Design Project II – ArcelorMittal Recycling

EDSGN 100 – Introduction to Engineering Design
Section 009, Team 6

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Abstract

_____The design team was propositioned by ArcelorMittal to create a system that reduces and reuses one of the three forms of waste that they are currently landfilling. It is currently a cradle-to-grave system that, if refined, will reduce landfilled waste and disposal costs.

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Introduction

_____This was the second Design Project for Xinli Wu's Intro to Engineering Design course. The objective was to modify ArcelorMittal's current system or create an entirely new system to reduce and recycle the waste created at ArcelorMittal's Steelton Plant. It was recommended that groups focus on one of the three waste forms: refractory brick, pallets, and drum totes. Along with making a formal presentation, the project also included writing this report, which includes many components such as the following: problem and mission statement, System Diagram, a Gantt chart, and more. Our group met either once or twice a week over the course of 6 weeks to brainstorm, design, and present our project. All planning and designing was in the design lab at Hammond Building.

Description of Design Task

Problem Statement

The problem is ArcelorMittal's Steelton plant has an abundance of refractory brick, unusable broken pallets, and chemical ridden plastic drums, all of which end up in a landfill.

Mission Statement

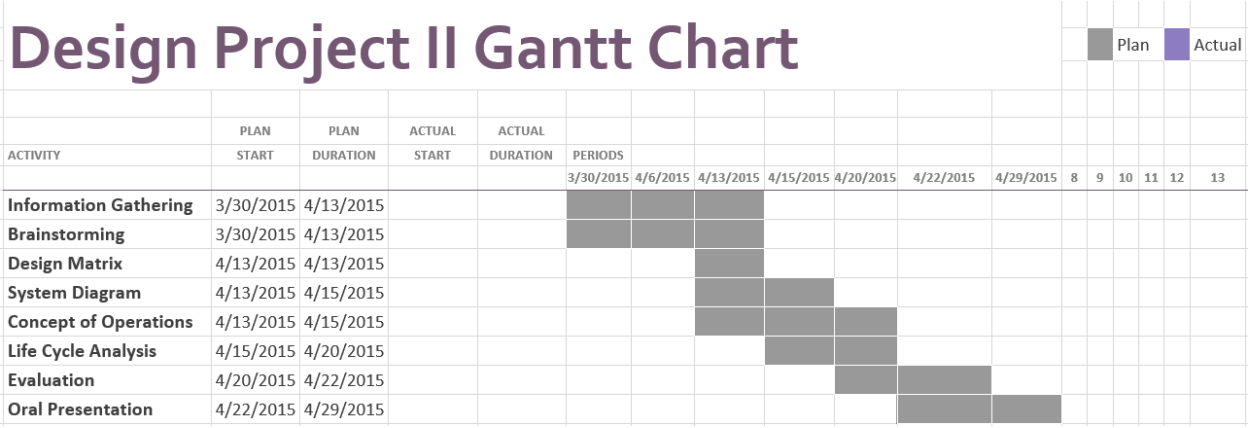
The mission is to design a process to effectively prevent one of the three types of waste from ending up in a landfill.

Sustainability

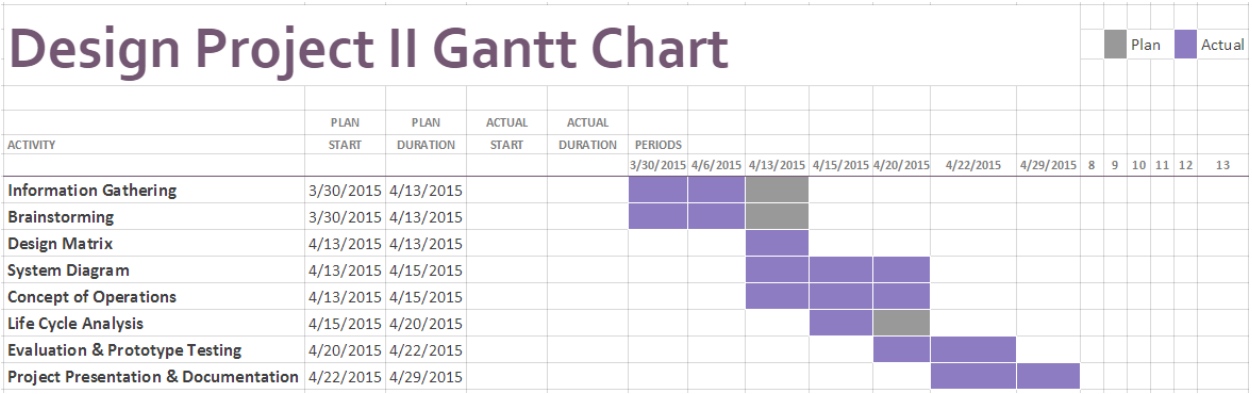
Sustainability is attempting to overcome challenges and problems in a way that will benefit current and future generations socially, environmentally, and economically.

