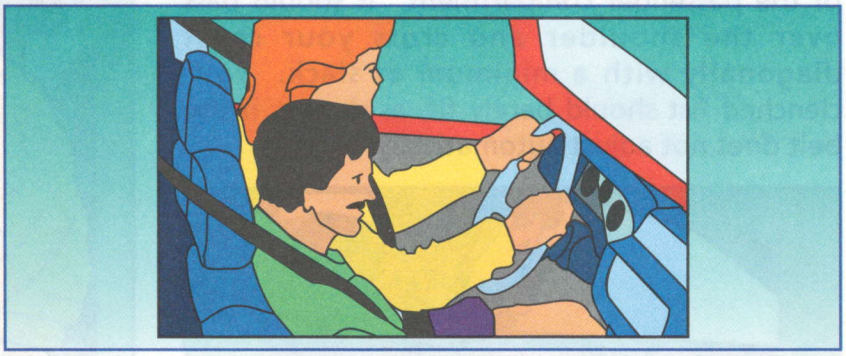
Occupant Protection

Contents

Engineers are responsible for improving vehicles, highway design, and traffic control systems. Today's automobiles are safer, more efficient, and more comfortable to drive than ever before.

In the event of a collision, the interior has been designed with a padded dash, head restraints, controls that are recessed or break away, a collapsible steering column, and shatter-proof windshields. The vehicle has energy-absorbing bumpers to minimize low speed impacts. The front and rear sections are designed to crush. Beams reinforce the side doors to reduce the possible effect on the passenger compartment in crashes.

The single most effective safety device during a collision is the safety belt!!



AFTER COMPLETING THIS CHAPTER, THE STUDENT MUST DEMONSTRATE COMPLETE COMPREHENSION OF THE IMPORTANCE AND PROPER USAGE OF:

- **safety belts and air bags.**
- **child safety restraints and head restraints.**
- **new safety technology.**

8-A Safety Belts

A safety belt that the occupant must attach or buckle is called an **ACTIVE RESTRAINT** device.

The lap portion of this belt is designed to keep you in your seat (**not thrown from the vehicle**). It should be adjusted to fit snugly low across your hips below the stomach.The shoulder

Restraint Systems

When a vehicle is involved in a collision, three impacts occur in rapid succession.

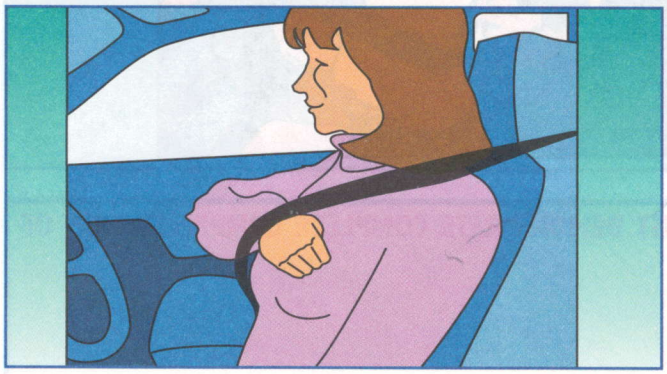
- **The vehicle collides with another vehicle or object.**
- **The occupants collide with the interior of the vehicle or other occupants.**
- **The interior organs collide with the interior of the body cavity.**

You have already seen how engineers design the vehicle to absorb impacts and how you as the driver can minimize the force of impact during a collision.

In a crash at 30 mph, the impact on a vehicle occupant is equal to falling from a three story building. The force of impact equals 35 TIMES YOUR BODY WEIGHT. The brain and other interior organs strike the interior of the skull and body cavity with this tremendous force when the body collides and stops instantly.

To minimize the consequences of these two impacts, RESTRAINT DEVICES should protect the occupants. These are designed to keep them in their seats, to cushion the stopping motion, and to prevent the second impact. At the same time, they slow the forward motion (effect of inertia) and bring the occupants to a stop more gradually (impact distance).

portion prevents you from striking the interior of the passenger compartment. It should pass over the shoulder and cross your chest diagonally with a minimum of slack. Your clenched fist should barely fit, as shown, if the belt does not adjust automatically.



In many new vehicles, the center post mounting of the safety belt is adjustable for height. If your vehicle has this option, adjust the height so that the belt crosses your chest and collar bone (this is especially important when youths, **never under 12 years of age**, occupy the front passenger seat).

