

Alcoa – Sustainability

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Alcoa

EDSGN 100 – Section 012

Team 5

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Project Website: http://sedtapp.psu.edu/design/design_projects/edsgn100/fa13/

Project Summary: The goal of this project is to take advantage of aluminum's intrinsic properties to increase efficiency or sustainability of products and product systems across campus. In order to do this, teams must first identify an opportunity to introduce aluminum on campus and examine its use at all inputs and outputs. The teams must then use the materials available to create a design solution, investigate how others respond to the solution, and ensure that the solution meets performance and regulation requirements in an economically viable manner. Teams will present their findings, including models, cost analyses, and implementation plans.

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Introduction

Millions of smartphone cases are sent to landfills when users upgrade to new phones, so introducing affordable, protective aluminum phone cases and a new recycling program at Penn State will aid in sustainability by reducing the amount of plastic that is wasted.

Sustainability: Sustainability is providing the best for people and the environment both now and in the indefinite future. It is the capacity of resources to endure use.

In the early stages of the project, the team's focus was to find an innovative way to introduce an aluminum-based product that would be functional and appealing and that would reduce the amount of recyclable materials that go to landfills every day. With these parameters in mind, the team began to brainstorm for ideas that would affect the largest group of people on the University Park campus – the students.

To achieve this goal, the new product would have to be useful to students. Useful means that the new product would either fulfill or surpass the functionality of its substitutes for a comparable cost. After finding the best group for which a product would be designed, the team determined the features that the product would have to have. The product would have to be feasible, highly recycled by students, cost-effective, and it would have to have an easy recycling process.

Feasibility refers to how realistic it would be to put the idea into effect. Going into the design process, the team assumed that a new recycling program or an addition to a current recycling program would have to be introduced. This was considered under the feasibility feature.

Concept Development

The team used the features above to list five ideas that fit the constraints of this project. These ideas were aluminum to-go cup lids, aluminum trash bins, aluminum keyboards, aluminum disposable cups, and aluminum phone cases. These ideas were analyzed, and two were eliminated, narrowing the options to three. The team eliminated to-go cup lids because aluminum did not appear to improve sustainability or efficiency on campus, and the team eliminated aluminum trash bins because the team believed that this would not be an economically viable solution.

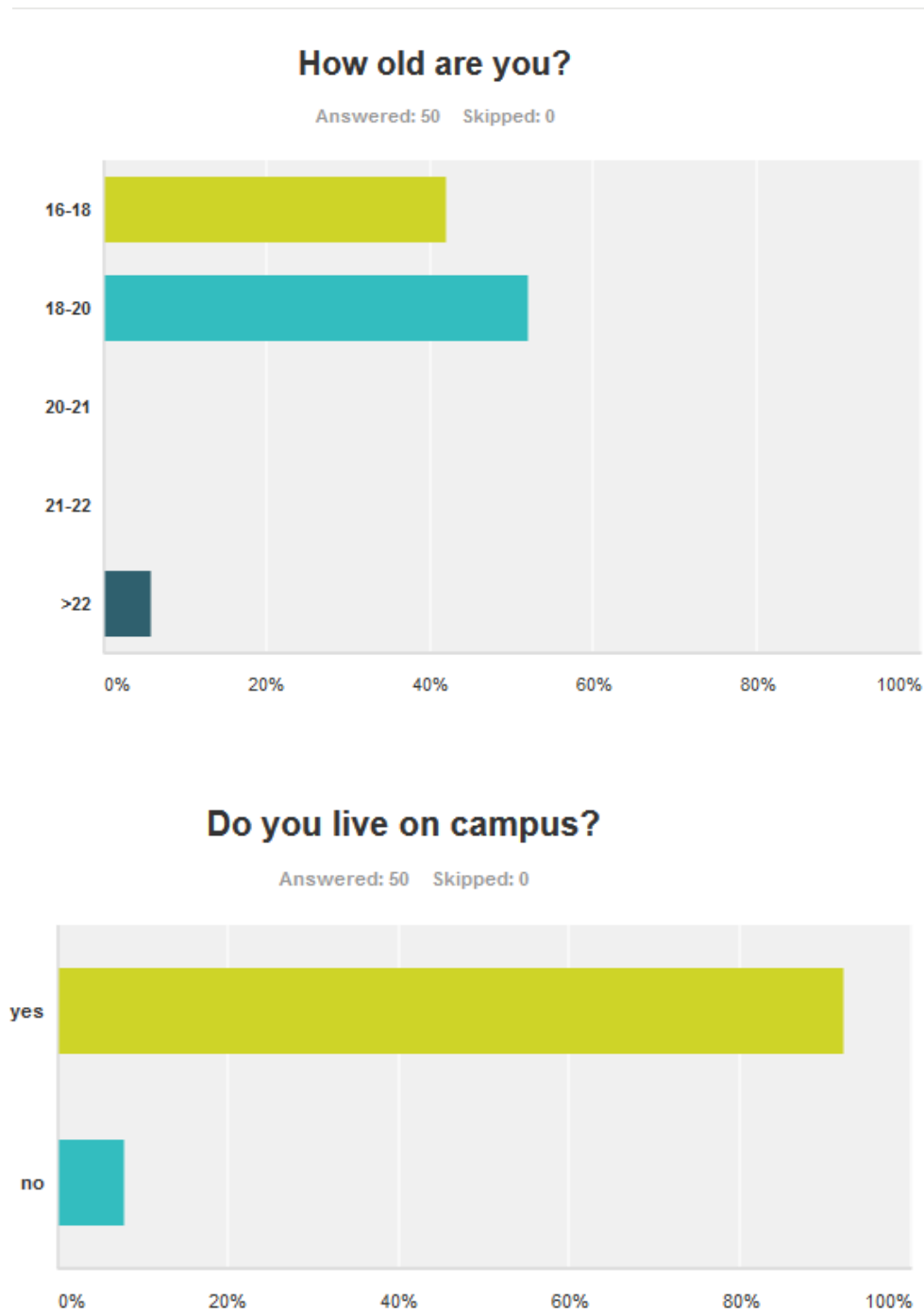
After narrowing the options, the team created a design selection matrix, seen in Table 1, to determine the top two ideas. For the design selection criteria, the team used the features that the product should have and gave them equal weight. The values given to concepts for each of the criteria ranged from one to five. A score of one represented poorly suiting the criterion, and a five represented suiting the criterion very well. The team based these values on each member's judgment from his previous experience. The concept receiving the lowest score would be eliminated.

