Magicharge

Introduction to Engineering Design

Section 018

EDesign100

Design Project #2

Report

The Allegiant

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Executive Summary

As an Engineering Design team, The Allegiant, we are collectively creating a Cell Phone Charging Sensor, the Magicharge, to create a more convenient lifestyle. The world has become technologically advanced in numerous ways and is continuing to become more advanced. As the world's connectivity is increasing, it is difficult to efficiently stay on pace with our rapidly growing technological society. As society is changing, our generation as a whole is becoming more dependent on cell phone use. Numerous professionals depend on cell phones to assist them throughout their hectic day. The problem is that cell phones do not have an eternal battery and they have to be charged. Numerous times we forget to charge our phone or we simply do not have the time. We then are faced with limited battery usage that will eventually run out midday with the potential risk of missing important events we could have avoided. Our Cell Phone Charging Sensor will help avoid missing an event due to a low battery which will ultimately benefit and enhance lifestyles of our technologically advanced generation.

Magicharge

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1.0 Introduction

As an Engineering Design team, we are working to create a Cell Phone Charging Sensor, Magicharge, to improve lifestyles of our technologically advanced generation. The use of technology has become more widespread throughout the world. New technologies are emerging everyday as our generation is becoming exposed to ideas that help improve the everyday life. Our generation is becoming more dependent on phones but they are not everlasting. Our goal is to create a Machine-to-Machine solution for low battery complications while being cost efficient. We will use real-time connectivity inside a home to connect a cellphone to a charging unit in a room of choice. In designing this technology we will create a convenient and time efficient way to charge a cell phone. This new technology will benefit the lives of every cell phone consumer of this generation and generations to come. In order to accomplish this technology we chose the best option that will efficiently charge a cell phone. In this report we will analyze the best cost and the environmentally efficient materials to use. Subsequently, we will discuss what functions would be the most beneficial to everyday lives, while researching existing charging units so that we do not infringe on those technologies. We will then discuss how these functions will work and how they will benefit the technologically advanced lifestyles of our generation. We will finally evaluate our technology and how well we benefited the lives of our technological society.

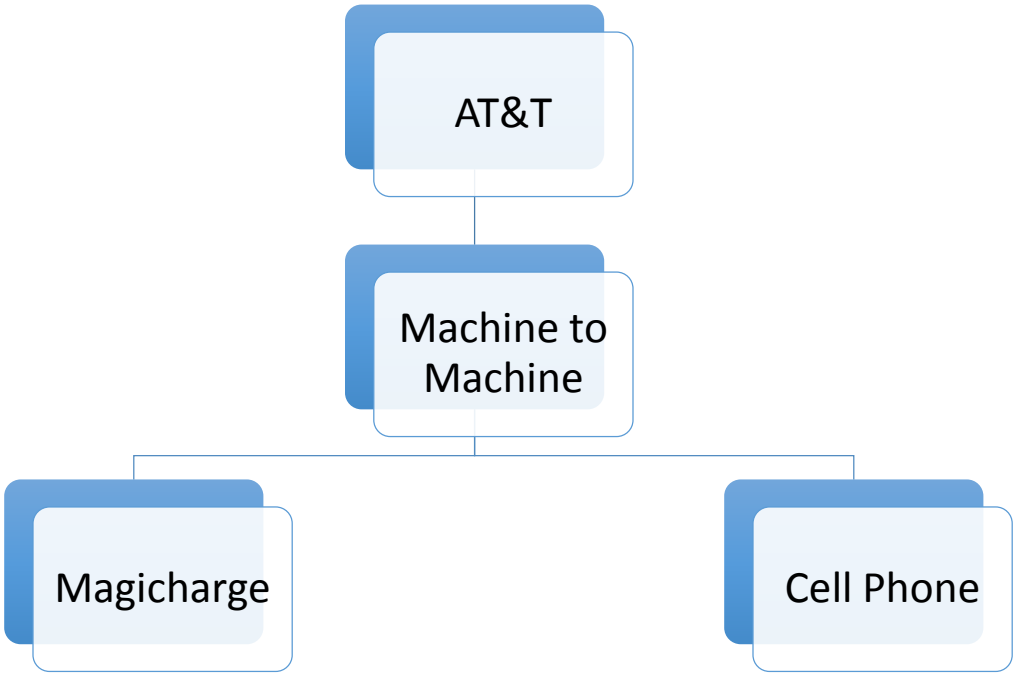
2.0 Mission Statement

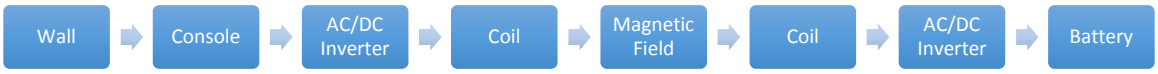
As an Engineering Design team, we have been encouraged to create a Cell Phone Charging Sensor that will enhance and benefit the lifestyles of our rapidly growing technological generation while being cost and time efficient. Our technological goal is to use real-time connectivity to create a Machine-to-Machine solution for cell phone low battery complications that could be used conveniently inside a room of a house. Our technological goal will help generate the overall goal. Our overall goal is to produce a convenient and time efficient way to charge a cell phone that will improve the consumer's lifestyle now and in the future. We will ensure that this technology will be of the highest quality to put on the market that will eventually improve the world's lifestyle as a whole.

2.1 Machine-to-Machine

Our technological goal is to create a Machine-to-Machine solution using real-time connectivity in relation to AT&T. We would use the connectivity through AT&T as a Machine-to-Machine solution to create our Magicharge for cellphones. Our Design team thought the best to describe and depict the relationship of our product was through a Systems Diagram. This is shown in Diagram 1.

