

# Drive Alert

## Delphi

Engineering Design

Section 22

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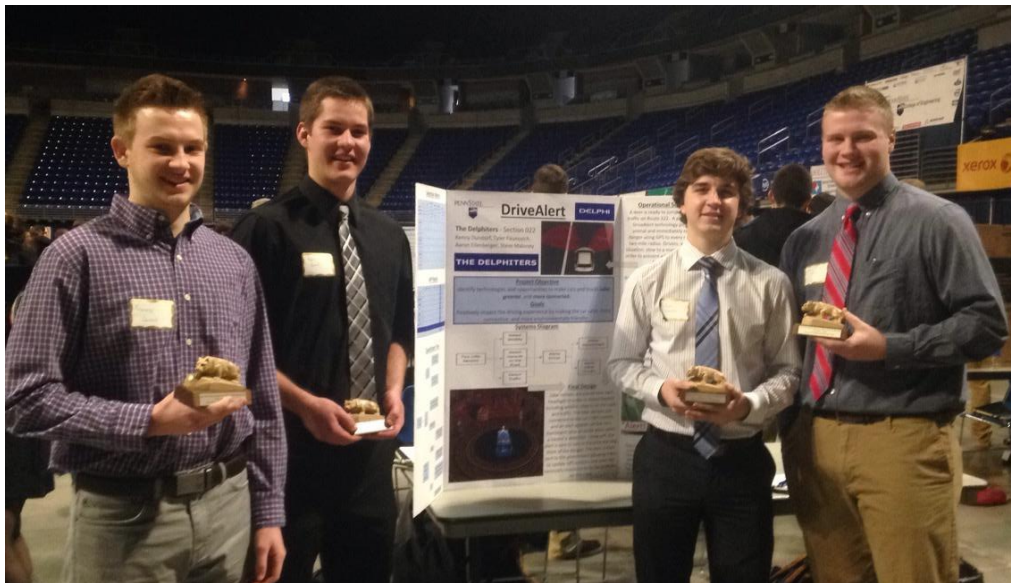
**THE DELPHITERS**

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*Figure 1: The Delphiters take home the Most Affective Design Award at the annual engineering showcase.*

## **Project Summary**

The goal of the Delphi Project was to create or alter available technology to make cars safer, more connective, and more environmentally friendly. The design process included researching Delphi and the technologies they currently have, brainstorming different design concepts, selecting a final design concept, and developing a model of the final design concept. While brainstorming ideas for this project, our group agreed that we wanted to create a product that would make everyone's driving experience as safe as possible. With that being said, we believed that rather than creating a system that would limit the severity of an accident, we could create a system that would help stop accidents from occurring in the first place. We wanted to use sensors to detect and identify hazards on the road. Then, we wanted the driver of the car that detects the hazard, other drivers in the area, and the department of transportation to be alerted of the hazard. Through extensive research, we decided lidar technology would make a great sensor for our system and information could be relayed using wifi connections. The system we created for detecting hazards on the road and relaying information about the hazards to the driver, drivers in the area, and the department of transportation has the potential to make cars safer, more connective, and more environmentally friendly.

## **Introduction and Problem Statement**

Our design consists of a system that integrates Delphi's three main goals: safety, connectivity, and environmental efficiency. In the future, we would like to see improved safety while driving, improved connectivity among drivers, and better utilization of government resources. Our system would achieve safety by detecting hazards on the road so drivers can avoid them. Our system would achieve connectivity by communicating hazards to other drivers in the area and the department of transportation. Our system would achieve environmental efficiency by reducing wildlife deaths and reducing harmful emissions caused by car accidents and idling cars.

Currently, there are crude systems in place for traffic alerts, connectivity to the department of transportation, and connectivity to other drivers. Current detour and accident alerts give very little time for drivers to adjust their route. Current road repair consists of workers for the department of transportation surveying roads in order to find problems. Currently, connectivity between cars is relatively nonexistent.

Our system would utilize sensors to detect potholes, nails, glass, wildlife, accidents, road closings, traffic, and any other hazards. From there, our system would relay the location and identity of the hazard to the driver, other drivers in the area, and the department of transportation. Rather than driving around and surveying roads to find hazards, the department of transportation could use information gathered by cars equipped with our system to fix hazards in a more efficient way. Drivers can use information obtained by our system to avoid any and all hazards. Our system is

unprecedented in its holistic approach to driver-to-driver connectivity and unmatched in its ability to alert those capable of improving road conditions to possible danger.

