Update Report: Toyota Sudden Unintended Acceleration

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Executive Summary

This report is an update to Safety Research & Strategies report *Toyota Sudden Unintended Acceleration*, released on February 5, and an Addendum, released February 17. It examines in detail the developments and the documents that have been added to the public record in the eight months since. Multiple congressional investigations and litigation have introduced new information that clarify what happened before the August 29, 2009, crash of California Highway Patrol Officer Mark Saylor and the events that ensued. The tragic crash, which killed Saylor, his wife, young daughter and brother-in-law, became a watershed for a problem that appeared in 2002 and for which many elements remain unresolved.

Before Saylor, Toyota Sudden Unintended Acceleration (SUA) was the subject of eight National Highway Traffic Safety Administration (NHTSA) investigations and two agency-influenced and limited recalls. After the Saylor crash, highly public and resonant through the 911 recording of passenger Christopher Lastrella's panicked call to an emergency operator, nine more investigations were launched – by Congress, by NHTSA and by other governmental agencies. Toyota, while admitting no wrongdoing, embarked on an aggressive public relations campaign to quiet critics and regain its reputation through a series of new recalls which only partially address the defects in their vehicles.

The new documents show that behind Toyota's confident statements of no electronic problems, fail-safes that always work as designed and promises to regain customer trust lay a company beset by quality problems created and exacerbated by its growth to the position of the world's largest automaker. Internal documents show that workers throughout the company – from the trade unions to the vice-presidency – were concerned that the reliability of Toyota's products was slipping, and undermining the very quality that persuaded millions to buy their vehicles.

In a November statement, Irv Miller, then-Group Vice President of Toyota Motor Sales, U.S.A., Inc., told ABC News: "We can come up with no indication whatsoever that there is a throttle or electronic control system malfunction."[1] More recently, the automaker's Chief Quality Officer for North America affirmed this position to reporters. "Toyota has not found a single case in which electronics would lead to sudden unintended acceleration," said Steve St. Angelo, of the company's investigations of 4,200 acceleration-related complaints.[2]

New information shows that this is not true. Toyota has had indications – at least since 2003 – that its new Electronic Throttle Control Intelligent (ETCS-i) could and did malfunction and that its electronic fault detection strategy has gaps. The Engine Control

[1] Toyota Recall Fails to Address 'Root Cause' of Many Sudden Acceleration Cases, Safety Expert Says; ABC News; November 25, 2009

[2] Toyota's Reviews Find No Electronic-Throttle Acceleration Flaw; Alan Ohnsman; Bloomberg/Business Week; October 4, 2010

Module (ECM) does not always catch the errors it is designed to catch. This deficiency takes on a greater significance with a multi-root cause problem like SUA. If the ECM doesn't catch the discrepancy between driver commands and vehicle behavior, the system can not fail safely. Compounding these issues are ergonomic factors and the lack of overarching safety backstops that make it difficult for Toyota drivers to control a vehicle that experiences unintended acceleration.

In dealing with defect investigations and issues, Toyota appears to have chosen a containment strategy. The automaker attempted to address throttle surges in the early-model Camry vehicles with a Technical Service Bulletin (TSB). When that fix did not stem the stream of SUA complaints, and the trend was so strong that even NHTSA – with far fewer complaints than the automaker itself – took note, it sought to limit investigations by asserting that consumers' experiences, as described, simply could not have happened; and that its system could not fail without the ECM taking note. Toyota had an opportunity in 2007 to install a more universal fix – a brake override. Instead, it chose to push for a limited floor mat recall.

In dealing with public questions about its product reliability, Toyota has countered critics with information purporting to exonerate its electronics. It has employed Exponent, a California research firm which markets itself as a "science and engineering consulting firm that provides solutions to complex problems,"[3] to dispute outside electronics experts who have called some of its systems into question. Congress, however, using peer reviewers, criticized Exponent's published reports for lacking a scientific process. Toyota has historically and consistently stated that its Event Data Recorder (EDR) is a prototype tool that has never been scientifically validated, and its results are not reliable. Yet, it has used EDR data in cases where it is alleged to support Toyota's contention that the driver, rather than the vehicle, erred.

Advice from public relations consultants and press releases not withstanding, Toyota has not been transparent. It has sought and obtained confidentiality for any substantive document NHTSA has asked it to produce. It continues to do so. This is notable, because there are many other defect investigations in which the vast majority of the information submitted by the automaker is made public.

New publicly available documents show that NHTSA has been concerned about the early model Camrys since 2003, but seemed to falter in ferreting out the root causes. The agency has strong core competencies and has conducted thorough investigations of complex mechanical defects in the past. In the case of SUA, however, the public record shows that NHTSA has been hampered by an institutional bias towards mechanical interference and driver error, based on old data gathered in the era of prior technology.

Three vehicles stand out in the complaint data: The Camry, the Lexus ES and the Tacoma. Yet, there is little in the public record to suggest that NHTSA has employed a scientific process in using the data to determine what about the designs of these vehicles has resulted in the high number of complaints following the introduction of ETCS-i in

[3] 10-K Filing; Exponent; January 1, 2010

these models. The agency, faced with limited resources and a complex problem, has logically addressed the easy mechanical issues. In the case of later model Camry and ES models, that fix is the all-weather floor mat (AWFM) recall to prevent entrapment of the accelerator pedal in vehicles that were fitted with heavy rubber all-weather designs. After the Saylor crash, Toyota, under apparent pressure from NHTSA, expanded its limited 2007 recall of AWFMs and implemented a brake override. Regardless of other potential root causes, a brake override would provide drivers with an additional protection to reduce unwanted engine torque. Toyota documents show that the company began examining competitors' implementation of brake override in 2007 but ultimately negotiated the cheapest recall remedy until bad press and a determined agency intervened.

Nonetheless, many troubled vehicles remain unrecalled and the newly released documents show that NHTSA has and continues to focus on driver error. For example, Toyota's 2009 Recall 09V388 covered 4.4 million vehicles, comprised of seven Toyota and Lexus models spanning model years 2004-2010. Toyota has not extended any remedies to owners of some models, such as the 2002-2006 Camrys, despite high numbers of SUA claims.

After 2004, when NHTSA opened and closed its only defect probe of a possible electronic cause of Toyota SUA complaints, Preliminary Evaluation (PE) 04-021, the agency sidestepped any vehicle issue that pointed beyond human or mechanical factors. ODI investigators knew that the Camry was a problem. Yet, lacking expert knowledge in electronic systems, a scientific approach for using the data and isolating differences among the ETCi systems in vehicles with the highest complaint rates, and testing protocols beyond traditional techniques, NHTSA investigators time and again return to theories of driver error and floor mat entrapment – even when evidence strongly suggests otherwise.

Finally, the public record, as created by the news media, has largely stayed on the surface of the issue. For example, this summer, when a retiring NHTSA manager leaked an agency report on EDR readouts obtained by NHTSA in 58 suspected SUA events, journalists – without access to the data – reported uncritically that driver error was responsible for 60 percent of the crashes studied. Many failed to put that information into context that was easily obtained via a Google search – that Toyota has always claimed that its EDR data was unreliable. Second, fewer, if any journalists, actually read the data, which, even a cursory examination shows are rife with inconsistencies.

Today there are now no fewer than seven investigations of various aspects of the problem: Toyota SUA, its recalls or NHTSA's investigative process. Will any of this activity advance the understanding of the agency, automakers or the public about automotive electronic faults, detecting those malfunctions and establishing remedies which address them?

Introduction

On February 5, three weeks before the first Congressional hearing, Safety Research & Strategies (SRS) released *Toyota Sudden Unintended Acceleration* the first, and to date, only comprehensive accounting of Toyota's Sudden Unintended Acceleration (SUA) problems.[4] The report and an Addendum[5] provided a factual accounting of the sprawling record and were available to the public on SRS's website.

In the eight months hence, much more information has come to light, but nothing that changes the outlines traced by the incomplete public record. Rather, new details have been released in the course of multiple Congressional investigations and litigation that fill in those lines and bring the picture into sharper focus. It is clear, for example, that the linchpin of Toyota's defense is broken. Despite Toyota's repeated assertions in early investigations that SUA cannot occur and that its electronic fault detection system is infallible, the automaker has known – now and in the past – that neither of those statements is accurate.

In February, we concluded:

- SUA is occurring among a wider range of Toyota models and model years than has been investigated or remedied.
- Neither Toyota nor NHTSA has identified all of the causes of SUA in Toyota and Lexus vehicles. Both have adopted the simplest, mechanical explanation for these incidents.
- Pedal entrapment may be a cause of SUA. The data show that floor mat interference cannot be the only cause.
- Sticking accelerator pedals do not appear to cause the SUA events as reported by drivers.
- NHTSA has not yet conducted a thorough investigation of all possible causes. It has been hampered by decisions to limit data and exclude data which do not fit its hypotheses. The agency may lack expertise and resources. It has been unduly influenced by its past experiences investigating SUA in mechanical throttle systems. Toyota's electronic system is significantly different and more complex than the older, mechanical systems.
- Toyota has not accepted its responsibility in manufacturing and selling vehicles which have design flaws that can contribute to SUA. It has insisted that its system cannot fail and has blamed drivers and suppliers.
- Toyota's past recalls have not been fully effective. Drivers of recalled vehicles with implemented countermeasures have experienced SUA.

[4] Toyota Sudden Unintended Acceleration*;* Sean Kane et al.; February 5, 2010; Available at: http://www.safetyresearch.net/Library/ToyotaSUA020510FINAL.pdf

[5] Addendum to Safety Research & Strategies February 5, 2010 Report: Toyota Sudden Unintended Acceleration; Exclusion of Early Camry Deaths Hamper Later Investigations; February 17, 2010; Available at: http://www.safetyresearch.net/Library/report_addendum.pdf

- Toyota has not addressed SUA problems in some of the models and model years with the worst complaint records, many of which are not eligible for any of the current remedies.
- In view of the automaker's and the government's inability to isolate all of the causes of SUA, Toyota should implement a brake-to-idle override on all affected models and model years to ensure public safety.

These conclusions stand today, but they have gained some urgency. Congress invited Toyota to submit data that would exonerate itself from the charge that an electronic malfunction may be a root cause of SUA. According to a Congressional investigation the company failed to produce any documents to buttress its claims of innocence.[6] Instead, the investigation concluded that Toyota has chosen to fight a public relations battle. The automaker continues to claim that its electronics system could not be at fault and to blame drivers, pedals and floor mats for SUA events. It has poured resources into commissioned science, image-repair and vigorous attacks on critics. There is little evidence that it had expended the same effort in getting to the root causes of SUA in its vehicles.

The National Highway Traffic Safety Administration (NHTSA), which, in the past, failed to fully investigate or find any cause for the constant stream of complaints – short of accelerator pedal entrapment by floor mats or interior trim, has stuck closely to the path of driver error. This is insufficient. As electronics take over more basic driving functions, such as braking, steering and acceleration, it is imperative that NHTSA understand the complexity of these systems, and more importantly, how they fail and the unintended consequences that can accompany failures. NHTSA needs more current expertise and the ability to stay abreast of new technology in order to effectively regulate and investigate. Motor vehicles continue to undergo massive transformations from nearly all mechanical controls that operated directly from driver input to sophisticated electronic controls that integrate previously unlinked systems together and carry out functions based on interpretations of driver inputs. While the Toyota SUA issue appears to be generally a rare occurrence, ignoring causes beyond the mechanical and driver error issues ignores this larger shift and its implications for future regulations and defect investigations.

This time-consuming and painstaking process has not occurred in a vacuum of scientific abstraction. We would be remiss if we did not acknowledge the powerful human distractions that could influence the on-going investigations and their outcomes. Individual and institutional reputations are at stake and billions of dollars hang in the balance. Seven years after Toyota drivers began lodging SUA complaints and NHTSA and Toyota began minimizing and dismissing them, the agency and the automaker have powerful disincentives to find themselves wrong. Congress has been accused of taking Toyota to task to buoy the fortunes of American-based automakers. Lawyers have been accused of inventing a scandal for profit. Writers of every stripe, most woefully uninformed, readily cast blame on the editorial pages.

[6] Update on Toyota and NHTSA's Response to the Problem of Sudden Unintended Acceleration; Transcript; Hearing of the Oversight and Investigations Subcommittee of the House Energy and Commerce Committee; May 20, 2010

Lost in this tornado of political and economic forces is the motoring public. Drivers and their passengers will be the true losers if the authorities lose sight of the lives that have been lost, and the injuries and economic consequences that may yet be incurred by vehicles that do follow the driver's command to stop, that lurch unexpectedly, and speed uncontrollably. NHTSA and Toyota owe it to the public – the taxpayers and consumers who support them – to get it right.

The Defects

In seven years, neither Toyota nor NHTSA have shown any real effort in determining potential causes for SUA in Toyota vehicles beyond driver error and accelerator pedal entrapment. Why? The focus has been primarily on mechanical interference and driver error. Any evidence that falls outside these explanations is routinely dismissed. Driver error and mechanically related causes are undoubtedly causes of SUA – but they are not the only causes. In the case of Toyota, the root causes of SUA may be traced back to design inadequacies – some of which NHTSA pinpointed in 2007. Some are being uncovered by more current assessments of Toyota's electronic architecture and fail-safe and fault detection strategies. These factors have combined to create an enormously complex problem.

The tendency to narrowly define the defect as the cause of the problem may hamper the search for a solution. For example, in the case of a random, intermittent electronic fault, it may be more practical to define the defect condition more broadly as an engine that exceeds its Maximum Design Idle (MDI). MDI, or Benign Idle, is commonly defined as the highest idle speed that a given engine can achieve when operating normally, i.e., without faults, and within the range of operating temperatures specified in FMVSS 124 – Throttle Controls. The Alliance of Automobile Manufacturers has defined MDI as the maximum un-faulted idle state that would be encountered in the real-world within the range of environmental conditions currently specified in the standard [FMVSS 124].[7] By definition, exceeding the MDI without driver input, means that the vehicle engine is running outside of its design intent. While there are degrees of safety dependent on the amount of unintended torque the engine generates, this starting point provides a basis for examining why conditions can occur outside of intended parameters – particularly those that go uncaptured by the fault detection capabilities in the ECU.

As vehicles continue to transition from mechanical to electronic controls, drivers are increasingly dependent on the electronic architecture to detect faults in both mechanical systems and electronics in order to prevent unwanted events. The fault detection software, which relies on algorithms that are making calculations based on sensors and driver's inputs, are designed to catch errors or malfunctions and to bring the system into a

[7] FMVSS 124 Outstanding Issues; Slide Presentation; Alliance of Automobile Manufacturers; NHTSA 2002-12845-0013; December 12, 2002

safe mode that prevents unwanted outcomes (or the potential for unwanted outcomes). Fault detection capabilities – particularly those that do not capture faults that can lead to loss of important safety functions – regardless of their frequency – should be remedied.

Increasingly, the evidence suggests that Toyota's fault detection software, which takes on a greater importance as fully mechanical systems are replaced by electro-mechanical systems like Electronic Throttle Control (aka, EGAS or Drive-by Wire), may be playing a role in unwanted acceleration.

Human Factors

According to a recent presentation by NHTSA's Roger Compton, human error looms large in all crashes: "Human factors are a contributing factor in more than 90 percent of all crashes."[8] In SUA-alleged crashes, it is among the more emotionally-charged root causes. Many have waded into the discussions of human error in Toyota SUA wielding a broad brush, without controlling for factors that may determine how many of these complaints are attributable to driver error, what type of complaints and what design flaws encourage drivers to make errors. Many of the current assumptions are based on old studies conducted in the era of mechanical throttles. While one can argue that human behavior and the tendency to err remains a constant, the way automobiles receive and interpret a driver's commands has undergone wholesale change. This introduces another significant factor into the detection process that cannot be ignored.

Human error in SUA-blamed scenarios encompasses a wide territory. For example, in 2004, the agency asked Toyota to supply more information on a Minnesota crash involving a 2002 Corolla.[9] The driver was at highway speed on I-94 at 12:30 p.m. that February, when she slammed into the rear of a semi-tractor trailer, which was stopped in backed-up traffic with its four-way hazard lights engaged. Witnesses said that the driver appeared to make no attempt to brake as she crashed into the highly visible obstruction. The St. Clair County Sheriff's office reported that a stuck throttle was a possible cause of the crash, but lacked the ability to determine this and the case was closed. If we assume there is no vehicle-based explanation, what kind of human error could lead to this type of crash? Was the driver distracted or physically compromised by fatigue, alcohol or a medical condition and somehow missed a highly visible obstacle?

A second scenario is the event that occurs at low speed. This is the classic example of pedal misapplication, in which a driver mistakenly depresses the accelerator pedal instead of the brake, and when the vehicle doesn't stop, presses harder, believing he or she is still applying the brake. Pedal misapplication can also occur when the driver's foot slips off one pedal and lands on the other, or mistakenly depresses both at once.

Most of the research on SUA and human factors was conducted in the 1980s and 1990s, prompted by the debate over what really caused Audi 5000 drivers to experience SUA.

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[8] Human Factors Considerations: Unintended Acceleration & Pedal Errors; Slide Presentation; Roger Compton; National Highway Traffic Safety Administration; June 30, 2010

[9] DI04-115; Accident Investigation; National Highway Traffic Safety Administration; September 24, 2004

(The subject became less interesting as a research question after the advent of brake-to-shift interlocks, which, NHTSA reported, had reduced the SUA crash rate by 60 percent, compared with similar vehicles without brake-to-shift interlocks.[10]) The studies tended to focus on pedal misapplication in the low-speed scenario. In a 1994 paper by Wolfgang Reinhart, he defines unintended acceleration as "incidents of high-powered unwanted vehicle acceleration from a stationary position or very slow speed, accompanied by reportedly ineffective brakes. Previous studies and investigations conducted by NHTSA, and by Canadian and Japanese government agencies have concluded that the major cause of such incidents has been drivers unknowingly depressing the accelerator instead of the brake pedal on automatic transmission-equipped cars."[11]

Reinhart and others have found that low-speed/stationary SUA events only occur in vehicles with automatic transmissions and are more likely to occur when the driver is first engaging the brake. Other factors contributing to pedal misapplication were unfamiliarity with the vehicle, pedal application when the upper body is turned, and the size and age of the driver. Very young, i.e. new drivers, and elderly drivers were more prone to pedal errors. The agency is the midst of research, which apparently began in 2008, involving pedal misapplication and the elderly.[12] At a June presentation, Compton shared the interim results of a "literature" review, consisting of news stories in which a pedal error was reported as the cause of the crash. It skewed heavily toward the elderly, with 39 percent of these media-reported crashes involving drivers older than 75. (Two thirds of all such crashes, regardless of the driver's age, occurred in close quarter-maneuvers in parking lots.)

The pedal misapplication argument is much harder to make for high-speed events. In one 1990 paper, researchers, sponsored by Audi, conducted two driving tests using volunteer drivers of all ages. The first test was a static simulated driving test. In that round of 258 static tests, 129 subjects made 26 pedal errors. The second was a field experiment which placed drivers in vehicles unfamiliar to them and then subjected them to a sudden, full open-throttle acceleration, which a tester controlled with a hand throttle. The researchers found virtually no pedal misapplication in that scenario:

> "During the field tests involving unexpected and higher-than-normal engine speeds, only one out of 169 drivers responded by stepping on, and continuing to depress the gas pedal instead of the brake." [13]

The crash that killed Barbara Schwarz in September 2007 is a real-world example. Jean Bookout and her friend and passenger Schwarz were exiting Interstate Highway 69 in Oklahoma in a 2005 Camry. As she sped down the ramp, Bookout realized that she could

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[10] The Effect of Countermeasures To Reduce the Incidence of Unintended Acceleration Accidents; Wolfgang Reinhart; National Highway Traffic Safety Administration; SAE Paper 946097; 1994

[11] The Effect of Countermeasures To Reduce the Incidence of Unintended Acceleration Accidents; Wolfgang Reinhart; National Highway Traffic Safety Administration; SAE Paper 946097; 1994

[12] Human Factors Considerations: Unintended Acceleration & Pedal Errors; Slide Presentation; Roger Compton; National Highway Traffic Safety Administration; June 30, 2010

[13] Pedal Errors in Late-Model Automobiles: A Possible Explanation for Unintended Acceleration; John Tomerlin, Mark W. Vernoy; SAE Paper 900142; February 26-March 2, 1990

not stop her car. She tried applying the foot brake and the parking brake. The vehicle left a 100-foot skid mark from the right rear tire, and a 50-foot skid mark from the left. The Camry, however, continued speeding down the ramp, across the road at the bottom, and finally came to rest with its nose in an embankment. Schwarz died of her injuries.

NHTSA has been inconsistent in its approach to pedal misapplication and allegations of Toyota SUA. In 2003, as ODI investigator Steve Chan began to look at the sharp uptick in vehicle speed control complaints involving Camrys with the new Electronic Throttle Control System–Intelligent (ETCS-i), he posited that pedal misapplication could be a culprit:

> "(3) total pedal misapplication where the driver steps on the gas pedal instead of the brake pedal; and (4) partial pedal misapplication where the driver steps on both the gas pedal and the brake pedal instead of just the brake pedal."[14]

But Chan discarded the pedal misapplication theories:

> "By process of elimination, possible defect no. 3 is unlikely because the subject vehicles were built with a brake-shift interlock feature. Possible defect no. 4 could relate to the eleven complaints and two crashes categorized in the table in Section I above under 'Brake pedal too low/close to gas pedal' and 'While brake was applied.' The writer and a Co-op had visited two Toyota dealers and found that the lateral brake and gas pedal distance to be approximately 3 inches. This distance is not considered to be too short. (Ford recalled (02V266000) the MY 2000·2002 Taurus and Sable to adjust the brake pedal to gas pedal lateral distance to 50 mm minimum.) However, ODI has 36 records of complaints for MY 2002-2003 Toyota Canny concerning brake pedal going to the floor when applied. There was only 1 similar complaint for the MY 2001 Toyota Camry. So for drivers with large shoe sizes and/or who pivots their foot to operate the gas and brake pedal, depressing the gas pedal while braking is a possibility even thought [sic] the distance between the pedals are not consider [sic] to be too close."

Despite this, the theory of pedal misapplication cropped up in other investigations. When ODI's Scott Yon and Chan spoke to the Las Vegas Metropolitan Police about the January 2004 deaths of George and Maureen Yago in their 2002 Camry XLE, the pair brought up pedal misapplication. The Yagos' Camry suddenly rocketed off the fourth floor of a casino parking garage. Two witnesses following the Yagos into the garage said that they saw the vehicle pull slowly into a space and come to a stop (observing that the Camry's brake lights were lit), when the vehicle suddenly took off. According to the police report:

> "Chan explained in the past two years there have been numerous complaints about a problem with the 2002 and 2003 model year Toyota Camrys. The complaint stems from a sudden acceleration problem, supposedly, operators of this type of vehicle have been slowing down or stopping, and suddenly, the car accelerates. In

[14] Issue Evaluation; Unintended Acceleration (UA) on Model Year (MY) 2002-2003 Toyota Camry; Steve Chan; National Highway Traffic Safety Administration; December 9, 2003

> the previous complaints, some of the incidents had resulted in a collision, this was the first death. Chan explained how in 2002, Toyota went to a new type of accelerator. In the previous years, a gas pedal was connected to the engine via some type of cable or linkage. In 2002, the gas pedal is now connected to some type of a pedal position sensor, this sensor is in turn connected to wires, these wires connect to the cars computer, there are more wires which connect to some type of a servo or actuator. This connects to the engine to control the engine RPMs. After this change is when these type of incidents started to occur." [15]

The police report went on to say:

> "Although, it does need to be brought up, there may have been other changes which coincided with this modification, changes such as pedal or seating position changes. We spoke about misapplication, being a possible cause of these types of collisions, misapplication is where a person goes to step on the brake, but is actually pushing on the gas. As the vehicle accelerates forward, the driver panics, and pushes down harder because the vehicle is not stopping, the vehicle only accelerates more, so until the driver realizes what is going on and lifts off the gas, or what happens more often is, they hit something. Although I do not have any current statistics, the type of case where a collision results predominantly occurs with the elderly. Plus their reaction times are slower and by the time they realize what is occurring a collision has occurred. [Chan] did not have any information on the ages of the drivers involved in their complaints, during my inspection of the gas pedal, locations of this vehicle, it seemed to me the pedals were extremely close. Furthermore, they appeared to be at the same height. It seemed to me a person could easily push on both pedals at the same time, and not know it. This would lead to a driver accelerating while braking."[16]

The independent observations of two witnesses of brake lights and a stopped vehicle did not figure into these speculations.

In a subsequent investigation, ODI's Scott Yon suggested partial pedal misapplication could be to blame. In investigating Defect Petition (DP) 08-001 for SUA in Tacoma vehicles, Yon suggested that petitioner William Kronholm's cross country ski shoes caused him to accidentally hit the gas and the brake at the same time, resulting in two engine surges. Kronholm later tested Yon's theory and found that it was only possible to hit both pedals at once if he twisted his foot at a 90-degree angle. This showed him that this was not cause of the engine surges, but in the *Federal Register* notice denying Kronholm's petition, Yon suggested the opposite: "He subsequently reported that it was possible for him to inadvertently hit both pedals while wearing the ski shoes."[17]

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[15]State of Nevada Traffic Accident Report; Yago Crash; Corey Moon, Investigator; Las Vegas Metropolitan Police Department; January 22, 2004

[16]State of Nevada Traffic Accident Report; Yago Crash; Corey Moon, Investigator; Las Vegas Metropolitan Police Department; January 22, 2004

[17] DP08-001; Denial of Defect Petition; Federal Register Notice; National Highway Traffic Safety Administration; September 3, 2008

Since Chan's 2003 observations about the possibility of pedal misapplication, NHTSA appears not to have made any systematic attempt to isolate pedal misapplication incidents in the data. Toyota's pedal placement is not an outlier compared to peers, and placement does not appear to have had a significant effect on the incidence rate of SUA complaints.

