D.R.I.V.E.

Delphi Automotive

EDSGN 100 Introduction to Engineering Design

Section 09

Design Team VI

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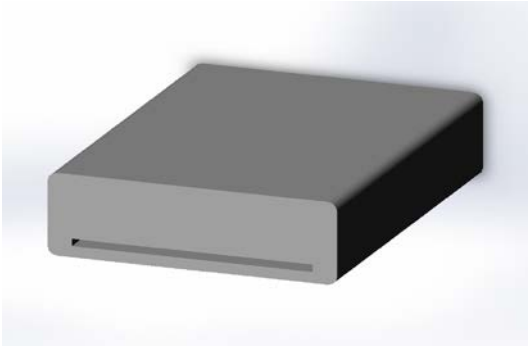

http://www.personal.psu.edu/jmr6277/edsgn100_fall14_section09_team6_dp2.pdf

17 December 2014

Abstract

This report contains the design project of a car safety improvement created by Team VI. The engineering design process, from initial brainstorming to final design, is documented in this report. Team VI has worked hard this semester to construct this product based on the specifications laid forth by Delphi Automotive and Professor Xinli Wu. Design Team VI presents D.R.I.V.E.

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Introduction

In a society of constant technological innovation, driving will be soon completely automated and free of emissions. However, small steps must be taken to achieve this monumental goal. Meanwhile, people are responsible for the vehicular safety of themselves and the world around them. Society must also be held accountable for the carbon footprint being left on the planet. Improvements must be made to motor vehicles to make them greener, safer, and more connected.

Design Task

Problem Statement

The problem was that there are over ten thousand deaths caused by major accidents that are attributed to reckless driving every year. This means that people feel the benefits of unsafe driving outweigh the risks. There needs to be extra incentive for drivers to maintain safe driving habits, no matter the situation.

Mission Statement

The mission was to reduce accidents caused by reckless driving to zero instances per year. This design will provide an incentive to drivers to practice safer driving habits.