## **Background**

While we were still brainstorming ideas for our design, we had to do a patent search to see if our ideas were already out there. There is a patent that uses lidar technology as an object detection device for cars.<sup>1</sup> This was one of the technologies that we were interested in using. It turned out to be a good thing that this technology was already out there, because we thought that it would work perfectly in our design. We also wanted to look into patents that dealt with connectivity between cars. There is a patent that uses wifi connectivity in vehicles.<sup>2</sup> We thought that using wifi in our system would be a good idea, as well. There was not a patent on the system we wanted to design, so we continued on with the design process.

Following the patent search, we looked to see what kind of sensors could be used for our design. The Google Car uses lidar technology to drive itself, and we looked into how exactly their technology works. The lidar technology they use creates an image of the road, allowing the car to drive itself.<sup>3</sup> We thought that this technology would be perfect for our design, because it could detect hazards on or near the road. We also looked in laser technology and infrared technology. Laser technology can detect a hazard, but it cannot create an image of the hazard.<sup>4</sup> Infrared technology can detect a hazard and create an image of the hazard, but it is very expensive.<sup>5</sup> Another part of our system was to connect the GPS systems in cars using Wifi connections, and this technology is not yet available.

Along with research into patents and the different technologies in our design, we wanted to research the effects that our design would have on today's society. We tried to find statistics to show how relevant our design would be. We found that over 50% of car accidents are caused by things other than driver error; including potholes, wildlife, small objects, traffic, and other hazards on the road.<sup>6</sup> We found that from July 1, 2011 to June 30, 2012, nearly \$4 billion in car damage was caused from wildlife.<sup>7</sup> Research by AAA found that \$6.4 billion dollars in car damage is caused each year by potholes.<sup>8</sup> Finally, we found that each day, Americans waste 3.8 million gallons of gas from idling.<sup>9</sup> If gas was \$3.00 a gallon, that would be \$11.4 million dollars in gas wasted each day in idling. After finding all of these statistics, we decided that there is a definite need for our system.

## **Customer Needs**

We decided that our system was capable of hitting on all three megatrend areas: safe, connective, and green. With our system, customers would have a much safer driving experience. They would not have to worry as much about hitting wildlife, potholes, and other hazards that are on the road, because these objects would be detected and relayed to them with our system. Customers would be able to use the

connectivity of our system to ensure a safe driving experience. The department of transportation could use the connectivity of our system to be more efficient in fixing hazards on the road. Customers would also be able to use the connectivity of our system to avoid traffic, and the harmful emissions that coincide with sitting in traffic could be avoided. Avoiding traffic helps customers save time, as well.

We developed an AHP matrix to help evaluate our different design ideas. We decided on a list of requirements that we felt were important to the success of our design. Our list included safety, connective, durable, cost, efficient, green, and easy to use. The AHP matrix was used to determine which requirements were the most important.

