

Cover Story

Safety on Wheels: A Crash Test!

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With the burgeoning number of vehicles on roads, traffic chaos and unruly traffic accidents can only be expected. But technology today is trying to ensure driver safety in times of crashes, or even before they happen.

How safe are you in the automobile you drive? Today, safety is probably one of the first concerns that comes to our mind when we buy or drive a car. And this is because cars are increasingly becoming a part of our lives, as well as a cause of deaths!

According to World Health Organization statistics, there were around 1.25 million road traffic deaths globally in 2015, which was nearly equal to the population of Mauritius in the same year! Just imagine a population equal to an entire country’s, being wiped out in just one year only because of road accidents. Appalling, right?

So, it is no surprise that ‘passenger safety’ is one of the biggest fields of research in the automobile industry today. Every year manufacturers spend millions of dollars in crash testing to ensure their vehicles can be as safe as possible, and to bring road-accident fatalities down to a minimum.

When it comes to ensuring safety in cars most of us generally think about airbags. But are airbags really sufficient to save our lives? Or do we need something more? If yes, what else? What can be more effective in saving our lives, and more importantly ‘preventing’ accidents from happening in the first place? So, here’s what you need to know.

Passive Safety Features

Airbags are an example of ‘Passive Safety Features’, which prevent or minimize injury to the passengers in a crash. These kinds of features help absorb the crash forces, restrain the occupants from hitting the interior, or prevent objects inside the vehicle from striking the occupants. Seatbelts, headrests, physical structure of the vehicle, etc. are some other examples.

Essentially, ‘Passive Safety Features’ are the components or technologies that help in protecting the occupants during a crash. But wouldn’t it be better if we could steer clear of a crash first of all?
Active Safety Features
Safety features in a vehicle that help prevent a crash by providing the driver with better ways of controlling the vehicle and avoiding hazards are called ‘Active Safety Features’. Unlike passive safety features, which are designed to protect vehicle occupants once a crash has occurred, these features help prevent or mitigate road crashes. Anti-Lock Braking system, Electronic stability control, Automatic Braking are some examples of ‘Active Safety Features’. These features will engage to either prevent the crash from occurring, or reduce the severity of an unavoidable crash.

Therefore, the automobile industry is increasing its focus on developing Active Safety Features. And as a result, many car manufacturers are actively incorporating novel technologies in their vehicles, with an aim to make their vehicles crash proof in the near future. This move may be gradual but it just might be a radical step in the right direction towards road safety. Because it will not only help in bringing the road-accident related casualties down, but also help save the thousands of dollars wasted in repairing the damaged vehicles.

So, let us take a look at some of the most advanced and amazing automobile technologies that are actually saving lives on the road!

Anti-Lock Braking System (ABS)
Skidding is the phenomenon of locking up of the wheels of a vehicle when a sudden or extreme braking force is applied. When the front wheel(s) of a vehicle are locked its ability to change direction is reduced. Similarly, when the rear wheels are locked vehicle stability is reduced.

Skidding can be avoided by releasing the brake pressure just before the wheels lock up, and then reapplying the same. This process of releasing and reapplying the brakes in succession is known as pressure modulation. Modern Anti-Lock Braking Systems not only prevent the wheels from locking up in emergency braking, they also ensure steering ability. These systems can modulate the brake pressure almost 15 times per second! That means applying, releasing and reapplying brakes consecutively for 15 times, and doing all that in just one second!

ABS monitors the vehicle speed and the speed of the wheels accurately, and then controls the brake fluid pressure to prevent locking up of wheels under heavy braking. Although ABS prevents complete locking of the wheels, in reality it does allow some wheel slip to achieve the best possible braking in all conditions.
Under emergency braking with ABS, drivers apply the brake pedal firmly and hold it meanwhile the ABS regulates the brakes. A typical modern-day ABS comprises of an Electronic Control Unit, a sensor on each wheel, an electro-hydraulic pump and a pressure accumulator. All these work in tandem to decide when the antilock operation is required, and control the same.

