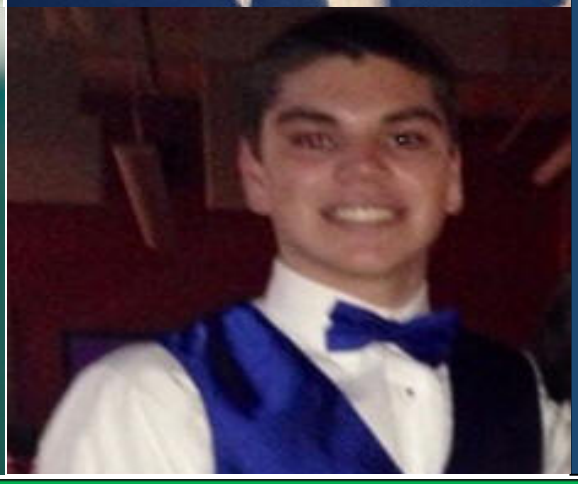
Delphi Project



EDSGN 100

Section 014

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Executive Summary

Making cars greener and/or safer were two areas that our group was interested in working on. We studied both current issues and opted to make a safer car.

The lack of attention when driving cars accounts for a big percentage of deaths every year. We identified this need and decided to target it by developing a product that could alert the driver when his attention was being diverted from the road. We conducted two surveys, two selection matrices, and one scoring matrix in order to narrow down the best concept.

We understand our limitations and we understand our constraint in developing a functional prototype of our concept. However, we wish that our idea could sometime be implemented or at least serve as a step for future research in the continuous process of making products that will save lives.

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Introduction

As we transition into this new century, more and more technologies arise to satisfy people's needs. These technologies cover a wide range of fields and, every day, people find new applications for them in different areas of their lives. We seek to take these technologies further and find a way to apply new and innovative ideas to the automotive industry. We came across the challenge of developing a product that would make a car safer, greener, or more connected.

We undertook this challenge and began our research on these different fields. We wanted to find a spot where we could have the most impact. We analyzed numerous environmental challenges that cars caused. For instance, today, the average gasoline powered car emits 13,572.69 lbs of carbon dioxide per year. This has a huge impact on the environment and needs to be reduced. Along with this, eventually fossil fuels will run out and cars will need a new source of fuel.

Another major issue we came across in this field is the “texting while driving” problem that exists today. In 2011, at least 23% of auto collisions involved cellphones. This is caused because the minimum amount of attention taken away from the road by a cellphone is 5 seconds. Driving at 55 mph, this is already equivalent to driving the length the length of a football field with eyes closed.

Both facts are alarming and need to be addressed. In developing our new product, we came up with different ideas in both fields (greener and more secure cars). However, we decided to conduct a survey to narrow down our product and find what our customer would find most appealing. After settling down for a more specific focus, we brainstormed several possible concepts that we selected using a matrix scoring. This process was always accompanied with thorough feedback from prospective customers in order to develop the best and most accepted concept.

First Concepts

The first stages of our product design involved ideas that would make a car greener or safer. We brainstormed several approaches that will respond to these issues and we came up with our first three concepts.

Roof Turbines: The roof turbines consist of implementing turbines that could capture wind energy and power up the car as it traveled. These turbines would be able to power up the battery and help light up smaller parts of the car.

Wheel Turbines: The wheel turbines consist of power-generating turbines incorporated into the wheels of the car. These turbines would be able to power up the battery and help light up smaller parts of the car.

Eye-Sensor: The eye-sensor consists of a device that can detect the user's vision and provide an alert for when his vision is not directed to the road.