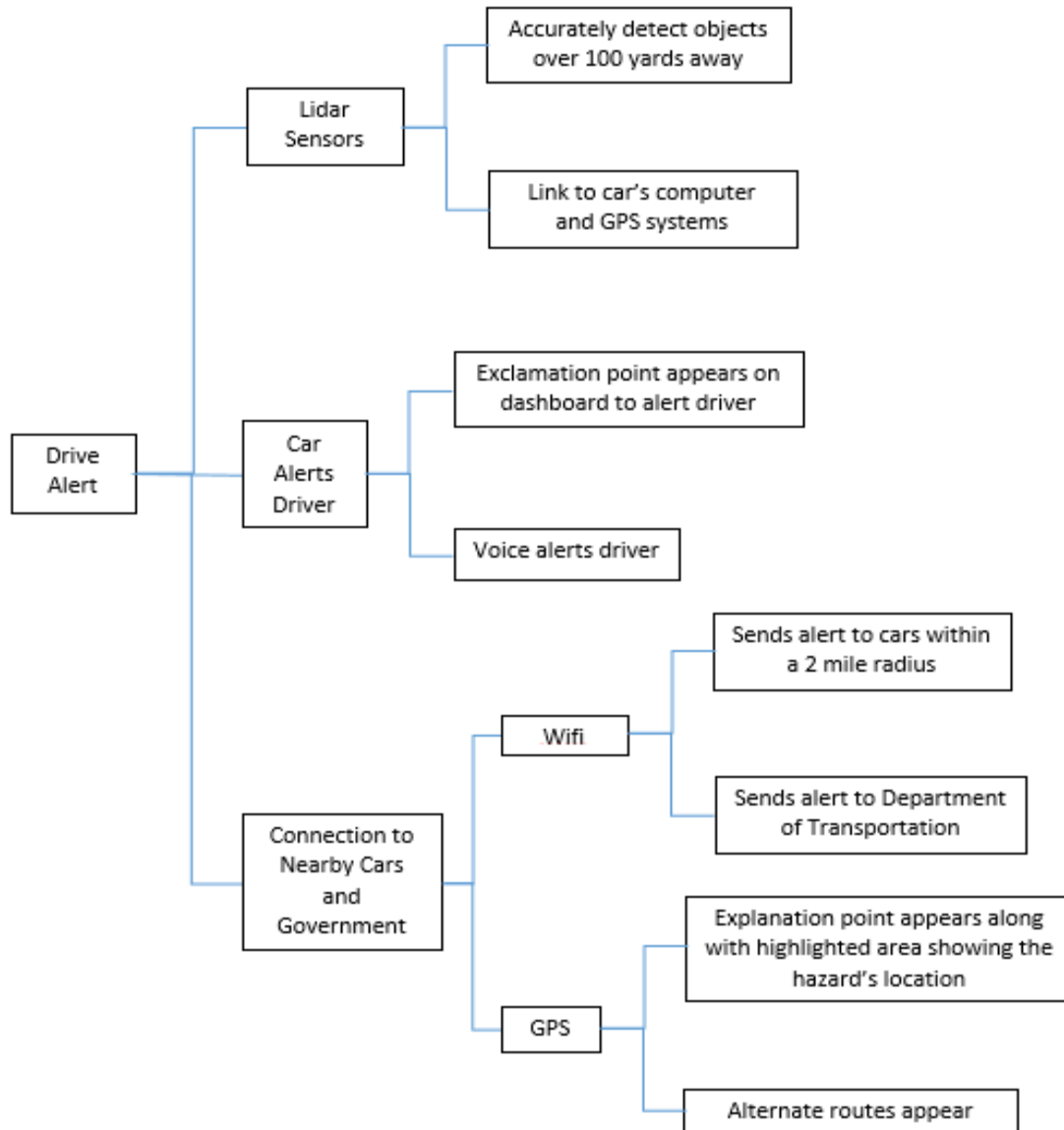
*Table 1: The requirements that we felt were necessary for our system were put into the following AHP matrix.*

	Safe	Connective	Durable	Cost	Efficient	Green	Ease of Use		Total	Weight
Safe	1.00	2.00	7.00	5.00	8.00	4.00	3.00		30.00	0.40
Connective	0.50	1.00	4.00	2.00	2.00	2.00	1.50		13.00	0.17
Durable	0.14	0.25	1.00	0.50	0.50	0.50	0.50		3.39	0.05
Cost	0.20	0.50	2.00	1.00	2.00	1.50	1.00		8.20	0.11
Efficient	0.13	0.50	2.00	0.50	1.00	2.00	1.00		7.13	0.10
Green	0.25	0.50	2.00	0.75	0.50	1.00	1.00		6	0.08
Ease of Use	0.33	0.75	2.00	1.00	1.00	1.00	1.00		7.08	0.09
									<b>Grand Total:</b>	<b>74.80</b>

As it turns out, safety was the highest valued requirement, followed by connective, cost, efficient, easy to use, green, and durable. The AHP matrix served as the basis of our concept generation and concept selection processes, which will be discussed in the next two sections.

## Concept Generation

Once we realized we wanted to satisfy the three megatrends, we put our heads together to come up with a design that effectively detected oncoming hazards and relayed those hazards to both drivers and transportation departments. The main components of the design were detecting hazards with sensors, alerting the driver of the impending obstacle, and relaying the location and identity of the hazard to drivers in the area and the department of transportation. The following concept tree shows the key components in our design.



