Project 2 Final Report

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Team 6

Abstract

The objective of our design project is to create a design for a mobile cell phone charger that meets as many consumer needs as possible. To accomplish our goal, we will go through multiple processes that give us more information and a consumer perspective of the design. From our survey results, we concluded that the majority of people use a cell phone regularly and constantly need it charged. We also concluded that the functions most important to the customer that we can try to improve are its portability, user friendliness, durability, and environmentally safety. Following survey analysis, we were able to develop a design target through a series of procedures (AHP chart, benchmarking, patent search, etc.) that we feel would be ideal for consumers. Concepts were then generated in order to select the best overall concept and come up with a preliminary design. From this preliminary design, design improvements were instituted to ensure a better final design. The most sustainable material was selected for better a better design to prevent harmful effects on the environment. This final design is the best design for our customer needs and overall sustainability.

1.0 Introduction

People always find themselves needing to charge an electronic device while they are on the move. They are very busy and do not have time to charge a device using the standard charging system. As a team, we were tasked with developing a portable charging device that could be used to charge any electronic equipment. This charging device would need to use other sources of power other than regular wall or vehicle power. Some of the primary issues that will be discussed include making a device that can be used in any environment for a specific device. We will have to narrow down our ideas so that we can make a specific charging device for a certain piece of electronic equipment. The processes and tools that we will use will include a customer needs assessment, an external search, concept generation, and concept selection. The customer needs assessment will help us determine the most important customer needs and help us narrow down our design target. An external search will give us a better understanding of the product that is already out on the market so that we can make improvements on our design. After, we will develop concepts based on our results from the other sections and ultimately select the best design to be our prototype.

1.1 Initial Problem Statement

The problem we were given is to create a charging device that can be used for mobile devices that uses other sources than regular wall or vehicle power. The charger will be used for specific devices that will use nonstandard energy sources. The charger must be able to work in any environment that the device is in. We want to make a charger that works for cell phones because almost all people use phones every day and rely on charging devices.

2.0 Customer Needs Assessment

We created a list of questions that we used to survey potential customers. These questioned were developed by the team and given to ten people. This will help us determine the most important customer needs for the design of our charger. After surveying, we can weight our needs based on the importance of each compared to another need. This will ensure that we make sure the most important needs are considered when we develop our charger.

Table 1 Initial Customer Needs List

Durable Affordable Size Weight Efficient Reliable Aesthetics User friendly Simple/ease of use Environmentally safe Portable Sustainable Material Strength	This is our initial customer needs list developed from our focus group and will help us determine our overall customer needs list.

Table 2 Hierarchal Customer Needs List

1. Portable
    1. Size
    2. Weight
2. User friendly
    1. Reliable
    2. Simplicity
    3. Aesthetics
    4. Affordable
3. Durable
    1. Material
    2. Strength
4. Environmentally safe
    1. Sustainable
    2. Efficient

This list shows our hierarchal customer needs list based off of our initial customer needs. This was developed from our results of our survey.

Figure 1 AHP Pairwise Comparison Chart

	Portable	User Fr.	Durable	Environmentally safe	Total	Weighting
Portable	1.00	.33	.50	.25	2.08	.08
User Fr.	3.00	1.00	5.00	3.00	12	.46
Durable	2.00	.20	1.00	3.00	6.2	.24
Environmentally safe	4.00	.33	.33	1.00	5.66	.22

This is our AHP chart comparing our most important customer needs. This tells us that user friendliness is our most important customer need and portability is our least important.

Table 3 Weighted Hierarchal Customer Needs List

1. Portable (.08, .08)
    1. Size (.06, .75)
    2. Weight (.02, .25)
2. User friendly (.46, .46)
    1. Reliable (.046, .10)
    2. Simplicity (.046, .10)
    3. Aesthetics (.023, .05)
    4. Affordable (.23, .50)
3. Durable (.24, .24)
    1. Material (.12, .50)
    2. Strength (.12, .50)
4. Environmentally safe (.22, .22)
    1. Sustainable (.11, .50)
    2. Efficient (.11, .50)

This is our weighted hierarchal customer needs list, which displays specifically all of our needs and their importance which is shown through the weights of each need.