Human factors can influence an SUA-related event beyond causing the vehicle to suddenly accelerate – they can make the vehicle harder to stop. This can also be caused by designs that present confusing options to a driver who must react quickly to a full throttle event.

In examining the human factors that make it difficult to stop an SUA event, NHTSA and Toyota have identified several design errors. During the course of Engineering Analysis (EA) 07-010, NHTSA researchers at the Vehicle Research and Test Center (VRTC) interviewed Toyota and Lexus owners, tested Toyota vehicles and identified several design flaws that would make it difficult for a driver to regain control of a runaway Toyota:[18]

- "With the engine throttle plate open, the vacuum power assist of the braking system cannot be replenished and the effectiveness of the brakes is reduced significantly.
- Brake pedal force in excess of 150 pounds was required to stop the vehicle, compared to 30 pounds required when the vehicle is operating normally.
- ESC activation may restore vacuum to the brake booster, providing a significant increase in braking capability, but only until ESC activity ceases.
- The owner survey indicated the 3 second delay in the operation of the ignition button is not widely known by owners and because of this, drivers found themselves unable to turn off the engine when the vehicle was in motion.
- Many owners complained that the neutral gear position in the gated shift pattern was not immediately obvious, leading to unsuccessful attempts to disengage the engine from the drive wheels."[19]

Toyota has repeatedly claimed that the brakes can always overcome the throttle – and that may be true under ideal conditions. However, auto manufacturers and suppliers from Toyota to Mercedes to Continental Teves have long recognized that drivers often don't take full advantage of the power of the brakes in a panic situation, and have subsequently developed brake assist technology to compensate for the human factors.

For example, research by the Laboratory of Accidentology, Biomechanics and Human Behavior at PSA Peugeot Citroen-Renault analyzed driver's behavior in emergency situations and found that drivers' braking actions are typically inefficient. Fifty percent of drivers did not activate the ABS because they did not step firmly enough on the brake; for

[18] EA07-010; Final Report: 2007 Lexus ES-350 Unintended Acceleration; Michael Monk; National Highway Traffic Safety Administration; April 30, 2008
[19] EA07-010; Final Report: 2007 Lexus ES-350 Unintended Acceleration; Michael Monk; National Highway Traffic Safety Administration; April 30, 2008

85 percent of drivers, the maximum braking was delayed due to a non-efficient brake pedal hit.[20] Research about 20 years ago by Mercedes found similar results: "It was in the early 1990s that Mercedes engineers conducting tests in the driving simulator found that while the majority of male and female drivers operate the brake pedal rapidly in an emergency situation, they often do not do so with sufficient force. The technical braking performance is therefore not used to the full, and the braking distance is considerably increased."[21] Mercedes was the first to make brake assist technology standard on its vehicles, and the feature is in many current models from a range of manufacturers.

The loss of power brake assist is a possible and likely explanation for some owner complaints that allege simultaneous loss of braking during SUA events. Engine vacuum supplies the power assist and it is significantly diminished when the engine throttle is wide open. Many complaints also indicate that the driver "pumped" the brake pedal, which further depletes any vacuum to the brakes and eliminates power assist. Brake pedal feel hardens following a loss of power assist, and requires significantly greater applied pedal force to slow the vehicle and increases stopping distance greatly. According to the VRTC's evaluation of a 2007 Lexus ES 350:

> "With the engine throttle plate open, the vacuum power assist of the braking system cannot be replenished and the effectiveness of the brakes is reduced significantly. During trapped throttle acceleration testing, several methods to defeat acceleration proved effective but not necessarily intuitive. These methods included:
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> > **3.3.1** Application of the brake - Significant brake pedal force in excess of 150 pounds was required to stop the vehicle, compared to 30 pounds required when the vehicle is operating normally. Stopping distances increased from less than 200 feet to more than 1,000 feet."[22]

While a professional driver may know to apply upwards of 150 pounds of brake pedal force, most drivers will face an unfamiliar scenario – the loss of brake power assist, hard pedal feel, and an apparent lack of brake effectiveness. Even if the average driver depresses the brake pedal hard enough, the increased stopping distance presents a real hazard. Additional study of driver reactions to SUA events and loss of brake assist and normal brake pedal feel is needed. In addition, many SUA events end in a crash before any driver could possibly react and apply the brakes. Driver reports of simultaneous brake loss during an SUA event should not be dismissed or automatically categorized as driver application of both pedals. Post-SUA event brakes are often inspected and found fully functional and capable of preventing vehicle movement with the throttle open. This

[20] Active Safety Experiments with Common Drivers for Specification of Active Safety Systems; Perron, T., Kassaagi, M., Brissart, G.; Renault / PSA Peugeot Citroen; SAE Paper #2001-06-0004; June 4, 2001
[21] Real World Safety Benefits of Brake Assistance Systems; Breuer, J., Faulhaber, A., Frank, P., Gleissner, S.; DaimlerChrysler AG, Mercedes Car Group; 2007
[22] EA07-010; Final Report: 2007 Lexus ES-350 Unintended Acceleration; Michael Monk; National Highway Traffic Safety Administration; April 30, 2008

scenario does not address the true ergonomic and human factors issues that are potentially at play during an SUA event.

Much has been made of SUA events involving elderly Lexus and Toyota drivers without untangling the complexities. Some of the questions that need to be examined include:

Are elderly drivers really more prominent in the Toyota SUA complaint or crash data as some media and blogs suggest? If they are, is this an artifact of model demographics? Or is it an artifact of which motor vehicle crashes are covered by the media in the first place?

What are the SUA complaint rates on vehicle models with similar or older demographics?

Is the SUA complaint rate involving elderly drivers greater in Toyotas with ETC-i, versus those with mechanically based throttles?

Do SUA events that involve elderly drivers have particular characteristics? Are these low-speed/stationary SUA scenarios or scenarios where the vehicle is already underway on the road or highway?

Are elderly drivers more prone to crash in an SUA-alleged event because they are slower to recover from a startling event or because they lack the strength to depress the brakes hard enough to bring the vehicle to a stop?

So far, neither NHTSA, nor any other entity, has published any research which controls for the myriad factors that could point with any confidence or statistical validity to a pattern of human error in older drivers of Toyota and Lexus models.

Electronics/Diagnostics

Toyota has staked the reliability of its electronics on the strength of its fail-safe strategy. Time and again, Toyota has said that its fault-detection system does not and cannot fail and that the absence of any Diagnostic Trouble Codes (DTCs) equals the absence of any problem. Current evidence suggests that Toyota's fault-detection may be the Achilles' heel of its system.

Even as Toyota introduced electronic throttle control to the MY2002 Camry, company engineers understood the absolute necessity of reliability and well-engineered fail-safes in the development of drive-by-wire systems. In a 2001 paper published by the Toyota Technical Review, the author prefaces specific design information with this point:

> "In order to ensure the safety of electronic control systems, it goes without saying that the parts must have a high level of reliability so that they do not fail, and a multilateral approach, such as by examining it as a total system to include the relationship with the driver, is necessary. Parts of the requirements related to safety design are established in various regulations and specifications, but the

> overall construction could not be regulated, so the reality is that the accumulation of knowledge is the manufacturers' responsibility."[23]

Toyota researchers affirmed these principles in a 2005 paper on a drive-by-wire system for an intelligent vehicle:

> "By introducing FBW and DBW, the advantages are that the dangers by unsafe human operations are prevented, and system configurations are simplified, but at the same time, it is pointed out that there are dangers such as malfunctions by run-away computers, electronic noises, etc. Hence an important challenge is how to secure reliability. In aircraft, when the system fails, it is critical to maintain functions, hence it is dealt with by constituting multiple systems (1). On the other hand, in vehicles, a failsafe function has been secured using a configuration whereby in order to prevent dangerous conditions from ensuing when a failure happens, only the DBW function is securely stopped, while normal drive functions, that is, the mechanical transmission mechanism, are kept and maintained."[24]

Despite this, four separate entities – including Toyota – have documented that errors can be introduced into Toyota's electronic system that are not detected by the Engine Control Module (ECM, also referred to as the ECU).

The first independent assessment that Toyota's fault detection capabilities in context of the potential for unwanted acceleration was described in a report by Dr. David Gilbert, professor of automotive electronics at Southern Illinois University, Carbondale. Dr. Gilbert's preliminary report, *Toyota Electronic Throttle Control Investigation*, was commissioned by SRS.[25] The purpose of Dr. David Gilbert's research study was to contribute to a better understanding of ETC system malfunctions and the fail-safe detection capabilities of some Toyota vehicles equipped with ETC. His research primarily examined the fail-safe detection capabilities of electrical circuitry, particularly at the Accelerator Pedal Position Sensor (APPS) and the voltages and associated wiring circuits.

Dr. Gilbert's preliminary study demonstrates that there are conditions in the Toyota and Lexus models tested in which the redundancy of electronic circuitry in the ETC is lost – particularly in the APPS. Losing circuit redundancy in the system creates a loss of the fail-safe modes that Toyota has programmed. Notably, the system will not detect an error – no DTCs are set. Once the vehicle has lost its designed redundant fail-safe without any fault detection, it is operating in an unsafe condition. Providing signal redundancy at the APPS is a critical safety feature that must accurately convey driver demands for throttle

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[23] Safety Design of Electronic Vehicle Control Systems; Masanori Hirose; Toyota Technical Review, Vol. 51, No. 1; June 2001; Certified Japanese to English translation by Alexandria Translations for Safety Research & Strategies

[24] 293 Intelligent Vehicle With Drive By Wire; Akihide Tachibana; Toyota Motor Corp.; 2002; Certified Japanese to English translation by Alexandria Translations for Safety Research & Strategies

[25] Toyota Electronic Throttle Control Investigation: Preliminary Report; David W. Gilbert, PhD, Omar Trinidad; February 21, 2010

opening, thus APPS voltage inputs should always be confirmed by the ECU as definitely correct. Dr. Gilbert's report noted the following regarding Toyota's fault detection strategy and APPS voltage:

> "It was noted in the service literature that the threshold limits for a voltage difference of "0.02 Volts or less" between the two APP signal circuits should set a DTC P2138 (Appendix: TIS Document, p. 3). This voltage appeared to be an unusually close threshold value for a short between circuits. In other words, these two signal voltages could have been *almost* identical, and remain safely within the parameters of the P2138 DTC threshold limits. The VPA and VPA2 normally operate through a common range of parallel planes of voltage values. In addition, the two signal voltage values are normally supposed to rise and fall in unison with each other. If the two signal voltages were in some fashion to become interconnected (shorted) through a certain amount of circuit resistance, the lower VPA voltage could be pulled up slightly in value. The higher VPA2 voltage could be affected in the opposite manner and pulled down slightly in value. At the same time, both sensors could conceivably stay within the upper voltage boundary of 4.8 Volts or more for the P2123 and P2128 DTC criteria. Similarly, the VPA2 1.2 Volt low threshold limit value for a P2127 DTC would not be reached, and the VPA 0.4 Volt low threshold limit value for a P2122 DTC would not be reached. Signal interconnection through resistance could then potentially tie the two circuits together without setting a DTC. At that point, APP signal circuit redundancy is lost and neither signal circuit is verifiable by the ECM as defective. The ECM will only react to defective voltages outside of the range of programmed limitations-so if the circuit is not defective; it must be good. Without a DTC set, the ECM will not logically enter into a fail-safe mode of operation."

Dr. Gilbert concluded:

> "After completing preliminary tests for APP sensor signal voltages for the Toyota Electronic Throttle System, it was determined that ECM malfunction detection strategies were not sufficient to identify all types of fundamental APP sensor and/or circuit malfunctions. Some types of ETC circuit malfunctions were detectable by the ECM, and some were not. Most importantly, the Toyota detection strategies were unable to identify malfunctions of the APP sensor signal inputs to the ECM. APP sensor signal circuits must be undeniably correct to electrically convey the appropriate driver commands to the ECM.
>
> With the two APP sensor signals shorted together through a varying range of resistances, all four Toyota vehicles reacted similarly and were unable to detect the purposely induced abnormality. The types of signal faults introduced into the APP circuit should have triggered the vehicles' ECM to illuminate a MIL within seconds. The ECM should have then set a DTC, entered the vehicle "fail-safe" mode, and reduced engine speed and/or power. When the two APP signal circuits are shorted together, the redundancy of the APP circuit design is effectively nullified and lost. In other words, neither of the shorted APP signal circuits can be

> verified by the ECM as either correct or incorrect. The condition then exists for a serious concern for driver safety. In the tested Toyota ETC vehicles, incorrect or corrupted APP sensor signal inputs could potentially result in unwanted engine speeds. Additional research should be done to determine if other vehicle manufacturers may have similar inconsistencies in ETC circuit fault detection."

Dr. Gilbert's initial research also included operation of vehicles in which the shorted APPS signal circuit fault was installed within the known resistance values but did not set a DTC. His observations of vehicle operational behaviors found that all of the test vehicles could be operated without the ECU detecting the malfunction and, depending on the resistance value of the APP signal circuit fault, a vehicle could or could not experience noticeable changes in accelerator pedal operational behavior. Accelerator pedal operational characteristics ranged from normal response, sluggish response, and travel with inconsistent engine speeds. (This is notable because consumer complaints report sluggish response and travel with inconsistent engine speeds.) While operating these vehicles with compromised APPS (i.e., no APPS signal redundancy), the shorted APPS were connected to the sensor's 5 Volt supply circuit with the vehicle in drive, which resulted in a full throttle condition that was undetected as a fault. Dr. Gilbert cautioned that while this result shows unintended acceleration can occur undetected, more research needed to be done to ascertain how this double fault condition might occur in the service environment. Regardless, the compromise of the APPS and loss of signal redundancy should never go undetected by the ECU.

Quite simply, Dr. Gilbert's findings prove that Toyota's assertion that its electronics are infallible is incorrect, and they form the basis for further study of potential electronic failures that might lead to SUA. Further, Dr. Gilbert's findings demonstrated that once the fail-safe is lost and undetected by the vehicle computer as an error, various scenarios can be introduced in which the ECM can command a wide-open throttle condition without any input from the driver, and without setting any error codes.

These findings provide an important baseline for understanding a potential electronic root cause of unintended acceleration in Toyota vehicles. While Dr. Gilbert's testing demonstrates that vehicles can react to sensor errors in ways that appear consistent with consumer complaints of unintended acceleration, it will take additional research to determine whether there is a connection between the two.

Toyota responded to Dr. Gilbert's report through their outside experts at Exponent, whose work was done at the direction of the automaker's litigation counsel, Bowman and Brooke. Exponent claimed that the scenario Dr. Gilbert describes in his report was highly unlikely:

> "For such an event to happen in the real world requires a sequence of faults that is extraordinarily unlikely. Furthermore, the individual "faults" required individually are far more likely to result in a detectable problem (for example, setting a trouble code or entering a fail-safe mode of operation), than combining

> in just the right manner to produce a sudden unintended acceleration (SUA) event."[26]

Exponent's report also attacked Dr. Gilbert for failing to make a probability assessment of the scenario or of the likelihood of it actually occurring in vehicles in the field and claimed that resistive or short circuit faults would leave a "fingerprint" on the physical wiring or other components of the vehicle, which could include witness marks and other telltale signs of their existence (e.g., breached insulation, contamination between wires, low impedance measurements between wires, stains, etc.)." Further, Exponent stated: "Dr. Gilbert has presented no evidence of his postulated sequence actually occurring in a real vehicle, or even evidence of an incipient event (e.g., signs that a resistive fault was developing), and did not look at any incident vehicles for 'fingerprints' of any such fault." Exponent does not provide any support for its claim that these "fingerprints" would be evident.

Dr. Gilbert, however, did not claim that SUA was caused by short circuits in the APPS. The significance of his evaluation was in demonstrating that Toyota's fault-detection system failed. Gilbert's preliminary testing showed that the ECM did not find a critical single-point failure and that once this failure went unregistered, normal operation of the vehicle was unimpeded despite the loss of a critical safety feature. Regardless of the likelihood of a real-world replication of Gilbert's fault sequence, Toyota has stated – without equivocation – that its ECM will pick up single and multi-point failures:

> "Toyota believes that the DTC system works as designed, and that if a single or multi-point failure were to occur, the ECU would signal a DTC and put the system into one of its failsafe modes."[27]

Exponent also claimed that:

> "Using slight variations on Dr. Gilbert's scenario, other makes of vehicles responded in a manner similar to the 2010 Avalon and 2007 Camry when rewired. These findings illustrate the artificial nature of Dr. Gilbert's demonstration and its inability to explain reported incidents of SUA."

However, Exponent did not explain the variations from Dr. Gilbert's scenario nor did Exponent provide the details of those variations to Dr. Gilbert during his visit to Exponent's facility.

In addition, Dr. Christian Gerdes, a professor at Stanford University who reviewed Dr. Gilbert's work at Toyota's request, told the House Energy and Commerce Committee that

[26] Evaluation of the Gilbert Demonstration;, Exponent Failure Analysis Associates; March 2010
[27] PE04-021; Toyota Response; Chris Tinto; Toyota Motor Corp.; June 19, 2004

Dr. Gilbert's approach was a legitimate starting point for a more in-depth inquiry into the causes of SUA.[28]

Likewise, Professor Todd Hubing, Michelin Professor of Vehicle Electronic Systems Integration at Clemson University's International Center for Automotive Research (I-CAR), affirmed Gilbert's findings before a National Academy of Sciences (NAS) panel looking into SUA. Dr. Hubing also presented the results of I-CAR's independent tests on Toyota vehicles, which found that an *undetected single fault* resulted in wide-open throttle. Dr. Hubing described I-CAR's laboratory evaluation of two Toyotas which found that the fault detection capabilities are not robust enough to detect the single fault that led to wide-open throttle that was not commanded by the driver. In his presentation, Dr. Hubing supported Gilbert's conclusions and countered Exponent's claim that these electronic anomalies can't happen in the real world.[29] However, he cautioned that more analyses were necessary.

Dr. Hubing also addressed the state of current automotive electronics design and integration strategies. Dr. Hubing asserts that they are not sustainable, because today's fleet relies on analog sensor inputs for safety critical functions whose accuracy cannot be validated and a reliance on undefined software whose performance cannot be modeled or validated. He also criticized a safety critical reliance on individual hardware components, particularly microcontrollers. Hubing offered Toyota's APPS as an example, which employs two redundant, but nearly identical Hall-effect position sensors. Interference affecting one sensor can affect the other sensor in an identical way, resulting in a bad reading with no error code generated, he said. He listed three possible causes of unintended acceleration: bad sensor input that fools the ECM into opening the throttle; a software glitch that gives unintended command to open throttle (which may or may not involve a bad input); a hardware (microprocessor) malfunction processor that latches up or jumps to wrong subroutine requiring a hard reset.

Dr. Hubing's presentation pointed to the extraordinary volume of software coding in today's vehicles. He estimated that the average luxury vehicle today contains approximately 100 million lines of code – more than 15 times the amount in sophisticated aircraft: the Boeing 787 Dreamliner has 6.5 million; the F-35 Joint Strike fighter jet has 5.7 million lines.

Finally, Toyota itself has conceded that faults in the electronic system can occur without detection by the ECU. In an August recall intended to correct stalling in 2005-2008 Corolla and Corolla Matrix vehicles, Toyota submitted field technical reports on the problem, many of which noted that DTCs were not set, even when the technician could duplicate the problem. (See *Toyota's Fail-Safe Can and Does Fail* section) In a

[28] Update on Toyota and NHTSA's Response to the Problem of Sudden Unintended Acceleration; Transcript; Hearing of the Oversight and Investigations Subcommittee of the House Energy and Commerce Committee; May 20, 2010

[29] Analyzing Unintended Acceleration and Electronic Controls; Todd Hubing; Clemson University; July 1, 2010

Frequently Asked Question section about the recall on its website, Toyota was forced to take back earlier assertions that its fault detection system doesn't fail:

> **"Are there any warnings that this condition has occurred?**
>
> In most of the cases, the check engine light will illuminate if this condition occurs and the vehicle may experience harsh shifting. *However, there may be some cases where the check engine light does not illuminate and harsh shifting does not occur*."[30]

Mechanical

SUA can have mechanical causes, beyond floor mat entrapment. For example, a throttle could mechanically stick due to a variety of causes, such as mis-manufactured parts or corrosion. A recent inspection of a 2004 Camry by Dr. David Gilbert found that the vehicle, which exhibited unintended acceleration events, suffered from a throttle that was prone to intermittent sticking.[31] He again raised concerns about the design of Toyota's fault detection strategy and fail-safe implementation, because the condition did not consistently trigger a DTC and allowed the engine to race to approximately 2,400 rpms with no input from the accelerator pedal.

Gilbert's report recounted the Camry owner's description of the event:

> "He continued to drive the vehicle with the MIL ON. He was crossing a bridge at moderate speed (35-40 mph), when the car surged and then accelerated. He was able to gain control of the car and bring it to a stop. He shut the engine OFF and restarted it. After the restart, the engine RPM would race up and down. Wishing to exit the bridge, and being very near his home, he managed to move the car with the engine stalling frequently."

After running several tests, including a visual inspection, replacing the throttle body, mechanically manipulating the throttle opening, observing the vehicle while in motion, and using a Toyota Tech Stream scan tool to perform an electronic diagnosis, Gilbert concluded that the Camry's erratic operation was due to an ETC throttle body assembly with a throttle plate that was mechanically binding. In limited tests, Gilbert found that the ECM did detect the malfunction, by setting a DTC and illuminating the check-engine light.

> "However, the manner in which this vehicle's engine operates with a defective throttle body assembly and while in a 'fail-safe mode' is most concerning. The engine RPM limits of fail-safe operation should be investigated further to determine if they are excessive. It could be argued that intermittent sticking or partial binding of the throttle plate assembly could result in a RPM surge or

[30] Customer FAQs for Corolla/Corolla Matrix Recall; Toyota Motor Sales, USA Website; September 14, 2010
[31] 2004 Camry LE Inspection Notes; David Gilbert; April 24, 2010

acceleration. In the limited time of this vehicle inspection, the amperage level of the throttle body motor was observed to increase until the throttle plate moved. While this may not be an issue on a freely operating throttle plate, it may be that restricted movement could cause the ETC to 'overshoot' the targeted throttle opening. It could be plausible that an ETC throttle body that is gradually approaching the point of binding may be more dangerous than one that is completely stuck. I am also concerned that it may be possible for this ETC system to 'pass' a self-test on initial start-up, and exhibit a stuck throttle plate condition at a later time while the vehicle is being driven. How this ETC system reacts for fail-safe operation, may depend on when and how the throttle plate becomes actively stuck. The allowable parameters for driving an ETC vehicle, while it is operating in a fail-safe mode, should be investigated to see if these questionable conditions can exist."[32]

Still unresolved are allegations that a Toyota supplier of throttle bodies released to the manufacturer an unknown number of units with cracked shaft throttle bodies, which could cause an unintended acceleration. In November 2009, an anonymous accuser from Franklin, Kentucky charged that Toyota had been aware of a problem with cracked shaft throttle bodies and sent NHTSA's ODI a used throttle body assembly in which the shaft that controls the throttle blade, situated within the throttle body housing, had a crack on the engine side of the valve, along the long axis of the shaft.[33] The defect, the anonymous accuser wrote, could result in a wide open throttle. Franklin Kentucky is the home of Franklin Precision Industry (FPI), which manufactures throttle bodies for Toyota and Nissan and is part of Aisan Industry Co. Ltd., a large Japanese automotive supplier, part-owned by Toyota.

SRS investigated the allegations in the anonymous letter to NHTSA.[34] We located a source with first-hand knowledge of Franklin Precision Industry's operation. This source provided the following information:

- Throttle bodies (for 4-cylinder engines) with cracks in throttle shafts were inadvertently produced at FPI several years ago (around 2006/2007) and allegedly for at least two weeks. Production at the plant during that time was estimated at 20,000 units.

- This mistake was widely known throughout the plant.

- The root cause was said to be poor quality steel in throttle shafts supplied by Betty Machine in Hendersonville, TN. This was traced to specific lot numbers of throttle shaft shipments.

- An internal FPI investigation was conducted by the Quality Department with assistance from Japanese staff.

[32] 2004 Camry LE Inspection Notes; David Gilbert; April 24, 2010
[33] NHTSA VOQ 10298108; December 18, 2009
[34] Safety Research & Strategies Letter to NHTSA Administrator Strickland; February 16, 2010

- It was believed that a small but unknown quantity of throttle bodies were produced and potentially shipped to Toyota.

The presence of broken throttle shafts in some Toyota vehicles may be a potential root cause for some unintentional acceleration incidents.

