High-Tech Motor Vehicle Safety Systems

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Abstract

Sophisticated electronic sensing and control systems are increasingly being integrated into the motor vehicle fleet to provide drivers with advanced occupant protection and collision avoidance mechanisms. There is currently no single source of information for the Canadian motoring public to obtain information on the operation and benefits of such new vehicle safety technologies. A project to develop a series of linked web pages outlining the major features of high-tech motor vehicle safety systems, in simple terms that will be readily assimilated by the general public, has been undertaken on behalf of the Canadian Association of Road Safety Professionals. The major concepts and functions of the systems described are illustrated by appropriate diagrams and/or photographs. Links are provided to additional technical information, performance evaluations, and external web sites providing supplementary data. The project includes advanced occupant restraints (seat belt pretensioners, load limiters, advanced frontal air bags, side air bags and head curtains), active head restraints, anti-lock braking systems, brake assist, traction control systems, electronic stability control systems, event data recorders, night vision systems, adaptive cruise control, blind spot detection and backup warning systems. The readily-accessible web pages provide useful information to the vehicle-buying public and will assist individuals to make informed choices for safety features that may only be available in certain makes and models and/or as optional equipment.

Résumé

Les systèmes perfectionnés de détection et de contrôle électronique sont de plus en plus intégrés au parc automobile afin d'offrir aux conducteurs une protection des occupants et des mécanismes de prévention des collisions évolués. Il n'y a actuellement aucune source unique d'information pour les automobilistes canadiens sur l'utilisation et les avantages de telles technologies en matière de sécurité des véhicules. Au nom de l'Association canadienne des professionnels de la sécurité routière, un projet a été entrepris afin d'élaborer une série de pages web reliées soulignant les caractéristiques importantes des systèmes perfectionnés de sécurité des véhicules automobiles en des termes simples pouvant être compris par l'ensemble de la population. Les fonctions et les concepts principaux des systèmes décrits sont illustrés par des figures ou des photographies appropriées. Des liens sont fournis donnant accès à des renseignements techniques additionnels, à des évaluations de rendement et à des sites Web externes fournissant des données supplémentaires. Le projet comprend des systèmes évolués de retenue des occupants (prétendeurs de ceinture de sécurité, limiteurs de charge, coussins

gonflables frontaux évolués, coussins gonflables latéraux et rideaux gonflables de pavillon), des appuis-tête efficaces, des systèmes de freinage antiblocage, une assistance au freinage d'urgence, des systèmes d'antipatinage à l'accélération, des systèmes de contrôle électronique de stabilité, des enregistreurs de données de conduite, des systèmes de vision nocturne, un régulateur de vitesse intelligent, un détecteur d'angle mort et des avertisseurs sonores de recul. Les pages Web facilement accessibles fournissent des renseignements utiles aux acquéreurs de véhicules et aideront le public à faire des choix éclairés concernant les dispositifs de sécurité qui pourraient être disponibles seulement sur certains modèles et certaines marques ou encore comme options.

INTRODUCTION

As progress continues in the world of automotive technology, especially in terms of on-board electronic systems, many advanced safety systems are coming to market. Some of the new devices affect vehicle crashworthiness, for example offering greater occupant protection through improvements to seat belts and air bags. However, most of the innovation is taking place in the area of collision avoidance. Manufacturers are installing devices designed to help drivers prevent collisions. Examples would include anti-lock braking systems (ABS) and electronic stability control (ESC). Where collisions are not avoided, some systems, such as brake assist, will help at least mitigate the crash severity.

The pace of such technological improvements is very rapid; however, details of the function of the new safety technologies, and information promoting their potential benefits, are reaching consumers much more slowly. For example, research into the effectiveness of electronic stability control has shown that these systems are highly effective in reducing single-vehicle crashes. [1] In particular, reductions in fatal, single-vehicle crashes have been estimated as 30-50% for cars and 50-70% for sport utility vehicles, with fatal rollover crashes about 70-90% lower with ESC regardless of vehicle type. However, despite these enormous, potential safety benefits, a recent Canadian study found that there is a general lack of awareness about the technology among road users. Sixty percent of drivers had never heard of ESC, and less than 5% had vehicles with ESC. [2]

The lack of public awareness of road and motor vehicle safety issues in general, and knowledge of new vehicle safety systems in particular, is of considerable concern. If consumers are not aware of the benefits of these potentially life-saving technologies, they will not be in a position to seek out vehicles which are so equipped, demand that manufacturers provide these systems as standard equipment, nor will they be able to make an informed decision on the purchase of such safety systems where these are offered only as optional equipment.

