The Evolution of Safety at Toyota – Part 3: The Future of Safety

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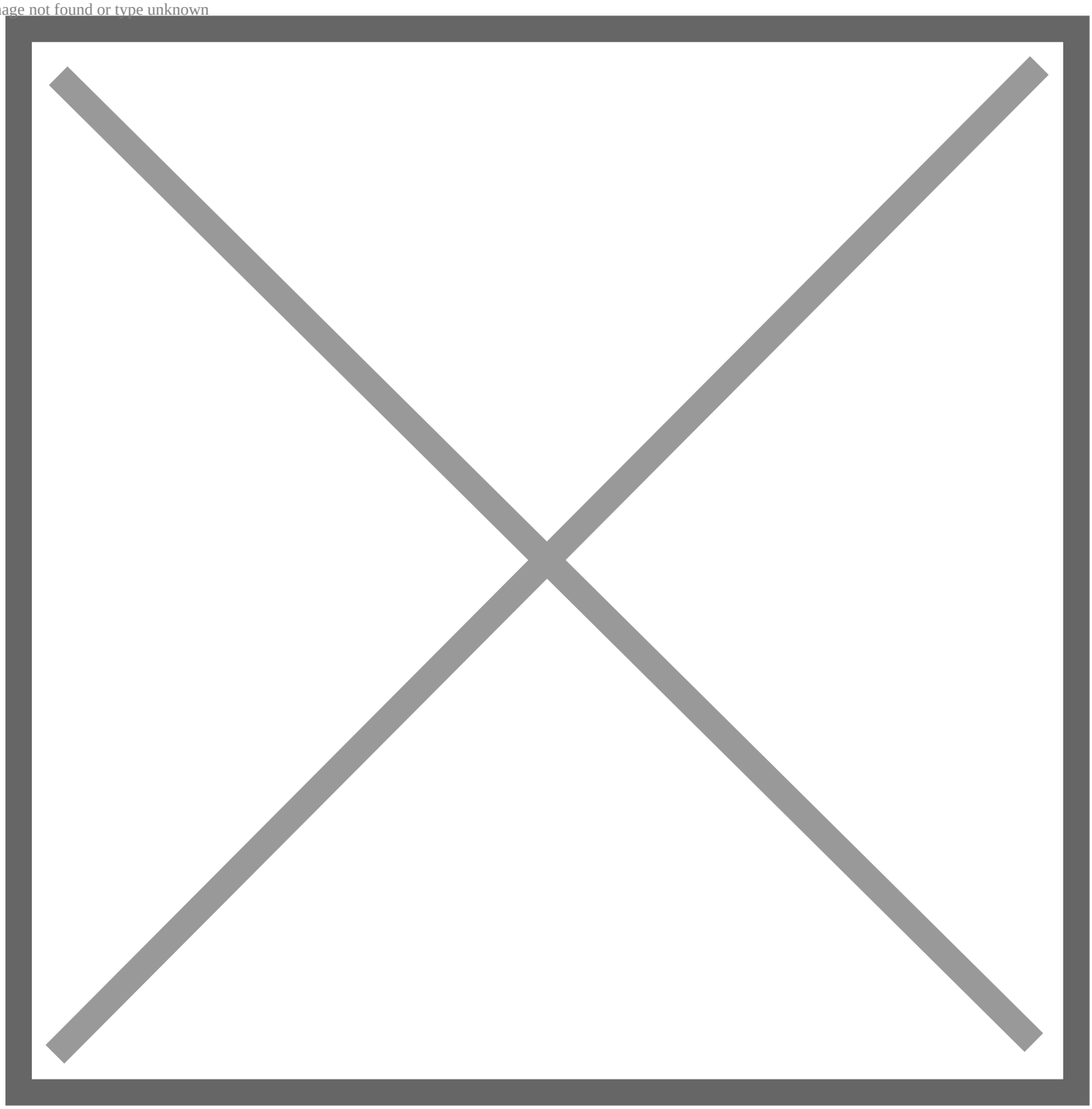


When Toyota first started concentrating on vehicle safety in the 1950s, no one would have been able to imagine the cars of today. Cars that have airbags and seat belts that help occupants walk away from crashes that used to be fatal. Cars that sense their surroundings and act as a teammate to help reduce the negative effects associated with driver errors by steering or braking themselves.

The vehicles of tomorrow are likely to be just as dramatically more advanced compared with today's cars.