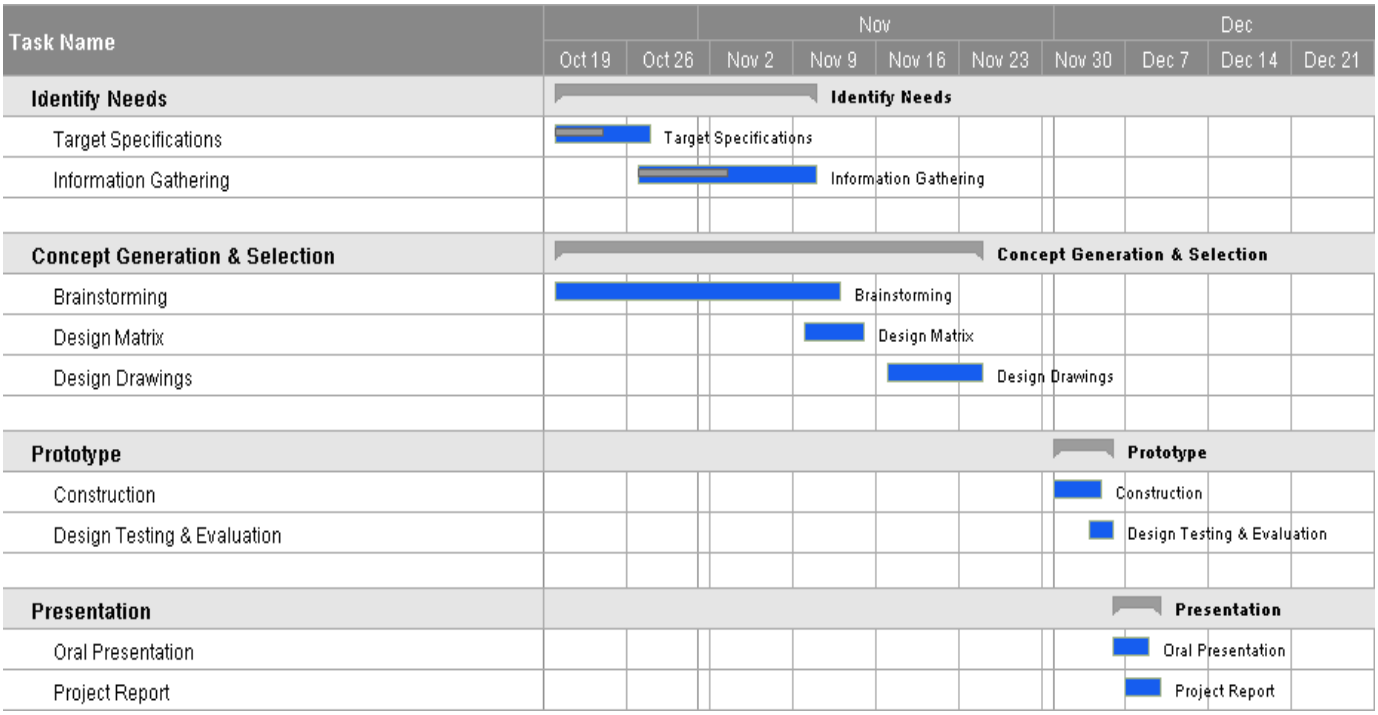
Design Specifications

The sponsor, Delphi Automotive, set the design specifications for this project in a presentation on October 13, 2014. The design is required to improve the safety, emissions, or connectedness of motor vehicles. Click here for the Delphi presentation.

Design Approach

Project Management

Table 1 Gantt Chart



Concept Generation

The five concepts generated by Team VI were a motorcycle signal, fog lights, eye sensors, the D.R.I.V.E. system, and transition windows.

FIG. 1 Concept A Motorcycle Sensor

The concept of the motorcycle signal was to have a sensor on every motorcycle and car that would let a driver know when there is a motorcyclist in a nearby area. The sensor would be on the front of the motorcycle and send a beacon to a receiver in the GPS of the car. There would be a warning sound to alert the driver.

FIG. 2 Concept B Fog Lights

The fog lights concept would provide drivers clearer vision in foggy weather. Though useful, this idea was too expensive and required an in-depth knowledge of light's interaction with water particles.

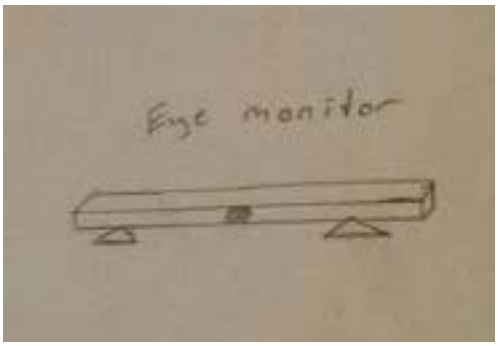


FIG. 3 Concept C Eye Monitors

The eye sensors idea was a monitoring device that could sense when/if the driver were starting to drift into sleep. Several automotive companies have already addressed this idea.

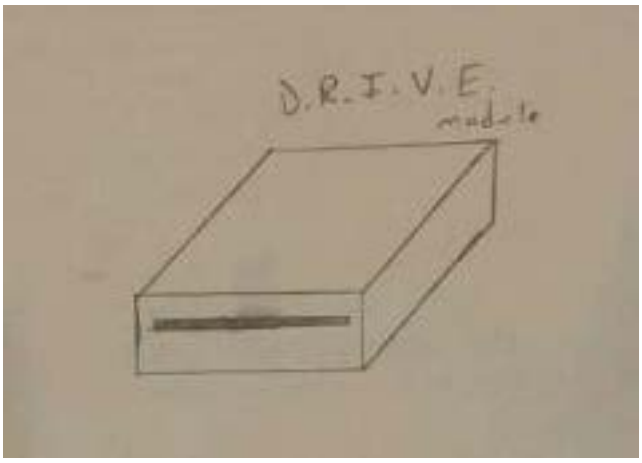


FIG. 4 Concept D D.R.I.V.E.

