Safety concerns with the 21st century car

If you're looking to automotive electronic defects as the cause of an accident, here is your starting place

By Daniel Dell'Osso

Most current cars use modern electronics to manage any number of vehicle functions. And the amount of computer and electronic technology in cars is only expected to increase. Manufacturers are projecting that as early as 2015, cars will be equipped with collision-avoidance technologies that will not rely on driver input. In fact, some of those technologies are already in the market place: e.g., the rear obstacle avoidance system that automatically applies the brakes when it senses a car may be about to back into something.

At the same time, the recent General Motors recall of more than 2.6 million vehicles and Toyota's problems with sudden acceleration demonstrate these technologies are fallible. And tragically, the failures of these systems can be just as catastrophic as a tire-blowout or a collapsing roof. What makes these failures more dangerous than the poorly designed roof structure or tire is that they can be invisible. Often, they do not leave forensics, which leads to an incorrect conclusion about how the accident occurred and/or how a person was injured, allowing the defect to go undetected.

The GM electronic ignition failures provide a perfect example. When the ignition fails, the engine shuts off. As a result, power brakes and power steering are lost, causing a loss of vehicle control and a collision. Because there is no obvious forensic evidence of engine shut-down, the officers investigating the crash often incorrectly conclude that the crash was the result of driver error, allowing the danger and the defect to remain hidden.[1]

The use of computers to control vehicle operations is not new. Virtually all modern airplanes use computers to control every aspect of flight. The current commercial airliner is capable of flying to its destination, landing and stopping without pilot input. That does not mean that these systems are not without their issues and that failures have not occurred. (See "*Three boys*" Plaintiff May 2013, chronicling the deaths and life-threatening injuries of 14 soldiers whose helicopter crashed when the computer controlling the engine commanded an in-flight shut-down.) However, with this expanding use of technology, lawyers involved in auto-products litigation must also expand their knowledge and understanding of these electronic technologies.[2]

To begin, the electronic systems that manage a vehicle are comprised of basically three hardware components: sensors,

wiring, and electronic control units or computers. Obviously, any type of hardware failure can result in degradation of system performance with sometimes catastrophic results. However, the use of onboard computers creates a new and entirely different failure mode related to software dependability and security.

Wiring

The days of the simple wiring harness are gone forever. Modern cars have over three miles of wiring, weighing more than 150 pounds. The wiring, along with associated connectors, comprises the third heaviest vehicle component after the engine and transmission. Defects in the wiring and connectors are associated with any number of vehicle-system failures. By way of example, Toyota recently announced a recall of certain 2012-2013 vehicles because of problems with water accumulation causing short circuits in the wiring controlling air-bag operations causing non deployment, and/or inadvertent deployment events. An air bag that fails to deploy when it is needed or one that deploys when it is not needed represents a serious risk to vehicle occupants.[3]

Wiring is also an essential component of Electronic Power Steering (EPS) systems which are standard equipment in a number of 21st century cars. EPS uses sensors and an electronic control unit, or ECU, essentially a computer, to translate driver-steering inputs into movement of the front wheels. A failure of the wiring or sensors can cause a vehicle loss of control due to the steering wheel jerking or being non-responsive to driver inputs, resulting in a loss of vehicle control with dire consequences. Vehicles manufactured by Mazda, Toyota, and General Motors have all been the subject of recalls related to their electronic power steering systems.

Nevertheless, some vehicle manufacturers have moved beyond EPS and are now offering "drive-by wire" steering. These systems eliminate the direct mechanical connection between the steering wheel and the steering gearbox. Steering is accomplished through electrical signals created by movement of the steering wheel which are then transmitted to a computer that operates a separate motor driving the steering gear.

Sensors

Many of the systems on today's cars rely on sensors to operate. Sensors are devices which measure physical conditions and provide information to other electronic components. Those components then use that information to manage discrete vehicle and safety systems. For example, air-bag systems use sensors to evaluate crash severity and fire the air bags if necessary. Sensors are also used in most anti-lock braking systems. In this application, sensors are used to determine when a wheel is about to lock. When this occurs, the sensors signal the brakes to release, even though the driver may be pressing on the brake pedal. Sensors are used in the front passenger seats of vehicles to determine whether the seat is occupied by an adult or child for the purposes of firing or suppressing the passenger side air bag. These weight sensors were incorporated to help address the problem of children in the front seat being injured or killed by deploying air bags. Again there have been a number of recalls related to defects in these sensors.