This paper describes an initiative to help improve public knowledge of motor vehicle safety features, with an emphasis on high-tech systems, through the development of a series of web pages describing specific devices. The completed pages are posted on the web site of the Canadian Association of Road Safety Professionals where they provide a single source of information on the technologies. [3] The major concepts and functions of each safety feature are described in simple terms, and illustrated by appropriate diagrams and photographs. Links are provided to a number of external web sites providing additional technical information, performance evaluations, and supplementary data.

WEB PAGE FORMAT

The web pages relating to the series of high-tech motor vehicle safety systems are anchored by a main page that serves to introduce the suite of documents and provides an interactive menu to the individual pages.

Each topic has a brief blurb describing the nature of the specific safety feature, together with an associated graphic. Clicking on either the title of one of the safety features, which appears in the form of a hyperlink, or on the accompanying graphic, takes the user to the specified sub-page.

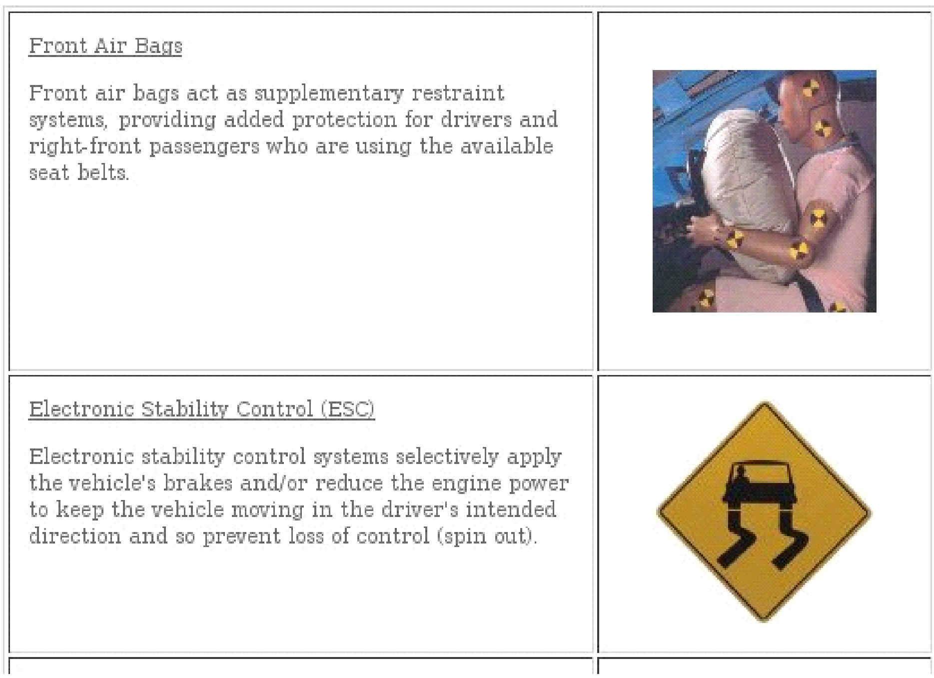

Figure 1 - Extract from the menu system on the anchor page

The information relating to each safety system is laid out in a standard manner. The main body of the page is broken into a number of sections, while a side bar provides a synopsis of important details.

An initial paragraph introduces the nature of the specific device and outlines its safety purpose. Basically, the subsequent sections are structured as follows:

- How does it work? - provides a lay person's description of the technology, its functionality, and any special issues that are associated with the device (e.g. the “smoke” resulting from air bag deployment that may incorrectly be assumed to be related to the vehicle being on fire)

- Are there any risks? - indicates any special precautions that may need to be taken to maximize the benefits of the technology and avoid any unintended consequences (e.g. sitting somewhat distant from an air bag module in order to avoid inflation-related injury.)

- What can science tell us? - provides a synopsis of a number of scientific publications relevant to the safety issue, and gives links to the original material.
- Useful links? - provides addresses for a number of web pages related to the technology that have been developed by manufacturers, government departments, and safety organizations.

High-Tech Vehicle Safety Systems - Front Air Bags

Front air bags

Front air bags, for the driver and right-front passenger, mainly provide protection against head contact with the steering wheel and dashboard. They are designed as supplementary restraint systems (SRS), meaning that the protection they provide is in addition to that offered by the use of a regular lap-and-shoulder seat belt.

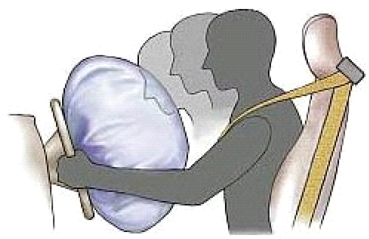

Image courtesy of Technology Associates

How do they work?