Diagram 1- Systems Diagram





3.0 Customer Needs Analysis

We addressed our technological and overall goal of creating a Cell Phone Charging System in our mission statement. In order to design the most beneficial technology, we needed to analyze what was most important to the consumer and how to satisfy their needs. Our technology not only had to fit the consumer's needs, but also had to be cost efficient. In order to do this we had to consider features that would be most satisfying to the consumer. We also had to consider the materials and ways of connectivity to make the technology work. After we analyzed and extracted the features, we created a design that would satisfy the consumer's wants while being cost efficient.

3.1 Hierarchy of Customer Needs

In order to evaluate and analyze the customer's needs, we needed to create a list of features we think consumers would look for and want most in a cell phone charger. After the list was created we ranked the features in order of importance from 1 to 5, with 5 being the most important. A feature is listed as important based on how the needs of the feature are relative to the want of the feature. This list is shown in Table 1.

Table 1- Hierarchy of Customer Needs

Need	**Importance**
Affordable	5
Convenient	5
Appearance	2
Environmental Friendly	4
Size	3
Moveable	3
Lightweight	4
Time Efficient	5
Easy To Use	5
Durable	5

3.1.1 Product Dissection

First, we extracted and analyzed our Cell Phone Charging Sensor, Magicharge, to each individual component to see what could be improved upon and what the weaker components were. Table 2 shows the individual parts of the charger, including materials and its function. Table 3 shows the features of the charger to see if their job is carried out efficiently. We also evaluated how important the feature was to the customer. Table 4 shows what market the charger would be sold to and the cost of the charger rom external research. While dissecting the charger, we saw that the charger was a bit complex but it would sell relatively well in the market. We also saw that some of the features were counterproductive so we eliminated some features. We then drew a design of our charger that would satisfy the customer needs while being cost efficient and productive.

Table 2- Product Components

	Magicharge Parts	Material	Function
1	Console Coil	Copper	Exchanging energy through magnetic coupling.
2	Sticker Coil	Copper	Help exchange energy through magnetic coupling.
3	AC/DC Inverter	Metal/Magnetic Field	Convert the direct current coming from the wall outlet to the alternating current.
4	Electrical Plug/ cord	Thermoplastic	To power the system.
5	Misc. Wires/Circuitry	Metal	To make the system run.
6	Exterior	Plastic	To protect the internal parts.
7	Buttons	Plastic	To connect the phone as well as turn the system on and off.
Packaging			Our product will come in a cardboard box wrapped in bubble wrap and packing peanuts to ensure that there will be no breakage.

Table 3- Product Features

Aesthetics	Black box with LED lighting.
Connect button location	Towards the top to the left.
Power LED light location	Towards the bottom to the right.
Ease of button use	Easy to press on and off with no extra effort.
Packaging	Packaging is well wrapped and secure.
Quality	Product is of very good quality.
Durability	Product is expected to last 5 years.
Safety	Product is very safe, all materials are protected inside.
Versatility	No attachments or USB ports.
Environmental Friendliness	External will contain plastic but not enough to be harmful for the environment.
Weight	About 1 lb.
Other features	Starts charging when phone is below 60% and stops when at 85%. Comes with downloadable phone application that will allow each user to be aware of their battery and its state of charge and lifespan.

Table 4- Market of the Product

Cost	This product will be $110.
How long has this product been on the market?	Wireless charging systems have been on the market since 2007.
Target Population	College students Business Employees
Versions of the products	There were similar products on the market like ours but ours was more advanced and had more features.
Improvements between the versions of the product	There have been slight variations and improvements between the products.
Where can our product be sold?	Any electronic store and online sellers like Amazon.

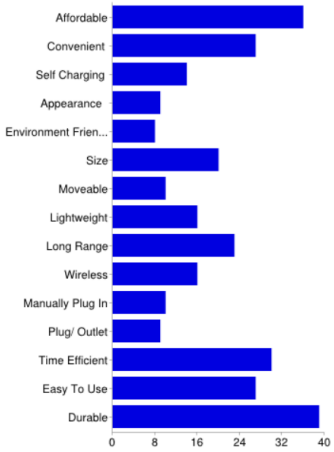
3.1.2 Survey

Using our mission statement and what we thought customers would think is important, we were able to create a list of features for a cell phone charger. Using this list, we produced a survey that would help us evaluate what feature would be the most important to the consumer. We set up a survey for all college students aging from 18 to 22 that attend Penn State University. College students were used in the survey because it is our generation where technology is rapidly growing. Table 5 shows the survey results and which feature was the most important to college students. Naturally affordability and durability was the top choice. To succeed the most in the market our product will have to be an affordable price for college students, as well as durable, so they do not have to keep paying for a new product. Self-charging and wireless were among the top features college students would like to see in a charger. This contributes to the convenience and time efficient factors that were also the most important. The least important feature for the cell phone charger was environmental friendliness. This shows that when deciding on technology the effect on the environment does not play a role on most college student's decisions.

Table 5- Survey Results

Summary

What do you look for most in a cell phone charger?



Affordable	36	12%
Convenient	27	9%
Self Charging	14	5%
Appearance	9	3%
Environment Friendly	8	3%
Size	20	7%
Moveable	10	3%
Lightweight	16	5%
Long Range	23	8%
Wireless	16	5%
Manually Plug In	10	3%
Plug/ Outlet	9	3%
Time Efficient	30	10%
Easy To Use	27	9%
Durable	39	13%

3.1.3 Needs Metric Matrix

After producing the customer needs, it is imperative to visually see what each need will require quantitatively. Therefore, a matrix chart is created to compare the customer needs to the metrics it will use and the amount of constrictions for each need. This could be seen in Table 6.