NEVER ATTACH THE SAFETY BELT IF IT IS TWISTED!

NEVER WEAR THE BELT LOOSELY OR IMPROPERLY!

In either case, you will defeat the proper operation of the safety belt. The result may be a more serious injury if a crash were to happen. During a collision, the combined action of the safety belts will maintain your seating position (**to better control your vehicle**), cushion the impact, and distribute the force over your shoulders, hips and rib cage (**to reduce injury**).

The **NHTSA** (National Highway Traffic Safety Administration) has found that lap/shoulder

Statistics

The National Highway Traffic Safety Administration (NHTSA) estimates that 317,929 lives were saved by safety belts from 1975 through 2013 (12,584 lives in 2013 alone). In 2013, if all occupants (over age 4) involved in fatal crashes had worn their seat belts, an additional 2,800 lives could have been saved! DOT HS 812 153

belts, when used properly; reduce the risk of fatality to front-seat passenger car occupants by 45 percent and the risk of moderate-to-critical injury by 50 percent. They also stop passengers from **becoming projectiles thereby interfering with the driver or causing injury to other occupants**. For light-truck occupants, safety belts reduce the risk of fatal injury by 60 percent and moderate-to-critical injury by 65 percent.

Texas law requires all occupants (front and back seat) be secured by a safety belt and children under 8 years of age (less than 4 feet 9 inches in height) be restrained in an approved child safety seat.

PASSIVE RESTRAINT DEVICES do not require the occupant to fasten or buckle these protective devices. Some vehicles are equipped with passive seat belts that are attached to the door and to the floor; they automatically fasten when the door is closed. Some systems require fastening the lap portion once seated. Never use only the shoulder portion, as the lap and shoulder portions were intended to work together.This safety belt provides the same protection to the occupant.

SAFETY TIPS

The safety belt is the single most effective safety device when a collision occurs. Make sure that you and all your passengers wear them properly at all times. Failure to wear a safety belt has been identified as symptomatic of drivers that take unnecessary risks. Make reduced-risk decisions! Wear your safety belt!

8-B Air Bags

The air bag is another passive restraint device. It adds to the protection provided to the occupants of the vehicle.

Air bags can be installed in the center of the steering wheel for the driver, in the dash for other front seat passengers, and in the upper door frame, seat edge, or door panel for side impact protection. Sensing devices cause the air bags to inflate instantly in a collision over a predetermined speed, and then deflate a fraction of a second later. They further cushion the force of impact and distribute it over a wider surface of the torso. They complement the protection provided by the seat belts.

Because of the speed of inflation and the force this produces, there are certain safety precautions you must adopt. You should adjust your seat for a minimum 10 inch clearance between your chest and the steering wheel. As well, you should attempt to direct the air bag at your chest, rather than at your face. You can achieve this by adjusting the steering wheel (if so equipped), or by raising your seating position. Use the power seat control or a wedge-shaped cushion, if you do not have a power seat option.

A sensor causes the air bags to inflate instantly in any frontal collision over 10 to 15 mph. The

inflation system ignites a solid propellant producing a large volume of nitrogen gas - the air bag bursts from its storage site at over 200 mph (faster than the blink of an eye!). A second later, the gas dissipates through tiny holes in the bag and it deflates. (This whole process occurs in only one twenty-fifth of a second.) A powdery substance may be released along with the air bag - it is cornstarch or talcum powder which manufacturers use to keep the bag pliable and lubricated while in storage.

AIR BAGS DO NOT REPLACE SAFETY BELTS! THEY COMPLEMENT THEM!

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- Used together, they reduce the probability of a fatality by 70 %.
- The air bag alone - only 35 %.
- The seat belt alone - 60 %.

CAUTION: Passenger side air bags can cause harm to children in any child restraint attached to the front seat!
The safest position for passengers (especially children) is the back seat!

THE RISKS

It didn't take long to learn that the force of an air bag deploying can hurt those who are too close (the risk zone is the first 2 to 3 inches of inflation). "Too close" can occur when an occupant, typically unbelted or leaning out of position, is thrown forward just before the crash impact (the period known as pre-crash braking) to within a few inches of, or directly on top of, the rapidly accelerating air bag. ***Depowered*** air bags were introduced to reduce this danger.

