Vehicle Safety Features – Current and the Future

Dale O. Ritzel, Ph.D.
Director Emeritus, Safety Center
Southern Illinois University
Carbondale, IL 62901-6731
safety@siu.edu
Vehicle Safety Features to be Reviewed

- Anti-lock Brake System
- Brake Assist
- Electronic Stability Program
- Traction Control
- Smart Cruise Control
- Pre-crash sensing
- Crash Severity Sensing
- Occupant Detection Sensing
- Wheel Speed Sensors
- Rear Detection Systems
- Blind Spot Detection System
- Night Vision System
- Vehicle Side Alert
- Lane Departure Warning Tracking System
- Drowsy-Driver Detection and Warning System
Anti-lock Brake System

- The theory behind anti-lock brakes is simple. A skidding wheel (where the tire contact patch is sliding relative to the road) has less traction than a non-skidding wheel. If you have been stuck on ice, you know that if your wheels are spinning you have no traction. This is because the contact patch is sliding relative to the ice. By keeping the wheels from skidding while you slow down, anti-lock brakes benefit you in two ways: You'll stop faster, and you'll be able to steer while you stop.
Inside ABS

There are four main components to an ABS system:

- Speed sensors
- Pump
- Valves
- Controller
The anti-lock braking system needs some way of knowing when a wheel is about to lock up. The speed sensors, which are located at each wheel, or in some cases in the differential, provide this information.
Valves

- There is a valve in the brake line of each brake controlled by the ABS. On some systems, the valve has three positions:
  - In position one, the valve is open; pressure from the master cylinder is passed right through to the brake.
  - In position two, the valve blocks the line, isolating that brake from the master cylinder. This prevents the pressure from rising further should the driver push the brake pedal harder.
  - In position three, the valve releases some of the pressure from the brake.
Pump

Since the valve is able to release pressure from the brakes, there has to be some way to put that pressure back. That is what the pump does; when a valve reduces the pressure in a line, the pump is there to get the pressure back up.
The controller is a computer in the car. It watches the speed sensors and controls the valves.
Brake Assist

- Basically, a brake assist system monitors the driver’s use of the brake pedal, automatically sensing an attempt to stop the car as a result of panic.

- It then generates very high braking power, even when the driver is only pressing lightly on the brake pedal. When this is used together with anti-lock braking systems, it results in faster and safer braking.

- Depending on the driver, statistics for emergency stops in cars using this technology range from a 20% - 45% reduction in stopping distances, a potentially significant difference in critical situations.
Brake Assist

- Some road tests show that a driver needs up to 240 feet (73 meters) to stop a car going approximately 60 mph (100 km/h). In the same scenario, cars with brake assist were able to come to a complete stop in as little as 130 feet (40 meters).

- Since it only takes one-fifth of a second to travel a car length at highway speeds, the superior speed with which the brake assist is able to react also accounts for its improved safety results over traditional braking systems.
Brake Assist
Electronic Stability Control

- Electronic Stability Control (ESC) is the generic term for systems designed to improve a vehicle's handling, particularly at the limits where the driver might lose control of the vehicle.
- Robert Bosch GmbH were the first to deploy an ESC system, called Elektronisches Stabilitätsprogramm (ESP®) that was used by Mercedes-Benz.
- It was then introduced to the mass market by Continental Automotive Systems under the broader name of Electronic Stability Control, which is now the more common term recognized by the Society of Automotive Engineers, although individual motor manufactures use a range of different marketing names.
Electronic Stability Control

- ESC compares the driver’s intended direction in steering and braking inputs, to the vehicle's response, via lateral acceleration, rotation (yaw) and individual wheel speeds.
- ESC then brakes individual front or rear wheels and/or reduces excess engine power as needed to help correct understeer (plowing) or oversteer (fishtailing).
- ESC also integrates all-speed traction control, which senses drive-wheel slip under acceleration and individually brakes the slipping wheel or wheels, and/or reduces excess engine power, until control is regained.
- ESC cannot override a car's physical limits. If a driver pushes the possibilities of the car's chassis and ESC too far, ESC cannot prevent a crash. It is a tool to help the driver maintain control.
Electronic Stability Control

1. Hydraulic unit with attached ECU and pressure sensor
2. Wheel speed sensors
3. Steering angle sensor
4. Yaw rate and lateral acceleration sensor

Engine management with
5. ECU
6. Throttle actuator
7. Injection valves
8. Ignition module
9. Accelerator pedal sensor
Electronic Stability Control

- ESC combines anti-lock brakes, traction control and yaw control (yaw is spin around a vertical axis). To grasp how it works, think of steering a canoe. If you want the canoe to turn or rotate to the right, you plant the paddle in the water on the right to provide a braking moment on the right side. The canoe pivots or rotates to the right. ESC fundamentally does the same to assist the driver.
Electronic Stability Control

In understeer, the vehicle travels straight ahead despite steering efforts. The ESC gently brakes the inside rear wheel, assisting the vehicle to steer on its intended path.