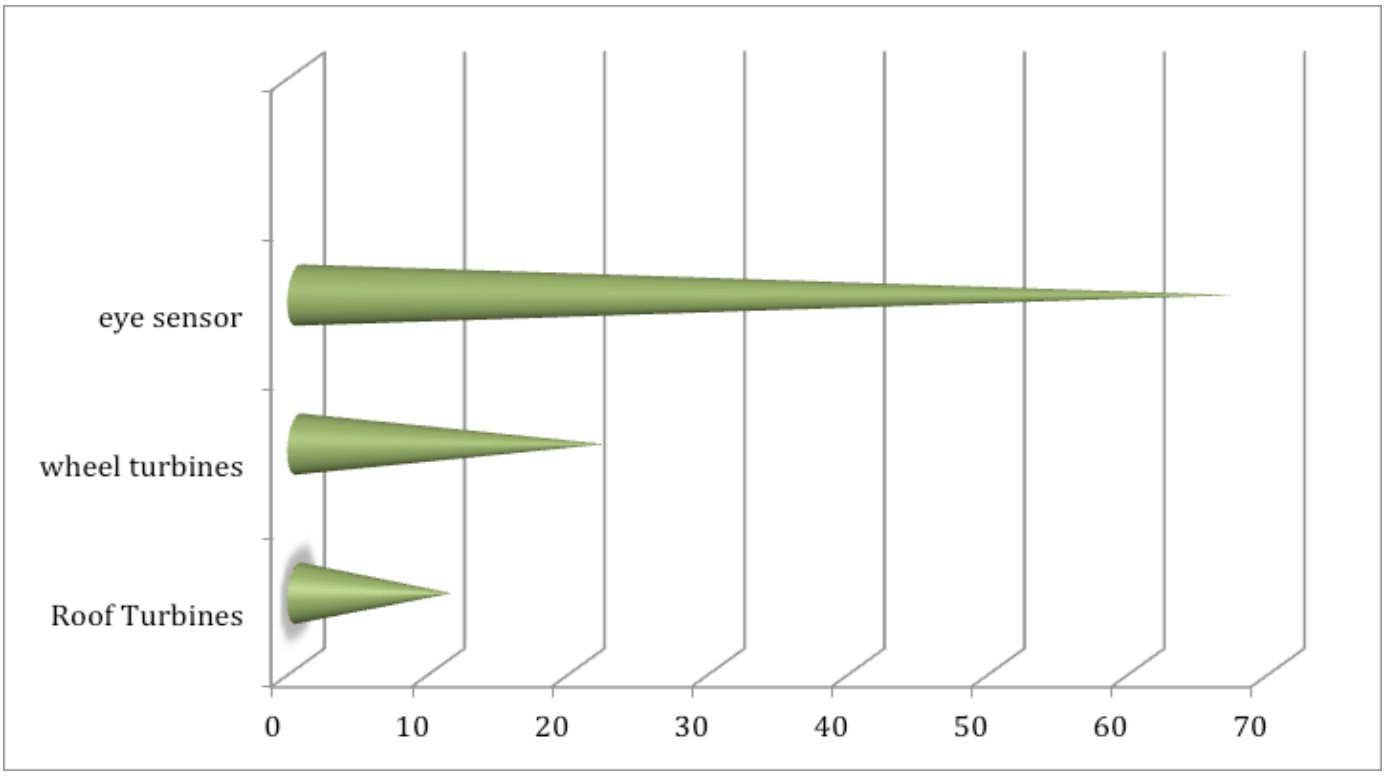
With these first basic concepts we decided to conduct a survey to find out which of these ideas customers found the most appealing. We also

put the concept through a matrix scoring to see which concept had the most advantages.

Surveys #1

Penn State Survey

100 people were asked: Which of the following three ideas most appeals to you? Adding roof turbines to harness wind energy in cars, adding an eye sensor to eliminate distracted driving, or adding turbines on the wheel of the car to generate energy.



Concept Selection Matrix

	First Concepts Considered		
Selection Criteria	A	B	C
	Roof Turbines	Wheel Turbines	Eye-Sensor
Effectiveness of implementation	-	+	++
Ease of manufacture	0	+	+
Ease of implementation	++	0	0
Cost/Benefit	+	+	-
Durability	0	-	+
Customer's perception	0	+	+
Sum +s	3	4	5
Sum 0s	3	1	1
Sum -s	1	1	1
Net score	2	3	4
Rank	3	2	1
Continue?	No	No	Yes

The first selection criteria that we considered was focused on the ease of implementation and manufacturing, the cost benefit, the durability, the effectiveness of each design, and the customer's perception according to the data obtained by the survey.

