EDSGN100
Design Project #2
PROGRESS Report

S.I.S. (Student Identification System)

Introduction to
Engineering Design
EDSGN 100

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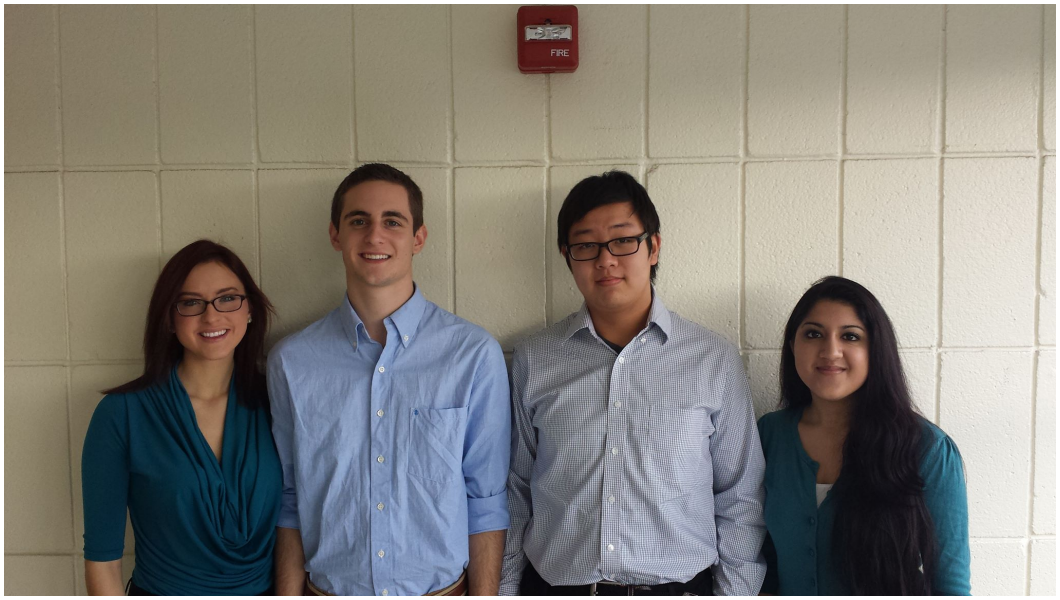

Submitted to:
Professor Smith
Date:
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Executive Summary

Our objective was to design a product that addressed our initial problem statement given by Alcoa, while tending to our customer's needs discovered through the use of a survey given to Penn State students. Redefining sustainability guided the direction of our design process, and aided in the creation of a customer needs assessment. The product developed, a Student Identification System, was created through the use of the engineering design process consisting of multiple steps ranging from external research to sketching and dimensioning. Through external and internal research we explored preexisting concepts and ideas, while also developing and generating new concepts. We implemented these external and internal findings in our concept generation, and then used Pugh charts to vote on a final concept to be prototyped. With the assistance of our House of Quality, we were able to come to a final concept selection, thus producing a final design. Our selected design was drawn out in isometric, frontal, backside, right, and left view through the use of SolidWorks. The inside functioning and mechanics of the design were explained in great detail, which showcases the benefits to the design selected and the advantages it would bring not only to Alcoa, but also to Penn State students.

S.I.S. (Student Identification System)

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1.0 Introduction

Our goal as a design team involved identifying opportunities across the Penn State campus to take advantage of aluminum's diverse properties for the purpose of increasing our particular definition of sustainability to develop a product which meets the needs of Alcoa, along with the needs of Penn State students. Alcoa is currently the world's leading producer of aluminum, conducting operations in over thirty countries worldwide. Alcoa presented our team with an initial problem statement, which gave us insight to the advantages of aluminum and provided a clear objective for the design project. Aluminum is a lightweight yet incredibly strong material, which has been used in various markets dating back to the 1880's. Aluminum has contributed to the development of the Wright flyer, the design of Boeing 787 Dreamliner, the creation of multiple cookware materials, and is even responsible for the development of high performance automobiles. Taking this background information into consideration, our team was able to proceed with the design process to develop a product which implements certain properties of Aluminum; specifically Aluminum's light weight, lack of corrosion, and strong durability. By analyzing the needs of current Penn State students, along with the needs of Alcoa, our team was able to generate solid concepts to later be analyzed, prototyped, and selected.

1.1 Initial Problem Statement

This project involves the design and application of aluminum products to improve the efficiency of energy use and/or increase sustainability of the campus. Students should take clues from current applications to formulate ideas for the use or promotion of aluminum. The teams are encouraged to look for opportunities throughout the campus to substitute aluminum for other materials, to think about recyclability and recycled material content, and/or how the introduction of a new aluminum product can help reduce energy consumption in existing systems.

1. Identify a campus opportunity that will benefit from the introduction of aluminum or the increased use of aluminum products.
2. Examine your element as a system and examine at all inputs and outputs.
a. Consider the connections to the Borough of State College and Centre County (and the region, state, country if need be)
3. Utilize readily available material to help formulate product solutions for the selected opportunity.
4. Investigate behavior—how will people share the vision you are proposing?
5. Ensure that the solutions meet all applicable performance requirements, satisfy relevant regulatory codes, and is economically viable.

1.2 Definition of Sustainability

The definition of sustainability entails a product that is economically feasible in terms of the cost of the different components used in the making of the finalized product, while also being environmentally friendly in terms of resources used and ultimately aiming to make the everyday life of a Penn State student more efficient.

2.0 Customer Needs Assessment

We obtained the customer needs of our target populations by producing a survey and as a result we got over a hundred responses (Table 1.) Our survey was specifically aimed at Penn State students living on campus. We submitted this survey to three different groups on Facebook that solely included Penn State students, aged 18-22 thereby ensuring that we would obtain as many responses as possible in order to make sure our customer needs were as accurate as possible. To obtain our customer needs. we analyzed Alcoa's requirements along with the needs of Penn State students. In addition to the survey, we as a group used the process of internal brainstorming to generate our customer needs statement based on the requirements of Alcoa, thereby producing the customer needs mentioned in Table 2.

Table 1. Results from our survey

Questions		**Responses**	
	Yes	No	Don't live on campus
Have you ever lost your key?	17	82	3
	Never	Sometimes	Often
How often do you forget to sign in on the attendance sheet during class	83	12	7
	Never	Sometimes	Often
How often do you forget your ID when you have an exam?	94	5	3
	Yes	No	Don't live on campus
Do you frequently find yourself waiting in line at the dining commons'	76	26	3

2.1 Qualitative analysis of the results obtained from our survey

The first question was whether the students had ever lost their dorm key, and 17% of the survey takers said yes, some of which stated that they had lost their key more than once. When asked whether the survey takers had ever forgotten to sign into the attendance sheets in their classes, 12% said sometimes and 4% said very often. A total of 8% said yes to whether they had forgotten their ID to an exam. When asked whether the survey takers often found themselves waiting in line at the dining commons, 76% said yes. Due to this large value, our design project group decided to make the idea of drastically reducing the amount of time spent waiting in line a priority.