In the past, much of Toyota's attention has been to keep vehicle occupants, drivers and passengers, safe. It involved adding features to help mitigate against more types of crashes and adding layers to minimize injuries. Looking toward the future, goals may include finding solutions to try and minimize stress and overcome mental lapses for drivers. This will take advantage of new technology capable of monitoring driver alertness, assist in building awareness of what's going on outside the vehicle, and potentially help mitigate the negative consequences of driving mistakes. Of course, balanced against that goal is the sometimes competing goal of respecting the customer's autonomy and minimizing unwanted alerts to encourage use of the available technology.

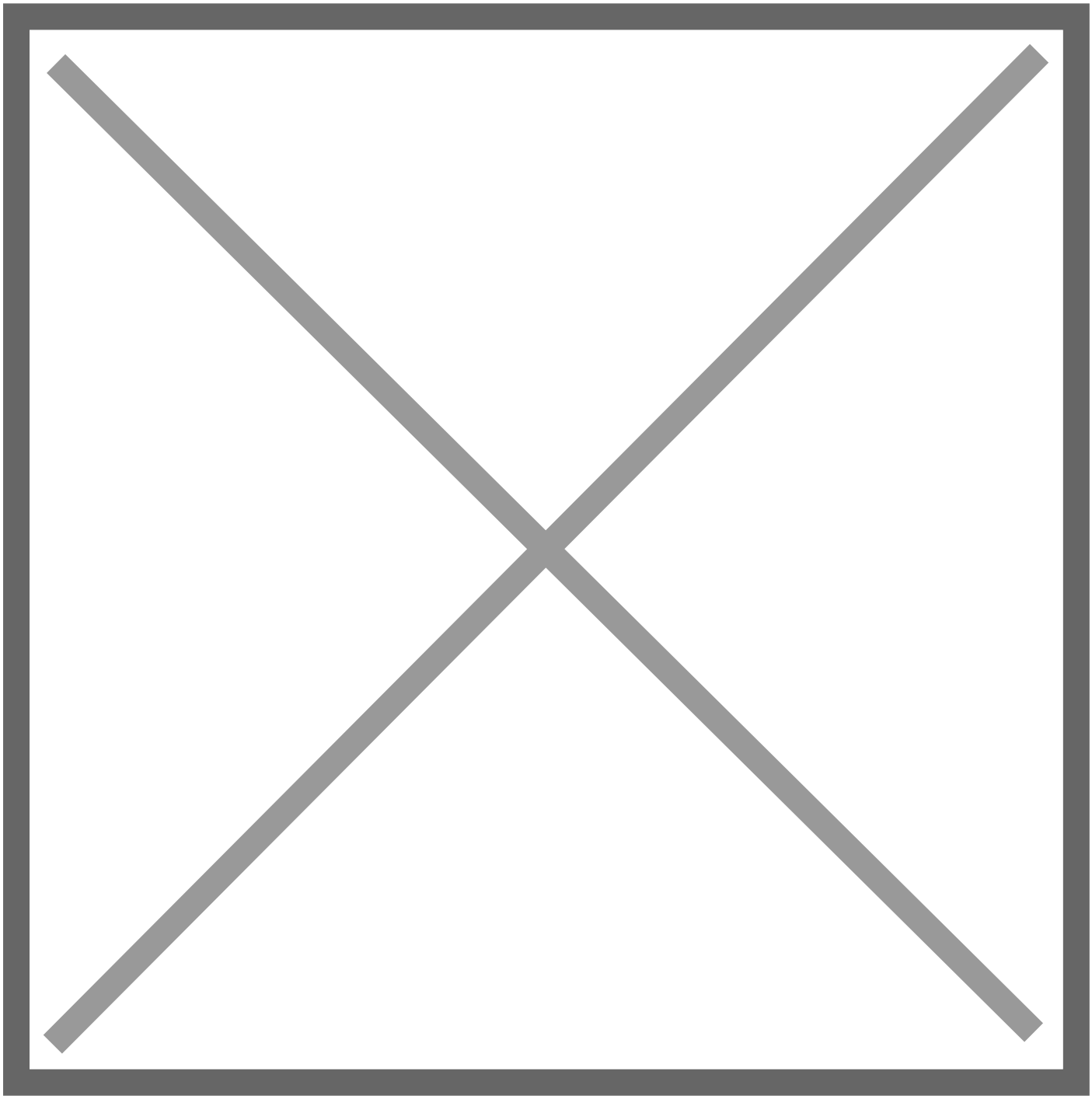
Toyota believes that in addition to manufacturing safe vehicles, automakers can help raise the safety awareness of drivers as well as pedestrians and others who use the road, said Ken Koibuchi, a fellow at the Toyota Vehicle Development Center. Part of this is working with national and local governments to assist in offering advice on how to improve the road environment in which vehicles drive in order to continue our march toward our ultimate goal of zero fatalities and injuries in traffic accidents.