3.0 Revised Problem Statement

Based on our survey results and AHP charts, we have concluded that user friendliness and durability are our most important customer needs along with environmental concerns. We want to develop a charger that is very simple and easy to use for our customer. This can include the cost and reliability of the charger. Also, we want a charger that will last the customer for at least two years to ensure that the charger lasts as long as the phone lasts. We want the charger to be functional in any environment that the customer is using his or her phone.

4.0 External Search

The external search process will involve experimentation with existing devices, a patent search, product archeology, and benchmarking. This process helps us determine useful information about the product's history and other products on the market. We hope to use this information when making our design.

4.1 Dissection/Experimentation

Experimentation involved measuring the charging power of different charging devices and determining the amount of time needed to charge a phone. The amount of power needed to charge a phone was 4.75 Volts, which would needed to be maintained over a certain period of time to charge a phone. We then used different charges to charge the phone and determined that the solar charger took 10 minutes to charge 5% of the battery, the shaking charger took 12 minutes to charge 5% of the battery, and the standard charger took 7 minutes to charge 5% of the battery. We determined that the standard charger generated the most power and was able to charge the phone more quickly than the different chargers. This helped us see that the standard charger would be the best option when trying to develop concepts.

4.2 Patent Search

During our patent search process we searched for something unique in terms of the shape and material of the charger. We wanted something different that drew the consumers' eye but was still effective at doing its job.

What we ended up finding were three relatable patents. Two of them involved the shape; we thought that a round sleek charger would be both aesthetically pleasing and cost efficient. We also wanted it be big enough to install an efficient circuit board that would be able to hold ample energy.

We wanted our product last as long as possible and be able to able to withstand the many impacts it may be subject to throughout the course of the day, so in our patent search we found one involving a sturdy material; that way consumers will be able to use our product for a much longer span of time.

Table 4. Art-Function Matrix for Electric Toothbrush

FUNCTION		**ART**
	Shape	Material
Source of Energy	US6084379	USD382535
OFF Switch		
Detachability	US6030247	

4.3 Product Archeology

The portable phone charger has become greatly more advanced over time. The changes it has seen have made it more convenient to carry around, easier to use and overall, just more user friendly. Older versions of the portable phone charger looked like or at least somewhat resembled this design:

While this device does provide the luxury of being able to provide power to your phone while away from an outlet, it seems like a minor inconvenience to have the charger dangling from your phone. Also, batteries are needed to make this version of the portable phone charger actually charge your phone. Newer versions of the portable phone charger have been made much more appealing and convenient. Newer versions have begun to look like this:

This provides protection to your phone, since it is in a case, while conveniently charging it. There are no extra accessories required and it is essentially a two-in-one deal.

4.4 Benchmarking

As part of our Benchmarking process, we compared available IPhone chargers on the market to our hierarchal list of customer needs. We will compare the regular IPhone chargers and two portable charging systems. This will show us how these products compare to our most important customer needs.

Table 5. Benchmarking of Four Products

Feature	**IPhone Charger**	**Elecom Portable Battery Charger**	**ZAGGSparq IPhone Charger**
Portable	1	2	2
User friendly	4	3	3
Durable	3	2	2
Environmentally safe	1	3	3

These products were based on a scale from 1 (being the worst) to 5 (being the best). The overall scores of each help us determine the pros and cons of each product. We want to be able to incorporate the pros of these and avoid the cons so that we make the best charging system.

4.5 Design Target

After our external search, we learned about the different products out on the market and determined that each one has its own advantages and disadvantages. This helps us because we can use different aspects of each design and try to implement them into our new design. We will be able to use this research in order to develop different design concepts.

