.
- Selling:
 - 30%
 - To be sold to other companies for their own purposes
- Particle Board:
 - 30%
 - To be exchange within ArcelorMittal branches

ECONOMIC VIABILITY



Converting the pallets into mulch to create a biodegradable environment around the plant and in the local area while simultaneously used in creating new wood materials

Conclusion

- Eliminate Steelton's accumulation of pallet waste
- Higher efficiency
- Environment restoring purposes - a technique that will indirectly help Steelton
- Increased economic development/interaction within own branches and other sectors
- Local communities, surrounding neighborhoods - cleaner environment
- Great global, economic, and environmental benefits

Tri-Fold Brochure:

Introduction

- Main ideas for development:
 - What is waste?
 - Its implications?
 - How can it be turned into usable material?
- Our definition of sustainability - the longevity and durability of a system or process, or a network of systems and processes working together to maintain natural resources, advance the economy, shape politics, and even develop human culture



Description of design task

Problem statement:

- The problem is that ArcelorMittal Steelton disposes a large amount of wooden pallets during their steel-making process.
- The ineffective pallets accumulate at a fast rate and there is not an efficiently-implemented way to handle the lumber waste.

Analysis



Distribution of Material

- Mulch: 40% - Landscape surrounding site and the local community.
- Selling: 30% - To be sold to other companies for their own purposes
- Particle Board: 30% - To be exchange within ArcelorMittal branches

ECONOMIC VIABILITY

DIRECT OUTPUT



INDIRECT OUTPUT

Converting the pallets into mulch to create a biodegradable environment around the plant and in the local area while simultaneously used in creating new materials

Conclusion:

Investing in sustainability now will yield great global economic and environmental benefits for the future of this industry

From Pallets To Gardens

By
Vicente Moncada
Ted Strouboulis
David Haller
Ernest Duran





Design Task

Mission:

- Devise a system that reduces the waste of wooden pallets and other lumber material.
- The solution must aim to be an efficient, safe, and cost-effective manner of disposing and reusing the waste as useful resources.
- Essential to focus on finding alternative uses for wasted lumber to be re-used as new forms before the end of its lifecycle.
- External systems (eg. other industries, surrounding communities, and environments) would benefit as a whole

Design Specifications:

- Create opportunity to reduce ArcelorMittal's waste footprint
- Established solution that meets all applicable requirements
- Must be economically viable (worthwhile and profitable to Steelton & ArcelorMittal overall)
- Mindful of all possible inputs and outputs (eg. labor, waste, raw materials, time, and investment)
- Beneficial to the industry and the environment as a whole.



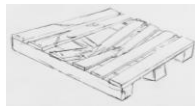
Approach

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Initial Design Ideas

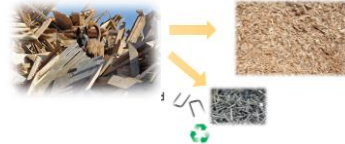
Incineration/Fuel
Domestic Projects
Larger Construction
Returnable Packaging
Biodegradable Product
Eternal Companies



Final Design

Disintegrating Process

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- Transported to recycling stations
- Regardless of how broken
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