A third possible mechanical cause of SUA in some Toyota vehicles are Original Equipment accessory pedal covers. These rubber and plastic pedal covers are designed to slip over the existing OEM accelerator and brake pedals to give them a sporty look. Toyota's instructions direct the owner to use liquid soap and water to install the covers. They are affixed by the molded-in rubber lip designed in the back of the pedals. According to the installation instructions, all OE pedals should be engaged and disengaged to ensure proper functionality, and that there is no interference with the floor pan or floor mats. Because these covers are slip-ons, they increase the size of the brake and accelerator pedals, extending the bottom portion of the accelerator pedal by approximately 0.172 inches.[35]

Toyota claims, in at least one instance, that these pedal covers could have contributed to an unintentional acceleration which resulted in a December 2009 crash. Following is a brief description of that crash:

> **Vehicle:** 2006 4-Runner with 4.0 L V6; JTEBU14R668055991, approximately 41,000 miles at the time of the incident.
>
> **Incident Description:** The driver, Michael Teston, of Maaumelle, Arkansas, was driving into a small town with the cruise control on. He reports tapping the brakes to disengage the cruise, the cruise control then disengaged and the vehicle began to slow. Mr. Teston coasted with his foot on the brake as he approached a parking lot for a convenience store. He turned into parking lot at approximately 15 mph, still coasting with his foot on brake. As his speed reduced to approximately 3 to 5 mph, Mr. Teston reports that he heard the ABS brakes activating followed by clicking sound when the engine raced to full-throttle. The vehicle surged forward and hit a pole approximately three feet in front of him. Once the vehicle impacted the pole, the rear of the vehicle began hopping as the rear tires continued to spin. Mr. Teston placed the vehicle into Park and the engine maintained wide-open-throttle until the ignition was turned off. There were two witnesses to the event. Mr. Teston's vehicle was fitted with OE carpeted floor mats that were in place and secured.

North Point Toyota (in North Little Rock) inspected the vehicle, and determined that there was nothing wrong. In addition, a Toyota Technical Specialist examined the vehicle in January (Toyota case number 0912122197).

[35] Safety Research & Strategies Letter to NHTSA Administrator Strickland; Appendix A; February 16, 2010

In a February 3 letter to Mr. Teston, Gulf States Toyota, Inc noted that during the inspection, the driver's floor mat was in place and properly secured and there were "no codes stored in the computer to indicate any product concern or failure."[36] Instead, Toyota blamed its own pedal covers:

> "Our Technical Specialist noted that aftermarket pedal covers were installed on the brake and accelerator pedals that increased the length of the pedals, which could have contributed to the accident described."

Mr. Teston purchased the "aftermarket pedal covers" from a Toyota dealer as a Toyota accessory. They were installed by the Toyota dealer.[37] They remain available for purchase on Toyota Motor Sales' corporate website. Based on the automaker's representations, it appears that Toyota has a duty to recall these parts.

To date, there has been no public response by NHTSA regarding the throttle body allegations or the aftermarket pedal covers.

Owner Complaints

Toyota and Lexus owners have been complaining about SUA in their vehicles for years. On October 6, Toyota said that unintended acceleration complaints to its consumer hotline had diminished from 800 calls to the still-high rate of 150 calls per week.[38]

SRS has compiled and maintains Toyota SUA incident data comprised of consumer complaints submitted to NHTSA, claims data submitted by Toyota to NHTSA investigations, and incidents in litigation, media accounts, and accounts from individuals who have contacted SRS. SRS conducted an independent analysis of those data and determined that between January 1, 1999 and September 7, there have been 6,194 reported incidents, resulting in 2,309 crashes, 1,073 injuries, and 48 deaths.

The SRS analysis defined SUA broadly as any incident in which the complainant reported an engine acceleration that was unintended – regardless of whether the car was in gear. This mirrors the consumer complaints in which drivers have likewise described incidents in which the vehicle surged while in idle mode, moving very slowly or travelling at a high rate of speed.

SRS has reviewed all Prius complaints and ***excluded*** from the analysis those that are related to the Prius braking issues. In many cases it is very clear that the complaints relate to the known braking defect. In some cases that describe the sensation when braking as "unintended acceleration," SRS exercised judgment about the nature of the defect.

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[36] Safety Research & Strategies Letter to NHTSA Administrator Strickland; Appendix A; February 16, 2010

[37] Safety Research & Strategies Letter to NHTSA Administrator Strickland; Appendix A; February 16, 2010

[38] Toyota Goes Extra Mile on Brake Safety; The Japan Times; October 6, 2010

Overall, if the complainant described a frequent, repeatable, and brief unintended acceleration, particularly in conjunction with braking and/or rough road surfaces, they were excluded from this analysis. That process resulted in the exclusion of 695 Prius complaints.

The fatality count is based on an assessment of the incident reports and represents deaths potentially related to unintended acceleration. In order to be included in the fatality count of 48, there must be surviving passengers from or witnesses to the crash, or investigations of the incident must have ruled out any medical conditions or crash characteristics that would have likely contributed to the incident and/or concluded that the crash was the result of a defect related to SUA. Incidents that are noted as simply loss of vehicle control or unexplained single vehicle crashes with no indication that a UA event occurred have not been included in this count. [Note: These criteria are modified from our previous examinations and are intended to provide as accurate a fatality count as possible. However, it is important to acknowledge that some incidents not included in this count are still potentially relevant to SUA.] Appendix A contains summaries of the incidents included in the fatality count.

Table 1. Toyota SUA Incidents Reported from January 1, 1999 to September 7, 2010

Total Incidents	**6194**
Crashes	**2309**
Injuries	**1073**
Deaths	**48**

It should be noted that from January 1, 1999, to September 7, an additional 76 crashes were reported, resulting in an additional 65 injuries and 96 deaths. These additional incidents represent crashes that speculate SUA; primarily these are crashes for which there are no witnesses or surviving passengers, or incidents that have not yet been investigated thoroughly. Appendix B contains summaries of these additional 76 incidents.

Tables 2 and 3 contain a breakdown of deaths and injuries resulting from SUA incidents, by vehicle model.

Table 2. Number of Injuries Resulting from Toyota SUA Incidents Reported January 1, 1999-to September 7, 2010, By Model

4RUNNER	**11**
AVALON	**74**
CAMRY MODELS	**392**
CELICA	**3**
COROLLA	**122**
ECHO	**1**
LEXUS ES MODELS	**98**
LEXUS GS MODELS	**11**
LEXUS GX MODELS	**6**
HIGHLANDER	**42**

LAND CRUISER	**4**
LEXUS IS MODELS	**10**
LEXUS LS MODELS	**9**
MATRIX	**22**
OTHER	**7**
PRIUS	**58**
RAV4	**33**
LEXUS RX MODELS	**32**
LEXUS SC MODELS	**1**
SCION VEHICLES	**8**
SEQUOIA	**3**
SIENNA	**40**
TACOMA	**53**
TUNDRA	**18**
VENZA	**3**
YARIS	**6**
UNKNOWN CAMRY OR ES MODELS	**6**

Table 3. Number of Deaths Resulting from Toyota SUA Incidents Reported January 1, 1999-September 7, 2010, By Model

4RUNNER	**1**
AVALON	**6**
CAMRY MODELS	**23**
COROLLA	**2**
LEXUS ES MODELS	**6**
HIGHLANDER	**1**
LEXUS IS MODELS	**1**
LAND CRUISER	**1**
PRIUS	**1**
RAV4	**1**
LEXUS RX MODELS	**2**
SIENNA	**2**
TUNDRA	**1**

Note that the incidents included in this analysis only represent those that are in the public realm. According to internal documents Toyota presented to the House Committee on Energy and Commerce, Subcommittee on Oversight and Investigations, the automaker produced a representative sample from a larger set of claims. The committee noted that 37,900 customer contact reports were identified by the company as "potentially related to sudden unintended acceleration."[39]

[39] Letter to Jim Lentz from the Committee on Energy and Commerce, Subcommittee on Oversight and Investigations; February 22, 2010

To illustrate trends in the publicly available incidents, the figures on the following pages provide breakdowns of the incidents by various characteristics. Unless otherwise noted, the data contained in the charts are limited to 1998 and later model year vehicles. Models have been collapsed into model groups, and models for which there are fewer than 100 incidents reported from January 1, 1999 and September 7, have been collapsed into the "Other Models" category. Appendix C contains summaries of all of the incidents included in the analysis.

Figure 1

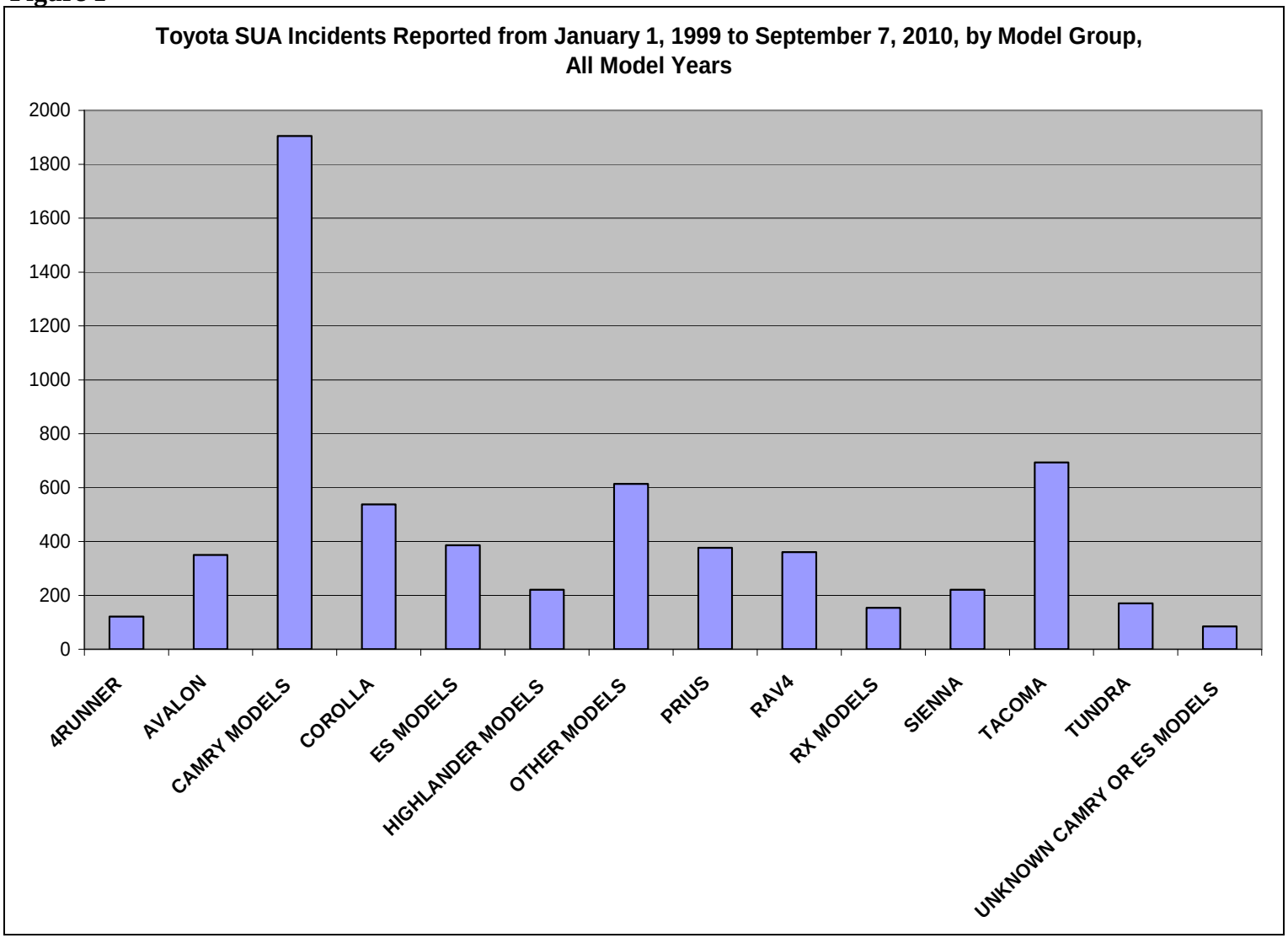

Toyota SUA Incidents Reported from January 1, 1999 to September 7, 2010, by Model Group, All Model Years
2000
1800
1600
1400
1200
1000
800
600
400
200
0
4RUNNER
AVALON
CAMRY MODELS
COROLLA
ES MODELS
HIGHLANDER MODELS
OTHER MODELS
PRIUS
RAV4
RX MODELS
SIENNA
TACOMA
TUNDRA
UNKNOWN CAMRY OR ES MODELS

Figure 2

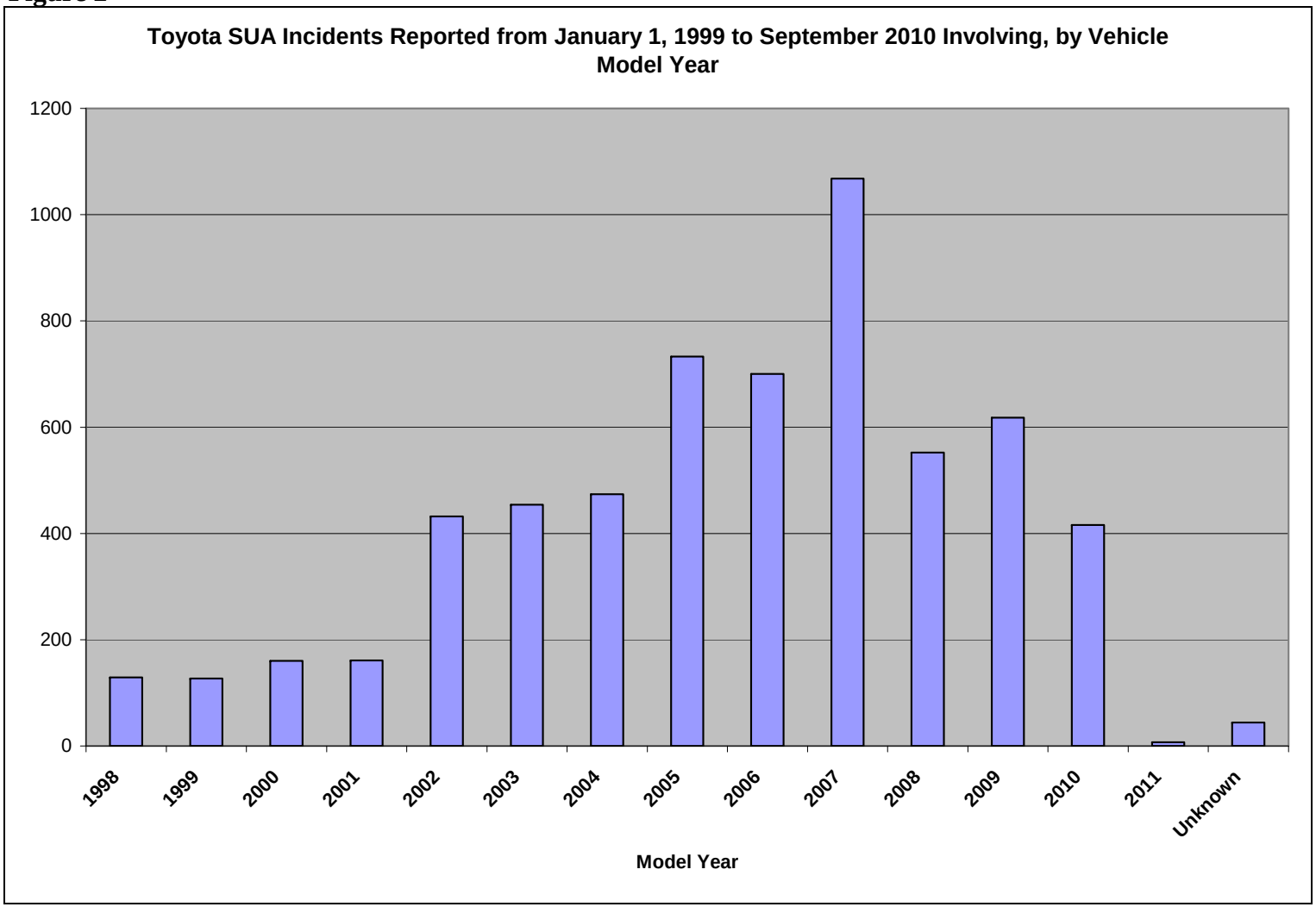

Toyota SUA Incidents Reported from January 1, 1999 to September 2010 Involving, by Vehicle Model Year
1200
1000
800
600
400
200
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Unknown
Model Year

Figure 3

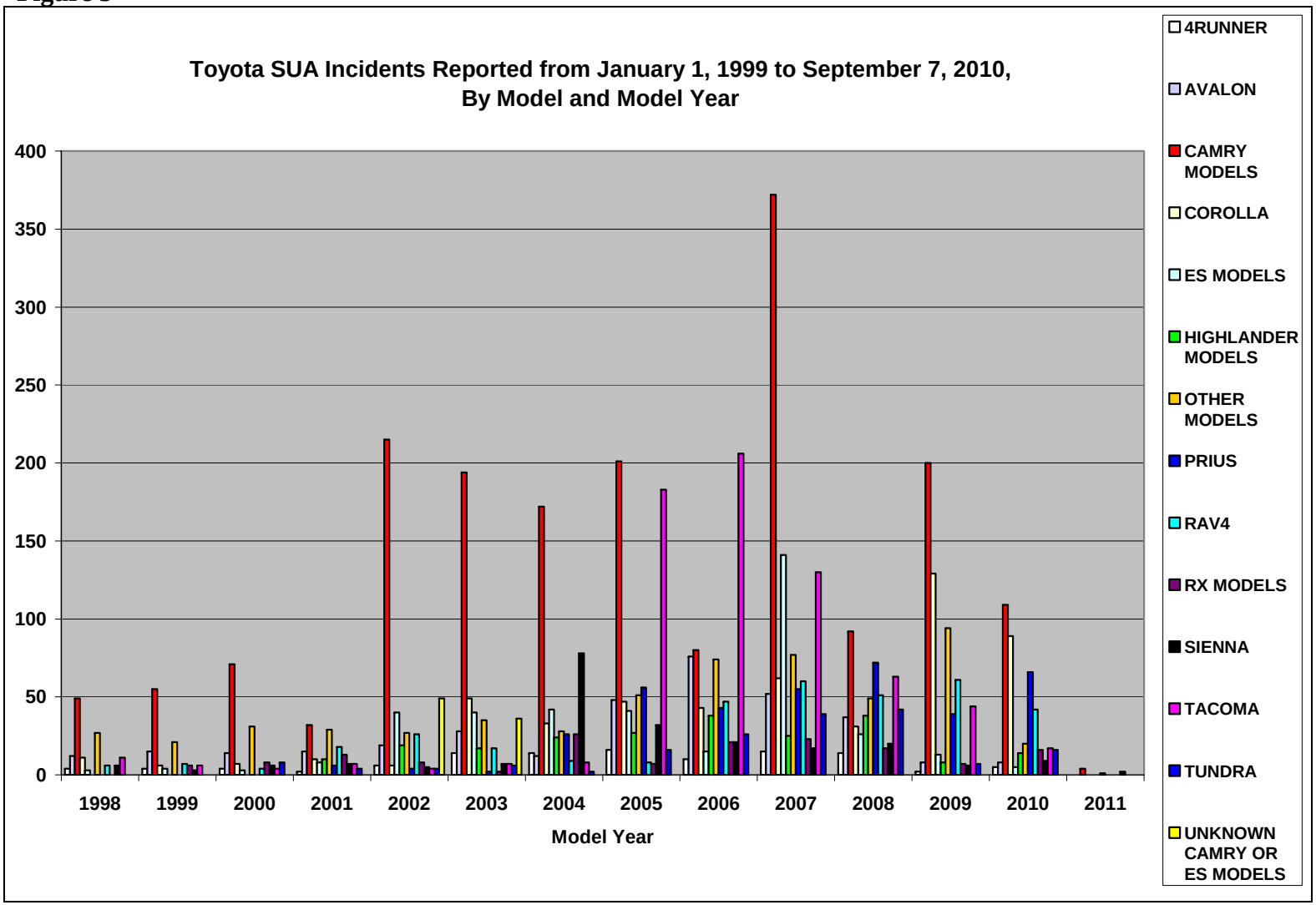
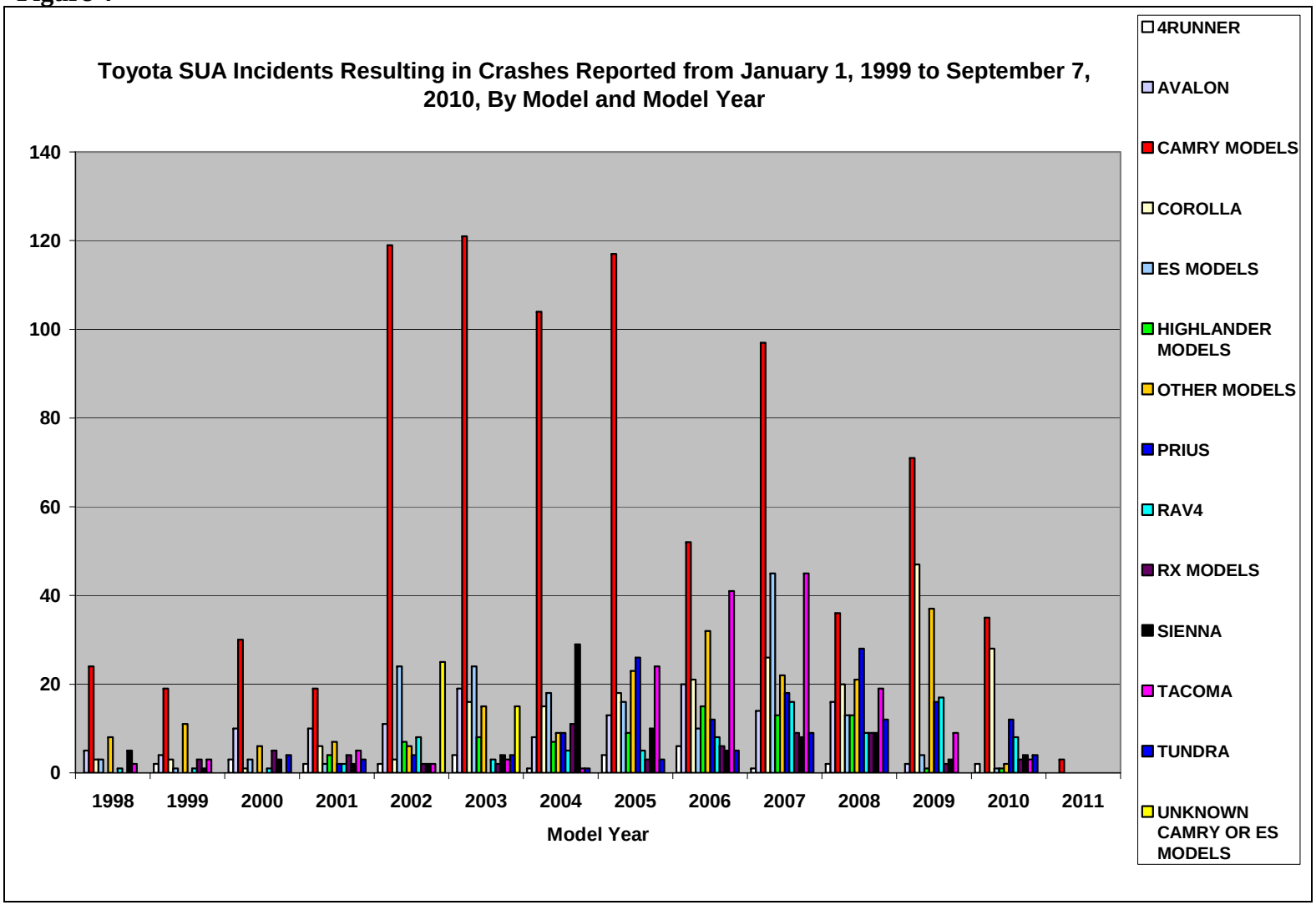

Toyota SUA Incidents Reported from January 1, 1999 to September 7, 2010,
By Model and Model Year
400
350
300
250
200
150
100
50
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Model Year
4RUNNER
AVALON
CAMRY MODELS
COROLLA
ES MODELS
HIGHLANDER MODELS
OTHER MODELS
PRIUS
RAV4
RX MODELS
SIENNA
TACOMA
TUNDRA
UNKNOWN CAMRY OR ES MODELS

Figure 4


Toyota SUA Incidents Resulting in Crashes Reported from January 1, 1999 to September 7, 2010, By Model and Model Year
140
120
100
80
60
40
20
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Model Year
4RUNNER
AVALON
CAMRY MODELS
COROLLA
ES MODELS
HIGHLANDER MODELS
OTHER MODELS
PRIUS
RAV4
RX MODELS
SIENNA
TACOMA
TUNDRA
UNKNOWN CAMRY OR ES MODELS

Recent reports highlight the drop in reported SUA events in Toyota vehicles during the third quarter of 2010. To examine this decrease in reported events, it is important to consider the factors that contributed to an increase in reporting in November 2009 and February 2010, and to examine the characteristics of the incidents that were reported during that time.

To gain insight into the decline in reported incidents, SRS examined a subsample of the data used in the analysis above. Specifically, SRS examined the relationship between date of report and date of incident in 5,284 consumer complaints to NHTSA, for which the agency had coded a precise incident date.