Table 1: Preliminary Design Selection Matrix

Features	Aluminum Keyboards	Aluminum Phone Cases	Aluminum Cups
High Recycling Rate	2	3	4
Cost to put into effect	2	3	3
Feasibility	5	1	3
Ease of Recyclability	1	4	5
Demand for Product	3	4	4
Total	13	15	19

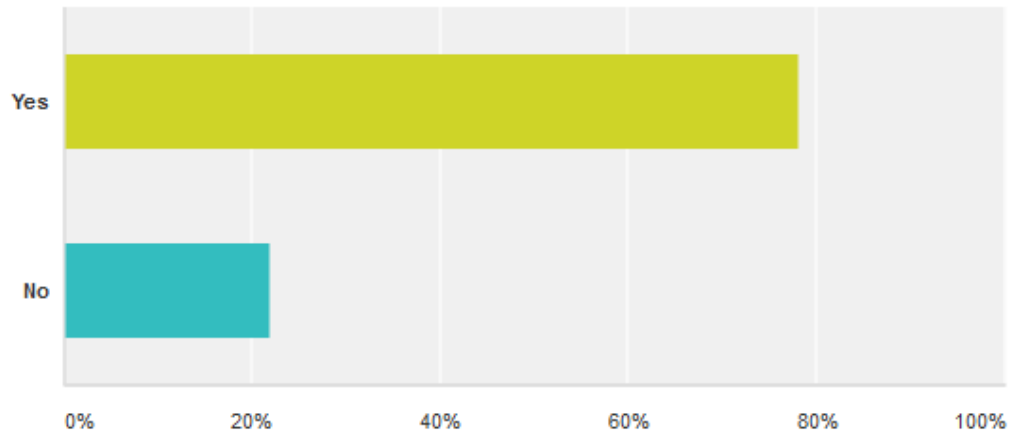
The concept for aluminum keyboards was eliminated after analysis from the design selection matrix. After this elimination, the team discussed at greater length what each of the two remaining concepts would entail, including detailed design ideas, marketability, possible vendors, and the recycling program changes that would have to be made. The team also conducted surveys using www.surveymonkey.com to gain a greater understanding of the group that would be using these products. Links to the surveys were posted on the Penn State Class of 2017 Facebook page. Figure 1 shows survey questions and results for aluminum disposable cups, and Figure 2 shows results for aluminum phone cases.

Figure 1: Survey Questions and Results for Aluminum Disposable Cups



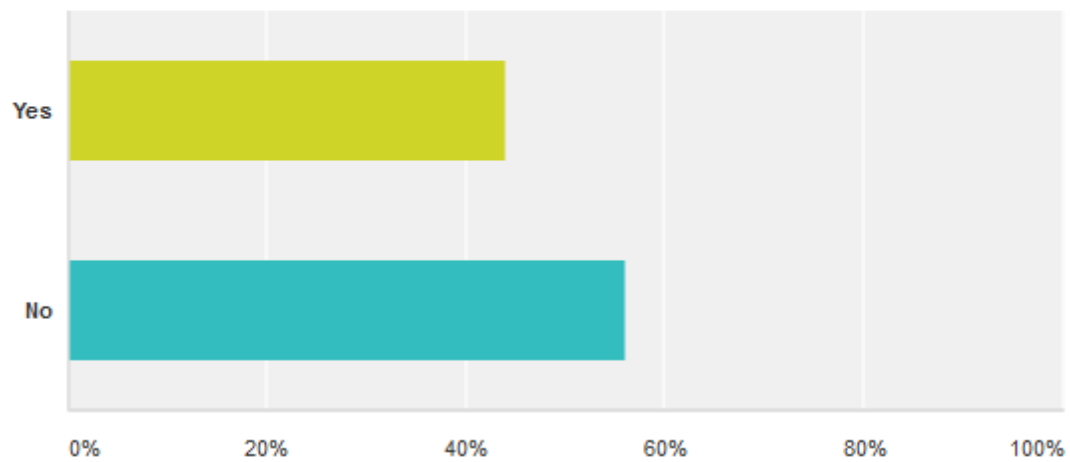
Do you usually buy in the On-campus stores?