*Figure 2: The concept tree maps out the main components in our system.*

The concept tree proved to be a crucial part of the design process because it helped us organize all of our ideas.

### **Concept Selection**

A selection matrix was made to compare each of our design ideas using the requirements from the AHP matrix. All three of our designs included a connection to a GPS system, but we were unsure of what technology we were going to use.

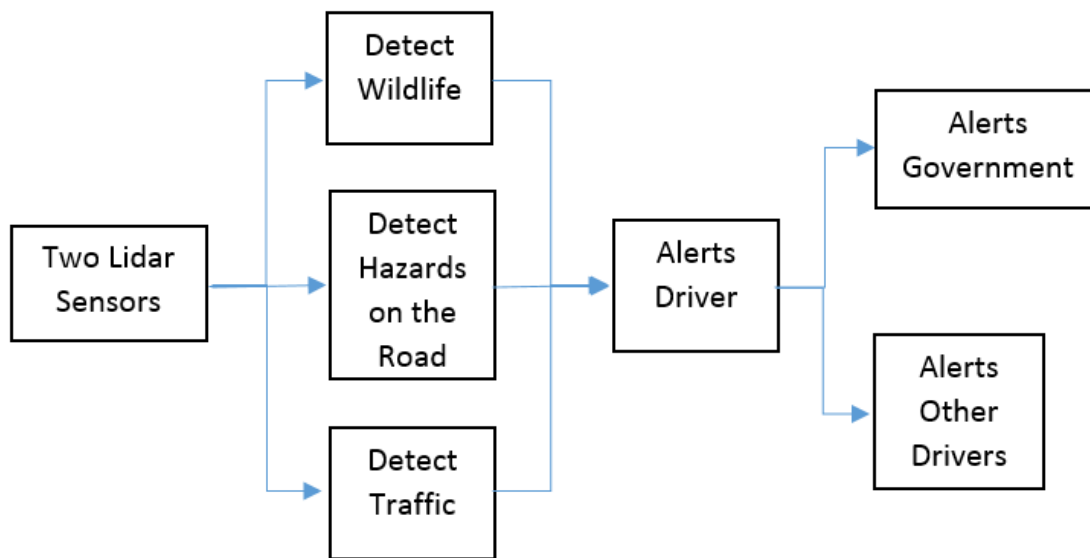
*Table 2: The following selection matrix shows our three design ideas along with the requirements from the AHP matrix. Each design was ranked, and the design with the highest score was chosen as our final design.*

Feature / Requirement (weight)	Safe Has ability to accurately detect hazard (0.40)	Cheap Costs less than \$1000 per unit (0.11)	Connective Quickly and efficiently alerts other drivers and government (0.17)	Efficient Works during any conditions (0.10)	Easy to Use People of all ages and backgrounds can use it (0.09)	Durable Will never need replaced (0.05)	Totals
<b>Design 1:</b> Laser Sensors Connected to GPS	3 = 1.20	2 = 0.22	5 = 0.85	3 = 0.30	5 = 0.45	3 = 0.15	3.17
<b>Design 2:</b> Lidar Sensors Connected to GPS	5 = 2.00	5 = 0.55	5 = 0.85	3 = 0.30	5 = 0.45	3 = 0.15	4.30
<b>Design 3:</b> Infrared Sensors Connected to GPS	3 = 1.20	2 = 0.22	5 = 0.85	4 = 0.40	5 = 0.45	3 = 0.15	3.27

We narrowed down our options to three different technologies: laser sensors, lidar sensors, and infrared sensors. We knew we wanted our final design to work through the already existing GPS system, but we didn't know what sensors we wanted to use. After thorough research, we realized that lasers could not create an image of the road, and infrared sensors were too expensive. After looking into technology utilized by the Google car, we decided that lidar technology was the best design. Lidar uses light rays to create an image of the surroundings.<sup>3</sup> With a perfect scan radius and relatively low price, lidar was the perfect sensor to implement into DriveAlert. The final design features two lidar sensors placed near the headlights that continuously scan the road for hazards.