The eye-sensor had great receptivity by the people who answered the

survey, which was a big incentive for us to continue pursuing this idea. The matrix scoring process also showed that this concept was the most realistic and had the most benefits.

Therefore, we decided to begin our investigation about eye-sensors and to further our knowledge into this field.

Research of Photoelectric Sensors

A photoelectric sensor is a device that can sense a distance and if an object is present. They usually use infrared sensor technology in order to operate. There are three types of photoelectric sensors commonly used today. The first is through-beam sensors in which the receiver is placed in the line of sight of the transmitter. These sensors are especially useful for situations where they need to be very accurate. The second type of sensor is called a reflective sensor. This sensor works kind of like a mirror, the transmitter and receiver are put in the same place and it works when something disrupts the light beam thus

tripping the sensor. These sensors are a lesser version of the first, but they are much more cost effective. The final type of sensor is the diffuse sensor. This sensor transmits a beam of radiation and works only when that beam is reflected off of an object and returns to the receiver. This is the best sensor when distance needs to be found. All three options have their pros and cons, but they all get the job done.

Through-beam sensors seem to be the most widely used sensor as well as the most effective. With their superior accuracy, however, the cost is something that must be considered. In many cases, fiber optics are used where regular circuitry just will not do. Fiber optics are usually used in more hostile environments. The lack of moving parts makes fiber optics perfect for our sensor. Through-beam sensors are more accurate than any other type of photoelectric sensor because there is no variation in where the light is detected, it simply detects when an object breaks its line of view. The best way to visualize a through-beam sensor is a classic museum heist where the thief has to navigate through the beams without touching them or else an alarm will sound.

This mode of sensing would be particularly successful for our concept because the vehicle's operator would be wearing the receiver and as soon as they turn away the beam is broken, thus triggering the alarm.

Another, less useful, type of sensor is the diffuse sensor. The concept of the diffuse sensor is relatively similar to that of the through-beam. The difference is that the diffuse sensor detects the presence of an object while the through-beam senses the lack of presence. Diffuse sensors are much more unreliable and less accurate than through-beam. The only real plus side of diffuse sensors is their extremely low production cost.

The final type of photoelectric sensor researched is the reflective sensor. This sensor works with the exact same concept as the through-beam except the receiver and transmitter are positioned in the same exact location. This sensor works when the laser emitted reflects off of an object and is bounced right back to the receiver. If this laser is interrupted for any reason, the sensor will be tripped and the alarm will sound.

The through-beam sensor, while being the most expensive, seems to be the most effective option for the purpose of safety. The other options were considered, but accuracy was decidedly the most important factor in choosing the through-beam sensor.

	Up sides	**Down sides**
Through-Beam	VERY accurate and have the longest range	Most expensive of all three
Diffuse	Cheapest sensor and only needs to be installed at one point	Less accurate and a shorter range than the through-beam
Reflective	None	Less accurate and a shorter range than the through-beam Slightly downgraded version of the through-beam sensors in every regard

PATENT SEARCH:

Below is a list of patents that would be useful for our Photoelectric Sensor.

United States Patent 3711716 A

Hattori T. , et al. Jan 16, 1973

Photoelectric sensor for line tracing and edge tracing comprising means for switching photocell between different branches of a bridge circuit.

Abstract

This invention relates to a photoelectric tracing system in which the sensing device can be easily changed from a line tracing type to an edge tracing type and vice versa. This technology could one day be used to scan spherical surfaces including the human eye and could one day sense eye movement.

United States Patent WO2013110846 A1, et al. Aug 1, 2013

Eye sensor

Abstract

An apparatus, comprising a transparent capacitive sensor; a body configured to support the transparent capacitive sensor in front of an eye of a user; and a driver configured to receive signals from the sensor

and to determine eye movements based on the received signals, wherein the sensor is configured to detect movement of the eye based on electrostatic effect caused by a bulge of the cornea of the eye. The apparatus may be wearable by the user like eyeglasses. Or applied to vehicles.