Air bags are computer controlled. Sensors monitor the vehicle's deceleration and determine when a collision is occurring. If the crash is of sufficient severity, the computer commands the air bags to deploy. All this happens very quickly - typically in just a few hundredths of a second - faster than the blink of an eye! The air bag firing circuit is activated, the chemical propellent ignited, and the gas generated inflates the fabric of the air bag. This creates a cushion, spreading the forces of collision and allowing the occupant to avoid any hard contacts with portions of the vehicle's interior.

The first generation of air bags followed this relatively simple deployment strategy. There is a collision severity, the deployment threshold, below which the air bags will not fire. The seat belt system provides adequate protection in such minor crashes. The vehicle's computer uses multiple criteria to judge if air bag deployment is required, thus it is not possible to give a single collision speed below which the air bags will not fire.

Quick Facts

- Always wear your seat belt; air bags only provide additional protection!
- Sit as far back from the air bag as you can. Let the bag inflate and do its job!
- Never install an infant carrier in the right-front seat
- Children aged 12 and under should be in the rear seat away from air bags
- Check the

Figure 2 - Extract from a sample web page

In some cases the above-noted material is supplemented by special sections in order to reinforce important information. One such example, in the case of frontal air bags, is a section on the special risks imposed on young children by passenger-side air bags.

The side bar ("Quick Facts") provides a mechanism for rapid review of various important aspects of the safety device, its appropriate use, and any specific risks that should be avoided.

SAFETY TECHNOLOGIES

A range of safety features has been selected for the initial series of web pages, reflecting a mix of both vehicle crashworthiness and collision avoidance systems. Many of these systems are available on current vehicle models, either as standard equipment or offered as extra-cost options. Some safety features are not widely available in the present vehicle fleet. Rather, these are limited to being installed only on the most expensive vehicles in manufacturers' lines. However, it is anticipated that as the technologies are further developed, manufacturing costs reduced, and the safety benefits of the systems are realized, public demand will increase, and more of these systems will trickle down into lower-priced vehicle models.

Descriptions of the technologies to be included in the present series of web pages are provided below. At the time of writing, material on front air bags and electronic stability control has been posted to CARSP's web site. Pages for the other safety features planned for the series remain under development and only brief descriptions of these systems are included in the present work.

CRASH PROTECTION TECHNOLOGIES

The following systems are designed to provide motor vehicle occupants with some level of protection against injury in the event of a collision.

Front Air Bags

The essential nature of front air bags is as a supplement to the protection offered by seat belt systems. In the event of a primarily frontal impact, the devices provide inflatable cushions for the driver and right-front passenger to prevent head and chest contact with the vehicle's front interior.

Electronic sensing and control systems identify the onset of a collision, determine if the crash parameters warrant air bag deployment, and activate the firing system as necessary. A chemical propellant is ignited and the gas that is generated results in rapid inflation of the air bag.

Motorists are frequently not aware that the deployment algorithm requires a collision severity above a certain threshold before a firing command is issued. They are also generally unaware that the sensing systems are effectively unidirectional and respond primarily to longitudinal vehicle deceleration. Consequently, drivers may hold the mistaken belief that the system is defective if their vehicle's air bags do not deploy in any collision event. In addition, it is possible for only one air bag to deploy as a result of a collision. This may be a function of the specific collision environment, or it may be that the vehicle is equipped with only a driver's air bag!

When an air bag does deploy, motorists are generally not aware of the rapid nature of the deployment, nor the fact that the air bag venting system causes subsequent deflation of the cushion, and may once again complain of a system malfunction. A very common misconception results from the cloud of powder that appears like “smoke” following deployment. Many vehicle occupants believe that the vehicle has caught fire as a result of the crash, whereas what they are in fact witnessing is the dispersal of a material, such as talcum powder, that is used to lubricate the folds of the bag fabric in order to ensure smooth deployment.

Because of the rapid inflation of the air bag, there are risks of occupant injury in the punch-out phase, as the bag's fabric breaks through the module cover, and in a membrane-loading situation, if the expanding fabric, comes into contact with an occupant in too close proximity to the air bag module. It is for these reasons that most safety organizations recommend that front-seat occupants sit back at least 25 cm from the air bag module, and that children aged 12 and under are located in the rear seat. A critical concern in the latter regard is that infants in rear-facing child restraints not occupy the right-front seat since the design of the child restraint necessarily would place the child's head adjacent to the passenger's air bag module.

Canadian research on air bag systems is used to reinforce the technical details of air bag systems, their deployment strategies, and real-world collision performance. [4, 5, 6] Similarly, a paper on the risks of occupant injury, with an emphasis on low-severity, air bag induced fatalities, is used to underscore the need to take appropriate care with air bags. [7] The latter paper also documents Canada's role in expediting advanced air bag designs to help optimize these systems for fully-restrained occupants and reduce the possibility of air bag induced injury.