The Driver Rewards Interactive Vehicular Experience, or D.R.I.V.E., system was originally designed as a social game to compare safe driving habits. By monitoring vehicular safety, drivers could compete with their friends, counties, and states over who are the safest drivers. This idea was promising, but needed to be changed from a “game.” Driving is too serious to be considered a game.

FIG. 5 Concept E Transitional Windows

Concept E, transitional windshields, would be chemically treated windows that acted similar to transitional glasses. Though convenient on sunny days, this was an expensive idea that would not generate customer excitement.

Concept Selection

Table 2. Design Matrix

Selection Criteria	Concepts				
	A Motorcycle Signal	B Fog Lights	C Eye Sensors	D Driver Score	E Transitional Windows
Safety	+	+	+	+	+
Feasibility	0	-	-	+	0
Cost	0	-	-	0	-
Green	0	0	0	0	0
Durability	+	0	-	+	-
Desire from market	+	+	0	0	+
Connectedness	+	0	0	+	0
Reliability	0	-	-	0	+
Sum +'s	4	2	1	4	3
Sum 0's	4	3	3	4	3
Sum -'s	0	3	4	0	2
Net Score	4	-1	-3	4	1
Rank	1	4	5	1	3
Continue?	Yes	No	No	Yes	Develop

Table 3. Weighted Design Matrix

Selection Criteria	Weight	Concepts					
		A		D		E	
		Motorcycle Signal		Driver Score		Transitional Windows	
		Rating	Weighted score	Rating	Weighted score	Rating	Weighted score
Safety	15%	5	0.75	5	0.75	5	0.75
Feasibility	15%	3	0.45	5	0.75	3	0.45
Cost	10%	3	0.3	3	0.3	2	0.2
Green	5%	3	0.15	3	0.15	3	0.15
Durability	15%	4	0.6	5	0.75	2	0.3
Desire from market	10%	4	0.4	3	0.3	5	0.5
Connectedness	15%	4	0.6	5	0.75	3	0.45
Reliability	15%	3	0.45	3	0.45	4	0.6
Score		3.1		4.2		3.4	
Rank		3		1		2	
Continue?		No		Develop		No	

Final Design Description

Design Team VI decided that the Driver Rewards Interactive Vehicular Experience system, with modifications, would best suite the design specifications. D.R.I.V.E. was the most unique of the five original concepts. After adjustments to the original idea, D.R.I.V.E. became a rewards based driver safety program. D.R.I.V.E. will provide constant incentive to driver's to practice proper driving habits. There will be rewards for safe driving tactics, and punishment for driving that recklessly endangers the driver as well as other vehicles on the road. This system will effectively and efficiently reduce the number of deaths caused by reckless driving every year in America.

The D.R.I.V.E. device is 1 in x 3 in x 4 in. It is connected to a vehicle's electronics and retrieves inputs from the car's readings. The D.R.I.V.E. device contains a GPS, accelerometer, Arduino, and an output signal. If a vehicle is previously equipped with a GPS, a simpler form of the D.R.I.V.E. module can be used. Installed in the dashboard of a vehicle, this final design would monitor key aspects of the driver's driving habits. Speed, acceleration, deceleration, turning force, use of turn signals, and use of seatbelts would all be recorded and evaluated by the D.R.I.V.E. point system. Safe driving habits are rewarded with positive points, while dangerous driving results in a loss of points.

Proposed Point Values
Speed- 8 mph or more under + 1-5 mph over speed limit= Neutral 0 points
7 mph to 0 mph under speed limit = Positive .1 points for every 5 safe miles driven
6 mph or more over speed limit = Negative .1 points for every mile + (each xtra mph *.01)

Turn signals- 10 proper turns using turn signals = Positive .1 points
2 improper turns= Negative .1 points

Turning force- 10 proper turns under safe level of G force unit's = Positive .1 points
2 improper turns= Negative .1 points

Acceleration/Deceleration – Prolonged acceleration/deceleration past safe level results in loss of points

Driver Seatbelt- positive .1 per trip wearing seatbelt
Negative 1 per trip not wearing seatbelt (95% of positive reduced)

