"The app that could save your life"

iCar is an app that allows people to connect with their car, whose main purpose is to prevent car accidents due to mechanical failures. It will notify the user of a mechanical failure, the danger of this failure, and of where to get the failure fixed.

Engineering Design 100, section 22
Team A: J:
Jackie Tucker (jrt5329@psu.edu), Ammar Al Hadhrami (ata129@psu.edu), Jala Mansour (jala.mansour@gmail.com), Anthony Chiodo (achi396@gmail.com)
Professor Ritter
December 15, 2014

Abstract:
In a time where car accidents are still relatively high, averaging about 10.8 million a year and leading to 33,000 deaths within 30 days, it is our goal to show that there are possible ways to decrease that number to zero fatalities (reference 5). After research, results have shown that about 12-13% of car accidents are due to mechanical failures (reference 5). We chose our focus to be on the driver’s safety. We looked at the customer's needs and then we performed an AHP matrix to
see what our priorities should be. We used surveys for suggestions (these can be seen in appendix B) and came up with different ideas that would increase the safety of the passengers and driver (all the various ideas can be seen in appendix A). In the end we decided that having an application in the car that alerts the driver about any failures and sends them a notification, before the failure happened or immediately after it happened, would be the ideal way to resolve the problem of car crashes due to mechanical failures. We created this device in order to increase the safety of the driver while keeping the driver connected to their vehicle. The trouble is to avoid the driver from being distracted from the app, and that some people do not have iPhones. In the end we decided that the pros outweighed the cons, and that ultimately this app would help decrease the number of crashes due to mechanical failures. We then came to the conclusion that it is a very cheap product, it is very effective and has a lot of potential for the future.

**Problem Statement:**

In an ideal situation, we would like to design cars that are both connected and safe, to the point that there are zero fatalities caused by mechanical failures within the car. Safety features such as airbags and seatbelts significantly lowered the number of fatalities when they were first introduced to automobiles. In our current situation, there are still many people die or are injured due to crashes. In fact, in 2009 there were 10.8 million accidents, and an average of 33,000 deaths within 30 days (reference 5). Twelve to thirteen percent of these crashes are due to mechanical failures. Another study showed that twenty nine percent of truck crashes are due to brake failures. Our project will investigate what features there currently are that warn the driver about mechanical failures and expand upon those features. To do this we plan to update the driver about car issues and information on the car, such as brake problems, needing to change the oil or tires, mileage, and much more through their cellular device, without causing a distraction while driving. This would increase both the safety of the driver and passengers and increase the connectivity of the driver to their car. We will also analyze the cost to make sure our product is cost efficient both for us and the customer.

**Background:**

Given that our main goal is to increase the safety in cars while keeping the driver connected to the car, we discovered that the best type of cars to use to test our product are Chevrolet cars because of all the features they offer. One of the main features that makes the app more connected and easy to use is wifi. Chevrolet cars are one of the very few that offer it. In addition, they have the sensors necessary that connect the car to the app to send signals to notify the driver of any malfunctions (Reference 7).

**Customer Needs:**

When designing our product there are several requirements and customer needs that were necessary to meet in order to make both Delphi and the customer buying and using our product happy. We converted these customer needs into metrics so we could compare the different designs and products we came up with to see which ones fit the customer needs the best.
Table 1: Customer Needs to Metrics

<table>
<thead>
<tr>
<th>Customer Needs</th>
<th>Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe</td>
<td>Does it enhance the driver’s safety? Does it distract the driver? Take a survey to test this</td>
</tr>
<tr>
<td>Easy to use</td>
<td>Takes less than 5 minutes to teach people how to use this</td>
</tr>
<tr>
<td>Cost</td>
<td>It costs under $30,000 to manufacture</td>
</tr>
<tr>
<td>Effective</td>
<td>Take polls and use statistics to see if the amount of crashes due to mechanical failures has reduced since the introduction of the app</td>
</tr>
<tr>
<td>Environmentally Friendly</td>
<td>Does it produce and harmful emissions? Research to see if any materials used are bad for the environment.</td>
</tr>
<tr>
<td>Accurate</td>
<td>Can the product accurately show problems and where the mechanical failure occurred? Survey mechanical shops to find the answer for this.</td>
</tr>
</tbody>
</table>

These needs include safety, ease of use, cost, effective, environmentally friendly, and accurate. We completed an AHP matrix (see below) in order to determine what requirements were most important, so we could keep those in mind when designing a product.