"We conduct research to understand human driving behavior and psychology, and then we develop vehicles that make use of the results," Koibuchi said. "We confirm the effectiveness and usage of commercialized safety technologies, and further analyze and study the results to apply them to the next stage of development."

An example of this is the work to improve Toyota Safety Sense (TSS). After TSS started becoming on Toyota and Lexus vehicles in 2015, there was a significant reduction in rear-end crash rates within five years, said Nick Sitarski, vice president of Integrated Vehicle Systems at Toyota Motor North America.

By crunching data and evaluating how that correlates with certain types of crashes, like those with other road users, Toyota added or refined capabilities in each successive version of TSS. Pedestrians, bicyclists, and nighttime driving conditions have been recent focuses.

"Toyota wants to provide a safe and pleasurable driving experience for our customers," Sitarski said. "Our main focus with respect to active safety is how to reduce the number of serious accidents."



The Toyota e-Palette is an example of a future autonomous vehicle equipped with advanced safety systems.

To that end, TSS has been incrementally enhanced to help prevent crashes at higher speeds vs. earlier versions. That will continue. Another recently developed technology is an emergency driver safety system that can help stop the vehicle if the driver is unresponsive.

Toyota's work on semi-autonomous driving functions, to date, is seen by the company as a convenience technology, and is being integrated as an option in some cases for customers into today's vehicles. The

availability of some of these options are well before fully autonomous cars take over all driving functions from humans – which may be decades away. Some of the sensing systems, more powerful processors and improved software that will be part of the future are already helping to improve advanced driver-assistance systems, which, in turn, are already assisting drivers today.

“Seat belts, body structure, and airbags are certainly important items. At the same time, we’re working to have an additional positive impact by eliminating or reducing the severity of an accident to begin with,” Sitarski said. “It gets back to the Toyota way of thinking about solving problems. You try to address the problem with the earliest root cause.”

Another way Toyota works to improve safety for its customers and other parts of society is through its Collaborative Safety Research Center (CSRC). Since 2011, CSRC has embodied Toyota’s philosophy of working with partners to not only build better vehicles but to make society as a whole better. Toyota employs a core group of world-class research scientists at its labs in Ann Arbor, Michigan. But it also funds collaborative projects at partner universities, and it works with safety stakeholder groups, government agencies and professional organizations to identify the missing pieces and create new solutions that may improve safety.

Research findings get applied to Toyota vehicles once the technology is deemed reliable and appropriate. But CSRC results also are shared openly with other research institutions and safety professionals. Other automakers are welcome to use the information, too.