Figure 5 provides a breakdown of number of incidents, by calendar year of incident and calendar year reported, for complaints reported from 2004 to 2010. There is a clear increase in reporting in 2009 and 2010. What is notable about the reports in 2010 is how many of them are of incidents occurring in previous years.

Figure 6 magnifies this increase by illustrating number of incidents, by calendar year of incident and month reported, for complaints reported in 2009 and 2010. Note that a large number of complaints made in February and March 2010 are of incidents that occurred in previous years.

Unquestionably, this demonstrates the effect of the media and NHTSA announcements of defect investigations on reporting. Rather than dismiss this media effect as creating events that otherwise wouldn’t exist, it is valuable to consider why reporting is so influenced by media reports, and why previous incidents went unreported prior to SUA media coverage. It seems likely that, without the media coverage about SUA, some consumers would never have heard about NHTSA's consumer complaint hotline or NHTSA's online systems for complaint intake or would not have known how to reach either. Compounding that factor is the dismissal of SUA claims by Toyota at the dealership and corporate levels.

Figure 5

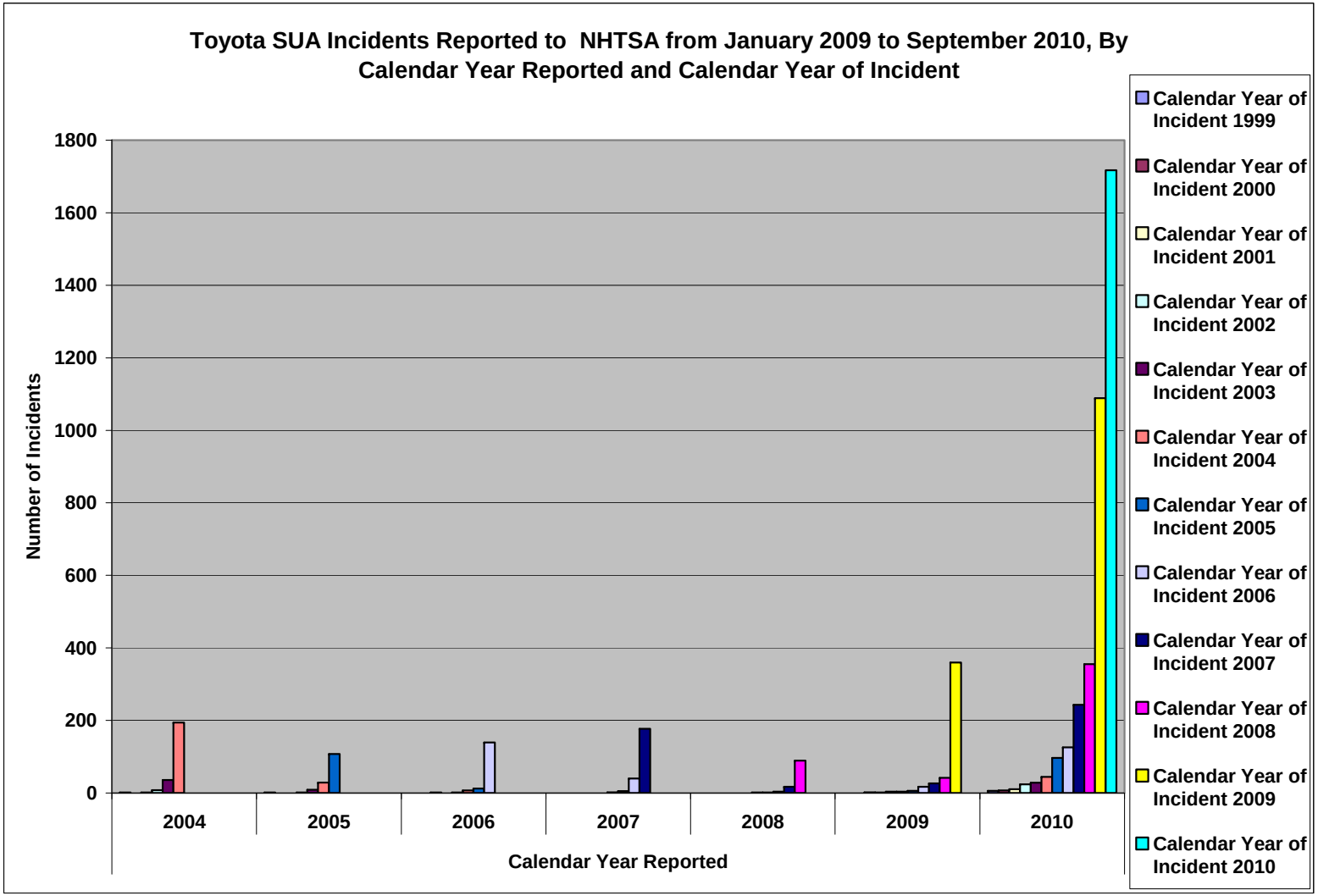
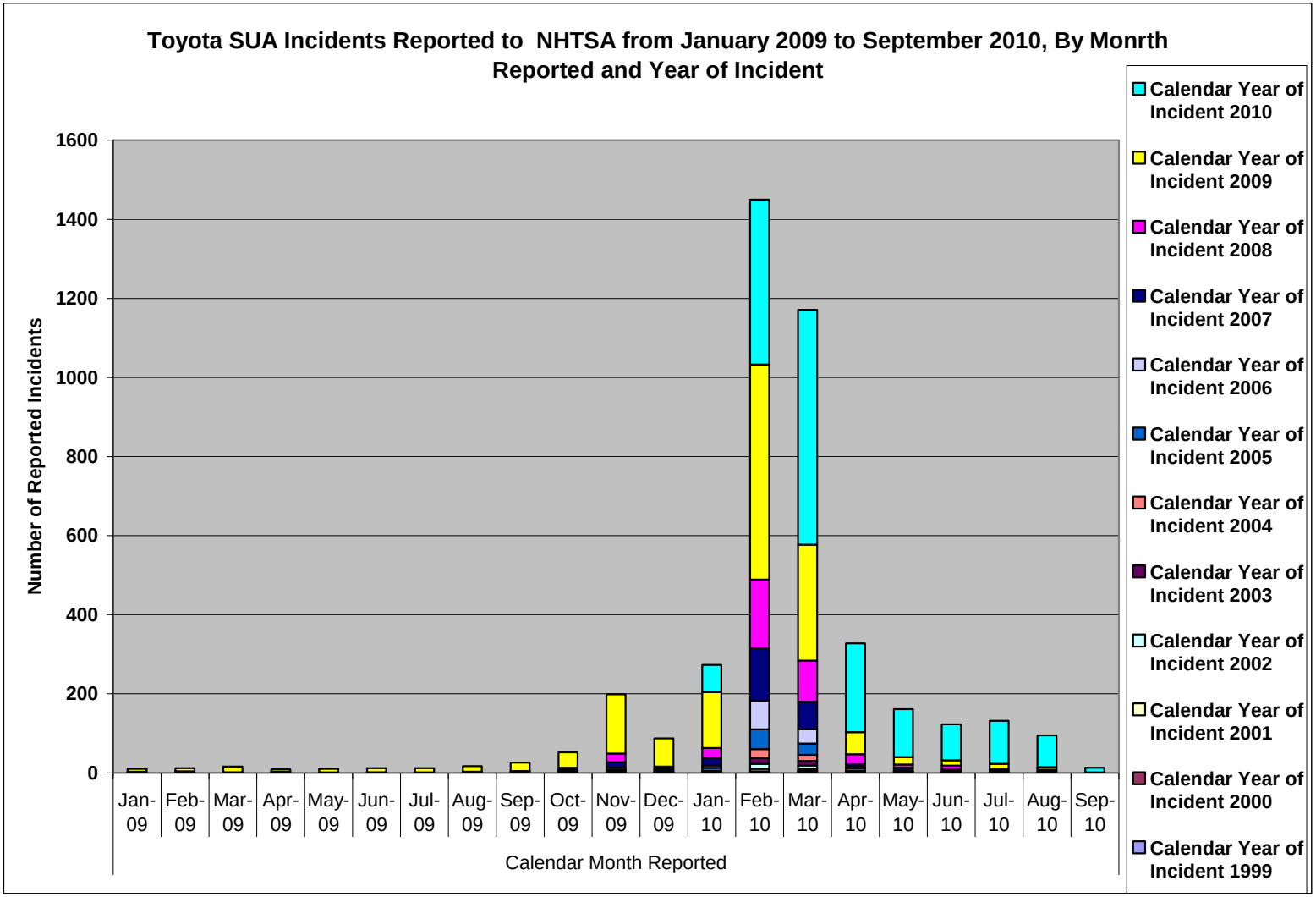

Toyota SUA Incidents Reported to NHTSA from January 2009 to September 2010, By Calendar Year Reported and Calendar Year of Incident
Number of Incidents
1800
1600
1400
1200
1000
800
600
400
200
0
2004
2005
2006
2007
2008
2009
2010
Calendar Year Reported
Calendar Year of Incident 1999
Calendar Year of Incident 2000
Calendar Year of Incident 2001
Calendar Year of Incident 2002
Calendar Year of Incident 2003
Calendar Year of Incident 2004
Calendar Year of Incident 2005
Calendar Year of Incident 2006
Calendar Year of Incident 2007
Calendar Year of Incident 2008
Calendar Year of Incident 2009
Calendar Year of Incident 2010

Figure 6


Toyota SUA Incidents Reported to NHTSA from January 2009 to September 2010, By Monrth Reported and Year of Incident
Number of Reported Incidents
1600
1400
1200
1000
800
600
400
200
0
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Jul-09
Aug-09
Sep-09
Oct-09
Nov-09
Dec-09
Jan-10
Feb-10
Mar-10
Apr-10
May-10
Jun-10
Jul-10
Aug-10
Sep-10
Calendar Month Reported
Calendar Year of Incident 2010
Calendar Year of Incident 2009
Calendar Year of Incident 2008
Calendar Year of Incident 2007
Calendar Year of Incident 2006
Calendar Year of Incident 2005
Calendar Year of Incident 2004
Calendar Year of Incident 2003
Calendar Year of Incident 2002
Calendar Year of Incident 2001
Calendar Year of Incident 2000
Calendar Year of Incident 1999

Quality Control Systems Data Analysis

A scientific analysis from Quality Control Systems Corp. (QCS) released on February 3, 2010, found that the proportion of consumer complaints related to vehicle speed control in some Toyota Camry, Tacoma, and Lexus ES vehicles is substantially higher in those models with electronic throttle control systems (Toyota's "ETCS-i") than it is for the same models without electronic throttle control.[40] [This study was detailed in SRS' February 5 report]. A recent presentation for the National Academies of Science committee examining electronic vehicle controls and unintended acceleration by R.A. Whitfield of QCS provided additional explanation of these findings.[41]

The complaint data challenge Toyota's assertions in a number of ways. First, Toyota has insisted that there is no reason to believe that there could be an electronic cause of these sudden acceleration events. However, QCS' analysis finds that the proportion of consumer complaints related to vehicle speed control in some Toyota Camry, Tacoma, and Lexus ES vehicles is substantially higher in those models with Toyota's ETCS-i system than it is for the same models without it.[42] The report also finds the proportion of reported speed control failures among complaints in the non-recalled Toyota Camry vehicles with ETC compared to the recalled Camry vehicles with ETC particularly troubling.

The study was limited to the period beginning in 1999 until just before the Santee, California crash in August 2009 so that the publicity surrounding the crash would not affect the study's results. [Note: In the NAS presentation, Whitfield also examined the effect of publicity at various points that coincided with NHTSA investigations before the Saylor event. For each of the vehicles studied, non-recalled vehicles with ETCS-i show SUA complaint rates that are greater than those same vehicles without ETCS-i. The difference was statistically significant for the Toyota Camry and the Toyota Tacoma.]

The original QCS report in February was supplemented for the new NAS presentation in a number of ways. Instead of relying strictly on the component coding of speed control related complaints, the narratives of the complaints were searched for key words and phrases indicative of unintended acceleration. The new analysis controlled for years in service by limiting the data to complaints about vehicles in the first calendar year after the production model year. Total numbers of unintended acceleration complaints were normalized based on vehicle production numbers reported by Toyota to NHTSA. The data were not restricted to complaints with decodable VINs, and certain assumptions were used about engine design (with and without ETCS-i) based on documents produced by Toyota to Congress for its investigation. Like the February analysis, the new one was restricted for the period prior to the Saylor crash.

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[40] Electronic Throttle Control Systems in Toyota Consumer Complaints to NHTSA; Quality Control Systems, Corp.; February 3, 2010

[41] What NHTSA's Data Can Tell Us about Unintended Acceleration and Electronic Throttle Control Systems; Quality Control Systems, Corp.; October 11, 2010

[42] Electronic Throttle Control Systems in Toyota Consumer Complaints to NHTSA; Quality Control Systems, Corp.; February 3, 2010

With these methodological changes, the association of electronic throttle control systems with unintended acceleration for the Toyota Camry, the Lexus ES 300 series, and the Toyota Tacoma appeared to be even more pronounced. Whitfield believes the assertion that "all" vehicles demonstrate unintended acceleration is very misleading because "all" vehicles don't have the same rates of unintended acceleration. Whitfield says that, "rate-based comparisons of unintended acceleration are helpful when they are based on theories related to actual differences in vehicle design. This is because differences in rates of UA may be important clues in focusing engineering analyses on specific problems in design, manufacturing, and testing."

The QCS presentation acknowledges that floor mat interference, sticky gas pedals, and driver error have played a role in some sudden acceleration events involving Toyota vehicles. This is based on the fact that some of the complaints frankly state owners' opinions that these were causes for some of the incidents. However, many other owners' reports were adamant that these were not the causes of the unintended acceleration events, for example, in vehicles in which floor mats had been removed. Since Whitfield looked at the effect of electronic control systems separately by model, he believes that electronic throttle control systems likely explain the disparity in complaint rates for the three models studied, to the extent that driver, environmental, and other vehicle-related effects can be ruled out by the study's design.

Investigations

NHTSA has no open defect investigations into SUA affecting specific Toyota models. The agency is in the midst of a more general investigation into the SUA phenomenon in partnership with the National Aeronautics and Space Administration (NASA) with some focus on Toyotas. A second SUA inquiry is now being conducted by NAS.

In February, the agency launched three probes into the previous floor mat and sticking accelerator pedal recalls. Two of those investigations, Timeliness Query (TQ) 10-001 and TQ10-0020, focus on whether Toyota followed the strictures of 49 CFR Part 573.5(b), which requires a manufacturer that has determined that a safety defect or noncompliance exists to report it NHTSA within five working days. The third probe, Recall Query (RQ) 10-003 looks at whether Toyota did enough to properly identify the defect and applied the remedy to proper makes and models of vehicles. The agency has also occasionally asked Toyota for additional information regarding death and injury crashes related to SUA that have been reported to NHTSA via Toyota's Early Warning Reporting (EWR) submissions.

Three different Congressional committees have held hearings to investigate the responses of Toyota and NHTSA to consumer complaints of SUA. At the request of several Congress members, the Office of the Inspector General (OIG) is now auditing ODI. In addition, *MDL No. 2151: In Re: Toyota Motor Corp. Unintended Acceleration Marketing, Sales Practices, and Products Liability Litigation*, a Multi-District Litigation (MDL), is now reviewing documents in the course of conducting its discovery.

NHTSA's First Investigation into Toyota SUA

Internal documents that have been released via congressional investigations and the Multi-District Litigation (MDL) suggest that NHTSA knew early on that the Camry was a troubled vehicle and that the trouble was somehow connected to the advent of Toyota's electronic throttle control in 2002. Further, they indicate that NHTSA struggled with reported SUA events that could not be explained by their favored, mechanically-related theories.

In 2003, the agency explored the possibility of investigating the Camry, but this probe never got off the ground. By the end of 2003, the number of Vehicle Owner Questionnaires submitted to the agency by Toyota customers complaining of SUA in Camry, Solara and Lexus ES 300 vehicles had shot up from about 10 in 2001, before the introduction of the electronic throttle, to about 300 from 2000 and 2003.[43]

In December 2003, Steve Chan, a NHTSA ODI staffer, wrote an Issue Evaluation (IE) documenting the spike in acceleration complaints in Camry vehicles equipped with a drive-by-wire throttle.[44] The memo noted that Toyota had already issued two technical service bulletins (TSBs) that related to the problem, and those bulletins, combined with the number of consumer complaints, formed the basis of the IE. In doing his peer analysis, Chan showed that the total complaints for Camry and Lexus vehicles, 44, far exceeded those for Honda, Nissan and Dodge models, but that the Camry and Lexus complaint rate was comparable to that of the Nissan Maxima. Nonetheless, Chan found that "the complaints do not show a geographic or seasonal trend but do show a strong recent trend of UA incidents."[45] Chan's risk assessment concluded: "Although most of the alleged UA incidents had occurred at very low speed (5 to 15 mph), the percentage of incidents that resulted in a crash is high (27/40 or about 68%). Estimation from some of the complainants on engine surging duration ranged from a low of 2 seconds to as high as 20 seconds. These incidents, though generally at low speeds, are of high risk to pedestrians because they represent situations that could occur in parking lots, at intersections, and at school lots."[46]

This investigation never progressed to the next level. The agency had just closed a Toyota Defect Petition in September, with no finding. (DP03-003 was filed on May 27, 2003, by Massachusetts resident Peter Boddaert, owner of a 1999 Lexus LS 400, who

[43] Camry/Solara/ES300 UIA VOQs Vs MY; National Highway Traffic Safety Administration; February 19, 2010
[44] Issue Evaluation; Unintended Acceleration (UA) on Model Year (MY) 2002-2003 Toyota Camry; Steve Chan; National Highway Traffic Safety Administration; December 9, 2003
[45] Issue Evaluation; Unintended Acceleration (UA) on Model Year (MY) 2002-2003 Toyota Camry; Steve Chan; National Highway Traffic Safety Administration; December 9, 2003
[46] Issue Evaluation; Unintended Acceleration (UA) on Model Year (MY) 2002-2003 Toyota Camry; Steve Chan; National Highway Traffic Safety Administration; December 9, 2003

experienced multiple instances of SUA.) [47] Later, the 2002-2003 Camry was added to PE04-021 in March 2004.[48]

In the midst of PE04-021, NHTSA again demonstrated its concern over the sheer number of Camry complaints. On June 3, ODI Investigator Scott Yon sent Santucci an e-mail along with a graph showing a 400-percent increase in the speed control-complaint rate involving the early model Camry vehicles, and suggested that he and Santucci discuss the trend by phone. On June 4, 2004, Toyota submitted its second set of responses to NHTSA's Information Request in PE04-021, asserting: "Toyota believes there is no possible factor or trend of vehicle/component defect. For any factor other than the vehicle itself the driver's age, driving circumstances or style, Toyota is unable to specify any particular trend because of indistinct or limited information."[49]

Death and Injury Investigations

Since at least 2004, NHTSA has requested additional information from Toyota, based on EWR submissions, of fourteen death and injury incidents in which unintended acceleration was alleged.

The Death Investigation (DI) Information Requests from Toyota include some combination of the following: complaints filed in civil lawsuits, internal customer relations contact memos, crash photos, and police, medical injury and coroner's records. The information included, by itself, does not appear to substantially contribute to the body of knowledge in a defect investigation. Police reports sometimes contain errors, and records of trauma to the human body generally are not instructive in determining potential defects associated with unintended acceleration. The most critical request in each DI, Toyota's "assessment of the circumstances that led to the incident including Toyota's analysis of the claim and/or notice regarding allegations of a defect," is optional.

Toyota's consistent response has been: "Toyota understands that this request is optional and respectfully declines to respond at this time."

Further, the reports, which span a six-year period, involve different makes, models and model years and throttle control systems – not all of them electronic. The circumstances of the crashes selected also vary – some involved scenarios in which the driver was already underway, sometimes at highway speed, and inexplicably, failed to stop before an obvious obstruction, like a stopped semi-trailer, or left the roadway at high speed before crashing.

The dates of the unintended acceleration Information Requests, however, appear to coincide with open defect investigations. For example, the agency issued requests for seven incidents, including the deaths of Juanita Grossman, Guadalupe Alberto and Barbara Schwarz, in early model Camry SUA incidents and the Saylor family on

[47] DP03-003; Defect Petition; Peter Boddaert; April 25, 2003
[48] PE04-021; Opening Resume; National Highway Traffic Safety Administration; March 3, 2004
[49] PE04-021; Toyota Response; Christopher Tinto; June 4, 2004

February 16, the same date it issued Information Requests to Toyota in TQ10-001, TQ10-002 and RQ10-003. In August 2008, the agency requested further information on five possible pedal entrapment death and injury cases, including a California fatality, just after it had upgraded PE07-016 into Lexus floor mat entrapments to an Engineering Analysis (EA).

The agency did not appear to have issued DI requests for many other deaths attributed to SUA incidents.

Timeliness Query 10-001

NHTSA opened TQ10-001 on February 4, to determine if automaker's pedal entrapment recalls 07E-082, 09V-388, and 10V-023 were issued within the statutory time period.[50] The investigation's aim was to obtain a more detailed chronology of the events leading up to Toyota's first floor mat recall, to more fully understand and evaluate, among other things, when Toyota first learned of the possibility of an issue of floor mat interference with the accelerator pedals installed.[51]

In March, Toyota submitted a detailed chronology of the events leading up to its first floor mat recall in September 2007, when Toyota shut down EA07-010, by launching a floor mat recall.[52] The chronology contains scant detail, but it does yield several interesting points: Toyota claimed to have had practically no complaints about floor mat interference; it scrambled to take action beginning in March 2007 to avert a NHTSA investigation; and it initiated a floor mat "field action" in the European market sometime in July 2007, two months before the automaker announced a recall in the U.S.

Further, the chronology is at odds with information presented to the agency in PE07-016. The chronology does not explain these discrepancies.

For example, the chronology showed that prior to taking any action, Toyota had only two reports of floor mat interference – a field technical report in February 2006 involving a 2005 Prius and a September dealership report involving a 2007 Lexus ES 350, using multiple floor mats – before it decided to stop the sale of all-weather floor mats (AWFMs) to implement changes. In its June 11, 2007, response to PE07-016, Toyota says it had no field reports related to pedal entrapment in MY2007 Lexus ES 350s.[53] Further, according to the response Toyota filed in June 2007 to PE07-016, it had received 38 consumer complaints related to pedal entrapment in Lexus ES 350 vehicles – eight involved crashes; five with injuries. The chronology does not mention any of these incidents as influencing their ensuing actions.

[50] TQ10-001; National Highway Traffic Safety Administration; February 16, 2010
[51] TQ10-001; Preliminary Chronology of Principal Events; Toyota Response; Christopher Tinto; March 24, 2010
[52] PE07-016; Toyota Response; Christopher Tinto; June 11, 2007
[53] PE07-016; Toyota Response; Christopher Tinto; June 11, 2007

On March 27, 2007, the automaker added a hangtag to be removed by customers and put a product usage label on the packaging.[54] A stop-sale would appear to be an extraordinary reaction if there were only two incidents in seven months involving different makes, models and model years. (Toyota did not submit for the public record details of either incident indicating why they reached that level of response.) However, it is more likely that Toyota's decision to add these warnings was an effort to get out in front of a pending NHTSA investigation.

According to the Toyota chronology, the automaker learned on March 29, 2007, that NHTSA opened a Preliminary Evaluation on the floor mat issue.[55] However, internal Toyota e-mails offered as exhibits in the MDL show that Toyota knew much earlier that a NHTSA defect investigation on floor mat interference in the ES 350 was in the offing.[56] In the days leading up the official opening of an investigation, Toyota's manager of government affairs, and former NHTSA investigator, Christopher Tinto, informed his colleague Mitch Kato, about the state of negotiations with NHTSA, which clearly began before Toyota's March 27 decision:

> "I spoke to NHTSA management today (K. Demeter) about a potential compromise on the ES350 floor mat Issue. In lieu of a Part 573 safety recall, I offered the following:
>
> Toyota will send a letter to all 2007MY ES350 owners reminding them not to install all weather mats on top of existing mats; In addition, we will enclose a caution label advising owners of the same, and ask owners to affix the label on the flat surface on the backside of the mat; We will also alert dealers of the issue, and remind them not to install mats on top of existing mats; If the owners want to have the dealer affix the label to the mat, Toyota will offer that they bring their vehicles to the dealer to ask them to do it, free of charge. However, we will NOT file a 573 (i.e. this is not a safety recall), because a) this is an 'aftermarket' install b) there is no design or manufacturing defect in the mat or vehicle, and c) the issue really boils down to improper installation of the mats by the owner or the dealer (but I noted that Toyota has no evidence that dealers are actually doing this.) Ms. Demeter said that there is precedent in NHTSA's history for safety recalls in this area, but understood our idea she pledged that they would discuss it internally and get back to me with a response to our proposal in a few days. She also insured me that NHTSA would not open a formal PE until she gets back to me."[57]

Over the course of events outlined from February 2006 to March, Toyota only acknowledged *five* incidents of possible pedal entrapment (including the Saylor crash) leading to a floor mat recall involving 3.8 million vehicles – even though Toyota Motor Sales President James Lentz told Congress that the company had received 37,900

[54] TQ10-001; Preliminary Chronology of Principal Events; Toyota Response; Chris Tinto; March 24, 2010
[55] TQ10-001; Preliminary Chronology of Principal Events; Toyota Response; Chris Tinto; March 24, 2010
[56] URGENT ES350 Issue; Chris Tinto; E-mail; Toyota; March 28, 2007
[57] URGENT ES350 Issue; Christopher Tinto; E-mail; Toyota; March 28, 2007

consumer complaints potentially related to SUA – with only 30 percent of those complaints covered by either the sticky pedal or floor mat recalls.

