“Co-Pilot Technology”
EDSGN 100
Section: 14
Team 9
December 15, 2014

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Abstract

This project is based on Delphi’s specifications for a technology to improve upon the safety, communication, and eco-friendliness of automobiles. The focus of this project is specifically Delphi—they are the only customer. The goal is to design a creative solution to the problems involving humans and automobiles that meets all the requirements presented by Delphi in a cost effective manner. The design should provide a “smart” solution to common struggles that face automobile users while driving, without changing the cost of the automobile drastically. The final product will meet the product specifications set by Delphi and be presented by December 13.

Introduction

Automobiles today exemplify some of the most sophisticated technology owned by most consumers. Manufacturers are continuously offering new innovative content in their cars. In their developments, manufacturers recognize that new technological innovations will provide many solutions to meet developing consumer needs. Most new technological advancements in automobiles fall under the categories of connectivity, safety and efficiency. Our team focused on two of those categories, connectivity and safety. To improve both the connectivity and safety in cars today, our team designed a heads up display system, integrated with other safety components in order to greatly improve the convenience and safety of the driving experience.

Mission Statement

Our mission was to take a proactive approach upon safety through the proper utilization of connectivity features designed to enhance the driver experience and awareness. The aim is to keep the driver’s eyes on the road at all times throughout the drive.
Customer Needs Analysis

<table>
<thead>
<tr>
<th>Customer Needs</th>
<th>Needs Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>I want a car with improved GPS navigation and real-time updates.</td>
<td>The car will connect to a smartphone to improve GPS and cellular capabilities.</td>
</tr>
<tr>
<td>I want a car with voice command.</td>
<td>The car will have a microphone allowing specific functions to be performed from the touch of a button.</td>
</tr>
<tr>
<td>I want the car to sense environment in front of me.</td>
<td>The car will have sonar sensors on the front bumper to alert the driver of potential hazards ahead.</td>
</tr>
<tr>
<td>I want steering wheel controls.</td>
<td>The driver will be able to access several features using controls on the steering wheel.</td>
</tr>
<tr>
<td>I want the car to sense my awareness.</td>
<td>The system will include a camera sensing the eye movement of the driver.</td>
</tr>
<tr>
<td>I want a display system while keeping my eyes on the road.</td>
<td>The projector will be directly in front of the driver and will be transparent.</td>
</tr>
<tr>
<td>I want a display system that is not distracting.</td>
<td>Ambient light sensors will be used to control the projector’s brightness.</td>
</tr>
</tbody>
</table>

Our customers, the Delphi Automotive Company, are seeking new vehicle technology to improve upon safety, connectivity, or to make them ecologically friendly. The design must create a better car, allowing our group to focus on safety and connectivity together. The technology was to be non-distracting, aware of the environment around it, and keep the driver’s eyes on the road as much as possible. Aside from the restriction the customer allotted, more were brainstormed into the needs metrics matrix to better narrow our designs. The customer needs the design by December 12, 2014.
Establishing Customer Needs

With such a wide variety of technology on the market in all fields, it was necessary to discover what would be the best technology to develop. Through surveys answered by participants aged 18-45, data was charted on how their attention is used while driving, how comfortable they were with new displays in the car, and an open ended question about what they feel they need most in their next car.

Participants answered the survey with nearly 85% of them admitting to texting while operating a vehicle. Also, the 75% of those participants felt that they would be comfortable with implementation of an interactive windshield projection system into their vehicle. Some of those asked desired more connectivity between all of their devices into their vehicle, more eco-friendliness, more cup holders, and other ways to access controls on their car.

These surveys helped to break down ideas which the team also had for technology designs. The information from the surveys was constantly being worked with throughout the project in order to find what market we are aiming for, to learn how other drivers act while driving, and to find out what their future technology ideas are for vehicles.
Preliminary Sketches

Josh’s Design
- Identifies possible hazards
- Full screen HUD
- GPS
- Voice Commands
- Bluetooth and USB compatible

Nick’s Design
- On/Off button
- One main screen HUD
- Voice Commands
- Bluetooth and USB compatible

Matt’s Design
- HUD with changeable views
- Scroll Ball
- Voice Commands
- Bluetooth and USB compatible

Mashru’s Design
- Multi-HUD
- Utilizes button controls
- Voice Commands
- Bluetooth and USB compatible
Concept Generation

Several sketches were made as a preliminary design for the car connectivity and safety design. The best sketch from team member was next implemented into a selection matrix to help narrow down what final concept to make. To select the design criteria, a large pool of design characteristics were narrowed down according to how influential they were in regards to customer needs. Each model was then scored against the other models with the goal of narrowing down the concepts into one final design. The highest two scoring designs were chosen to continue upon in the goal to create a final design out of the concepts.