Table 6- Needs Metric Matrix Chart

Need	Matrix	Weight (lbs)	Voltage(V)	Charger Length(in)	Charger Width (in)	Charger Height (in)	Energy Consumption (kWh/yr)	Strength(lbs)	Time to Charge (min)	Time Spent Using (min)	Price ($)
Affordable			X				X				X
Convenient									X	X	X
Appearance		X		X	X	X		X			X
Environmental Friendly			X				X				X
Size		X		X	X	X	X				
Moveable		X		X	X	X		X			
Lightweight		X		X							
Time Efficient							X		X	X	X
Easy To Use			X							X	X
Durable		X		X	X	X		X			X

4.0 External Research

Our mission statement gave our design team benchmark ideas in order to create our Cell Phone Charging Sensor. In order to do so, we had to research the technicalities on how to make the sensor operate efficiently and cost effectively. That research would have to include how to incorporate the features within our design. We finally had to research materials that would benefit our design to give it a sleek and appealing external design. Researching these materials would help our team gain a better understanding of how to create our product and also develop our product to be of highest quality.

4.1 Patent Research

While generating and creating the concept of Magicharge, a machine capable of charging a phone without attaching wires to the phone, we researched existing patents for similar inventions. The number one patent that continually surfaced during our research was the recent patent awarded to Apple for a wireless charging system. The US Patent & Trademark Office released the publication of Apple's patent on September 19, 2013. The patent's official name is "Device orientation based docking functions" and the patent number is No. 8645604. This new device is basically an inductive charging pad, however, it is bigger and renamed "a dock". Its most innovative feature is that it performs a task based on the orientation of the device being charged. For example, when the user places their phone face down on the mat the system would begin charging the phone. While if the phone was placed faced up or display side up data syncing and charging may take place. This new charging mat is being developed to not only charge phones, but IPods, IPads, and computers. The next step in this charging mat's future is to be implemented into all computers and Apple devices so that the user would simply have to place their phone on top of their computer in order to charge it. Apple's wireless charging system uses inductive charging magnetic resonance just like ours. It also has the same goal, to charge a device without using wires. Although this patent is similar to our idea, it is not the same. With Apple's invention, the device the user desires to charge must be touching the wireless charging system. We hope to charge a phone from a distance. Additionally, Apple wishes to charge not only phones, but the majority of their products. Another feature that differs between these two ideas is that because Magicharge is charging phones from a distance it will be stationary. It will have to be set up in one particular room and plugged into an outlet. Apple's charging mat will be more mobile and the mat itself will not have wires.

Another company that is highly involved in wireless capabilities is WiTricity. This company was formed in 2007 by a team of physicists at the Massachusetts Institute of Technology (MIT). They have numerous patents dealing with wireless energy transfer. The goal of this company is to accomplish powering an entire household with wireless electricity. They have developed technology that can send power through the air, mostly using magnetic resonating power, which will bounce off of WiTricity hub installations in order to create an oscillating magnetic field throughout the house. It has the capabilities

to power laptops, DVD players, cellphones and more. The end goal is to eventually make wires unnecessary. Their patent for “Wireless energy transfer”, US7825543, and their patent for “Systems and methods for wireless power”, US8115448, are the most similar to our design. We both have chosen to use magnetic resonation and inductive energy transfer. However, a huge conceptual difference is we desire to charge phones, a small device, and they desire to power a household without wires.

4.2 Benchmarking

Using the benchmarking process we found other wireless chargers already existing throughout the market to compare to our Cell Phone Charging Sensor. In Table#, a variety of charging pads we researched for the benchmarking process are displayed. Table 7, displays the different features of the charging pads we found that are being compared to our product. After researching information about other wireless charging systems, we will rate each system based on how well it satisfied the customer needs based on the survey generated in 3.1.2. We will use a scale of 1 to 5 with 5 being the best. This will be shown in Table 8. During this process we saw what our sensor needed to improve on and what it was lacking. Using the benchmarking process, we also found that our sensor was more advanced compared to the others. The Duracell PowerMat showed to be the most efficient and more popular than the rest of the charging pads.

Table 7- Products used in the Benchmarking Process

Duracell PowerMat	**Energizer Qi Inductive Charging Pad**	**JBL Powerup Wireless Charging Speaker for Nokia**

Table 8- Benchmarking the Products

Features	Duracell PowerMat-1 Device	Energizer Qi Inductive Charging Pad-2 Devices	JBL Powerup Wireless Charging Speaker for Nokia
Dimensions	3.75”H x 3.75”L x 0.375”D (in)	24(H) x 185(L) x 202(W) (mm)	145(H) x 115 (L) x 280(W) (mm)
Product Weight	0.30 lbs	1.6 lbs	3.5 lbs
Power Supply	Universal Power Supply (100-240 VAC)	100-240 VAC	AC power connector
Price	$39.99	$89.99	$149.50
Colors	Black White	Black	Black Aqua White
Warranty	1 year	1 year	1 year
Appearance	Aluminum Base High Polish Surface.	Sleek Black Glossy Finish	Plastic finish Speakers
Automatic Power Shut Off When Fully Charged	Yes	Yes	No
Light	Yes	Yes	Yes
Device Compatibility with Most Phones	Yes	No only iPhone 3G/3GS and the BlackBerry Curve.	No only Nokia cell phones
USB Port	No	Yes	Yes

