

A TIMES INVESTIGATION

# Data point to Toyota's throttles

The automaker cites floor mats, but reports of acceleration trouble shot up after the move to electronic control.

KEN BENSINGER  
AND RALPH VARTABEDIAN

Eric Weiss was stopped at a busy Long Beach intersection last month when he said his 2008 Toyota Tacoma pickup unexpectedly started accelerating, forcing him to stand on the brakes to keep the bucking truck from plowing into oncoming cars.

Toyota Motor Corp. says the gas pedal design in Weiss' truck and more than 4 million other Toyota and Lexus vehicles makes them vulnerable to being trapped open by floor mats, and on Wednesday, it announced a costly recall to fix the problem.

But Weiss is convinced his incident wasn't caused by a floor mat. He said he removed the mats in his truck months earlier on the advice of his Toyota dealer after his truck suddenly accelerated and rear-ended a BMW.

"The brakes squealed and the engine roared," the 52-year-old cabinet maker said of the most recent episode. "I don't want to drive the truck anymore, but I don't want anyone else to, either."

Amid widening concern over unintended acceleration events, including an Aug. 28 crash near San Diego that killed a California Highway Patrol officer and his family, Toyota has repeatedly pointed to "floor mat entrapment" as the problem.

But accounts from motorists such as Weiss, interviews with auto safety experts and a Times review of thousands of federal traffic safety incident reports all point to another potential cause: the electronic throttles that have replaced mechanical systems in recent years.

The Times found that complaints of sudden acceleration in many Toyota and Lexus vehicles shot up almost immediately after the automaker adopted the so-called drive-by-wire system over the last decade. That system uses sensors, microprocessors and electric motors — rather than a traditional link such as a steel cable — to connect the driver's foot to the engine.

For some Toyota models, reports of unintended acceleration increased more than five-fold after drive-by-wire systems were adopted, according to the review of thousands of consumer complaints filed with the National Highway Traffic Safety Administration.

Toyota first installed electronic throttles in 2002 model year Lexus ES and Camry sedans. Total complaints of sudden acceleration for the Lexus and Camry in the 2002-04 model years averaged 132 a year. That's up from an average of 26 annually for the 1999-2001 models, the Times review found.

The average number of sudden-acceleration complaints involving the Tacoma jumped more than 20 times, on average, in the three years after Toyota's introduction of drive-by-wire in these trucks in 2005. Increases were also found on the hybrid Prius, among other models.

Toyota spokesman Brian Lyons said the automaker could not explain the trend.

## Recalled models

Toyota said it is recalling more than 4 million vehicles to address the risk of floor mats trapping open the gas pedal. Here are the vehicles and model years affected:

- Toyota Camry: 2007-10
- Toyota Prius: 2004-09
- Toyota Avalon: 2005-10
- Toyota Tacoma: 2005-10
- Toyota Tundra: 2007-10
- Lexus ES 350: 2007-10
- Lexus IS 250 and IS 350: 2006-10

But Toyota has consistently held that electronic control systems, including drive-by-wire, are not to blame.

"Six times in the past six years NHTSA has undertaken an exhaustive review of allegations of unintended acceleration on Toyota and Lexus vehicles," Toyota said in a statement this month. "Six times the agency closed the investigation without finding any electronic engine control system malfunction to be the cause of unintended acceleration."

NHTSA officials have consistently said they have not found any electronic defects. "In the high-speed incidents, which are the type of crashes in which death or serious injury is most likely, the only pattern NHTSA has found to explain at least some of them are pedal entrapment by floor mats," a spokeswoman said in a written statement.

Toyota has been under a spotlight since the San Diego crash, in which the driver's des-

perate efforts to stop the car were recorded on a 911 emergency call made by a passenger.

After that incident, The Times reported that sudden-acceleration events involving Toyota vehicles have resulted in at least 19 deaths since the introduction of the 2002 model year. By comparison, NHTSA says all other automakers combined had 11 fatalities related to sudden acceleration in the same period.

Independent electronics and engineering experts say that the drive-by-wire systems differ from automaker to automaker and that the potential for electronic throttle control systems to malfunction may have been dismissed too quickly by both Toyota and federal safety officials.