Patent US7931370 B2 , et al. 26 Apr 2011

Eye movement sensor device

Abstract

The eye movement sensor comprises a helmet adjustable to the head of a patient who is undergoing an ophthalmologic examination, in a unit with seat and projection screen of light spots in front, the same helmet incorporating a front light projector which emits a light spot towards the screen, as well as means of image recording of each one of the eyes, which records their movements captured from an angle which

permits viewing the eye in all its positions. Said means of recording preferably consists of a video camera disposed below the projector of the helmet, focusing a pair of mirrors, incorporated on different sides of the lower part of the helmet downward, under each eye respectively, to capture the specular reflection of its movements; or instead, two cameras under each eye.

Customer Needs

Impact of Texting and Driving

According to research from 'www.textinganddrivingsafety.com', over twenty three percent of car accidents involve the use of cellular devices. In 2013, over 420,000 people were injured in car accidents caused by distracted driving. As is clearly evident from the facts stated above, distracted driving is a huge issue in American society today, and must be stopped. It is estimated that over three thousand people have

died as a result of distracted driving just last year. Our concepts were designed in order to not only make driving a safer and a more enjoyable experience, but also to save thousands of lives. The biggest and perhaps most frightening obstacle for drivers is texting and driving. Texting not only requires one's eyes to shy away from the road, but it also takes the driver's hands off of the wheel and their cognitive attention from the road. The first step to ending distracted driving is to educate the public of its fatal consequences, but since many people do not like being told what to do, technology is needed to make an impact. Our sensor design would greatly reduce the amount of distracted drivers on the road at any given point in time and would make the world an overall safer place.

Number	Needs	Importance
1	The sensor must be able to alert the vehicle's operator in the event that they become distracted	5
2	The alerts must be easy to perceive by the driver but not distract him.	5
3	The user must find the alerts convenient, helpful, and effective.	5
4	The sensor and its elements must be durable and not require constant maintenance.	4
5	The sensor must be cost effective as to not greatly impact the total price of the vehicle.	3
6	The sensor must be easy to manufacture and implement into the vehicle.	3
7	The sensor needs to be small enough to fit discreetly inside of the vehicle.	3

Before creating our product, we first needed to establish customer needs. First, we said that the sensor must be able to alert the driver in the case of distracted driving. This idea is the basis of our project and is necessary to keep our drivers safe and focused. Next, these alerts must not distract the driver. The whole point of our product is to prevent distracted driving. Therefore, having alerts that created too much of a

commotion would defeat the whole purpose of our eye sensor. Also, our alerts needs to be convenient and helpful to drivers. If the alerts becoming annoying and aggravating, the driver could lose her/her temper and engage in road rage. In addition, the eye sensor must be durable and not require constant maintenance. If the eye sensor breaks easily, this could be dangerous for the driver. If the driver become reliant on the sensor reminding them to look at the road, he/she could accidentally look away from the road for too long and have an accident. And if the sensor needs constant maintenance, it is likely that the user will eventually give up and stop using the product. The sensor must also maintain an affordable cost. We want our product to be available for the common driver and not just those who can afford the sensor. Additionally, the sensor must be easy to manufacture and install in a vehicle. If our product is too hard to put into a car, then no one will use a sensor. And as a result, we will not reduce the negative effects of distracted driving. Finally, we knew that our eye sensor must fit discreetly in a car. We realized that customers would not want a large