## Systems Diagram

The system diagram shows the inputs and outputs for our system. Two lidar sensors detect hazards wildlife, hazards on the road, and traffic. The driver is immediately alerted of the hazards. Drivers in the area and the department of transportation are also alerted of the hazards.



*Figure 3: The systems diagram shows the inputs and outputs of our system.*

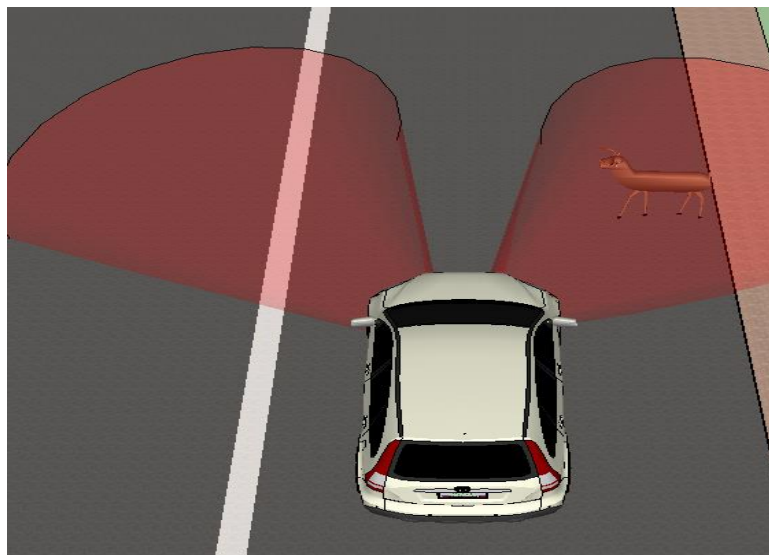
## Final Design Discussion

Our product begins with the utilization of lidar technology. Lidar (Light Detection and Ranging) is a fairly new technology that works on principles similar to that of radar. Radar emits sound and calculates the time it takes for the sound to bounce off an object and return to the instrument. Lidar uses light instead of sound, which increases the pulses it can emit in a given time, meaning that it can create an image faster than radar. Lidar was first designed as an advanced solution to 3D mapping of the earth. The technology has evolved and is now outfitted on cars such as the Google Car pictured below. It has proven useful for the Google Car because of its ability to render a 3D and 360 degree picture of its surroundings in real time. The technology has an effective range of approximately 600 feet and can tell the difference between objects such as a bag and a small animal.<sup>3</sup>



*Figure 4: The Google Car uses lidar technology to create an image of the road and its surroundings. [http://velodynelidar.com/lidar/hdlpressroom/images/google\\_prius.jpg](http://velodynelidar.com/lidar/hdlpressroom/images/google_prius.jpg)*

Our design uses this technology to pick up on dangers such as wildlife, potholes, debris in the road, and any other obstruction that could cause the driver harm. Our system uses two lidar sensors positioned in the front of the car near the headlights. The sensors will oscillate providing a larger effective range, allowing them to pick up on dangers both in front of and on the side of the vehicle.



*Figure 5: The lidar technology that DriveAlert uses allows the car to pick up hazards both in front of the car and on the side of the car.*

After the danger is picked up by the sensors, it will be transmitted to the driver. The driver will simultaneously be alerted with a visual and audio message. The visual will be a bright red exclamation point that appears on the dashboard, with the purpose of simply getting the drivers attention. The audio alert will notify the driver of the type of



obstruction and the location of the obstruction on the road. The vehicle's GPS will then be updated with the details of the danger. The GPS will display this alert with text as well as a visual of the obstruction on the digitized road.



*Figure 6: The driver will be alerted with a bright red exclamation point on the dashboard, a voice alert, and an alert on the car's GPS system.*

The first vehicle acts as a data acquisition device that can obtain information on the road and pass the information on. The alert will first be sent via wifi to all the cars within a two mile radius. The transmission will update the vehicles GPS giving the driver awareness to the type of obstruction and how far away the obstruction is. This will provide the driver with the information necessary to avoid the danger, preventing vehicle damage and crashes.