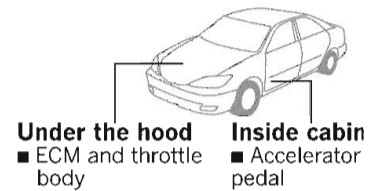
Unlike mechanical systems, electronic throttles — which have the look and feel of traditional gas pedals — are vulnerable to software glitches, manufacturing defects and electronic interference that could cause sudden acceleration, they say.

### Ask the computer

“With the electronic throttle, the driver is not really in control of the engine,” said Antony Anderson, a Britain-based electrical engineering consultant who investigates electrical failures and has testified in sudden-acceleration lawsuits. “You are telling the computer, will you please move the throttle to a certain level, and the computer decides if it will obey you.”

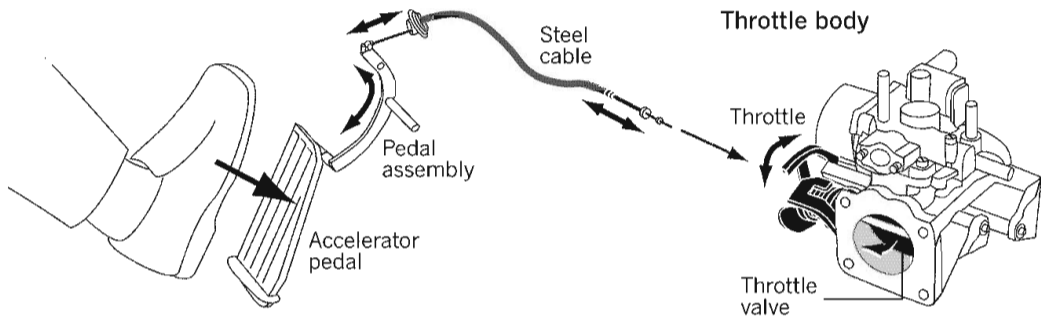
## Comparing acceleration systems

Toyota and Lexus began switching their throttle controls from mechanical to electronic in 2002. Here’s how the two systems work:



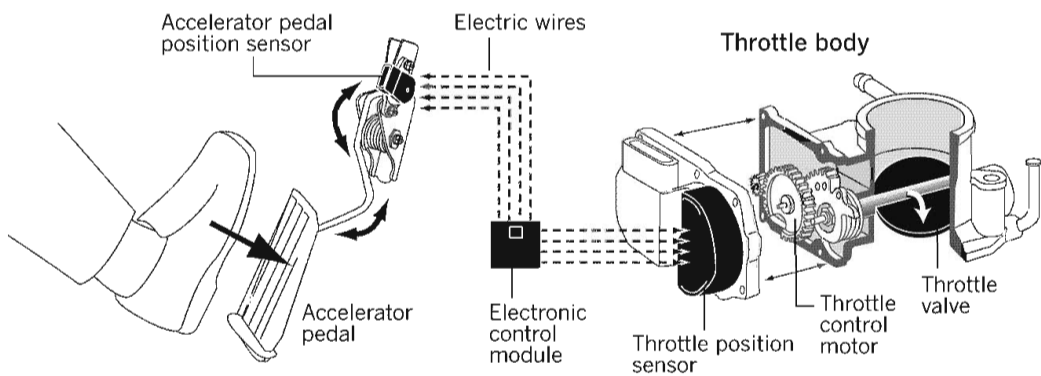
### The old mechanical way

When the driver presses down on the accelerator pedal, it pulls a cable that physically opens the throttle valve, thereby regulating the intake of air and gasoline to the engine.



### The new electronic way

An electronic sensor detects the position of the accelerator pedal and sends a signal to the vehicle’s computer, or electronic control module (ECM). The module then signals the throttle to regulate air intake.



Sources: Toyota, Times research. Graphics reporting by WIL RAMIREZ

Note: Items are representational and not to scale

MATT MOODY Los Angeles Times

Although Toyota says it knows of no electronic defects that would cause a vehicle to surge out of control, it has issued at least three technical service bulletins to its dealers warning of problems with the new electronic throttles in the 2002 and 2003 Camry.