Table 9- Benchmarking

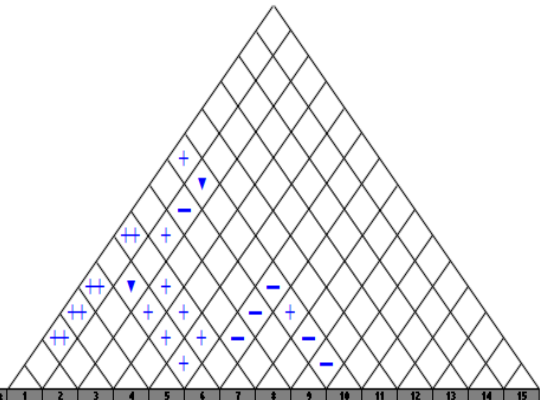
	Duracell PowerMat	**Energizer Qi Inductive Charging Pad**	**JBL Powerup Wireless Charging Speaker for Nokia**
Affordable	5	3	1
Convenient	5	5	3
Self-Charging	5	5	5
Appearance	5	5	4
Environmental Friendly	4	4	2
Size	5	5	3
Moveable	5	5	3
Lightweight	5	4	1
Long Range	1	1	1
Wireless	5	5	5
Manually Plug in	1	1	1
Plug/Outlet	3	3	5
Time Efficient	5	5	5
Easy To Use	5	5	5
Durable	5	5	5

4.2.1 House of Quality

In order to display how customer needs are turned into targets that should be met in the final design, we used a House of Quality. In the House of Quality, we evaluated the relationship between the technical requirements and the customer to decide if there was

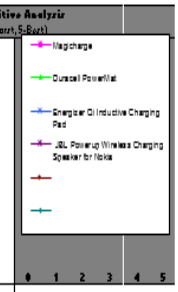
a strong or weak correlation between them. We then had to decide if the technical requirements should be minimized or maximized to achieve the target which is displayed above the requirements. In order to compare the technical requirements, the “roof” is used to display the negative or positive relationship they contain with one another. Subsequently, we used the same products in the benchmarking process to compare with our product. Finally, for each requirement we developed a target value to achieve. Using this process, we developed a plan to help us execute and succeed with our final design as well as showing us parts of the design we need to change.

Table 9- House of Quality



Legend		
θ	Strong Relationship	9
O	Moderate Relationship	3
▲	Weak Relationship	1
++	Strong Positive Correlation	
+	Positive Correlation	
−	Negative Correlation	
▼	Strong Negative Correlation	
▼	Objective Is To Minimize	
▲	Objective Is To Maximize	
X	Objective Is To Hit Target	

Row #	Max Relationship Value in Row	Relative Weight	Weight/Importance	Quality Characteristics (a.k.a. "Functional Requirements" or "How") / Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	1 Weight (lbs)	2 Voltage (V)	3 Charger Length (in)	4 Charger Width (in)	5 Charger Height (in)	6 Energy Consumption (kWh)	7 Strength (lbs)	8 Time to Charge (min)	9 Time Spent Charging (min)	10 Price ($)	11	12	13	14	15	Competitive Analysis (0-Worst, 5-Best): Magicharge	Duracell PowerMat	Energizer Qi Inductive Charging Pad	JBL Powerup Wireless Charging Speaker		
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	▼	▼	X	X	X	▼	▲	▼	▼	X											
1	9	13.5	5.0	Affordable	▲	▲				O	O			θ						3	5	3	1		
2	9	10.8	4.0	Self-Charging		▲				O		O	O	θ						5	5	5	5		
3	9	5.4	2.0	Appearance	O		θ	θ	θ		▲			O						5	5	5	4		
4	9	8.1	3.0	Size	θ		θ	θ	θ	O	O			O						4	5	5	3		
5	9	10.8	4.0	Lightweight	θ		θ	θ	θ	O	O			O						4	5	4	1		
6	9	10.8	4.0	Long Range		θ				O		▲	O	O						5	1	1	1		
7	3	8.1	3.0	Wireless		▲				O	O	▲	O	O						5	5	5	5		
8	9	5.4	2.0	Plug/Outlet		θ	▲	▲	▲	θ				▲						4	3	3	5		
9	9	13.5	5.0	Time Efficient		▲				▲		θ	θ	O						5	5	5	5		
10	9	13.5	5.0	Durable	O		▲	▲	▲		θ			θ						5	5	5	5		
				Target or Limit Value	1 lb	Minimal	8 in	6 in	2 in	14 (kWh/yr)	10 (lbs)	0 min	20 min	$ 110											
				Difficulty (0-Easy to Accomplish, 10-Extremely Difficult)	8	5	1	1	2	5	8	5	4	2											
				Max Relationship Value in Column	9	9	9	9	9	9	9	9	9	9											
				Weight / Importance	240.5	191.9	237.8	237.8	237.8	249.6	248.6	173.0	210.8	516.2											
				Relative Weight	9.5	7.5	9.4	9.4	9.4	9.8	9.8	6.8	8.3	20.3											



4.3 Design Target

Once completing the benchmarking process, we assessed the advantages the other charging systems had. We would take these advantages and incorporate a similar aspect into our product. We found that the products varied in weight but we wanted a moveable product with a decent weight and size. The products that we benchmarked also varied in prices. Affordability was the most important feature found from the survey in 3.1.2, therefore we needed to market our product at a price where our generation could afford while also keeping its credibility. We also realized the products incorporated auto shut off as a popular feature which we could incorporate a similar idea in our final product. The other charging systems also had USB ports, but we did not find this to be necessary in our final product.