Answered: 50 Skipped: 0



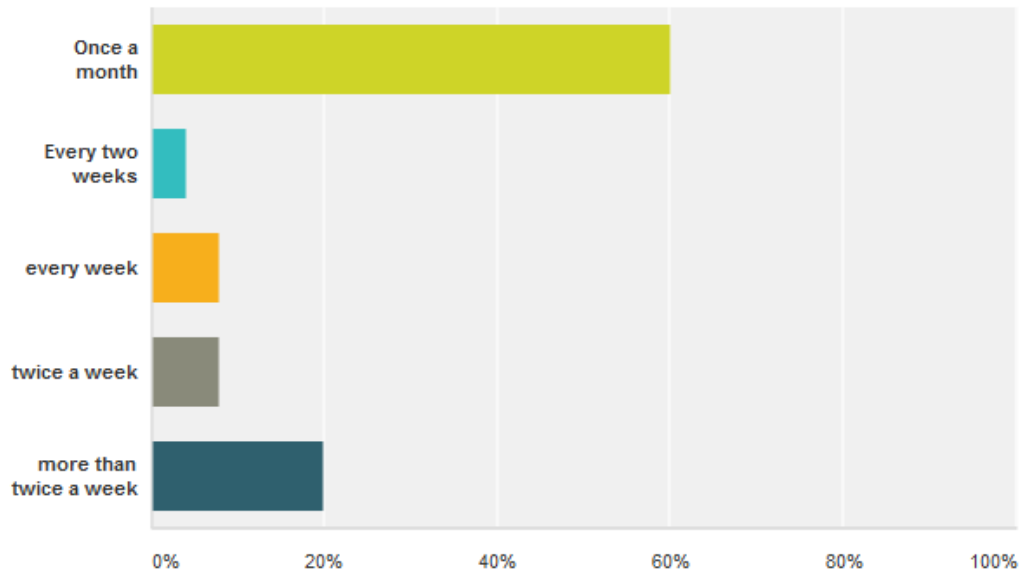
Do you use disposable cups?

Answered: 50 Skipped: 0



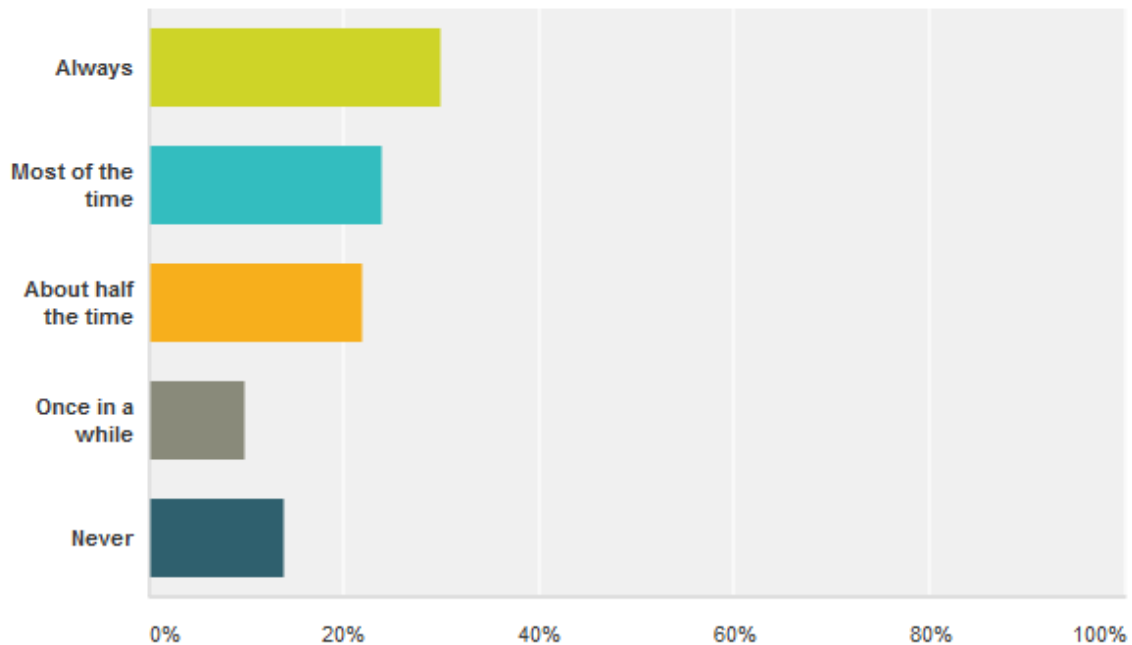
If you answer Yes, How often do you buy a packet of cups?