Table 2: AHP Matrix

<table>
<thead>
<tr>
<th></th>
<th>Safe</th>
<th>Ease of Use</th>
<th>Ease of Manufacture</th>
<th>Cost</th>
<th>Effective</th>
<th>Environmentally Friendly</th>
<th>Connect</th>
<th>Accurate</th>
<th>Total</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe</td>
<td>1.0</td>
<td>1.00</td>
<td>5.00</td>
<td>5.00</td>
<td>1.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>19</td>
<td>0.20</td>
</tr>
<tr>
<td>Ease of Use</td>
<td>1.0</td>
<td>1.00</td>
<td>5.00</td>
<td>3.00</td>
<td>1/2</td>
<td>1.00</td>
<td>2.00</td>
<td>1/2</td>
<td>14</td>
<td>0.15</td>
</tr>
<tr>
<td>Ease of Manufacture</td>
<td>1/5</td>
<td>1/5</td>
<td>1.00</td>
<td>1/2</td>
<td>1/3</td>
<td>1/3</td>
<td>1</td>
<td>1/5</td>
<td>3.76</td>
<td>0.039</td>
</tr>
<tr>
<td>Cost</td>
<td>1/5</td>
<td>1/3</td>
<td>2</td>
<td>1</td>
<td>1/3</td>
<td>1/3</td>
<td>1/2</td>
<td>1/4</td>
<td>4.95</td>
<td>0.053</td>
</tr>
<tr>
<td>Effective</td>
<td>1.0</td>
<td>2.00</td>
<td>3.00</td>
<td>3.00</td>
<td>1.00</td>
<td>1.00</td>
<td>2.00</td>
<td>1.00</td>
<td>14</td>
<td>0.15</td>
</tr>
<tr>
<td>Environmentally Friendly</td>
<td>1/2</td>
<td>1.00</td>
<td>3.00</td>
<td>3.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1/2</td>
<td>11</td>
<td>0.11</td>
</tr>
<tr>
<td>Connected</td>
<td>1/2</td>
<td>1/2</td>
<td>1.00</td>
<td>2.00</td>
<td>1/2</td>
<td>1.00</td>
<td>1.00</td>
<td>1/3</td>
<td>6.83</td>
<td>0.0714</td>
</tr>
<tr>
<td>Accurate</td>
<td>1/2</td>
<td>2.00</td>
<td>5.00</td>
<td>4.00</td>
<td>2.00</td>
<td>2.00</td>
<td>3.00</td>
<td>1.00</td>
<td>18.5</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Grand total: 92.04

This matrix shows that safety and accuracy were the most important, while cost and ease of manufacture were the least important. This makes a lot of sense because a person’s safety is
really the most important thing and should be able to cost any price. Later we can use our metrics and the AHP matrix to determine what design of our product is the best design.

**Concept Generation:**

When we started our brainstorming for design ideas we focused our thinking on finding new design ideas that meet Delphi’s three target areas which are safe, green, and connected. Then we came up with the idea of designing a system that notifies the driver about any mechanical problems within the car. After researching the components we could use for the design, it turned out that there are three main components that we will need for the design, which are the sensors, connection, and a display.

![Classification Tree](image)

**Figure 1**: This classification tree shows the major components of our design as well as the specific options for each component. Our final model combines the best of these design components.

After researching, it turned out that we will need to use all the sensors in the car, so then we had to choose between the different connections and display methods. We used a concept selection matrix to choose the main components for the design.
**Concept Selection:**
After completing the classification tree we created three different combinations of connections and displays in order to achieve three different designs for our product. Our first design was wifi with an app and email, our second was USB with an app and email, and our last one was Bluetooth with an app. Using the values from the AHP matrix for weighted values, we created a design selection matrix in order to see what design was the best design.

**Table 3: Design Selection Matrix**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design 1: Wifi with app and e-mail</strong></td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>3.659 (WINNER)</td>
</tr>
<tr>
<td><strong>Design 2: USB with app</strong></td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>3.615</td>
</tr>
<tr>
<td><strong>Design 3: Blue tooth with app</strong></td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>3.362</td>
</tr>
</tbody>
</table>

Since all the designs were very similar, the totals were very close. In the end wifi with the app and email won. It was stronger in safety because with a USB the driver needs to remember to plug something in, and with Bluetooth there can be a lot of connection issues (more so than with wifi). Because the user doesn’t have to plug in anything, or get additional technology, wifi is also easier to use than a USB. It is also more effective than a USB or Bluetooth because it can do its job without any assistance. If the user forgets to connect to Bluetooth or plug-in a USB then the product won’t be effective at all. The Wifi with the app and email is safe as long as there is wifi connection. We chose to focus on Chevrolet cars because they already had wifi. This also makes this idea very inexpensive. It is simple to use, and assuming the app works correctly, and no harmful materials are used, this app has the potential to be very effective.

