ESC AS A BASELINE FOR ACTIVE SAFETY

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ABSTRACT

Electronic Stability Control (ESC) systems were first introduced in the mid 1990's. This technology is proving itself by preventing crashes and saving lives each day. Several studies from Europe and Japan have shown significant reductions in serious crashes and fatalities when vehicles are equipped with ESC. Results of recent studies in the U.S. now confirm these gains also apply on the U. S. highways.

Now that ESC is in place on many vehicles, this technology has become a baseline for expansion of Active Safety functions to further reduce crashes. These systems add sensors and actuators to ESC to anticipate crashes and integrate other vehicle safety systems to further protect the vehicle occupants. This Active – Passive Integration Approach will enter the market in the next few years and promises another major step in reducing traffic crashes and the tragedies that result.

INTRODUCTION

Traditional vehicle safety systems have largely been passive and focused on occupant protection. Smart Automobiles will work proactively to help avoid potentially fatal vehicle crashes from occurring. The future belongs to innovative driver-assistance technology. These systems will impact active vehicle safety and make our highways safer. Helping to drive this shift is the leveling-off of safety gains over the last decade.

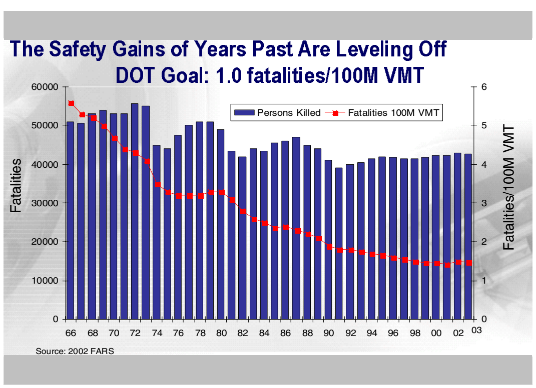

Figure 1

Overall, the number of crashes in the U.S. has remained relatively unchanged over the past two decades, at just over 6 million per year according to NHTSA data. With accident metrics at a plateau, the time is right for new, technology-based systems to enter the market with new solutions to old problems. Using ESC as a base, Continental is adding ever-smarter systems and capability to vehicles, eventually leading to a "Total Safety System."

Tomorrow's automobile will have "anticipatory" qualities that enable it to provide operating recommendations and active support to the driver. It will do this by monitoring the ambient traffic situation, and recognizing upcoming circumstances that require responsive action, and where desired, taking that action. This revolution is being made possible by the great leaps in microelectronics capability and functionality – accompanied by the decline in prices of semiconductor technology. Consequently, automotive applications have been expanding in great technological leaps.

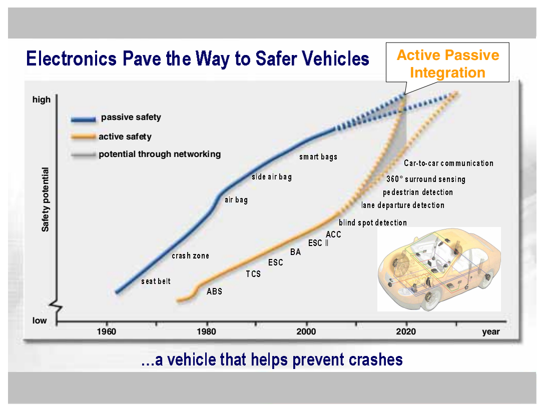

Figure 2

Figure 2 shows the progress of both passive safety systems such as seat belts and air bags, and active systems such as ABS, ESC and ACC.

DISCUSSION

Electronic Stability Control

Electronic Stability Control systems were first introduced by Mercedes in the mid 1990's. Since that time, ESC applications in Europe have increased to some 35 percent of new cars sold. In Japan, the application rate is about 15 percent. In the US, the adoption of this safety technology has been much slower, with 10 percent of new cars sold in 2004 equipped with ESC.

