



Plan T for Delphi Automotive: Texting Alert System for Safe Driving



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Executive Summary

Texting and driving is a rising concern in today's society. The death toll increases each day due to people focusing more on a text message than on the road. With all the technology that is used on a daily basis, it makes it easy to justify sending "a quick text" while at the wheel. However, this simple act has the potential to evolve into a disaster. In an attempt to find a solution for this problem, *Achilles' Wheels* has developed a system that enables a car to become completely text-free while it is in motion to ultimately discourage texting and driving.

Our company developed Plan T by initially observing customer needs to obtain product requirements. Three designs were then created in order to meet all of said requirements. To determine the optimal design for the customer needs, we used an AHP matrix and then a concept selection matrix.

However, of our three designs, the one that scored highest was impractical as it completely shut off the driver's phone. We eliminated this from our design choices and worked with the second highest score, which was a sensor system. This system works by having multiple sensors placed in front of/above the passenger seat so as to detect eye, face, and hand movement. If two (or more) of these sensors detect abnormal driving behavior, an audible alarm will sound (similar to that of a seatbelt alarm).

Conclusively, this system is an effective solution to the problem. Despite the cost of the system being near \$1500, it is comparable in cost and safety to airbags and should be a standard safety feature within the coming years.

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Problem Statement

Problem Statement

Where We Want to Be:

Our goal is to eliminate 75% of all texting related accidents with cars equipped with Texting Alert System.

Currently:

As of now, drivers are free to text and drive and are only discouraged by the law or potential danger. However, 23% of auto-accidents involve cellular devices. By texting and driving, the driver is 23 times more likely to get into an accident. Even by just reaching for a cell phone can increase a driver's risk of crashing by 1.4 times. 1,600,000 accidents occur per year due to texting and driving. New statistics show that texting and driving can be up to 6x more dangerous than driving while intoxicated.

How Will We Get There:

We plan on addressing the issue of texting and driving by creating a system that can detect if the driver is distracted due to his or her cell phone. This system will drastically reduce the option of texting and driving through a sensor mechanism. These sensors will be able to detect eye, face, and hand movement and set off an alarm that will not stop unless the driver resets and is attentive to the road. In order to produce an effective design we will determine which types of sensors work best with detecting eye, hand, and face movement. After selecting the best option for each we will then decide where each sensor should be placed to be as accurate as possible.

Design Process

Background

Currently there are only a few devices out there that seek to prevent texting and driving. One of these devices is the "DriveSafe Device" made by Esurance. This device works by plugging into your car and downloading an application onto your phone [3]. After downloading the application, you can choose your personal cell phone access (such as put a limit on it) and it also detects risky driving behaviors. Although this device has a similar goal as ours does, the way it functions is entirely different from our design, which will utilize the driver's motions to detect texting. Another product created to prevent texting and driving is the OrigoSafe. This device must be installed into the car and works by using your cell phone as a key to start the car [2]. Both the DriveSafe Device and the OrigoSafe are mostly for parents who want to make sure their children are not texting and driving, but not so much for the everyday driver. Our company's device operates much differently than either of these and is aimed at preventing every driver from texting and driving.

Customer Needs

Table 1: This data below shows the AHP matrix for our specific customer needs.

	Reduce Accidents	Reduce Texting	Not Disruptive	Accuracy	Reliability	Cost	Total	Weight
Reduce Accidents	1.00	2.00	4.00	3.00	2.00	5.00	17.00	0.28
Reduce Texting	0.50	1.00	2.50	1.00	1.00	5.00	11.00	0.18
Not Disruptive	0.25	0.40	1.00	0.25	0.25	2.00	4.15	0.07
Accuracy	0.33	1.00	4.00	1.00	1.00	5.00	12.33	0.20
Reliability	0.50	1.00	4.00	1.00	1.00	5.00	12.50	0.21
Cost	0.20	0.20	0.50	0.20	0.20	1.00	2.30	0.04
						Grand Total	59.28	

Our goal was set on reducing the sheer number of texting related accidents. Thus, in our AHP matrix, we gave reducing accidents priority over other metrics. Close behind that in weight is reducing texting. If the system is unable to reduce the driver's ability or urge to text, then it's failing. The metrics reliability and accuracy carried a lot of weight when compared to the other metrics such as cost to make. Cost to make was the least of our concern since human lives are priceless. If our system is effective in reducing texting related accidents, then the cost of the system will be of less importance. Especially if our system becomes a standard safety feature in new cars; implemented as often as airbags, ABS, or traction control. Lastly, we don't want our system to be too disruptive to the driver, such as shocking the phone out of the driver's hands. It could get to the point where the anti-texting system disrupts the driver's ability to drive. We heavily considered this limitation while weighing our concepts.