**System diagram:**
Figure 2 is the system diagram which shows how the system works. First, the sensors in the car (mentioned in appendix D) will detect the mechanical problem, then using Wi-Fi technology it will transmit the data to the Wi-Fi service provider which will transmit it to the user’s phone. After that, the phone will notify the user about the problem, and finally the user will go through the information that were initially sent by the car.
**Figure 2:** The system diagram of the design which shows the system’s process flow from the very first step of the sensors sensing the information to the very last step of the user being notified.

**Model/Prototype App:**
We have designed the app with many features, starting with the most important one which is the mechanical problems. Once you tap the mechanical problems button, the app will directly take you to another tab, this new tab has two parts, the first part is the critical problems and the things you need to fix immediately. The second part is the problems that are expected to happen in the future. The next feature is a summary about your last trip, this tab has information about the trips you made, like how many gallons of gas were used, how many miles were covered, and a map of the trip. The next is feature the nearby auto shops which shows the locations and some details about the auto shops near you. Another important feature is the full summary. Once you get in this tab you will get a full summary of what the car sensors detect including body parts, powertrain parts, and anything related to car safety. For example, in the safety button you can get information about the battery, steering torque and the brake booster. The last tab in the app is the settings tab. In this tab you have notifications, preferences options, and you can also choose which measuring units you want to use.
Concept of Operations:

Scenario One: You are driving on a long trip during the night. You know what direction you are heading in but you may not know the area that well. All of a sudden, your lights begin to dim, you start to smell burning rubber, and you hear a grinding noise. Assuming that you do not have any expertise in automobiles, you have no clue about what is going on with your car, but in this case, it is that the alternator failing (Reference 2). This is where iCar comes into play. Sensors (which can be found in appendix D) in the car will detect which part of the automobile is malfunctioning and send data and information using the car’s wifi to your service provider, which will then send you the data of what is wrong with your car to your phone app. You open the app and hit the button, “Mechanical Problems.” this will then go to a page named, “Detailed Problem Overview,” that lists all the immediate problems with your car, and expected problems that are to come. This section will tell you that the crankshaft sensor has detected a problem with your alternator and describes what is specifically wrong with your alternator. In this case, the belt is wearing off and the alternator part is worn out. You can then go back to the home page and press “Nearby Auto shops.” This page uses a map and your current location and will display the locations of the closest auto body shops. You can then take your automobile to the auto shop to get your alternator fixed.
Scenario Two: You are driving and know that you are low on gas. You feel that you can make it to your destination, but have that eerie feeling that you won’t. You pull over to the side and open the iCar app. In this, you hit the “Mechanical Problems” button and are brought to the page that details what current and future problems there are. In the section listed “Expected Problems” there is a tab that says “Fuel Range: 74 miles.” This indicates that you have 74 miles left on the gas tank. It just so happens that your destination is 100 miles away. Under the “Nearby auto shops” tab, shows where nearby auto shops are, and where the nearest gas stations are by using your current location. You notice that the nearest gas station is only twenty miles away. Then you fill up your gas tank and continue to your destination.

Scenario Three: Let’s say you are looking for ways to improve your driving. This means that you want to stay on the road for as little time possible and don’t want your car to be worn down due long driving. You open the iCar app and review your most recent trips and all trips before that under the “Last Trip Summary” tab and the “All trips summary” tab. Under these, the app will show you your miles driven, gallons of gas used, max speed, average speed, trip duration, average rpm, and trip map. If you don’t know what some this terminology means, the app will explain it to you and tell you how you can enhance your driving skills and help you become a better driver. Let’s say you notice that your average rpm is in the 4k-5k range. The app would tell you that this will tear down your engine quicker. It will advise you to lower it to the 1-3 thousand range. You can also use all the other information on how to change your driving so your automobile doesn’t become completely destroyed.

Cost Analysis:
There are many costs that had to be taken into account when making and designing our app. First we had to think about how much it would cost to hire workers and engineers who put in the time and effort in making the app and maintaining it. It would cost about $28,800 just to pay the workers. There is also the cost of designing the app, which after research has come to be about
$20,000. Therefore, the total cost of the app design is about $48,800. In order to find out how much will be added to each car’s manufacturer, we divided the total cost by the average number of cars sold by Chevrolet in 2013, which was 1,947,124, so the cost came out to be $0.025 (reference 6). This means that about $0.15 will be added to each car’s price so that the money spent on the app making is all gained back within a year. The price came out to be really cheap for what was expected and for the consumers to be able to afford. Considering how much the app has to offer and all it can do for the driver, the cost nearly non-existent. It is very affordable and really easy to use so the consumer will not have any problems with it.