Answered: 25 Skipped: 25



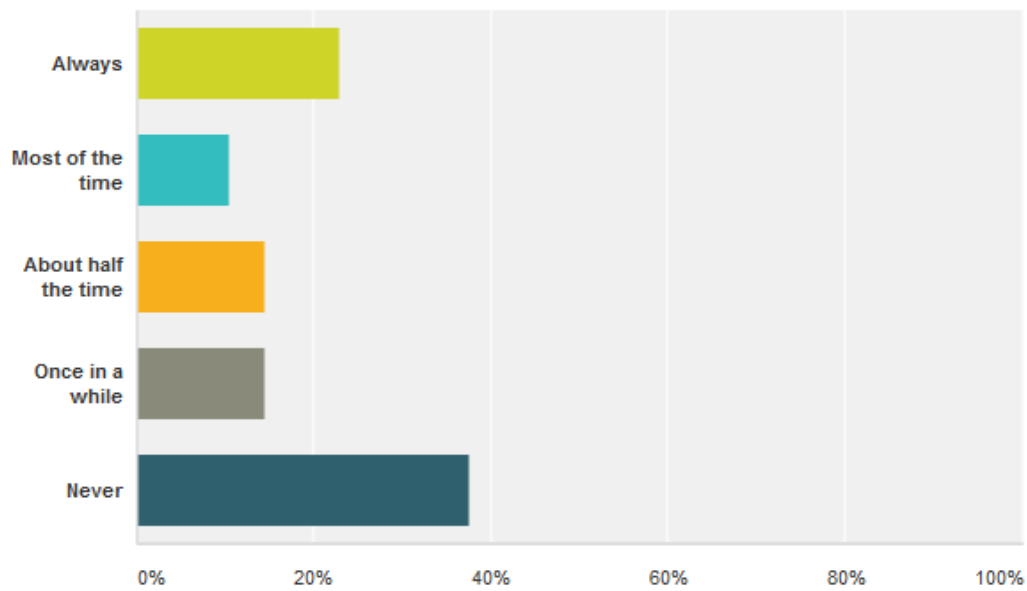
How often do you recycle?

Answered: 50 Skipped: 0



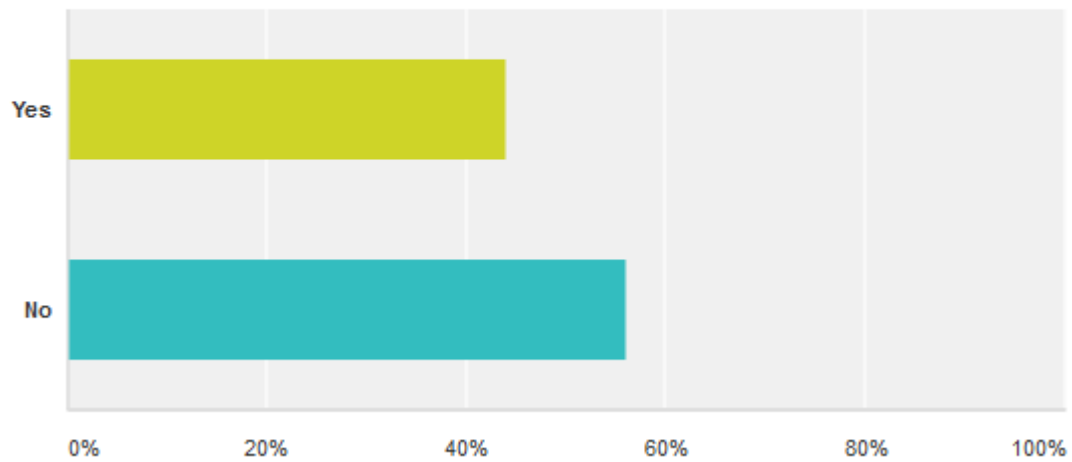
How often do you recycle disposable cups?

Answered: 48 Skipped: 2



Would you buy an aluminum disposable cup?

