

# The Evolution of Safety at Toyota - Part 1: The Origins of Toyota's Life-Saving Designs

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Toyota's work on safety innovation dates back more than seven decades. The philosophy of safety evolved with changes in society, from a time when safety wasn't a major element of automotive design to today, where mitigating crashes, reducing fatalities, and minimizing injuries inside and outside of vehicles permeates the company's operations.

The story of safety at Toyota runs parallel to how the global motoring public has come to think about cars and transportation. As automobiles became more popular, units in operation increased, and the risk of crashes increased. As experts began to study crashes in more detail, they came to realize that there were three important elements to consider: the driver, the environment, and the vehicle.

At the beginning, the emphasis was about what caused crashes and how to protect vehicle occupants if a crash did occur. Toyota and other automakers focused their efforts on reducing the risk of injury to occupants in various crash modes.

Driving a vehicle is a significant responsibility, and poor driver behavior remains the leading cause of crashes. Driver education is an important part of overall vehicle safety, as are behaviors like drunk driving, distraction, and the lack of universal seat-belt use. Road design is also an important consideration, and highway engineers have worked for years to root out and correct design flaws that can contribute to crashes. Toyota has supported and continues to support efforts to educate drivers through various modes of communication, and by supporting other external efforts made by organizations that share Toyota's goal of encouraging safe and responsible vehicle operation.

In fact, Toyota has worked hard on all elements of auto safety. But the thing it has the most control over is vehicle design – using engineering innovation to help prevent crashes or to reduce the likelihood of injury if a crash does occur. In this first article, we'll look at Toyota's efforts on safety from the 1960s through some active safety innovations the company rolled out in the early 21st century.

### **Early Efforts**

Early efforts to make vehicles safer focused on the collision after the collision – how people could be seriously injured or killed by coming into contact with parts of the interior after a violent crash. Eventually, as cars became more and more crashworthy, the biggest safety targets became preventing crashes altogether.

As Toyota's efforts on safety evolved over the years, continuous improvement (“kaizen”) and reducing the injuries and fatalities associated with motor-vehicle travel came to embody one of the core elements of the company's philosophy: respect for people.

“Safety is a part of everything we do,” said Kevin Ro, Director of Technical and Regulatory Affairs in Toyota Motor North America's Washington, D.C. office. “We want our customers to be safe. Each person on our team thinks about our own family members behind the wheel of the vehicles we build. When we do our work, we take every aspect of safety very seriously. And that runs up and down the whole company.”