<table>
<thead>
<tr>
<th>Concepts:</th>
<th>Nick Model</th>
<th>Matt Model</th>
<th>Mashru Model</th>
<th>Josh Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection Criteria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>User friendly</td>
<td>0</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Non-distracting</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Simple to operate/change</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Steering wheel controls</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Voice controlled</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Cost effective</td>
<td>+</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Durable</td>
<td>+</td>
<td>0</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Sum +'s</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Sum -'s</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Sum 0's</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Net Score</td>
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<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Continue?</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Concept Selection

Once the conceptual sketches were screened, a concept-scoring matrix was created to better determine what design or designs to continue with. Each design was placed in the matrix, and the selection criteria was weighted according to how significant it was to the missioned design.

Non-distracting was set to be the most important criteria for the design since the goal was not to make the driver’s experience more difficult than it already is. The functionality of the design, which was thought of as the connective safety features’ innovativeness, received the second highest weight since the design needed to be cutting edge to impress the customer. The simplicity of the components of the designed was also at the same weight as functionality since all drivers must be able to use the technology to be able to benefit from it.

Eventually, two concepts were chosen as the best from the selection matrix. The two concepts were to be integrated together into a final design with the key features from each design incorporated as well. In this way, the best final design was to come out of each initial design.

<table>
<thead>
<tr>
<th>Selection Criteria</th>
<th>Nick Model</th>
<th>Matt Model</th>
<th>Mashru Model</th>
<th>Josh Model</th>
</tr>
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<tr>
<td>Weight</td>
<td>Rating</td>
<td>Weighted Score</td>
<td>Rating</td>
<td>Weighted Score</td>
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<tr>
<td>Functional</td>
<td>15%</td>
<td>4</td>
<td>0.6</td>
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</tr>
<tr>
<td>User Friendly</td>
<td>10%</td>
<td>4</td>
<td>0.4</td>
<td>5</td>
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<tr>
<td>Non-distracting</td>
<td>25%</td>
<td>5</td>
<td>1.25</td>
<td>4</td>
</tr>
<tr>
<td>Simple to operate/change</td>
<td>15%</td>
<td>3</td>
<td>0.45</td>
<td>3</td>
</tr>
<tr>
<td>Steering Wheel Controls</td>
<td>10%</td>
<td>4</td>
<td>0.4</td>
<td>5</td>
</tr>
<tr>
<td>Voice Controlled</td>
<td>10%</td>
<td>5</td>
<td>0.5</td>
<td>5</td>
</tr>
<tr>
<td>Cost Effective</td>
<td>10%</td>
<td>5</td>
<td>0.5</td>
<td>4</td>
</tr>
<tr>
<td>Durable</td>
<td>5%</td>
<td>5</td>
<td>0.25</td>
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</tr>
<tr>
<td>Total Score</td>
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<td>4.3</td>
<td>4.2</td>
<td>4.25</td>
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<tr>
<td>Rank</td>
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<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Continue?</td>
<td>Integrate</td>
<td>Integrate</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
External Research

While designing our vehicular technology, we wanted to make sure we don’t use any ideas that were patented. While researching for patents, much of the implementation of the products had similarities but these were the few that stuck out:

Head-up Display- Designed in the 1980’s, the HUD acts to assist the information that is being used throughout the cabin of the vehicle. This information is displayed on a projected display on the wind screen as an attempt to keep drivers’ eyes on the road more. Oldsmobile even was as far as to use the technology in 1988 in a design for the pace car at the Indianapolis 500. Some issues the designers faced were brightness, the projection bulb, and the projection surface.¹

Ambient Light Sensor- ALS are commonly used in many electronic devices of all sizes. In cars they are used within the GPS systems for the use of “converting illuminance of up to 16Klx to digital data without temperature-dependent dark current disturbance²” while consuming little power. The ALS is made up of two basic parts, photodetectors and conversion circuits, which generate the signals based on input light and changing the signals into codes to be then used.

**Final Design**

“Co-Pilot” technology was designed with the needs of the driver in mind at all times. The thought process behind the technology was to give the driver another set of eyes on the road, and even an extra hand behind the wheel in the form of “Co-Pilot” technology. Throughout brainstorming, all the ideas aimed to not eliminate driver distraction completely, but to integrate how the driver handles the distraction into the functions of the vehicle. The design simply had the idea that people will not stop doing harmful activities, so it was necessary ways to deal with this behavior and make smarter choices to solve the distractions.

To achieve the best design, it was obvious that all of the features of the car had to be synced together into one system to achieve the goal. All of the components were to be implemented in the design including an ambient light sensor, laser spotters, sonar sensors, and a driver awareness camera to help make a more aware car. Each of these components was designed to work in tandem with the component next to it to be able to operate best for the driver.