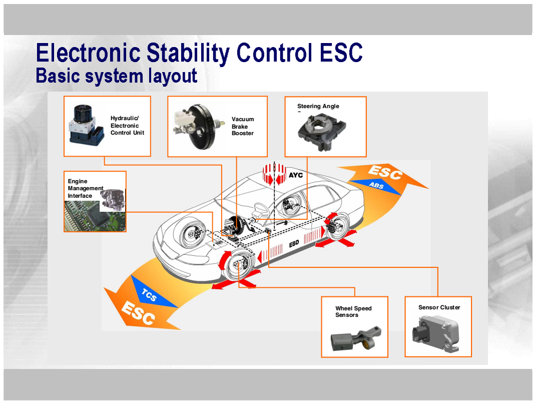

Figure 3

This technology uses sensors to measure each of the wheel speeds, the steering wheel angle, the vehicle yaw rate and lateral acceleration. The system calculates the driver's desired path and the actual vehicle motion and applies the brakes, individually, to correct for differences.

Studies in Japan and Europe have shown significant reductions in crashes and fatalities when ESC was installed on vehicles. Recent studies in the U. S. now confirm these results on U. S. highways. A National Highway Transportation Safety Administration (NHTSA) study last fall indicated a reduction of 30 percent in fatal crashes for passenger cars equipped with ESC and 63 percent for SUVs equipped with ESC. The Insurance Institute for Highway Safety (IIHS) released a study that showed similar findings, with a reduction of 41 percent in single- vehicle crashes and concluded that more than 7000 lives could be saved each year in the U. S. if all passenger vehicles were equipped with ESC.

Partly as a result of these studies, several automobile manufacturers have increased the applications and announced that future models will offer ESC as standard equipment. We estimate that 50 percent of new vehicles will be equipped with ESC by 2008.

Adaptive Cruise Control

Adaptive Cruise Control (ACC) provides a real-world example of technology integration serving to accelerate this timeline. ACC is available on cars today. Both radar-based and infrared-based systems are in use. ACC uses sensors to monitor and maintain a set speed and distance to the vehicle in front. Should traffic in front slow, the ACC-equipped vehicle will automatically reduce speed to maintain a safe distance. When traffic resumes speed, the vehicle will re-accelerate to the speed at which it was previously set.

The next generation of ACC will feature a full-speed-range function to provide even more driving convenience through the use of a special, closing velocity sensor. These ACC systems can slow a vehicle to a standstill, and not just to 30 kph as with current systems. After coming to a standstill, these new systems will also detect any movement by traffic ahead, and notify the driver. An important safety benefit of these ACC systems is that they prevent tailgating, which is a factor in many rear-end collisions, which account for 29 percent of light vehicle crashes, according to the U.S. Department of Transportation.

Even more important may be the integration with ESC to provide the functions of the APIA project.

Tomorrow's Technologies Will Drive Enhanced Active Safety

This next technological leap forward will feature the cross-linking of today's many, varied, and largely stand-alone chassis control units. Additional and enhanced functionality will be achieved, not so much by adding extra hardware or control equipment, but instead by connecting existing equipment electronically, adding software and having the various pieces of networked equipment communicate with each other. In effect, the car will have electronic reflexes, with each step enabling the next. Referring back to Figure 2, as the active and passive systems are integrated, additional safety potential is achieved.

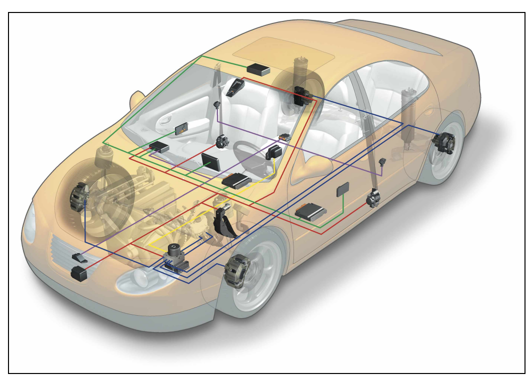
Figure 4

Active Passive Integration Approach (APIA)

Continental is working aggressively on these developments in a project called the APIA, and also known as the "Total Safety" project. APIA points the way to a vehicle that helps avoid accidents and prevents injuries. This is achieved by integrating the sensors and controls of the ESC with environmental sensors, to network active and passive vehicle safety systems. Forward sensors from the Active Cruise Control monitor the distance and closing velocity of a vehicle in front. A safety control module determines the probability of an accident for the current traffic situation. When necessary, the module initiates a staged hazard response designed to protect the occupants and other road users. The goal is to incorporate proactive vehicle intervention technology to prevent accidents from happening. A prototype of this vehicle has been built and demonstrates the potential to avoid or minimize the effect of rear-end crashes. When an APIA vehicle closes on another car too quickly, the APIA car senses the closing velocity and makes needed adjustments. First there is a distance warning, then feedback from the gas pedal – and the driver brakes, avoiding a collision.