### **The Age of Passive Safety**

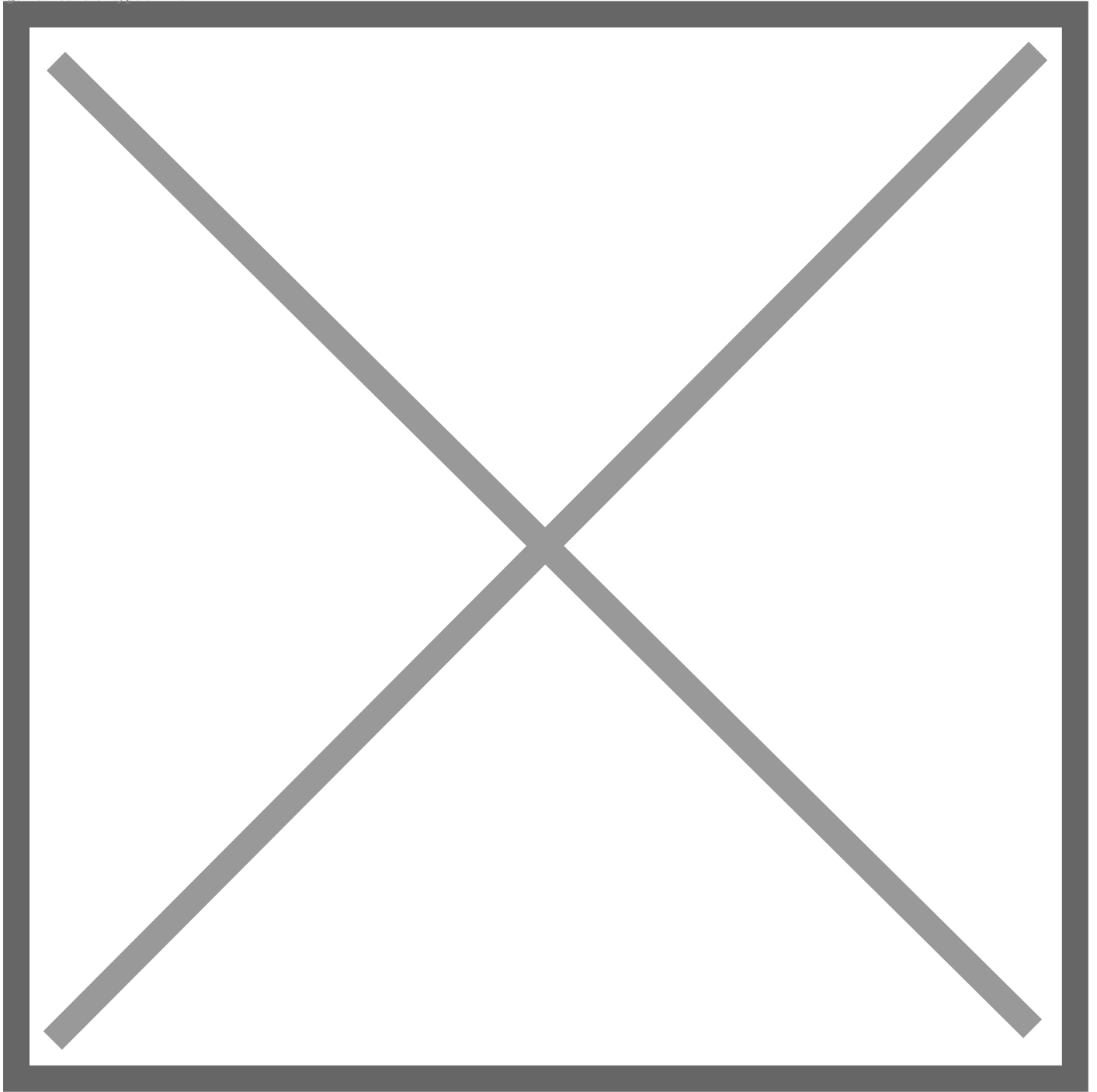
In the 1960s, cars had surged in popularity after World War II. Automobiles were playing an increasingly important part of Japan's economy and improving consumers' lives. But with increased numbers of vehicles, came an increased number of crashes, and a corresponding increase in crash-related injuries and fatalities.

In the U.S., Congress passed the National Traffic and Motor Vehicle Safety Act in 1966, which established the first-ever mandatory safety standards for new cars. Among the requirements were seat belts and energy-absorbing steering columns. Other new requirements included stronger seatbacks, shock-absorbing materials for interior surfaces, door locks that could stay closed in a crash, and laminated windshield. By that time, Toyota had established its U.S. sales arm and was selling Toyopet Crown sedans and Land Cruiser SUVs. Toyota saw

compliance with the U.S. FMVSS and other national standards as an important way to protect the motoring public from the unreasonable risk of injury.

The initial focus in vehicle design was protecting vehicle occupants if a crash occurred. As many injuries and fatalities occurred after a collision because unrestrained drivers were ejected from vehicles or came into violent contact with parts of the car, seat belts were one way that automakers could help keep people in place. More advanced body and frame design with newer materials permitted superior energy absorption while also improving the ability to protect the space around the occupant, thereby reducing the risk of injury caused by contact with the vehicle's structure. As an example, engine compartments were redesigned to absorb the enormous forces involved in higher-speed crashes.

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*Toyota first installed the seatbelt in 1963, in the Toyota Pacifica Convertible*

By 1967, Toyota had redesigned its flagship Crown sedan and incorporated 20 separate design changes to make drivers and passengers safer in the event of a crash. That's the same year Toyota introduced its first 3-point safety belt. The improvements continued after that. In 1968, the company brought out a crushable front body – what's become known as a crumple zone, a way for that part of the vehicle to dissipate the crash energy away from vehicle occupants. In 1971, Toyota introduced a new method of attaching windowpanes directly to the

vehicle body to help prevent passenger ejections.