Toyota also acknowledged that before it launched the first, limited floor mat recall in September 2007, it had initiated some sort of a floor mat campaign for its European customers in July. Little is publicly known about what Toyota calls a "field action." Under the TREAD ACT, manufacturers must report an overseas safety recall or "other safety campaign in a foreign country on a motor vehicle or motor vehicle equipment that is identical or substantially similar to a motor vehicle or motor vehicle equipment offered for sale in the United States."[58] SRS could not find any evidence in the public record that Toyota reported this floor mat "field action" to NHTSA prior to disclosing it in TQ10-001.

In the ensuing two years, the cycle repeated itself. According to the chronology, Toyota reports having received only two more complaints.[59] (SRS is aware of a January 2008 crash involving floor mat entrapment in a Lexus ES 350, which occurred on a Connecticut highway. This crash was reported to Toyota. It was also submitted to NHTSA as part of the company's quarterly EWR,[60] but it is not one of the complaints mentioned in the chronology.)

After the Saylor crash spotlighted Toyota's SUA problems, the automaker again ramped up a response. The very public loss of life, involving a California Highway Patrol officer, caught Toyota's attention in a way eight previous NHTSA investigations did not.

A September 2009 e-mail from Toyota's Koji Sakekibara to his colleagues underscored the delicate position in which the automaker found itself:

> "In light of the information that two minutes before the crash, an occupant made a call to 911 telling that the accelerator pedal was stuck and the vehicle would not stop, I think that the Body Engineering Division should act proactively first, (investigate issues such as whether the accelerator assay is the cause, how to secure floor mats, the timing of introducing shape improvements.) Furthermore, taking into account the circumstances that in this event a police officer and his entire family TMS-PQSS Public Affairs Group thinks that the NHTSA and the USA public already hold very harsh opinions in regards to Toyota (As I think you know, in some cases in the USA killing a police officer means the death penalty.") [61]

This time, the internal assessment took other solutions into account: "Toyota conducted various analyses to evaluate the emergency shutdown method of Toyota vehicles and

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[58] Transportation Recall Enhancement, Accountability, and Documentation Act; Section 3; Reporting Requirements; November 1, 2000
[59] TQ10-001; Preliminary Chronology of Principal Events; Toyota Response; Christopher Tinto; March 24, 2010
[60] DI08-083; Sequence 6; Gary Masi Incident; November 14, 2008
[61] Important Information: America ES350 – Artlcle; Koji Sakekibara; E-mail; Toyota Motor Sales; September 1, 2009

competitor vehicles, to evaluate the brake override system of competitor vehicles, to evaluate the accelerator pedal shape change to reduce the risk of pedal entrapment by floor mats, and to compare the shift levers of Toyota vehicles with competitor vehicles."[62] After initially advising owners to remove the AWFMs from their vehicles, Toyota issued a second-phase response, which included a brake-to-idle override for some models, and newly designed floor mats for all vehicles under the recall.

This chronology begs more questions than it answers – it admits to almost no internal evidence of a problem over a four-year period. Is Toyota suggesting that consumer complaints, EWR data and legal and warranty claims had no role in driving their recall decisions? Does Toyota expect NHTSA to accept the explanation that on the basis of two field reports, Toyota initiated a stop sale? Based on Toyota's EWR data, NHTSA opened at least five Death and Injury inquiries on incidents in which floor mat entrapment was alleged. Toyota does not mention any on these incidents in its chronology.

The outline of events casts Toyota's floor mat recall campaigns in September 2007 and October 2009 as rear-guard actions, driven by NHTSA or other externalities. While the agency investigation is in the Preliminary Evaluation stage, the automaker conducts pedal entrapment analyses in an Avalon and Prius in relation to pedal geometry and the AWFM, and finds nothing wrong.[63] Once NHTSA elevates the investigation to the Engineering Analysis stage, Toyota decides to conduct a floor mat recall in September 2007.

In 2010, one Toyota official recalled that the company had considered installing a brake-to-idle override during its discussions:

> "During the floor mat sticking issue of 2007, TMS suggested that there should be a 'fail safe option similar to that used by other companies to address unintended acceleration.' I remember being told by the accelerator pedal section Project General Manager at the time (Mr. M) 'This kind of system will be investigated by Toyota not by Body Engineering Div.' Also, that information concerning the sequential inclusion of a fail safe system would be given by Toyota to NHTSA when Toyota was invited in 2008. (The NHTSA knows that Audi has adopted a system that closes the throttle when the brakes are applied and that GM will also introduce such a system.)"[64]

Any Toyota discussion about installing a brake override solution in 2007 is not included in this chronology. Other internal e-mails and presentations released publicly suggest that Toyota was much more interested at the time in the least costly solution – a floor mat fix.

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[62] TQ10-001; Preliminary Chronology of Principal Events; Toyota Response; Christopher Tinto; March 24, 2010

[63] TQ10-001; Preliminary Chronology of Principal Events; Toyota Response; Christopher Tinto; March 24, 2010

[64] Important Information: America ES350 – Article; Koji Sakekibara; E-mail; Toyota Motor Sales; September 1, 2009

Timeliness Query 10-002

NHTSA opened TQ10-002 to investigate the events leading up to Recall 10V-017, for defective accelerator pedals that were "hard to depress, slow to return, or could, in the worst case, stick in a partially depressed position."[65] This recall, known in the vernacular as the "sticky pedal recall," initially affected 2.3 million Tundra, Sequoia, Avalon, Camry, Corolla and Corolla Matrix, RAV4, Highlander and Pontiac Vibe vehicles.[66] The January 21 recall eventually expanded to include 5.4 million Lexus and Toyota models.

NHTSA requested additional information to "more fully understand and evaluate, among other things, when and what Toyota learned of sticking accelerator pedals installed on its vehicles, the chronology of events leading up to Toyota's defect decision, Toyota's responses to problems with sticking accelerator pedals (both in the United States and abroad) and the timing of those responses, and the timeliness of Toyota's submission of its part 573 report."

The two-part chronology, from July 2006 to January, traced simultaneous timelines regarding Toyota's reactions to reports of sticky pedals occurring in the U.S. and Europe. It showed Toyota first seeking to minimize the problem as one occurring under very specific conditions – high humidity and heat, either caused by climate and ambient air temperatures or those created by the proximity of the heating ducts to the pedals.[67] Further, Toyota's chronology characterized the problem as one that is not safety-related. In September 2009, TMC confirmed that a vehicle with a sticky pedal could stop in approximately the same distance as a pedal without the problem.

Nonetheless, on September 29, 2009, Toyota "issued a Technical Instruction and identified a production improvement and repair procedure to Toyota distributors in 31 countries across Europe to address complaints of sticky accelerator pedals, sudden increases in engine RPM, and sudden vehicle acceleration."[68]

Toyota didn't launch a similar recall in the U.S. until January 21. A few days before the automaker filed its Defect Notice, Irv Miller, then-TMS' Group Vice President of Environmental and Public Affairs chastised his colleagues for failing to act quickly:

> "I hate to break this to you but WE HAVE A tendency for MECHANICAL failure in accelerator pedals of a certain manufacturer on certain models. We are not protecting our customers by keeping this quiet. The time to hide on this one is over."[69]

[65] TQ10-001; National Highway Traffic Safety Administration; February 16, 2010
[66] Recall 10V-017; Toyota; January 21, 2010
[67] TQ10-002; Preliminary Chronology of Principal Events Slow to Return and Sticky Accelerator Pedal Issues; Toyota Response; March 24, 2010
[68] TQ10-002; Penalty Agreement; Attachment; O. Kevin Vincent; National Highway Traffic Safety Administration; April 5, 2010
[69] E-mail to Katsuhiko Kogenai; Irv Miller; Toyota; January 16, 2010

On April 5, the agency notified Toyota that it had violated the timeliness provision of the recall regulations and fined it $16.4 million, the largest civil penalty to date levied by the agency against an automaker. The notification cited the four-month lag between the actions in Europe and the U.S. recall:

> "Based on documents produced by Toyota related to this recall, it appears that Toyota determined or should have determined that vehicles equipped with the CTS accelerator pedal contained a safety-related defect no later than September 29, 2009."[70]

On April 19, Toyota agreed to pay the fine, but did not admit any wrongdoing.

> "We agreed to this settlement in order to avoid a protracted dispute and possible litigation, as well as to allow us to move forward fully focused on the steps to strengthen our quality assurance operations," Toyota said in a statement.[71]

Recall Query 10-003

The third recall-related query looks at Toyota's SUA-related recalls globally: did Toyota define the underlying defects "too narrowly as interference between the accelerator pedal and the driver's side floor mat, or as a lever design (including materials) or performance problem giving rise to a sticking accelerator pedal, without fully considering the broader issue of unintended acceleration and any associated safety-related defects that warrant recalls."[72]

It compels Toyota to actually acknowledge the existence of SUA beyond the very limited examinations of previous investigations, asking for: "Toyota's assessment of the cause or factors contributing to the unintended acceleration (if Toyota has not and has never identified the actual or likely cause or factors contributing to the unintended acceleration, so state)."[73]

In this investigation, the agency similarly took its widest view yet of the phenomenon:

> "For purposes of this investigation, 'unintended acceleration' refers to unintended, unrequested, uncontrollable, and/or unexplained acceleration of a subject vehicle, and to the failure of a vehicle's engine to return to idle when the driver takes his or her foot off of the accelerator pedal or raises his or her foot to a position where the engine ordinarily would return to idle, regardless of the alleged or determined cause of the acceleration or failure to decelerate or return to idle and regardless of the speed at which the event allegedly took place. Unintended acceleration thus is broader than interference between the accelerator pedal and

[70] TQ10-002; Penalty Agreement; Attachment; O. Kevin Vincent; National Highway Traffic Safety Administration; April 5, 2010
[71] Toyota Motor Corporation Agrees to Settle NHTSA Civil Penalty; Press Release; 2010
[72] RQ10-003; Opening Resume; National Highway Traffic Safety Administration; February 16, 2010
[73] RQ10-003-003; Manufacturer's Information Request; Pg. 9; National Highway Traffic Safety Administration; February 16, 2010

> driver's side floor mat and sticking accelerator pedals with levers made of a particular plastic(s)."[74]

In its Information Request, NHTSA asked for many more documents related to Toyota's SUA assessments and a detailed chronology of all information and allegations related to SUA – other than those attributed to pedal interference or sticking pedals already mentioned in TQ10-001 and TQ10-002. The Information Request also asks Toyota to respond yearly, quarter by quarter, from 2007-2010, whether it was "considering and/or assessing alleged or actual unintended acceleration, other than interference between the accelerator pedal and driver's side floor mat," and required the automaker to submit "a statement of all reasons why Toyota has not included the incident as being caused or contributed to by interference between the accelerator pedal and driver's side floor mat or by a sticking pedal, and a statement of Toyota's belief as to the cause or contributing factors of the unintended acceleration."[75]

The agency sought other key and detailed information regarding the functioning and development of the electronic throttle control system; the system's redundancies; and its testing protocols, specifications, designs for and protections against electromagnetic interference.

To date, little of substance has been added to public file. An anonymous commenter submitted several publicly available technical papers suggesting "the possibility of cosmic rays disrupting electronics at sea level, essentially flipping a bit from one to zero, or vice versa."[76] The commenter said that Single Event Upsets (SEU) create "soft" errors that are not detectable except through redundant electronic and communication systems:

> "The automotive industry has yet to truly anticipate SEUs. The reason SEUs are now relevant to the automotive industry is because electronics have gotten smaller and the required voltage levels have dropped significantly, therefore making electronics more susceptible to cosmic radiation even at sea level. SEU is one possible explanation for sudden unintended acceleration (SUA) in Toyotas. Electromagnetic Interference (EMI) is another, among others including software logic/programming errors."[77]

On April 26, Toyota asked that its submission receive confidential treatment.[78]
The agency's response has not yet been added to the public record.

However, because this investigation examines the efficacy of the floor mat and sticky pedal recalls, which began in 2007, Toyota's actions and assessments regarding the early model Camry vehicles will be excluded. The 2002-2005 Camry remain the model and

[74] RQ10-003; Opening Resume; National Highway Traffic Safety Administration; February 16, 2010
[75] RQ10-003-003; Manufacturer's Information Request; Pg. 9; National Highway Traffic Safety Administration; February 16, 2010
[76] RQ10-003; Submission on Sea Level SEU Phenomenon; Anonymous; February 17, 2010
[77] RQ10-003; Submission on Sea Level SEU Phenomenon; Anonymous; February 17, 2010
[78] RQ10-003; Request for Confidential Treatment; Adam C. Sloane; Toyota; April 26, 2010

model years with the largest number of complaints. These vehicles are still unrecalled and ineligible for the brake override feature.

Congressional Investigations

Two Committees in the U.S. House of Representatives and one in the U.S. Senate have probed the causes of Toyota SUA, the adequacy of its recalls and NHTSA's response. The House Committee on Energy and Commerce held hearings in February and May. The House Committee on Government Oversight and Reform held one hearing in February entitled: "Toyota Gas Pedals: Is the Public at Risk?" The Senate Committee on Commerce, Science and Transportation followed in March with a hearing on "Toyota's Recalls and the Government's Response."

Despite accusations that Congress criticized Toyota to improve the image of American automakers, these hearings have been notable for three reasons: they forced top executives of Toyota and government agency heads to state their positions and make other admissions on the record; they took a more skeptical approach to Toyota's and NHTSA's assertions, testing them with outside experts; and they requested many more documents from Toyota (encompassing more than 100,000 pages) and released a few of those internal documents to the public. These materials, in combination with testimony given at the hearings, have advanced the public understanding of NHTSA's and Toyota's actions since the Toyota SUA issue came to the fore in 2003. They show:

- NHTSA was looking at the unintended acceleration problem in Camry vehicles as early as 2003.[79] In 2004, NHTSA saw a distinct upward trend in Camry speed control complaints in consumer complaints.[80] In that same year, State Farm Insurance contacted NHTSA to alert them to this same trend.[81]

- Toyota had 37,900 customer complaints in its database potentially related to unintended acceleration.[82]

- The sticky pedal and floor mat recalls would only address 30 percent of these complaints.[83]

- Toyota's approach to defect investigations is focused on minimizing the scope of the inquiry and the impact of any recall to Toyota. A good relationship with the

[79] Issue Evaluation; Unintended Acceleration (UA) on Model Year (MY) 2002-2003 Toyota Camry; Steve Chan; National Highway Traffic Safety Administration; December 9, 2003
[80] Re: For Review; CamryVSCTrend-200402; Scott Yon; National Highway Traffic Safety Administration; E-mail; June 3, 2004
[81] Toyota's Recalls And The Government's Response; Panel I; Senate Commerce, Science And Transportation Committee; Transcript; March 2, 2010
[82] Response By Toyota And The National Highway Traffic Safety Administration To Incidents Of Sudden Unintended Acceleration; Panel I; Oversight And Investigations Subcommittee Of The House Energy And Commerce Committee; Transcript; February 23, 2010
[83] Response By Toyota And The National Highway Traffic Safety Administration To Incidents Of Sudden Unintended Acceleration; Panel I; Oversight And Investigations Subcommittee Of The House Energy And Commerce Committee; Transcript; February 23, 2010

agency was key to its success in these areas. (See *Toyota and NHTSA: Managing the Relationship* section)

- Toyota employed a deliberate and high-cost strategy to attack critics, engaging through its outside counsel one science-for-hire firm and a high-profile public relations firm to undercut critics' reputations and damage their credibility. (See *Toyota: Managing the Message* section.)

- Toyota did not produce any evidence to show that it had engaged in "extensive testing" to determine a cause of SUA.[84]

- Toyota's scientific consultant Exponent was actually hired to defend the automaker in a class-action lawsuit. (See *Toyota and Exponent: Managing the Science* section)

- Exponent's study, purporting to show that Toyota's electronic throttle control could not fail, was unscientific and simplistic. (See *Toyota and Exponent: Managing the Science* section)

National Academy of Sciences

In March, the National Research Council's National Academy of Sciences (NAS) convened a panel of engineers, scientists and others to probe the phenomenon of SUA. The group's directive is to study all possible causes of SUA, including software glitches, electromagnetic interference, driver error and mechanical causes. Dr. Louis Lanzerotti, an expert in space plasmas, geophysics and other space engineering from the New Jersey Institute of Technology, heads the group. [85]

The 17 panelists, who are unpaid volunteers, were gathered from suggestions provided by the National Research Council (NRC) staff and members of its sub-groups, the National Academy of Sciences and the National Academy of Engineers. The NRC also chooses panelists under a conflict-of-interest policy that takes current potential conflicts into account.[86]

As the sponsor, NHTSA provided the broad objectives of the study. They include a review of vehicle control electronics design and reliability and other causes of unintended acceleration; best practices for safety assurance; testing limitations in establishing the

[84] Update on Toyota and NHTSA's Response to the Problem of Sudden Unintended Acceleration; Transcript; Hearing of the Oversight and Investigations Subcommittee of the House Energy and Commerce Committee; May 20, 2010
[85] Electronic Vehicle Controls and Unintended Acceleration; Membership Information; National Academy of Science; 2010
[86] Electronic Vehicle Controls and Unintended Acceleration; Membership Information; National Academy of Science; 2010

causes of rare events; and improvements in design, manufacturing and testing of electronic throttle controls.[87]

The examination of electronic issues will include software life-cycle process; computer hardware design, testing and integration with the software; vehicle systems engineering; and electromagnetic compatibility and interference.

The panel expects to publish its findings June 2011.[88]

NHTSA/NASA Partnership

NHTSA has also enlisted aid of NASA to delve more deeply into possible electronic causes of SUA. According to a presentation by NASA engineer Mike Kirsch the space agency will employ a systems engineering process to determine "if there are design and/or implementation vulnerabilities in the Toyota electronic throttle control (ETC) system that could realistically be expected to cause unintended acceleration (UA)."[89]

NHTSA and NASA are examining an array of issues: the specific conditions necessary for ETC failure to occur; the physical or electronic evidence that may be left behind; the expected ranges of throttle opening; and the possibility of an ETC failure affecting the braking system.[90]

The two agencies are taking a specific interest in the Generation 6 Camry, which encompasses the model and model years with by far the most complaints. Gen 6 starts with the 2002 Camry, in which electronic throttle control was first introduced, and includes four more years to MY 2006. A chart of VOQs presented by NHTSA's Roger Saul showed that the UA complaint rate for the Camry skyrockets between 2001 and 2002 from less than 5 per 100,000 to more than 20 per 100,000.[91] The partnership is specifically testing Gen 6, Gen 5 and 7 Camry vehicles to document the features and capabilities that may contribute to unintended acceleration.

Finally, the partnership will study the complaint symptoms and history of each vehicle to develop an understanding of how the design is supposed to work and how it might fail. Researchers will develop event sequence diagrams and fault trees to use in creating the testing protocols.[92] In determining which test scenarios to employ, NHTSA and NASA

[87] Electronic Vehicle Controls and Unintended Acceleration; Project Information; National Academy of Science; 2010
[88] Electronic Vehicle Controls and Unintended Acceleration; Project Information; National Academy of Science; 2010
[89] Assessment of ETC System; PowerPoint Presentation; Mike Kirsch; National Aeronautics and Space Administration; June 30, 2010
[90] Assessment of ETC System; PowerPoint Presentation; Mike Kirsch; National Aeronautics and Space Administration; June 30, 2010
[91] Possible Electronic Causes; PowerPoint Presentation; Roger Saul, Mike Kirsch ; NHTSA, NASA; June 30, 2010
[92] Assessment of ETC System; PowerPoint Presentation; Mike Kirsch; National Aeronautics and Space Administration; June 30, 2010

will evaluate and prioritize the feasibility of the failure and how well the failure behavior matches reported incident reports. The tests will be performed on vehicles that were the subject of an SUA complaint and non-complaint vehicles. [93]

Inspector General's Audit

On February 19, the Office of Inspector General (OIG) announced that it was initiating an audit of NHTSA's ODI.[94] Questions and concerns from both individual members of Congress and congressional committees about the Toyota recalls prompted this investigation. The audit will examine the actions taken by NHTSA in the recent Toyota recalls and the process for identifying and investigating safety defects. The OIG expects to coordinate its work with NHTSA's ongoing investigations of Toyota.

In 2002, the OIG conducted a comprehensive review of ODI's work, as required by the TREAD Act, and in 2004 the office conducted a follow-up review. The audit's objectives are to examine NHTSA's efforts to ensure that ODI has the appropriate information systems and processes in place to promptly identify and take action to address potential safety defects as intended by the TREAD Act; assess NHTSA's procedures and processes for ensuring that companies provide timely notification of potential safety defects; and examine the lessons learned from the Toyota recalls to identify any improvement needed in current policies and procedures.[95]

Litigation

Even before the Saylor crash, wrongful death and personal injury lawsuits were pending against Toyota Motor Corporation and Toyota Motor Sales, Inc. in U.S. state and federal courts. The individual suits alleged that floor mats and/or faulty electronic systems had caused Toyota and Lexus vehicles to accelerate out of control.

In late 2009, the wave of the floor mat and sticky pedal recalls was followed by a wave of Multi-District Litigation (MDL) cases in federal courts nationwide. The MDLs (also known as consumer class action lawsuits) alleged defects in a variety of vehicle components, including electronic throttle controls. In addition, the MDL lawsuits charged Toyota with breach of implied warranty and negligence and sought compensatory and punitive damages on behalf of Toyota owners.

In March, a federal judicial panel of judges was assembled to combine these MDLs into one case, select a centralized, convenient venue for all the parties, and establish an efficient approach to handling the litigation. After a series of hearings, the panel in May invoked a multidistrict litigation referred to as *MDL No. 2151: In Re: Toyota Motor Corp. Unintended Acceleration Marketing, Sales Practices, and Products Liability*

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[93] Assessment of ETC System; PowerPoint Presentation; Mike Kirsch; National Aeronautics and Space Administration; June 30, 2010

[94] INFORMATION: Audit Announcement – NHTSA's Office of Defects Investigations Project No. 10M3003M000; DOT, Office of Inspector General; February 19, 2010

[95] INFORMATION: Audit Announcement – NHTSA's Office of Defects Investigations Project No. 10M3003M000; DOT, Office of Inspector General; February 19, 2010

Litigation, and selected the Central District of Southern California as the venue. The panel appointed Judge James V. Selna to preside.

Shortly after his appointment, Judge Selna approved a preservation order for all evidence – including dealer records – which compelled Toyota to preserve all data that may relate to the case, and exclude these records from the company's record retention and destruction policies. He also ordered Toyota to produce to the MDL lawyers all documents Toyota Motor North America (TMA) and Toyota Motor Sales, Inc. (TMS) had already given to Congress and NHTSA.

On August 2, attorneys for the lead MDL plaintiffs filed the first master consolidated complaint on behalf of owners. The suit covers 55 different makes and models of Toyota, Lexus and Scion vehicles, purchased since 1998. The consolidated complaint alleges that the electronic throttle control system is defective and alleges breach of contract, breach of implied warranty of merchantability, fraud by concealment and unjust enrichment. The MDL plaintiffs also claim that Toyota knowingly hid defects associated with unintended acceleration beginning in 2002 and fraudulently promoted the safety of its vehicles. The individual federal lawsuits alleging injury and death from Toyota SUA also have been transferred to the Central District of Southern California, under the guidance of Judge Selna.

Also on August 2, a separate consolidated class complaint was filed seeking economic damages and damages for personal injuries and deaths suffered by Toyota, Lexus and Scion consumers who purchased their vehicles outside of the U.S. The overseas plaintiffs represented owners from a wide variety of countries including Mexico, China, Indonesia, Germany, Turkey, Jamaica, Peru, South Africa, Egypt and the Philippines. This MDL Consolidated Complaint also asserts a claim under the federal RICO Act.

Less than 30 days after the filing of the First Consolidated Complaints, attorneys on behalf of Toyota filed a Motion to Dismiss claiming that the class plaintiff's had failed to clearly state a defect or cause related to sudden acceleration. Plaintiffs' counsel has not yet filed a response. A filing of an Amended Master Consolidated Complaint is anticipated in October.

Litigation is also pending in various state courts nationwide. Cases in California and Texas have been consolidated to pre-trial Multi District Litigation proceedings.

The California Joint Consolidated Court Proceedings, *No. JCCP4621 Toyota Motor Cases*, a state-based MDL for pre-trail proceedings, is pending in Superior Court California County of Los Angeles with Judge Anthony J. Mohr presiding.

The Texas state MDL proceedings, *10-0352 In Re Toyota Sudden Acceleration Litigation*, are pending in 152nd District Court of Harris County with Judge Robert Schaffer presiding.

Toyota also moved to transfer personal injury SUA cases pending in New York to pre-trial MDL proceedings. That motion is pending before the Litigation Coordinating Panel in the Unified Court System in the state of New York.