Concept Generation

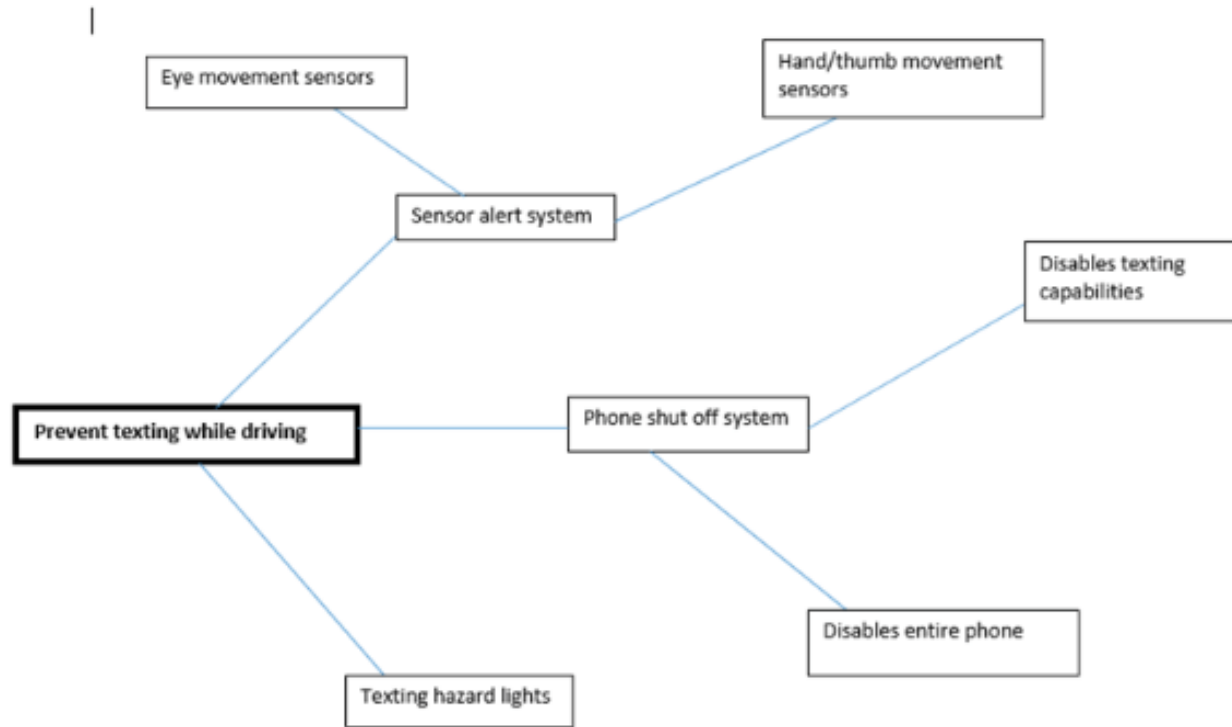


Figure 1: The chart above shows the concept selection classification tree for the 3 individual designs that were created to meet user requirements.

When we initially began brainstorming ideas we came up with ten different issues that we felt we could develop a product for. From there, we narrowed it down to creating a device that would help decrease the number of accidents caused from texting and driving. Our company designed three different ideas, as shown in Figure 1, to address the issue of texting and driving. These included sensor alert systems as well as a phone shut-off system and a text disabling system. We decided that using multiple sensors to detect texting and then consequently sounding an alarm would be the most effective and practical design based on our results from our concept selection chart.

Concept Selection

Table 2: The data below shows the 3 different designs and their weights compared to the specific customer needs that are required for an optimal design.

Feature/Requirement	1. Reduce Accidents (0.29)	2. Reduce Texting (0.19)	3. Not Disruptive (0.07)	4. Accuracy (0.21)	5. Reliability (0.21)	6. Cost to Make (0.04)	Total
Design 1: Sensor Alert System	3	4	3	3	3	1	3.14
Design 2: Phone Shutoff System	5	5	5	3	3	3	4.13
Design 3: Texting and Hazard Lights	3	2	5	3	3	2	2.94

As seen in Table 2, the “Phone Shutoff System” most effectively met all of the requirements of the product. However, this design was impractical and unsafe. The idea of this system is that it completely shuts off the driver’s phone while they are in motion. This means that cannot use the texting application but they also cannot use the Internet function or make a phone call. Due to today’s dependence on cell phones, customers would not want to invest in this system. Moreover, making phone calls while driving is permitted in some states.

