Vehicle Safety Systems **Thomas Mcguire, James O'Doherty, David Kennedy**

Introduction

This project aims to showcase modern vehicle safety systems. This project will go into detail about modern airbag systems and seat belts which are responsible for countless lives saved and are now industry standard.

History of vehicle safety systems

Seat Belts:

Seat belts were first invented in the 19th century by an English engineer named George Cayley. He originally created it to use on his glider (r1). The first seat belt patent for a car was granted in 1885, but it wasn't until the 1950s that seat belts began to be widely used in cars (2). The three point harness seen in today's cars was invented by a Volvo engineer in 1959, Volvo collectively decided to leave the patent open to allow other automakers to use their design in the interest of safety. By the 1970s all vehicles had to be fitted with seat belts by law and on the 1st of February 1979 it became the law that all persons in the front of the car had to wear a seatbelt in Ireland (3). Seat belts have been proven to reduce crash-related injuries by about 50%, saving over 15,000 lives in the United States in 2017 alone. Notably, over half of the fatalities—51% of people aged between 13 and 54—were not wearing a seatbelt at the time of the crash (4).

Airbags:

The first patent for an airbag specific to automobiles was filed in 1951 by John Hetrick. Widespread adoption of airbags didn't start until the 1990s, with modern vehicles fitted with multiple airbags and complex systems (5). It became law in 1991 for all passenger and light commercial vehicles to be built with airbags for both the driver and passenger (6). Airbags mainly protect the head and spinal cord. Studies have shown that airbags lower the risk of receiving serious head injury by up to 85% in the event of a head on collision (7).

Modern airbag systems



Figure 1: Airbags in a vehicle (8)

Airbags are inflatable cushions designed to prevent occupants of a vehicle from coming into contact with hard surfaces within the vehicle. There are multiple types of airbags, which serve different purposes in different areas of a vehicle. These include curtain airbags for side windows, frontal airbags around the dashboard and steering wheel along with seat belt airbags built into seat belts. Airbags use three parts to work, these are the impact sensor, the inflation module and the bag itself.

Different sections of a car will have impact sensors tracking the direction and force of an impact to determine whether airbags should be inflated and which ones. Inflation modules then inflate the airbags in 25 milliseconds at speeds of up to 160 mph (9).

The airbags are designed to fully inflate with harmless nitrogen gas, creating a protective cushion between occupants and hard surfaces. They then immediately deflate to allow passengers to exit the vehicle or for emergency services to access those inside.



Figure 2: Driver's airbag components



A safety belt's sole purpose is to minimize serious injury or death. In the event of a crash, a seat belt works by slowing the driver down at the same rate as the vehicle, preventing them from being thrown forward and striking an object that would cause sudden deceleration. A typical seat belt consists of a lap belt, which rests over your pelvis, and a shoulder belt, which extends across your chest, as seen in figure 3. When worn correctly, it will apply most of the stopping force to the rib cage and the pelvis, which are relatively sturdy parts of the body, and the force is spread across a large surface area (10).



Seatbelts play a vital part in the protection of occupants in a crash. Seat belts work using retractor mechanism, which restricts movement when a vehicle comes to an abrupt stop. This is achieved by a weighted pendulum, which acts as a lock for the mechanism as illustrated in figure 4.





Safety belts



Figure 3: Three-point safety belt



Figure 5: Seatbelt restriction mechanism as a complete unit.

Conclusion

In conclusion, safety continues to be a top priority in the automotive industry. As vehicles become heavier and faster, the potential risks in the event of a collision also increase. This ongoing challenge is driving manufacturers to invest heavily in the research and development of advanced safety technologies. As a result, modern vehicles are significantly less likely to be involved in fatal accidents compared to older models.

For example, one study found that while vehicles built before 2001 made up 20 per cent of cars on the road, they accounted for 36 per cent of fatal crashes. In contrast, vehicles manufactured between 2012 and 2017 made up just over 30 per cent of cars on the road but were involved in only 13 per cent of fatal crashes (11).

Looking ahead, the future of automotive safety will be shaped by advancements such as autonomous vehicles, Al-driven crash prevention, and vehicle-to-vehicle communication. These technologies aim not only to protect occupants during a crash but to actively prevent collisions,

Figure 6: A Volvo seatbelt sporting "Since 1959" on it's buckle

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