In oversteer, the rear of the vehicle begins to breakaway (tishtail). The ESC gently brakes the outside front wheel to bring the rear of the vehicle back in line.
Vehicle manufacturers use electronic stability control systems under different marketing names:

- **Acura**: Vehicle Stability Assist (VSA)
- **Audi**: ESP - Electronic Stabilization Program
- **Buick**: StabiliTrak
- **BMW**: Dynamic Stability Control (DSC), including Dynamic Traction Control
- **Cadillac**: All-Speed Traction Control & StabiliTrak
- **Chevrolet**: StabiliTrak (except Corvette - Active Handling)
- **Chrysler**: Electronic Stability Program (ESP)
- **Dodge**: Electronic Stability Program (ESP)
- **Daimler Chrysler**: Electronic Stability Program (ESP)
Vehicle manufacturers use electronic stability control systems under different marketing names:

- **Fiat**: Electronic Stability Program (ESP)
- **Ferrari**: Controllo Stabilita (CST)
- **Ford**: AdvanceTrac and Interactive Vehicle Dynamics (IVD)
- **GM**: StabiliTrac
- **Hyundai**: Electronic Stability Program
- **Honda**: Electronic Stability Control (ESC) and Vehicle Stability Assist (VSA)
- **Infiniti**: Vehicle Dynamic Control (VDC)
- **Jaguar**: Dynamic Stability Control (DSC)
- **Jeep**: Electronic Stability Program (ESP)
- **Kia**: Electronic Stability Program (ESP)
- **Land Rover**: Dynamic Stability Control (DSC)
Vehicle manufacturers use electronic stability control systems under different marketing names:

- **Lexus**: Vehicle Stability Control (VSC) and Traction Control (TRAC) systems
- **Lincoln**: AdvanceTrak
- **Maserati**: Maserati Stability Program (MSP)
- **Mazda**: Dynamic Stability Control
- **Mercedes**: Electronic Stability Program (ESP)
- **Mercury**: AdvanceTrak
- **Mini Cooper**: Dynamic Stability Control
- **Mitsubishi**: Active Skid and Traction Control MULTIMODE
- **Nissan**: Vehicle Dynamic Control (VDC)
- **Oldsmobile**: Precision Control System (PCS)
- **Pontiac**: StabiliTrak
- **Porsche**: Porsche Stability Management (PSM)
Vehicle manufacturers use electronic stability control systems under different marketing names:

- **Renault**: Electronic Stability Program (ESP)
- **Rover**: Dynamic Stability Control (DSC)
- **Saab**: Electronic Stability Program
- **Saturn**: StabiliTrak
- **Seat**: Electronic Stability Program (ESP)
- **Skoda**: Electronic Stability Program (ESP)
- **Subaru**: Vehicle Dynamics Control Systems (VDCS)
- **Suzuki**: Vehicle Stability Control (VSC)
- **Toyota**: Vehicle Stability Control (VSC) and Vehicle Dynamics Integrated Management (VDIM)
- **Volvo**: Dynamic Stability and Traction Control (DSTC)
- **VW**: Electronic Stabilitization Program (ESP)
Traction control helps limit tire slip in acceleration on slippery surfaces. In the past, drivers had to feather the gas pedal to prevent the drive wheels from spinning wildly on slippery pavement. Many of today's vehicles employ electronic controls to limit power delivery for the driver, eliminating wheel slip and helping the driver accelerate under control.
Electronic Traction Control

- Enter electronic traction control. In modern vehicles, traction-control systems utilize the same wheel-speed sensors employed by the antilock braking system.
- These sensors measure differences in rotational speed to determine if the wheels that are receiving power have lost traction.
- When the traction-control system determines that one wheel is spinning more quickly than the others, it automatically "pumps" the brake to that wheel to reduce its speed and lessen wheel slip.
In most cases, individual wheel braking is enough to control wheel slip. However, some traction-control systems also reduce engine power to the slipping wheels.

On a few of these vehicles, drivers may sense pulsations of the gas pedal when the system is reducing engine power much like a brake pedal pulsates when the antilock braking system is working.
Traction Control
Smart Cruise Control

- Smart Cruise Control helps make cruise control usable even in congested traffic. With a concealed radar sensor behind your front bumper, the system automatically maintains a driver-set distance from the vehicle in front of you – even if it slows down.

- Smart Cruise Control can also warn you if traffic starts to slow down.

- Available on select Cadillacs and Jaguars.
Smart Cruise Control
Pre-Crash Sensing

- In a few tenths of a second before a crash, near-zone radar sensors are capable of identifying the relative speed towards an object and the estimated time of impact. The regular crash sensor is then put in alert mode and activates the appropriate safety device. The safety devices may include modules for vehicle control, adaptable interior or exterior structures, restraint systems or any combinations of these.
With Pre-Crash Sensing:
- Object tracking begins
- Object identified as a potential threat
- Alarm indicates threat
- Windows close
- Seats stiffen
- Seatbelts pre-tension
- ABS applied reducing speed
- Object impacts vehicle
- Airbag is triggered
- Airbag impacts occupant

No Pre-Crash Sensing:
- Object impacts vehicle
- Airbag triggered
- Airbag impacts occupant
The severity of a collision can be measured by the advanced crash sensing system, which is provided by sensors mounted on the front and sides of the vehicle. Crash sensing systems use radar, laser and/or ultrasonic sensors to detect potential impact situations. The sensing system is typically a single ECU to measure the severity of the impact, and provide deployment signals to the appropriate squibs.