The data will then be passed on to multiple Government agencies. The first set of data will be sent to the numerous agencies that run the GPS systems, allowing them to update the GPS system in all vehicles. This will provide an alert to every car that travels on the road with the obstruction. The message will then be sent to the department of transportation so they can take the necessary action to fix the problem.

Another capability of our product is to gather information on traffic. The sensors can determine the distance and speed of surrounding cars to paint a picture of traffic flow and traffic density. GPS systems will be updated to show the flow of traffic on all

roads. When the user turns on his or her car and inputs their destination into their GPS, they will be given a route that avoids traffic, allowing them to get to their destination faster and more efficiently. The capability to alert drivers of upcoming traffic reduces the harmful emissions due to idling, thus making the driving experience less damaging to the environment.



*Figure 7: Lidar sensors detect the number of cars in the area and the speed at which they are traveling. This allows our system to account for traffic. [https://encrypted-tbn3.gstatic.com/images?q=tbn:ANd9GcS8m0Xga86U4l4pRb-z\\_AaZTRFEyfUp86fxwVdIYbcPP1Y8fXPiyw](https://encrypted-tbn3.gstatic.com/images?q=tbn:ANd9GcS8m0Xga86U4l4pRb-z_AaZTRFEyfUp86fxwVdIYbcPP1Y8fXPiyw)*

## **Operational Scenarios**

### Scenario One

Early one summer morning, after a late night thunderstorm, the visibility is very low due to a heavy fog. As you wind your way down the road, speeding because you are late for work, you can't see the mother deer and offspring about to cross the road half a mile away. As you approach the deer, the lidar technology on the car picks up the deer and immediately alerts you via the dashboard and a voice alert: "Danger, animal crossing ahead." With this in mind, you look to your GPS to see the animals' location, and slow down to 20mph. The deer are able to cross the road, avoiding a possible deadly scenario.

### Scenario Two

You're driving on a state road going about 80 mph, and there is a massive pothole 200 yards ahead. You are in the middle of a conversation with your mom who is in the passenger seat. You are paying attention to where you are going, but you're distracted by the conversation, so you would not see the upcoming pothole. All of a sudden, the lidar sensors in the grill of your car detect the upcoming pothole. Immediately, a bright red exclamation point appears on the dashboard, and your GPS

system gives a voice alert saying “Danger, pothole ahead.” The warnings give you enough time to shift your full attention to the road. You see the pothole, and you avoid it by gently swerving out of the way, avoiding car damage and a possibly wreck.

#### Scenario Three

You are a state employee tasked with maintaining the roads. You are used to wasting time by driving around in search of potholes and other obstructions in the road. Your agency recently updated their technology which utilizes civilians to pick up dangers on the road. Your work day begins, and instead of searching for problems, you are given a list of obstructions in the county. This data was picked up the day before by cars in the area. You spend your day efficiently fixing the reported problems, and little time wasted.

#### Scenario Four

It’s the end of your work day and you are almost home. While you are turning into the back alley where your garage is located, you are thinking about unwinding and watching the Monday Night Football game. You are focused on the road but cannot see the children playing whiffle ball in the back yard because the house’s garage obstructs your view. You see a high fly ball hit into the air but don’t think much of it until your DriveAlert system tells you a child is very close to your vehicle. As a result, you stop the car. Seconds later, a boy tracks the fly ball and unknowingly wanders into the alley. Thanks to your Drive Alert system, you made it home safely and so did the boy.

#### Scenario Five

It is your one year wedding anniversary, and you have a reservation at a fancy restaurant for 6 p.m. You were busy the day before, and you did not have time to pick up flowers. However, you decided you could pick them up after work. You get out of work at 4:30 p.m. get into your car. You set the destination to a flower shop that is three miles away from your house. A warning pops up on the screen saying that there is heavy traffic on the highway that you normally take home. You take an alternate route, pick up the flowers, and make it home in perfect timing to go out on your date. Later than evening on the news, you learn that there was a major accident on the highway that you normally take home from work. Delays were as long as an hour. DriveAlert allowed you to make it home in time for your dinner reservation, and it also saved your marriage.

As you can see, there are many different scenarios for which DriveAlert can be used. The system is very accurate and reliable, making the driving experience almost stress free.