It is also very feasible because it is socially acceptable since everyone depends on technology now and their smartphones so an app for such problems is probably the solution. It is very easy to implement in cars just as it is easy to implement any app on a smartphone. Since it is to help the driver stay connected and safe it has no harmful side effects or any issues that could cause a problem for people.

**Life Cycle Analysis:**

As mentioned in the cost analysis, the app has very little effect on material and component production. This app only adds $0.15 to the value of a vehicle. What this app can do is increase the lifespan of a car. According to Autonews (reference 3), in 2013 the average lifespan of an automobile was 11.4 years. Some ways that a car can last longer is by taking care of problems it has immediately and just performing maintenance on it consistently. However, how would an average person (assuming they don’t know anything about automobiles) when to fix or keep maintenance with the car? The app will alert them of immediate and future problems that the car has by looking in the “Mechanical Problems” section of the app. Here they know when they can get their car serviced at the right time, and keep their car in top condition. In today’s age, the average car usually reaches 200,000 miles before it reaches a state of being un-drivable. A man named Mark Webber who lives in Boston, MA drives a 1990 Volvo 740 that has over 300,000 miles (Reference 4). He said that there is no reason to buy a new car. From this statement we can assume that he has taken extraordinary measures in taking care of his Volvo. This app tries to get more drivers to be like Mr. Webber so that their cars can last decades and last 100,000 more miles than the average miles a car can reach today.

**Conclusions:**

While there are many great benefits to our product, there are also some faults. Since it does use and require wifi there is always a possibility of the wifi being down and not working, causing the app to not work correctly. We also have to take into consideration that not everyone has a smart phone. We could have emails sent to them, but not everyone checks their email, and then the information would not get to them immediately. Then there is also always the question of if the notification is sent to the phone about a serious issue while the person is driving would it be distracting? With this said the benefits of our product outweigh the cons. Our product would prevent a serious issue before it even occurs by using the upcoming problems tab. It is extremely easy to use and can be explained in a short amount of time. The cost would only add $0.15 to the price of the car in order to get the money put into it back in a year. Also, since our product does not use any harmful materials it is environmentally friendly.

The app has a lot of potential and it can be developed to have a more professional look and to have more features. For instance, pictures can be included in the app to make it more user
friendly so the driver can understand the problem and know exactly which part of the car is not working properly. Also video tutorials can be included in the app, these videos can teach the driver how to fix some of the problems without needing to go to an auto shop.

Since no one in the group had a lot of knowledge about cars in the beginning we learned a lot throughout this process. We didn’t only learn some information and statistics on car crashes but we also learned about the whole process of creating a product. There are tons of ideas out there and before making a product you need to make sure it doesn’t exist and that no one has a patent on the idea. We also learned how to complete an AHP matrix in order to weigh the relative requirements for a product. Getting other people’s ideas about a product and their suggestions on how to improve a product is also very important to this whole process (suggestions for our product can be found in appendix C). It’ll give you different points of view and helps to make a product the best it can be.
References


Appendices:

Appendix A
Concept Generation

These are our different ideas for this project.

<table>
<thead>
<tr>
<th>Idea</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Panel</td>
<td>Charges battery for electric cars; on exterior of car</td>
</tr>
<tr>
<td>Wind turbine</td>
<td>Recharges batteries by harvesting wind</td>
</tr>
<tr>
<td>Alarm that goes off if speeding</td>
<td>Alarm warns the driver when they are speeding, and doesn’t shut off until they reduce speed.</td>
</tr>
<tr>
<td>Seat Belt starter</td>
<td>Car will not start unless everyone has seatbelt on.</td>
</tr>
<tr>
<td>Stop sign detector</td>
<td>Detects stop signs and automatically slows down the vehicle if the vehicle is approaching the sign too fast.</td>
</tr>
<tr>
<td>Phone charger starter</td>
<td>The car will not start unless your phone is plugged in to a charger-like device.</td>
</tr>
<tr>
<td>Airbags outside car</td>
<td>Airbags deploy outside of the car during a crash.</td>
</tr>
<tr>
<td>Sensors that stop the car</td>
<td>This slows down the car when they detect outside objects, such as animals, are closeby</td>
</tr>
<tr>
<td>Truck radio</td>
<td>To communicate from car to car.</td>
</tr>
<tr>
<td>Breathalyzer</td>
<td>Car won’t start unless this device determines the driver is in good condition to drive.</td>
</tr>
<tr>
<td>Center of lane device</td>
<td>Helps keep the car in the middle of the lane so there is no drifting or floating on the road.</td>
</tr>
<tr>
<td>Car to car distance safety</td>
<td>Helps keep a good distance between cars.</td>
</tr>
<tr>
<td>Phone Application</td>
<td>Reminds the driver about car mechanical problems.</td>
</tr>
</tbody>
</table>
Appendix B
Customer Surveys
In these, we surveyed close friends and families and asked them about what they want to see in the future of cars. The last names have been concealed.