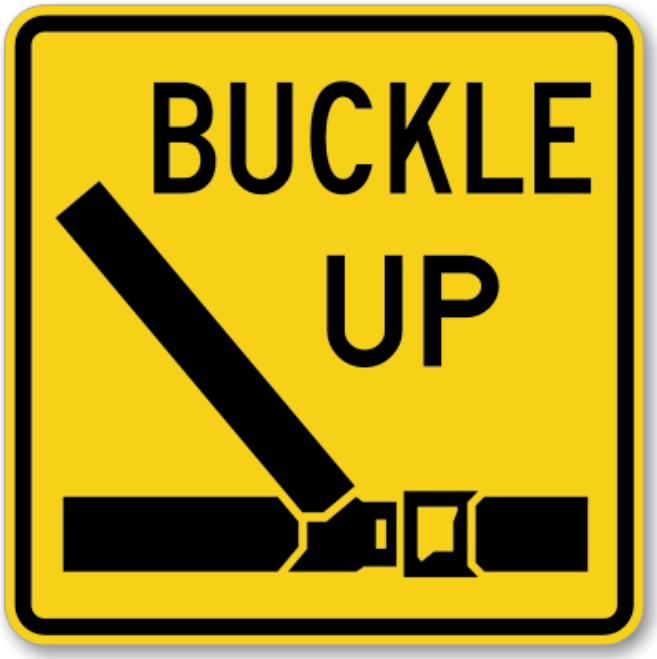
sensor in their car for several reasons. First, a large sensor would not be aesthetically pleasing. Also, many people keep a lot of junk in their car and may not have enough room for an eye sensor.

Further Brainstorming and Concept Generation

As we established our customer needs and conducted in-depth research of the available technologies, we proceeded to brainstorm new concepts for a safer car, incorporating our new innovative ideas. In choosing a sensor we decided to opt for the sensor that would ensure maximum security for the driver. This decision was a no-brainer for the team because we intended to develop a product that could help save lives. However, we did discuss the several alternatives for alerting the driver that his attention was being diverted, and in order to come up with the best design, we conducted a new research and we

prepared a new scoring matrix.

The types of alarm that were considered are: Vibrating Steering Wheel, Vibrating Seat, Car Talks to You, Lighting Alerts, Loud Alarms, Tightening Seat Belt.

