Alcoa Project Report

EDSGN 100 - Section 24
Submitted to: Professor Bilen
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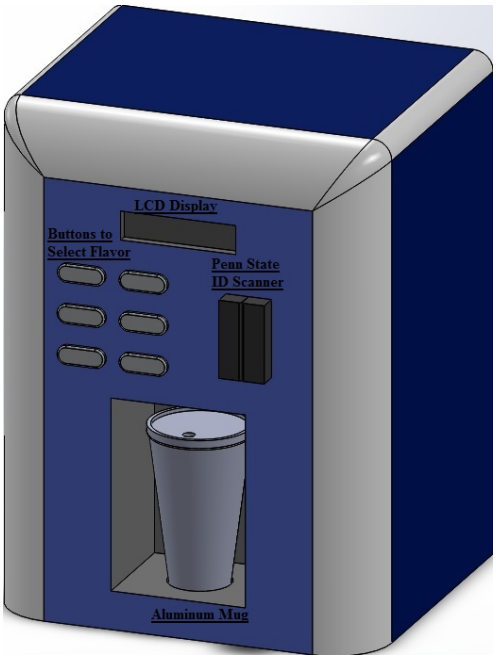

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Executive Summary

This report presents the design and prototyping of a coffee refilling station with a recyclable and reusable aluminum travel mug. The goal centered around the use of aluminum to promote energy and sustainability at the Pennsylvania State University. By creating a system that allows students to purchase coffee at convenient locations on campus with a promoted reusable mug, we have successfully increased recycling and sustainability on campus using aluminum.

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Table of Contents

A. Introduction and Problem Statement
B. Concept Generation
C. Design Selection
D. Review of Design Features
E. Analysis And Testing
F. Description of Design Operation
G. Life Cycle Analysis
H. Summary

1.0 Introduction

The goal of our project is to create a product utilizing the intrinsic properties of aluminum to make Penn State more energy efficient and sustainable. We began with a presentation on our corporate sponsor, ALCOA, to gain key information on the recyclability and sustainability of aluminum along with some basic information on the company and its history. After coming up with an idea to satisfy the project goal, we began creating designs with the objective to create a cheap and user friendly coffee refilling station in convenient locations on campus. We utilized customer needs and concept generation techniques to make a set of standards our design should meet. This report expands on the concept generation, customer needs assessment, external research, and concept selection involved in creating our design.

1.1 Initial Problem Statement

We need to create an aluminum design that promotes sustainability and energy efficiency on Penn State campuses.

2.0 Concept Generation

In order to generate concepts for our design we utilized three methods of brainstorming. Mycoted.com provided a list of professionally used concept generation techniques. As a team, we researched the techniques and chose the methods that we felt were most applicable to our problem statement. The concept generation techniques we chose include "Bodystorming", "Listing Pros and Cons", and "Circle Time."

The idea of Bodystorming is to pretend that the product we are designing actually exists, and to act out how it would work in real life. This technique emphasises the idea of getting up, moving, and testing with your own body, rather than sitting at a table and brainstorming. Allowing your body to run through the motion of utilizing a product gives the designer an idea whether a design function is feasible or not.