The third design we created was a “Texting and Hazard Lights” system. This system included motion sensors that would detect texting-like behavior and then turn a set of hazards on so that other drivers around you would become aware that you are not paying attention to the road. However, this would not discourage the driver from texting, as it does not necessarily have a direct effect on them.

Thus, our company chose the second-highest scoring option, which was the “Sensor Alert System”. This includes a set of multiple motion sensors that can detect eye, head, and hand movement to determine whether you are focusing on the road or driving while distracted due to a cell phone.

Final Design

Final Design Overview



Figure 2: Image of one of the sensors that will be placed around the driver’s seat (not to scale).

Plan T is a system in which there are several motion sensors placed into the vehicle that can detect whether the driver is looking at the road and not using their phones. These sensors, as seen in Figure 2, will specifically detect eye, head (chin), and thumb movement. Four sensors will be placed in the vehicle surrounding the driver’s seat. The first sensor, as seen in Figure 3, will be placed in the left corner of the vehicle so that it can detect left eye movement. Conversely, the right eye motion detector would be placed as seen in Figure 4. The head movement motion sensor, as seen in Figure 5, will be placed in the center of the ceiling dashboard so it has a straightforward projection on the driver’s face. Lastly, the thumb movement motion sensor will be placed as viewed in Figure 6; above the center console.

The locations for these sensors are specific of their duties. The motion sensors for the driver’s eyes are in front of the driver and on both sides so as to improve accuracy. If the driver’s eyes move out of a certain range (± 30 degrees of a programmed centerline), then these alarms will sound. The head movement motion sensor detects if a person’s face is moving downward in an attempt to look at their phone. The last sensor is above the console and is placed where drivers most frequently place their hands while trying to text. This sensor will pick up a certain speed (speed of someone’s thumb while texting) and it will sound.

The alarms for system will only sound if at least two of them detect abnormal behavior. Otherwise, they might pick up on normal everyday activity such as drinking a coffee on the way to work. Thus, the system requires that at two or more of the alarms are stimulated before sounding an alarm.

In order to disable the notification that the driver is texting, they must immediately stop the action and return to the preprogrammed driver position. Meaning, eyes must be on the road, face looking in the direction of the vehicle, and hands are within a close vicinity of the steering wheel.

The “Sensor Alert System” is the most effective design for the reduction of texting and driving. When compared to the design criteria, this system does an excellent job of meeting those requirements. It is able to reduce accidents and texting, as their phone will not distract the driver. The system as a whole is overall not disruptive to the driver, as they are only required to refrain from texting to avert it becoming activated. The reliability of the sensors is relatively high, as they will be constructed for durability. However, the accuracy of the sensors may pose some issues for this system. If for some reason one of the sensors calibration is incorrect by a few degrees or positioning, then the driver will be forced to listen to the alarm regardless of their actions. We took this into consideration and decided to implement a troubleshooting function that will reset the sensors. Moreover, the cost to make these sensors and install them into a vehicle is high, but as mentioned, airbags are expensive as well and they are a mandatory safety precaution that every car manufacturer has to include in their vehicle.



Figure 3: This image shows the location of the first eye movement motion sensor



Figure 4: This image shows the location of the second eye movement motion sensor

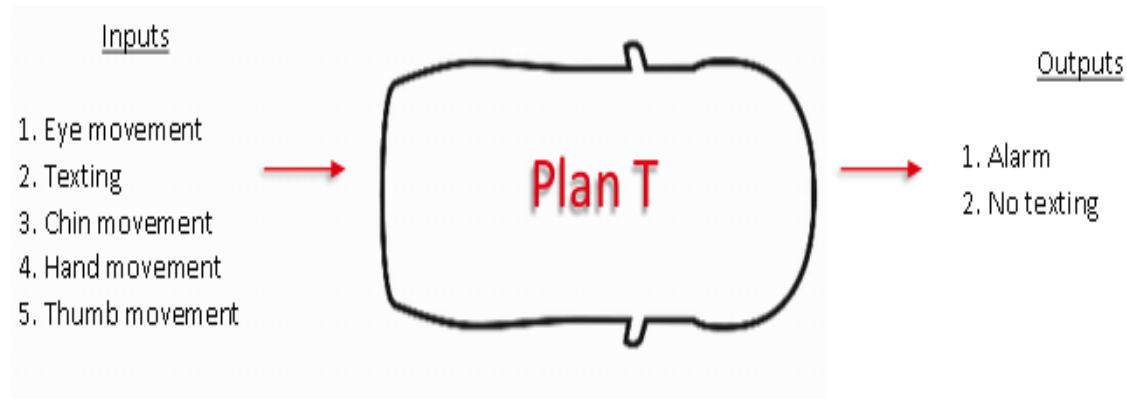


Figure 5: This image shows where the head movement motion sensor would be



Figure 6: This image shows where the thumb movement motion sensor would be (above the center console).