**Autonomous Emergency Braking (AEB)**

A number of crashes are caused due to late braking and/or braking with insufficient force. A driver may brake too late for several reasons: he is distracted or inattentive; visibility is lower, for instance when driving in heavy fog, rain or snow; or in unpredictable situations, when the driver ahead brakes unexpectedly or a pedestrian crosses the road without paying attention. Often, the driver doesn’t apply sufficient braking force to avoid a crash or does not brake at all because there is not enough time to react.

AEB systems improve safety in two ways: firstly, they help to avoid accidents by identifying critical situations earlier and alerting the driver. Secondly, in case of an unavoidable crash they reduce its severity by lowering the speed of collision, besides preparing the vehicle and restraint systems for impact.

Most AEB systems use radar, stereo camera and/or LiDAR (Light Detection & Ranging) based technology to identify potential collision objects in front of the car. This data combined with the car’s own speed and trajectory is used to determine whether or not a critical situation is developing. If a potential collision is detected, generally AEB systems first try to alert the driver that an emergency action is needed. If still no action is taken and a collision is imminent, the system will then apply the brakes.

Some systems apply maximum braking force, while others just strong enough. Either way, the objective is to reduce the speed at the time of crash. In some cases, if an evasive action is detected by the driver, the AEB system will deactivate at once.

**Lane Departure Warning System**

Quite often, a driver may unintentionally veer towards the edge of the lane on the road. By the time the driver realizes that the car is in a potentially dangerous situation, the wheels of the car may already be on the grass or gravel at the side of the road, or even in the path of oncoming traffic. This sudden, late realisation by the driver may prompt a panic response that can often lead to loss of control and ultimately a crash.

Basically, a Lane Departure Warning System warns the driver when the car is getting close to a lane marking. The type of warning can be different depending on the system. While some systems give an audible signal, others produce a vibration in the steering wheel to simulate the feeling of the car running over a ‘rumble strip’. The intention is just to make the driver aware that the car is in danger of going out of its lane.

Some systems require lane marking only on one side of the vehicle while others rely on having a distinct marking on both sides. Most systems suppress the warning signal if the direction indicator is used and operate only at highway speeds. A camera is usually situated at the top of the windshield behind the rear view mirror. The real-time images from this camera are continuously analysed by a computer to track the lane markings or an unmarked road edge. Simultaneously, the driver’s steering input is also monitored along with the vehicle’s speed and trajectory. All these parameters are combined to determine whether the car is about to depart from the lane of travel or not.

However, since Lane Departure Warning Systems rely on distinct lane markings, their effectiveness is reduced if the lanes cannot be clearly distinguished. For example, in case of heavy rain or fog, mud or snow, an indication is given to the driver that the system is unable to assist.
Heads Up Display
HUD or Heads Up Display is a digital transparent display that is projected onto the windshield of the vehicle, without requiring the drivers to take their eyes off the road. This technology was initially developed specially for aircraft pilots, and for military aviation.

As the name suggests, HUD allows the driver to view information with the head positioned ‘up’ and looking forward. This eliminates the need to look away from the road ahead in order to look at the different instruments.

At present, the automobile industry has two different mechanisms for employing HUD. One way is to have a small, transparent plastic disc called the ‘Combiner’ that is used as a mirror for the information shown. Another way is to use the outer surface of the windshield in such a way that any image projected onto it will get reflected back to the driver.

HUD can very well be one of the best safety systems in a car, when combined with other advanced technologies like Adaptive Cruise Control and On-board cameras. Latest HUD systems can use the on-board cameras to detect where the lane markings are on the road, and project them on the windshield exactly where they appear.

This scenario is particularly useful during common weather problems that can cause major safety hazards for drivers, like fog. HUD systems usually display features like speedometer, tachometer, navigation systems, etc. in production cars.

which the driver engages the handbrake of the car momentarily, while pulling away on an inclined surface.

