DUI Prevention System

Team 5
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Engineering Design 100
Section 25
Professor Ritter
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**Objective:** To significantly reduce the number of drunk driving related accidents in the United States.

**Executive Summary**

The design project outlined by Delphi looked to find designs that improve the safety, connectivity, and efficiency of the modern day vehicle. After generating 10 concepts, 3 were selected and inserted to a weighted selection matrix to choose a winner. Our winning design mainly focuses on improving the safety aspect of the vehicle by incorporating a system that reduces the number of drunk drivers on the road. The system consists of a breathalyzer, a software installed into the OBD II port, and alcohol odor sensors to determine if the driver is drunk and what course of action should be taken. If this concept is incorporated into the modern vehicle, the number of drunk drivers will significantly reduce and the roads will be much safer.

**Problem Statement**

Our design focuses on making the roads an overall safer environment. We hope to significantly reduce the number of drunk drivers on the road by incorporating a software that detects the smell of alcohol and determines whether or not the driver is drunk. If the driver is drunk, the system will then take a course of action to ensure the driver is off the road. This concept, if incorporated, has the potential to save many lives while bringing us closer to a society free from automobile fatalities, injuries, and accidents.

Every two minutes, someone is injured in an alcohol related accident. Drunk driving is at an all time high and has causes more deaths annually than the entire Iraq war and September 11 attacks combined. Innocent people die every day because of this issue so a significant solution is needed.

Approaching this problem, our group has to account for the cost, development, and potential for inaccurate readings. Fortunately, the sensors are quite inexpensive and the only major development issue was the software. Implementing the software would not be a problem because installation can easily be done through the OBD II port. To prevent any future misreadings by the breathalyzer, we decided that the driver of the car must have the breathalyzer recalibrated once a year at a routine inspection.
Background

In America alone, 28 lives are taken every day by drunk driving accidents. Furthermore, someone is injured in an alcohol related crash every two minutes. Drunk driving remains prevalent throughout society, despite the known risks of impaired driving. When man can not make the proper decision to not drive impaired, the machine must make the decision. Our design uses concepts from previous patents including the Ignition Interlock Breathalyzer (US 7934577 B2) and Electronic Odor Sensor (EP 12357 A1) to prevent anyone from driving while under the influence of alcohol. In order to make these objects functional, they must be connected through a variety of wiring harnesses as well as a software that must be installed into the OBD II port.
Customer Needs

<table>
<thead>
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<th>safe</th>
<th>ease of use</th>
<th>cost</th>
<th>reliability</th>
<th>durability</th>
<th>connectivity</th>
<th>total</th>
<th>weight</th>
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</thead>
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<tr>
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<td>1</td>
<td>3</td>
<td>3</td>
<td>1.5</td>
<td>4</td>
<td>1.5</td>
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<tr>
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<td>1.5</td>
<td>0.33</td>
<td>1.5</td>
<td>0.33</td>
<td>5</td>
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<td>0.66</td>
<td>1</td>
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<td>4.17</td>
<td>0.09</td>
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<tr>
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<td>0.66</td>
<td>1.5</td>
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<td>1.5</td>
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<tr>
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<td>1</td>
<td>0.5</td>
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<td>0.09</td>
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</table>

For our customer needs, we decided that the biggest need for the design was safety because of the numerous number of accidents and deaths caused by impaired drivers. Above all else, the security of those within the vehicle must be ensured. We decided that taking these drunk drivers off the road was the best way to guarantee the safety of other drivers on the road. Our second most weighted feature was connectivity. Having all the safety devices would be pointless if the car and its functions was not connected to them. Other criteria we selected for our AHP include ease of use (being easy enough for a drunk person to use), cost, reliability, and durability.

Concept Generation

Before we had any ideas for what we wanted to create for our project, we knew we wanted to increase safety in automobiles by reducing drunk driving. With this being our number one goal, we thought of different ways we could accomplish this. The three main ideas we came up with to reduce drunk driving was with sensors, user interface, and car actions.