5.0 Concept Generation

With all of our information gathered from the start, we started to develop preliminary design concepts that we could use. Each one is unique and has its specific pros and cons.

Concept Classification Tree

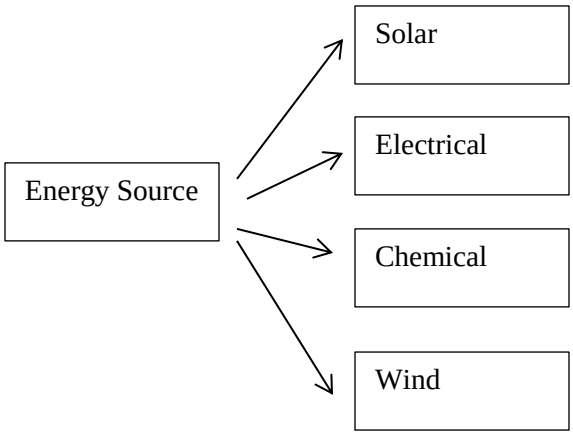
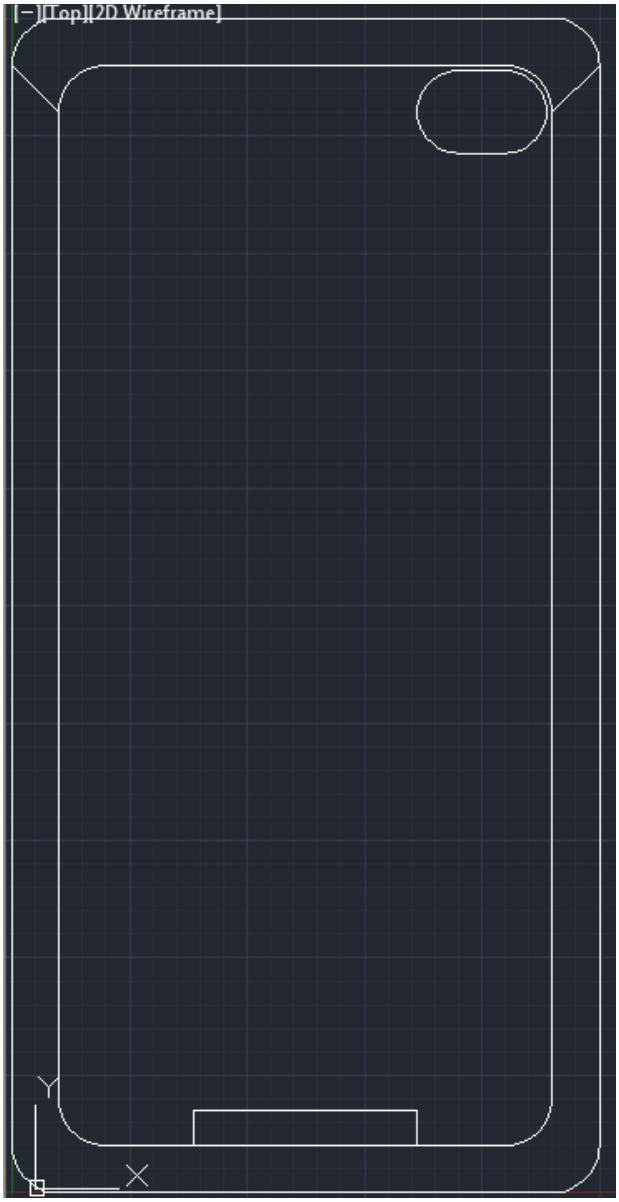


Table 6 Morphological Chart

Portable	**User Friendly**	**Durable**	**Environmentally Safe**
Compact	Simple	sturdy	sustainable
lightweight	reliable	strong	efficient
	Aesthetically pleasing		