Table 2. was generated by ranking each need based on importance on a scale of 1-5, 1 being the lowest amount of importance and 5 being the highest amount of importance.

Table 2. Penn State Students' Needs and the assigned importance

Needs Statement	**Assigned Importance**
Finalized product is used to identify students	5.0
Finalized product aims to drastically reduce the amount of time spent waiting in line in the dinir commons on campus	4.0
Finalized product should be one that can be easily located if it gets lost	4.0
Finalized product should be strong and durable to prevent plastic deformation	3.0
Finalized product should be cost efficient	2.0
Finalized product should be light-weight and ea to carry	1.0

2.2 Hierarchy of Customer Needs

A successful concept requires an appropriate way to assign weighted importance to the customer needs. These weights can be used to establish a hierarchy and provide us with a quantitative value to our customer needs. Therefore we ranked our customer needs on a 1 to 4 scale (as shown in Table 3) with 1 being the most important and 4 being the least. These rankings were obtained based off of the needs of Alcoa as well as the results obtained from the survey which was taken by current Penn State students.

Table 3: Hierarchy of Customer Needs

Hierarchy of Customer Needs	
Needs	**Rank**
Finalized product is used to identify students	1
Finalized product aims to drastically reduce the amount of time spent wai in line in the dining commons on campus	1
Finalized product should be one that can be easily located if it gets lost	2
Finalized product should be strong and durable to prevent plastic deformation of product	4
Finalized product should be cost efficient	3
Finalized product should be light-weight and easy to carry	4
Finalized product makes use of aluminum's intrinsic properties	2
Product must use aluminum as a substitute for other materials	2
Finalized product should be recyclable	3
Use of product must increase the sustainability of the campus	2
Finalized product should aim to reduce energy consumption in existing systems	2
Product must be connected to the Borough of State College and Centre County (and the region, state, country if need be)	1

Table 4. Needs Metric Matrix

NEED \ METRIC	low frequency chips inside the key 120-140 KHz	Ultra high frequency chips inside the key 868-928 MHz	Aluminum alloy for key	IDKEY can be located by a specialized frequency wave	Make a data library to store the information of students
Finalized product is used to identify students					X
Finalized product aims to drastically reduce the amount of time spent waiting in line in the dining commons on campus	X				
Finalized product should be one that can be easily located if it gets lost				X	
Finalized product should be strong and durable to prevent plastic deformation of product			X		
Finalized product should be cost efficient	X	X	X		
Finalized product should be light-weight and easy to carry			X		
Finalized product makes use of aluminum's intrinsic properties			X		
Product must use aluminum as a substitute for other materials			X		
Finalized product should be recyclable			X		
Use of product must increase the sustainability of the campus			X		
Finalized product should aim to reduce energy consumption in existing systems			X		
Product must be connected to the Borough of State College and Centre County (and the region, state, country if need be)					X

2.3 Revised Problem Statement

After analyzing our customer needs we then moved on to revising our initial problem statement set by Alcoa. From the results of our survey we realized that a crucial aspect of our finalized product was that it would be possible to locate the product if it ever was to get lost and that it aimed to efficiently reduce the amount of time students spend waiting in line at the dining commons on campus. These customer needs combined with the needs of Alcoa are what helped us come up with our finalized product - which includes a way to locate the finalized product, if it was to ever get lost by the means of the internet - as long as the student has a Penn State 9 digit ID number and can answer security questions specific to each individual. In addition to these specific requirements, by keeping Alcoa's requirements in our minds, we had to ensure that our finalized product was economically feasible and made use of aluminum's intrinsic properties.

3.0 External Search

Next external research must be performed to provide a better understanding of the available technology that can be used in our product. In addition to discovering our customers' needs, our design project team used literary sources and patents to obtain external research. The main technology that our product utilizes is radio frequency identification (RFID) tags and readers. External research provided our group with a better understanding of what our finalized product should entail as well as how it compared to other similar products in the market.

3.1 Literature Review

The first use of radio frequency identification (RFID) technology was employed by the British Royal Air Force during World War II. They created an Identify Friend or Foe (IFF) system that used radio frequencies to identify aircraft as foe or friendly. This technology largely remained in the military for the next few decades. Meanwhile in the 1960's a commercial system called Electronic Article Surveillance (EAS) was being created to prevent shoplifting. This technology uses magnetic devices that could be attached to a product in a store. The device could then be activated and deactivated by a passing it over a magnet. Portals are also set up at the exits of the store to detect activated devices. This prevents shoplifting because any unpurchased products will set off the security alarm created by the portals. This technology is very limited though because it simply senses the presences of an object. Recently RFID tags have been created that allow objects to be identified with stored information differing for each tag.

RFID tags can hold prewritten information that RFID readers are able to access and read. You can think of this as a cell phone and cell phone tower. The cell phone holds information that it can send back to the cell phone tower. The tower is capable of connecting with multiple phones at the same time. So now an object can be identified with product information or serial numbers. There are many different types of RFID tags that have varying uses.

First let's look at the three methods of powering these tags. The most widely used type of tag is a passive tag. These tags do not have any batteries on the actual component, meaning they cannot power themselves. These tags use coils of wire that capture the energy from the radio waves sent out by the RFID readers. They convert the energy from the radio waves into usable electricity that can then be use power the tag and sent the necessary information back to the reader. The second method of powering is called semi-passive tags. These tags have a battery but they don't continuously send out the information they have for a reader to see. The reader has to first send out a radio wave that the tag picks up and then knows to send a wave back with information stored on the tag. The main advantage of

semi-passive tags is that they can store much more information than passive tags can. They have their own power which is capable of sending out larger amounts of information. The third method of powering is active tags. Active tags also contain a battery but unlike semi-passive tags they continually send out their stored information for readers to pick up. The main advantage to these tags is that each tag is able to communicate with other tags in the area forming a network of information.

After choosing the method of powering the type of RFID it is also important to choose the type of RFID. Low Frequency (LF) and High Frequency (HF) tags are capable of being detected up to 20 cm from the reader. These types of tags are useful for contactless payments and car fobs. Ultra-High Frequency (UHF) and Microwave tags are capable of being detected up to 3 meters from the reader. These are useful for product counting in stores and loading docks. Ultra-Wide Band (UWB) tags are able to be read up to 10 meters and can be used for factory management.