In 1968, Toyota launched a national children's traffic safety campaign in Japan, including picture books distributed to nursery schools and kindergartens. That started a long-term national awareness about traffic safety that continues today. Toyota also participated in in-depth police investigations into crashes that added to awareness about how people, the environment and vehicle design contributed to motor-vehicle related injuries.

### **Toyota's Experimental Safety Vehicle**

In the 1970s, spurred by the U.S. Department of Transportation, auto companies, universities and researchers designed concept cars that explored new approaches to protecting auto occupants, without regard to commercial viability.

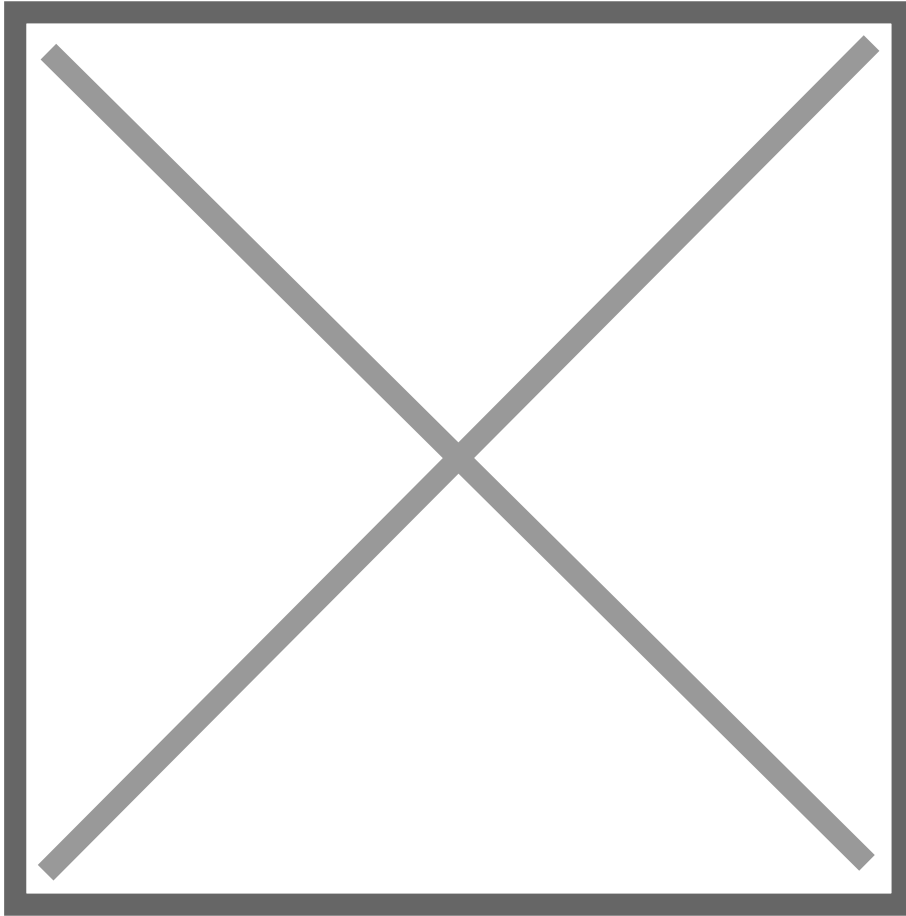
This resulted in some radical designs incorporated into cars known as Experimental Safety Vehicles (ESVs). Toyota worked with the Japanese government on a 2,000-pound vehicle with exemplary safety performance. This vehicle had an S-shaped front frame to absorb force of 80 km/hour crash, as well as a shock-absorbing bumper and a single-piece plastic instrument panel.

The ESV was mainly a research-and-development effort, a way to stretch the ingenuity of Toyota's engineers to think big and make creative breakthroughs. Nevertheless, many ESV innovations found their way onto production vehicles, including the Toyota Corona.