The HUD would project information of the windshield where the laser spotters would also be pointing out hazards detected from the sonar sensors. To ensure quality of the lighted features, an ambient light sensor measured light coming into prevent blinding by the display. The driver monitoring camera had intentions of analyzing the drivers conditions including if they are looking down the road or even drowsy behind the wheel. Voice controls and a scroll ball allowed for the driver to control all the features of the car from one place preventing further distractions.
Model
Components

**Sonar Sensor**
- Detects environmental hazards
- 3 incorporated on final design for object down range

**Laser Spotter**
- Points out hazardous objects detected by sonar sensors on windshield
- 3 incorporated on final design for objects to the left, right, and center of the vehicle

**Ambient Light Sensor**
- Senses the amount of light entering the vehicle
- Controls the brightness of the HUD and lasers
- 1 incorporated into the final design adjacent to HUD
Cost Analysis

Each of the components from the design went through heavy research and analysis in determining specific products to implement in the design. When brainstorming for designs and some of the restrictions to the design, one key factor the team wanted to keep in mind was cost. The goal for cost was to keep it under $2,000 which would not make car manufacturers have to raise the cost of the vehicle significantly to incorporate the new technology. Once each component and the level of performance necessary from it were decided, they were found online and a cost analysis chart was completed. With the cost of the sonar sensors so expensive, the team aimed to limited the amount of them necessary in the design. The total cost of the “Co-Pilot” technology was $1,203, which was inside the budget range.

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost Per Unit</th>
<th>Units</th>
<th>Total ($)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Light Sensor</td>
<td>24$</td>
<td>1</td>
<td>24$</td>
<td><a href="http://www.partsgeek.com">http://www.partsgeek.com</a></td>
</tr>
<tr>
<td>Projector</td>
<td>250$</td>
<td>1</td>
<td>250$</td>
<td><a href="https://www.chinavasion.com">https://www.chinavasion.com</a></td>
</tr>
<tr>
<td>Steering Wheel Button</td>
<td>3$</td>
<td>3</td>
<td>9$</td>
<td><a href="http://www.latemodelrestoration.com">http://www.latemodelrestoration.com</a></td>
</tr>
<tr>
<td>Microphone</td>
<td>50$</td>
<td>1</td>
<td>50$</td>
<td><a href="http://www.partswebsite.com">http://www.partswebsite.com</a></td>
</tr>
<tr>
<td>Micro Camera</td>
<td>50$</td>
<td>1</td>
<td>50$</td>
<td><a href="http://www.supercircuits.com">http://www.supercircuits.com</a></td>
</tr>
<tr>
<td>Steering Wheel Track Ball</td>
<td>20$</td>
<td>1</td>
<td>20$</td>
<td><a href="http://www.meritline.com">http://www.meritline.com</a></td>
</tr>
<tr>
<td>Light (tracking)</td>
<td>13.18$</td>
<td>3</td>
<td>39.54$</td>
<td><a href="http://www.amazon.com">http://www.amazon.com</a></td>
</tr>
<tr>
<td>Sonar Sensors</td>
<td>250$</td>
<td>3</td>
<td>750$</td>
<td><a href="http://www.americanmuscle.com">http://www.americanmuscle.com</a></td>
</tr>
<tr>
<td>Wiring</td>
<td>10$</td>
<td>1</td>
<td>10$</td>
<td><a href="http://www.lowes.com">http://www.lowes.com</a></td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>1,203$</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Examination of the Manufacturing Process

All of manufacturing for the technology would be done at the vehicle manufacturer’s level specifically before the outer shell is placed on the car. This technology would all be placed as to be an addition to the car such as a technology model so the car would be mass-produced just as the regular vehicles would be. Instead of simply applying the body to the vehicle after the frame is assembled, the parts such as the sonar sensors would be attached as seen on the model view for the body to cover the area but still allowing them to work. The interior of the vehicle would be made the same for each vehicles and the only difference would be that the model using the technology would have the HUD, sensors and all the lasers assembled. Other models would simply be hollow in the spot with a cover on top of where the components would be.

This design is to be universal for all vehicles so the manufacturing process would be universal by all manufacturers with hollows out regions where the sensors would go and so on just as some manufacturers do today with base models and luxury models.

Lifecycle Assessment

The components in the design are set to need little maintenance or no maintenance at all for use so that the driver can simply use the technology without thought of checking it. All of the components are designed with intentions to last as long as the major parts of the vehicle, such as the engine, so fixing and changing the parts would not be necessary. The component with the shortest lifespan would be the bulb in the HUD, 10 years, which could be changed just as projector bulb is changed since bulbs sometimes burnout prior to their expected times. All other parts of the design with exception to the sonar sensors should be monitored and kept up with as does regular car cleaning occurs.
Conclusion

In order to create the most effective technology, Team 9 used technology surveys to determine the problem facing drivers, figure out how to assess the problem, discover how the customers felt with the design solution. The problem chosen to be designed for was distracted driving. Brainstorming was an important part of the design and took up the most time in order to capture the most innovative and unique designs. The technology that was decided to embark upon was for the concept of having an assistant or “Co-Pilot” in the car with you whenever you need it. Design sketches were screened and scored with matrices until two designs were chosen as the best. Those two, along with the key features from each design, were used to create a final design which we continued upon.

The final design consisted of a HUD, an ambient light sensor, sonar sensors, laser spotters, a camera, a microphone, a track ball, and several buttons. All of the components was to act as one system, taking data and analysis from all components at a single time. The system would detect hazardous environmental condition and point them out, analyze how cognitive the driver is behind the wheel, and allow the driver to control the car’s features without ever having to change eyelevel. This design would then effectively solve the problem which distractions cause to drivers while even helping them see things that they may have missed such as deer in the road. The design successfully made the budget, costing a total of $1,203.
References