After reviewing the methods of powering and the types of tags we have chosen to use two tags in each of our products. Both with be passively powered. One will be a Low Frequency tag and one will be an Ultra-High Frequency tag. The reason we chose passively powered tags is because they are battery less and very durable. We decided to use a Low Frequency tag because this type would be useful at the dinning commons and at football games as a contactless payment to speed up the entrance process. The product could be waved over a reader and the close range would only read one tag at a time to avoid confusion. We chose Ultra-High Frequency tags as well because these would be useful for counting students in large areas such as the hub, and for automatically taking attendance in classes. The 3 meter range of (UHF) tags would be perfect for doorways were many students are entering at once. The readers at each door would be able to process all students at once instead of one at a time. Students need only to have their key on them as per usual.

3.2 Patent Search

We performed a patent search to identify what patents needed to be obtained in order to create our final product, as well as what isn't already patented that we could improve on.

Table 5. Art-Function Matrix

FUNCTION				ART		
	Combined LF and HF RFID system	**Ultra high frequency radio frequency identificatio n tag**	**2.4G wireless transceiver chip**	**Single chip MR sensor integrated with an RF transceiver**	**Front-end architecture of RF transceiver and transceiver chip**	**Radio transceiver on chip**
Allows a system to use both a low frequency and high frequency RFID at the same time	**US 7456743 B2**					
Design for a Ultra High Frequency RFID tag		**2005066889 A1**				
Design for a receiver tag in the 2.4 GHz to 1Mhz range			**CN 102739278 A**			
A magnetic field sensing device and a radio frequency transceiver				**US 7420365 B2**		
A more compact and space saving RFID tag design					**US 8138853 B2**	
A radio traceiver on a single chip						**CN 1143446 C**

3.3 Benchmarking

All of the products included in the benchmarking have been issued a ranking from 1-5. These rankings are used to compare the evaluate each product and compare the product to our customer needs, with 1 being assigned to those products that strongly disagree with our customer needs, 2 being assigned to those that disagree to an extent, 3 being assigned to those that are neutral, 4 being assigned to those that agree to an extent and 5 being assigned to those products that strongly agree with out customer needs. and the constraints place on the design project.

Table 6. Benchmarking of Four Products

Feature	**Penn State issued ID cards**	**Contactless Payment Credit Cards**	**E-ZPass**	**Car FOB**
Aesthetics	credit card sized (3)	small - same size as credit card (3)	Bulky and unattractive white plastic square (1)	Sleek minimalistic design (4)
Environmental friendliness	Uses plastic (1)	Uses plastic (1)	Uses plastic (1)	Uses plastic (1)
Convenience of use	Have to swipe for everything - commons and for payment (3)	very easy - can stay inside of bag/purse to pay for purchase (5)	very easy - once installed no further work is required (5)	easy to use - simple buttons (4)
Ergonomics	small and easy to hold (4)	no interaction required (5)	no interaction required (5)	small and easy to hold (4)
Cost effectiveness	cheap plastic (2)	cheap plastic with RFID tag (2)	higher quality RFID tag (3)	RFID tag and other transmission buttons (2)

Table 7. Photos of Benchmarked products

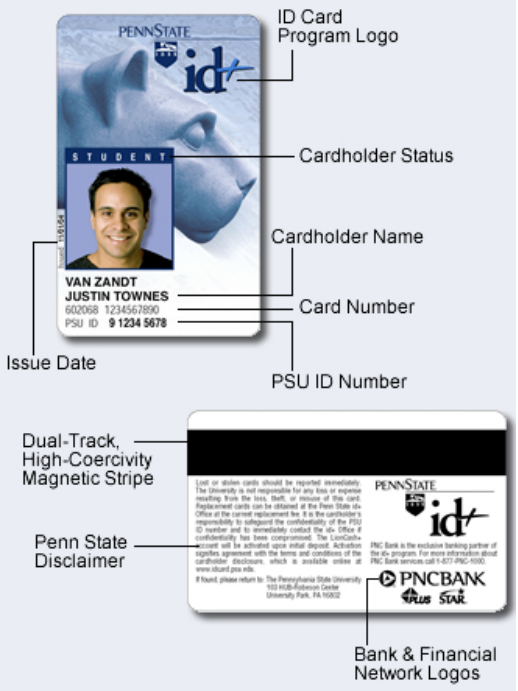
 Penn State issued I.D. Card	Contactless Payment Credit Card
E-Z Pass	Car Fob

Table 8. HOUSE OF QUALITY

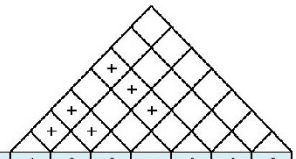
QFD: House of Quality

Project: Students Identify System
Date: 12/08/2013

Correlations	
Positive	+
Negative	−
No Correlation	

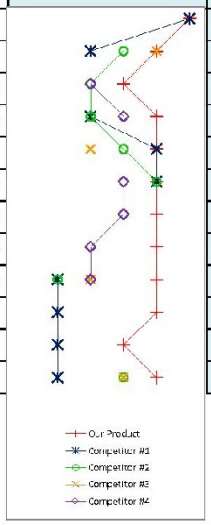
Relationships	
Strong	●
Moderate	○
Weak	▽

Direction of Improvement	
Maximize	▲
Target	◇
Minimize	▼

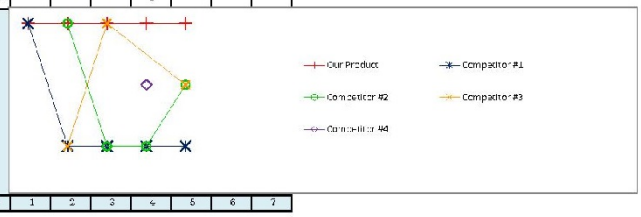


Row #	Weight Chart	Relative Weight	Customer Importance	Maximum Relationship	Customer Requirements (Explicit and Implicit) / Functional Requirements	Make a database to store the information of students	Low frequency chip inside of the key (120-140 KHZ)	Ultra-high frequency chip inside of the key (868-928 MHZ)	Aluminum alloy for key	SIS can be located by a specialized frequency wave			Our Product	Penn State issued ID cards	Contactless Payment Credit Cards	E-Zpass	Car FOB	0 1 2 3 4 5	Row #
1		13%	12	9	Finalized product is used to identify students	●	○	○					5	5					1
2		13%	12	9	Finalized product aims to drastically reduce the amount of time spent waiting in line	▽	○	▽					4	2	3	4			2
3		10%	9	9	Finalized product should be one that can be easily located if it gets lost	▽	▽	▽		○			3		2		2		3
4		2%	2	9	Finalized product should be strong and durable prevent plastic deformation of product				●				4	2	2		3		4
5		4%	4	9	Finalized product should be cost efficient		●	●	●				4	4	3	2			5
6		2%	2	9	Finalized product should be light, weight and easy to carry		▽	▽	○				4	4	4		3		6
7		10%	9	9	Finalized product makes use of aluminum's intrinsic properties				●				4				3		7
8		10%	9	9	Product must use aluminum as a substitute for other materials				○				4				2		8
9		4%	4	9	Finalized product should be recyclable		▽	▽	●				4	1	1	2	2		9
10		10%	9	9	Use of product must increase the sustainability of the campus				●	○			4	1					10
11		10%	9	9	Finalized product should aim to reduce energy consumption in existing systems				○				3	1					11
12		13%	12	9	Product must be connected to the Borough of State College and Centre County (and the region, state, country if need be)	●							4	1	3	3			12