Occupant sensing systems are required to discriminate the severity of the crash event in the first milliseconds of an impact. Occupant sensing and crash sensing together will control airbag deployment, releasing the airbag in what is termed a "multi-stage" deployment or suppression and provide less threatening airbag protection for infants and children.
Crash Severity Sensing
Occupant Detection Sensing

- designed to classify the occupant seated in the front passenger seat for potential airbag suppression. It consists of a pressure sensor, bladder assembly, belt tension sensor and an electronics control unit (ECU).
- The sensing system detects loading force on the front passenger seat and classifies the seat as empty or the occupant as an adult or infant/child. The ECU processes the sensor data and provides a deployment-allowed output to the vehicle’s sensing and diagnostic module when a defined threshold is met.
Occupant Detection Sensing

Benefits

- Helps reduce the potential for airbag-induced injury
  - Allows airbag suppression when seat is empty
  - Allows airbag suppression when occupant is below defined threshold
  - Allows airbag suppression for children as defined by the advanced airbag regulation FMVSS 208
  - Allows airbag deployment when 5th percentile female and larger adults are present
- Does not require driver action to suppress passenger airbag
- Integrated into the seat assembly
- Uses low-cost, proven automotive technologies
Wheel Speed Sensors

- Passive Wheel Speed Sensors
- Active Wheel Speed Sensors
Front Wheel Speed Sensor
Rear Detection Systems

- Two light beams detect when you are about to hit or back over something behind you. A warning sound goes off.
- Some systems have cameras for better detection.
The Blind Spot Detection system continuously monitors the rear blind spots on both sides of the vehicle. When a vehicle is present in either blind spot, for example an overtaking vehicle, the driver is alerted to this potential hazard by a visible icon displayed in the door rear view mirror. The system is expected to enhance road safety by reducing collisions with unseen vehicles during lane change maneuvers.
Blind Spot Detection System

Watch the traffic in your blind spot

- Blind Spot Detection system alerts drivers to the presence of vehicles in their rearward blind spots.

- Bumper mounted radar sensors detect all moving vehicles in the blind spots. The BSD system calculates the position, distance, and speed of these vehicles.

- When a vehicle is a potential danger, a symbol is displayed in the rear view mirror and a warning signal sounds to alert the driver.

- Oncoming vehicles are recognized but not reported.

- Characteristics:
  - High-resolution, highly accurate, Multi-Beam Radar (MBR) sensor.
  - Up to 60 meter range.
  - Programmable detection area.
  - Accurately detects vehicles in all road and weather conditions.
  - Intuitive driver system interface.
Night Vision System

- How it works - As the camera collects infrared energy (photons), that unit of energy hits a pixel in the apparatus. Like a television, the apparatus is comprised of many pixels. When the photon hits a pixel, it changes the temperature of that pixel and its capacitance. The camera integrates a read-out of all the capacitors and projects an image on a display in the driver’s windshield. In order to function, the device must stay within a very narrow temperature range.
Night Vision System

- Night Vision helps the driver detect objects long before the car’s headlights would illuminate them.

- Night Vision allows the driver to see well beyond the reach of the car's headlights. This technology helps drivers detect and avoid potentially dangerous situations.
Vehicle Side Alert

- Side Alert is designed to help drivers be aware of vehicles in their side blind spots when changing lanes and making turns. A cost-effective safety enhancement for light-duty vehicles, passive infrared sensors integrated into mirrors, taillights or side fascia measure adjacent lane temperature over time to detect vehicles entering the side blind spot. If a vehicle is detected in the blind spot, Side Alert can help drivers avoid a lane change accident by providing a visual indication in the mirrors. When the turn signal is activated to signal a lane change, the driver also receives an audible alert.
Lane Departure Warning Tracking System

- Departure Warning system is a lane tracking system that helps alert drivers when they unintentionally drift out of their intended lane. Using a camera and image processing to detect painted lane markers up to 25 meters ahead of the equipped vehicle, the system determines the vehicle’s heading and lateral position in the lane to provide the appropriate warning.
Drowsy-Driver Detection and Warning System

- Drowsy driver alert monitors the driver’s gaze and head position to assess visual distraction.
- The drowsy driver warning system uses low-level infrared signals (which are not visible) to monitor eye closure.
- Driver distraction alert assesses the driver’s drowsiness level and can apply stimuli to help alert the driver of the situation.
Assignment

- After reading and reviewing the information contained on previous 43 slides and other readings, write a 1-2 page paper on the future automobile, including would you believe will be the important safety features and other devices that will provide safe vehicle for all drivers. Also address the one factor that will still have problems on the highway.