In a more aggressive scenario, should an APIA vehicle close even faster, more functionality would be activated. The distance warning would come on again, as would the gas pedal feedback. Then, the brake system would pre-charge, the sunroof and windows would automatically close, and the seatbelt pre-tensioner would activate.

With yet a more aggressive scenario, and the APIA vehicle closing even more quickly making a crash imminent, in addition to the gas pedal, brake system, sunroof/window and seatbelt responses; the airbags would be readied for deployment and the seats would readjust to place occupants in safer positions for the impending crash.

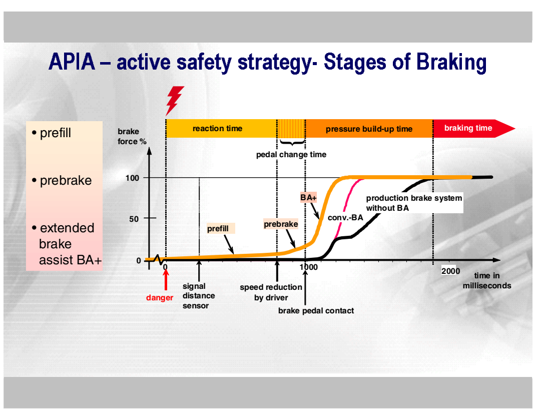

Figure 5

Figure 5 illustrates the improved braking function of the APIA vehicle. When the APIA vehicle anticipates the need for braking, it pre-charges the brake system. When needed, the system will apply the brakes at 0.3g to slow the vehicle. If the driver quickly moves his or her foot from the throttle to the brake, brake assist is activated and full braking is applied.

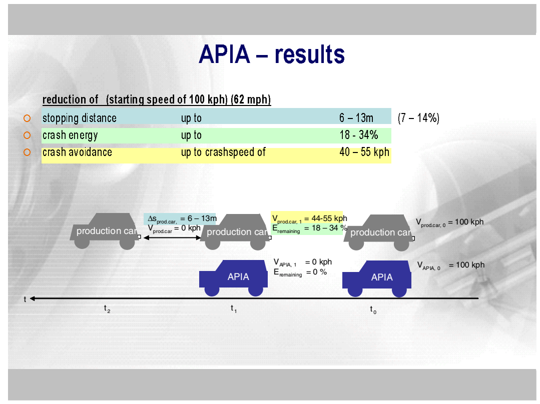

Figure 6

Figure 6 shows an example result of this functionality. Note that when the APIA car is stopped, the production car is still traveling at 44 – 55 kp/h.

Long term, the objective is to develop a comprehensive vehicle assistance system that will provide drivers with the best possible information and support under all conditions and minimize injuries if a crash does occur. The APIA system reflects Continental's basic safety philosophy. Motor vehicle safety is made up of three components: avoidance, control and protection.
Avoidance, in this concept is provided by technology or system features that can keep a driver from getting into trouble in the first place. Control, is the next objective and is provided by the integrated safety systems in the event trouble begins. Finally, protection of vehicle occupants is automatically provided when the traffic situation has continued to escalate and sensors detect that a collision is imminent.

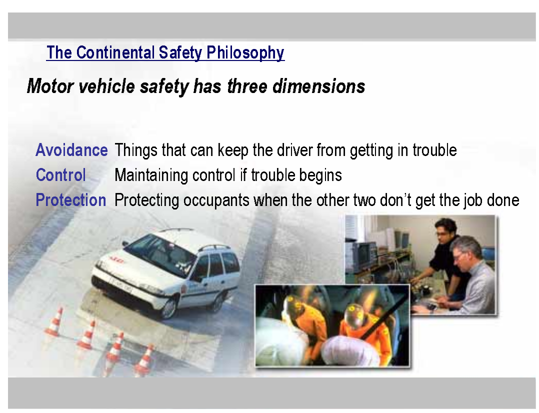

Figure 7

Driver-Assistance Systems of the Future

Technology that is on the road today cannot prevent accidents caused by a driver taking no response, or an inappropriate response to an emergency traffic situation. However, in the relatively near future, automobiles will have anticipatory capabilities that will allow systems to make appropriate recommendations for vehicle occupant safety. They will also provide active driver support.