Toyota's Position

Toyota continues to maintain that it can find no electronic cause that would explain the SUA complaints it had received as of February. To date, Toyota executives have also insisted that the current recalls for sticking pedals and floor mats have solved the problem. The automaker blinked a couple of times at the February 23 hearing before the Committee on Energy and Commerce's Subcommittee on Government Oversight and Reform.

Co-chair, Representative Henry Waxman asked TMS President Jim Lentz:

> "Do you believe that the recall on the carpet changes and the recall on the sticky pedal will solve the problem of sudden unintended acceleration?" [96]

Lentz replied, "Not totally."[97]

Similarly, Toyota's position on the relationship between sticking pedals and SUA has wobbled. At the same hearing, Rep. Bart Stupak questioned Lentz about sticking pedals and high speed events:

> "REP STUPAK: Do you have any analysis, any evidence that sticky pedals can cause a sudden, unintended acceleration?
> MR. LENTZ: It depends on the definition of 'sudden.' If it means that you can be depressing a pedal, take your foot off the pedal and the car continues its speed, it does cause that.
> REP. STUPAK: Quoting your counsel, 'typically does not translate into a sudden high-speed acceleration event' -- sticky pedals. So sticky pedals really isn't doing anything about sudden high-speed --
> MR. LENTZ: Not for high speed."[98]

The public record shows that Toyota's statements cannot be accepted at face value. However, the preceding eight months have seen the automaker backtrack on two

[96] Response By Toyota And The National Highway Traffic Safety Administration To Incidents Of Sudden Unintended Acceleration; Panel II; Oversight And Investigations Subcommittee Of The House Energy And Commerce Committee; Transcript; February 23, 2010
[97] Response By Toyota And The National Highway Traffic Safety Administration To Incidents Of Sudden Unintended Acceleration; Panel II; Oversight And Investigations Subcommittee Of The House Energy And Commerce Committee; Transcript; February 23, 2010
[98] Response By Toyota And The National Highway Traffic Safety Administration To Incidents Of Sudden Unintended Acceleration; Panel II; Oversight And Investigations Subcommittee Of The House Energy And Commerce Committee; Transcript; February 23, 2010

important positions. The first involves the veracity of its Event Data Recorders (EDRs) and the second involves the robustness of its fault detection system.

What Did Toyota Know About SUA and When Did It Know It?

As more internal NHTSA and Toyota documents come to light, it's clear that Toyota has known for at least seven years that it had a SUA problem with some models that it could not explain. Their knowledge comes not only from internal customer complaints, but, from its own technicians. In addition, Toyota has known that its ECU- the computer that manages the engine systems, via sensors – does not always work as intended. Electronic malfunctions can occur that are not detected by the ECU. Toyota has presented evidence to the agency in an unrelated investigation showing instances in which the ECU experienced a malfunction, but did not set an error code.

Yet, the reliability of Toyota's fault detection system has formed the primary basis of its defense against SUA complaints.

Here's a sampling of Toyota's public statements:

> "With regard to allegations of unintended acceleration, *Toyota does not believe that uncontrollable acceleration can occur without the driver applying the accelerator pedal because of the several detection systems described above.* If an abnormal condition occurs, such as the ETC sending the signal to the throttle body to open the throttle without applying the accelerator pedal due to a failure of a component or a malfunction of the system, or if the throttle simply were to open on its own, the system goes into failsafe mode."[99]

> "In case the ECU itself experiences a malfunction and an abnormal throttle control signal is sent to the throttle motor, the above detection system will still work as designed because of built in redundancy. The ECU has two CPUs and these two CPUs are comparing each signal received every 100 milliseconds in order to measure its own functionality. In the event of a multipoint failure (one of the CPUs or any sensor or sensors) the system will go into failsafe mode and illuminate the engine warning lamp because of the built in redundancies in the ETC system."[100]

> "We've had diagnostic capabilities in our engine control modules for well over a decade now, and so any time there is an electrical fault in a circuit or in an actuator or in the computer, we've got the ability to record those diagnostic trouble codes - DTCs, as we call them - and any technician, not just a Toyota technician - any technician can read out the diagnostic trouble codes on our vehicles, and our publicly available repair information would let them determine what the specific meaning is of each code."[101]

[99] DP05-002; Toyota Response; Chris Tinto; Toyota Motor Corp.; November 15, 2005
[100] PE04-021; Toyota Response; Chris Tinto; Toyota Motor Corp.; July 19, 2004
[101] Toyota Electronic Throttle Control Webinar; Paul Williamsen; Toyota; February 22, 2010

> "Toyota believes that the DTC system works as designed, and that if a single or multi-point failure were to occur, the ECU would signal a DTC and put the system into one of its failsafe modes."[102]

Internally, documents tell the story of electronic systems that can and do fail – without the setting of DTCs. They also show that Toyota knew that unintended acceleration could occur – with no mechanical or human cause. In one exhibit cited by the MDL master consolidated complaint, one of Toyota's own technicians noted this as early as May 2003:

> "On May 5, 2003, in a 'Field Technical Report' Toyota acknowledged the fact that "[s]udden acceleration against our intention,' was an 'extremely serious problem for customers.' The technician reported a UA incident and stated: 'We found miss-synchronism between engine speeds and throttle position movement.' The probable cause was unknown, but '(e)ven after replacement of those parts, this problem remains.' The author requested immediate action due to the 'extremely dangerous problem' and continued: '[W]e are also much afraid of frequency of this problem in near future.'[103]
>
> In a Field Technical Report dated December 12, 2008, a technician stated: 'After traveling 20-30 feet the vehicle exhibited a slight hesitation then began to accelerate on its own. Engine speed was estimated to have gone from 1500 rpm to 5500 rpm at the time of the occurrence...Probable Cause =Unknown.'[104]
>
> "In a February 27, 2007 email sent by Toyota manager Michiteru Kato to Santucci, Mr. Kato decided against sending his most knowledgeable ECU (Engine Control Unit) engineer to a demonstration being conducted for NHTSA on its electronic power steering, in order to avoid questions regarding ECU failures: '...I thought that 3 guys from TMS is too many (two at most), and if the engineer who knows the failures well attends the meeting, NHTSA will ask a bunch of questions about the ECU. (I want to avoid such situation).'[105]

Other exhibits suggest that Toyota was hearing about these failures from NHTSA and other professionals:

> "In May 2004, a Forensic Technologist and MSME examined a vehicle in New Jersey that had experienced a UA event. The report was forwarded to Toyota on

[102] PE04-021; Toyota Response; Chris Tinto; Toyota Motor Corp.; July 19, 2004
[103] MDL No. 2151: In Re: Toyota Motor Corp. Unintended Acceleration Marketing, Sales Practices, and Products Liability Litigation; Complaint; August 2, 2010
[104] MDL No. 2151: In Re: Toyota Motor Corp. Unintended Acceleration Marketing, Sales Practices, and Products Liability Litigation; Complaint; August 2, 2010
[105] MDL No. 2151: In Re: Toyota Motor Corp. Unintended Acceleration Marketing, Sales Practices, and Products Liability Litigation; Complaint; August 2, 2010

> January 13, 2005. It concluded that the vehicle's ETCS was not operating correctly. This report was not provided to NHTSA." [106]

On June 4, 2004, NHTSA sent an e-mail to Chris Santucci showing a 400 percent increase in Camry vehicle speed control complaints, since the introduction of its new electronic throttle control system.[107]

Toyota's Fail-Safe System Can – and Does – Fail

On Aug. 26, Toyota recalled nearly 1.3 million 2005-2008 Corolla vehicles prone to unpredictable engine failure. The recall was influenced by PE09-054, a new NHTSA investigation to examine why Corolla vehicles would suddenly stall on drivers, sometimes while the vehicles were in motion. Although this defect is not related to SUA, it forced Toyota to make an important admission: its fault detection system is not infallible.

In a March 2 response to the agency's Information Request in PE09-054, Christopher Santucci wrote:

> "Toyota does not believe that anyone would have prior warning that the alleged defect was occurring or that the subject component was malfunctioning. However, a malfunction indicator would illuminate if a malfunction did occur."[108]

However, field technical reports also submitted as part of the automaker's response showed multiple technicians documenting that the ECU did not acknowledge a malfunction by setting a DTC. Among them:

> "Vehicle towed into dealership with a crank, not start condition. Technician confirmed engine would not start and *MIL does not illuminate.* The scan tool would not communicate with the ECM. Power and ground connections to the ECM were confirmed good."[109]

> "Customer mentioned that his vehicle stalls intermittently. We confirmed this problem took some time to correct as it was hard to duplicate. It happened while driving and also when idling. After stalling it would start up again and run fine. Then it will run fine for several days before stalling again. Complete inspection of entire fuel and ignition systems passed. *No DTCs stored or pending.*"[110]

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[106] MDL No. 2151: In Re: Toyota Motor Corp. Unintended Acceleration Marketing, Sales Practices, and Products Liability Litigation; Complaint; August 2, 2010
[107] Re: For Review; CamryVSCTrend-200402; Scott Yon; National Highway Traffic Safety Administration; E-mail; June 3, 2004
[108] PE09-054; Toyota Response; Chris Santucci; March 2, 2010
[109] PE09-054; Toyota Technical Field Reports, Page 1; 20050414Y00060; March 2, 2010
[110] PE09-054; Toyota Technical Field Reports, Page 17; 20060725A00070; March 2, 2010

> "Customer states vehicle dies while driving down the road…Technician verified the customer's complaint and upon further diagnosis found the vehicle dies while driving. *Vehicle restarts with no codes."*[111]
>
> "The Customer states: that the engine will crank but will not start. The customer called AAA; the AAA staff confirmed the condition and tapped on the fuel pump module and the vehicle engine started. A few days later the customer encounter the problem again, at this time the vehicle was towed into the dealership. FTS inspection result of 8/27/04. The customer complaint could not be duplicated. Engine starts fine (about 1 sec cranking is needed to start the Engine). Test-drove the vehicle about 3 miles in the city, no abnormalities were found. *No DTC memorized in ECM*."[112]

In its FAQ to customers, Toyota was forced to walk back earlier and repeated assertions that its fault detection system doesn't fail:

> **"Are there any warnings that this condition has occurred?**
>
> In most of the cases, the check engine light will illuminate if this condition occurs and the vehicle may experience harsh shifting. However, there may be some cases where the check engine light does not illuminate and harsh shifting does not occur."[113]

These field technical reports show problems that the ECU did not catch and record going back to September 2004. Nonetheless, in SUA investigations, Toyota continued to claim that its fault detection system would catch any abnormality. In closing PE04-021, and in denying DP09-001 and DP05-002, NHTSA cited, in part, the lack of trouble codes set in the fault detection system as reasons to forego further investigation. Toyota has now conceded that its fault detection system is not flawless. This casts a measure of doubt upon NHTSA's decisions to close past SUA probes based on this assumption.

Cursory Inspections and Quiet Buybacks

Before and after the advent of Toyota's so-called Swift Market Analysis Response Team (SMART) last spring, the automaker has deployed corporate technicians to inspect vehicles from owners who complained. The typical Toyota experience for owners who report an unintended acceleration incident is a visit to the dealership, where the vehicle is presumably checked out and given a clean bill of health. The consumer is not always privy to what precise tests were conducted or what they showed. Some customers who ask for the test data are told they aren't allowed to have them. SRS has interviewed dozens of Toyota owners who tell stories that are remarkably similar.

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[111] PE09-054; Toyota Technical Field Reports, Page 23; 20070405G00040; March 2, 2010
[112] PE09-054; Toyota Technical Field Reports, Page 38; 20040908700570; March 2, 2010
[113] Customer FAQs for Corolla/Corolla Matrix Recall; Toyota Motor Sales, USA Website; September 14, 2010

Diana Buckley of Canton, Georgia, hit a pole in a Lowe's parking lot on April 10, after her 2004 Sienna lunged forward while her foot was on the brake. Buckley described maneuvering into the parking spot at a very low speed. Her foot was on the brake in preparation for bringing her vehicle to a complete stop, when the vehicle lunged forward. "I quickly looked down at my foot, and it was definitely, definitely on the brake. I pushed down, but it was too late – I only had 10 or 12 feet to respond," she says.

The Buckleys had already experienced a number of prior experiences, like the one that resulted in the parking mishap. Diana Buckley says they started in 2005 and 2006. Sporadically, in low speed situations, the driver would give the Sienna a little gas and it would hesitate and then lurch forward powerfully. The Buckleys had taken the vehicle in to the dealership each time, and each time, the vehicle was returned with no finding of a malfunction. Once, however, the dealership mechanic conceded:

> "We've got lots of these complaints and sooner or later, they are going to have to do something," Buckley recalled.

After her April incident, Buckley pursued a claim against Toyota. After six weeks of fruitless interactions with the dealership and Toyota, the company sent an independent inspector to look at her Sienna. He also cleared the vehicle. Buckley asked to see the Tech Stream data along with any other documentation of the tests, and he politely told her that he wasn't allowed to share the data generated by the vehicle with the vehicle owner. She would have to go to Toyota for that information.

Joseph Chen of Mountainview, New Jersey, had a frustrating experience with an FTS who conducted an inspection on his eight-month-old 2010 Highlander, after its engine accelerated while Chen was stopped for a traffic light, with his foot on the brake. Chen waited at the dealership for an hour and a half, while a FTS inspected his vehicle and took it for a test drive – only to find out that the FTS left without speaking to him. Chen had hurried over, after the dealer called to tell him that the technician had arrived. In a later telephone conversation, the technician told him that there was nothing wrong with his vehicle and that the incident could be attributed to driver error.

Roger Kupec of Morehead, Minnesota was at a credit union drive-through making a withdrawal, when he experienced an unintended acceleration event. He had shifted the car into Park and left the engine running. While he conducted his transaction, the engine idled normally. As he prepared to leave the drive-through, he put his foot on the brake pedal and then shifted the car into Drive. The car jolted forward, and a large plume of smoke came out of the exhaust pipe. He pressed down harder on the brake pedal, turned the steering wheel to avoid hitting a building and shifted the car into Neutral. Even in Neutral, the engine continued to race rapidly, as if the gas pedal were pressed to the floor, with no indication of slowing. Kupec could see that his foot was only touching the brake pedal and that the pedal was free of any hindrances. Video surveillance footage shows the brake lights coming on. The floor mats in his 2009 RAV4 were secured to the floor by clips. He turned off the vehicle, exited the car, and pushed it away from the ATM.

After the incident, the vehicle was towed to Corwin Toyota, where Kupec was informed that they performed diagnostic tests and were unable to identify any malfunctioning equipment in the vehicle. The dealer also performed the accelerator pedal recall. But the service technicians were not able to explain why the car accelerated. A Toyota Corporation representative came to Fargo to consult with Corwin staff. Afterward, the Toyota representative told Kupec that he believed the car to be safe.

Toyota has three inspection scenarios – one for concerned customers who have not experienced a UA event; another for owners who claim to have had a UA event, but no crash; and a third for those who have had an event and suffered a crash.[114] Scenario II follows a flow chart involving corporate claims case managers, owner interviews, and a more involved set of diagnostics that may involve an EDR download or a system scan. The dealer conducts an interview with the vehicle owner to get a detailed description of the incident. The automaker's Technical Assistance System agents determine what level of inspection is needed – a visual check of the floor mats and pedals, a Tech Stream download to search for stored DTCs and/or a five-mile test drive to check the operation of the cruise control. Woven into the chart are instructions such as: "Explain normal vehicle system characteristics that are of concern to the owner," and "Discuss what to do if the owner experiences unintended acceleration." [115]

In the meantime, Toyota has quietly bought back some vehicles. In November 2009, Toyota bought back a five-week-old 2010 RAV4 from Brian Blackman and Rosemary Moran of Powell River, British Columbia, Canada. On Nov. 11th, Brian Blackman phoned his wife, Rosemary, and reported: "Something terrible just happened." Blackman was driving into the driveway, and was almost stopped and ready to put the car into park, when the RAV4 took off. Blackman put his foot on the brake, but the vehicle continued to accelerate. Blackman slammed the vehicle into Park and the vehicle stopped, but the engine continued to race. He pressed the stop/start button and finally, the engine quit. The incident occurred in a matter of 4-5 seconds, but the experience really shook him up. He realized that had he not reacted, he would have crashed into the deck of their home. After the incident, the couple turned to the dealer, Rice Toyota of Vancouver Island, for a refund.

Three engineers came to inspect the vehicle, and after two days, the couple got a call from Toyota Canada, that the company would buy back the vehicle. On November 22, 2009, Blackman said that he signed the vehicle over to Toyota and was told that the vehicle was going to Japan or California for further analysis. Rosemary Moran said via e-mail: "Toyota gave us all our money back, (over $40,000 Canadian). They have never said why we were given our money back. They said they couldn't find anything wrong with our car, but took it away to examine it and they said that they would get back to us when they found out what the problem was. We have not heard one word."

[114] Unintended Acceleration (UA) Toyota Technical Inspection Guide; Toyota Dealer UA Process Flow; 2010

[115] Unintended Acceleration (UA) Toyota Technical Inspection Guide; Toyota Dealer UA Process Flow; 2010

Toyota and NHTSA: Managing the Relationship

According to documents that have recently become public, Toyota considered the management of its relationship to NHTSA a critical element in dodging defect investigations. Toyota's Washington D.C.-based regulatory team was unusual, in that it consisted of two former ODI staffers, Chris Tinto, Vice President of Regulatory and Technical Affairs, and his assistant manager, Chris Santucci. Both used their institutional experience to minimize the effect of any ODI inquiries on the fortunes of their new employer.

For example, in 2004, during a critical phase of an investigation into SUA in Camry and Lexus ES vehicles, Santucci testified that he had conversations with ODI about the scope of the investigation – specifically, what types of SUA events would be considered. The agency eventually narrowed its definition of SUA in that probe to one that wiped away all of the incidents with the most harmful outcomes – injury and death.[116]

By 2006, the importance of smoothing and strengthening Toyota's relationship with the agency would grow. In that year, there was some internal recognition that the foundation of safety and reliability on which Toyota's sterling reputation was built had begun to crumble. In the fall, both Jim Press, then-President of Toyota Motor North America, and the 20-member All Toyota Labor Union sounded the alarm. The latter expressed its views in a letter to then-president Katsuaki Watanabe warning that quality was slipping dangerously and would threaten the company's survival. "We are concerned about the processes which are essential for producing safe cars, but that ultimately may be ignored, with production continued in the name of competition," the letter said.[117]

Press raised his concerns in an internal presentation, entitled *A New Era for Toyota in North America*.[118] This presentation documented the link between recalls and dents to Toyota's reputation and image. In the slide notes, Press says that the data show: "Toyota's numbers are on a steady rise, in both recalls and NHTSA investigations, while the Detroit 3.5 average is actually trending downward. In both indicators, while we still trail the Detroit 3, we exceed both Honda & Nissan."[119] Recalls impact the bottom line, because customers consider them when making a purchase, as do Toyota's institutional investors, he said.

Press also noted that Toyota's credibility with NHTSA was declining: "Our ability to manage the tide of safety investigations rests largely on our ability to work well with NHTSA. Over the last few years, we have seen our relationship begin to slip slightly with NHTSA. The reasons are complex. They include a combination of increased recalls, more investigations, and tougher negotiations between Toyota and the agency."[120]

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[116] Deposition of Christopher Santucci; Pg. 283; Alberto v. Toyota; December 9, 2009
[117] Toyota Workers Raised Safety Concerns With Bosses in 2006 Memo; L.A. Times; March 8, 2010
[118] A New Era for Toyota and TMA in North America; Jim Press; Toyota; September 29, 2006
[119] A New Era for Toyota and TMA in North America; Jim Press; Toyota; September 29, 2006
[120] A New Era for Toyota and TMA in North America; Jim Press; Toyota; September 29, 2006

Press urged the company: "First, we need to safeguard what is left of our good working relationship with NHTSA. Working together with TMC, our technical responses to investigation-related requests from NHTSA should be vetted internally with respect to their potential public relations impact, as well as their technical appropriateness. This is an essential step to rebuilding their confidence in Toyota."[121]

Two years later, Press's admonishments did not appear to usher in a new era. In a 2008 presentation, Chris Tinto raised the same points.[122] Tinto also noted that poor product quality was coming back to the company as defect investigations. Among his observations in the presentation were these: "Some of the quality issues we are experiencing are showing up in defect investigations (rear gas struts, ball joints, etc); NHTSA's management is aggressive, *and* not technical; Although we rigorously defend our products through good negotiation and analysis, we have a less defensible product; TMA has been quite successful in remediating difficult issues (ex: ES 350/Camry floor mat recall), but it is becoming increasingly challenging."[123]

Internally, Toyota bragged about its success in limiting the 2007 investigation into floor mat interference in the Lexus ES 350 recall to floor mats. In a series of internal emails, Tinto and Santucci, discussed the pressure that NHTSA was putting on the automaker to do something about the floor mat situation. Despite Toyota's attempt to fend off further agency action by informing customers and adding new warning labels, NHTSA was on the verge of issuing a public service announcement:[124]

> "They claim that this remains a serious issue, even subsequent to our mailings to Lexus owners; They recognize that this is a misuse issue (stacked mats), however, they believe that something about the throttle pedal or floorpan design lends itself to easier jamming than other models produced in the past; they also believe that the Prius, Camry and Avalon may also be prone to being overly sensitive to floor mat jamming and claim to have some evidence of such; they claim that jamming can occur with Toyota mats or aftermarket mats; they claim that the issue is further complicated by the fact that NHTSA believes that customers do not know how to shut off the car when in motion (i.e. hold the start button for 3 seconds). NHTSA said that they feel that this is so important/urgent that they are considering a NHTSA public service announcement, informing the public to insure they install the mats correctly (i.e. proper clip use, and no stacking) as well as how to shut off the vehicle with the push button start."[125]

NHTSA was also suggesting that Toyota install a brake override, similar to the feature that Volkswagen had installed in its vehicles, and to reprogram the ignition button so that pressing the button multiple times would also turn off the engine.[126] Toyota resisted

[121] A New Era for Toyota and TMA in North America; Jim Press; Toyota; September 29, 2006
[122] January 2008 Draft Presentation; Chris Tinto; Toyota
[123] January 2008 Draft Presentation; Chris Tinto; Toyota
[124] URGENT UPDATE on ES350 Investigation; E-mail; Chris Tinto; Toyota; August 24, 2007
[125] URGENT UPDATE on ES350 Investigation; E-mail; Chris Tinto; Toyota; August 24, 2007
[126] URGENT UPDATE on ES350 Investigation; E-mail; Chris Tinto; Toyota; August 24, 2007

ODI's suggestions for a more comprehensive fix. Instead, the agency settled for much less. EA07-010 was closed two months later, when Toyota initiated a limited floor mat recall campaign.[127]

In a September 15, 2007, e-mail, Josephine Cooper, Group Vice President of Toyota Motor North America, took pains to celebrate that success to her superiors. Attaching an e-mail from Chris Tinto emphasizing the $100 million saved by avoiding a recall that called for the replacement of the throttle control assembly, Cooper wrote:

> "Gentlemen:
> I thought you would be interested in the outcome--and the avoidance of much bigger issues (and costs). The TMA and TMS team did a good job..."[128]

One year later, Toyota executive Yoshimi Inaba boasted in an internal presentation that the company had saved $100 million in limiting the remedy of sudden acceleration in Lexus and Camry vehicles to a 55,000-unit floor mat recall.[129]

In 2009, Toyota enjoyed similar success in shutting down DP09-001. In April 2009, Jeffrey Pepski, a Lexus ES 350 owner from Minnesota asked the agency to re-open its investigation into SUA in that vehicle. Pepski had tried pumping and pulling up the accelerator with his foot, but could not stop the acceleration. Further, Pepski's Lexus was equipped with a standard carpet mat, not the all-weather variety singled out for previous investigations. In his petition, Pepski criticized the agency for focusing "too narrowly" on floor mat interference. Specifically, he requested "an additional investigation of model years 2002-2003 Lexus ES 300 for those 'longer duration incidents involving uncontrollable acceleration where brake pedal application allegedly had no effect' for which Ms. Kathleen C. Demeter, Mr. Jeffrey L. Quandt and Mr. D. Scott Yon determined was not within the scope of an earlier investigation (PE04-021) closed on July 22, 2004."[130]

On May 5, about a week before Toyota would send a point-by-point response to Pepski's detailed petition, one of Toyota's Washington staffers, Chris Santucci sent an e-mail to colleague Takeharu Nishida. Santucci's correspondence alerted Takeharu of his progress in the behind-the-scenes horse-trading with the agency. As characterized by Santucci, NHTSA was looking for a way out of yet another Lexus SUA investigation:

> "For background, NHTSA did inspect the petitioner's vehicle. While they did not see clearly the witness marks of the carpeted floor mat on the carpet in the forward, unhooked position, they do suspect that the floor mat was responsible for the petitioner's issue."[131]

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[127] EA07-010; Closing Resume; National Highway Traffic Safety Administration; October 11, 2007
[128] ES350 recall/NHTSA meeting; Josephine Cooper; E-mail; September 15, 2007
[129] Toyota Washington, D.C.; Internal Presentation; Yoshi Inaba; July 6, 2009
[130] DP09-001; RE: Petition of an Interested Party under Part 552 of 49 CFR Chapter V; Jeffrey Pepski; March 13, 2009
[131] Re: Defect Petition; Chris Santucci; E-mail; Toyota; May 5, 2009

> "I have discussed our rebuttal with them, and they are welcoming of such a letter, They are struggling with sending an IR letter, because they shouldn't ask us about floormat issues because the petitioner contends that NHTSA did not investigate throttle issues other than floor mat-related. So they should ask us for non-floor mat related reports, right? But they are concerned that if they ask for these other reports, they will have many reports that just cannot be explained, and since they do not think that they can explain them, they don't really want them. Does that make sense? I think it is good news for Toyota."[132]

(Jeff Pepski recently responded to SRS about this email: "My incident occurred on February 3, 2009. My petition to NHTSA was dated March 13, 2009 and I met with the NHTSA reps [Bill Collins and Stephen McHenry with the DOT] and Toyota rep [Mike Zarnecki, the Field Technical Specialist from the Lexus Central Area Office] on May 1, 2009. Since no chain of evidence existed, the possibility of any observable witness marks as of May 1 would be remote and the level of reliability would be non-existent. All three parties were present when I asked Mike Zarnecki to demonstrate how the floor mats could have possibly caused the accelerator pedal to become entrapped. After much manual manipulation of the floor mat, he was able to show how it may occur. At my request he pulled up and pushed down on the gas pedal; the floor mat immediately became free. I explained that the SUA that I experienced did not cease after I had done the same while driving on February 3. If the floor mat had entrapped the accelerator pedal as all three claimed, the vehicle would have stopped accelerating after dislodging the floor mat. The SUA I experienced continued as the floor mat was not the cause.")

