ALCOA-Sustainability Project Aluminum To-Go Box

Team: Bob the Builders

EDSGN 100

Section 014

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Short abstract that summarizes the project

Our project consists of using aluminum on campus to better the Eco friendliness of PSU. As a group we believed that the environment is at risk with current way Styrofoam is being disposed at Penn State. We faced several complications on our way there but we believe we have found a better alternative to enjoy take-out food while supporting the growth and cleanliness of our environment.

Introduction

Over the course of a week, we observed many different cases in which aluminum would help create a more recyclable environment. After looking over all of our observations, we decided that replacing the styrofoam take-out containers at the dining hall with aluminum ones would allow us to take advantage of aluminum's qualities and use it in place of the styrofoam. Styrofoam is not as easily recyclable as aluminum and and can't be recycled as many times. Aluminum has the ability to be recycled an infinite amount of times as well as be lightweight and anti-corrosive. We believe that aluminum would reduce the amount of energy needed to create these containers as well as reduce the waste that is left behind.

Our Vision

The ideal solution is to replace non-renewable materials with Aluminum which is recyclable. Currently, The Pennsylvania State University is using Styrofoam in the food services around campus. Styrofoam is very difficult to recycle and takes more energy as well as time. According the United States Environmental Protection Agency (EPA) each year Americans throw away 25,000,000,000 Styrofoam cups. We, the engineering students of The Pennsylvania State University, envision replacing Styrofoam food containers with Aluminum as it is recyclable. In less than 30 days Aluminum is recycled and returned back to their respective consumers. Making new aluminum cans from used cans takes 95 percent less energy than using virgin materials.

Customer Need Analysis

As a group we came in agreement of what our customer Alcoa wanted as a product. Our professor provided us a document that listed statements about Alcoa. Then as a group we rank each statement from 1 to 5, 1 being the least important and 5 the most important. After ranking each statement we separated the ones that were our top ranked. We compiled a list of 6 statements out of 20 and plus statement. From these 6 statements we felt that we needed to meet these criteria when design our product. We concluded that Alcoa wanted groups to brainstorm new ideas or research current applications of aluminum products that can be used throughout Penn State campus. The two most important need that we needed to fulfill was our product's recyclability and sustainability at Penn State campus.

Problem Statement

Our project consists of using aluminum on campus to better the Eco friendliness of PSU. We faced several complications on our way there but we believe we have found a better alternative to enjoy take-out food while supporting the growth of our environment.

Model Solution

In Depth Model Description

During our Concept Selection phase, we chose to design our model container in a cylinder shape which is a two piece container. One piece is the container where food will be placed while the other piece is the lid of the container. The main part which is the container is design to be 8 inches in diameter and 3 inches in height. The thickness of the wall of the container is 0.15 inches of aluminum. As group we decided that 8 inches in diameter with a 0.15 thickness of the wall is enough space to hold food of any type whether be hot or cold food. The total height which include the container and the lid is 3 inches. The lid is 1 inch in height. The container is 3 inches. The feature of this container is that it is a screw-like top container so that lid is screwed onto the container which prevents any food from escaping if it were to drop. The most important component to our product is the type of aluminum alloy we used to make our product. As a group we chose to use aluminum alloy 4032-t6 because it met our target specification which we will explain more further in our report. Overall the design of our container is ideal for take-out foods throughout campus because it is easily portable and will serve its purpose in maintaining heat for hot food and also cold food.

Target Specifications

We really care about the size as well as the shape of the container. We aimed to make the container weigh about one pound. We believed this was a good weight that would allow the

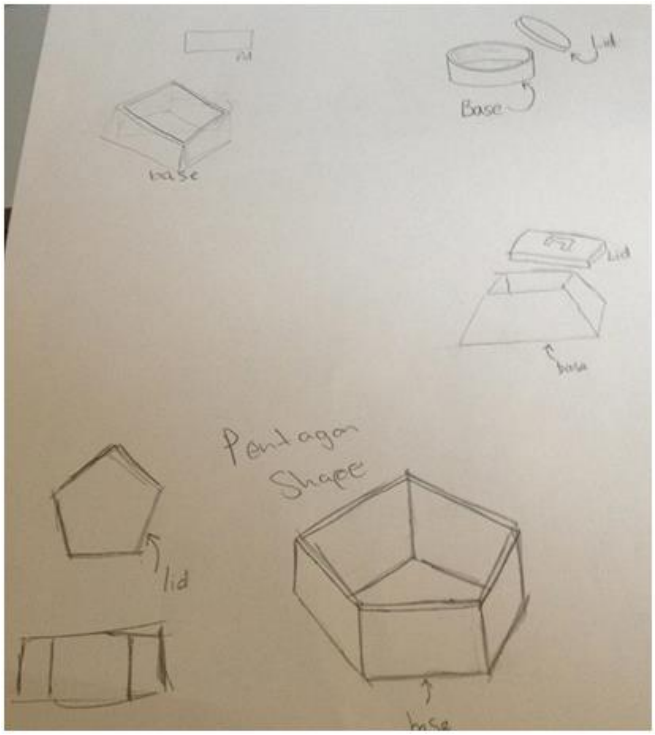
container to be sturdy and maintain its shape as well as be light enough so that it wouldn't be a burden to carry around. We also decided to go with a container that was square shaped and had dimensions around 6x6x2 (inches).