Similar to a credit score, a person's driver's score will reflect his or her responsibility. Low scores show poor judgment and unsafe driving tactics, while a high score will indicate proper driving techniques. The lowest score possible will be 0 points, and the maximum 1000 points. There are five levels to the D.R.I.V.E. point system:

Level 1 0-99.9 points

Level 2 100-249.9 points

Level 3 250-449.9 points

Level 4 450-699.9 points

Level 5 700-1000 points

Prototype/Model

Working Drawings

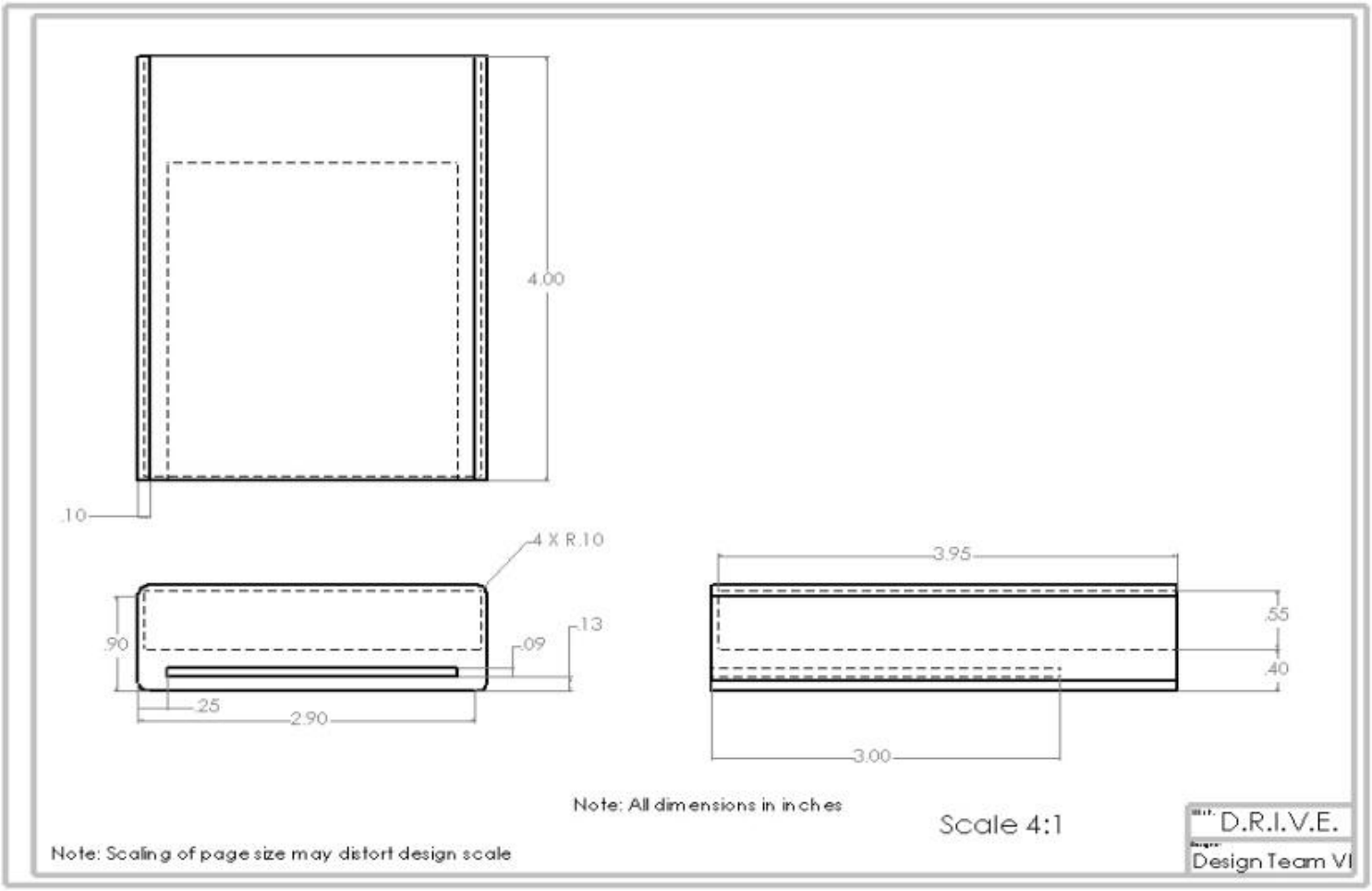


FIG. 6 Multiview Drawing of D.R.I.V.E. Module

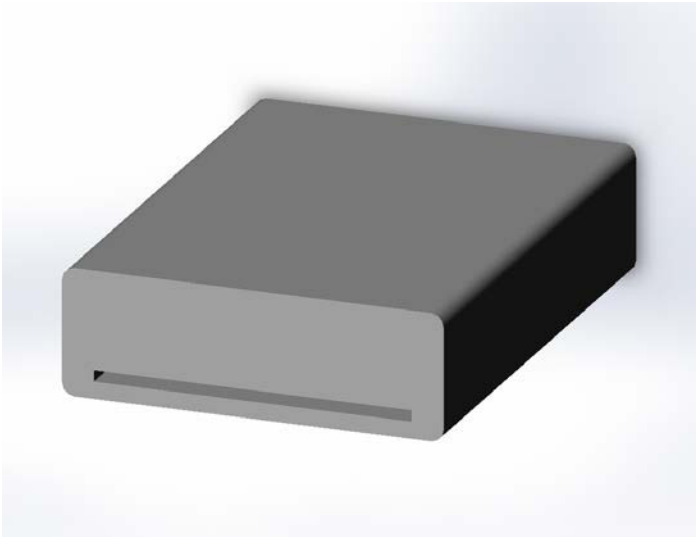


FIG. 7 D.R.I.V.E. 3D CAD Model

Prototype

FIG. 8 D.R.I.V.E. Prototype with Inserted Driver's ID

FIG. 9 Car Domonstating D.R.I.V.E. Location

This to scale prototype (FIG. 8) of the D.R.I.V.E. module has a slot for ID insertion as well as a spot for input from the vehicle's GPS system, if available. The D.R.I.V.E. module will be located in the dashboard, approximately beneath the black square in the demonstration vehicle (FIG. 9).

Design Features

D.R.I.V.E. is simple, but effective, because of its design features. There are very few components involved in the system so finding any possible problems would be easy. As time moves forward and technology evolves, D.R.I.V.E. can be easily upgraded. The few number of components also makes it easy to install into any car. There are no moving parts in the system which makes the system less vulnerable to breaks or malfunctions. Although the system is recording specific data regarding driving habits, none of the specific data can be accessed by an outside source. This protects drivers' privacy.