In October 2009, NHTSA denied the Pepski petition.

Toyota and Exponent: Managing the Science

Toyota hired Exponent in December 2009[133] after the public outcry over the deaths of the Saylor and Lastrella families. While NHTSA eventually concluded that a floor mat entrapped the gas pedal of the rented Lexus in the Santee, California crash, many others – including automotive electronics experts and safety advocates – raised the possibility that Toyota and Lexus vehicles were plagued by electronic problems located in the electronic throttle control system.

At the behest of Toyota's outside counsel Bowman & Brooke, Exponent produced two reports, purportedly intended to get to the bottom of 37,900 SUA complaints Toyota had received since installing electronic throttle controls. The first report, *Testing and Analysis of Toyota and Lexus Vehicles and Components for Concerns Related to Unintended Acceleration,* was released on February 4, right after the first Congressional hearing on

[132] Re: Defect Petition; Chris Santucci; E-mail; Toyota; May 5, 2009
[133] Testing and Analysis of Toyota and Lexus Vehicles and Components for Concerns Related to Unintended Acceleration; Exponent; February 4, 2010

Toyota SUA.[134] Exponent was given an "unlimited budget," to delve into Toyota's electronics.[135]

According to the report, Exponent evaluated six Toyota and Lexus vehicles containing various versions of the ETCS-i system and one Honda vehicle to use as a peer comparison, along with more than 100 new and used ETCS-i and pre-ETCS-i components (throttle bodies, accelerator pedals, ECMs) "under a variety of normal and abnormal conditions." Exponent scientists concluded:

> "Throughout the evaluation and testing conducted to date, the ETCS-i components and whole vehicles behaved in a manner consistent with published performance characteristics. Exponent has so far been unable to induce, through electrical disturbances to the system, either unintended acceleration or behavior that might be a precursor to such an event, despite concerted efforts toward this goal."

The co-chairmen of the Committee on Energy and Commerce's Subcommittee on Oversight and Government Reform invited outside experts to review Exponent's work. Based on their assessments, the committee excoriated Exponent's work as simplistic, unscientific, too limited in scope, and lacking any real investigation into root causes:

> "Michael Pecht, a professor of mechanical engineering at the University of Maryland, and director of the University's Center for Advanced Life Cycle Engineering (CALCE), told the Committee that Exponent 'did not conduct a fault tree analysis, a failure modes and effects analysis . . . or provide any other scientific or rigorous study to describe all the various potential ways in which a sudden acceleration event could be triggered'; 'only to have focused on some simple and obvious failure causes'; used 'extremely small sample sizes'; and as a result produced a report that 'I would not consider . . . of value . . . in getting to the root causes of sudden acceleration in Toyota vehicles.'"[136]

> "Another expert consulted by the Committee, Neil Hanneman, an engineer with over 30 years experience in automotive manufacturing, product design, and product development, reached a similar conclusion, informing the Committee that the report 'does not follow a scientific method' and fails to test 'major categories' of potential causes of sudden unintended acceleration, including 'electromagnetic interference/Radio frequency interference,' 'environmental conditions,' the electronic control module (ECM), and 'the software algorithms in the ECM."[137]

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[134] Testing and Analysis of Toyota and Lexus Vehicles and Components for Concerns Related to Unintended Acceleration; Exponent; February 4, 2010
[135] Prepared Testimony of James Lentz; Committee On Energy And Commerce; February 23, 2010
[136] Letter from the Committee on Energy and Commerce to James E. Lentz; Reps. Henry Waxman and Bart Stupak; February 22, 2010
[137] Letter from the Committee on Energy and Commerce to James E. Lentz; Reps. Henry Waxman and Bart Stupak; February 22, 2010

In addition, the Committee did its own review of the Exponent research and found it to be missing key elements:

> "On February 19, 2010, the Committee staff interviewed one of the primary authors of the Exponent report, Dr. Paul Taylor. He stated that the report did not examine any vehicles or components that consumers reported to have had unintended acceleration events. He also said that the study did not analyze the vehicles' computer systems, seek to identify potential chip failures, examine software and programming of the vehicles' electronic control modules, conduct any testing under differing environmental conditions, or assess the effects of electromagnetic or radio frequency interference on the electronic throttle control system. According to Dr. Taylor, these are not among his or his co-authors' 'areas of expertise.' Dr. Taylor said that Toyota's counsel has hired other researchers at Exponent to conduct such tests of Toyota and Lexus vehicles, but Toyota did not request that Exponent provide interim reports on these additional studies."[138]

The second report was issued specifically to refute Dr. David Gilbert's finding that Toyota's fault-detection system did not note short-circuits in the APPS, which conveys the driver's desired speed and opens and closes the throttle.[139]

> "When the two APP signal circuits are shorted together, the redundancy of the APP circuit design is effectively nullified and lost. In other words, neither of the shorted APP signal circuits can be verified by the ECM as either; correct or incorrect. The condition then exists for a serious concern for driver safety."[140]

This conclusion was a direct threat to Toyota's central defense throughout eight SUA investigations by NHTSA – that a sudden unwanted acceleration could not occur without the ECM identifying the abnormality and recording it as a DTC. No DTC, no problem.

Exponent was then dispatched to counter the Gilbert report. Toyota intended to use this report, *Evaluation of the Gilbert Demonstration*, to dismiss Gilbert's work as a mere parlor trick, but Exponent actually validated Gilbert's conclusions.[141] Exponent's report, however, maintained that the conditions that would lead to a fault without the vehicle's computer taking note could not happen in the real world.[142]

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[138] Letter from the Committee on Energy and Commerce to James E. Lentz; Reps. Henry Waxman and Bart Stupak; February 22, 2010
[139] Toyota Electronic Throttle Control Investigation: Preliminary Report; David W. Gilbert, PhD, Omar Trinidad; February 21, 2010
[140] Toyota Electronic Throttle Control Investigation: Preliminary Report; David W. Gilbert, PhD, Omar Trinidad; February 21, 2010
[141] Interview of Shukri Souri; Pg. 83; Committee on Energy and Commerce; May 12, 2010
[142] Evaluation of the Gilbert Demonstration;, Exponent Failure Analysis Associates; March 2010

Toyota also invited Professor Christian Gerdes of Stanford University to evaluate Gilbert's work. Gerdes affirmed to the committee Gilbert's report was a legitimate examination of a possible weakness in the fault detection system.[143]

As part of the ongoing Congressional investigation into Toyota SUA, the Committee on Energy and Commerce probed the relationship between Exponent and Toyota and found cause for concern:

- Exponent was hired – not in the name of scientific inquiry, as Toyota claimed – but to defend Toyota in a class-action lawsuit.[144]
- Exponent was hired -- not by Toyota – but by outside counsel Bowman & Brooke, to shield its work from plaintiff's discovery requests. [145]
- All communications between Toyota and Exponent had counsel present.[146]
- Exponent billed Toyota for 11,000 hours of work, yet took no notes, had no written protocols for its work and no interim work product. One document was amended as the project continued, with earlier versions not kept for the record.[147]
- Exponent was unresponsive to the Committee's request for documents.[148]
- Exponent submitted a substantially altered version of a document in direct contradiction to the Committee's instructions.[149]
- Exponent has profited handsomely from its defense work for Toyota, billing the automaker $3,330,552.36 on the SUA investigation since December 7, 2009, [150] and $10.7 million between 2000 and 2009. Last year's revenues represented its biggest single year -- $2.1 million.[151]

Based on the assessments of outside automotive electronics experts, Committee Chairman Rep. Henry Waxman and Sub-Committee Chairman Rep. Bart Stupak criticized Exponent's work as being incomplete and lacking scientific rigor.[152]

Toyota and the Media: Managing the Message

On February 24, Toyota CEO and grandson of the company founder, Akio Toyoda, stood before the House Government Oversight and Reform Committee and vowed:

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[143] Opening Statement of Rep. Bart Stupak, Chairman, Committee on Energy and Commerce; Subcommittee on Oversight and Investigations; "Update on Toyota and NHTSA's Response to the Problem of Sudden Unintended Acceleration"; May 20, 2010
[144] Toyota Class Actions Project No. 0907698.000; Subbaiah Malladi; Exponent; December 7, 2009
[145] Toyota Class Actions Project No. 0907698.000; Subbaiah Malladi; Exponent; December 7, 2009
[146] Interview of Shukri Souri; Committee on Energy and Commerce; May 12, 2010
[147] Interview of Shukri Souri; Pg. 59; Committee on Energy and Commerce; May 12, 2010
[148] Letter from the Committee on Energy and Commerce to James E. Lentz; Rep. Henry Waxman; June 29, 2010
[149] Letter from the Committee on Energy and Commerce to James E. Lentz; Rep. Henry Waxman; June 29, 2010
[150] Response to May 14, 2010 e-mail, Question/Request Nos. 15 and 16; James J. Ficenec; May 19, 2010
[151] Letter to Bruce L. Braley; Theodore M. Hester; King & Spalding; March 30, 2010
[152] Letter from the Committee on Energy and Commerce to James E. Lentz; Rep. Henry Waxman; June 29, 2010

> "And as the CEO of the company, I will make sure that we will never ever blame the customers going forward."[153]

However, in the last eight months, Toyota has responded aggressively to take back the narrative surrounding SUA. The tactics have included discrediting critics who have raised concerns about Toyota's electronics, and ramping up its response to consumers who have complained – sometimes in a manner which casts blame on the customer.

In April, the automaker announced that it had established its Swift Market Analysis Response Team (SMART) "utilizing existing product engineers, field technical specialists and specially trained technicians to quickly and aggressively investigate customer reports of unintended acceleration in Toyota, Lexus and Scion vehicles in the United States. The rapid-response Swift Market Analysis and Response Team will attempt to contact customers within 24 hours of receiving a complaint of unintended acceleration to arrange for a comprehensive on-site vehicle analysis." [154]

This team has been used to dispute driver's claims. One of the most public instances occurred in March, when Toyota held a press conference in Qualcomm Stadium to refute the experience of James Sykes, a 61-year-old Prius owner, who alleged that his vehicle accelerated suddenly and would not respond to hard braking. His struggles to regain control of his vehicle were observed by a California Highway Patrol officer, who was called to the scene, and recorded on a 911 tape. The police report noted that the Prius' brakes were burnt out and that an examination of Sykes' vital signs by emergency medical personnel immediately after the event showed he had very high blood pressure and heart rate. The police did not charge Sykes.

Toyota used the press conference to announce the results of a preliminary examination, which Toyota said showed that Sykes had touched the brakes 250 times. Toyota officials suggested, without saying so, that Sykes faked the event.[155] Notably, news outlets also reported many unflattering details of Sykes personal life – a first for any consumer that reported a Toyota SUA event. This, no doubt, has had a chilling effect on consumers' willingness to share their experiences.

Toyota's other public relations strategy – to discredit critics – began in February when it commissioned an online survey conducted by Opinion Outpost, featuring questions about Dr. Gilbert, ABC and SRS. Opinion Outpost conducts polls for clients looking to survey a preferred demographic or market segment. The respondents are paid for each successfully completed survey in points which eventually can be redeemed for cash. This

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[153] Toyota Gas Pedals: Is The Public At Risk?; Panel II, House Oversight And Government Reform Committee; Transcript; February 24, 2010

[154] Toyota Announces 'SMART' Business Process for Quick Evaluation of Unintended Acceleration Reports; Toyota Motor Sales; April 8, 2010

[155] Toyota Response to Complaints Take a Confrontational Tone; Ralph Vartabedian, Ken Bensinger; L. A. Times, April 8, 2010

poll asked the survey takers to judge the credibility of Dr. David Gilbert, Sean Kane of SRS and Brian Ross of ABC News.

In a *Los Angeles Times* article about Toyota's tactics, company spokesman Mike Michaels did not explicitly concede that Toyota had sponsored that survey. He said: "We do opinion surveys all the time. We were researching the potential for getting messages out, in particular for our advertising."[156]

Documents released by the House Committee on Energy and Commerce however, show that Toyota hired the Benenson Strategy Group (BSG), a prominent public relations consultant, to develop the best lines of attack.[157] The survey BSG created contained questions designed to test the average consumer's awareness of Toyota's most prominent critics, and gauged reaction to statements such as:

> "Toyota Motor Corp. is rebutting the findings of a study presented in a Congressional hearing and on ABC News that claimed to present evidence of a 'design flaw' in Toyota's electronics that could cause sudden unintended acceleration. The company says that this was a 'parlor trick' that relied on manipulation of the wires and electronic system in a way that is 'extremely unlikely' to ever occur in reality, and it could be done just as easily with vehicles from several competitors."
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> "The American people deserve the truth about the safety of their cars, not biased studies by trial lawyer consultants who stand to make millions suing Toyota. The facts are: Toyota and its dealers are working around the clock to make things right for its customers. More than one million cars have already been repaired. And, a world-class engineering firm has conducted a comprehensive review of Toyota's electronics. Their interim report confirms that our fail-safe systems work."
>
> "Sean Kane, a paid consultant for plaintiffs' lawyers suing Toyota, and David Gilbert, an academic working for him, deliberately deceived Congress and the American people."
>
> "While Sean Kane claims to be an independent safety expert, he is the owner of a for-profit company that serves as a paid consultant for the plaintiff lawyers that are currently suing Toyota. Despite what he says, he is not working for the best interest and safety of the American people."
>
> "Sean Kane, the owner of Safety Research & Strategies Inc. who testified during the Congressional hearings, is a paid consultant for trial lawyers who are suing Toyota, not a 'safety expert' advocating for consumers."

[156] Toyota Response to Complaints Take a Confrontational Tone; Ralph Vartabedian, Ken Bensinger; L. A. Times, April 8, 2010
[157] Kane/Gilbert Message Test; Benenson Strategy Group; 2010

BSG pinpointed SRS and Gilbert as two prime targets, based on their ability to influence the "Elites." [158] After testing messages with a sample of consumers, BSG concluded:

- "Despite very low levels of awareness of Sean Kane and David Gilbert, all 3 audiences view the individuals as credible, with more than 8 in 10 saying they would be credible figures to discuss Toyota safety."

- "Notably, the statements tested do work to significantly damage Kane to Gilbert's credibility."

- "However, while the statements are effective at increasing the proportion of audiences that say 'ETC is not a cause of sudden acceleration,' the majority of respondents still believe ETC is at least somewhat to blame for Toyota's issues."[159]

BSG recommended: [160]

To have the most impact, particularly among Elites, Toyota needs to:

- "Call out Kane/Gilbert's monetary or self-interested motives to undermine credibility, indicate other third-parties have questioned their credibility

- Referencing other studies that reproduced same results on other vehicles to diminish the belief that ETC causes sudden acceleration in Toyota vehicles

- Portray transparency, open and honest"[161]

Toyota also used the survey language in a March 11 letter to ABC President David Westin, demanding an apology for a story reported by Brian Ross on Dr. Gilbert's study that the network aired on the eve of the first Congressional hearing.[162] The letter hits all of the memes captured in the online opinion poll – Kane, Gilbert and their reports are tainted by litigation; ABC fabricated its test; and together they are misleading Congress and the public. For example, Toyota General Counsel Christopher Reynolds writes that "the American public and the U.S. congress were seriously misled" by ABC, Kane and Gilbert. And he takes the network to task for concealing "the fact that Professor Gilbert's work was financed by Sean Kane, a paid advocate for trial lawyers involved in litigation against Toyota."

At the May 20 hearing, Rep. Bart Stupak, co-chairman of the Committee on Energy and Commerce's Subcommittee on Government Oversight and Investigation confirmed that

[158] Toyota Debunking Kane/Gilbert Message Study; Benenson Strategy Group; March 8, 2010
[159] Toyota Debunking Kane/Gilbert Message Study; Benenson Strategy Group; March 8, 2010
[160] Toyota Debunking Kane/Gilbert Message Study; Benenson Strategy Group; March 8, 2010
[161] Toyota Debunking Kane/Gilbert Message Study; Benenson Strategy Group; March 8, 2010
[162] Toyota Letter to David Westin; Christopher Reynolds; March 11, 2010

Toyota commissioned the poll and criticized the automaker for suggesting that it did not take its pollster's advice:

> "Toyota told the committee that the company did not follow its pollster's suggestion to attack Dr. Gilbert, but the documents suggest otherwise. On March 8, a Monday, Toyota held a press conference and released a report by Exponent criticizing Dr. Gilbert's work."[163]
>
> "Two days before the press conference, the vice president of Toyota's public relations firm noted in an e-mail to a colleague the importance of finishing the poll before this event saying -- and I'm quoting now – 'We really, really need to get this done especially with elites. Toyota has a press conference on Monday and need our data to know what to say' That's the document we have right here."[164]

Toyota not only attempted to discredit Gilbert's findings in a web-based press conference, the automaker also sent its defense attorneys to Southern Illinois University Carbondale (SIUC) to meet with university officials. For more than 20 years, Toyota had donated vehicles, provided internships and professional networking opportunities for SIUC's Automotive Technology students. But after Gilbert's report, Terry Martin, manager of customer quality at Toyota, and Neil Swartz, an SIUC alumnus and corporate manager for distribution in Toyota's North American Parts Division, resigned from the department's advisory board. SIUC emails, obtained through a Freedom of Information Act request, show that on March 8, Mark Thompson, who identified himself as an SIUC alum and a Toyota Motor Sales employee, sent an e-mail to then-chancellor, Sam Goldman, expressing his concern about Gilbert's findings and suggesting that Gilbert be fired and that Toyota might discontinue its financial support of the university's automotive technology program.[165] Although Gilbert had sought and obtained university approval for his Toyota tests, the university temporarily took away his keys to the lab and compelled him to travel to Exponent, to observe the company's SUA demonstration.

Event Data Recorder

Event Data Recorder (EDR) or "black box" data from motor vehicles provide additional information for crash investigators to help discern the details of an incident. NHTSA has been working with real-time crash information using a prototype device since the 1970s, but the EDRs of today began to become widespread in the U.S. fleet in the 1990s.

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[163] Opening Statement of Rep. Bart Stupak, Chairman, Committee on Energy and Commerce; Subcommittee on Oversight and Investigations; "Update on Toyota and NHTSA's Response to the Problem of Sudden Unintended Acceleration"; May 20, 2010

[164] Opening Statement of Rep. Bart Stupak, Chairman, Committee on Energy and Commerce; Subcommittee on Oversight and Investigations; "Update on Toyota and NHTSA's Response to the Problem of Sudden Unintended Acceleration"; May 20, 2010

[165] Toyota Appreciates Professor's Help But...; Jim Suhr; Associated Press; July 11, 2010

Automakers installed the so-called black boxes to record data associated with air bag deployments and near-deployments. While these data can be helpful, they are not always accurate, and as any seasoned crash investigator understands, the data must be examined in context of other evidence. Further, the lack of transparency by many manufacturers regarding what data are actually recorded, retrieved and analyzed compounds the difficulty in using EDR data. This creates a conflict of interest when one party controls all of the data – particularly when those data may implicate a vehicle defect.

Toyota SUA has spotlighted the weaknesses of EDR data – especially when used in isolation of other crash evidence. On one hand, Toyota has consistently maintained that the crash information captured by its EDR is unreliable. On the other, the company uses the data in selected instances to discredit vehicle drivers when they appear to point to driver error. Assessing the accuracy of Toyota EDR data is further hampered by Toyota's lack of transparency. Different models and model years have different versions of the software. Depending on the case, the automaker does not always reveal what download information is available on that vehicle.

In addition, many in the public are unaware of EDR data's limitations and place undue reliance on their accuracy. The EDR is not an independent, infallible witness. It provides information the automaker tells it to provide. Like any machine, it can malfunction and make mistakes. Unfortunately, both NHTSA and Toyota have exploited this ignorance, making claims about specific SUA incidents that can not be substantiated by EDR data alone. In some cases, other evidence in the event contradicts the information provided by the EDR download; in others, the EDR itself has recorded specific data points which conflict with other data points, such as velocity, the position of the throttle and presence of braking.

EDR Data Contain Inaccuracies

Data collected from vehicle EDRs have been accepted by courts as evidence in trials.[166] However, real-world downloads show that there are inaccuracies in data and research has shown that complete data are not always recorded in crash events. In a study entitled, *Evaluation of Event Data Recorders in Full Systems Crash Tests*, the authors examined Ford and GM EDRs. They concluded:

> "The majority of the EDRs examined in this study did not record the entire event. In one-third of the GM tests (10 of 30), 10 percent or more of the crash pulse duration was not recorded. In two of the four Ford tests, the last 100 ms of the crash pulse was not recorded. A data loss of this magnitude would prevent a crash investigator from using an EDR to even estimate the true delta-V of a vehicle."[167]

[166] Motor Vehicle Event Data Recorders: Part I – Validation and Use of Data for Admission to the Courts; G. Barbera, O. Jacobson, B. Cornelissen, C. Thomas, D. Anderson; Collision 2006; 1(1): 43-51; Collision Publishing

[167] Evaluation of Event Data Recorders in Full Systems Crash Tests, P. Niehoff, H.C. Gabler, J. Brophy, C. Chidester, J. Hinch, C. Ragland; Paper 05-0271; Proceedings of the 19th International Technical Conference on the Enhanced Safety of Vehicles, Washington, DC; 2005

These issues have underscored the necessity of using data retrieved from EDRs in conjunction with physical evidence. In a presentation, GM's Executive Director of Vehicle Safety, Robert C. Lange noted that when using EDR data, one must always account for and correlate data with physical information.[168] Similarly, the general information section in Toyota's *SRS Event Data Recorder Operation Manual* specifically states:

> "The accuracy of the memory of Toyota's Event Data Recorder ('EDR') is still being validated, and the readout tool for the EDR is still in the prototype stage. Toyota cannot verify the complete reliability of such information, unless such data can be independently corroborated, e.g., through physical evidence, etc."[169]

Toyota EDRs

According to publicly-available sources, Toyota has been installing airbag EDRs in its vehicles since the 2001 model year,[170] and vehicle stability control EDRs since the 2000 model year.[171] The first versions focused on frontal crashes. In 2002, Toyota expanded capabilities to include rollover events. In 2004, it developed technology to incorporate side impact collisions.[172] However, according to a deposition of Toyota engineer Motoki Shibata, taken on October 7, 2005, Toyota has actually been able to record and download vehicle data as far back as 1997.[173] In this deposition, Mr. Shibata referred to the data recorder as a G-wave memory readout tool and said that Version 2.01 of the *SRS Airbag G Data Readout Tool Operation Manual*, referenced in the deposition, was most likely used for certain 1997 model year vehicles like the Lexus ES 300 and Toyota Camry.[174] [175]

Toyota describes its EDR thus: "EDRs are on-board devices that receive information from the electronic system that control certain aspects of the vehicle. The EDR receives information from these systems and are intended to record data several seconds prior to and/or fractions of a second after a crash or near crash event."[176] Beginning with the 2007 Model Year, all Toyota and Lexus vehicles have an EDR. According to Toyota, there are a variety of EDRs installed in Toyota vehicles, but they can be divided into two main types: those that record only post-crash data, and those that record pre- and post-crash data.[177]

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[168] Air Bag Blue Ribbon Panel Public Meeting; Robert Lange; General Motors; May 7, 2007
[169] SRS Airbag Event Data Recorder Readout Tool (Version 2.41) Operation Manual; Toyota Motor Corporation
[170] Docket 2006-25666-459; Ex Parte Meeting with Toyota on the EDR Final Rule; Meeting with NHTSA – Event Data Recorders; Toyota Presentation; November 29, 2006
[171] Event Recorders Q&A; Toyota Motor Sales Website; June 25, 2007
[172] Docket 2006-25666-459; Ex Parte Meeting with Toyota on the EDR Final Rule; Meeting with NHTSA – Event Data Recorders; Toyota Presentation; November 29, 2006
[173] Deposition of Motoki Shibata; Chandruptala v, Toyota Motor Corporation, et al; October 7, 2005
[174] Deposition of Motoki Shibata; Chandrupatla v, Toyota Motor Corporation, et al; October 7, 2005
[175] SRS Airbag G Data Recorder Readout Tool (Version 2.01) Operation Manual; Toyota Motor Corporation
[176] Event Recorders Q&A; Toyota Motor Sales Website; June 25, 2007
[177] Toyota Clarifies the Facts About Event Data Recorders; Toyota; Press Release; March 12, 2010

In addition to the EDR, Toyota's Hybrid vehicles can report Operation History Data which record special operations performed by the driver and the number of times abnormal conditions have been input into the Hybrid Vehicle (HV) control ECU.[178] The history recorded includes accelerator and brake application information. These data are retrieved using a Toyota tool called a Tech Stream. Unlike the EDR readout tool, this is available to the public for purchase. Like the EDR data, there are questions about what is actually recorded and the accuracy of Operation History Data reports. The Operation History Data appears to have been used by Toyota in response to the San Diego incident in which the driver, James Sykes, alleged he could not control his Prius as it sped down the freeway. Toyota and NHTSA inspected the vehicle. Neither has released the data. But in a March 15 press release, Toyota noted that the hybrid self-diagnosis system showed evidence of numerous, rapidly repeated on-and-off applications of both the accelerator and brake.[179] Again, there has been no supporting documentation authenticating the reliability and accuracy of these data.

