Assistive Vehicular Interface (AVE)

This project outlined by Delphi Automotive aspired to design new, innovative technology to help cars of the future to become safer, more environmentally friendly, and more connected. After researching current technological advancements in cars, three concepts were selected that fit Delphi's three main goals. Almost one hundred potential consumers were then surveyed on which of the three ideas they would most like to see in cars or what would be most applicable to them. The three concepts were then weighted and scored based on importance and perceived success of achieving each requirement. The results yielded Vehicle to Vehicle Communications (V2V) and Augmented Reality Dashboards as the favorites. The final concept combines the two ideas to create an Augmented Reality Dashboard navigation system. This navigation system highlights paths and directions on the windshield instead of on a phone or console screen. This then prevents the driver from having to take his eyes off the road to look down and gives the car access to wireless internet and various online map applications. This concept could revolutionize the driving experience and achieve Delphi's goals of increased safety and connectivity within cars.

The purpose of this project was to "identify technologies and opportunities to make cars and trucks safer, greener, and more connected." The main problem from this objective that the team tackled was safety, with a secondary focus on connectedness.

Car-related death is a very real and serious problem around the world, in both developed and developing countries. In 2012 alone, there were 33,561 vehicle-related deaths in America; that is 10.69 deaths of every 100,000.[1] The team brainstormed and researched technologies that

could be incorporated into vehicles to make them safer for both passengers and those around vehicles. The team also surveyed ninety-eight people outside of our group to get a grasp on what the general population might like to see in cars.

In this project, each team had to pick one or more of the three goals which Delphi established to address and design a solution and make an improvement towards. The new design needed to be not be so outlandish that it could not be used in the next five to ten years by Delphi.. The challenge the group chose to address was how to implement a technology to make the car safer and more connected. Using these parameters for a problem statement, the team looked into design options.

The resources utilized for research included Delphi's website and miscellaneous scientific publications and blogs found on the Internet. This research was done to help the team become aware of existing ideas and concepts that could be used as a springboard for the team's design. The team found ideas including crash-preventing airbags, vehicle-to-vehicle communication, and alternate reality dashboards, all which had had little to no real life implementation.

To select the final three concepts for consideration, the team members presented the concepts each had developed or discovered to the rest of the team for consideration. The three concepts that were selected from the rest were crash-preventing airbags, vehicle-to-vehicle communication, and augmented reality dashboards. Crash-preventing airbags deploy underneath a vehicle and help to slow it down before an imminent collision. Vehicle-to-vehicle communication allows cars to "sense" each other and avoid each other on the roads. Augmented

reality dashboards project information important for the driver to know from the dashboard onto the windshield.

The team surveyed ninety-one people to gather information for general reception of the concepts. A sample of the survey can be found in Appendix A. The survey results revealed a very positive response to all three concepts, The team originally intended to combine the vehicle-to-vehicle communication technology and the augmented reality dashboard technology, but discoveries made later in the design process concerning costs and current availability caused the team to focus solely on the augmented reality dashboard. Modifications were made, and the team's design was named the Assistive Vehicular Interface, or AVE.

An analytical hierarchy process (AHP) matrix was made in order to determine the relative importance of each requirement, and can be found in Table 1. The requirements were:

- Safe
- Connected
- Simple
- Intuitive
- Compatible with Current Technology
- Easy to Maintain
- Easy to Manufacture
- Low Cost

#N/A	Safe	Connected	Simple	Intuitive	Compatable	Maintainable	Ease of Mfg.	Cost	Total	Weight
Safe	1	1.25	4	2.5	1.5	2	1.75	1.5	15.5	0.19
Connected	0.8	1	3	2.5	1	1.5	1.5	1.25	12.55	0.16
Simple	0.25	0.33	1	0.5	0.25	0.33	0.33	0.5	3.49	0.04
Intuitive	0.4	0.4	2	1	0.75	1.5	1.25	1.33	8.63	0.11
Compatable	0.67	1	4	1.33	1	2.5	3	1.5	15	0.19
Maintainable	0.5	0.67	3	0.67	0.4	1	0.75	1.25	8.24	0.1
Ease of Mfg.	0.57	0.67	3	0.8	0.33	1.33	1	1	8.7	0.11
Cost	0.67	0.8	2	0.75	0.67	0.8	1	1	7.69	0.1
								Grand Total:	79.8	