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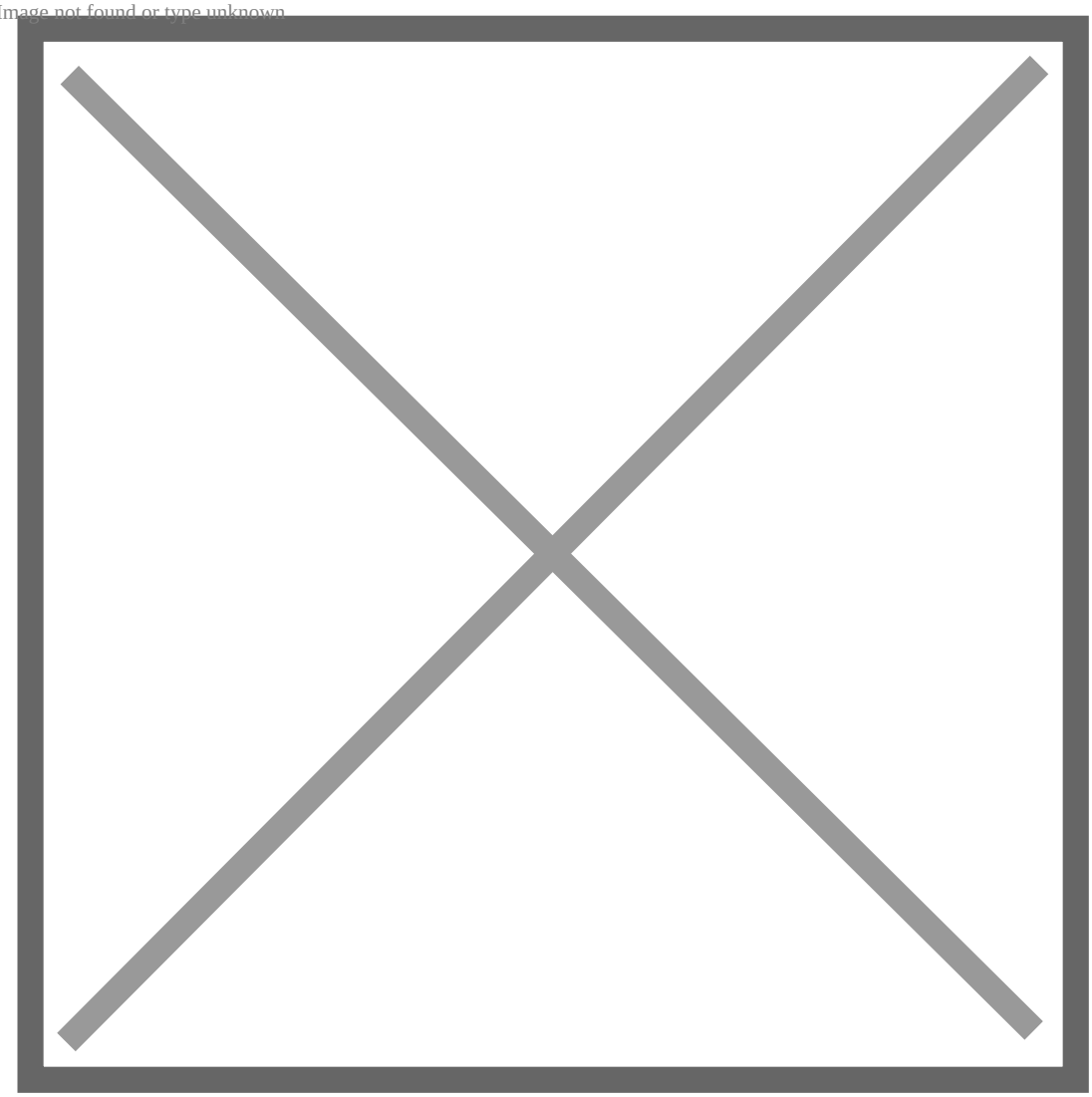