Customer Competitive Assessment



	Column #	1	2	3	4	5	6	7
	Direction of Improvement							
	Target	above 6W Students	120-140 KHZ	868-928 MHZ	6061-T6 Aluminum	120-140 KHZ/868-928 MHZ		
	Max Relationship	9	9	9	9	3		
	Relative Weight	25%	20%	20%	25%	10%		
	Weight Chart							
Technical Competitive Assessment	Our Product	5	5	5	5	5		
	Penn State issued ID card	5	1	1	1	1		
	Contactless Payment Credit Cards		5	1	1	3		
	E-Zpass		1	5		3		
	Car FOB				3			
	0 1 2 3 4 5							
	Column #	1	2	3	4	5	6	7



3.4 Design Target

Through the use of external search, our team was able to establish design targets which eventually guided and directed our concept generation and selection process. The literature review process provided our team with information regarding RFID tags, and the mechanisms behind how they operate. We then were able to choose which mechanisms would work best for the type of RFID we needed to create. We chose passively powered tags due to their durability. We then decided to use Low Frequency tags and Ultra-High Frequency tags because these tags would be useful for counting students in large areas such as the hub, for automatically taking attendance in large classes, for managing the lines outside of football games, and reducing the time spent waiting in line in the dining commons. Next, a patent search was conducted, followed by benchmarking. The patent search identified what patents need to be obtained in order to design our final product. Benchmarking allowed our team to get an idea regarding what advantages and disadvantages are present in the RFID tags currently being used worldwide. From the information obtained through benchmarking, we were about to compare it to our customer needs and improve upon the current RFID tags to create a tag which would efficiently meet the needs of our target population (Penn State Students). The external search process provided our team with insight and knowledge regarding RFID tags, thus creating a design target which ultimately lead to our concept generation.

4.0 Internal Search

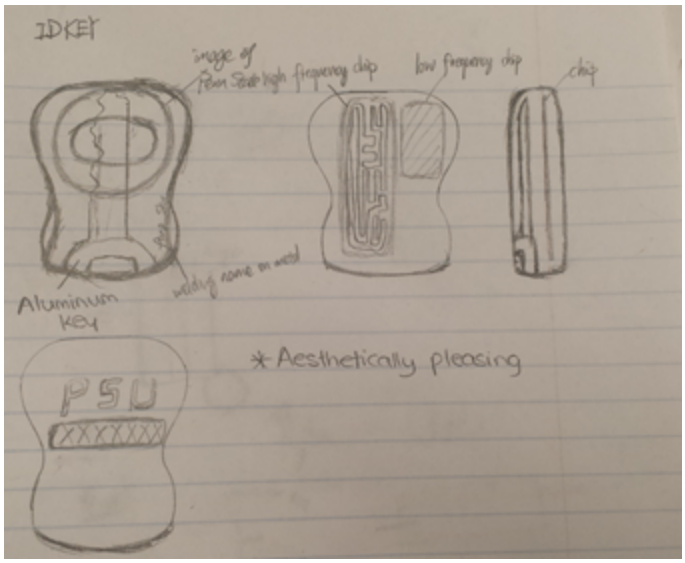
Our next step in the design process involved internally researching, which consisted of brainstorming and mind mapping individually and collectively. Taking the external research and design targets into account, our team was able to create possible designs based on the information gathered. To carry out our internal search, each team member spent three minutes generating a concept, after which the concept would be passed around to the person sitting clockwise to the individual, who would then spend three minutes adding his or her own ideas to the concept in front of him or her. Once every team member had had a chance to look at everyone's concepts, we decided to overview all of the concepts and the various ideas that each team member came up with. During internal searching, all judgment had to be suspended in order to accomplish the development of multiple concepts and ideas. Criticizing, condemning, and complaining all had to be banned in order to productively work as a team. Our design team proved successful at internally researching, and produced a wide range of concepts and designs to be included in the concept generation process.

4.1 Concept Generation

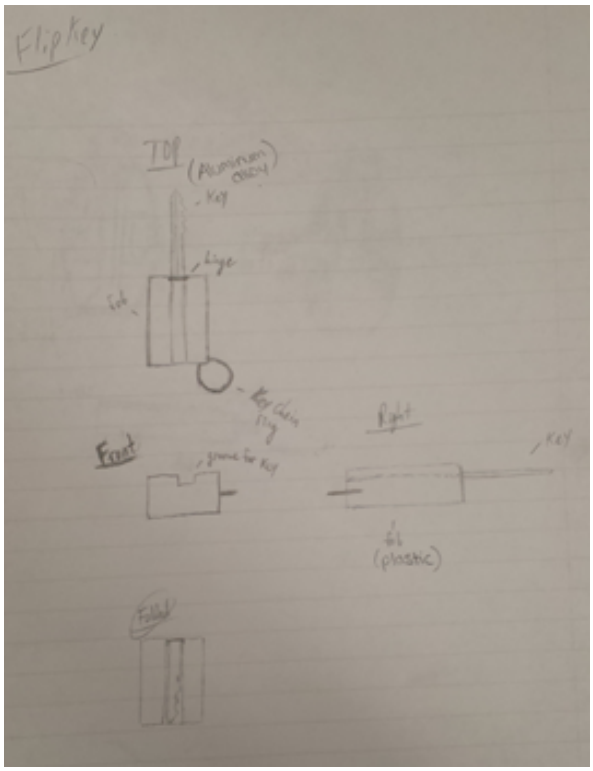
We used a 4-3 method to generate our first batch of concepts. We each individually wrote and drew our ideas and concepts for three minutes. We then passed each of the concepts to the person sitting to our right and that individual would then work on the concept and edit it and add their own individual ideas to the concept - therefore we came up with concepts that included all of our collective ideas thereby generating concepts that included a variety of different ideas and included a range of accessories. We then discussed our various ideas in order to come up with concepts that would be feasible and then redrew concepts while incorporating the various ideas such as the USB and the bottle opener. We included these concepts in the Morphological Chart (Table 6.) to compare the different concepts that we came up with in order to collectively pick winning concepts. Once we generated our concepts we had to keep in mind the fact that our concepts had to match with our customer's needs - which is why we finally discarded the idea of the bottle opener.