<u>Table 1:</u> *Analytical Hierarchy Process (AHP) Matrix depicting the relative importance of each requirement*

In addition, a design matrix was also constructed in order to determine which concept best satisfied each requirement with regards to importance. The three initial concepts were: Vehicle-to-Vehicle Communications (V2V), Augmented Reality (AR) Dashboard, and Crash Preventing Airbags. V2V allowed vehicles to wirelessly exchange anonymous information on position, speed, and location. This then allowed the vehicle to sense hazards and relay warning alerts to the driver. AR dashboards utilized special glasses and a portion of the windshield to project dashboard information such as speed, location, directions, time, and fuel levels onto the windshield. Crash-preventing airbags placed airbags on all exterior sides of the vehicle in order to decrease the impact placed on the vehicle in the event on a collision. The design matrix can be found in Table 2.

	AHP	Vehicle-Vehicle	Weighted	Augmented Reality Dashboard	Weighted	Crash Preventing Airbags	Weighted
Safe	0.19	4	0.76	2	0.38	5	0.95
Connected	0.16	5	0.8	4	0.64	1	0.16
Simple	0.04	1	0.04	1	0.04	2	0.08
Intuitive	0.11	5	0.55	5	0.55	5	0.55
Compatable	0.19	3	0.57	4	0.76	5	0.95
Maintainable	0.1	5	0.5	5	0.5	4	0.4
Ease of Mfg.	0.11	4	0.44	4	0.44	3	0.33
Cost	0.1	2	0.2	2	0.2	4	0.4
		29	3.86	27	3.51	29	3.82

Table 2: *Design Matrix rating the ability of each concept to satisfy each requirement*

After the Design Matrix was scored, V2V "won" after best satisfying each requirement with regards to importance. However, a navigation-centered re-design of the AR dashboard was selected as the final design concept after positive survey feedback.

After discussing different ideas, the team agreed that the final concept was to focus on the navigational aspects of the augmented reality dashboard. Two cameras are mounted on the sides of a vehicle and collect and analyze data concerning the vehicle's location and surroundings. This information is partnered with GPS technology, which allows the cameras to "see" the route the vehicle is taking on the road. Computers then translate the route determined by the GPS technology onto the images of the road gathered by the cameras. Projectors hidden behind the dashboard are able to project this route onto the windshield, allowing the driver to see visual directions on the real road, as opposed to looking at a mounted GPS or a GPS on a smartphone.

The upgrade from the typical one camera to two will significantly increase the cost of this technology, but also significantly improves the technology's capabilities and accuracy.

A prototype of the re-designed AR dashboard can be found in Figure 1.

Figure 1: *A prototype of the navigation-centered AR dashboard re-design*

The Assistive Vehicular Interface is capable of significantly enhancing the driving experience. The feature of having the route projected onto the windshield will allow a driver to keep his or her eyes on the road rather than looking at a smartphone or GPS unit to see directions. Since many car accidents are caused by distracted drivers, AVE has the potential of significantly reducing the amount of accidents by keeping drivers' attention on the road. In-use failure of this technology does not put anyone or anything in jeopardy, as a vehicle will still have full functional capabilities; it simply loses its enhanced navigational abilities.

An example of possible uses of AVE would be with a driver in an unknown area. This driver, if using the technology that is available right now, would have to continuously keep looking at his or her phone or a GPS. This equates to time spent not looking at the road, and it only takes a split second for a mistake to happen and an accident occur. With AVE, the driver is able to follow the route just by following a highlighted route on the windshield. By limiting the time the driver is looking away from the road, the safety of the both the driver and those around the driver goes up substantially.