Design Approach:

Gantt Chart



(Table 1. Initial Gantt Chart)



(Table 2. Final Gantt Chart)

Tables 1 and 2 above feature the team's Gantt chart, before and after the project was completed. Gray tiles were placed under dates we planned to complete their associated tasks and purple were placed under the dates that the task was worked on and/or completed. The design team allotted more time than usual to information gathering and brainstorming because there was no concrete resolution to the problem; it was up to the team to research and create an effective solution to ArcelorMittal's Waste issues. Luckily, coming up with ideas was not as difficult as they thought it would be, but creating a system diagram took longer than they had originally planned. The Gantt chart allowed the group to manage their time effectively, know when/where time could be afforded, and when they were under a time crunch. Because of proper planning, the group was able to complete the project on time.

Customer Needs Assessment

In late March, a representative from ArcelorMittal conducted a presentation outlining the challenge they were extending to Introduction to Engineering Design students. The challenge

was to study one of their waste streams (either pallets from incoming material delivery, waste refractory brick, and empty drums or totes received from delivery of fluids) and to design a system to reuse and/or recycle that waste. Two explicitly-stated goals were included:

- Reduce landfilled waste
- Reduce disposal costs

The design team was not worried about reducing landfilled waste as much as they were reducing the disposal cost to the company; all of their ideas would undoubtedly reduce waste headed for the landfill, but how could they implement a system that posed a minimal burden, if any, on the company?

Concept Generation

The team was conscious that they were to focus on one waste product, but were afraid to eliminate two right away in case any good ideas came to mind during the information-gathering and brainstorming stages. They were able to come up with a few initial ideas, including:

- House(s) out of the brick (at home or abroad)
- Chipping the pallets and waste lumber
- Melting down the drums and totes
- Create a distribution center for locals to collect materials as they please
- Playground out of all of the materials

(Figure 1. Example Playground)

(Figure 2. Pallet Chipper)

All of the ideas would certainly divert the material from a landfill; the question now was which idea was the best? The team was able to determine which idea was “best” by comparing the ideas to one another through a specific list of criterion seen in the next section.

Design Selection Matrices

Selection Criteria	Concepts				
	A(Houses)	B(Landscaping)	C(Melt down resale)	D(Distribution center)	E (Playgrounds)
Cost to Company	0	0	-	-	0
Benefit to Environment	.+	.+	-	0	.+
Practicality	0	0	0	0	0
Profit Potential	.+	0	0	0	0
Benefit to Society	.+	0	0	.+	.+
Sum +'s	3	1	0	1	2
Sum 0's	1	4	3	3	3
Sum -'s	0	0	2	1	0
Net Score	3	1	-2	0	2
Rank	1	3	5	4	2
Continue?	Yes	Edit	No	No	Edit

(Table 2. Original Design Matrix)

After comparing the ideas, the group found using the refractory brick for housing projects to be the best in terms of the cost to the company, the benefit to the environment, benefit to society, and practicality. However, chipping the wooden material for landscaping and constructing playgrounds were not too far behind. The team decided to edit those two ideas and reevaluate.

Selection Criteria	Refined Design Matrix		
	A(Houses)	B (Landscaping)	E (Playground)
Cost to Company	0	0	0
Benefit to Environment	.+	.+	.+
Practicality	.+	0	0
Profit Potential	.+	0	.+
Benefit to Society	.+	.+	.+
Sum +'s	4	2	3
Sum 0's	1	3	2
Sum -'s	0	0	0
Net Score	4	2	3
Rank	1	3	2
Continue?	Yes	No	No

(Table 3. Revised Design Matrix)

After editing concepts B and E, providing free mulch and finding a market for playground respectively, we still found using the bricks as housing materials to be the premier idea. After deciding that donating the bricks would be the best option the team decided to reach out to Habitat for Humanity: a charity organization that builds houses for those less fortunate. The design team sent this email out to the Corporate Donation Office who seemed enthusiastic