Here are some of our design concepts that we generated:

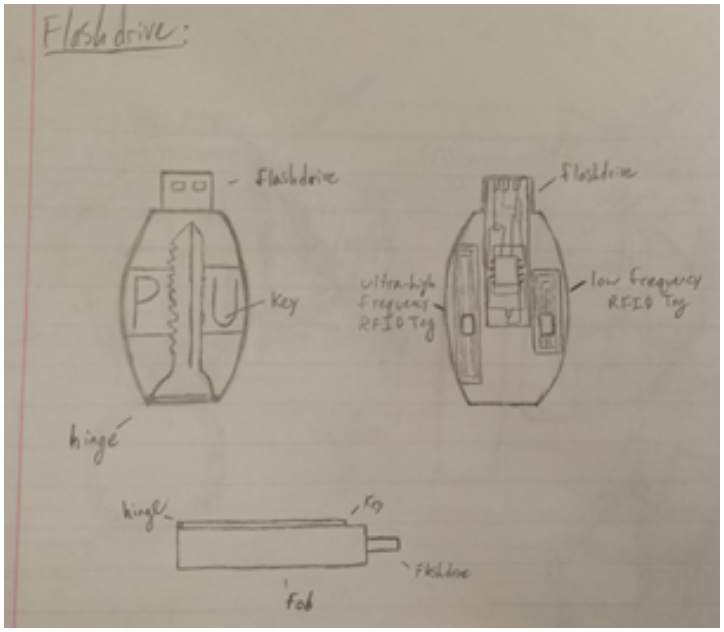
1) ID-KEY



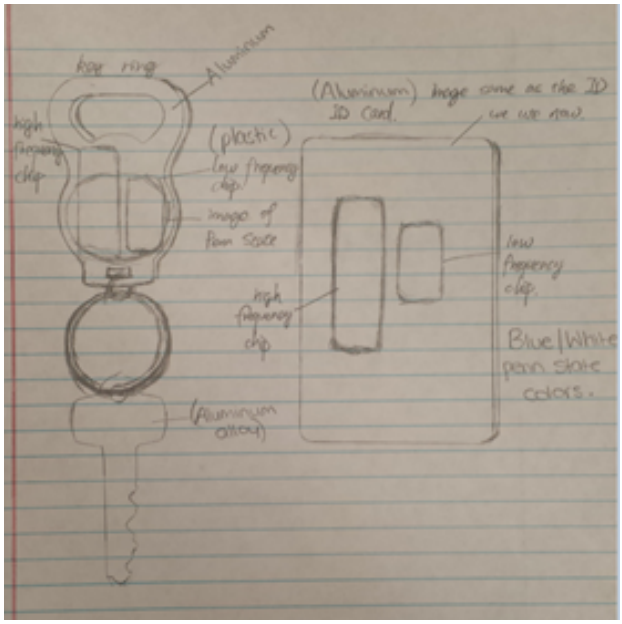
2) FLIP KEY



3) Flash Drive



4) Key Ring **5) ID Card**



6) Normal Key

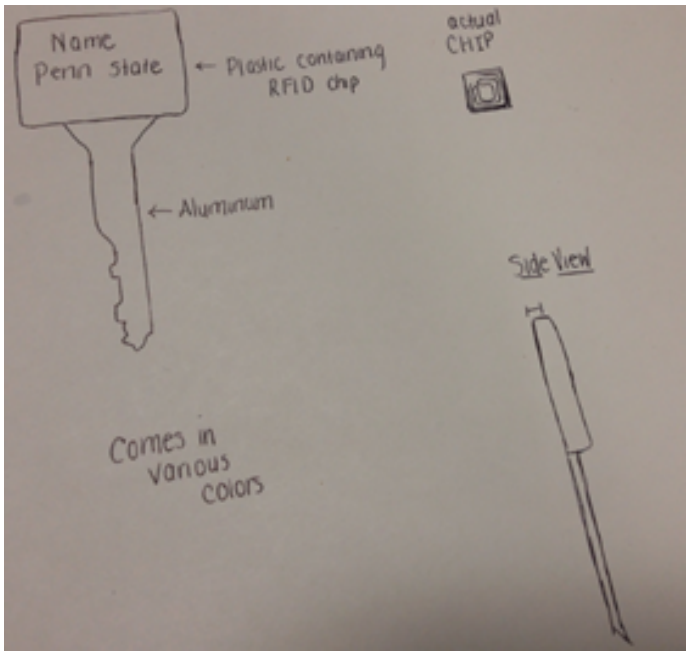
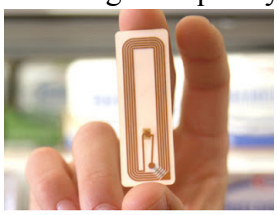
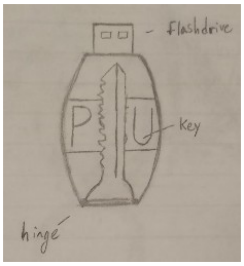
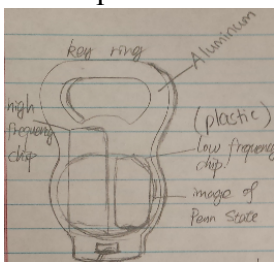
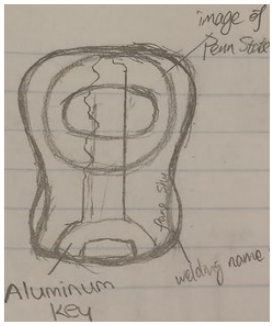
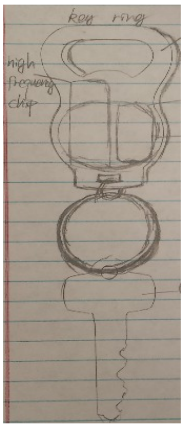
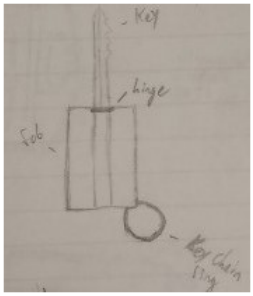
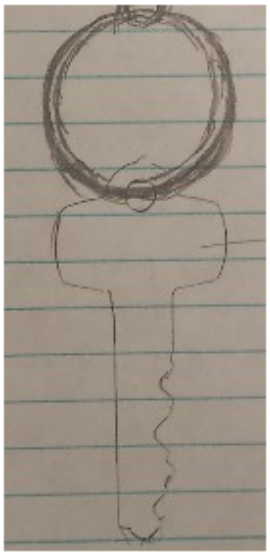


Table 9. MORPHOLOGICAL CHART

	Option 1	**Option 2**	**Option 3**
RFID Tags	Low Frequency	Ultra High Frequency 	LF & UHF
Fob type	round	square	curved

Extra Additions	flashdrive 	bottle opener 	personalized 
Carrier	key chain 	lanyard	fob itself
Colors	white	blue	personal choice

Key attachment	hinge 	slide out	key ring 

4.2 Concept Selection

Once the surveys, research and brainstorming were complete, our team was able to come to an ultimate concept selection. Through the use of a Pugh chart, we were able to determine which of the concept generated designs met the customer's needs most efficiently. Pugh charts are designed to allow engineers to solve problems by evaluating, rating, and comparing different options and alternatives. In our Pugh Chart, seven types of criteria were accessed, including categories such as ease of use and environmental friendliness. Each design was ranked by the use of a 0, +, or -. The 0 represents a standard or base point. If a design excelled in a particular category of criteria, if received a +; indicating that it is above the standard or basis. If the design was less efficient in a certain department of criteria, it received a - sign. The 0's, -'s. and +'s were then summed and a net score was calculated. We used the information and ranking provided in this structure to contribute to our final concept selection decision, thus producing the most practical and efficient design for our customers.