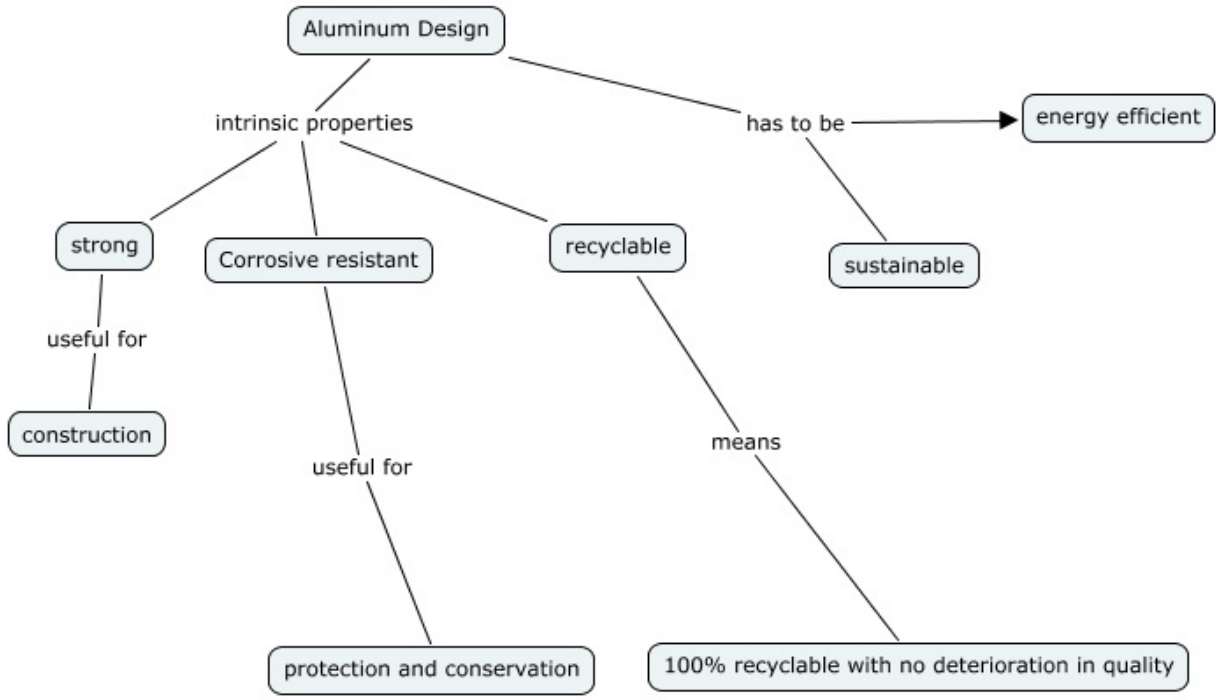
Circle time, also known as "Group Time", refers to any moment that a group of people are together for an activity that involves everyone and ensures that nobody is excluded. Mycoted's "Circle Time" is a brainstorming method that instructs users to, first, sit in a chair or cushion and in a circular seating arrangement so each user can clearly see and hear one another. In this circle, we each shared any ideas we had on the project, holding an object that signifies the ability to speak without interruption. The object was passed from one user to another that requested to speak next. No negative feedback was allowed, especially in response to the speaker's idea. This rule promoted vocal sharing of ideas

without fear of judgement to guarantee that every thought was spoken and understood.

Once we had a list of potential design ideas, we utilized the "Pros and Cons" technique to determine the feasibility of each option. This technique includes taking each option one by one and listing the potential advantages and disadvantages.

These concept generation techniques allowed us to create five design concepts that centered around our problem statement. Each concept centered around utilizing aluminum in a fashion that would make Penn State more energy efficient and sustainable.

Figure 1: CMAP



2.1 Customer Needs

The customer needs criteria were generated in a very specific manner that the group thought would produce the most accurate results. Each of us stood in front of a different store that sold coffee. The locations include the Starbucks on College Ave, The Mix at Pollock Commons, The Big Onion at Findlay Commons, and Off the Ground at South Commons. Each group member was designated to one spot and stood there and attempted to survey as many people as possible. Questions were asked from the interview script (provided below) and properly recorded. This method was very efficient at

generating results quickly and from the proper audience, but it was a convenience sample and therefore was most likely not representative of the whole population here at Penn State University Park Campus.

The next method we used was a simple random sample. We used a random number generator to select 10 rooms from Mifflin and Pollock Halls and went to the doors and asked the subject the questions from the interview script. Most people answered their doors, but for the few that did not, a new room number was selected and the new subject was questioned appropriately. This method was also a convenience sample but the advantage was that we got a broader view of the customer needs this time. Everyone's results were confidential and remained anonymous, no names were used.

The sample script attempted to help the group with generating ideas for our design. If the subject did not drink coffee, the survey was discontinued as they would most likely not produce the most accurate results that we were looking for due to the subject's lack of interest in the topic. A sample of the script is below:

Interview Script

1) Do you drink coffee? (If no, discontinue survey)
2) How often do you drink coffee?
3) How much are you willing to pay for a good cup of coffee?
4) Do you use a travel mug or paper cups?
5) Would you use a travel mug if a convenient system was available?
6) What would you want to see in that system?

A very wide range of subjects were used in the study and we produced about 50 results for the study to have a large enough sample size. The results that we found are listed below in Table 1.

Table 1: Interview Results

Question Number	Result
2	Less than a cup a day: 10% One Cup a day: 24% Two Cups a Day: 42% Three or More 24%
3	50 cents-1 dollar: 100%, 1-2 dollars: 91%, 3-4.50 dollars: 38%
4	Travel Mug: 16% Paper Cups: 84%
5	Yes: 81% No: 19%
6	Easy payment system, user friendly, convenient locations, cool design, coffee variety

We did not record the number of people who said they did not drink coffee as their results were not important to conducting our survey.