Some of the sensors we thought we could use were alcohol sweat sensors, alcohol odor sensors, a breathalyzer, and a swerve detector. We chose these because the sweat sensors, the odor sensors, and the breathalyzer could all be used to directly detect the presence of alcohol in the car or driver and the swerve detector could detect the effects of alcohol on the driver.

The user interface we thought we could use was a breathalyzer and warning the driver of a potential shutdown. A breathalyzer could be used to test if a driver is drunk or not. Warning the driver of a shutdown could be used if there is reason the believe the driver is impaired so that he or she has time to pull off the road before the car shuts down. We thought of several ways to warn the driver of this. We could project a message on the dashboard, project a message on the windshield, alert the driver with beeping noises, or use voice alerts.

We also came up with different actions that the car could automatically perform to prevent drunk driving. The biggest idea we came up with was to have the car slow down and eventually stop if there is reason to believe the driver is drunk. The car could also turn on its
hazard lights if it needs to slow down and stop to alert other drivers on the road. Another action the car could perform is to contact a taxi service to take the driver home if it has been confirmed that he or she is drunk.

Since our goal was to increase safety, for our final idea we combined different sensors, user interface, and car actions that would help to reduce drunk driving. Below is a picture of our classification tree.
Concept Selection

<table>
<thead>
<tr>
<th></th>
<th>safe (31)</th>
<th>ease of use (11)</th>
<th>cost (40)</th>
<th>reliability (19)</th>
<th>durability (20)</th>
<th>connectivity (21)</th>
<th>totals</th>
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<tbody>
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<td>2</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>3.75</td>
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<tr>
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<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3.32</td>
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<tr>
<td>air coolant in engine</td>
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<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1.78</td>
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</tbody>
</table>

Originally, we developed three concepts to choose from: alcohol odor sensors, an integrated GPS that automatically updates to weather conditions and traffic reports, and adding an air coolant to the engine to increase efficiency. Our customer needs favored safety and connectivity above all else. The air coolant scored low in both these categories and thus received the lowest total score. The GPS and odor sensors were scored very closely, with the odor sensors beating the GPS in every category by one point except for cost, where the GPS won by a single point. Cost was our lowest weighted category and thus the margin was unable to be overcome and the alcohol odor sensors were selected by a somewhat slim margin of 0.43.

Systems Diagram
3D Model/Prototype App/Images of interface, process, etc

Shown below: 1) alcohol odor sensor 2) breathalyzer
Concept of Operations

Cost and Feasibility Analysis

We found the cost for all of the parts of our system online at retail prices. The cost for one alcohol odor sensor was $4 (5). We plan to include 3 of these sensors in our system so the cost for all of the sensors would be $12. The costs for a breathalyzer is $140 (4). The cost for the OBD II software that will track the movements of the car and basically control the entire system
is $150 (6). The total retail price of all of the parts of the system is $302. When it is taken into account that Delphi will not be buying these parts at retail price and that Delphi will be buying large quantities of these parts at a lower cost, the price for the parts for one of these systems will be $129.06 (7).

There are also non-recurring engineering (NRE) costs associated with our product. These include the costs for the design of the product and the costs to change production lines. If 3 engineers with a salary of $40/hour work on the design for this product for a month, (assume 4 weeks in a month and 40 hour work weeks) then the cost of the wages for the engineers would be $19,200. This means that the loaded labor costs would be 1.5 times that, or $28,800. The costs to change the vehicle production lines to add this system would be about $300,000. This means that the total NRE costs would be $328,000 (7). If Delphi puts this system in 20,000 cars per year and wants to recover this cost in one year, then the NRE cost for each new product will be $16.40 (7). The loaded wages for assembly and quality assurance would be $25/hour. It would take approximately 0.25 hour for the assembly line to install the system meaning that the assembly and QA costs per system would be $6.25 (7).