Table 10. Pugh Chart

	Concepts					
Selection Criteria	**A**	**B**	**C**	**D**	**E**	**F**
	IDKEY	Flipkey	key ring	ID card	flash drive	Normal Key
Ease of use	+	+	+	+	+	+
Ergonomics	+	-	0	-	+	-
Environmental friendliness	+	-	0	0	0	-
Features	+	0	+	-	+	-
Ease of manufacture	+	+	+	+	+	+
Portability	+	+	+	+	+	+
Aesthetics	+	-	+	-	0	-
Sum +'s	7	3	5	3	5	3
Sum 0's	0	1	2	1	2	0
Sum -'s	0	3	0	3	0	4
Net Score	7	0	5	0	5	-1
Rank	1	4	2	4	2	6

Table 11: Concept Scoring

		Concepts					
		A		C		E	
		IDKEY		Key ring		Flash Drive	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Ergonomics	10%	4	0.4	2	0.2	4	0.4
Ease of use	20%	4	0.8	3	0.6	4	0.8
Environmental friendliness	10%	3	0.3	4	0.4	4	0.4
Features	20%	3	0.6	2	0.4	4	0.8
Aesthetics	15%	4	0.6	3	0.45	4	0.6
Ease of manufacture	10%	3	0.3	4	0.4	3	0.3
Portability	15%	4	0.6	4	0.6	4	0.6
	Total Score	3.6		3.05		3.9	
	Rank	2		3		1	
	Continue?	No		No		Develop	

5.0 Final Design

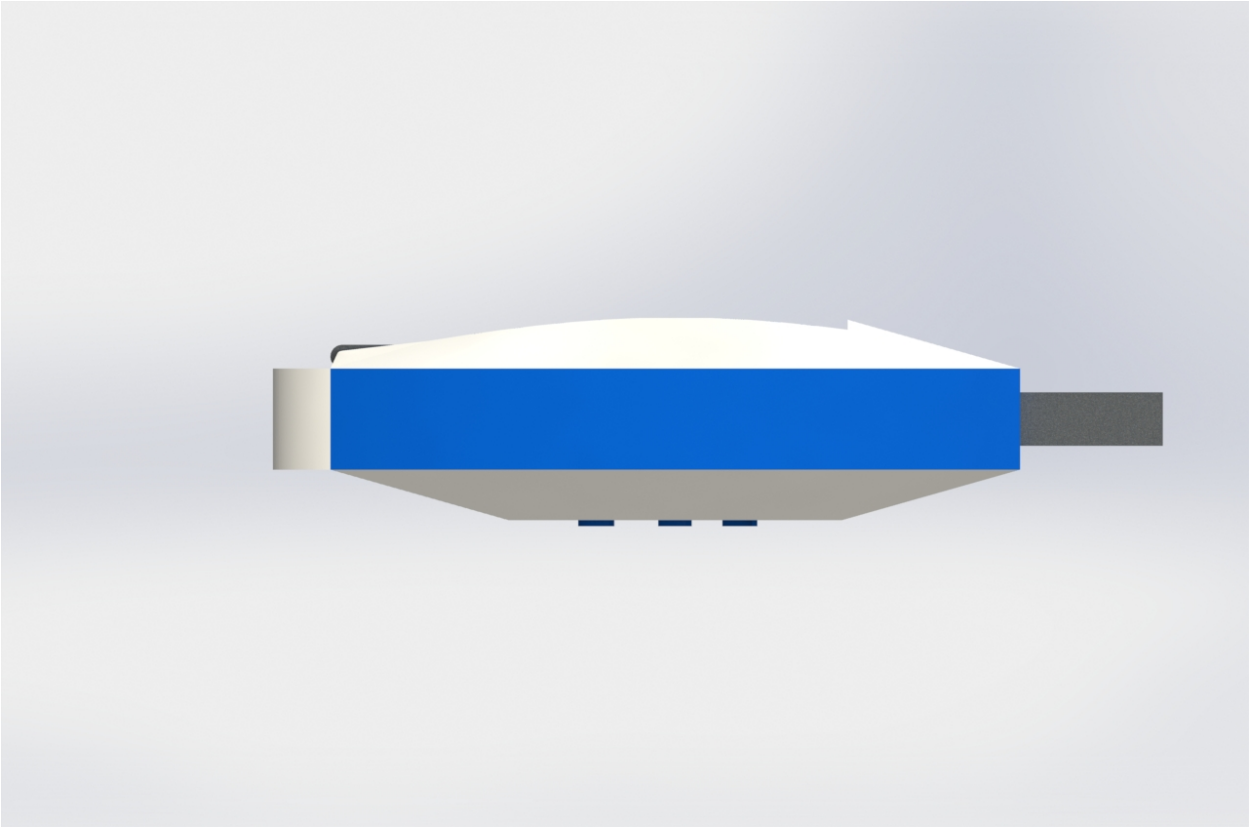
The final design for the SIS is a small oval plastic body that houses both a low frequency and ultra-high frequency RFID tag. There is an 8 GB USB flashdrive attached to side. The key is free to rotate on a metal pin and is able to hinge away from the body to open a door. The overall design is smaller than a PSU ID card .