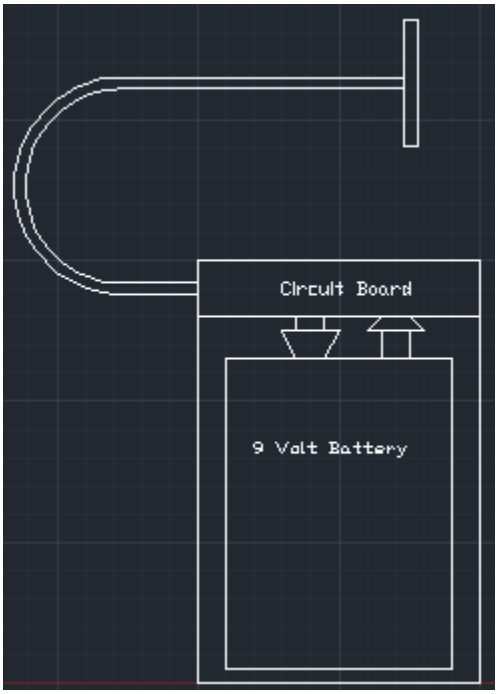
Now, we generated concepts based upon our customer needs list and our problem statement.

Figure 1 Concept 1



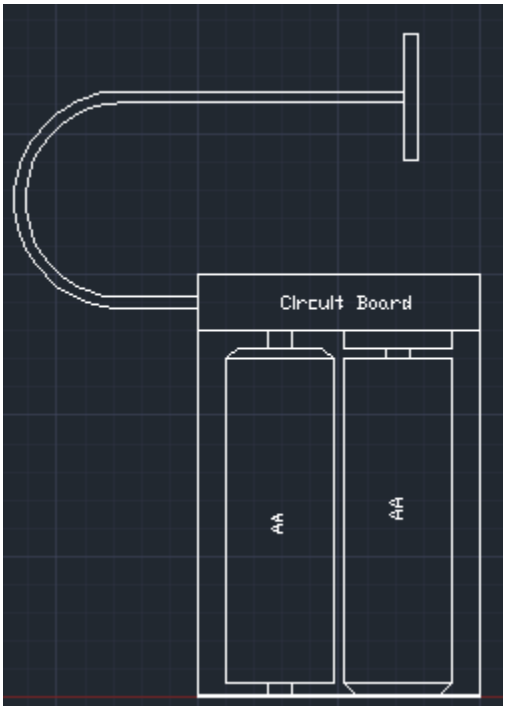
This case is designed to fit around the iPhone 4S. This case acts as a protector against falls and such and also acts as a second battery to keep the phone at full battery for as long as the charge holds. The battery pack inside the case holds a charge for around seven hours. A disadvantage is that it only works for the iPhone.

Figure 2 Concept 2



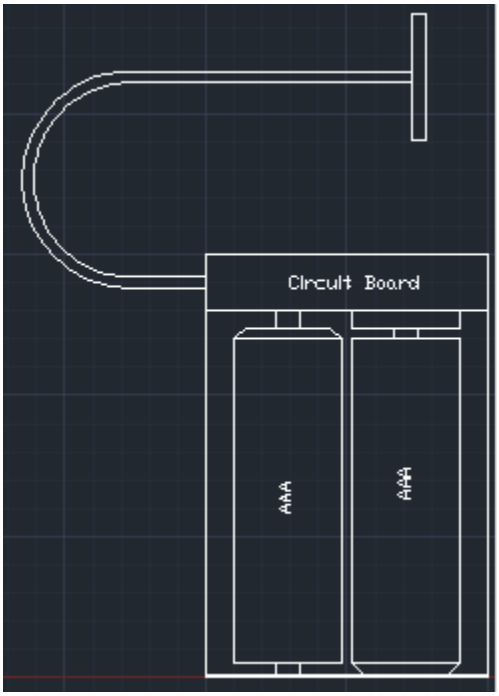
This small battery pack is equipped to charge your phone on the go. It has a spot for a replaceable 9-Volt with easy access to replace the battery when the charge is dry. The circuit board works by directing power from the battery into a USB port then the cable hooks into the USB port and can charge the phone. This is useful because it can adapt to any type of phone charger and is compact.