B1-Ammar
Q: What technologies and safety features would you like to see in future cars?

Ahmed:
I would like to see digital dashboards that display the information in more interesting way, and are easy to read. And another great feature would be having a technology to block the sunlight.

Mohammed:
Having self-adjusting seats with automatic seat belts would make it safer for the driver.

Salim:
If the cars have a technology that reads the texts messages you receive while driving, there will be less accidents, because texting is one of the main reasons for accidents.

B2-Jala
Question: “What would be something a car manufacturer should have in their cars or improve on to make them safer?”

Answers:
- Damian: “car companies should be required to put more safety technology into their cars. Really expensive cars have collision warnings and blind spot detectors but they should put them in more affordable cars.”
- Faith: “more airbags or cars that don’t start until all passengers are buckled in.”
- Natalie: “more money invested in safety testing and research on camera that shows you your blind spots.”

B3-Antony

1. What type of new technology would you like to see in cars? Or cars could improve upon?
2. What about technology that monitors the driver?
3. What about cars that operate in their own occasionally?
4. Additional ideas?

Margaret:
1. Hover crafts. Detect hazards (safety and connected), weather hazards, accidents.
2. Yes I would like to see that.
3. Yes that would be good. No self-operating cars because it will cut jobs, no response to emergency situations, who pays for accidents?
4. Warning for red lights.
Anthony Sr.
1. Cars that would automatically disengage text messaging as soon as the car started. Cars that can self-parallel park. Your car could sense objects in front and back of the car so you wouldn’t hit them, the car wouldn’t move (specifically at a full stop).
2. No I would not like that.
3. Yes that would be great.

Alex
2. Not Sure
3. Not Sure
4. No additional Ideas.

B4-Jackie
Question: What would you change or improve about cars? What additional technology or safety system would you like to have in your car?

Mom: A detector to tell you if you are too close to people in front of you. Accidents happen because people do not have a fast reaction time.

Jess: I want my car to read emails to me. Also they should have a breathalyzer so no one can drive drunk. It would be cool if there’s a way to check energy level too and yell at you if you are too tired to drive.

Matt: I want cars to drive themselves.

Blake: Drive itself and go fast and further on less gas. Also some type of intercar warning system that allows the cars to communicate and tell each other when they are on a crash course. Also make better airbags.
Appendix C
Feedback on the App

Team #1 commented on our app and design and gave feedback on what we could improve on.

1. Some of the suggestions made by the other team were:
   - The driver should have the option of how they should be notified of an failures or malfunctions in the car.
   - Take into consideration that they might not have a smartphone.
   - Think about the different sensors needed so that the app can determine the necessary information.
   - How can the app be used while driving without risking the safety of the driver?
   - The statistics show that the driver will be very connected with car.
   - Also, make sure that it is easy to figure out how a car computer works.

2. While using the app while driving is a concern, we can have an automated voice tell the driver what is wrong with the car. Similar to an alarm, when the app detects a problem in the car, the driver will hear the voice say what is wrong with the car. We can add a tab in the app that shows the statistics of the car (miles driven, gas consumption, average miles driven in a ride, etc). Another way we can notify the driver is via an automated voice, the app sends a notification, an email, or however the driver would like to be notified of the problem. We would like the driver to have the option of choosing how to be notified, especially if they do not have a smartphone. We also plan on using the sensors and computer that the car comes with to detect the problems within the car. Once the sensors detect the problem, the app will then receive the datum from the sensors and notify the driver of what is wrong with the car.
Appendix D
Sensors Diagram
This diagram lists all the sensors that of a car (Reference 1).

**Figure 5**: Safety, powertrain, and Body applications sensors that usually come with most of modern cars, and these sensors will be used to detect the mechanical problems in the car.
Figure 6: This is a poster that summarizes the main idea of our design and what it can do