The Corona, Toyota's best-selling compact car for years, incorporated ESV ideas like an energy-absorbing steering column, automatic lap belts, disc brakes and electronic skid control.

### **Braking, Steering and Traction — Active Safety**

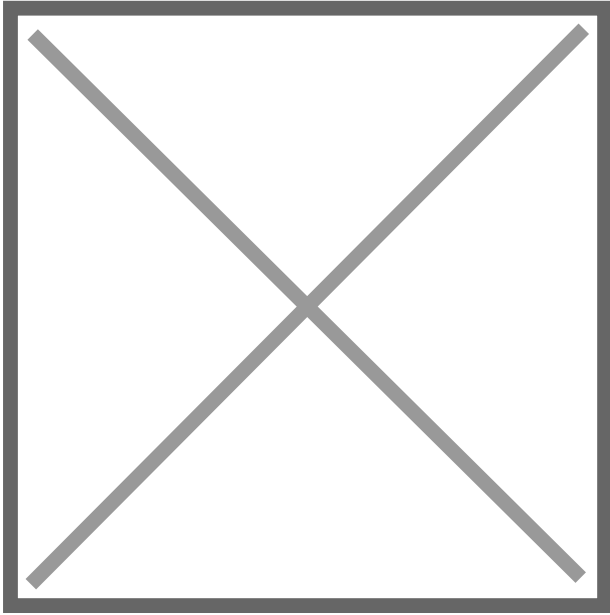
Over the decades, technological advances in areas such as sensors and computing power allowed automotive engineers to focus more heavily on reducing crash-related injuries and fatalities by mitigating or preventing the crash itself. Introduced in 1971, anti-lock brakes and electronic skid control proved effective in improving a driver's ability to maintain or regain control of their car, whose tires may be in a state of reduced traction.



*Graphic used to show the difference when using ABS in sudden braking;  
Toyota first installed electronically controlled, anti-skid brakes in the  
Toyota Crown in 1971*

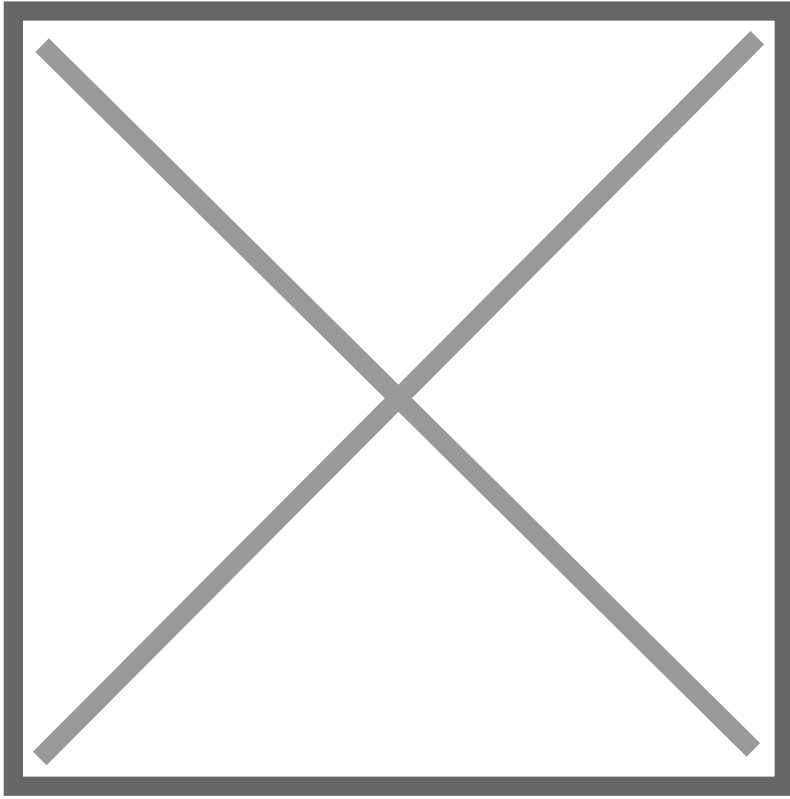
By the 1980s, Toyota had become a fixture in American life. Ads like “Oh What a Feeling” filled the television airwaves. Toyota became the nation’s leading import brand. Toyota’s national sales headquarters opened in Torrance, California in 1982. Toyota teamed up with GM to build a jointly run plant in Fremont, California in 1984. And the Lexus brand launched in 1987. The Georgetown, Kentucky plant that would be the model for manufacturing in North America produced its first Camry in 1988.