After taking into account the costs of the parts, the NRE costs, and the assembly and QA costs, the cost for Delphi to produce one of these systems is $151.71. For Delphi to make a profit on this system, they will have to charge car manufacturers $303.42 per system. For the car manufacturers to make a profit, car buyers will be charged $910.26 per system (7). Although this cost is a little bit high, we believe that it is worth it because it is a safety system that will help to save lives on the road. Originally, the target customers will probably be people buying luxury cars because they will be able to easily afford it, but over time as the cost of the technology decreases, we believe this system could be afforded by average car buyers. Also, car insurance companies have been known to reduce insurance premiums for cars that have safety features such as seatbelts, airbags, and antilock brakes. This is because cars with these safety features like these are statistically less likely to be in a collision. If car insurance companies are willing to reduce premiums for cars that have our DUl prevention system then this will help to offset the cost of the system. Taking into consideration all of these factors, this system will be cost effective.

Our design could be adopted by automakers without too much trouble but it would take some time. Although this system could be added to cars already owned, it would not be cost effective to do this to all cars already owned because not all car owners can afford it. The best way for car manufacturers to adopt this system would be to integrate it into new luxury cars first, then as the cost of the technology goes down, begin to add it to less expensive cars.

One obstacle our design will have to overcome is privacy issues. Our design monitors driving patterns of the driver, so some people may feel that this is an invasion of their privacy. Because of this, we designed our product so that the only place the monitored driving patterns are stored is the system’s computer and they will not be exported to any external computer or storage system. This was done so that nobody will be able to monitor the driving patterns of
another person and so that the driver retains his or her privacy. Another decision we made to retain the privacy of the driver was to have the system contact a taxi company for a drunk driver instead of the police. We knew that if the system contacted the police then most people would not want the system in their car because it would increase the likelihood of them getting a DUI. We decided to have the system contact a taxi company so that a drunk driver would get home safely and not get in any legal trouble. These steps were taken to ensure that drivers of cars with this system will retain their privacy so that they will be more willing to use it. (4)

**Life Cycle Analysis**

Our design simply adds another safety feature, and therefore will not substantially impact the life cycle of the car. The proposed addition will only serve to lengthen the life of the vehicle by reducing alcohol related crashes. However, the electronics will negligibly diminish the battery life of the vehicle while the software installed has no effect on the life of the vehicle. On the other hand, the odor sensors and breathalyzer will need to be replaced if damaged. However, we counteracted the possibility of damage by putting multiple sensors and installing a cushioned compartment in the dash. To ensure the most accurate results, damaged sensors will need to be replaced and the breathalyzer will need to be recalibrated once every 12 months.

**Conclusions**

Our product is a system that is designed to prevent drunk driving. It uses alcohol odor sensors to detect alcohol and then it monitors driving patterns to determine if the driver is drunk. If the system determines the driver is drunk, then it will make him or her stop and take a breathalyzer test. If the driver passes he or she can continue driving, if not the system will contact a taxi service to take the driver home. This product could significantly reduce drunk driving if it is adopted on a large scale. The downside of it is the cost and the potential privacy issues associated with it. We believe that our design or a design similar to it could be developed and adopted by major automobile manufacturers in the future.

We learned several lessons during the course of this project. We learned more about how to interpret customer needs and how to make an AHP matrix. We learned about how to design for different scenarios using a concept of operations. We also learned about analyzing the cost and feasibility of designs as well as their life cycle. The biggest lesson we learned was that there is a large amount of work that goes into a design for industry.

**References**

Delphi Costing and Business Case Analysis Worksheet (7)

http://www.amazon.com/Alcohawk-CA2010-Breathalyzer-Alcohol-Tester/dp/B005DZSRV6/ref=sr_1_7?ie=UTF8&qid=1418419132&sr=1-7&keywords=breathalyzer (4)

https://www.sparkfun.com/products/8880 (5)

http://www.ebay.com/itm/like/171536518435?lpid=82 (6)