Links to associated material include pages on the web sites of Transport Canada, the National Highway Traffic Safety Administration (NHTSA), the Insurance Institute for Highway Safety (IIHS) and CARSP.

The “quick facts” about front air bags relate primarily to the precautions that vehicle occupants should take to avoid air bag induced injury. These include the need to use the available seat belt, sit back from the air bag module, and to properly restrain children in the rear seat. When additional material becomes available in the planned series of web pages, the side bar will include links to associated technologies such as advanced air bag systems, side air bags and head curtains.

Advanced Front Air Bags

Advanced front air bags are designed to meet the needs of different occupants in a variety of crash situations. Depending on their design, these systems automatically determine if and with what level of power the driver's front air bag and the passenger's front air bag will inflate. The appropriate level of power is based upon a variety of sensor inputs that can typically detect occupant size, seat position, seat belt use and crash severity. Advanced front air bags were designed primarily to minimize the risk of an air bag-related injury to children and small-stature adults. In crashes where a higher-powered air bag deployment would not be necessary and/or could cause injury, the system reduces the risk by either suppressing the front air bag, or deploying the bag with less inflation force. [8]

Seat Belt Load Limiters

Most late model vehicle seat belts are fitted with load limiting systems that restrict the force acting on the occupant. The load limiter works in tandem with occupant safety technologies such as seatbelt pretensioners and air bags. Once a pre-set limit is reached, the seat belt webbing begins to slowly release or “pay-out”, allowing the occupant to move forward into the airbag. Normally the load limit is approximately 3 to 4 kN, although it may be as high as 6 kN. Some advanced systems may decrease the load limit as the webbing is released or utilize multiple load limits depending on crash severity, occupant mass and position.

The simplest load limiter is a fold sewn into the belt webbing. The stitching is designed to break when a certain amount of force is applied to the belt. As the stitching tears away, the webbing unfolds allowing the belt to extend. Another common system has the seat belt retractor mounted at the bottom end of a vertical rail. The retractor is able to slide up the rail, by deforming a set of teeth, once the belt load reaches a certain threshold. In both of these systems, the maximum extension of the seatbelt is restricted to approximately 15 cm.

More advanced load limiters rely on a torsion bar in the retractor mechanism that twists when enough force is applied to it. The torsion bar is secured to the locking mechanism on one end, and to the rotating spool on the other. When the force applied to the webbing exceeds a pre-set limit, the torsion bar will begin to twist allowing the webbing to extend. Maximum extension is usually restricted to approximately 15 cm although, on some systems, the seat belt may continue to pay-out as long as the load is above the threshold.

Research has shown that in frontal impacts load limiters can significantly reduce chest acceleration and chest deflection particularly for right front passengers. [9, 10] Benefits of load limiters include the potential for increased ride-down, limiting of concentrated shoulder belt loads and better load management with the force-distributing front air bag. However, reducing the belt load in this manner increases occupant excursion distance. This raises the risk of contact with the steering wheel and other components especially if there is intrusion or non-deployment of the front air bag. Decreased occupant restraint during rebound and in secondary impacts is an added concern.

Seat Belt Pretensioners

Pyrotechnic seat belt pretensioners help develop proper seat belt fitment and manage occupant energy in a crash by removing seat belt slack. Pretensioners can be integrated into the buckle or retractor and take up as much as 15 cm of torso or lap belt slack. Activation of the pretensioner either pulls down on the buckle side of the seatbelt mechanism, or tightens up the spool side of the mechanism, thus reeling in some length of the seatbelt webbing. Keeping a front seat occupant from moving forward relative to the vehicle interior is crucial to minimizing injury when the air bag deploys. [11]

Seatbelt pretensioners typically use the same sensor system as the vehicle’s airbag to detect a rapid deceleration caused by a collision. A means of mechanically locking the webbing to maintain belt tightness is usually also employed. It takes approximately 10 to 20 milliseconds for a pretensioner to activate once a deployment event is determined. If deployment is commanded relatively late in the crash sequence, such that the belt is already under significant occupant load prior to pretensioning, there is a chance of injury. Some high end vehicles may also have a motorized reversible pretensioning feature in addition to the pyrotechnic pretensioner. The motor on the reversible pretensioner activates when critical situations such as panic braking are recognized.