4.4 Global Marketplace

Around the world there are numerous companies that have developed wireless charging systems. The first company, Intel, is well known in the field on technology. Intel has come forward with an ambitious project known as 'The charging bowl'. It is a smart bowl that is capable of wirelessly charging any electronic device. Intel showcased this product among several other innovations at the 2014 Consumers Electronic Show (CES). The bowl and stand measure approximately 10 inches in diameter and utilizes magnetic resonance technology, which is the basis of recent A4WP innovations. It is an extremely cost effective and comfortable way of charging your phone without actually plugging in something. One major drawback of this product is that it can currently only charge Intel's newly announced headset. However, the company has confirmed that it plans to accommodate more devices. The bowl will take time to hit the market as Intel has not provided an availability date yet. Pricing is also not known at the moment.

The second company is relatively unknown. Ossia came forward with a product named COTA. COTA, unlike Intel's charging bowl, is built on their patented smart antenna technology. COTA is a much more ambitious project than Intel's charging bowl. The charging bowl requires you to place your device in the bowl for it to get charged. However, COTA automatically and remotely keeps devices like smartphones and cameras charged. There is no manual labor and it is also cost effective. A single COTA charger can power up to a dozen devices in your house or office. There will be no need to worry about keeping your phone charged now. It happens without you. Not only does it charge wirelessly, it is also programmed to look for patterns in device usage, check for devices as they leave and return to your home or office and ensures that every device within range is automatically charged to full capacity. Its range is approximately 30 feet. COTA is still under the prototype stage. Commercialized versions of the product should be on the market within a few months. As far as the cost of a single COTA charger goes, Zeine has confirmed that it will be over $100, not giving a precise price. Once consumerized, the COTA charger will be as big as a large tower PC.

5.0 Concept Generation

While generating and creating our design, we came up with numerous designs and concepts. In this section we will display all concepts we generated that we thought would benefit our final design. Most of our designs had similar concepts, but varying with different features. We will decide which concept would best suit our sensor by extracting and inspecting each concept.

5.1 Concepts

Concept A-

When we first began brainstorming ideas for the AT&T challenge, we were intrigued by the concept of machine to machine technology. When devices are able to communicate data with one another, it makes our lives much simpler. Our first idea targeted a typical American household and the convenience of its residents. We thought it would be expedient if all battery powered technology and machines requiring upkeep could be logged into an application on one's phone. This application would alert the user when batteries needed to be changed in advance, give the user a notification when their various technologies needed to be updated, improved, replaced, or repaired. For example, the user would log in the date they last changed the overhead light bulb in the living room and the application would send them a gentle reminder about a week before the light was expected to go out. This would allow the user to have a light bulb on hand when the light did go out, instead of having a dark room until it could be replaced. The application would have the data for common light bulbs (and other technologies) already stored, so it would base its reminders of the general life expectancy of the particular light bulb logged into the application. This idea was only brainstormed and researched; it did not make it to the design portion of this project. Through research we learned there were a lot of applications similar to this idea and it would be difficult to call our own. We decided to continue brainstorming, but build off this original idea.

Concept B-

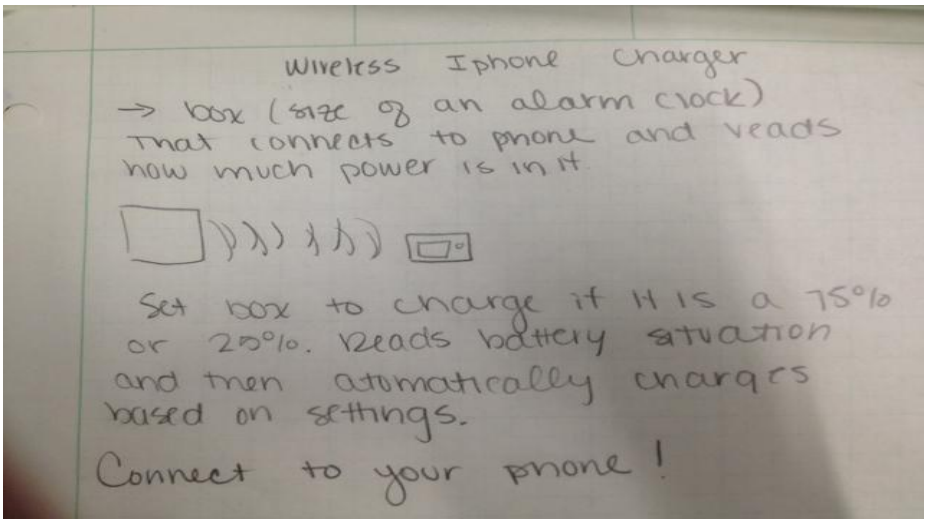
The next concept we generated for the AT&T challenge was a wireless charging hub for a typical American household. We pictured a box, much like a wireless internet router, that would have the capability to power relatively small devices throughout a house. The idea stemmed from the convenience of never having to change a light bulb again, never having to change the batteries in a remote control or having to charge one's phone. In general terms, this concept was for the majority of a household to be wirelessly charged or powered. We realized it would be a feat to power the entire household wirelessly so we focused on relatively small devices, like phones, remote controls, light bulbs, toasters, etc. Unfortunately, our idea for wirelessly powering a few devices in a household is already being developed by MIT researchers on a much larger scale. These MIT researchers, now a part of the company called WiTricity, are

well on their way to powering an entire house's devices wirelessly. The technology used to create wireless electricity through the house is called coupled magnetic resonating. It would originate from one place, say the garage, and then magnetic oscillations would create a chain reaction throughout the house. Resonators would need to be installed in the walls and floors of the house so that the magnetic waves could connect to coils to keep the oscillations going. This invention is still years away from production because of the lack of efficiency. WiTricity was able to power a 60 Watt light bulb, but it required 133 Watts of energy; a 45% efficiency rate. We realized this idea was too similar to the one created by MIT researchers and the technology too far over our heads. Therefore, we decided to continue brainstorming. This idea never made it to the design stages.