### **Cost and Feasibility Analysis**

Currently, lidar technology can be found on the market for close to a thousand dollars. However, as more and more companies such as Google and Ford experiment with it, costs are projected to decrease drastically. The cost of lidar is predicted to be approximately \$150 by the end of the year 2016.<sup>3</sup> This information is very good for

customers and the car manufacturers, because they can buy our product for less and sell the product to consumers for a reasonable price. In total, the projected production cost for DriveAlert is \$300. Without DriveAlert, Americans spend an estimated \$10.4 billion repairing damage from potholes and wildlife alone, as cited earlier in the report. With that being said, when we incorporate costs of research, engineers, labor, production, and other costs, we are able to sell the product to car manufacturers for \$619.27. In turn, the car manufacturers will be able to sell DriveAlert for just under \$2,000. DriveAlert stops car accidents from happening, so it saves lives and a lot of money. Therefore, we feel DriveAlert is very reasonably priced. Also, the way DriveAlert works, not every driver needs it to experience its benefits. As long as a driver owns an updated GPS system, which are relatively cheap today, they can receive alerts for obstructions ahead of them. Lastly, DriveAlert is very feasible, considering the technology in use today and its price.

### **Life Cycle Analysis**

Lidar sensors are relatively small; they are about 3 to 5 square inches.<sup>10</sup> They are also very light. The weight of lidar sensors will continue to decrease as the technology becomes more popular. Therefore, the amount of weight added to the car by lidar sensors is negligible, so the life cycle of the car is not really effected. The sensors will be placed in open space in the front of the car. The only modification to the vehicle is a transparent plate which houses the sensors. The housing will ensure the sensor is protected, allowing the sensors to last longer. If the car breaks down and the lidar sensors are still operational, they can be harvested from the vehicle and used elsewhere. Otherwise, the sensors can be recycled along with the car.

### **Conclusions**

DriveAlert has the potential to transform the safety, connectivity, and environment friendliness of driving. DriveAlert's use of lidar sensors to detect hazards on the road and wifi to connect drivers in the area and government agencies can be implemented and even expanded upon to create a world where driving causes zero injuries and zero fatalities. With this being said, the sky is the limit for our product. As lidar technology becomes more popular and its cost continues to fall, it can be economically feasible for people everywhere.

We learned a lot from this project. We learned more about the design process and how every part of it is very important for the overall success of a design. This project taught us to be creative and innovative in our thinking. Even though we did not know much about cars going into this project, we were able to think creatively and work as a team to come up with an innovative design. Overall, this project let us work together as a team to create a design with the potential of revolutionizing the driving experience.

## References

<sup>1</sup><https://www.google.com/patents/US8027029?dq=lidar+technology+on+cars&hl=en&sa=X&ei=cHCMVK7EEsiZsQTX7YCoAQ&ved=0CB0Q6AEwAA>

<sup>2</sup>[https://www.google.com/patents/US20100020774?dq=wifi+connectivity+between+cars&hl=en&sa=X&ei=fXKMVM65BPf\\_sATonIDIDw&ved=0CB0Q6AEwAA](https://www.google.com/patents/US20100020774?dq=wifi+connectivity+between+cars&hl=en&sa=X&ei=fXKMVM65BPf_sATonIDIDw&ved=0CB0Q6AEwAA)

<sup>3</sup><http://www.wsj.com/articles/laser-eyes-pose-price-hurdle-for-driverless-cars-1405969441>

<sup>4</sup><http://www.lasertech.com/>

<sup>5</sup>[http://www.ehow.com/how-does\\_5561845\\_do-ir-sensors-work.html](http://www.ehow.com/how-does_5561845_do-ir-sensors-work.html)

<sup>6</sup><http://www.smartmotorist.com/traffic-and-safety-guideline/what-causes-car-accidents.html>

<sup>7</sup><http://www.insurancejournal.com/news/national/2012/10/24/267786.htm>

<sup>8</sup><http://www.wusa9.com/story/news/nation/2014/02/24/potholes-damage-cost-us/5773501/>

<sup>9</sup><http://www.thehcf.org/antiidlingprimer.html>

<sup>10</sup><http://www.unmannedsystemstechnology.com/2014/03/velodynes-hdl-32e-lidar-sensors-used-to-measure-calibrated-reflectivity-data/>