Engineering Analysis

Selection Rationale

Design Team VI decided to metaphorically take the road less traveled with this design idea. Rather than proposing a design similar to existing prototypes or for a problem already solved by automotive industries, D.R.I.V.E. addresses a completely different side of driver safety. The driver's mind and thought process. The Driving Rewards Interactive Vehicular Experience is a design that promotes safe driving techniques. D.R.I.V.E. provides drivers with an incentive to practice proper driving habits. Drivers are rewarded for safe driving through the D.R.I.V.E. system. At the same time, D.R.I.V.E. also discourages dangerous driving. This system provides a constant deterrence from driving recklessly. This new feature in automobiles will also improve the lifetime of tires, parts, and the vehicle itself. This design was chosen because it will address Delphi's safety category in a way much different than Team VI's other initial concepts.

Concept of Operations

The D.R.I.V.E. device is located in the dashboard, which gathers all the information needed for the point system. In order for the system to recognize who is driving and who to give the points to there is a slot in the device where the driver would insert his or her driver's license. This prevents drivers from purposefully accumulating or losing points for other drivers. It is fair and ensures the driver has his or her driver's license when driving. After inserting the license the driver would accrue points by demonstrating safe driving techniques in the areas of speed, acceleration/deceleration, turning speed, use of turn signals and use of seat belt.