Another concern of ours was also the cost to manufacture these. We planned to have the cost of manufacturing to be about $0.50 per container. This would make it so that Penn State wouldn't be losing a huge chunk of money on containers that could be reused over and over again.

We also wanted the aluminum to be able to maintain the temperature of the food. We thought the aluminum would be a good idea since it acts as a thermos and would have a similar effect as wrapping leftover food with aluminum foil to keep in the heat.

We wanted our container to be as recyclable as possible. Since aluminum is infinitely recyclable, we didn't have any problems with that, what would be a problem is people throwing it out, so we devised a plan to give an additional 10% discount whenever someone returned their container.

Concept Selection and Generation



Before coming up with the final prototype, we each came up with different versions of what the container could look like. We made all sorts of 3 dimensional models and calculated the optimized area that would hold the most amount of food but wouldn't be overwhelmingly heavy.

Testing and Evaluation

Our final result ended up being a 4 inch radius 4 inch height cylindrical shape and weighing 2.43 pounds. This result was much larger than our original design because we thought it would be better to have more space rather than not enough for people. We also did a cylindrical shape so that we could add a screw on lid which would keep the food inside more securely even if the container was dropped.

The end cost was $0.60 per container which isn't too far away from the target amount of $0.50. Even though it's only 10 cents, that could add up and over time, Penn state could lose money because of that 10 cents per container.

We believe the aluminum does its job maintaining heat. The alloy we used, aluminum 4032-T6, wasn't as heat transferrable so that it wouldn't absorb all the heat and would keep the inside at about the same temperature for longer than other alloys such as aluminum 6061.

The container is made of all aluminum which means that the whole container will be 100% recyclable. This will definitely reduce the amount of styrofoam that will be wasted in the dining halls each year.

Overall, we think our product is a little too large and costly. The area of our new design is about 279% larger than our original design. It also costs $0.10 more. If we shrank the size, we could still contain a large volume while also decreasing the manufacturing cost of each container. We also think that the square shape would be superior to the cylindrical shape because it would be easier to manufacture, and would be easier to hold.

Alternate Concepts

- Aluminum trays (eating at dining commons)
- Reducing Styrofoam usages

Perform a Solidworks Sustainability Analysis

As a group we performed a sustainability analysis in Solidworks with our assembly container. We provided specific information for our model such as where will our container be manufactured and where will it be used mostly. We decided that the North American region will be best for our container and the region will determine the environmental impact of our product. The other information provided was that our product is made of aluminum alloy 4032-t6. With the information provided we review the results that the sustainability analysis provided us. Then we compared the result we got with common alloys such as alloy 1060 and alloy 3003-O to determine if our type of alloy 4032-t6 was the better option. Alloy 4032-t6 was our baseline so comparing it with alloy 1060 we saw an increase in carbon footprint, energy consumption, and air acidification. The results was that there was increase of 6% in carbon footprint, 7% increase in energy consumption, and 4% increase in air acidification. Also there was a large increase in material cost which the percentage was 300% increase from our baseline cost. After comparing alloy 4032-t6 with alloy 1060 we compared our alloy again with alloy 3003-O. The result of the this comparison was similar to the last comparison. With Alloy 3003-O we saw a 7% increase in

carbon footprint, 8% increase in energy consumption, 6% increase in air acidification, and a 320% increase in material cost. These percentages may seem trivial but it does have a major impact in our goal of making a product that is environmental friendly.

Refined Results/Knowledge Learned

From the start of our Alcoa project we began to realize the importance of narrowing down our many ideas to one main goal. This being said, we critiqued our goal time and time again to make it as efficient and sustainable as possible to meet the wants of the customer and Alcoa. As a team we completed a Customer Needs Analysis to help define the most important aspects of our project. This having been one of the first times we have ever implicated a Customer Needs Analysis we felt it strongly helped us define our project. Aside from the analysis, we spent a large amount of time choosing which Aluminum alloy would best fit our design. First, we chose various different Aluminum alloys for the Solidworks Sustainability Analysis. Then, we narrowed our choices down to four of the alloys which results best fit our target specifications in the following categories: environmentally friendly, cost of production per container, and weight. After about two hours of research and working together as a team we decided on the Aluminum alloy 4032-t6.

Future Modifications

Looking back, having completed our Sustainability Analysis and the prototype, we decided there would be a few modifications we would like to implicate if we were to reproduce a new and improved model version of our current design. One change would be the shape of the container. We are not so sure that the cylinder shape maximizes space as well as is easy to hold and transport. Next, we would like to make an addition to the lid in the form of a handle to allow the take-out process to create less hassle. This would allow people to use just one hand to carry the container, allowing a free hand to open doors or carry a beverage. So, by using the handle there would be no risk of spilling the food as it is sealed tight by the screw-on lid. Lastly, being the one target specification we did not meet was our weight, we plan to change the dimensions to allow for a lighter weight container, even if it does not quite meet the target weight.

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