The throttle systems on six-cylinder engines can cause the vehicle to "exhibit a surging during light throttle input at speeds between 38 mph and 42 mph," according to one of the bulletins that was published by Alldata, a vehicle information company. The solution provided to dealers was to reprogram the engine control module.

NHTSA, the nation's primary agency for auto safety, has conducted a total of eight investigations of unintended acceleration in Toyota vehicles since 2003, prompted by defect petitions from motorists and its own examination of complaints. But the agency has tested electronic throttle systems only twice in those probes, its records show.

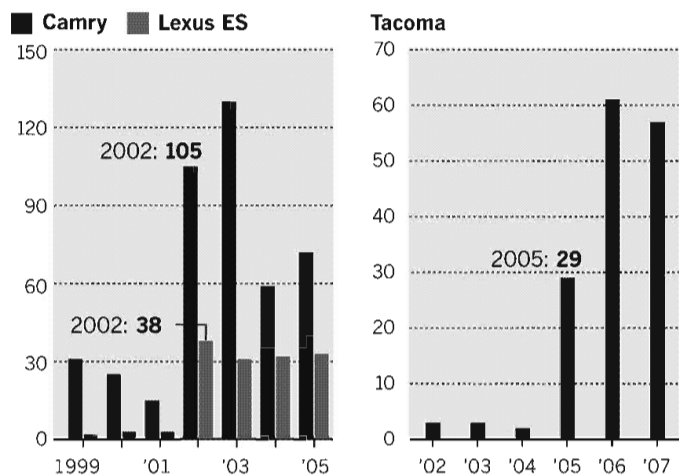
Three years ago, the agency asked Toyota to test an electronic throttle component from a 2006 Camry, a task the company delegated to the Japanese supplier that manufactured the part. The supplier exterminated the throttle, and then NHTSA allowed Toyota to keep virtually the entire 74-page report almost completely confidential. The report, posted on the agency's website, has dozens of redacted pages.

The other test, conducted at a NHTSA laboratory in Massachusetts, found that a Toyota throttle exhibited unusual behavior when researchers applied a magnetic field to the device's sensitive electronics. Engine speed surged by 1,000 revolutions per minute, according to a 2008 report by the agency's Vehicle Research and Test Center.

Nonetheless, the lab concluded that the system "showed no vulnerabilities to electric signal activities." The details of the experiment were not explained in the lab report,

## A surge in reports

Complaints of sudden acceleration for Toyota and Lexus models increased significantly after the adoption of electronic throttles, in 2002 for Camry and Lexus ES, and 2005 for Tacoma.



Sources: National Highway Traffic Safety Administration, Times research

MATT MOODY Los Angeles Times

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— ANTONY ANDERSON,  
electrical engineering consultant

and the agency never explained the apparent contradiction.

### Advanced systems

The electronic throttle was first introduced by BMW in 1988. Like a conventional throttle system, it controls the flow of air into the engine. Today, every new Toyota vehicle sold in the U.S. uses drive-by-wire. The systems cost less to install on the assembly line and increase the efficiency of the vehicle.

To run these advanced throttle systems, each auto-

maker develops its own electronic control modules and proprietary software that has unique control logic. The operations of the systems are opaque to consumers, as are potential failures.

In a worst-case scenario, consultant Anderson says, stray electrical voltages, electromagnetic signals or bad sensor readings could cause an undetectable error within the car's network of up to 70 microprocessors, setting off an unpredictable chain of reactions. One of those, he said, could be

a command to completely open the throttle.

The auto industry has battled allegations of electronic defects in sudden-acceleration lawsuits for more than two decades, arguing that they are not caused by any vehicle defect.

Richard Schmidt, a former UCLA psychology professor and now an auto industry consultant specializing in human motor skills, said the problem almost always lies with drivers who step on the wrong pedal.

"When the driver says they have their foot on the brake, they are just plain wrong," Schmidt said. "The human motor system is not perfect, and it doesn't always do what it is told."

To be sure, the complaints by Toyota and Lexus owners about sudden acceleration involve a tiny share of the company's vehicles on the road.