To Whom it May Concern,

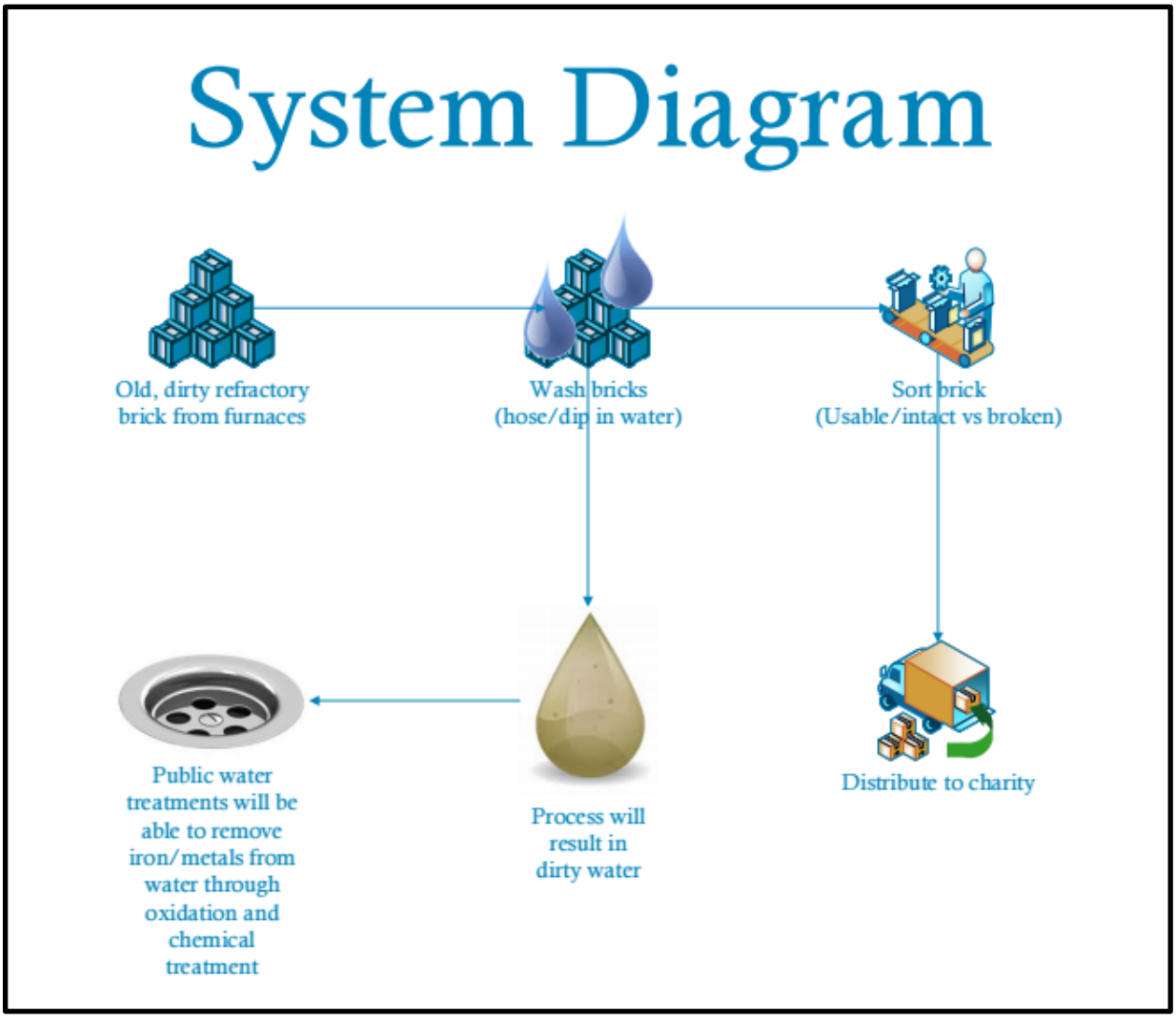
I am writing on behalf of myself and four other students in the College of Engineering at The Pennsylvania State University. Each semester, a large corporation sponsors a design project for students to address a certain issue that the company might be facing. This year, ArcelorMittal, the world's number one steel and mining company, has tasked us with finding a method to reuse or recycle refractory brick from their furnaces in Steelton, PA.

We were wondering if you have ever used recycled brick or if Habitat for Humanity would have any use for this type of brick? We are grateful for any information that you could provide us with.

about the idea and redirected them to the Harrisburg office.

(Figure 3. Habitat Email)

System Diagram



(Figure 4. System Diagram)

Pictured above is a diagram of the final system. After the bricks are removed from their respective locations, they should be washed, sorted, and then distributed to the charity organization. The second step will result in dirty water, contaminated with, but not limited to, iron, carbon, aluminum, and other metals/metalloids. Obviously this could potentially pose a threat to the environment/society but, after some research into public water management and treatment, the water should be safe to dispose of down the drain. Oxidation and chlorine/chemical treatment will be able to expel these materials.