The team determined the cost of AVE by researching similar ideas to find a base cost. The total cost is for the design is estimated to be around $2,600. Delphi's manufacturing cost can be projected to be around $1,100. Because the total cost was found by crunching numbers found online, the team worked backwards to find the manufacturing cost. This was done by using the

formula given to all the teams in class. The formula was $Z = 1.2\ (1.3)(1.5)(\Sigma\ A) = 2.34\ (\Sigma\ A)$. X was the price to manufacture, Y was the price the distributor gets, and Z was the retail price. Then the total cost was divided by this number: $Z_T / 2.34$. The manufacturing cost came out at $1,111. Because the team had the total cost first, the formula that was used was the only the second one. The price that was estimated fell very nicely into the range of what people were willing to pay, which the team determined on the survey.

The life cycle of the Assistive Vehicular Interface would not be wasteful in either materials or energy. To create the product, the manufacturer would only need to produce two small projectors and small cameras on the front of the car to collect information. Both of these products would not be much of an environmental issue during the manufacturing stage. During the actual life AVE, the system can run off electricity provided by the car's battery. At the end of the product's life, many of the metals and plastics in the parts can be recycled to be used again. Because of how small these products are, the gains of recycling would be small, but over time, saving as many resources as possible will benefit the economy and the environment. So in conclusion, the life cycle analysis shows that AVE is environmentally friendly and sustainable.

The final concept was chosen because of its innovative take on navigation and its positive reception by the surveyed public. AR dashboards were already considered conceptual, cutting-edge technology, and this re-design modified the technology to solely increase navigational ability. The design was not without downfalls. The concept was highly involved and required two front-facing exterior cameras, two interior dashboard projectors, and a vehicle with wireless internet capabilities. Additionally, potential distractions to the driver arose due to projecting images onto the windshield. Also, a software to process the upcoming road based on

information received from the cameras and project a highlighted route onto the windshield would have to be developed. Ideally, these concerns would be addressed in the first couple rounds of prototype testing until the concept is perfected. Over time, wireless internet in vehicles is expected to improve in addition to AR dashboard technology which would aid the concept greatly. Hopefully, this feature would be available to the public in the next ten to fifteen years as an add-on and a commonplace in vehicles in the next twenty years.

This project presented by Delphi helped to develop crucial problem solving skills in engineering students. The project provided a real world situation for a major company and asked students to adhere to only three goals: Safe, Connected, and Green. The AHP matrix served very useful for determining the relative importance of each requirement, and the design matrix assisted in the process of narrowing down the different concepts and selecting the best option. In addition, essential teamwork skills were further developed through problem solving in a group setting. Thus, this project outlined by Delphi Automotive proved very effective in reinforcing crucial problem solving skills to future engineers.

Appendix A Survey Questions

1. What is your age?
2. What is your gender?
3. What is your occupation?
4. Do you own a drivable automobile?
5. Please rank the following ideas to enhance vehicular safety from a scale of 1 (least appealing)-3(most appealing),
    a. crash-preventing airbags
    b. vehicle-to-vehicle communication
    c. augmented reality dashboard
6. Which of these three ideas would you most like to see implemented in cars in the next five to ten years?
7. How much would you be willing to pay to have your favorite of these technologies in your vehicle?
    a. <$1000
    b. $1000-$3000
    c. $3000-$5000
    d. >$5000
8. Have you ever been in a vehicular accident?
9. Do you consider yourself a safe driver?
10. How much of a factor is safety when you are looking to buy a new vehicle?

a. The only factor

b. A major factor

c. A moderate factor

d. A minor factor

e. Not a factor

11. What other factors impact your choice in vehicle? (Select all that apply)

a. Fuel efficiency

b. Environmental friendliness

c. Brand

d. Cost

e. Aesthetics

f. Speed

g. Other

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