

Design Issues Paper

Team 9: Safety Enhancement Features for the 21st Century Automobile

Tom Aprik, Natalie Hannon, Jeremy Konz, Don VanderLaan

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Technology in automobiles has the capability to increase safety in today's fast-paced society. The Intelligent Vehicle Initiative (IVI), part of the U.S. Department of Transportation, partners with the federal government and industry to prevent driver distraction and support implementation of crash avoidance systems. The proposed "alerting system", the subject of Team 9's design project, aims to notify drivers of proximal emergency vehicles on the road. This topic fits under the overall umbrella of the IVI and is on the fore-front of sensing technology. With 37,248 fatal vehicle crashes in 2007 in the U.S. alone (National Statistics), there is a definite reason to invest in technology that enhances automobile safety.

Protection of intellectual property is critical in today's competitive automotive market. Closely-kept information has resulted in high profitability in the automotive industry – a prime example is Chrysler's introduction of the minivan in the 1990s. The challenges that the automotive industry faces today are large from an economic standpoint. Automotive companies need engineers to design new technology to provide a competitive advantage in the market.

Team 9's sponsor, General Motors, is investing in a new kind of sensing technology known as 5.9 GHz Dedicated Short-Range Communication (DSRC). DSRC and global positioning systems (GPS) combine to comprise GM's vehicle-to-vehicle (V2V) communication system (DSRC: An International Perspective 4). V2V is a 360 degree wireless detection sensor which replaces multiple autonomous sensors and allows vehicles to "talk" to each other (4). V2V provides benefits such as reduced cost, extended sensory range, immunity to false alarms and extreme weather conditions and new driver assistance features (4). A companion technology is vehicle-to-infrastructure communication (V2X). Its applications are safety enhancements for multiple-vehicle interactions (7). This information supports Team 9's project topic. The emergency vehicle "alerting system" fits into the scope of V2X safety applications and could be implemented as part of it. Technology advancements will redefine future GM products as not only greener, but safer. Protection of intellectual property during the development phase of V2X applications is critical for GM to maintain a competitive advantage in the market.

Universal design principles are extremely important for the application of the “alerting system” inside an automobile. It is important that the best sensory techniques are employed to warn the driver of an approaching emergency vehicle. To be effective, the “alerting system” should inform, rather than distract or startle the driver. GM has implemented a variety of warning methods in a prototype version of the V2X communication system (Holstege). For instance, visual warning lights are displayed in a side-view mirror if the driver attempts to merge into a lane where another car is present. Further, the seat vibrates if the driver signals to merge into a lane where another car is present. Both methods are different ways to convey information, designed to capture the attention of the driver and prevent an accident. The Intelligent Vehicle Initiative (IVI) applies human factors engineering to projects to help understand how technology impacts drivers. For the “alerting system”, the challenge is to make the warning detectable and understandable to the driver (Perel). In addition, the “alerting system” has to determine when the driver needs to be warned (Perel). Applying universal design principles will make the “alerting system” more effective to all drivers.

Product liability is a huge concern related to the “alerting system”. The metric by which the success of the “alerting system” will be judged is a reduction in emergency vehicle related crashes. Even with that established, it is not the sole responsibility of the “alerting system” to reduce emergency vehicle related crashes. It is up to the driver of the automobile to use the information provided to act in a responsible and appropriate way to avoid a crash. Drivers of emergency vehicles must also not take the “alerting system” for granted and assume that drivers are aware of the situation. Essentially, drivers in both vehicles must still use caution and individual judgment to avoid a crash.

The reliability of the “alerting system” poses another huge product liability concern. If the “alerting system” does not detect an emergency vehicle, GM risks the event of a lawsuit for a subsequent crash. It is important that the “alerting system” is robust enough to detect emergency vehicles in a variety of situations. If the “alerting system” detection is not sensitive enough there is the risk of missing a siren. On the contrary, if the “alerting system” detection is too sensitive there is the risk of creating a false alarm. False alarms could cause distraction and drive customer complaints. Before the technology is deployed into production vehicles, extensive testing must verify the reliability of the “alerting system” for legal and customer satisfaction reasons.

Product lifecycle management is the most complex design issue because it deals with all aspects of the product, from start to finish. The first stage of the product lifecycle is determining the product requirements. Team 9's challenge at the on-set of the semester was to establish firm product requirements from General Motors. The tight time schedule of the class led to a take-over by Team 9's facilitator, who provided a structured specification for product requirements. This resulted in a subsequent challenge to ensure that the proposed topic was relevant and of value to GM, the end customer. Additional research has verified that there is a business case for an emergency vehicle "alerting system" and that GM has interest in developing this technology. Ultimately, product requirements must be derived from market research. If there is not a market for a new product then there is no business case.

Concept engineering and prototyping is the next step in the product lifecycle. The main function of a prototype is to serve as a proof-of-concept that demonstrates the technical feasibility of the product. The look of the prototype can change so long as the functionality is consistent. Often, a prototype is used to convince management to continue to fund a project. A prototype of the "alerting system" will be available at Design Day, which encapsulates the work performed by the team during the semester. However, completion of a prototype is not the completion of the design process.

Product engineering results after a prototype has been perceived as both technically feasible and commercially viable. At this point, the "alerting system" could be integrated with existing GM electronics and communication systems. Any additional components needed to build the "alerting system" would be subjected to a rigorous cost take-out process. When the product is mass-produced, monetary denominations as small as pennies make a difference. Negotiations with suppliers would lead to business contracts deemed acceptable by both parties.

Manufacturability is an important consideration during product engineering. The "alerting system" relies on an external audio sensor to detect an emergency vehicle. Deciding where to mount the audio sensor on the automobile would need to be coordinated with the manufacturing process. There also might need to be a way to test the "alerting system" right off the manufacturing line for a quality check.

Sales and distribution of the "alerting system" would be dependent on the sales and distribution of the automobile. Several questions would arise when the "alerting system" is introduced to the market. Will there be customer demand for the "alerting system"? Will the

availability of the “alerting system” lead to a reduction in emergency vehicle related crashes? Will the “alerting system” be available for retrofit into older cars? Answers to these questions would be uncovered through analytic studies and market research, leading to a return to the beginning of the product lifecycle.

Awareness of design issues at the beginning of the product lifecycle will aid in the design of a successful product. Development of the “alerting system” with attention to protection of intellectual property, universal design principles, product liability and product lifecycle management is critical to its usefulness beyond the prototype stage. A team comprised of government and industry will need to work together to validate safety improvements resulting from the “alerting system”. The “alerting system” fits in to several government initiatives and also fits in to GM’s new V2X technology, making it perfectly positioned to have an impact in the automotive industry.

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