Side Airbags

Side air bags [12, 13, 14] are designed to deploy in the event of a serious near side impact. Torso side airbags are mounted in the side of the seat, or in the door, and help protect the occupant's chest. Head and torso combination side airbags are usually mounted in the side of the seat. They are typically larger than the torso side airbag, with an extra lobe to provide head protection. Sensors determine whether a crash is severe enough to warrant deployment of the side airbag.

According to the Insurance Institute for Highway Safety, side airbags that protect people's heads are reducing driver deaths in cars struck on the near (driver) side by an estimated 37 percent. Airbags that protect the chest and abdomen, but not the head, are reducing deaths by 26 percent. However, Transport Canada has found that children who are leaning against a side air bag when it inflates are at risk of serious injury. [15] Manufacturers have agreed to design future side air bags to meet the requirements of test protocols recommended by the Side Air Bag Out-of-Position Injury Technical Working Group.

Side airbags are not currently required to be fitted in Canadian vehicles. Proposed upgrades to the federal standard for side impact protection establish performance requirements, but do not mandate particular technologies. Manufacturers are likely to comply with this regulation through the installation of side airbag systems.

Side Curtain Airbags

Side curtain airbags are designed to help protect an occupant's head in a side-impact. In some vehicles, the curtain air bags will deploy in rollover crashes, and provide protection against occupant ejection. The curtain air bag deploys along the side glass and often remains inflated for 6 to 10 seconds. The curtain is usually a one-piece air bag approximately 2 m long and 30 to 40 cm tall; however, some vehicles feature segmented curtain air bags. The air bag is typically anchored at the front and rear pillars of the vehicle and folded into a flat roll, under the headliner, along the roof side rail. The side curtain airbag may extend into the rear compartment and thus helps protect both front and rear occupants in a side-impact. [16, 17]

Side airbags can provide significant safety benefits to adults in lateral impacts. NHTSA estimates that if all the vehicles on U.S. roads were equipped with systems offering head protection, 700 to 1,000 lives would be saved per year in such crashes. There has not been any indication of risks to children from current roof-mounted head curtains.

Active Head Restraints

Head restraints are designed to restrict head movement during a rear-impact and reduce the chance of neck injury. Active head restraints deploy automatically in the event of a rear-end collision. The seatback is incorporated into this system, creating a mechanism that cradles the head and torso.

Saab's Active Head Restraint is based on the lever principle. A padded head restraint is linked to a pressure plate inside the seatback. When a rear-end collision causes the torso to make impact with the seatback, force is exerted on the plate. This moves the head restraint up and forward, enabling it to catch the occupant's head before the motion that induces whiplash has a chance to begin.

Additionally, the seatbacks themselves feature crossbars and padding designed to absorb crash energy, and cradle an occupant's torso, reducing differential movement between the head and torso. [18, 19]

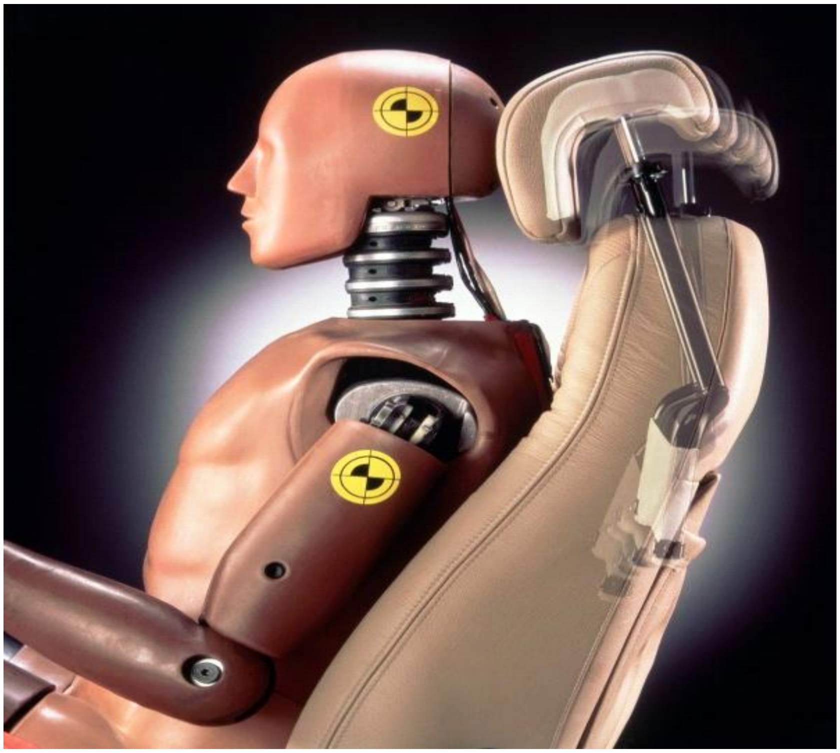

Figure 3 – SAAB Active Head Restraint

COLLISION AVOIDANCE TECHNOLOGIES

While improving vehicle crashworthiness will lead to a reduction of transportation-related deaths and injuries, another important strategy is to reduce the incidence of collisions or at least to mitigate their severity. A range of advanced technological solutions is now available that is aimed at making this goal a reality.