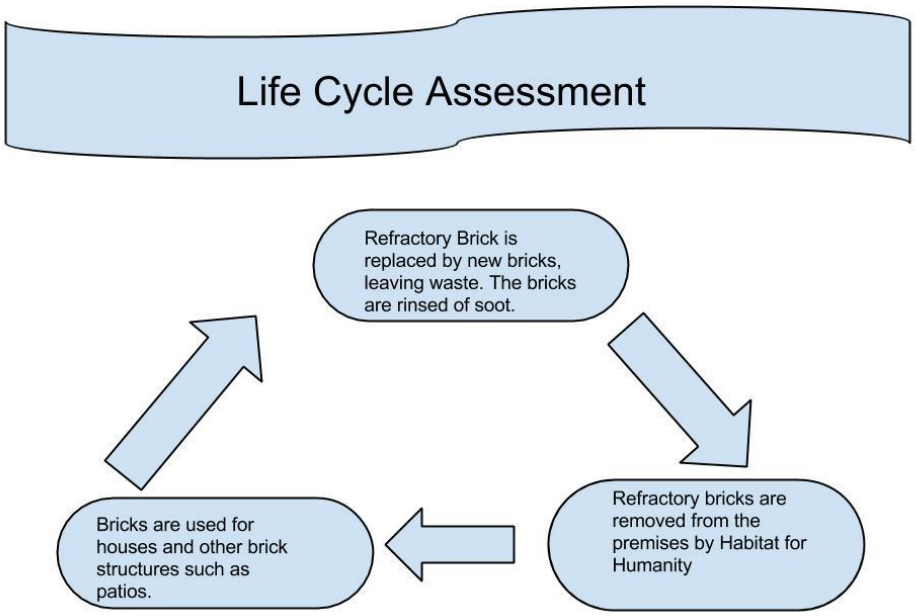
Concept of Operations

ArcelorMittal, a leading steel producing company experiences an excess amount of waste after their production that goes to landfills. This includes primarily drums, pallets, and refractory bricks. It is necessary to reduce the waste that is landfilled and also attempt to reduce the disposal costs of the waste. Some problems that face the group are that the drums have been contaminated with waste and need to be cleaned and also the pallets cannot be directly reused again.

The group is attempting to create alternatives to directly landfilling the waste, and a design matrix was created with multiple solutions. Some of the solutions are better than others, so the design matrix was revised in an attempt to improve or combine various solutions in order to more optimally solve the waste disposal and cost problem.

The group determined that a unique and effective solution to the waste problem is to focus on the refractory brick, and donate it to a large philanthropic organization, such as Habitat for Humanity. The intention is that Habitat for Humanity will use the bricks (intact or not) abroad and domestically. Abroad, the bricks may be used to build small houses in impoverished countries, whereas domestically the bricks could be used on houses as part of fireplaces or patios. Habitat for Humanity will be responsible for picking up and transporting the bricks on its own. This is convenient because the ArcelorMittal plant is in Steelton, which is close in location to the Harrisburg division of Habitat for Humanity.

Life Cycle Assessment



(Figure 5. Life Cycle Assessment)

The figure above shows the lifecycle of the bricks used by the ArcelorMittal plant in Steelton. First, the bricks are used in large ovens ovens used to heat steel to its melting point. Eventually, the refractory brick must be replaced. Right now the brick is replaced and the waste brick is transported to a landfill and left there, ending the bricks life cycle. By implementing the second two steps, the “cradle to grave” process length is maximised. The bricks will be given a new purpose through Habitat for humanity. Habitat will pick the bricks up from the Steelton plant or ArcelorMittal will transport the bricks there. Either way, ArcelorMittal will not be transporting waste any further than it already is. Habitat will then be able to use the bricks wherever deemed necessary. The bricks will be used here for years to come. According to Bankrate, brick houses have potential to last upwards of one hundred years. This would add a century onto the bricks life. Eventually, the houses or structures will become obsolete and torn down. But for now bricks are being kept out of the landfill and less brick is being consumed by the housing industry.

Summary & Conclusions

After completion of the project, Design Team 6 of section 009 believe that their system adequately addresses ArcelorMittal's waste issue concerning the refractory brick. They were able to successfully design a system that diverts the waste from the landfill and any other contaminants that result from the process are easily eliminated through means already practiced. The team was able to plan and effectively execute that plan to complete this project over the course of the past month.

The system that the team has produced is simple; it requires minimal effort to the company will not add to their expenditures. Additionally, ArcelorMittal will be able to write their donation off on their taxes and possibly get some money back in return. Perhaps a better system for dealing with the dirty water could be implemented in the future, but for now allowing public water management to take care of it should be fine.

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