There can be a number of parameters that can be detected to decide when to actuate the Hill Start Assist system. Some of these parameters are engine torque, backward motion, inclination, brake application, clutch engagement, etc. An array of sensors is also employed to control the braking under this system, like angle sensors, pressure sensors, torque sensors, wheel-speed sensors, etc. All of these along with the Electronic Control Unit (ECU) and Brake actuator determine when and how much of braking force has to be applied to prevent the vehicle from rolling backwards.

Hill Descent Control (HDC) is a mechanism that allows a smooth and controlled descent down the hill, without the driver even needing to touch the brakes! Isn’t it fantastic? It utilizes the ABS system to monitor and control each wheel’s speed, and it will apply the brakes automatically in case of the vehicle accelerating without the driver’s input.

Some manufacturers offer the option to increase or decrease the speed of the vehicle downhill, using buttons just like a Cruise Control system. Most vehicles have some kind of indicator on the dashboard to show when all the prerequisites are fulfilled and the system is available to be engaged.

Electronic Stability Programme
Also known as Electronic Stability Control (ESC), it is a generic term used for systems designed to improve a vehicle’s handling, particularly at the limits where the driver might lose control of the vehicle. ESP compares the driver’s intended course of direction with the actual path of the vehicle, in real-time.

It monitors the wheel speed sensors, steering wheel angle, lateral acceleration, yaw rate, etc. to detect if the driver is losing control. ESP employs in tandem, ABS, Electronic Brake Force Distribution (EBD), Traction Control System (TCS) and Active Yaw Control (AYC) to stabilize the vehicle and keep it on the road.

ESP regulates slip rates in longitudinal and lateral planes, and reduces the danger of stability loss during braking,
acceleration or steering under sudden evasive manoeuvres. It can modulate braking forces at individual wheels to correct the vehicle’s trajectory. It also ensures shorter braking distances even when road surfaces are different, for example, when there is grass or mud on one side of the wheels.

**Park Assist**
With limited parking spaces in cities, parking your vehicle is seldom an easy task. Improper parking often causes long traffic disruptions or scratches on vehicles and quite often is the result of the driver’s poor parking skills.

The Park Assist technology allows drivers to park their vehicles safely and efficiently with little driving input. The cars equipped with Parking Assist systems can steer themselves into a parking space without requiring any steering input from the driver. When engaged, the system starts working by identifying a suitable parking space with the help of sonars, cameras and sensors installed on the vehicle.

Once the driver shifts into reverse, the system will take over the steering control, while the driver only controls the accelerator and brake pedals. There will be audio-visual directions as well to direct the driver into the parking space. The systems are designed to disengage automatically, in case the steering wheel is touched, the brakes are firmly pressed or if the vehicle exceeds a set speed. The reverse parking camera display shows different coloured lines and arrows to show the ideal vs real-time directions of the vehicle.

These partially autonomous systems might be restricted to the high-end cars in the market as of yet, but are certainly a big step in automotive evolution.

**Pedestrian Airbag**
Perhaps the most ingenious of all pedestrian safety technologies yet, the Pedestrian Airbag automatically inflates on impact to cover the windscreen and lessen any injuries, particularly to the pedestrians. Volvo is the first company to introduce 'pedestrian airbag’, a technology first used in their Volvo V40.

As per a 2013 ‘Note for the media’ issued by WHO, more than 270,000 pedestrians all over the world are killed every year in road accidents. The ‘Pedestrian Airbag’ is probably the only one-of-its-kind feature that offers protection to the pedestrian, and also minimizes impact forces and resultant injuries.

The airbag is designed to protect pedestrians from accidental injuries at city speeds, from around 12 mph to 31 mph. The mechanism employs multiple sensors around the front of the car to identify the nature of collision, and then transmits this data to the car’s on-board system for analysis. The airbag covers the lower part of the windscreen, as well as the structural A-pillars, which are likely to cause the most severe injuries to the head.

Whenever the sensors detect an object resembling a human leg, the first reaction of the system is to release the bonnet hinges of the car with the help of a specifically-developed pyrotechnical release mechanism. The airbag inflates within a few hundredths of a second, which raises the bonnet up by 10 cm and thus helps reduce some of the impact force.
Cruise Control
Often over long distances driver fatigue leads to vehicle crashes. Cruise Control is a system that automatically controls the speed of a vehicle on long stretches of highways with constant flow of traffic.