Answered: 50 Skipped: 0



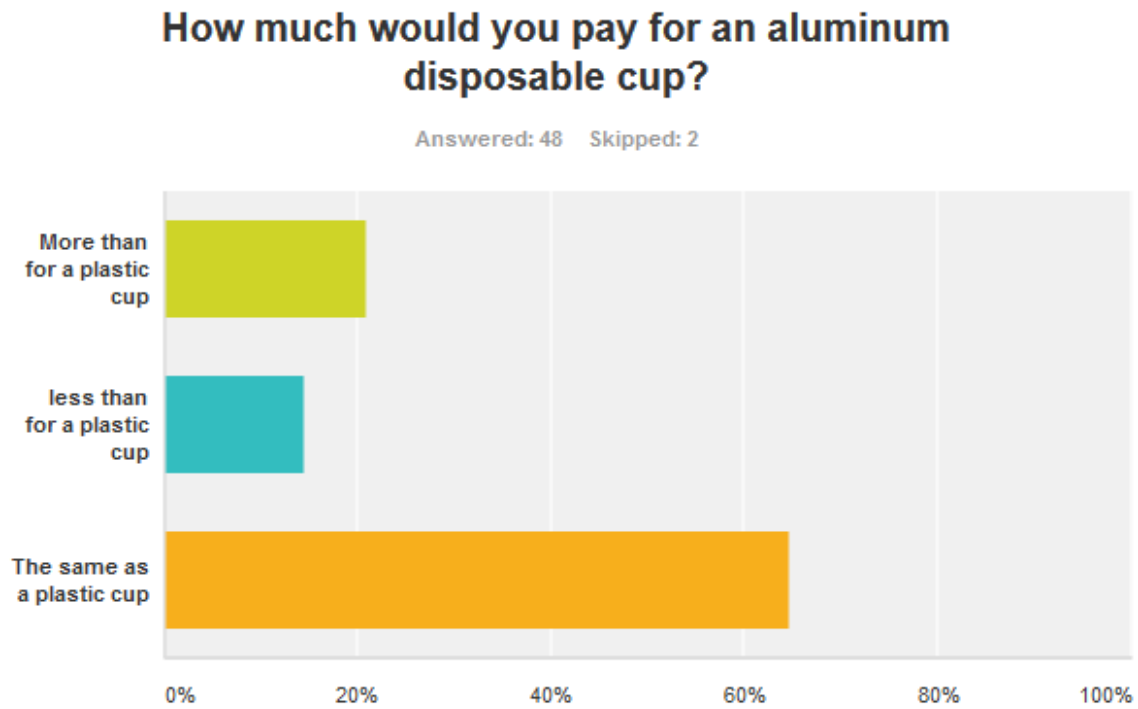
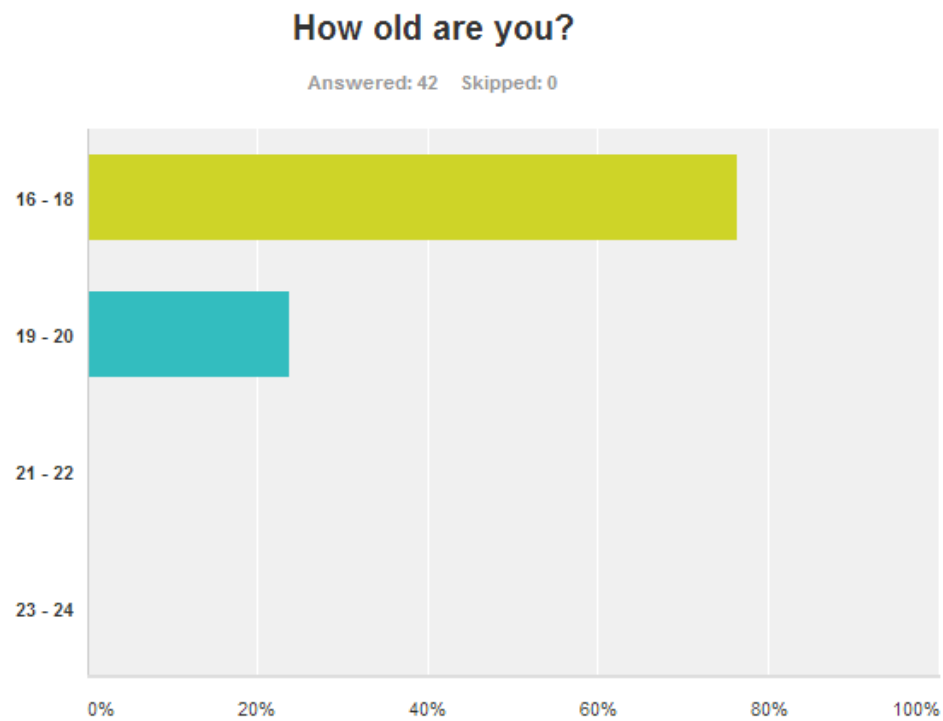
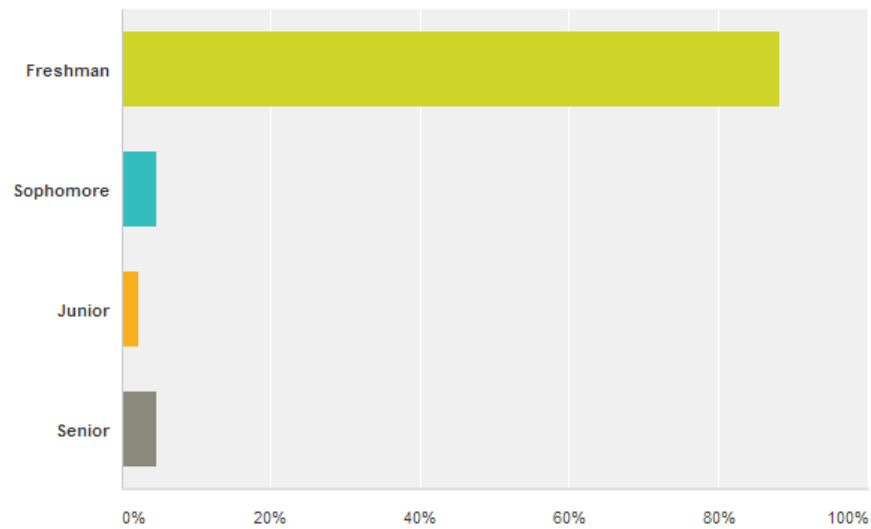


