The Art of Stopping

The Art of Stopping appeared originally in the October 2010 issue of *Claims*.

A Look at Automotive Technologies and Insurance Implications

By Peter R. Thom and Timothy A. Logsdon

If there is anything the rise of microprocessors has shown us it is that very little separates the wildest idea from realization. Fifty years ago, the notion of a driverless car was Sci-Fi fare. Nowadays it is not a matter of if, but when.

Mind you, driver-assist systems in vehicles have been the norm for a long time. In the 1940's the engineering breakthrough was the automatic transmission; ten years later it was power steering and braking. Up until the debut of microelectronics in the 1980's, though, the push to make driving safer, easier and more comfortable superseded automation efforts.

Everything changed with the advent of microelectronics. At first the technological footprint was somewhat invisible to the driver with advances like fuel injection and emissions control, but now the impact is more obvious. Today's advanced microprocessor technology is transforming automobiles from sophisticated mechanical devices to networks-on-wheels as shown by a recent Society of Automotive Engineers study noting that 90% of all vehicle innovations in the past three years have been electronic in nature. All car buyers can experience the benefit of a high-tech addition almost immediately, because technological enhancements appear in the economy vehicle class almost as soon as they do in the performance and luxury categories.

Such technological progress begs the question: Is there a downside to this electronic revolution? Toyota's headline-grabbing incidents of alleged unintended accelerations in its latest models certainly point to a nightmarish possibility for automakers of Congressional hearings, mass-tort litigation, and heavy regulatory fines when technology goes awry. Although tech-heavy products undergo extensive testing, revisions, and updates, even as they premiere in the marketplace, bugs present persistent challenges. There is a difference, however, between a mobile device with a glitch and an unstoppable car. The potential exposures for automakers and insurers are enormous as a result of complex products not performing as designed. Unraveling the flaws is a contentious and costly enterprise of dissection and analysis by dueling experts as well.

Technology's Cascade Effect

Even though there is concern about the side effects of the electronic direction of automotive evolution, all agree that today's automobile is an impressive space-age vehicle when compared to its forbearers. A great way to appreciate the array of features available to the buyer is to sit in the driver's seat of a new model. Ignore the salesman's hype and focus instead on the wonder of the dashboard; the ergonomics of the seating; and the reassuring presence of the safety features. The microprocessor networks that govern vehicle operation promise responsiveness beyond the ability of human perception and reaction. Even tricky maneuvers like parallel parking, changing lanes in traffic, and reversing with poor visibility have on-board alternatives to override human error.

No technology underscores this automotive transformation better than a trio of inter-related safety advances: anti-lock braking systems (ABS), traction control, and electronic stability control (ESC). *Consumer Reports* heralds ESC as the single most-important safety advance since the seat belt. Impressive statistics from the National Highway Safety Traffic Administration (NHTSA) back up that claim with projected decreases in single-vehicle accidents of 34% for ESC-equipped cars and 59% for SUVs. Rollovers should also decline dramatically with stability control preventing 71% of car and 84% of SUV rollovers. National vehicle ratings groups like the Insurance Institute for Highway Safety (IIHS) now require inclusion of an ESC feature to earn the highest vehicle safety rating. The Federal Government jumped on the stability control bandwagon by mandating ESC as standard equipment for all vehicles by 2012. The impact for insurance carriers is undoubtedly positive with fewer crashes per vehicle mile and reduced property damage claims.

ABS, traction control, and ESC exemplify the observation that, as automotive systems get more advanced, innovation becomes quicker and easier, propelling an accelerating cascade of developments in automotive performance and safety. In fact, ESC would not be possible in its current form without the prior development of ABS and traction control sensor technology. Complex and subtle enhancements to driving such as these can be conceptualized, refined, and implemented in a short time, drastically reducing innovation costs.

Auto Technology's Stars

Anti-lock Braking Systems: During heavy braking, a skidding wheel has less traction than a non-skidding wheel and thus requires a longer distance to stop. ABS prevents wheel skid using an electronic control unit (ECU), wheel-speed sensors on each wheel, and hydraulic valves for translating commands from the ECU. The ECU constantly monitors wheel speed and prevents the wheels from locking up (skidding) during braking by regulating the brake pressure at each wheel. A typical anti-lock system can apply and release braking pressure up to twenty times a second, which is detectable to the driver as brake-pedal pulsation.