In the 1990s, Toyota refined the seat belt, which has proved to be one of the most effective pieces of safety equipment. Pretensioners were introduced in 1991, and force limiters followed in 1997. Meanwhile in the 1990s, airbags became standard equipment that, when combined with proper seat belt usage, took passenger safety to the next level. Drivers’ side airbags were standard in 1992, and passenger-side devices were added in 1996. More advanced “depowered”, airbags came in 1997, lessening crash risks for smaller adults and children. Knee airbags followed, and were first introduced by Toyota in 2002.



Toyota released its first vehicles with an airbag in 1989, the Toyota Crown and Lexus LS400; airbags were not required in all passenger vehicles until 1997

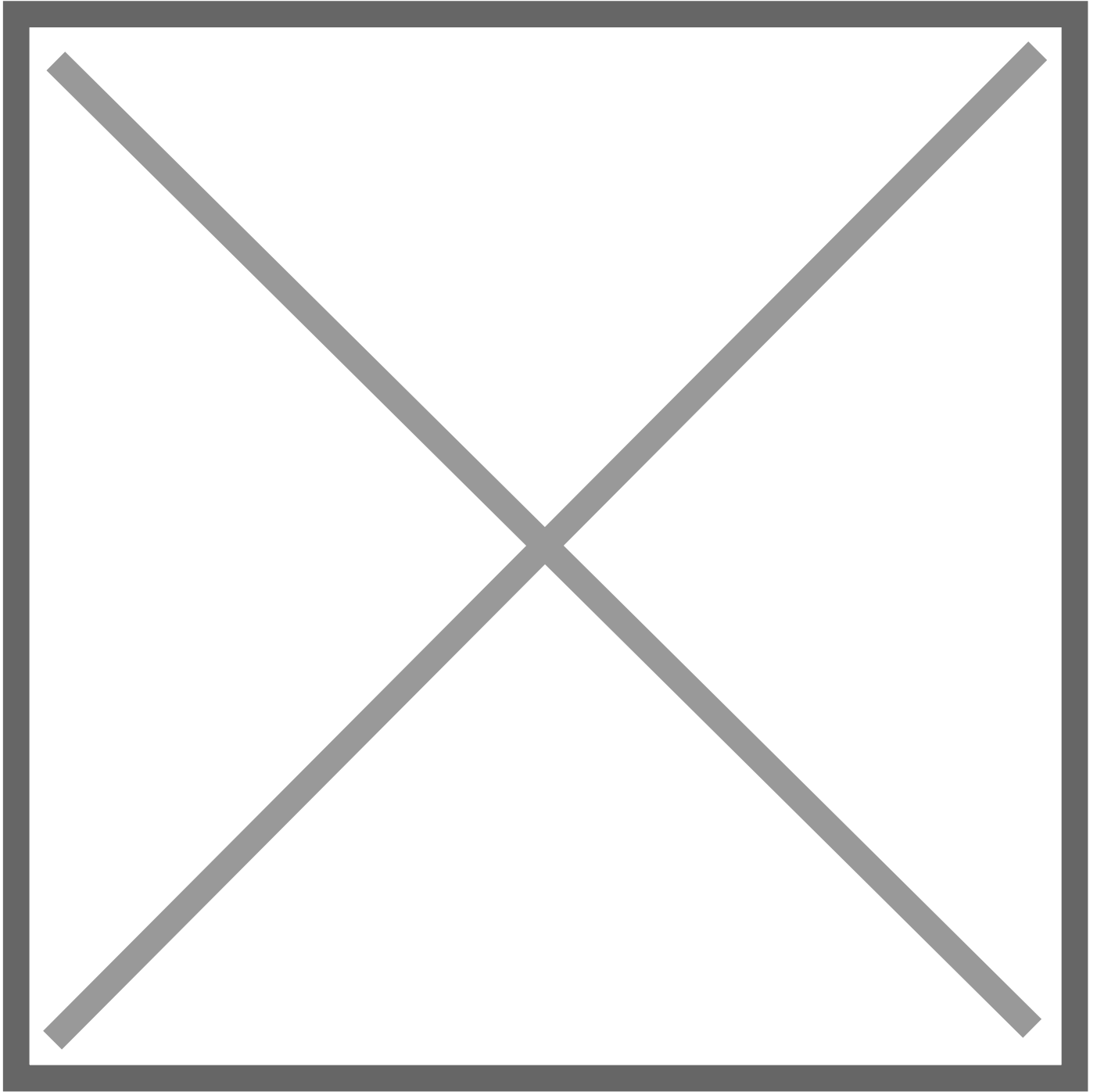
In 1995, Toyota introduced a system to enable drivers to maintain control of vehicles when traction is compromised and the vehicle is deviating from its intended path of travel. Called vehicle stability control (VSC), under certain circumstances, that system would prove effective in mitigating crashes caused by loss of control.