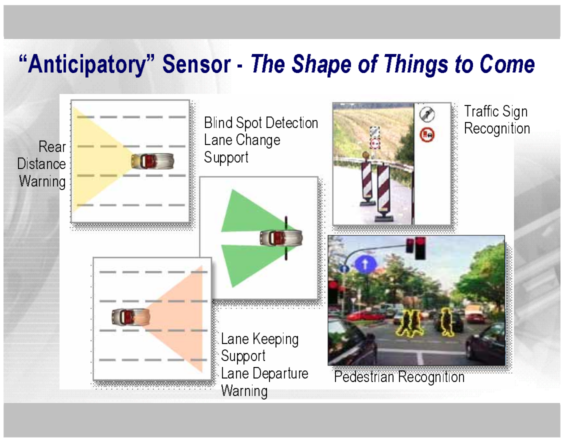

Figure 8

The following safety equipment reflects the state of current thinking and points to important capabilities under development:

Electronic Stability Control II or ESCII is the next generation of the ESC systems widely available on a number of vehicles today. ESCII builds upon the capability of sensors already in use to provide enhanced functionality, responsiveness and safety. An active steering capability is integrated with traditional ESC functions that include: anti-lock brake system (ABS), electronic brake force distribution (EBD), traction control systems (TCS), and active yaw control (AYC.) Together, the networked handling system enhances the stabilizing effect of ECS by enabling controlled, direct, automatic steering corrections in emergency situations.

Lane Departure Warning (LDW) is an assistance technology that is expected to make a significant impact on crash avoidance. NHTSA studies show that 55 percent of fatal crashes in the U.S. are caused by unintentional lane departure resulting from a variety of things including driver distraction and inattention. LDW uses cameras to identify lanes and a vehicle's position in relation to lane markings, as well as following vehicles and parallel traffic. If a vehicle drifts from its lane, the system will warn the driver. Additional sensors can be added to these systems that further enhance functionality by providing another aspect of safety in poor visibility and detecting obstacles, or other hazards are in the vicinity. As LDW capability becomes networked with other systems such as ACC and Navigation, total system responsiveness and flexibility will be enhanced.

Traffic Sign Recognition is a technology solution that aids compliance to situations where changing speed limits and ambiguous or unclear road signs are encountered during the course of travel. Some of the systems under development use digitally-broadcast traffic sign information from vehicle navigation systems. Vehicle navigation information is continually updated by service providers and this source would provide comprehensive coverage corresponding to virtually all mapped areas. Other systems being developed will receive data from radio transmitters installed on traffic signs. Still other, camera-based systems will "read" the signs. These systems will display information indicating the start and end points of speed limits on a multi-functional display inside the cockpit. The ACC system can also be programmed to maintain the vehicle speed to that posted. Integration with ESC will allow appropriate braking to maintain a set speed.

Perception of Vehicle Surroundings combines all of a vehicle's sensor information to create a complete, 360 degree model of its immediate vicinity. The sensor data is processed and then used to create a real-time depiction of the surroundings in a way that identifies any risks such as people, obstacles or traffic entering the lane.

CONCLUSIONS

We are in the midst of a revolution in smart vehicle technologies. Tomorrow's automobile will have "anticipatory" qualities that enable it to provide operating recommendations and active support to the driver. It will do this by monitoring the ambient traffic situation, and recognizing upcoming circumstances that require responsive action, and where desired, taking that action. This revolution is being made possible by the great leaps in microelectronics capability and functionality – accompanied by the decline in prices of semiconductor technology. Consequently, automotive applications have been expanding in great technological leaps

The vehicle systems discussed here represent a natural evolution of enhanced, technology-driven capabilities readily available to the broader motoring public in the very near future. Their development is being driven in large part by the safety concerns of regulatory agencies and enabled by the incredible leaps in technology we read about daily. Acceptance by the public will largely be driven by perception of need and cost. Long term success will be determined by these systems' effectiveness and reliability.

Disregarding uncertainties, the fact remains that traffic safety has reached a plateau, and technology is providing the means to dramatically improve it. This inexorable march of technology will only continue. As systems we envision today become commonplace, new concepts in traffic management will couple with advances in areas such as artificial intelligence and pattern recognition, causing today's visionary systems to be viewed in the much same light as we consider seatbelts today.