Figure 3 Concept 3



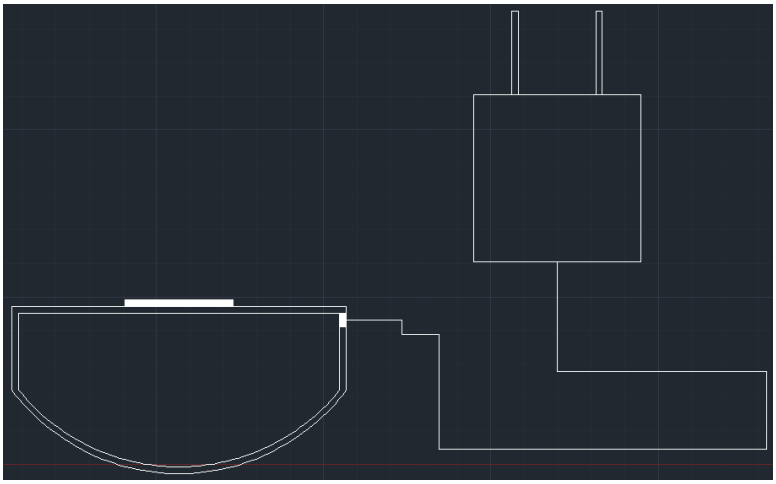
This small battery pack is equipped to charge your phone on the go. It has a spot for replaceable AA batteries with easy access to replace the battery when the charge is dry. The circuit board works by directing power from the battery into a USB port then the cable hooks into the USB port and can charge the phone. This is useful because it can adapt to any type of phone charger and is compact.

Figure 4 Concept 4



This small battery pack is equipped to charge your phone on the go. It has a spot for replaceable AAA batteries with easy access to replace the battery when the charge is dry. The circuit board works by directing power from the battery into a USB port then the cable hooks into the USB port and can charge the phone. This is useful because it can adapt to any type of phone charger and is compact.

Figure 5 Concept 5



This is a very small, lightweight, and portable charging device that using regular wall power as the source of energy to charge the phone.

6.0 Concept Selection

After generating specific topics, Pugh charts were developed to determine the best concept based on our customer needs. Each concept was tested against another concept to determine the best concept.

Pugh Charts

Power Generation	**Portable**	**User Firendly**	**Durable**	**Environmentally safe**	Total	Rank
Weighting	0.08	0.46	0.24	0.22		
Concepts						
Iteration 1						
Rechargeable Case	0	0	0	0	0	1
9 Volt Battery	-1	-1	1	-1	-0.52	2
AA Batteries	-1	-1	-1	-1	-1	4
AAA Batteries	-1	-1	-1	-1	-1	4
Small Charger	-1	-1	1	-1	-0.52	2

Case Design	**Portable**	**User Firendly**	**Durable**	**Environmentally safe**	Total	Rank
Weighting	0.08	0.46	0.24	0.22		
Concepts						
Iteration 1						
Rechargeable Case	0	0	0	0	0	1
9 Volt Battery	-1	-1	0	0	-0.54	2
AA Batteries	-1	-1	0	0	-0.54	2
AAA Batteries	-1	-1	0	0	-0.54	2
Small Charger	-1	-1	0	0	-0.54	2

Device Connection	**Portable**	**User Firendly**	**Durable**	**Environmentally safe**	Total	Rank
Weighting	0.08	0.46	0.24	0.22		
Concepts						
Iteration 1						
Rechargeable Case	0	0	0	0	0	1
9 Volt Battery	-1	-1	1	-1	-0.52	2
AA Batteries	-1	-1	1	-1	-0.52	2
AAA Batteries	-1	-1	1	-1	-0.52	2
Small Charger	1	-1	-1	-1	-0.84	3

From our Pugh charts we determined that the rechargeable case is our best concept based on our customer needs. The rechargeable case is best suited as the most portable, easiest to use for the customer, the most durable, and the most sustainable option.