Concept C-

The third design that our group generated was a wireless phone charger. We understood that there were already similar designs on the market, but we chose to improve the current designs. The current wireless phone chargers must be touching the phone in order to charge it. This is an inconvenience if one needs to pick up the phone to call, text, e-mail, or use the phone in any way. Therefore, our group thought what if the phone could be charged from a distance; see Picture 1 for a rough representation. The distinction was also made that the phone would not be powered from a distance, but rather charged. After further research, our group decided we could proceed with this concept and begin designing the actual device.

Picture 1-

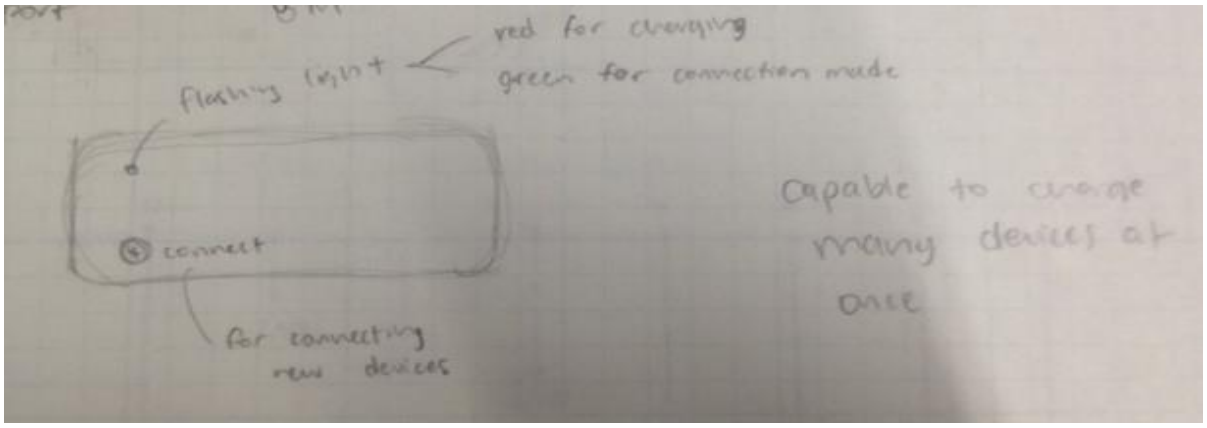


Concept D-

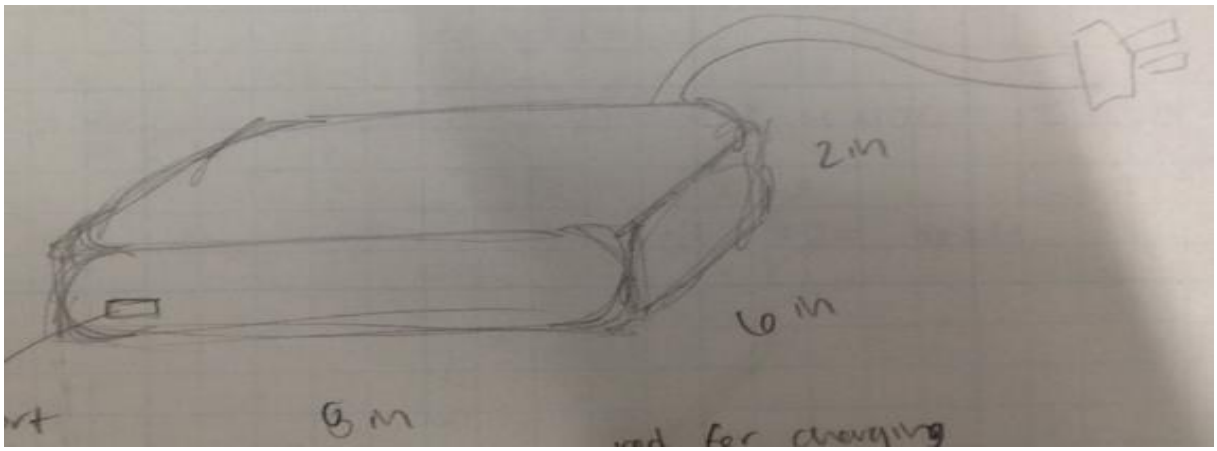
Concept C outlined our third and final design. However, we still had to continue to develop our concept for a wireless range phone charger. First order of business was the name. The name of our product is Magicharge. Magicharge would roughly be about the size of an alarm clock. Our design is 8 inches long, 6 inches wide and 2 inches tall.

It would have a plug attached to the back and the power source would be a standard outlet. The idea would be for the wireless charger to be placed in a room about the size of a dorm room or bedroom. A person's phone would initially need to be connected to the device so that for repeated use the device recognized the user's phone. Then whenever the user entered the room with their phone in hand the charger would turn on and reconnect to the phone. Magicharge would have the capabilities to read the battery level of the phone. If the battery was below 60% charged, Magicharge would begin charging until the battery has reached an 85% battery level. The cellphone will be charged to 85% because cellphones in general should never be charged to 100%, this is considered overpowering the device. By fully charging a cellphone to 100%, the user depletes the overall battery life of the cellphone and has to replace the entire cellphone much sooner than a user who consistently charges the phone to 85%. Pictures 2 and 3 show our final sketches for the Magicharge device and the reference designs for our CAD model design.

Picture 2-



Picture 3-



6.0 Concept Selection

In order to evaluate which concept would benefit our design the most, we illustrated our designs and concepts. Coincided with this, we will use the process of concept screening in order to evaluate and relate each concept with one another. Concept scoring requires an organized data chart in an Excel spreadsheet. The needs of the customer will be listed to the left while the concepts will be labeled at the top. We will rate each need and then tally the concepts. Subsequently, we will use the process of concept scoring in order to weigh the concepts in relation to importance.