Figure 2: Survey Questions and Results for Aluminum Phone Cases



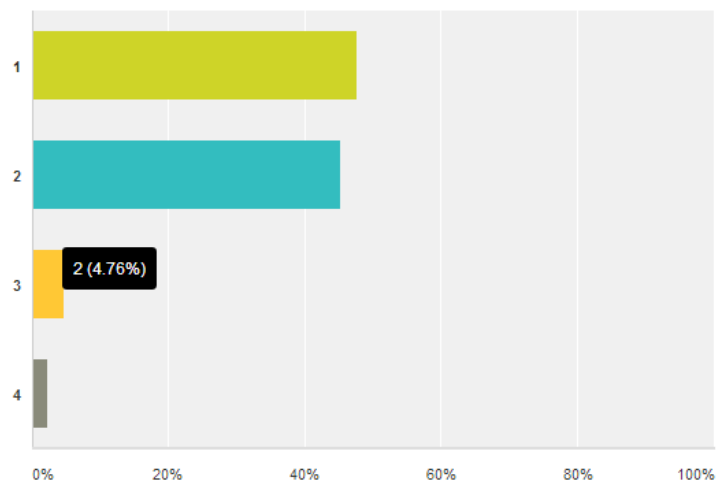
What year are you? Choose the best that applies

Answered: 42 Skipped: 0



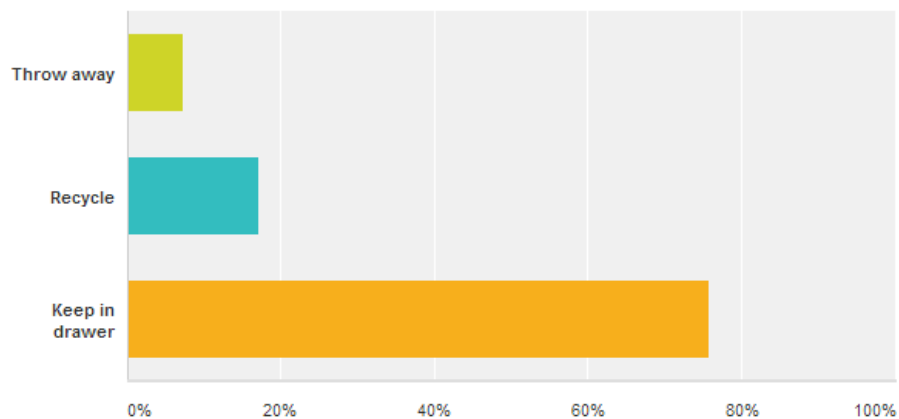
How many phones have you had in the last year?

Answered: 42 Skipped: 0



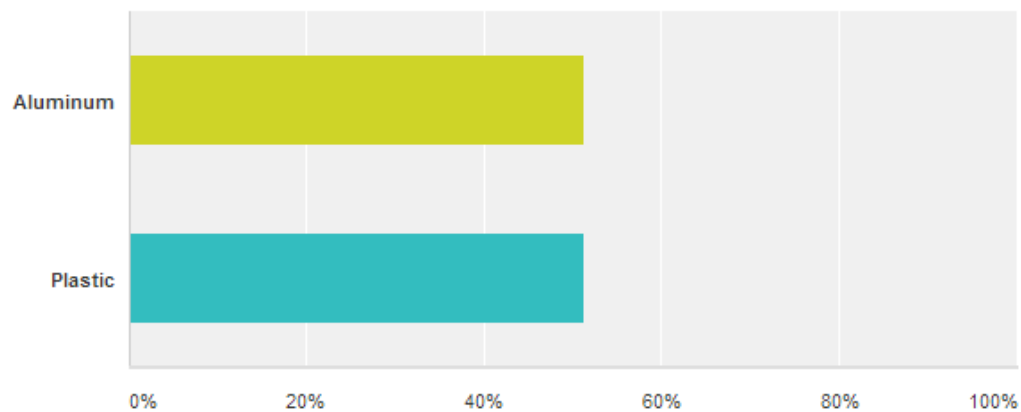
When you get a new phone what do you do with the old?