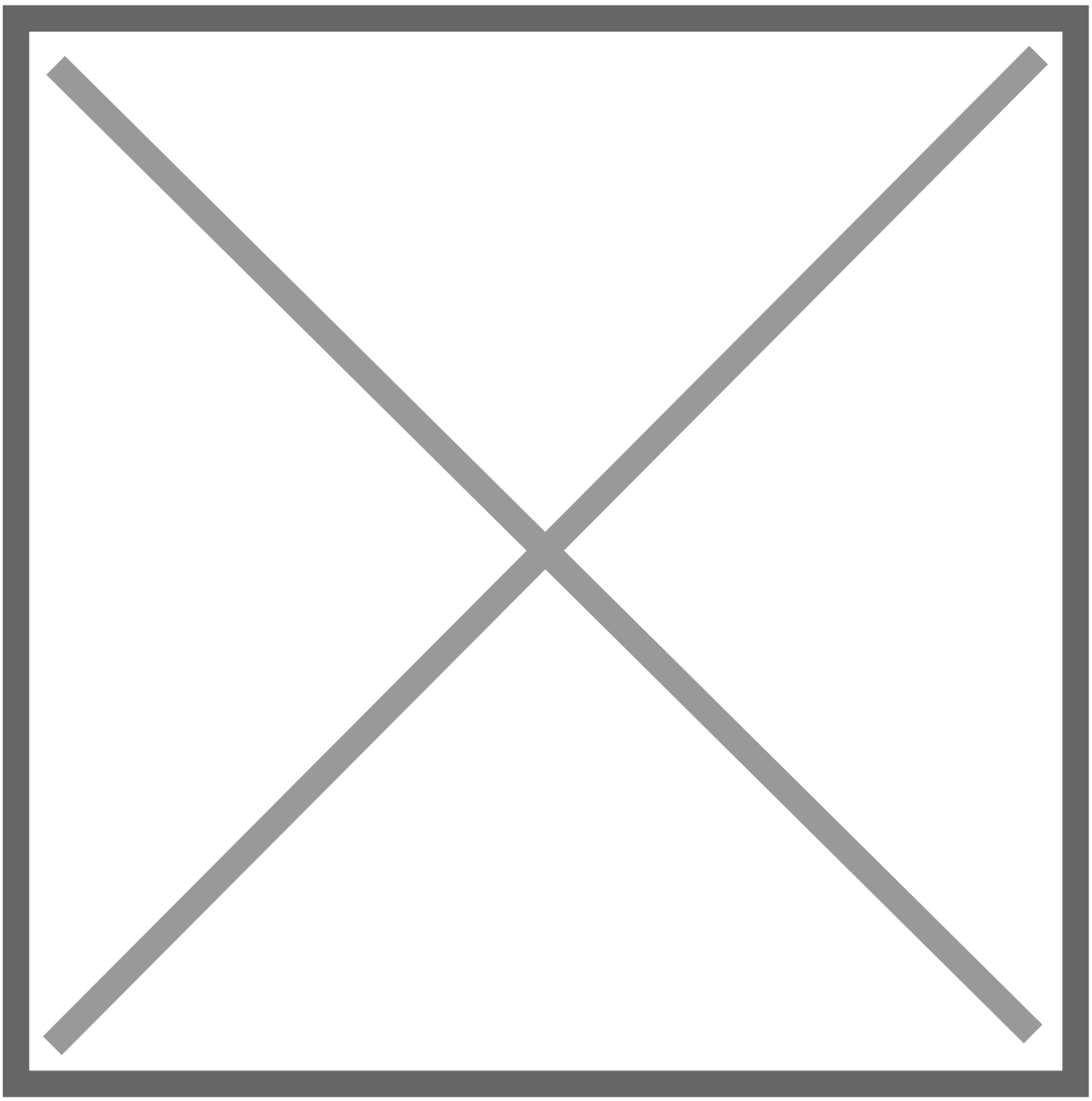
Total Human Model for Safety, or THUMS, is a virtual human body model software program for computer analysis of human body injuries caused in vehicle collisions.