But runaway acceleration represents a high proportion of the complaints filed by consumers about Toyota in federal databases. For the 2007 Lexus ES sedan, for example, 74 of 132 complaints filed with NHTSA alleged sudden acceleration.

And independent experts say the number of complaints actually filed is only a tiny fraction of all potential problems, because most people don't bother filing a report.

Critics say NHTSA hasn't kept pace with technological changes.

The auto industry has undergone a technological revolution in the last decade, and today about 25% of a vehicle's price reflects its electronics content. Nonetheless, NHTSA has adopted few, if any, standards for designing or testing vehicle electronics, according to industry officials. Indeed, the agency's two-page safety standard for accelerators was adopted in 1973.

Dale Kardos, who runs a consulting firm that helps automakers with regulatory issues, said manufacturers had repeatedly tried to get that standard updated because they feared they could no longer comply. "The industry would

like to see standards written to reflect modern technology," Kardos said.

Instead, independent organizations and the industry itself are setting standards and developing safety policies. The International Organization for Standardization, a nongovernment group that sets industrial standards, recently introduced a new standard for automakers to protect vehicle electronics.

Supplier TRW Automotive Holdings Corp., which makes computerized controls for brakes and air bags, said its systems have multiple layers of redundancy to make sure electronic faults are detected and isolated.

"Manufacturers' standards are far above the regulatory standards," said Ian Harvey, TRW's executive lead for electromechanical compatibility. "You wouldn't want somebody to make a cellphone call and the air bag goes off. That potentially could happen if you didn't take the proper precautions."

### Test drives

Despite the huge increase in complexity, when NHTSA investigators conduct field tests of alleged malfunctions of Toyota throttle systems, they rarely do more than drive suspect vehicles for a few miles, test the brakes and plug a diagnostic tool into their onboard computers to look for error codes, investigation records show.

Michael Pecht, a professor of mechanical engineering at the University of Maryland who has studied sudden acceleration for 10 years, said it's nearly impossible to replicate an electronic control system fault simply by driving a short distance.

"These are not things that occur every day. If it occurred a

lot, you could track it down. If it occurs once in 10,000 trips, then it is difficult to find," he said.

What's more, said Huei Peng, a mechanical engineering professor at the University of Michigan and a specialist in vehicle control systems, many of the kinds of electronic errors that a modern car is susceptible to are not detectable by the car's fault detection system.

"When there's no error code, it doesn't mean there's no error," Peng said.

Despite the potential risks associated with electronic systems, NHTSA's own reports indicate it often does not test them while investigating unintended acceleration.

In a 2005 probe of Lexus ES vehicles, NHTSA reported that its investigator reviewed two vehicles that had allegedly surged out of control, but that "no interrogation or communication with the electronic systems was performed" before giving them a clean bill of health.

Texas resident Thomas Ritter, who has a mechanical engineering degree and spent 15 years as an engineer at General Motors, Chrysler and other auto and truck makers as well as 25 years designing oil exploration equipment, believes Toyota's acceleration problem lies in the electronics.

Last July, his wife was driving her 2006 Lexus ES 330 with four grandchildren near Houston when it accelerated out of control. To avoid a wreck, she crossed four lanes of traffic before smashing into a masonry sign, totaling the car and deploying the air bags. No one was seriously injured.

"When you think about a machine operated by computers, almost anything can go wrong," Ritter said.

### A 'smart pedal'

Toyota announced Wednesday that it had developed a series of fixes to prevent floor mats from causing sudden acceleration.

In 4.26 million vehicles in the U.S. and Canada, Toyota said it would cut off a segment of the accelerator pedal and then later install a newly designed pedal. It also will add a so-called smart pedal, software that cuts engine power any time both the accelerator pedal and brake pedal are depressed at the same time.

Such software has already been adopted as a safety feature by a number of automakers, including Volkswagen, Audi, Porsche, BMW, Nissan and Chrysler, the companies said.

Independent auto safety experts said that though all of Toyota's fixes would help reduce the problem, it has not gotten to the root cause.

"These incidents are coming in left and right where you can't blame the floor mats," said Sean Kane, president of the consulting firm Safety Research and Strategies. "So they are chipping away at a problem that is widespread and complicated without having to unravel a root cause that could be very expensive."

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