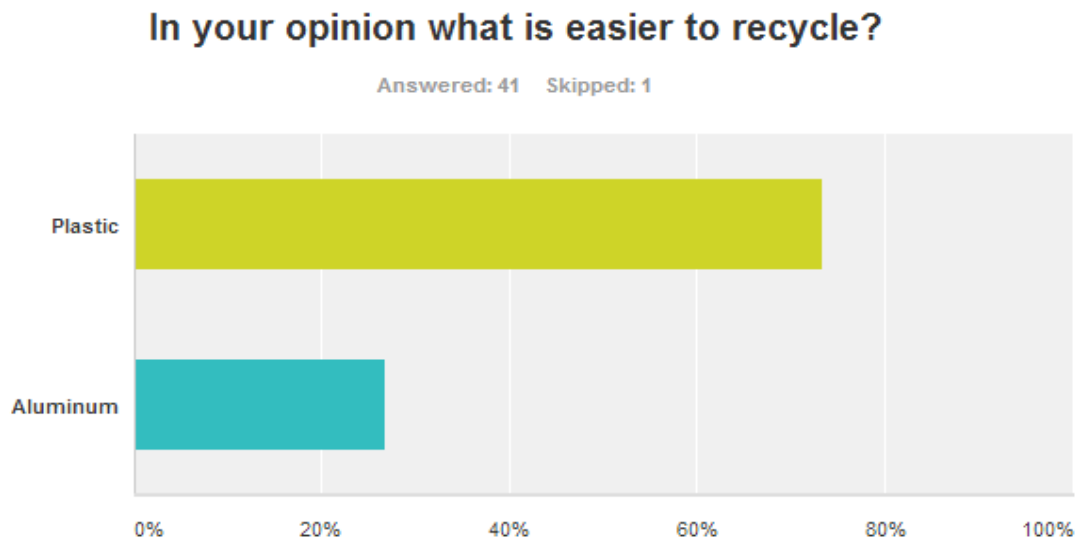
Answered: 41 Skipped: 1



Was your last phone made of aluminum or plastic?

Answered: 41 Skipped: 1





According to the responses, neither concept showed significant support. For example, less than half of the responders would actually buy an aluminum disposable cup. However, responses in both surveys indicate that the public would benefit from education about the recyclability of aluminum. The team believes that this can be incorporated into the new recycling programs.

A new design selection matrix that incorporated a criterion labeled “Favorability Based on Surveys” was created. The features previously included as criteria remained in the new matrix, and all criteria were given equal weight. With the new knowledge and greater understanding of the two remaining concepts, scores were given to the concepts for each criterion as seen in Table 2.

Table 2

Features	Aluminum Phone Cases	Aluminum Disposable Cups
High Recycling Rate	3	4
Cost to put into effect	3	3
Feasibility	3	3
Ease of Recyclability	4	5
Demand for Product	4	4
Favorability Based On Surveys	2	2
Total	19	21

The concept with the highest total score was the aluminum disposable cup. The team faced a dilemma here. Although the design selection matrix showed aluminum disposable cups to be the superior concept, the team decided to select aluminum phone cases. With information traveling among teams, it appeared that disposable containers were the most common concept. The team decided that aluminum phone cases would be a more innovative concept than aluminum disposable cups. Also, the team believed that aluminum phone cases could be made customizable for a small marginal cost. Thus, the aluminum phone case would be made more appealing to consumers.

After choosing this final concept, the key stakeholders were discussed. That is, who would be interested in, or impacted by, this design? The team determined that the key stakeholders (for the University Park area) would be students and electronics accessory vendors. These vendors would include places as small as phone case stands in the Nittany Mall to places as large as Wal-Mart. Many of these places can be found on the University Park Campus or a short distance away, such as the Student Bookstore. Because students are constantly around the places that sell phone cases, the team believed that this concept would sell very well, given that the product is functional (it protects the phone sufficiently) and costs a reasonable amount. If successful, the team believes that this product could be marketed world-wide, producing positive global effects.

Detailed Concept Development

After determining the final design solution, the team began designing a CAD model for an example phone case that would be the basis for cost analysis. The model used was the Nokia Lumia 520. The cases themselves will consist of a 6061-T4 milled aluminum overlay with a rubber underlay. Figures 3 through 6 show the multiple views of the overlay that would be used for the Nokia Lumia 520. This shell is designed to conform to the shape of the phone leaving sufficient space for a rubber underlay that would be between two and four millimeters thick.