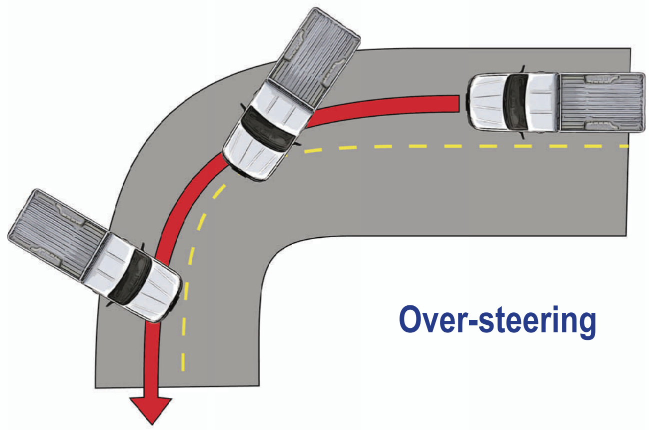
A quick look at ABS in action is useful: What if a driver needs to brake a car while steering off a highway onto a graveled shoulder? Without ABS the right wheels will skid on the gravel; while, in an ABS scenario, the system senses the instability and releases the brake so the right-side wheels can rotate, but then will pulse the brake on and off at a fast clip to maximize traction.

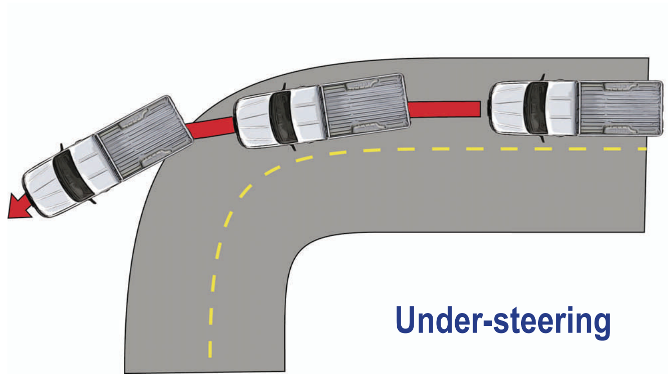
> The microprocessor networks that govern vehicle operation promise responsiveness beyond the ability of human perception and reaction.

Traction Control: Traction control is, in effect, the reverse of anti-lock braking. Wheel sensors prevent accelerating wheel spin rather than controlling the spin as in ABS. Brakes are applied-released-applied to prevent wheel spin, even though the accelerator pedal continues to be pressed. Advanced traction control systems may also trim the throttle to reduce power.

Using a similar example, picture a car accelerating with the left wheels on the pavement and the right wheels on a graveled verge—two surfaces with very different friction co-efficients. Without traction control, the right-drive wheel will spin; with traction control the system applies the ABS brakes to the right-drive wheel and gives the left-drive wheel the opportunity to maximize grip.

Physics Rules, but ESC Can Level the Playing Field





Electronic Stability Control: The heart of a stability control system is a "yaw" sensor. Imagine spinning a vehicle like a top around a line drawn through its center—yaw is that rotation. If car without stability control starts to spin in a turn, the rear of the car is "over steering" the intended steering-wheel input. A dizzying example of over steer is uncontrolled spins while turning. However, if a car is steering into a turn, but continues on a straight path, that car is "under steering." Ultimately, ESC is emergency maneuver intervention: the vehicle's electronics intervene to prevent a sensed instability and keep the vehicle on its intended path. Rollover prevention, especially for SUVs with high centers of gravity, is a huge benefit of stability control systems.

There are several real-world accident scenarios that demonstrate how stability control intervenes to control or minimize yaw.

Roadway Obstacles

Avoiding a road hazard is probably the most common emergency maneuver for any driver. Examples include dodging truck-tire debris; a ball being chased by a child in pursuit; and a bounding deer illuminated in the headlights of an oncoming car. Any of these is enough to ignite an adrenaline rush, but will the driver choose the brakes or steering wheel?

With ABS brakes, the pulsing brake pedal in a panic stop is a feedback reminder to the driver that ABS has intervened to prevent skidding while delivering the fastest possible braking. Should the driver choose to steer away from the obstacle, the wheel sensors in the stability control module combine forces with the yaw sensor to detect spin potential and then the ABS module will selectively apply brakes to the wheel(s) to keep the vehicle on its intended path.

Adverse Weather

There is a reason why tests of stability control systems take place on frozen lakes—there is nothing like the traction-robbing menaces of slippery ice and snow to challenge drivers. Even a simple turn on a winter road has a high degree of risk. Will the car actually travel in the desired direction or persist in going straight? With stability control, the yaw sensor will detect the vehicle traveling in a straight path while the wheel angle sensors will track steering input attempting a turn. The stability control system will intervene to apply and release the brakes at each wheel (at twenty times per second) to direct the car into a controlled turn until the vehicle is traveling in the path indicated by the steering input.