ISOMETRIC VIEW OF FINAL DESIGN

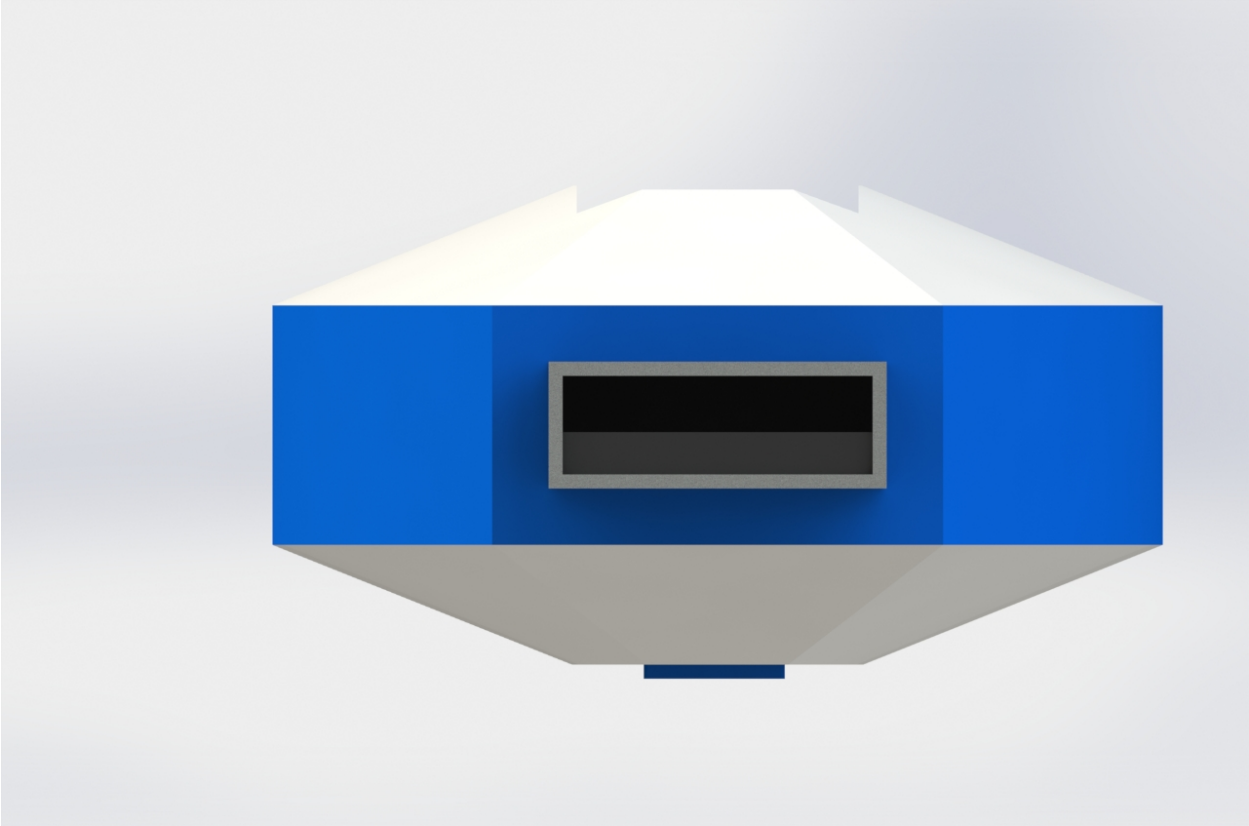
ISOMETRIC VIEW OF FINAL DESIGN SHOWING FLIP OUT KEY