All new passenger vehicles and light trucks are required to have driver and passenger air bags (a deactivation switch is optional). Since 2005, a third generation air bag was phased in. These ***advanced*** frontal air bags are designed to meet the needs of the occupant in a variety of specific crash situations. They automatically determine if, and with what level of power, the driver and/or the passenger air bag will inflate. **The appropriate level of power is based upon sensor inputs that can typically detect** (1) occupant size, (2) seat position, (3) seat belt use, and (4) crash severity - some systems use the occupant's distance from the air bag as well.

Vehicles with advanced frontal air bags are required to have:

- warning labels with the phrase "EVEN WITH ADVANCED AIR BAGS" on the sun visors for both the driver and passenger seating positions.
- an indicator light with the phrase "PASSENGER AIR BAG OFF" or "PASS AIR BAG OFF." When illuminated, this indicator light informs you that the passenger air bag has been turned off (suppressed) by the advanced air bag system and therefore will not deploy.
- a complete explanation of the system in the owner's manual

SIDE AIR BAGS

In recent years, side air bags to protect the driver and the passengers when involved in a side-impact collision have been introduced. The problem with this type of collision is that both the time factor (between the vehicle crash and the occupant being struck) and the space available (between the initial crash and the occupant) are very small compared to frontal impacts. The side air bag must perform quickly within very small time and space constraints.

Statistics

The National Highway Traffic Safety Administration (NHTSA) estimates that 39,886 lives were saved by frontal air bags from 1987 through 2013 (2,388 lives in 2013 alone). DOT HS 812 153

SAFETY TIPS

Insurance companies in Texas are required to offer rebates for vehicles equipped with air bags. Most manufacturers include them as standard equipment. Check that they are included, when you purchase your next vehicle.

There are essentially three types:

- **Curtain** - an air bag descends from the roof of the vehicle to protect the heads of occupants in both the front and rear seats;

- **Inflatable tube** - a tubular air bag attached to the roof (see above right) deploys to protect the head along with separate side air bags in the doors designed for the torso; and
- **Torso/head combination** - combination air bags deploy from the vehicle seats, or

sometimes from the doors, to protect both the head and torso.

Air bags have been designed and installed on some vehicles since the mid-1990s. The **IIHS** (Insurance Institute for Highway Safety) has been testing vehicles with various side air bag designs. Overall effectiveness in real-world crashes has been estimated at ***45% fatality reduction for drivers of cars with head-protecting side air bags***. In 2016, most vehicle models offer side air bags as standard equipment; other models and manufacturers offer them as an option.

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SAFETY TIPS

Approximately 25% of passenger vehicle occupant fatalities occur in side impact collisions every year. Head injuries are the leading cause. Side air bags - offering head protection - reduce the risk! Make sure your vehicle is equipped with side air bags!

8-C

Child Safety Restraints

It is extremely dangerous to ride in a moving vehicle while holding a child on your lap. Rather than protecting him/her, you are putting your child at risk! In a collision, a child being held will continue forward (kinetic energy - inertia), and the force required to stop this motion is beyond human capability.

IF YOU LOVE THEM, PROTECT THEM!
PUT THEM IN A CHILD RESTRAINT!
IT`S THE LAW IN TEXAS!

Children should be secured in a device appropriate to their height and weight.

Statistics

*In 2013, 278 children under age 5 were passenger vehicle occupant fatalities. **An estimated 31% (86) were totally unrestrained.** Three children (14 and under) were killed and 470 were injured every day in motor vehicle crashes. (DOT HS 812 154)*

These child restraints should be properly installed in accordance with the recommendations of CSS and the manufacturers of the seat and the vehicle.

REAR-FACING SEATS

Whether an **Infant-Only**, a **Convertible** or an **All-in-One**, the seat should be positioned facing the rear with the child firmly secured in the seat which is attached to the vehicle by a safety belt or ***LATCH SYSTEM*** to the back seat. The child is cushioned by the seat on all sides as the child's head is larger and heavier than the rest of his/her body.