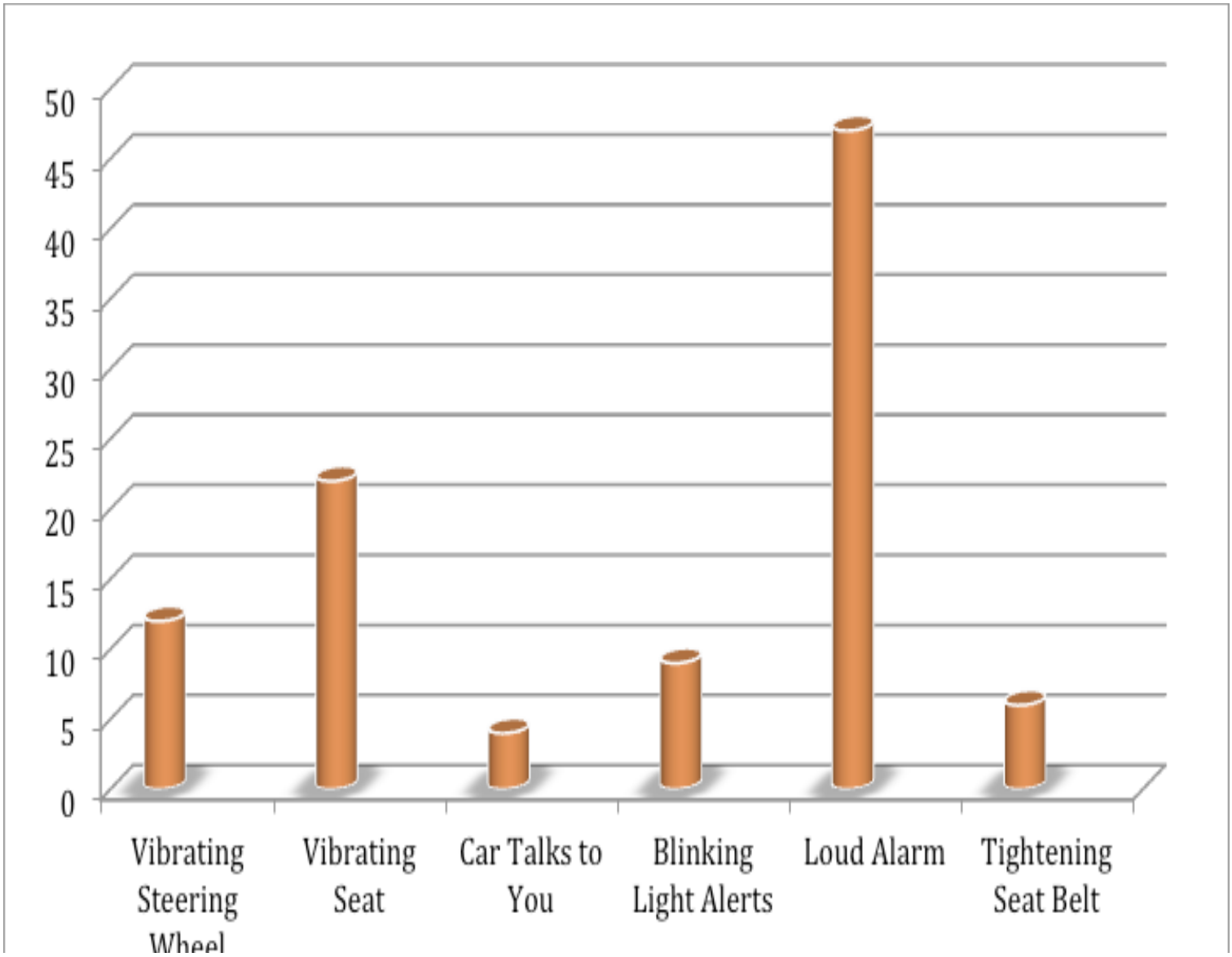


Penn State Survey #2

100 people were asked: What method would you want the most to grab your attention if you were falling asleep at the wheel?

What would be the most effective and less inconvenient way to do so?

These are the results.



Concept Selection Matrix for Alarm Concepts

	Alarm Concepts					
Selection Criteria	A	B	C	D	E	F
	Vibrating Steering Wheel	Vibrating Seat	Talking Alerts	Sound Alerts	Lighting Alerts	Tighter Seating Belt
Ease of manufacture	–	–	0	+	+	– –
Cost	–	–	+	+	+	– –
Durability	0	0	+	+	+	0
Energy efficient	0	0	0	+	0	0
User perception	+	–	0	0	–	–
Ease of perception of alerts	+	++	0	+	+	++
Effectiveness of alerts	+	+	–	+	+	0
Comfortable alerts	+	–	+	0	–	–
Sum +s	4	3	3	6	5	2
Sum 0s	2	2	4	2	1	3
Sum -s	2	4	1	0	2	6
Net score	2	-1	2	6	3	-4
Rank	3	4	3	1	2	5
Continue?	Combine	No	Combine	Yes	Yes	No

The main features considered in the selection for the best alarm concept were: Ease of manufacture, Cost, Durability, Energy Efficiency, User Perception, Ease of perception of alerts, Effectiveness of alerts, Comfortable alerts.

Along with the survey conducted, this matrix helped the team to

narrow down and settle for more specific concepts. After counting and scoring each of the concepts that we cam up originally. The results prompted us to further analyze Sound Alerts, Lighting Alerts, and combining the Vibrating Steering Wheel with the Talking Alerts.

Having these three concepts, we needed a Scoring Matrix in order to rank and choose the best alternative for our final product.

Concept Scoring Matrix

		Sound Alerts		Lighting Alerts		Vibrating Stirring Wheel w/ Talking Aler	
Selection Criteria	Weight	Rating	Weighted Score	Rating2	Weighted Score 2	Rating 3	Weighted Score 3
Ease of manufacture	15%	3	0.45	3	0.45	1	0.
Cost	5%	3	0.15	2	0.1	2	0
Durability	10%	3	0.3	3	0.3	2	0
Energy efficient	5%	3	0.15	3	0.15	2	0
User perception	20%	4	0.8	4	0.8	5	
Ease of perception of alerts	15%	5	0.75	4	0.6	5	0.
Effectiveness of alerts	15%	5	0.75	3	0.45	5	0.
Comfortable alerts	15%	4	0.6	2	0.6	3	0.
Total Score			3.95		3.45		3
Rank			1		2		
Continue			Develop		No		No

We pursued our Customer Needs very thoroughly when grading each of these three concepts. The Sound Alerts ranked first, followed by the combined concept of a Vibrating Steering Wheel w/ Talking Alerts and finally, the Lighting Alerts. These results provided us with the necessary information in order to choose which type of alarm we should incorporate in our design.