Electronic Stability Control

An electronic stability control (ESC) system selectively applies the vehicle's brakes and/or reduces the engine power to keep the vehicle moving in the desired direction and prevent loss of control. ESC attempts to compensate for inappropriate steering actions by the driver (oversteer), and reduced traction causing the vehicle to plow ahead rather than turning as the driver intends (understeer). The system assists the driver to maintain directional control and thus helps prevent the vehicle running of the road into the ditch, rolling over, or travelling across the roadway centreline into the path of oncoming vehicles. The intent is to avoid these and other similar undesirable situations that can potentially result in a collision and consequent occupant injury.

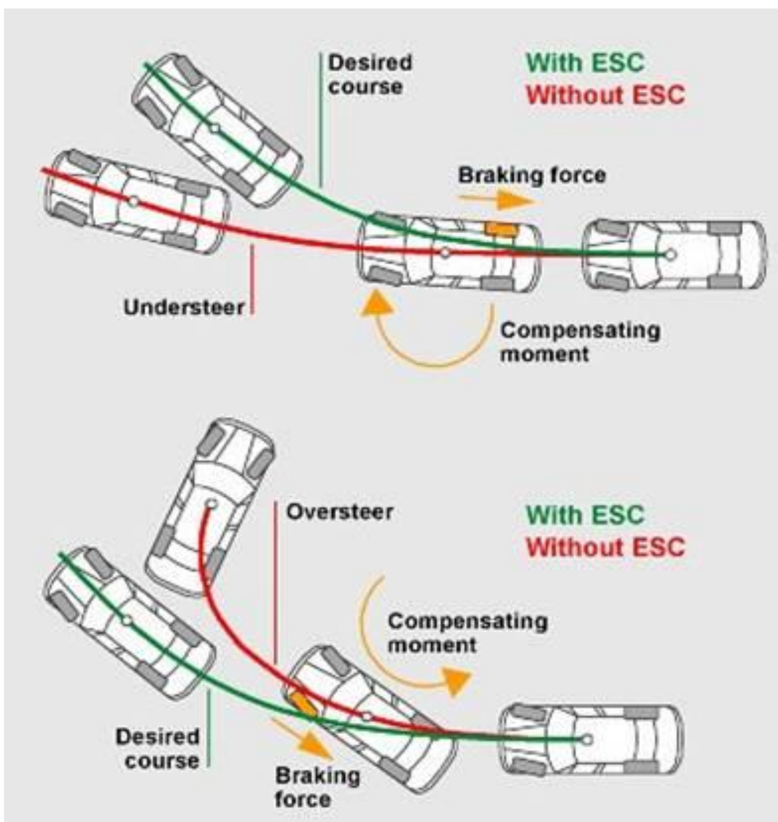

Figure 4 - Operation of an electronic stability control system
(Figure courtesy of Continental Teves)

Many modern vehicles are equipped with anti-lock brakes. These systems have sensors that monitor wheel rotation and determine if a particular wheel is going to lock up. Valves in the braking system then reduce the braking pressure on the wheel in question, preventing wheel lockup, and providing optimal braking. ESC makes use of the same technology, with some additional sensing and control systems, but actually applies the brakes on one of the vehicle's wheels in order to counteract any tendency for the vehicle to spin out of control.

A range of vehicle sensors monitor steering inputs, throttle and brake application, the vehicle's lateral acceleration, rotation, and the individual wheel speeds. An on-board microprocessor integrates all of the data and determines if the vehicle is not going to travel in the direction intended by the driver. In this case, the system will apply the brake on one of the wheels and/or reduce engine power as needed to help correct understeer or oversteer.

The concept of applying a single brake to develop a restoring moment and thus counteract vehicle rotation is somewhat difficult for the lay person to grasp. Consequently, a physical analogy, involving controlling the rotation of a large rectangular block by pulling on a rope tied to one corner of the block, is used to supplement the pictorial representation of ESC operation as shown in Figure 4.

It is important to note that ESC is an assistive technology. In particular, it cannot improve on the available traction for the vehicle's tires and the prevailing road surface condition, nor can it change the laws of physics. If a driver tries to drive too fast around a curve in the road, or steers too violently, ESC cannot prevent loss of control and a possible crash. Drivers, therefore, have to be aware that the consequences of pushing the limits of the system may well be a collision occurring at higher speed, with increased crash severity, and a risk of greater injury.