Never place an infant seat in the front seat. ***Keep your child rear-facing for as long as possible;*** until he or she reaches **the maximum height or weight limits recommended by the safety seat manufacturer.**

If you must check your child while driving, glance quickly and return your eyes to the road ahead in between glances. Do not become distracted. If any situation arises where your child requires attention, STOP THE VEHICLE, in a safe manner, then care for your child. **Do not put yourself and your child at risk.**

FORWARD-FACING SEATS

Whether a **Convertible**, an **All-in-One**, or a **Forward-Facing**, this seat is designed for children who are now taller, heavier and have become more active. This safety seat requires a quasi-permanent ***LATCH*** installation attached to the rear seat (a limit of 65 lbs. - seat and child together - unless vehicle manufacturer specifies otherwise). Secure the child safety seat according to the recommendations of CSS as well as the owners manual for the seat and for your vehicle. ***Keep your child in a forward-facing safety seat with a harness and tether until he or she reaches*** **the maximum height or weight limits of the manufacturer.**

Get used to conversing with your child without taking your eyes off the road. Visually check him/her by using the interior rear-view mirror. As previously mentioned, park your vehicle if you must offer physical assistance. The control of your children will become easier as they mature; the use of the seats, and eventually the safety belt, will become second nature.

SAFETY TIPS

Protect your children and child passengers! Make sure they are properly restrained in a properly installed, age-appropriate child restraint that is attached to the back seat (wearing a safety belt seated in back when they outgrow the restraints).

THE BOOSTER SEAT

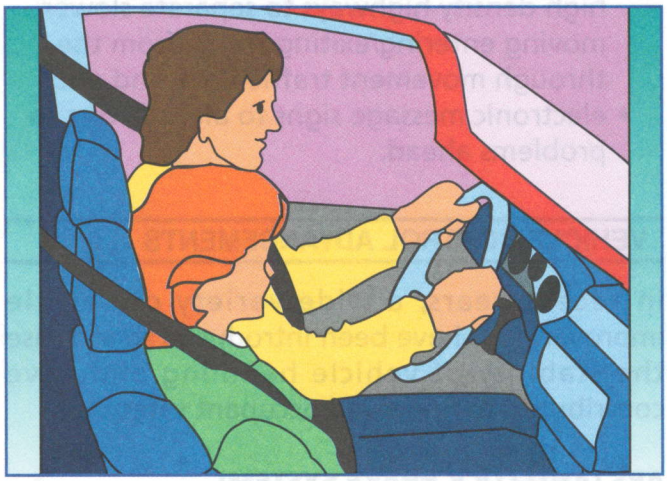
When children reach the maximum height and weight limit of the Forward-Facing Seat, they are not quite large enough to use the regular safety belts, especially the shoulder belt. They may transition to a Booster Seat. There are a variety available which raise the child to a sufficient height so that the shoulder belt may be worn safely. Some have high backs with cushioning at the sides (head and torso) for extra protection. Engineers have also designed a shoulder harness that can be raised or lowered to accommodate children of varying heights (a booster seat is still recommended).

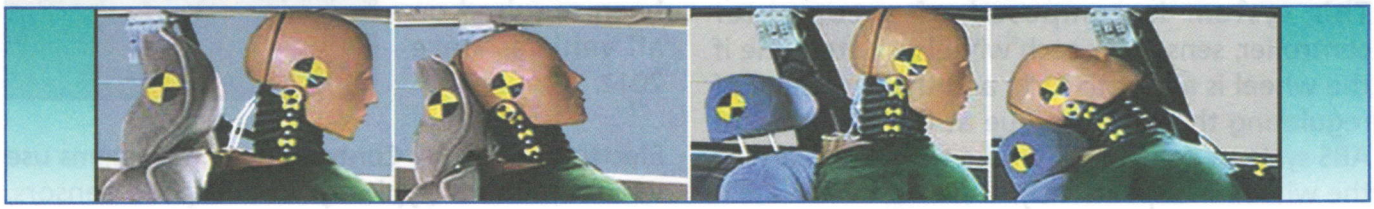
Keep your child in a booster seat until he or she reaches the maximum height or weight limits allowed by the seat manufacturer (*until at least 8 years of age or 4 feet 9 inches in height*).

8-D Head Restraints

All of today's vehicles have padded head restraints attached to the back of the front seats (some have them on the rear seats as well). They have been mandatory equipment on vehicles since the early 70's.

Whether adjustable or fixed, they are intended to prevent neck and spinal column injuries as a result of a collision. This is especially important when your vehicle is struck from the rear; a very common cause of whiplash. If adjustable, make sure the top of the restraint reaches just above the top of your ears (not the back of your neck), and don't lean on it while driving.





8-E Safety Technology

The safety engineers are responsible for many improvements in vehicle and highway design that have created a safer environment for today's drivers.