Life Cycle Assessment

All inputs for D.R.I.V.E. would be associated with the electrical components used in the final design. These electrical components would all be designed to last the life of the car and possibly longer since the system can be removed and transferred to another car. The life of the system is also increased because updates to the system will negate the need for replacing system parts. All of the system components can be recycled and used in the production of future parts. Overall, the environmental impact of the life of D.R.I.V.E. would be minimal due to its long life.

Feasibility & Adoption

A crucial component of the D.R.I.V.E. system is the possibility of rewards. This could come in many forms, but mainly from insurance companies. Working with insurance companies would allow people with good driver's scores to get reduced insurance rates. Taxi, bussing, and chauffeuring services would be interested in this design because consumers and employers would be able to see which drivers have safety as a priority. Along with monetary benefits, there would also be social benefits. The ability to see everyone's score would create some pressure to be a safer driver now that everyone can see it. Being able to see everyone's score also ties into people being able to look at a taxi driver's score to determine how safe he or she is. Through corporate connections and partnerships, these applications increase the feasibility of the D.R.I.V.E. system.

There are a few hurdles in the way of D.R.I.V.E. being implemented into the automotive world. In any reward based system the problem of cheating and fraud needs to be addressed. This could become a potential problem with D.R.I.V.E., but placing safeguards can possibly negate the effectiveness of fraudulent driving tactics to increase a driver's score. Another task that

would need to be accomplished in order for D.R.I.V.E. to be implemented would be partnerships with vehicle manufacturers. This would help make the system more attainable to the average consumer because the car would be made with the system installed in the dashboard. This system will become more effective as more drivers register with D.R.I.V.E. Government legislation could be passed in order to make its use in all cars mandatory, or to provide tax breaks for high driver's scores. With corporate and legislative help, D.R.I.V.E. could realistically be implements in every vehicle in the U.S. by 2020.

Economic Viability

D.R.I.V.E is meant to be a system that any driver can afford. Team VI chose components that offered a good consensus between price and quality. A single D.R.I.V.E. device would cost about $253. This price is comparable to a quality GPS on the market. Three main components enter in the fabrication of our device. The arduino GPS for a price of $100, accelerometer at a price of $4 and the aquarium monitor system at price of $149. There would also be costs to continue processing and distributing the information from D.R.I.V.E. systems. However, the benefits of driving safely while owning D.R.I.V.E. would quickly outweigh the costs of buying the system. Insurance rate reductions and tax breaks could make safe driving financially rewarding. Coupling with insurance companies, automobile manufacturers, and taxi and chauffeuring services could be economically beneficial for all involved parties as well.

Conclusion

Through the application of the design process and many hours of though and work, this system has grown into an idea that may very well be integrated into the lives of people in the United States, and potentially the world. The system is based in technology that already exists in society today. People want the roads to be safer. People want rewards for doing the right thing. People want a ways to compete and compare themselves to others. D.R.I.V.E. happens to use these basic truths in society to make this design feasible and economically viable. Although Design Team VI's knowledge and recourses as undergraduate engineering students provided limitations to the expansion of this design, D.R.I.V.E. has developed into an efficient and effective rewards based safe driving system. In the exploration of possible ideas to make automobiles safer, greener, or more connected, Design Team VI has produced the Driver Rewards Interactive Vehicular Experience to make car accidents a much less frequent occurrence in society. As technology continues to evolve, the D.R.I.V.E. system can be updated to more accurately portray a driver's safety, or lack thereof. This design project has improved the critical thinking skills of the members of Team VI, as well as fostered good teamwork and friendship. Design Team VI believes that D.R.I.V.E. could truly change the world.

Presentation

The Section 09 competition required a formal presentation. The presentation was supposed to be less than four minutes in length and accompanied by visual aids for the audience. Along with the prototype, Design Team VI created a PowerPoint to assist the flow of the presentation

Brochure

This tri-fold brochure effectively summarizes the D.R.I.V.E. system for people interested in this design. It was handed out to classmates during the Section 09 competition and was available for judges and spectators at the Fall 2014 College of Engineering Design Showcase.