6.1 Concept Screening

We used the process of concept screening to establish which concept was unparalleled to the others and to evaluate which concept would best suit our needs. We chose Concept A during the screening process as our reference in order to compare concepts to each other. Following this process we evaluated how each concept would satisfy the needs of the customer. By using this process, it helped us decide which concept we would incorporate into our final design that would please the customer significantly. Concept C and D showed to be the most promising concepts during this process. They have very similar concepts so we will combine them during the scoring process to achieve the highest efficiency of our product.

Table 10- Screening

	Concepts			
	A	B	C	D
Needs	Battery Application	Wirelessly Powered Household	Wireless Phone Charger	Cell Phone Charging Sensor
Affordable	0	+	0	-
Convenient	0	+	+	+
Self-Charging	0	-	+	+
Appearance	0	+	-	+
Environmental Friendly	0	0	0	0
Size	0	+	+	+
Moveable	0	+	+	+
Lightweight	0	-	+	-
Long Range	0	+	+	+
Wireless	0	+	+	+
Manually Plug in	0	-	0	0
Plug/Outlet	0	-	-	+
Time Efficient	0	-	+	+
Easy To Use	0	+	+	+
Durable	0	+	0	+
Sum of +'s	0	9	9	11
Sum of 0's	15	1	4	2
Sum of -'s	0	5	2	2
Net Score	0	4	7	9
Rank	4	3	2	1

6.2 Concept Scoring

Following the screening process, we evaluated that Concept D was the top design. This did not conclude that Concept D would be our final design. To make a final decision, we used the process of Concept Scoring in order to obtain a better distinction between the concepts that were used in the process of Concept Screening. Using the process of Concept Scoring, we used a weighing system that would help us gain a better knowledge of the importance of the customer needs relative to the concept. During the process, we wanted to see how well Concept A compared to the other products, therefore we did not use it as a reference concept. Concept C and D had similar concepts therefore we combined them to create Concept CD. We developed a ranking during this process that directed us to our final design decision. Concept CD was the highest ranking during our scoring process, concluding that it would be our final design we will continue to develop.

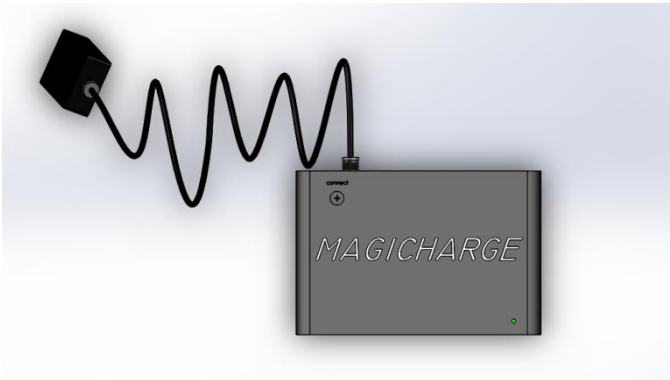
Table 11-Scoring

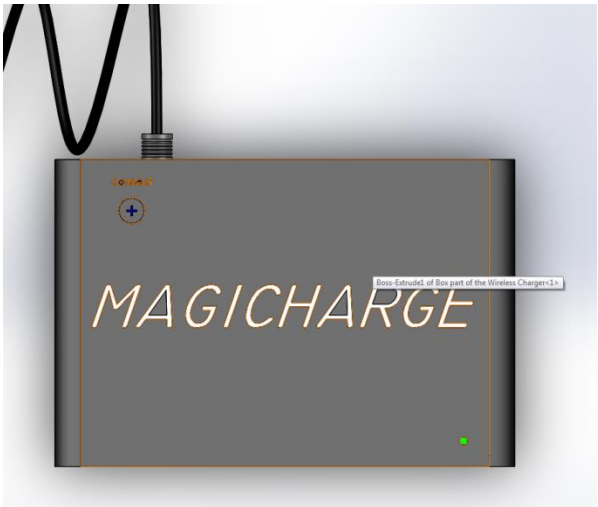
			Concepts				
			A		B		CD
			Battery Application		Wirelessly Powered Household		Cell Phone Charging Sensor+ Wireless Phone Charger
Needs	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Affordable	25%	3	0.75	3	0.75	3	0.75
Convenient	25%	4	1	3	0.75	4	1
Self-Charging	15%	1	0.15	1	0.15	5	0.75
Appearance	10%	4	0.4	4	0.4	5	0.5
Environmental Friendly	5%	2	0.1	1	0.05	3	0.15
Size	15%	4	0.6	4	0.6	4	0.6
Moveable	10%	4	0.4	4	0.4	4	0.4
Lightweight	15%	5	0.75	2	0.3	3	0.45
Long Range	15%	4	0.6	3	0.45	5	0.75
Wireless	15%	4	0.6	5	0.75	5	0.75
Manually Plug in	5%	1	0.05	1	0.05	1	0.05
Plug/Outlet	5%	1	0.05	1	0.05	4	0.2
Time Efficient	25%	4	1	3	0.75	5	1.25
Easy To Use	25%	2	0.5	3	0.75	5	1.25
Durable	25%	3	0.75	4	1	5	1.25
Total Score			7.7		7.2		10.1
Rank			2		3		1
Develop: Yes/No			No		No		Yes

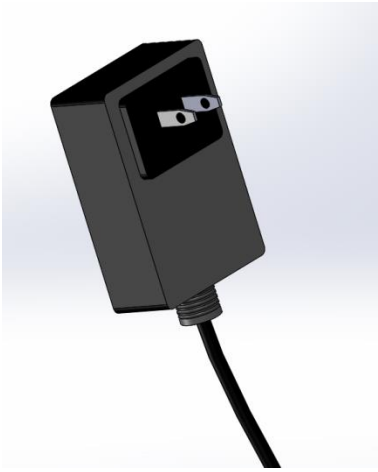
7.0 Embodiment Design and Final Design Description

Using the Concept Scoring process, we concluded that Concept CD would be our final design. The final design of Magicharge contains numerous features that will help it succeed in the market. Our team has broken up our product into its components that we will explain thoroughly as well as containing the price of each component. When describing each component we will explain its function and how it will assist in the completion of the final product to make it work effectively. We will also include a price analysis to explain how our product will be sold at its price as well as the cost of construction for one Magicharge.