After the group finished the results of question two, we found that in our sample, people drank an average of two cups of coffee a day. However, more than half of our subjects drank two or more coffees a day which we interpreted as a clear demand for coffee on campus. If a convenient system was generated that would suit their needs, our design and system could be successful. We continued to ask the next important question.

Question 3 asked how much a person would be willing to pay for a good cup of coffee. On campus coffee is generally very cheap especially with the campus meal points system. The people who drink coffee were all willing to pay 50 cents to a dollar on a cup of coffee. The percentage of people willing to pay for a cup of coffee decreased as the price increased. This inversely proportional relationship was not surprising but it did vary based on location. The subjects that were questioned in Starbucks were willing to pay a significantly high price for a cup of coffee. This made sense because the price for a cup of coffee at a Starbucks coffee shop is on average 3 dollars more than on the Penn State Campus.

Question 4 (travel mug or paper cup) was not a shock to our group. Based on the survey, a vast majority of people on campus use a paper cup that is supplied to them at the store they purchase their coffee at. This is because it is convenient to them and they can just throw that cup away and buy a new one the next time they want a cup of Joe. This really is not a problem for the average person but in reality this generates a lot of unneeded waste at Penn State that could be prevented. The problem is that there really is not a suitable coffee refilling system on campus that people could take advantage of so they do what they can to get coffee. We found that people who used a travel mug usually made their own coffee in their place of residence. However this is not very easy to do for most people especially for the students that live in the dorms. The next question made it clear that our system could be a success if conducted properly.

We asked the subjects if they would use a travel mug if a convenient system was created here on campus. We explained our general idea and we noted the number of people willing to use a travel mug dramatically increased. It was important that while we explained our ideas, we did not bias the subject and they gave us their honest opinion. However, we concluded that people's choice of where they drink their coffee from was just a convenience factor because there was no better trade off. Sustainability is commonly not important to most people, because the opportunity cost for being environmentally friendly and making their own coffee is too high for most.

The following customer needs were generated for a new system of buying coffee shown in Table 2.

Table 2: List of Customer Needs

1. Cheap
2. User friendly
3. Convenient locations
4. Efficient system
5. Coffee variety
6. Standard Sized Cup
7. Durable

After the customer needs were collected, we weighed them based on importance shown in Table 3.

Table 3: Hierarchy of Customer Needs

1. Efficient System
1.1 Coffee can be purchased and received quickly
1.2 The paying system is easy to use and utilizes Meal Point/Lion Cash
2. Cheap
2.1 People can buy as much as they want at a good price
2.2 Demand for coffee will stay high
3. User Friendly
3.1 Interface is self-explanatory and easy to use
3.2 Few steps required to receive coffee
4. Convenient Locations
4.1 Coffee stations are located throughout campus
4.2 Many stations are present
4.3 The stations are easily accessible to all students all over campus
5. Coffee Variety
5.1 Many different types of coffee are available
5.2 Multiple brews provide a higher demand for our system
6. Durable
6.1 Machine won't have to be replaced often
6.2 Cups won't have to be repurchased
6.3 Low maintenance is required
7. Standard Sized Cup
7.1 Cup that is provided fits in standard cup holder
7.2 Cup is not too big or too small
7.3 Size of cup is maximized

We weighed efficiency as the number one priority because it was a common request from our subjects. A majority of people already get their coffee from a shop in a paper cup because there is no other alternative. If the next big coffee dispenser is not efficient, what's the point? It will utilize a credit system that is common on the Penn State campus like lion cash or meal points.

Many people who order their coffee now get it from an on campus store. They use their meal points which gives them a large discount so they pay a very minimal fee. In order to attract customers with our new system, it must be cheap and efficient. In order to sell coffee at a cheap price, it must be produced at a cheap price to in order to make a profit.

In order to assure returning customers, the system must have an easy to use interface. Not all people are good at using technology so the coffee ordering must be simple and user friendly. Very few steps should be used to buy the coffee. If the system is user friendly customers will keep coming back and the demand for our product will remain high which is the ultimate goal.