Engineering Design Showcase Poster

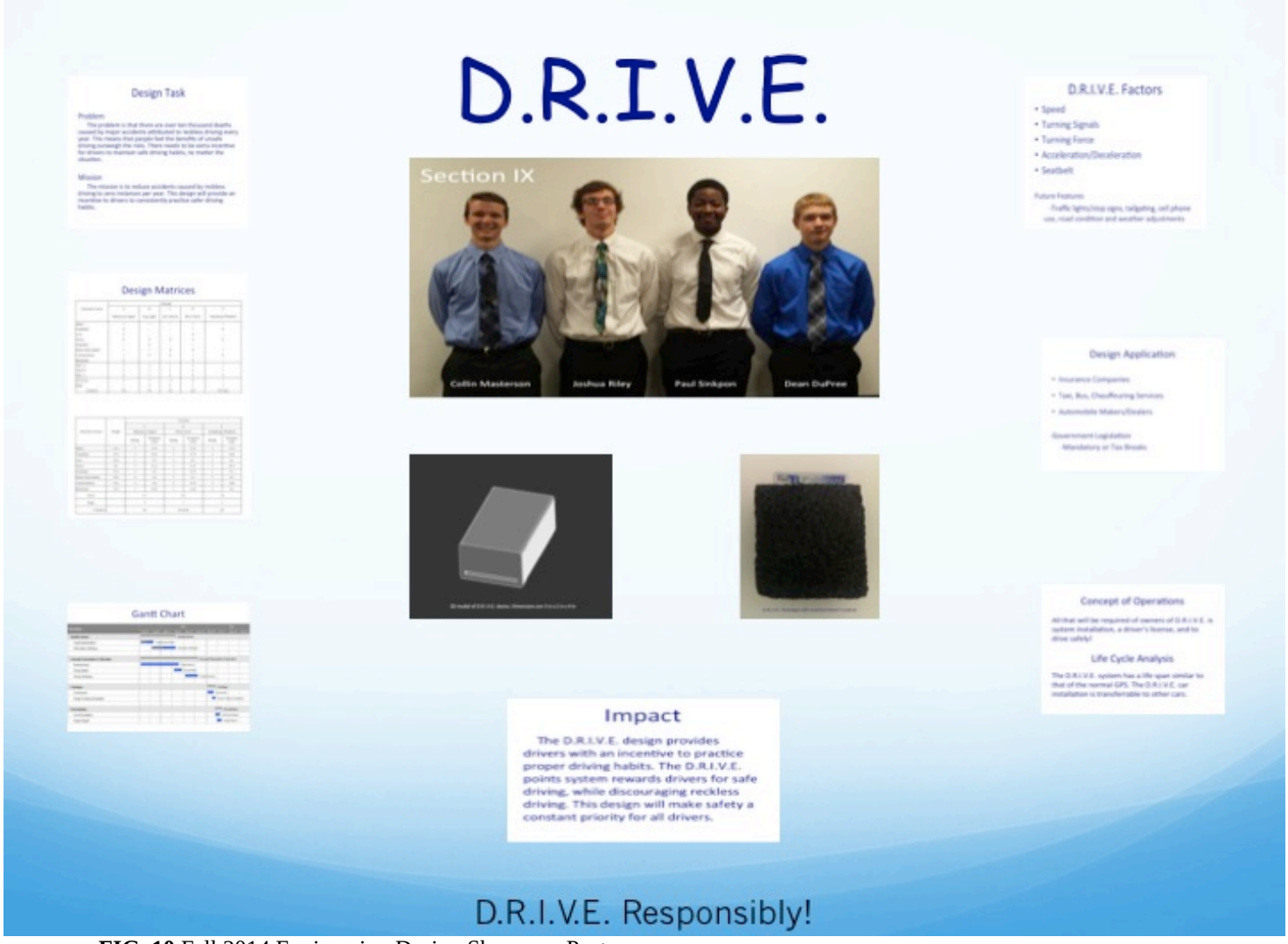


FIG. 10 Fall 2014 Engineering Design Showcase Poster

Acknowledgments

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- Thomas Antoniak, Teaching Assistant

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