Figure 3: Isometric View of the Nokia Lumia 520 Aluminum Overlay

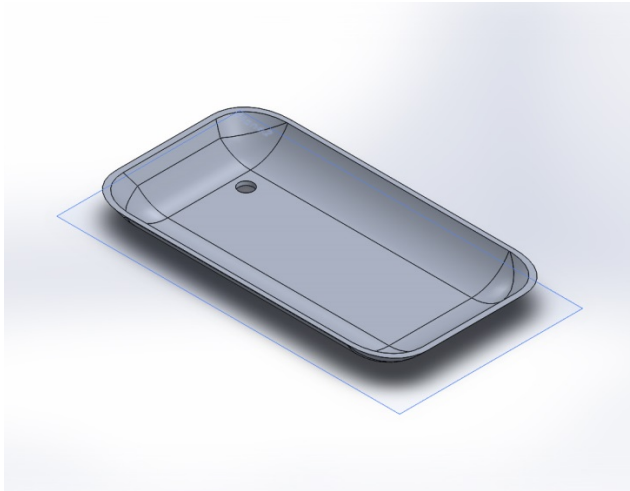


Figure 4: Side View of the Overlay

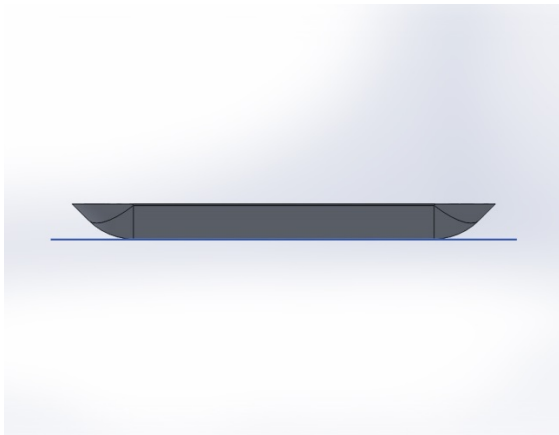


Figure 5: Front View of the Overlay

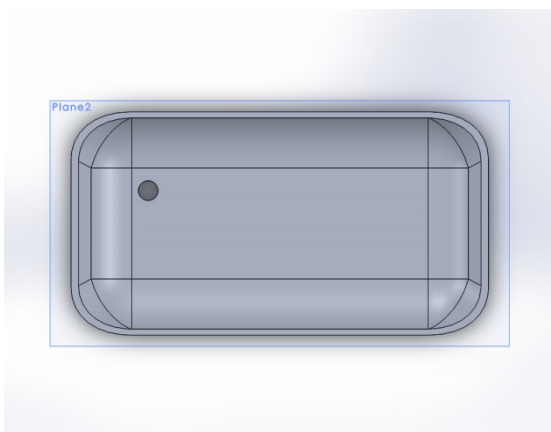
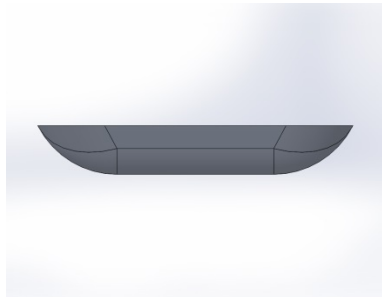


Figure 6: Top View of the Overlay



Using the Nokia Lumia 520 as the standard for the cases, the team began cost analysis and found that the price per case would be approximately \$8.00. It was determined that this price would result in approximately a 24% profit over ten years. This price was determined using the assumptions that:

- Electricity cost per case is \$0.25
- Materials cost for the aluminum and rubber is \$8.00
- \$2.00 would be subtracted from the cost because the cases use recycled aluminum
- Two machines would be purchased at a price of \$75,000
- NRE cost would be \$43,000
- Labor costs would be \$80,000 per year (two workers)
- 500,000 cases per year would be produced; and
- The U.S. discount rate will remain at 0.75% over ten years

The figures used for cost analysis were approximations. However, due to the inelasticity of the market for cell phone cases, the team believes that a much higher price could be charged per case in order to maximize profit. If the annual costs became much higher, the price could increase to maintain a reasonable profit margin.

Cases would be manufactured for smartphones from companies including, but not limited to, LG, HTC, Sony, Apple, Nokia, Samsung, and Blackberry.

In addition to manufacturing cases, an addition to the existing recycling program at Penn State must be introduced that incorporates bins for rubber and similar materials and bins for stronger aluminum alloys. Because most students would not recycle the stronger alloys on a regular basis, the team believes that approximately one bin per building for aluminum alloys would be sufficient.

Conclusions

The positive features of this design are its marketability and functionality for a recyclable, two-piece construction. The main purposes of the project were to find an innovative way to take advantage of aluminum's intrinsic properties and incorporate the concept at University Park. This product and the new recycling program will use aluminum's 100% recyclability to reduce the amount of material going to landfills by encouraging a shift from plastic to aluminum. Because smartphones are becoming more common, more students will be getting them. Smartphones are not typically made to endure physical stress like being dropped on concrete, so cases aid in the durability of these phones, which are expensive to buy and to repair.

Because aluminum is strong and light, using it in combination with a second protective piece in a phone case would protect the phone against typical wear. Thus, the aluminum phone case fulfills design priorities, and it does so for a reasonable cost, considering that the demand for phone cases is inelastic (cases are sold for prices ranging from \$1 to over \$100).

The team truly believes that this design solution would be a hit with stakeholders because some students prefer cases that have aesthetic appeal, and others prefer cases that protect the phone without much aesthetic appeal. The team thinks that this solution will be adopted by students and the places that sell phone cases because this case offers both aesthetic appeal and durability against wear and tear.

Appendix A

Cost Analysis Chart:

	Discount Rate	0.75			
	First Cost	193000			
	Annual Cost	3,205,000			
	Units sold annually	500000			
	Cost Per Unit	8			
Year	First Cost	Cost	Income	Electricity cost per case	0.25
1	193000	3205000	4000000	Material cost	8
2		3180963	3970000	Recycle Aluminum	-2
3		3157105	3940225	Cost	6
4		3133427	3910673	Price	8
5		3109926	3881343		
6		3086602	3852233	Annual Cost	
7		3063452	3823342	2 Workers, 40000 each	80000
8		3040476	3794667	Costo to make 500000	3205000
9		3017673	3766207		3,205,000
10		2995040	3737961		
NPV	193000	30989665	38676651		
Profit			0.240325		