7.0 Concept Improvement

Black Box Model

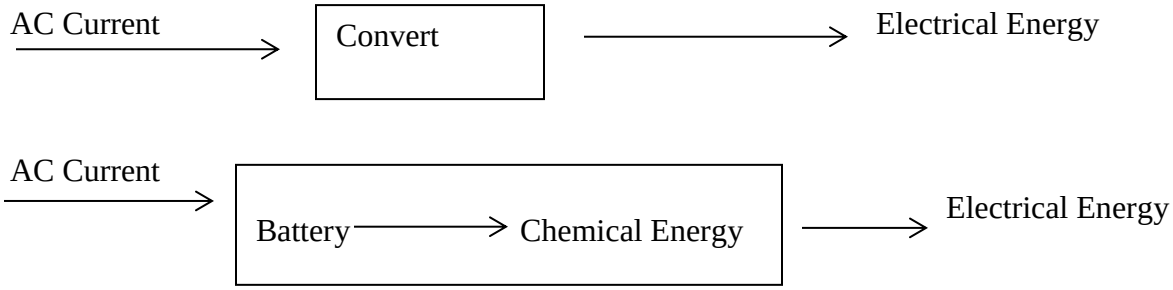


Table 7 Scamper Table

Substitute	Exterior edge: replace plastic with gel like material for added grip and easier use.
Combine	1500mAh battery gives a charge of 5% per 7 minutes combined with gel like grip, multiple different materials used together.
Adapt	Other concepts included batteries which wire into the phone, not fit around the phone itself. Positive: adaptable, Negative: inconvenient. Our design focuses on convenience.
Modify	Adding a strawberry scent to the gel portion of the case will allow people to enjoy the strawberry scent while making phone calls. And red.
Minify/Magnify	Magnify button access on the sides of the phone will allow for easier use.
Put to other uses	None
Eliminate	None
Rearrange	Rearranging components on this phone are minimal because it is form fitting to the phone.

Team 6's overall goal of this project is to make the phone more user friendly by increasing battery length and giving an easier and more efficient overall use of the phone.

After Implementing the Scamper technique, TRIZ is the final technique in the concept improvement section. Our main problem that we have come across is that our battery length of our case can be increased. The battery that our case currently holds is small and does not use the entire area of the phone. We believe that a larger battery can be used to increase the battery life and make the case more form-fitting to the phone.

Larger Battery- A larger battery will increase the battery life of the case so that the case lasts a longer period of time than the actual phone charger. The case will not require any additional charge because the same amount of power is required to charge the battery.

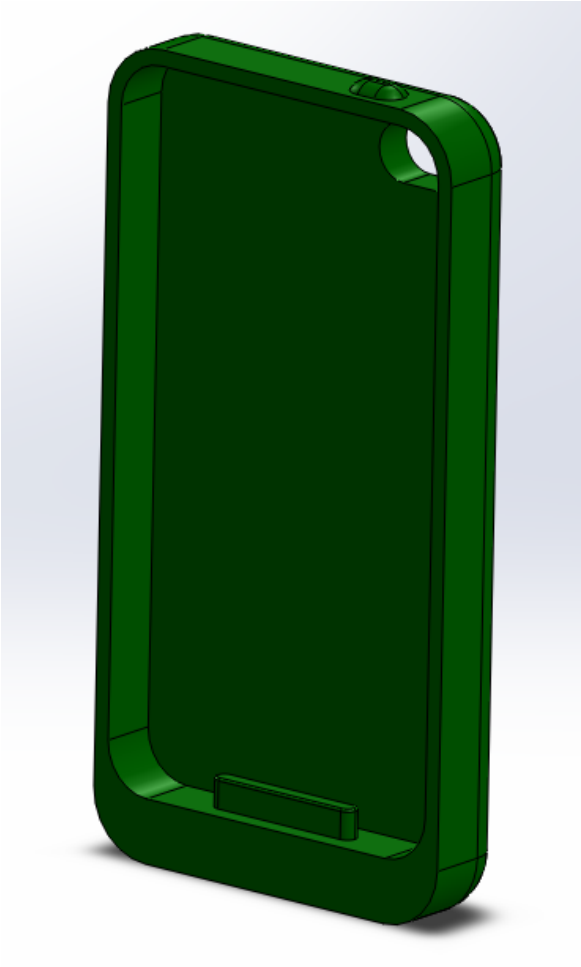
Form fitting to the Phone- Our preliminary design includes a battery that is small in proportion to the phone. We believe that we can implement a larger battery that will cover the entire area of the back of the phone and make the phone more form fitting.