Systems Diagram



Operational Scenarios

Our sensor system is designed to specifically detect when the driver is texting and sound an alarm. If the driver is in motion and picks up their phone, whether with their right or left hand, and begins texting, the eye movement sensor will sense that the driver's eyes are not on the road, the hand movement sensor will detect their face is not directly forward, and the thumb movement sensor will detect the thumb's motion. The combination of all three of these sensors being activated will in turn cause the alarm to go off and deter the driver from continuing to text. Once the driver stops texting the alarm will cease.

Another scenario where our design may prove effective is if the driver was backing out of a parking spot. Since the driver isn't looking at the road, the eye movement sensor would detect that. However, the hand and thumb movement sensor would detect the hands are on the wheel and the alarm would not be set off.

In another scenario, the driver may be drinking coffee while driving therefore setting off the sensor for hand movement. Yet their eyes would be looking at the road and thus the alarm would not be set off.

If the driver decided to try and get around the sensor system by blocking the sensors with tape or paper the sensors would detect that there is something blocking them and would set the alarm off.

Analyses

Cost and Feasibility

From the research we conducted, current technology has face detection systems priced near \$400 and \$100 for hand motion sensors [4]. The car buyer will be charged an additional \$1,500, which accounts for a manufacturing line, labor costs, and other inputs. Our target customers include everyone who texts, and that number is essentially everyone who's buying a car. Since texting and driving is such a widespread problem, and the law doesn't do much to stop it, Plan T is the next best answer. Hopefully within the next few years, it will be implemented as a standard safety feature in cars, similar to airbags and ABS. One airbag can cost \$500-\$1,000, let

alone multiple for the car [1]. With this perspective, the price of our system isn't as daunting as initially thought. With 23% of all automobile accidents involving texting and driving, Plan T is a promising solution to this issue [5].

Legally, the scariest scenario is if the driver is in an accident because of texting and the alarm was not going off. In order to minimize the chance of this happening, Plan T has to be exceedingly accurate. The technology needs to be perfected and then relentless testing would follow. According to Murphy's Law, a legal issue will arise, but minimizing the chance of it is our best bet.

Life Cycle (LCA)

The sensors will be built out of computer hardware in order to make them durable and have a prolonged life cycle. They will also be made out of minimal material as the sensors are small and have a small surface area.

The sensors will, however, have an impact on the car production, as they will add to the cost of manufacturing. Since these sensors are a new technology, the price for the exterior and interior materials is relatively high.

However, they will have little to no effect on how a driver can use his car. These sensors are stationary and placed in obscure locations so that they are not distracting. The driver will have no disturbance operating his vehicle while the sensors are in motion unless he begins to text. In which case, he would have to refrain from this behavior.

Lastly, these sensors show exhibit a limitation in regard to recycling. They are not made out of recyclable material so when one of them malfunctions and cannot be fixed, it must be removed and a new one must be installed. This would be a costly repair as the driver is paying for all new materials.

Conclusions

Plan T is an effective solution to texting and driving. The design is subtle and effective. With four hidden sensors, few people will be able to notice it in the car. As for reducing texting, it does the most effective job that is also reasonable and pragmatic.

From this point on, we imagine that the cons of our design, such as the price of the system and the accuracy, will improve dramatically in order to make it more affordable and functional. As far as accuracy is concerned, there are some positions where the driver could hold his phone and the system may not detect this. This must be fixed before the system could be implemented into all commercial vehicles.

During the development of Plan T, our team learned how to create new designs and then compare them to see which would be the most effective. Moreover, we learned the value of time management when it comes to deadlines for prototypes or reports. We also found how to be resourceful and to find the most efficient way to do something, keeping economy in mind.

Achilles' Wheels envisions a future where texting and driving is not responsible for a human life. Through our product, Plan T, we hope to put an end to this problem and ensure the safety and quality of the driver.

References

1. "Cost to Replace Airbags." *EHow*. Demand Media, 14 Nov. 2009. Web. 14 Dec. 2014.
2. "How It Works." *How It Works*. Origo., n.d. Web. 14 Dec. 2014.
3. "Make a Big Difference with One Little Device." *DriveSafe®*. N.p., n.d. Web. 14 Dec. 2014.
4. "Panasonic WV-ST165." *HD Indoor Pan/Tilt Network Camera with Face Detection WV-ST165*. Adorama, n.d. Web. 14 Dec. 2014.
5. "Texting and Driving Statistics." *Texting and Driving Statistics*. N.p., n.d. Web. 08 Nov. 2014.