While ESC is a relatively new technology, and has become fairly widely available only in recent years, researchers have recognized the system's potential for avoiding a number of collision situations. As noted earlier, ESC has proven to be extremely effective in reducing the incidence of single-vehicle crashes [1]. However, as also noted previously, the nature of the technology and its operation is not well understood by the general public. One difficulty in this regard is that ESC is a generic term for the technology. There is no standardization across the automotive industry and, in fact, different manufacturers use a wide range of proprietary names for essentially similar systems.

The web page that has now been developed is intended to help increase public awareness and knowledge on this topic. The associated links provided include background information on some of the terminology and basic concepts, promotional material from both Canadian and international safety agencies. Of particular utility for underscoring the system's performance, are links to video footage of testing of vehicles equipped with ESC, with the system both activated and deactivated. These graphically demonstrate the potential for the system to avoid a driver losing control.

The “quick facts” column provides a brief summary of the operating methodology of an ESC system, the effectiveness and limitations of the system, an indication that the system may be called by different names by different manufacturers, and that there is currently no requirement for the installation of ESC in new vehicles.

Anti-lock Braking Systems (ABS)

Few drivers are able to optimize the force they apply on the brake pedal, especially in an emergency situation or when encountering an unexpectedly slippery surface. If excessive pedal effort causes wheel lockup, the vehicle can yaw out of the driver's control (rear-wheel lockup), or go straight ahead, being impossible to steer (front-wheel lockup). Anti-lock braking systems (ABS) avoid skidding while braking and help the driver maintain steering ability in order to avoid obstacles.

ABS uses wheel speed sensors to determine if one or more wheels are approaching a locked condition during braking. If a wheel starts to lock, the brake force is reduced so that the wheel continues to rotate. The driver can then brake and steer at the same time. The braking and steering ability of the vehicle is limited by the amount of traction the tire can generate on the road surface. During ABS operation, a pulsation can be felt in the brake pedal, accompanied by a fall and then rise in brake pedal height and a clicking sound.

ABS in most late model vehicles works on all four wheels which increases directional stability and allows steering under maximum braking. ABS in many pick-up trucks works only on the rear wheels and thus the front wheels may still lock under hard braking. Vehicles with ABS do not necessarily stop in a shorter distance than vehicles without ABS. ABS may shorten stopping distances on dry or wet roads; however, on very soft surfaces, such as gravel or loose snow, ABS may actually lengthen stopping distances. [20]

Brake Assist

Brake Assist (BA) is a technology that ensures that the maximum pressure is applied by the brakes to stop a vehicle in an emergency situation. [21] Some manufacturers refer to the system as Emergency Brake Assist.

Brake Assist detects how quickly the driver is depressing the brake pedal to judge whether an emergency-braking manoeuvre is intended. If the system concludes that the situation is an emergency, but the pedal isn’t being depressed fully, it increases the hydraulic pressure in the braking system, to make up the gap, and develop maximum braking effort. While the system will not reduce the stopping distance of the car, it will make sure that the car is stopped in the shortest distance possible by compensating for any driver hesitancy in applying the brakes hard in an emergency situation. Some systems use adaptive learning to respond to individual driver's braking habits.

Traction Control Systems

Traction control is an enhancement of ABS that prevents wheel spin when accelerating on wet or slick surfaces. It uses the same sensors to monitor wheel speed during acceleration and detects if a drive wheel starts to spin. The traction control system then brakes the wheel to shift torque to the opposite drive wheel that still has traction. Most traction control systems only operate at speeds up to about 50 km/h. Additional control strategies include reducing the throttle, upshifting the transmission, retarding spark timing and deactivating fuel injectors. [22]

Event Data Recorders

Event data recorders are installed on many late model cars and light trucks as an adjunct to air bag sensing and control systems. EDR's can capture certain information relating to both the pre-crash and crash phases of motor vehicle collisions. These systems can be interrogated by means of a Crash Data Retrieval (CDR) tool allowing the stored data to be retrieved, analyzed and reported. When pre-crash data are available, this information typically consists of the vehicle's speed (mph), engine speed (rpm), throttle position (%), and the status of the brake light switch (on or off) for a period of five seconds prior to the event that triggered the recording. In addition, the EDR indicates the status of the driver's seat belt buckle switch (buckled or unbuckled) at the time of the event. [23]

Automakers perform thousands of safety tests on their vehicles each year, and the government and groups like the Insurance Institute for Highway Safety (IIHS) also perform crash tests that provide invaluable insights into vehicle crashworthiness. EDR's provide additional data on real-world collisions and enhance auto safety by providing a better understanding of crash events and injuries. The data stored in EDR's often provide vital information relating to air bag systems, such as firing times, and the nature of dual stage deployments, which are unavailable from any other source. Consequently these data are critical in evaluating system performance. As vehicle-based collision avoidance measures become both more common and more complex, there is an increasing need for high quality pre-crash data to aid in system evaluation and development.