Another very important feature that the new coffee dispensing system must have is convenience. If the coffee machines are located at almost every corner of campus then people will see it as a new standard because they can fill their aluminum coffee mug up anytime and anywhere. This is vital to the success of this idea. The more coffee dispensers that can be present on campus and effectively maintained, the better.

Most coffee connoisseurs prefer more than the average cup of coffee. For the more frequent coffee drinkers their tastes can evolve into a variety of flavors. Therefore, it is important to have a variety of different brews available in the dispenser. This way, the people who don't drink as much can get a regular cup of coffee and the people who drink more coffee can get their prefered flavor and all of the audiences are satisfied.

In order to be cost effective and sustainable, both the coffee machine and mug must be durable and last a long time. If people perceive that the machine is frequently breaking down or the mug is poorly designed and breaks after a while, they will get discouraged to try it and that means a profit reduction for our team. The more durable the machine, the lower the maintenance and this lowers costs and increases profit.

The size and shape of the cup are very important to the attractiveness of the product. The cup must be of standard size and fit all cup holders. The cup design must be attractive yet not irregularly shaped.

2.2 External Research

External research was conducted in order to gain insight on existing coffee makers and travel mugs. Information was gained through the use of a Bill of Materials and patent research.

Internet Sources:
http://en.wikipedia.org/wiki/Beverage_can

Patent Sources:
https://www.google.com/patents/WO2013074950A1?cl=en&dq=aluminum+travel+mugs&hl=en&sa=X&ei=fVOlUoywHbStsQTf5ICgBw&ved=0CFwQ6AEwBA

https://www.google.com/patents/WO2012120363A2?cl=en&dq=coffee+makers&hl=en&sa=X&ei=aVKlUpXKDs7hsATn_YLoCw&sqi=2&pjf=1&ved=0CDcQ6AEwAA

https://www.google.com/patents/CN203088537U?cl=en&dq=aluminum+mug&hl=en&sa=X&ei=-lOlUqO5E42isATinoCgDg&ved=0CDsQ6AEwAA

Table 4: Patent Search

Cited Patent	Patent Date	Publication Date	Applicant	Title
WO2012120363A2	Mar 7, 2011	Sep 13, 2012	Cerreti Gianfranco	Portable coffee mill-doser for moka coffee makers or coffee machines or similar
US6339985	Feb 1, 1999	Jan 22, 2002	Robert R. Whitney	Coffee maker
US2012/065561	Nov 16, 2012	May 23, 2013	Mocktail Beverages Inc.	Beverage container
CN 201320091098	CN203088537U	Jul 31, 2013	Nan	An aluminum alloy Mug

Table 5: Bill of Materials

Part #	Part Name	QTY	SOP Effect	Function	Mass (lbs)	Material	Manuf. Process	Dimensions (in)	Cost
1	**Cup top**	**1**	**No**	**Seals travel mug**	**0.06**	**aluminum**	**metal assembly**	**5 diameter 1 high**	**≈$0.68**

2	**Cup**	**1**	**Yes**	**Holds coffee**	**0.15**	**aluminum**	**Metal assembly**	**3x5x7**	**≈$1.5**
3	**Machine**	**1**	**Yes**	**Makes coffee**	**20**	**aluminum**	**Metal Assembly**	**20x17x26**	**≈$75**

3.0 Design Selection

Through the extensive process of generating concepts, we have made five designs that are all closely related but different in a unique way. To properly choose which design is best, we used a simple selection matrix. The selection matrix (shown in Figure 2) uses a weighting system and our own rankings of the designs in predetermined subjects to create a result. Each design serves the purpose of providing coffee, but are limited in certain areas of criteria used to determine which design is best for our objective. The criteria used in our selection matrix are a mix of ideas from the customer needs analysis and ideas of our own. Since we did not give away much information about the machine itself in the customer needs analysis, the criteria used from the interviewees are more related to the system but still apply to the physical coffee machine.