NASCAR Dreams

Here, ESC delivers a bittersweet pill to insurance companies and safety engineers: the technology can make aggressive driving safer. That covers the permutations of aggressive driving: too aggressive for conditions or for skill level. For daily driving, stability control addresses situations where the driver is surprised by the tight curve of a highway ramp or traveling too fast through unfamiliar territory. Integrating ABS wheel sensors, wheel-turn angle sensors, vehicle speed, and yaw-sensor readings, ESC software commands the braking system to apply individual wheel brakes to maintain the desired vehicle path.

All Systems Go

Advanced electronic control features include braking, steering, suspension, and collision warning/ avoidance systems. Together, these intelligent and automated vehicle control systems offer the consumer a safer driving experience with a higher performing, more fuel-efficient, and environmentally friendly automobile. Here's a rundown of how they operate.

Feature	Mechanism	Benefit	Driver-Controlled?
Enhanced Control and Braking Systems			
Antilock Brakes	ABS module software, wheel-speed sensors, brake hydraulics valving	Minimize stopping distance, maintain steering control when braking, maximize traction in all road and weather conditions	Cannot disable—always ON
Traction Control	ABS components plus additional sensors and software	Minimize wheel spin-induced skids by throttle and/or brake intervention	May have button—warning light if OFF, stays OFF until turned ON
Stability Control	Traction control components plus yaw sensors and electronic stability control (ESC) software	Apply ABS braking at any wheel, maintain desired vehicle path (straight or turning), rollover avoidance	Disable requires deliberate effort (several seconds)—reactivates with every ignition event
Trailer Sway Control	Enhanced ESC software	Trailering safety	Cannot disable—always on
Driver-Assist Safety Systems			
Blind-spot Detection Systems	Cameras and radar for motion/ object detection	Intervention for lack of attention and/or experience; fatigue; panic/emergencies	Cannot disable-always on
Parking Assist	Servo-assisted feedback: steering; braking; audible alarms		Driver activates
Lane Departure Warning	Side cameras and radar		Cannot disable—always on
Attention Assist	Eye-motion sensors and software		Cannot disable—always on
Adaptive Cruise Control	Integration of camera/radar to current cruise control		Driver activates
Pre-Accident Assist	Active roll bars and /or head restraint		Passive system similar to airbag
Automatic Emergency Braking	Radar for obstacle detection, enhanced brake control module		Make/model specific

Auto Technology Challenges for Insurers and Accident Investigators

While driver-assist technology can improve crash statistics, no electronic innovation to date can completely eliminate the interaction of physics and human error. ABS certainly will prevent wheel skidding on icy roads, but the stopping distance could still be up to ten times that of dry-road conditions. Excessive vehicle speeds in turns can still be a causative factor in an accident even if the stability control system performs as designed to ameliorate the consequences of poor decision-making. At least for now, microprocessors have not wiped out the need for auto insurance coverage.

There is something else, though, to concern insurance carriers. For every technology that reduces driver error, there is another designed to extract the absolute maximum from vehicle performance. Revisit that vehicle showroom for the array of just-off-the-assembly-line models. There is a strong chance that the dealer has displayed "the safest car on the planet," loaded with driver assists and safety devices, next to a fire-breathing 400+HP performance car with street-legal racecar capabilities. The reality for insurers is that strict underwriting and premium pricing may be only partially successful when dealing with the flipside of adopting new technologies. Credits for driver-safety technologies balanced with surcharges for high-performance systems may be useful tactics for handling exposure risk.

Accident investigators are not untouched by auto technology's march, either. The classic speed-from-skids analysis does not work with enhanced braking systems like ABS, which leaves scant tire marks from emergency braking maneuvers. Engineers can still determine vehicle speed; they just use a different toolset. But even as the new technology alters investigation techniques, it also delivers new sources of crash evidence. More and more, accident data can be tapped from a vehicle's own diagnostic and sensing modules. There is also a greater wealth of resources beyond the vehicle, ranging from NHTSA-provided online crush and deformation data to computer-aided accident simulations and tools from the public domain like Google Street View—a clever enhancement to the mapping service that can deliver 360 degree street-level perspective.

As to the role of these advanced performance and safety features in accidents, well, that is a much more complex subject. Toyota's recent acceleration troubles may point to a software glitch, but that is still open to debate. The reality is that virtually every time a crash occurs despite having a system like ESC, an outside factor like a tire blowout is the cause, rather than a system failure. The fundamental issue at work here is that microprocessor-driven systems are designed to incrementally advance a driver's ability to cope with driving challenges. So if a claimant blames ESC for a crash, the chances are good that he was operating the vehicle at the limits of his driving ability. Just because new cars bestow NASCAR-like abilities does not mean we should drive the milk run like we are taking the curves at the Brickyard.

Peter R. Thom is principal of Peter R. Thom and Associates Inc., a national firm of consulting automotive engineers. Associate **Timothy A. Logsdon** is a 30-year power sports industry veteran. They may be reached at **(800) 874-1664**; **www.prtassoc.com**.