THE REAR VIEW OF THE FINAL DESIGN

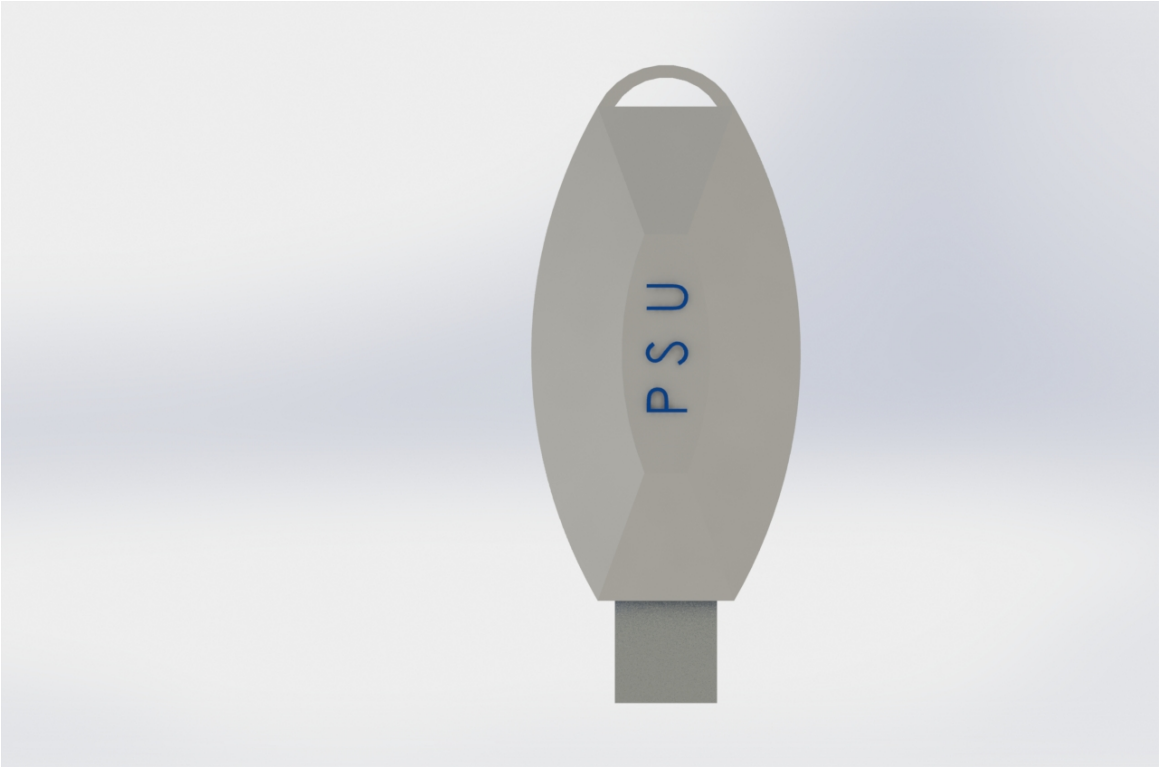
SIDE VIEW OF THE FINAL DESIGN



FRONT VIEW OF THE FINAL DESIGN



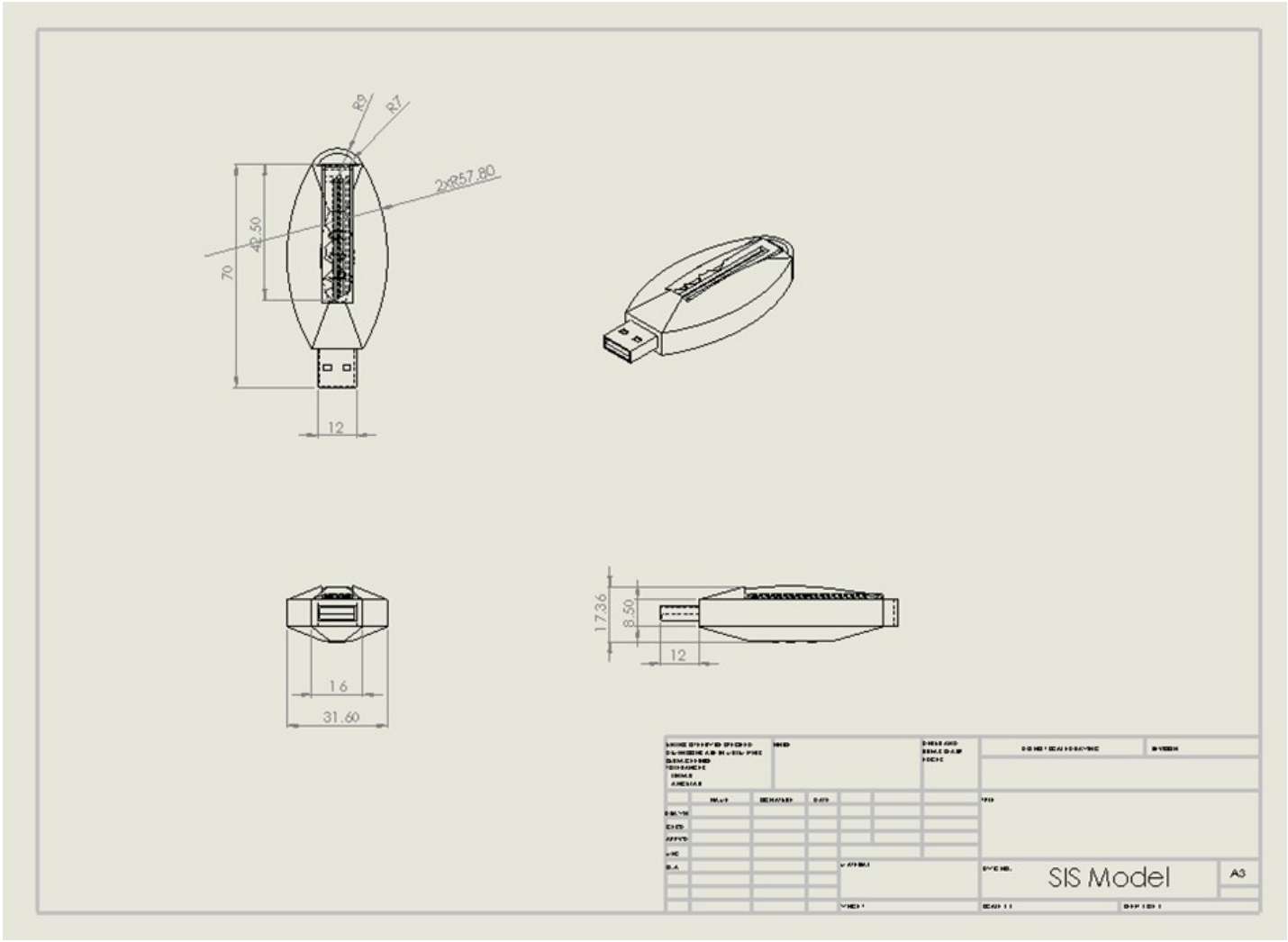
BOTTOM VIEW OF THE FINAL DESIGN



5.1 Design Drawings and Parts List

Below is the final design we have chosen it incorporates a USB Flashdrive and a key that hinges out from the side. It also has two RFID tags inside of it.

Final Drawing of the SIS with dimensions.


4.8
R7
2xR57.80
42.50
70
12
17.36
8.50
12
16
31.60
SIS Model
A3

5.2 Table 12. Bill of materials

Part Number	Part Name	Qty	Function	Mass	Material	Dimensions	Cost
1	Ultra- High Frequency RFID Tag	1	UHF tag for reading	N/A	Plastic and metal	55mm x 20mm	$0.15
2	Low Frequency RFID Tag	1	LF tag for reading	N/A	Plastic and metal	20mm in diameter	$0.11
3	Flashdrive	1	8 GB USB Flashdrive for storing data	12 g	Aluminum	12mm x 30mm x 4mm	$5.39
4	Key	1	Key for dorm rooms	8 g	Aluminum	65mm	$0.43
5	Metal rod	1	Hinge	N/A	Aluminum	2mm in diameter	N/A
6	Body	1	Plastic housing for components	N/A	Plastic	78mm x 32mm	N/A

5.3 Instructions for Assembly

To assemble the SIS first you take the plastic body that was performed and you place one low frequency and one ultra-high frequency RFID tag inside. Then you can slide an 8 GB flashdrive in the open end. The key is attached by the sliding the metal pin through the hole in the key and then placing the pin in the two holes where the key attaches. This allows it to rotate freely.

5.3 How does it work?

The SIS (Student Identification System) uses Radio Frequency Identification (RFID) technology. RFID technology consists of a set of tags and readers. An RFID tag is able to hold a small amount of data that the reader can then send a radio wave signal to find and receive. This is comparable to a wifi router and multiple cell phones. One router can send a signal and receive information from many different phones in the area. The same goes for the RFID reader that can send a signal and read the stored data off of many different RFID tags.

For the SIS we decided to include a low frequency and an ultra-high frequency RFID tag. The low

frequency tag can only be read by the RFID reader when it is within 20 cm from the reader. This is useful for getting football tickets or paying for meals in the dinning commons. The SIS simply has to pass by the reader and the students nine digit PSU ID would be accessed off of the tag. A computer connected to the reader could then access the account associated with the PSU ID. A picture of the student would also come up for security purposes. This would speed up the waiting time in the lines because cards would not have to be handed to the cashier and then swiped which slows down the lines.

We also included an ultra-high frequency tag which is capable of being read at a distance of 9 feet away. This type of tag is useful for taking attendance in class rooms as well monitoring number of students at certain locations. A reader can be placed at every doorway and as a student walks through the tag can be read. A unique feature these tags possess is anti-collision. Multiple tags can read at once without losing the information. This would happen if many students walked through a doorway at once.

The SIS also includes a USB flash drive - an accessory that is pertinent to all students. The key is made of aluminum and hinges on the side of the SIS. The two tags also fit inside of the SIS.

6.0 Conclusion

When looking back to the final design concept that we as a group generated, we decided that our project was successful. We managed to fabricate a concept that primarily aims make the everyday life of a Penn State student more efficient., while including a USB drive - an accessory used by all students. We managed to do this in a cost effective way, by using RFID tags while making use of aluminum's intrinsic properties such as its recyclability and the fact that aluminum is resistant to corrosion. In addition to this, our final design is aesthetically pleasing. Being a group of four young adults who are currently Penn State students, we knew exactly what kind of product to come up with that would be marketable to today's youth. We took all of the customer needs into account while generating our final design and as a result our final design takes most of internal research into mind while keeping practicality a priority and therefore our final design includes an adequate percentage of our customer needs.

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