Cruise Control is a servomechanism – an automatic device that uses error-sensing negative feedback to correct the action of a mechanism. The purpose of Cruise Control is to accurately maintain a speed set by the driver without any outside intervention by controlling the throttle-accelerator pedal linkage. Although at present, there are many highly advanced versions of Cruise Control available in some luxury cars, basically there are two main types.

- **Dynamic Cruise Control:** It is not exactly a collision avoidance system, but only serves to maintain a desired vehicle speed as set by the driver. This system takes the speed signal from multiple sources like speedometer cable, wheel speed sensors, rotating driveshaft, etc. The driver can set different functions with the help of buttons, usually mounted on the steering wheel. Some of the typical functions provided on a normal Cruise Control system are ON, OFF, RESUME, SET/ACCEL and COAST. The SET/ACCEL button sets the speed of the car and pressing it once will accelerate it by 1 mph, two by 2 mph and so on. Pressing in the opposite direction will decelerate the vehicle in a similar way. As a safety feature, the cruise control system will disengage as soon as you hit the brake pedal.

- **Adaptive Cruise Control:** With the number of cars on roads increasing exponentially, the functionality of normal (Dynamic) cruise control is becoming obsolete. As a result, a more sophisticated and refined version, known as Adaptive (or Autonomous) Cruise Control (ACC) is quickly gaining popularity. It lets the car hold a speed but allows adjustment to changing traffic conditions with the help of automatic braking and acceleration. A radar sensor continuously monitors the distance to the vehicles in the front and automatically adjusts speed to maintain a proper safe distance, thus preventing rear-end collisions. If you are approaching a slower vehicle ahead or if another vehicle cuts in front of you, the adaptive cruise control slows down the car by initiating corrective controls in the engine and braking system. Also, if you’re driving too close to the vehicle ahead, it will warn you in two steps. First, it will alert you with audio and visual signals, and in the second step, with a short braking jerk. The system will also bring your car to a complete stop, if required. Some ACCs employ a laser, while others a radar or camera. But irrespective of the technology, ACC can work in day or night. However, its abilities can be hampered by extreme conditions, such as heavy rain, fog, or snow.

Advanced Automotive Materials
Well, this one is not exactly a technology rather a development, but by no means a small one! In earlier times, metals like steel and aluminium were the only choice of materials available to build cars. But thanks to the advancements in material sciences and production technologies, cars are now being built using exotic materials as precious as gold!

High quality plastics are not only lightweight but easy to mould, and strong as well. Besides, they can absorb the crash forces much effectively and are considerably durable. Similarly, magnesium is one of the lightest metallic structural materials available and is almost 1.5 times less dense than aluminium. Wheels made from magnesium are significantly lighter than aluminium alloy wheels, and have almost the same strength.

Likewise, titanium has the highest strength of any material for its density. This helps reduce the car’s weight and provides tougher parts.

Another exquisite material, Carbon Fibre is made by embedding small strands of carbon into a fibrous mat and sealing it by a plastic or resin. For the sake of comparison, a 750 grams block of Carbon Fibre possesses almost the same strength of a 4 kilogram block of steel, which is simply amazing!

Most of these exotic materials are at present limited to racing cars or the most expensive cars in the world, but their engineering advantages mean that they might be used in normal production cars in the near future.

Modern technology and advanced engineering are helping build cars that are safer than ever before. Driverless cars are already being tested on pilot basis in some parts of the world. And automobile manufacturers are increasingly employing high end systems on their mass production vehicles. Even the governments are looking beyond conventional road safety laws, and focusing on vehicular safety as well. Inevitably, technology and automation have only become indispensable in modern cars, and hopefully for the better. Because our cars are no more just a means of commuting from one place to another, they are somewhat our second home!

So, the next time you venture out in a car it would do well to study the protective systems your vehicle ensures.

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