HIGHWAY DESIGN IMPROVEMENTS

Among the safety features that are being designed into roadways, there are:

- wider, clearly marked lanes,
- wider and clear highway shoulders,
- rumble strips at the road edge to alert drivers (drowsiness),
- Potts dots or other lane markers that can be felt or reflect at night,
- elimination of grade intersections,
- new design median barriers that minimize rebounding into traffic,
- break away sign support posts,
- new design guard rails that reduce penetration of guardrails into vehicles,
- crash attenuators such as vinyl liquid or sand filled drums in front of barriers or cement columns,
- protected left and right turn bays,
- collector/distributor lanes on high speed, high density highways to separate slower moving entering/exiting traffic from the through movement traffic flow, and also,
- electronic message signs to alert drivers to problems ahead.

VEHICLE CONTROL ADVANCEMENTS

In recent years, a wide variety of vehicle improvements have been introduced to increase the stability of vehicle handling and have contributed to improved occupant safety.

ABS (ANTI-LOCK BRAKE SYSTEM)

This system is composed of a computer controller, sensors at each wheel to determine if the wheel is about to lock, and the capability of regulating the brake torque at the wheel. Most ABS systems control the brake torque at each of the wheels independently. The concept is that the system monitors the vehicle wheel speeds, and then regulates the brake force to control the slip between the tire and the road surface. By avoiding wheel lock, vehicle stability is improved and the driver retains the ability to steer.

TRACTION CONTROL SYSTEMS (TCS)

There are a variety of **TCS** systems. Any time a tire is given more torque than it can transfer to the road, the tire loses traction and spins (hard acceleration). To prevent this on vehicles with **ABS**, the **TCS** applies the brake at that wheel. This slows the tire, preventing wheelspin.

The **TCS** can also reduce engine speed and torque, if braking alone is not sufficient. In that case, the **ABS/TCS** control module signals the engine control module (**ECM**). It then retards the spark and reduces the amount of fuel delivered by the injectors to stop wheelspin.

By controlling wheelspin, the vehicle stability, steerability, and acceleration are improved. Also, engine torque can be transferred through the differential from one drive wheel to the other. This can improve vehicle mobility and acceleration on surfaces which have non-uniform frictions. The system may disable when brake temperature rises excessively.

ELECTRONIC STABILITY CONTROL (ESC / ESP)

All **ESC** systems are based on **ABS** and apply on the two front (or 4 wheels) and may, or may not control engine speed and torque. An **ESC** system has been required on all vehicles since 2012.

Electronic Stability Control/Program Systems use various sensors (typically wheel speed sensors,

steering angle sensors, yaw rate sensors, and accelerometers) to monitor the dynamic state of the vehicle and the driver's commands. They then apply the brakes individually (and adjust engine torque) to adjust the rotational movement and correct the path of the vehicle to the driver's intended path. These systems improve the stability of the vehicle, the driver's control of the vehicle, and correct understeer and oversteer. ***ESC/ESP lowers the risk of a fatal single-vehicle crash by about half and the risk of a fatal rollover by as much as 80 percent.***

ACTIVE YAW CONTROL SYSTEMS (AYC)

All **AYC** systems are based on **ABS** and apply on the two front, or on all four wheels, and may, or may not, control the engine speed and torque. Active Yaw Control Systems use various sensors (wheel speed sensors, steering angle sensors, yaw rate sensors, and accelerometers) to monitor the dynamic state of the vehicle and the driver's commands. They then apply the brakes individually (and adjust engine torque) to adjust the rotational movement and correct the path of the vehicle to the driver's intended path. These systems improve the stability of the vehicle, the driver's control of the vehicle, and correct understeer and oversteer.

SUSPENSION STABILITY SYSTEMS

On many new vehicles, the suspension system is active. It can adjust to road conditions, vehicle balance, vehicle speed, and body roll. Various sensors send information to the **ECM**, which then sends signals to the hydraulic actuators (these replace springs and shocks) to raise or lower the wheel, stiffen or soften the ride, etc. All of these actions occur almost instantly, and go unnoticed by the driver. The concept is to keep the vehicle level while each tire pushes against the road surface with a constant force, despite weight shifts during cornering, hard acceleration, and hard braking.