Increased knowledge of crash type, severity, and restraint use can help trauma centres treat crash victims quicker and better. Not all injuries are readily identified and information on crash forces can alert medical professionals to the potential for internal injuries typical of a given crash pattern. When coupled with Automatic Crash Notification (ACN) systems, EDR data can help prioritize emergency response. EDR data can guide emergency dispatchers to send the most appropriate personnel and equipment to a crash site. Getting paramedics to crash sites sooner will save lives.

Vision Systems

Many serious collisions occur as a result of limited vision. Blind Spot Detection technology alerts drivers to potential risks presented by objects in their blind spot. Sensors on each side of the vehicle continuously scan the adjacent lane of traffic from the rear view mirror to one or more car lengths behind the rear bumper. Drivers are notified of potential risks by a lighted icon warning light in the outside rear-view mirror.

Night vision systems (NVS) have the potential to improve the visibility of objects in the dark, beyond the levels achievable with low-beam headlamps. These systems extend a driver's ability to see without increasing glare to other road users. This is accomplished by rendering portions of the invisible infrared spectrum of the forward scene into a visible image on an in-vehicle display.

The two forms of night vision enhancement technologies on vehicles are the near infrared (NIR) or active night vision, and the far infrared (FIR) or passive night vision. Active systems rely on an infrared light source to provide sufficient illumination, while passive systems amplify the existing environmental ambient lighting. The passive FIR systems display infrared spectra radiated by warm objects in the forward scene.

Proximity-based parking aid systems help the driver determine how close the vehicle's bumpers are to nearby objects. These typically operate within a limited range (e.g., within 1.5 m of the vehicle) during low-speed (e.g. <5 km/h) parking/backing conditions. In contrast, back-up warning systems are intended to alert drivers to the presence of unexpected or unseen objects behind their vehicles during backup manoeuvres. The systems typically use radar sensors to detect the presence of objects behind the vehicle and warning lights and sounds to notify the driver.

Adaptive Cruise Control

Adaptive cruise control (ACC) is similar to conventional cruise control in that it maintains the vehicle's pre-set speed. [24] However, unlike conventional cruise control, ACC can automatically adjust speed in order to maintain a set distance between vehicles in the same lane. A long range radar sensor is used to detect a target vehicle up to 200 m ahead and automatically adjusts the vehicle speed and headway accordingly.

Forward-looking radar, installed behind the grill of a vehicle, sends information to a digital signal processor, which translates the speed and distance information for a longitudinal controller. If the lead vehicle slows down, the system sends a signal to the engine or braking system to decelerate. Subsequently, when this road ahead is clear, the system will accelerate the vehicle back to the set speed while maintaining the proper headway. The driver can override the system at any time.

DISCUSSION AND CONCLUSIONS

Motor vehicle manufacturers put a lot of effort into researching, developing, and bringing new technologies to market; however, they do not always place the same level of emphasis on providing pertinent information on these systems to the purchasers of their products. Some safety information is provided in owners' manuals, and frequently this is well documented with good illustrations. But, the material is often accompanied by a vast amount of warnings, written by the company's legal department, and causing the reader's eyes to glaze over! Furthermore, purchasers do not generally refer to an owner's manual when considering which vehicle to buy (nor do most make much reference to this document after the fact!) Rather, buyers pore over glossy brochures that feature appealing images of the vehicle exterior and interior trim, but which generally pay scant attention to the details of safety features.

The widespread availability of access to the Internet, and its underlying hyper-text system, provides an excellent source of vehicle safety information to modern-day vehicle purchasers. Material can be garnered from a wide variety of sources on any given topic, and the indexing capabilities of the web's search engines generally make it simple to locate the information of interest.

The present work seeks to take advantage of these features of the Internet, and the credibility of CARSP's web site as an instrument of an independent association of road safety professionals, to disseminate a wide range of authoritative information on advanced motor vehicle safety systems. The intention is to provide basic details of these systems, with links to approved external sites that complement the specific features being described. A further advantage of using a web-based system is that the posted material can be readily expanded or updated as new or revised information becomes available.

The provision of this material will assist individuals to make informed choices for safety features that may only be available in certain makes and models and/or as optional equipment, and perhaps to demand further safety improvements from vehicle manufacturers and regulators.

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