Therefore, after these matrices and surveys, we came to the conclusion that our final product was going to be built around a Through-Beam photo sensor and an alarm system that incorporated Sound Alerts.

The Concept

In starting our presentation, we recognized that our product should help keep our car green, safe, or connected. After some consideration, we were most interested in developing a product that made the car more eco friendly or safe. We then conducted a survey asking

consumers to chose between a car with roof turbines (green), wheel turbines (green), or an eye sensor (safe). While analyzing the results, we discovered that consumers are most interested in the eye sensor.

We settled for a sensor with sound alarms, and we foresaw several risks associated that could arise associated with our design. Addressing all these issues are of uttermost importance because we are dealing with a device that ensures the security of the customers; we seek to save lives. The best way to address this issue will be through a thorough investigation of the sensors that are available in the market and in choosing the most accurate one. Also, there are several factors to be considered such as the different velocities that the car will adopt and the maneuvers that the driver does (such as going in reverse) that need to be addressed. We seek to fulfill all these requirements through intense planning and prototyping.

We understand our technical limitations in the making of this product. However, we hope that our investigation and ideas can help further the technological development of this artifact, and hopefully, its

future implementation in the automotive industry.

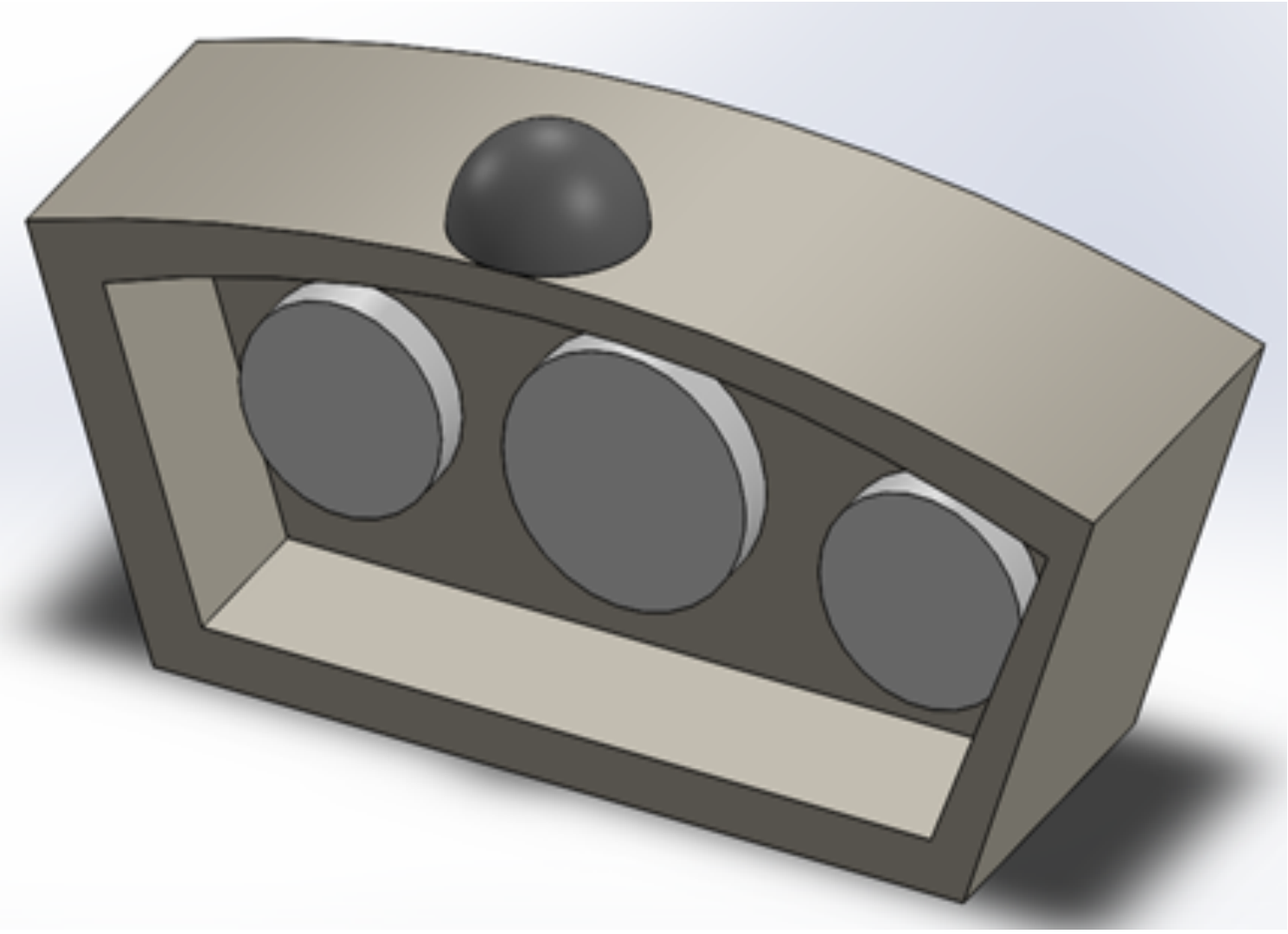
The Features

Our eye sensor will make sure that the driver keeps eye contact with the road, and if he/she does not, the car will make sure to alert the driver properly. For our alerts, we first decided upon an audible alarm that sounds if eye contact is broken from the road for an unsafe amount of time. The alarm will stop all music and will continue to sound until the driver regains visual connection with the road. We considered other ideas such as a vibrating steering wheel, tightening seat belt, and dimming lights. But in the end, we found that the audible alert system was most effective in alerting the driver. Our alert system will also be shut off in appropriate situations. For instance, while the car is traveling zero miles per hour, the alarm will not sound. A driver could be at a stop sign will stopped and must look both ways, breaking eye contact, in order to make a safe turn. Also, the alerts will shut off