ACTIVE STEERING CONTROL

Controlled steering systems have the ability to adjust the steered angle (steering input) or the camber angle (wheel alignment) to influence the longitudinal and lateral forces of each tire. This system improves the stability of the vehicle and the driver's control of the vehicle

VEHICLE CONSTRUCTION IMPROVEMENTS

Engineers have redesigned the automobile with a padded dash, controls that are recessed or break away, a collapsible steering column, side impact beams, and energy-absorbing bumpers.

CRUMPLE ZONES

Certain segments of the vehicle, in front of and behind the passenger area, were designed to collapse while the passenger compartment remained intact. Other segments were constructed to spread the force of impact over a wider area. Both of these were intended to reduce the risk of penetration into the passenger seating area. Side impact beams and air bags were an extension of this concept.

IMPROVED DOOR SECURITY

Door fasteners used to resemble those found in the interior of the typical home, and generally flew open in a crash. Improvements have been engineered so that locks and door latches stay closed under the most severe conditions and impacts.

WINDSHIELDS

With the advent of tempered glass, as required by national safety standards, facial disfigurement associated with partial ejection through laminated glass has literally been eliminated.

HEADLIGHTS

In the past 15 years, headlights have undergone dramatic improvement in terms of level of illumination, focus, and reliability.

New **Adaptive Headlights** react to the steering input, speed and elevation of the vehicle using electronic sensors and automatically turn the headlights up to 15 degrees in either direction using electric motors. When you turn right, the headlights angle to the right and illuminate the road in the curve. You can see into the curve at night. However, since adaptive headlights are directed at the road, the incidence of glare for oncoming drivers is reduced. At slow speed (for parking), many models add extra lighting rather than move the headlights.

The **Insurance Institute for Highway Safety (IIHS)** and **Highway Loss Data Institute (HLDI)** estimate that adaptive headlights have reduced property damage liability claims.

RADAR, ULTRASONAR, AND CAMERAS

There are a variety of ways new technology can handle emergency situations. Some activate interior lighting, unlock doors and shut off fuel when airbags deploy; others also activate the hazard lights and disconnect the battery terminal from the alternator. The high end systems also alert their respective response centers of the crash and make details available to emergency personnel.

BACKUP WARNING DEVICES

The technology varies - radar, microwaves, or ultrasound - the result is the same: the alert system warns you before you back into something or someone. An audible signal, seat vibration, or a voice (or a combination) warn you. Automakers are required to install backup cameras by 2018.

BRAKE ASSIST (collision mitigation)

This brake technology recognizes when you make a panic stop (a quick shift from gas to brake pedal). It will apply additional brake pressure to help shorten the stopping distance (if Brake Assist senses that you are braking too lightly). It may also sense a potential collision and stop the vehicle for you (smart cruise, crash avoid, etc.).

ADAPTIVE CRUISE (collision avoid)

Thanks to sensors and the use of radar, cruise control now adjusts the throttle and brakes to keep a safe distance from the vehicle in front of you. If the system senses a potential collision, it typically will brake hard, tighten the seatbelts and even stop. Once the lane is clear, it will return your car to its original cruising speed, all without your input (may be speed related).

BLIND SPOT DETECTION

This technology alerts you to cars or objects in your blind spot during driving or parking. If it detects something in the blind spot, it may flash a light in your mirror, cause the seat or steering wheel to vibrate, or sound an alarm (some models may only function when you put on your turn signal).

LANE CHANGE ASSIST / LANE DEPART

Similar to blind-spot but with more range, it judges an approaching vehicle's speed and distance to warn you of potential danger. Also warns of drift out of your lane and will correct - in the future, it may wake up snoozing drivers.

CROSS TRAFFIC ALERT

Using corner-mounted, side-looking radar that detects other vehicles, the system alerts the driver (light, chime, or vibration). When backing out of a parking space or driveway, the same sensors can detect vehicles approaching from the sides that may not be visible to you.

PARKING ASSIST

This technology, usually an option, will park the vehicle (parallel or perpendicular) for you.

V2V TECHNOLOGY

The **NHTSA** and the **DOT (Department of Transport)** are considering this technology to be mandated by law. **V2V** refers to **Vehicle-To-Vehicle** communication - your vehicle would be in constant communication with the other vehicles around it as to speed, direction, etc. - even on the cross streets - ***crash-avoidance by Wi-Fi.*** Vehicle to road (signs, signals, etc.) is also in the study project phase of development.