The overall goal of a larger battery is to increase the battery life and make the case more form fitting to the phone, so that the overall user friendliness of the case is increased.

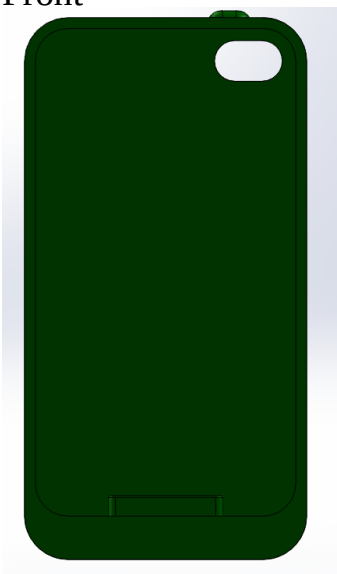
8.0 Final Design

The goal for our portable phone charger is not only to improve the capabilities of the phone itself, but also to make the overall phone more user friendly. Current models may offer a good exterior second battery, but the downsides of those designs are that it takes away from the ease of use of the phone. Our case not only improves the battery life of a single charge, but also features an easier use of the phone altogether. The design incorporates a battery on the reverse side of the case which plugs into the phone itself. The charge was measured to give a 5% charge in 7 minutes and the charge on the second battery can last up to 12 hours. Some of the improvement to the case other than the battery includes easier access to the buttons around the phone and the material, high-density polyethylene, which provides a grip more suited for the phone.

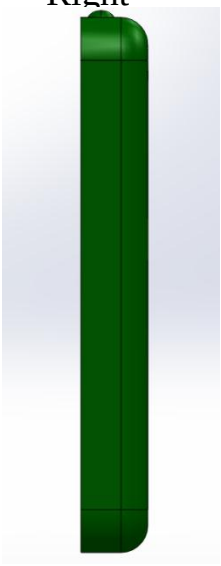
Final Design



Front



Right



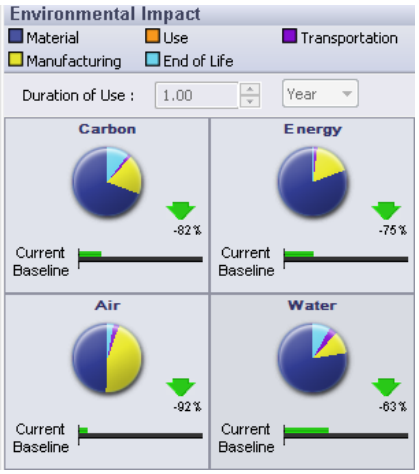
Top

8.1 Materials and material selection

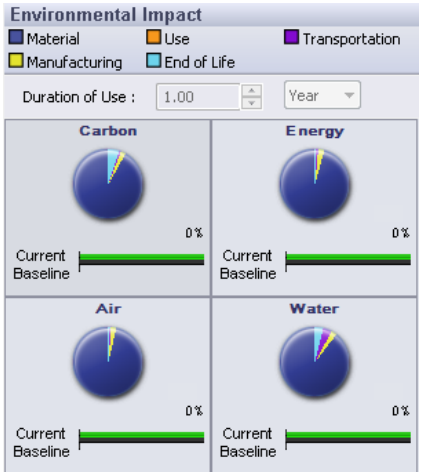
Decision Matrix for Material Selection

Criteria	Yield Strength (MPa)	Norm	Ultimate Strength (MPa)	Norm	Density (g/cm)	Norm	Carbon Density Norm	Total
Weights	.20	.20	.15	.15	.15	.15	.50	
High Density Polyethylene	28	.068	37	.077	.95	.12	.82	.576
Aluminum alloy 2014-T6	414	1.00	483	1.00	2.8	.36	0	.404
Steel ASTM A36 steel	250	.60	400	.83	7.8	1.00	.27	.530