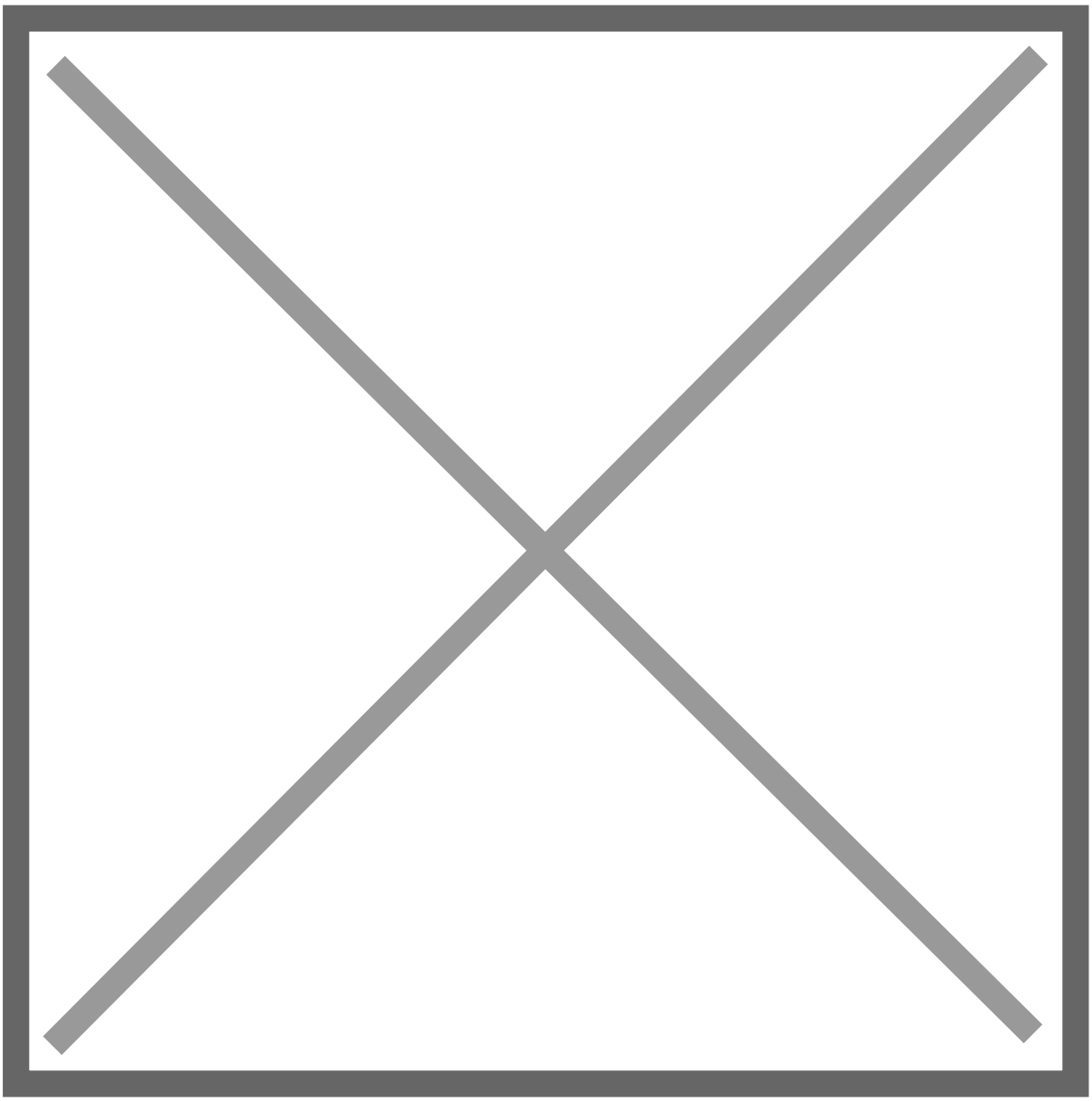
An example is the development of the Total Human Model for Safety, or THUMS. THUMS is a digital crash-test dummy developed jointly by Toyota and Toyota Central R&D Labs, Inc. This virtual human-body model emulates techniques engineers use to build cars with computer-assisted design. Using these computer models enables designs to evolve more quickly. It takes many years to do the kind of painstaking work to develop a new physical crash-test dummy.

In order to get to the next level of safety, Toyota is looking at further advances in peripheral monitoring, which are sometimes referred to as “Look Out technologies.” It’s also exploring, “Look In technologies,” which use technology to monitor what’s happening inside the cabin.

“You can expect to see more features,” said Danil Prokhorov, CSRC director. “In the future, with more advanced sensing, you can potentially identify even more internal and external situational cues that can indicate something is wrong.”

Toyota’s Proactive Driving Assist (PDA) aims to give the driver a sense of security, even under normal driving conditions. PDA slightly decelerates the vehicle when a crossing pedestrian is detected by the system and the driver releases the gas pedal. It also may change the driving path within the lane to give more safety margin by steering control when a pedestrian, bicyclist or parked vehicle is detected at the roadside ahead. Deceleration assist kicks in when the car enters a curve at a high speed or approaches stopped traffic, amplifying the driver’s action of taking his foot off the gas pedal.





Proactive Driving Assist helps drivers in maneuvers such as deceleration assist to reduce speed when traveling behind a vehicle or on curves.

Advancements like Proactive Driving Assist rely on analysis of real-world driving. By analyzing vehicle data, Toyota has identified some of the driving maneuvers used by drivers prior to a crash. In the future, this type of data and others will become even more common when developing and fine-tuning safety advancements for vehicles. To be able to collect certain data, new Toyota vehicles are now being equipped with data communication modules. With customer approval, these transponders provide one way to provide the company with data that can be used to improve future vehicles.

A potential next step is to further understand the workings of the human brain so that automotive neural networks can become more effective, Prokhorov said. Whether automakers can equip vehicles with technologies and functions that approach human capabilities is still a big question. But more experimentation based on

innovative research with various architectures, algorithms and hardware means neural networks will continue to evolve.

“Then you could potentially have more and more sophisticated architectures onboard, such that [vehicles] will be become smarter and smarter,” Prokhorov said. “With this kind of automotive brain, future vehicles may be able to match or even exceed competencies of vigilant human drivers.”

– Story by Jeff Plungis