Link to concept designs

Below is a rubric to elaborate on each of the abbreviated design titles:

1. This is a vending machine-sized coffee dispenser that would need to be refilled less, cost more, and would take up more space due to it's very large size.
2. This small machine may be placed on any table and provides a decent amount of coffee coming in several flavors
3. This machine would require constant maintenance by an employee which would also hinder its location availability
4. These would be basic coffee pots just like at home that are run by the students; coffee would be purchased at a nearby dispenser of 1 cup servings of coffee
5. This large machine would be filled with one flavor of coffee only once at the beginning of each day despite running out at any point during that day

Figure 2: Selection Matrix

		Concepts									
		A		B		C		D		E	
		Vending Machine		Table-Sized Machine		Worker Machine		Coffee Pots		One-Fill Machine	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Size	20%	1	0.2	5	1	5	1	4	0.8	5	1
Machine Cost	15%	2	0.3	4	0.6	4	0.6	5	0.75	5	0.75
Location Potential	15%	4	0.6	5	0.75	2	0.3	2	0.3	4	0.6
Effeciency	15%	5	0.75	4	0.6	5	0.75	1	0.15	2	0.3
Maintence (hi # = lo)	15%	4	0.6	4	0.6	1	0.15	2	0.3	4	0.6
Coffee Variety	10%	4	0.4	3	0.3	3	0.3	3	0.3	1	0.1
Cleanliness	10%	4	0.4	3	0.3	5	0.5	2	0.2	2	0.2
			0		0		0		0		0
			0		0		0		0		0
			0		0		0		0		0
	Total Score	3.25		4.15		3.60		2.80		3.55	
	Rank										
	Continue?	No		Yes		No		No		No	

Through scoring done by the selection matrix, we picked the small multi-flavor machine design.

4.0 Review of Design Features

The design of the product includes a aluminum travel mug and an aluminum coffee maker. The aluminum travel mug is a standard size mug with dimensions 3x5x8. It is made completely out of aluminum and contains a removable aluminum lid. On the travel mug is a barcode that is read by the coffee machine. The small multi-flavor machine has dimensions 20x17x26. On the front of the display are different buttons that correspond to different flavors of coffee. In the space where the coffee mug is placed is a scanner that reads the barcode that is individual to each mug.

Our product is unique because it provides students a quick, easy, and sustainable system to purchase coffee on campus. Our design contains a few weaknesses. Students must purchase a travel mug prior to taking advantage of the system. Although once purchased, students can reuse their aluminum mug for a discounted price. Another weakness is the fact that students must take care of their travel mug. It is the customer's responsibility to clean their mug after use.

5.0 Analysis and Testing

Analysis and testing of the final design was performed to understand the environmental impact and feasibility of our product. The environmental impact includes four quantities: carbon footprint, water eutrophication, total energy, and air acidification.

Link to sustainability report

Carbon Footprint - 16 kg CO2e
Total Energy - 200 MJ
Water Eutrophication - 4.4E-3 kg PO4e
Air acidification - 0.110 kg SO2e

6.0 Description of Design Operation

Students can buy an aluminum coffee travel mug to promote waste reduction. These cups could feature different designs. Each mug would be linked with the students' PSU ID+ accounts and have a barcode on the side. The coffee dispenser has a barcode scanner that reads the barcodes on the travel mugs. This reading provides a discount on coffee when purchased with meal points or Lion Cash.

Operation Steps

- Purchase aluminum mug from student bookstore or other Penn State run stores.
- Place mug in any of the coffee dispensers around campus
- Swipe student I.D. through card slot on front of machine
- Scanner reads the barcode on side of travel mug
- Customer chooses flavor of coffee desired by pressing the corresponding button on the front display
- Retrieve mug once coffee has finished being dispensed

7.0 Life Cycle Analysis

A life cycle analysis was performed in order to determine whether aluminum was the most sustainable material to use for our product. We used the sustainability calculator to determine the impact vs. lifetime use in terms of hours of watching TV. Three times of material were used for comparison. 6063-O Aluminum, ABS plastic, and pine wood. The paper (pine wood) material received 2 hours, plastic 6 hours, and 6063-O aluminum 1 hour. Paper impacts the environment less per unit made, but it's lifetime use and recyclability is much less than that of aluminum; therefore, 6063-O was the chosen material for our product.

8.0 Summary

We were presented with the task of utilizing aluminum in such a way that would promote recyclability and sustainability on the Pennsylvania State University campus. Our design goal was to create a system that allowed students to purchase coffee at convenient locations in a sustainable and recyclable way. Our design featured a reusable and recyclable aluminum travel mug that allowed students to purchase coffee at convenient locations on campus. Included in the design is an aluminum machine used to dispense the coffee.

This project gave us hands-on experience on the process of designing a product from start to finish. It allowed us to work in groups and culminate different ideas using the strategies we learned in class. We were presented with an initial task, and it was our responsibility for developing solutions using the knowledge we gained through lectures.