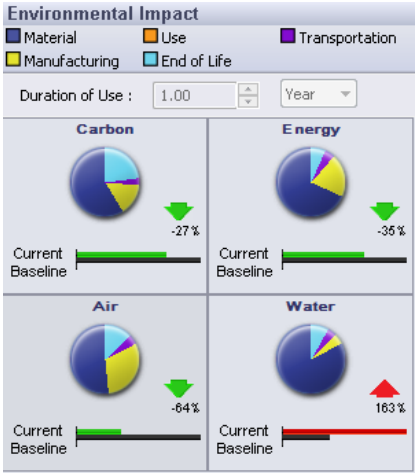
High Density Polyethylene



Aluminum Alloy



Steel ASTM A36 steel



Baseline is Aluminum Alloy 2014-T6

As part of our material selection process, we decided that our most important part of our product is the material of the rechargeable case. This part is our main material that must be considered. We developed our decision matrix for material selection based on yield strength, ultimate strength, density, and carbon footprint. Our most important aspect of the material being selected is the carbon footprint. Based off of our matrix, the best material for our case is high density polyethylene, which is a common plastic which we believe will be strong enough to hold our case together while still being lightweight for the customer. Also, the carbon footprint of this plastic is very low compared to our other materials, making it a more sustainable product.

8.2 List of Materials

Table 7 List of Required Materials

Qty	Description	Item Number	Vendor	Total Cost
1	HDPE 24" x 48" 1/32" Thick	42584	US Plastic Corp.	$11.69
1	Polymer Lithium Ion Battery - 1500mAh 11.1v	PRT-10470	SparkFun Electronics	$12.95

Table 8 Contact information for suppliers of required Materials

US Plastic Corp. 1390 Neubrecht Rd Lima Ohio, 45801-3196 1-800-809-4217	SparkFun Electronics 6175 Longbow Drive Suite 200 Boulder, CO 80301

8.3 Cost and Life Style Cost

Our main material that we are using for our case is high density polyethylene. This material is one of the most common plastics on the market and can be found readily. Also, since this plastic is very common, it is easily and cheaply manufactured. Because of this fact, we feel that high density polyethylene will be very efficient for our life style cost. Our case can be manufactured cheaply because of the abundance of polyethylene. This will ensure that this cost of our final product will be cheap enough for the average American. We feel that the total cost for our phone case will be around $40.00 based off of our materials and manufacturing process.

9.0 Conclusions

In conclusion, the final design we were able to produce is durable, portable, user friendly, and environmentally safe.

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Appendix

Team 6 Survey

1. How often do you charge your phone?
   A. Multiple times in one day
   B. Once a day
   C. Every other day
   D. Every few days
2. Do you feel that you charge your phone too often?
   Yes
   No
3. Do you unplug your charger when not in use?
   Yes
   No
4. Do you feel that your phone charger is too big? Too small?
   A. Too bulky, gets in the way
   B. Just right
   C. Too small, difficult to use
5. Do you charge your phone at the same time during the day?
   Yes
   No
6. Do you regularly worry about your phone dying?
   Yes
   No
7. Are you sometimes in situations where you need to charge your phone but do not have a charger or outlet?
   Yes
   No
8. Do you bring your phone charger around with you?
   Yes
   No
9. Do you often forget to charge your phone?
   Yes
   No
10. How long does your phone typically last?

11. Was your phone charger included in the price of the phone?
    Yes
    No