Magic Charge Final Design







Final Design Description

AT&T charged us with designing a product that would allow for greater connectivity. To fulfill their desire, our team, the Allegiant, designed Magicharge. Our product is the future in cellular phone charging. Combining the technology of current day wireless charging mats with the longer distance capabilities of magnetic waves, we designed a charger that will be capable of charging any phone within the room. From the outside, Magicharge may not look like anything special, just a small 8 inch by 6 inch black box. But the technology inside is what sets it apart from the rest. We will be using inductive copper coils as the basis of the technological aspect. There will be coils located in the device and in a stick-on back for your cell phone. These two sets of coils will be self-resonant, and will be capable of exchanging energy through magnetic coupling. This will be capable of charging your phone over the distance of an average sized room. After the initial connection sequence, anytime you and your phone enter the room, your phone will instantly connect with Magicharge. Each phone that has gone through the initial connection sequence will have a separate identity with the charger to make sure that the battery is used to its best potential. Magicharge will evaluate the state of your phone's battery and make a decision whether or not to charge. Keeping in mind the most effective way to elongate the life of a lithium ion battery, charging will begin if the phone is at anything less than sixty percent fully charged, but the device will keep in mind the last time that each phone has to undergo a charge. It will then charge the phone to eighty-five percent full battery power. Along with the wireless charger, our product will include a downloadable phone application that will allow each user to be aware of their battery and its state of charge and lifespan. This application will enable users to force charge their phone or stop charging. It will also alert users as to when it would be a good time to completely drain their battery, a process that should happen on a monthly basis to extend battery life.

As a whole, Magicharge will be a relatively small and affordable device to purchase. The entire package will contain the actual charging device, a wall plug, five phone coils, and five codes for free application download. The charging device, the box, will be an eight inch by six inch by two inch console that will contain the majority of the inductive coils, the circuit boards, wiring, and electronics. Attachable to this is the wall plug with a three foot cord, to allow users to position the device in a location that will promote charging from anywhere in the room. The phone coils will be an inch and a half in diameter and will come as a sticker to place against the battery of the cell phone. If users would like more phone coils to allow for more phones to be connected to Magicharge, they together with the free phone application code, can be purchased separately.

Price Analysis

The necessary copper coils that are required for the interior of the console and for inside the phone sticker are available in bulk from many supply companies. The company that we would suggest using has coils made out of 0.01 millimeter in diameter copper wire, which can be made into our choice size of coil. These are available for between two tenths of a cent and three dollars each, so are very affordable for the construction of our charger. The power inverters needed to convert the direct current coming from the wall outlet to the alternating current necessary to be transferred through the magnetic field are also relatively inexpensive. Pricing can be found around two dollars and fifty cents per inverter from multiple suppliers. One of these inverters is located in the console and the other is located along with the phone's coil to convert to current back to direct current so that the battery can be charged. Under mass production the entire console of the chargers can be constructed for a little less than ten dollars. Factoring in the cost of the plug and other incidental wires and circuitry, the total cost of construction of the entire device would be approximately thirteen dollars. The other aspect of the product is the phone application. In general, it costs about ten thousand dollars to develop an application of this sort and have it available at the appropriate stores.

If we want to keep the price of the device limited to no profit, an ideal selling price would be around seventeen or eighteen dollars. To make a reasonable profit, we suggest selling Magicharge for twenty-five dollars minimum. However, the best selling price for our device is more around one hundred and ten dollars. Selling our product at this price provides more credibility when compared to the wireless charging mats that are currently available. If someone were to see our product offered at a price equivalent or less than the chargers available today, they would think that our product is of low quality and not more impressive than said chargers. Selling at this higher price gives our Magicharge the desired credibility while keeping it affordable for most Americans.

Table 12- Cost of Construction of Magicharge

Component	**Price per Unit**	**Number**	**Price**
Console Coil	$3.00	1	$3.00
Sticker Coil	$0.07	1	$0.07
AC/DC Inverter	$2.47	2	$4.94
Electrical Plug	$2.34	1	$2.34
Misc. Wires/Circuitry	$2.00	1	$2.00
		Total Price	$12.35

Table 13- Final Cost Estimate

1 Magicharge	$110.00

8.0 Conclusions

As our final design was completed, we concluded that our team successfully accomplished both the overall and technological goals. Our Engineering team, The Allegiant, designed and created a Cell Phone Charging Sensor, Magicharge. We created a time and cost efficient wireless charging system that satisfied all of the customer's needs. We created a product that will benefit the technologically advanced lifestyles of our generation while effectively using a Machine-to-Machine solution. We developed our final product to its highest quality by using the design process as well as concept selection. As the Allegiant, we believe we successfully and effectively met the expectations of the project beyond doubt. Our team satisfied our mission statement's goals commendably by creating the highest quality charging system. Our Magicharge adequately satisfied the needs of the customers while exceeding our goals.

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