while the car is in reverse. To successfully back up a car, a driver must break eye contact with the sensor and turn his/her head to see out the back window. Our eye sensor will lay on the dashboard of a car and will be connected to the battery for a power source. Due to the different heights of drivers, our sensor will also be able to rotate up and down to maintain eye contact with the drivers. When researching sensors to use, we came across through-beam, diffuse, and reflective photoelectric sensors. After researching further, we decided to use the through-beam sensor. Even though the photoelectric sensor is the most expensive, it is the most accurate and has the longest range. Safety is our biggest concern for our customers, and we will definitely pay more money for safety. Also, if we used a cheaper sensor and it failed, we would have a lawsuit on our hands. This situation could be even more expensive than just paying for the more expensive photoelectric sensor. A through beam sensor uses a transmitter a receiver component. Our transmitter component is located on the dashboard and will shoot the beam. Our receiver will be attached to a pair of glasses worn by the

driver. This pair of glasses is provided with the car. However, the receiver component can be transferred to a pair of personal glasses or sunglasses. In fact, we would also like to be able to sync this sensor with Google glasses. As a result, you could later look at a computer and analyze your distracted driving habits. Also, with Google glasses the driver will be able to hear directions without looking away to see them.

Final Product



Conclusion

Overall, we were able to satisfy our customers' needs and create a safer driving environment not just for the driver, but everyone around them. This was done by creating a driver warning system when they get distracted by using a through beam photoelectric sensor. The transmitter of the sensor was placed on the dashboard of the car while

the receiver was located on a pair of glasses or incorporated into google glasses. When the beam between the transmitter and glasses is broken for too long the system will know the driver is distracted and the car will shut off the music and beep to alert the driver. The total cost of this system should be about $1,000 which is reasonable due to the fact that it increases safety greatly. Also with this project, we have learned many things about increasing the safety of driving and just how bad distracted driving can be. So many people get injured/die every year from distracted driving and this really showed our group that it is very important to stay focused while driving.

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