*Graphic shows how VSC helps maintain traction in an oversteer condition; VSC was first installed in 1995 in the Toyota Crown Majesta*

Also, about this time, a review of vehicle body design was explored as an approach to passive safety technology. The technology developed as a result was called Global Outstanding Assessment (GOA), and was adopted, to start with, in the Starlet released in Japan in December 1995. The name GOA was intended to signify performance in line with the corporate goal of achieving a leading level of safety performance. The development of GOA included experiments, unusual at the time, simulating offset collisions, or frontal collisions between two vehicles, not head-on, but with a slightly staggered contact.





*Toyota Starlet Lufre (Reflét) X (1995)*

### **Integrating Computer Power**

Toyota created a suite of active-safety features, called the STAR Safety System, and rolled it out on its product line in the mid-2000s. In 2004, Toyota rolled out its Vehicle Dynamics Integrated Management system, or VDIM. This was a way to link traction control, electronic stability control, electronic steering, and other systems with a computer. The idea was to improve responsiveness to driver input, performance, and overall safety. VDIM calibrated driver steering input according to vehicle speed, with active steering and throttle adjustments to

improve ride quality and directional control during performance driving.

The system was first introduced in the Japanese domestic market in July 2004, when Toyota debuted VDIM on the Toyota Crown Majesta. This was followed by the VDIM's export debut on the third generation Lexus GS, which was launched in 2005.

The STAR system was designed as a suite of six safety features, including Vehicle Stability Control (VSC), Traction Control (TRAC), Anti-lock Brake System (ABS), Electronic Brake-force Distribution (EBD), Brake Assist (BA) and Smart Stop Technology (SST). In the 2000s and 2010s, the features were available as part of different trim packages. In 2020, Toyota made the STAR system standard across its vehicle line.



*The Star Safety System was a suite of six safety technologies designed to help the driver when they are in harm's way; the system became standard on most new Toyota vehicles in 2010*

Toyota's ultimate goal is to eliminate traffic fatalities, said Derek Caveney, Senior Executive Engineer at Toyota Motor North America. Toyota believes that three parts of the safety equation need to be integrated to realize that vision: people, the traffic environment and vehicle design, he said. One thing remains unchanged, Toyota is still committed to focusing on the vehicle design's role in that equation, while also supporting efforts that relate to

the other two variables.

That involves research into driving behavior, safety education for drivers and passengers, studying crash-reduction data and developing human-centric safety technology, he said.

“We put an incredible amount of effort into the design and safety of our systems,” Caveney said.

With more than six decades of incorporating safety innovation into Toyota vehicles, every team member works to make sure the vehicles that roll out of the factory provide, either as an option or standard, safety technology that can help protect vehicle occupants.

“Our corporate philosophy is about quality, durability and reliability,” Caveney said. “It’s so the real-world benefit is there to cover real-world usage.

– Story by Jeff Plungis