Software issues

Twenty years ago, the only computer in your car was a simple four-bit processor used by the fuel injection system to meter fuel and maximize mileage while minimizing emissions. However, the use of computer processors in passenger vehicles has grown dramatically over the last 15 years. The average car today has 25 electronic control units (computers) with some having more than 100. In most cases, these ECUs are networked, sharing and using information gathered from sensors and other ECUs to make critical decisions relating to vehicle operations and safety. For example, hybrid vehicles use a computer to collect information from the accelerator pedal, process it, and transmit it through the vehicle's communication network to the computer that commands and controls the output of the gasoline engine. Obviously, the successful operation of this system is dependent on software. It is therefore critical that the software be dependable if it is to be reliable and safe.

> In systems where software failure could have significant human….costs, it is critical that the software be dependable — that it can be depended upon to function as expected and to not cause or contribute to adverse events in the environment in which it operates.

(*Software for Dependable Systems, Sufficient Evidence?* Jackson, Thomas, and Millett, editors; The National Academy Press, Washington, D.C. 2007; p. 3)

This means that dependability must be a design feature of any software used on an automobile. And, while the aviation industry has addressed the issue of software dependability for decades, the auto industry has done little. It was not until 2012 that the auto industry adopted a functional safety standard for electronic throttle control systems known as ISO 26262, in some instances having rejected earlier versions of the standard. The lack of design focus on dependability gave rise to lack of reliability and software failures resulting as an example in the sudden acceleration problems experienced by Toyota owners.

It is important to point out that software failures can be exceedingly difficult to prove because software failures do not leave forensics. When a computer fails, depending on the type of failure, and how the code is written, a "fault code" may be set indicating that there was a malfunction. However, unless the specific failure mode has been identified and the software written to set a fault code when that failure mode occurs, there will be no evidence of it. Another feature unique to software which makes failures difficult to identify has to do with sampling time. Most computers self-diagnose, checking themselves periodically to see if everything is working properly. However, if a failure occurs at a time when the computer is not self-diagnosing (sampling), then it will not recognize the failure and there will be no record of it.

One way to understand this concept is to think about someone trying to verify a lightning strike by setting up a camera to take a photograph during a thunderstorm every one-half a second. Obviously if a lighting strike occurs at one-fourth of a second, before the shutter on the camera opens, there will not be photographic evidence of it even though it has occurred. The same is true of computers. If a failure occurs at a time when the computer is not checking its operation, there will be no evidence of it. This is the challenge in proving cases involving software failures.

The final safety issue involving 21st century vehicles and their software is security. Just like the computer in your home or office, the computer in your car has the potential to be "hacked." If you can remotely unlock and start your car with your smartphone, one would have to expect that it is possible for a determined hacker to exploit the vulnerabilities in the code and unlock and drive your car away. Interestingly, at a recent Defcon hackers' conference in Las Vegas, hacking software

was released and remote control of a vehicle was demonstrated.

Thus while the 21st century vehicle contains a number of technologies that in some ways improve overall safety and performance, the advanced electronics that support those technologies are themselves subject to defects in design and manufacture which can cause the same serious injuries and deaths as defective roofs, tires and seatbelts.

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Endnotes

[1] While there may be no physical evidence of failure, there is sometimes electronic evidence from which a failure may be implied. Specifically if the crash is one in which the air-bag system is enabled, a download readout indicating that the ignition switch was in the "off" or "acc" position at deployment may be evidence from which an ignition switch failure can be implied.

[2] It is vitally important that anyone involved in or considering becoming involved in litigating cases involving vehicle electronic issues, become a member of the Attorneys Information Exchange Group. AIEG has been on the cutting edge of this litigation, and is equipped (at no charge other than the cost of a membership) to assist with understanding the technology, discovery and experts. AIEG has a large depository of documents obtained from manufacturers in discovery, along with deposition transcripts of key defense witnesses.

[3] As part of any investigation where a vehicle defect is suspected, it is always helpful to search the National Highway Traffic Safety Administration's web site at NHTSA.gov to see if the vehicle involved has been the subject of any recalls or defect investigations.