In order to extract and read the data stored on a Toyota EDR, proprietary equipment that downloads, analyzes and generates a report based on the data is required. This equipment is not available to the public. The EDR must be downloaded and any reports must be generated by Toyota or NHTSA, which has recently been provided with readout tools. Until March 3, when Toyota delivered one readout tool to NHTSA,[180] Toyota claimed that it had a single prototype tool in the U.S. that could extract the data and that it would only download data if requested by law enforcement, NHTSA or the courts.[181] The details of the quantity and quality of the Toyota EDR data have been shrouded in secrecy. No one, other than Toyota, knows exactly what data are recorded, retrieved and how they are processed and analyzed to produce a report.

According to Toyota, the type of data recorded varies depending on which generation of EDR is in the vehicle. Examples of the data that can be recorded include engine speed, whether the brake pedal was applied or not, vehicle speed, the accelerator pedal position, transmission shift lever position, whether the driver and front passenger wore seat belts or not, driver's seat position, SRS air bag deployment data and SRS air bag system diagnostic data.[182] Toyota doesn't disclose prior to the download which generation of EDR is installed on specific vehicle makes, models and years and what data are available on each version. The owner of the vehicle does not know what is being recorded, and when data are downloaded they have no way to determine whether the data are complete, how the data are being processed or the accuracy of the translation.

[178] P112 Hybrid Vehicle Control: Hybrid Control System: Operation History Data (2008 Prius); Toyota; December 21, 2009
[179] Toyota Offers Preliminary Findings From Technical Field Examination of Alleged 'Runaway Prius' in San Diego; Toyota; Press Release; March 15, 2010
[180] Toyota Clarifies the Facts About Event Data Recorders; Toyota; Press Release; March 12, 2010
[181] Toyota Clarifies the Facts About Event Data Recorders; Toyota; Press Release; March 12, 2010
[182] Event Recorders Q&A; Toyota Motor Sales Website; June 25, 2007

One Toyota employee affirmed this lack of transparency in an affidavit. Mark W. Jakstis, a Design and Technical Analysis Manger at Toyota Motor Sales, USA, Inc., addressed the accuracy and reliability of EDR data in a 2003 Toyota Echo and stated:

> "There is no single key or map to allow a manual translation of the hexadecimal data stored in the EDR as a cross check against the translation provided by the prototype tool in the form of the Prototype Readout Tool Report."[183]

In two recent data downloads from Toyota EDRs, the reports lacked critical data that do not appear to be recorded or are missing. In both cases, the vehicle owners have no information about the generation of EDR or what data should have been available for capture. When apparent inconsistencies in reports occur, the owner of the vehicle has no supporting documentation on the system in their vehicle or the EDR Readout Tool used to retrieve the data.

For example, in the cases of EDR downloads performed by Toyota in 2009 on a 2005 Lexus LS430 and a 2009 Toyota Avalon, the company did not provide documentation regarding the EDRs in the subject vehicles (i.e., what versions and the data captured by these systems), nor did the company provide the version of EDR Readout Tool used, prior to the downloads.

Toyota's EDR report on the 2005 Lexus LS430 contained both pre- and post-crash data. Included in these data are acceleration and braking data.[184] However, Toyota claimed that the EDR installed in the 2009 Toyota Avalon did not contain pre-crash data and therefore had no data on acceleration and braking.[185] Why does a later model vehicle have fewer data collected than a prior version? Are each equipped with a different EDR or is it simply selective data management by Toyota when the results are not advantageous to it?

These types of discrepancies are evident at a specific stage of the download process. The Toyota *SRS Event Data Recorder Readout Tool Operation Manual*, Section 2.1.6, directs the user to input the Accelerator Full Open Voltage.[186] This input was not required in an earlier version (2.01) of the manual.[187] In the 2005 Lexus LS430 EDR download, the Accelerator Full Open Voltage was entered, and the EDR readout produced pre-crash data. In the download of the 2009 Toyota Avalon, the Accelerator Full Open Voltage was not entered and there were no pre-crash data. Is there a correlation between entering the Accelerator Full Open Voltage and receiving pre-crash data? There is no public information that answers this question.

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[183] James McAlanon v. Toyota Motor Corporation, et al; Reply Memorandum of Defendants in Support of Motion to Preclude Evidence Derived from the Event Data Recorder in the 2003 Toyota Echo; May 23, 2008

[184] Prototype Readout Tool Report; 2005 Lexus LS430 EDR Download; November 10, 2009

[185] Prototype Readout Tool Report; 2009 Avalon EDR Download; January 12, 2010

[186] SRS Airbag Event Data Recorder Readout Tool (Version 2.41) Operation Manual; Toyota Motor Corporation

[187] SRS Airbag G Data Recorder Readout Tool (Version 2.01) Operation Manual; Toyota Motor Corporation

Regardless of what data are captured, Toyota places little faith in the data quality and reliability of its own system. The automaker notes in their *SRS Airbag Event Data Recorder Readout Tool Operation Manual*:

> "The accuracy of the memory of Toyota's Event Data Recorder ('EDR') is still being validated, and the readout tool for the EDR is still in the prototype stage. Toyota cannot verify the complete reliability of such information, unless such data can be independently corroborated, e.g., through physical evidence, etc."[188]

In *James McAlonan v. Toyota Motor Corporation, et al*., Toyota argued that the EDR data retrieved from a 2003 Toyota Echo in November of 2007 should be excluded as evidence because of the lack of reliability of the data.[189] The affidavit of Toyota manager Mark Jakstis stated that the readout is unreliable because there were errors and anomalies found; that those errors have not been explained by controlled crash test results, repeatable laboratory test results, or extensive field experience; and nor were they resolved by specific corroboration from physical evidence.[190] He also conceded that the readout tool has never been validated:

> "The prototype readout tool used to perform the readout in this litigation had never before been used to read out data from a 2003 Echo EDR involved in a real world crash. The readout tool has not been validated as a reliable device to accurately convert the data contained in this EDR to the form presented in the readout report."[191]

A recently publicized EDR readout underscores the inaccuracies and pitfalls of Toyota's system. Chris Eves was killed in a single-vehicle crash in 2007. Eves' parents asked Toyota to download the EDR data from his 2007 Tundra to determine why the crash occurred. Toyota initially refused, but under pressure from the Eves family -- and Senator Maria Cantwell, D-Wash, the automaker agreed to download the data.[192] In April, Toyota representatives retrieved the EDR data. The report showed that Mr. Eves was travelling at 75mph at impact and that the Delta-V of the crash was 177mph. [193] [194] This is impossible.

Toyota eventually conceded that the 177mph velocity change reading was inaccurate. In June, Toyota acknowledged there was a software bug in the device used to read the EDR

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[188] SRS Airbag Event Data Recorder Readout Tool (Version 2.41) Operation Manual; Toyota Motor Corporation
[189] James McAlanon v. Toyota Motor Corporation, et al; Superior Court of New Jersey Appellate; Decision; March 16, 2010
[190] James McAlanon v. Toyota Motor Corporation, et al; Affidavit of Mark Jakstis; May 23, 2008
[191] James McAlanon v. Toyota Motor Corporation, et al; Affidavit of Mark Jakstis; May 23, 2008
[192] 'Black Box' May Solve Toyota Crash Mystery; King5 News, Seattle; March 11, 2010
[193] Prototype Readout Tool Report; Eves EDR Readout; April 8, 2010
[194] Crash Victim's Father: 'We Now Have the Answers we Want'; KOMO 4 News, Seattle; August 12, 2010

data, which produced faulty speed data, but did not affect readings for pedal and brake applications. [195]

Did the software upgrade work? Sometime between the April and June, when Toyota released to NHTSA a software upgrade to the EDR Readout Tools, Toyota re-read the Eves' vehicle EDR, and the change in velocity went from 177 mph to 1.4mph.[196] As indicated by the crash photo below, the 1.4mph Delta-V from the second reading is also inaccurate.[197]

NHTSA's EDR Report

Despite these numerous red flags about the accuracy of Toyota EDR data, NHTSA authored a report based on readouts in 58 crashes in which SUA was alleged by the driver or merely suspected by law enforcement. This report was privately presented to Congress but leaked to *The Wall Street Journal* by retired NHTSA Recall Division Chief George Person. The news media, without seeking independent analysis of the data, widely reported that it showed that most of the crashes were the result of driver error. NHTSA also submitted it to the NAS panel studying electronic throttle controls and SUA issues related to Toyota vehicles. Our analysis of the EDR readouts – without the benefit of other crash evidence – indicates that they are full of inconsistencies and contradictions and provide very little useful information.

In its report, NHTSA described its investigative process as ascertaining the underlying facts of the incident, examining the vehicle, and reviewing the EDR data.[198] No other crash information was included in the publicly available version of the report. The selected crashes were not a random sample; but a collection assembled on the basis of an allegation or a suspicion of unintended acceleration and the availability of EDR data. This meant that no vehicles manufactured before 2007 were studied. (Again, on the basis

[195] Toyota Acknowledges Software Bug in Black Box Reader; L.A. Times; September 15, 2010
[196] Toyota Acknowledges Software Bug in Black Box Reader; L.A. Times; September 15, 2010
[197] Couple Seeks Truth in Son's Mysterious Crash Death;, KOMO 4 News; March 24, 2009
[198] Report - Ongoing NHTSA Research on Unintended Acceleration & Event Data Recorder (EDR) Readings; DOT; August 2010

of complaint data, the 2002-2006 Camry is one of the most troubled Toyota vehicles, but this model in the key model years was excluded from this analysis.) They were a mixture of parking-lot incidents, incidents that occurred while the driver was already underway and single vehicle, run-off-the-road events where police theorized that an SUA event could have precipitated the crash.

In April, NHTSA obtained 10 EDR readout tools from Toyota, which allowed ODI investigators to obtain data stored in the inspected vehicles' EDRs.[199] Based on the readouts, NHTSA noted:

> "Of the 58 cases studies, thirty-five recorders showed that no brake was applied. Fourteen cases involved partial braking: nine cases where brakes were applied late in the crash sequence; three involving early braking; and two involving mid-event braking. One incident involved a case of pedal entrapment. Another showed that both the brake and the gas pedal were depressed. In one case, the recorder only contained information related to a separate incident and in another, NHTSA is still working to resolve inconclusive data from an EDR. In five cases, the EDR was not triggered at all."[200]

NHTSA concluded that the EDR information yielded no new insight into possible causes of unintended acceleration in Toyotas beyond the known defects – pedal entrapment and sticking gas pedals.[201] Yet, the public release of this information set off a brief blaze of news articles reporting that the government's report found no electronic problems with Toyota vehicles and that most of the SUA incidents were driver error. NHTSA's report to Congress does little to dispel this misread, because it does not qualify the data with Toyota's repeated statements about the accuracy of its EDRs; it does not take note of the many inconsistencies in this particular set of data; nor does it discuss how the data could be open to a range of interpretations of what actually occurred in a particular crash. In short, the information was presented with no context, no explanations, and no serious analysis.

Through a Freedom of Information Act request, SRS obtained the EDR data. Our analysis comes with two caveats. One, the agency has not released the other supporting crash materials in the 58 cases. Two, NHTSA removed the investigation date from the EDR report, making it impossible to know if the downloads were conducted before June, when Toyota admitted to a software error in their EDRs and provided NHTSA with an update. In a *Los Angeles Times* news story, NHTSA officials said that they independently tested and verified the accuracy of the Toyota readers and were confident the data they produced reflected the information captured by the onboard recorders. The agency said it has since re-run the EDR data through the updated software.[202] NHTSA has not yet

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[199] Report - Ongoing NHTSA Research on Unintended Acceleration & Event Data Recorder (EDR) Readings; DOT; August 2010
[200] Report - Ongoing NHTSA Research on Unintended Acceleration & Event Data Recorder (EDR) Readings; DOT; August 2010
[201] Report - Ongoing NHTSA Research on Unintended Acceleration & Event Data Recorder (EDR) Readings; DOT; August 2010
[202] Toyota Acknowledges Software Bug in Black Box Reader; L.A. Times; September 15, 2010

issued an update to their original report noting this revised information. (SRS has filed a subsequent Information Request for the new data, and the dates of the 58 EDR investigations.)

Our preliminary review found missing data and inconsistent/questionable data. Some readings – if accurate – were open to interpretation, and by no means proved driver error or any other causal factor. For example, if the EDR download of a parking-lot crash shows no braking, does that mean that the driver was startled and didn't have time to brake, or is it a case of pedal misapplication? These critical nuances were not explored. Further, in five crashes, the EDRs contained no data. All of these vehicles struck a vehicle or another object. Why there were no data at all recorded in these events? Were the impacts insufficient to trigger an EDR record or was there a problem with the EDR or the EDR data?

Based on our initial evaluation, the data in some of the EDR downloads show that there may have been a pedal misapplication or an SUA event. These incidents share the following characteristics: a sudden and consistent increase in speed, acceleration voltage and rpms. Consider Case 17, involving a 2007 RAV4 that crashed into a tree. The driver described the incident: "At time of acceleration I had already begun braking to make a right turn. Engine began loud racing and car accelerated. With very little room to maneuver, I turned car hard right to avoid cars and ran into a large tree with car still accelerating, stopping only when hitting the tree and bounced off, When the car came to a stop engine was still racing and very loud." The EDR Pre-Crash Data indicated: "Early braking with deceleration followed by no brakes and rising accelerator application, engine/vehicle speed." What case can be made here? The data match the driver's description. Did he or she, while in the midst of braking, remove his or her foot from the brake and strongly depress the accelerator? Or, did the RAV4 experience a throttle malfunction?

The remaining EDR reports contain data that are inconsistent and questionable. For example, the pre-crash data for Case 3 show the vehicle speed dropping from 25 miles per hour to 12 miles per hour, but the brakes are not applied and the throttle is at the full position. Why does the speed drop if there is no braking? Case 5 also shows the speed dropping, with no braking and a full throttle.

In a few instances, the vehicle speed increases while there is brake application. In Case 15, the EDR reading for a 2007 ES 350 that crashed after the driver lost control while traversing a highway exit ramp, shows that the brake is applied. Initially, the speed drops from 60 mph to about 30 mph. In the last second before the crash, the data show that the brake is still applied, the vehicle speed jumps up to 55 mph, but the engine rpm and accelerator voltages drops. (The agency said this was a floor mat entrapment case.) Case 25 shows the accelerator and the brake off in the first four seconds before the crash, and the vehicle cruising at a low speed. In the last second, the brakes are applied and the accelerator voltage is full. The vehicle accelerates, despite the application of the brake.

These internal contradictions in individual EDR readings call the accuracy of all the data into question. The lack of transparency in NHTSA's process – the absence of supporting crash evidence and date of download – make it unlikely that much, if anything can be gleaned from these 58 EDR downloads.

Brake Override

Currently, manufacturers such as BMW, Mercedes, VW/Audi, Chrysler, Nissan, Honda, GM, Ford and Hyundai have implemented a brake-to-idle override feature in their vehicles. For example, a brake-to-idle feature is noted in a 1998 *Audi Self Study Programme Book,* covering the 2.7-liter V6 Bi-Turbo Engine which was available in the Audi A6 and A4:

> **"Safety function:** For safety reasons, the throttle valve is closed as far as a defined angular position when both the accelerator pedal and the brake pedal are depressed. If the brake is pressed first followed by the accelerator pedal, the driver input (torque request) is executed."

A 2000 reference on a Volkswagen owner's website notes:

> "All North American models use BOSCH's Motronic 5.9.2 electronic engine management systems. The TDI engine is a "drive by wire" design. There is no mechanical connection between the accelerator pedal and anything else. Pressing the accelerator pedal provides an input to the ECU (engine computer) indicating that more power is desired. The ECU takes into account accelerator pedal position and engine speed, then "decides" how much fuel is being requested by the driver. It compares this request with the signal from the MAF (airflow meter); if the MAF signal indicates that for whatever reason there is not enough airflow for the requested amount of fuel, the ECU cuts back the amount of fuel to prevent black exhaust smoke from being emitted. **It is worth noting that if the accelerator and brake pedals are both depressed, the ECU detects the condition and brings the engine to idle speed as a safety feature, ignoring the accelerator input**." [emphasis added]

Both VW and Audi use Bosch's Motronic engine management system. In an Autospeed.com article on the Bosch ME-Motonic System, the author states:

> "Interestingly, if in the Audi the accelerator and brake pedals are depressed together, the throttle valve is automatically closed to a defined small opening. However, if the brake is pressed and depressing of the accelerator then follows this, the torque request is enabled. I assume that the latter provision is solely for those who like to left-foot brake, with applications of power used to balance the car!"

Patents for a brake override feature go back to 1965, when GM was awarded U.S. Patent 3,207,276, *Accelerator Cancelling Pedal*, which described the device as:

> "..a vehicle safety device whereby the effect of accelerator pedal operation on the vehicle throttle is cancelled in the event the vehicle operator simultaneously depresses both the accelerator pedal and the brake pedal with one foot."

In 1983, Toyota obtained a patent for a "Throttle Valve Control Device for Internal Combustion Engine." The patent, originally filed in 1975, discloses "a fail-safe system comprising mechanical separation means such as an appropriate clutch between the actuator and the throttle valve, whereby the throttle valve is separated from the actuator by the clutch in the event that the throttle valve has stuck and throttle valve is returned to the full-open position by the force of spring. **This prior art system provides satisfactory fail-safe means to the extent that once the throttle valve has stuck, the engine becomes to be idling condition and thus the car is prevented from running away**. '" [emphasis added]

In October 2009, Toyota announced that it would install a brake override as standard equipment in all 2011 models and in seven older Camry, Avalon and Lexus models already in the U.S. fleet, as part of an expanded recall that replaced floor mats.
At a February hearing, Toyota Motor Sales President Jim Lentz described the retrofit as a computer system "reflash," or reprogramming, which could not be implemented on the early model Camry vehicles because some of the computer chips "are not rewritable, basically. They're hard coded." [203]

However, in June, the Committee on Energy and Commerce wrote to Lentz seeking information about the existence of a type of brake override mechanism in a 2005 Camry, based on examinations by outside experts:

> "We have been notified by outside technical experts that based on their examination of a 2005 Toyota Camry, some older model Toyotas may have a brake override function that activates when the vehicle's electronic throttle control system registers a diagnostic trouble code. These experts report that this brake override function is separate from 'limp home' mode…On April 28, 2010, electronics experts from Toyota briefed Committee staff on brake override features in Toyota vehicles. Neither you nor Toyota's electronics experts informed the Committee that some older model vehicles may already have a brake override function that is tied to a diagnostic trouble code. In doing this type of analysis, the ETC team has identified that a brake override software was included in the 2005 Toyota Camry. However, they found the feature only activated when a Diagnostic Trouble Code (DTC) was set."

Congress has not publicly released Toyota's reply.

[203] Response By Toyota And The National Highway Traffic Safety Administration To Incidents Of Sudden Unintended Acceleration; Panel I; Oversight And Investigations Subcommittee Of The House Energy And Commerce Committee; Transcript; February 23, 2010

FMVSS 124 Accelerator Controls – An Antique Standard

Today's drive-by-wire systems are governed by a standard that was put into place in 1972 – when digital fly-by-wire was born, but automotive systems were purely mechanical.[204] Federal Motor Safety Standard (FMVSS) 124 *Accelerator Control Systems* specifies the requirements for the return of a vehicle's throttle to the idle position when the driver removes the actuating force from the accelerator control or in the event of a severance or disconnection in the accelerator control system: 1 second for passenger vehicles and 2 seconds for light trucks. "The purpose of FMVSS 124 is to reduce deaths and injuries resulting from engine overspeed caused by malfunctions in the accelerator control system. The standard applies to passenger cars, multipurpose passenger vehicles (MPVs), trucks and buses."[205]

In the late 1980s, the agency began to field inquiries from automakers developing electronic throttle control systems. In a 1988 letter to Isuzu, for example, the agency noted that FMVSS 124 would apply to the new electronically based systems. [206]

In 1995, after seven years of issuing interpretations relating electronic systems to the mechanically-based standard, the agency asked for comments with the aim of revising the standard.[207] NHTSA asked automakers to respond to a variety of critical technical questions, such as "Are there other predictable points of failure of an electronic control system?"[208] The agency also sought information about the fail-safes and redundancies of electronic throttle control systems.

In recounting the responses to this query, the agency noted: "In general, the comments of vehicle and engine manufacturers did not address the specific questions in the notice. Instead, they voiced a preference for rescinding the standard altogether, suggesting that

[204] Docket 69-20-No.3, 37 FR 7097; Federal Motor Vehicle Safety Standards, Accelerator Control Systems; National Highway Traffic Safety Administration; April 8, 1972
[205] Laboratory Test Procedure for FMVSS 124 Accelerator Control Systems; National Highway Traffic Safety Administration; April 20, 2000
[206] Interpretation Letter to Koji Tokunaga, Isuzu; Erika Z. Jones; National Highway Traffic Safety Administration; August 8, 1988
[207] Docket 95-93-No.1, 60 FR 62061; Federal Motor Vehicle Safety Standards, Accelerator Control Systems; National Highway Traffic Safety Administration; December 4, 1995
[208] Docket 95-93; Federal Motor Vehicle Safety Standards; Accelerator Control Systems; 60 FR 62061; National Highway Traffic Safety Administration; December 4, 1995

market forces and litigation pressure are sufficient to assure fail-safe performance without a Federal motor vehicle safety standard."[209]

The agency held a workshop on 1997 with the Truck Manufacturers Association (TMA) and the Alliance of Automobile Manufacturers' predecessor organization, the American Automobile Manufacturers Association (AAMA). Both reiterated that there was no need for a safety standard. Seven years after it first requested comments, NHTSA finally published a proposed rule. The July 2002 NPRM proposed to explicitly state its applicability to new types of engines and throttle controls, and added new test procedures to address different types of powertrain technology, including one to the measurement of engine speed under realistic powertrain load conditions on a chassis dynamometer. The agency considered this test ''technology neutral." The new standard would not expand in scope, nor become more stringent. For example, the original requirement covered single point failures – or disconnections at one end of the throttle cable. The proposed amendments did not seek to add multiple-point failures.

Despite the agency's attempt to establish fail-safe criteria that were performance rather than design-based, The Alliance and Toyota led the effort to push back the rule. The Alliance argued that FMVSS 124 should include a direct measurement of powertrain output to the drive wheels – this would better address the agency's desire for a technology neutral test. The advantage, the Alliance maintained, would be that the test could be used on hybrid powertrains in which engine rpm might not indicate drive torque. The Alliance suggested that the powertrain output test should measure speed creep -- vehicle driving speed, instead of output horsepower or torque.[210] Toyota also argued for a speed creep test. It met with the agency to explain the potential difficulties with the proposed rule and show what a Toyota vehicle would do under different fault conditions.[211]

Instead of forging ahead, in November 2004, NHTSA withdrew the rulemaking, saying it would do further research on issues relating to chassis dynamometer-based test procedures for accelerator controls. [212]

Congress, however, may force NHTSA to finally address the evolution of automotive technology. In May, Rep. Henry Waxman and Sen. John Rockefeller submitted versions of the Motor Vehicle Safety Act of 2010, which would, among other things, compel

[209] Docket 2002-12845-001, 67 FR 48117; Federal Motor Vehicle Safety Standards, Accelerator Control Systems; National Highway Traffic Safety Administration; July 23, 2002
[210] Docket 2002-12845-013; Meeting with Alliance to Discuss FMVSS 124 NPRM; FMVSS 124 Outstanding Issues; AAM Presentation; December 12, 2002
[211] Docket 2002-12845-014; Meeting with Toyota to Discuss FMVSS 124 NPRM; Federal Motor Vehicle Safety Standards, Accelerator Control Systems; National Highway Traffic Safety Administration; April 21, 2003
[212] Docket 2002-12845-016, 69 FR 65126; Federal Motor Vehicle Safety Standards; Accelerator Control Systems - Withdrawal of Rulemaking; National Highway Traffic Safety Administration; November 10, 2004

NHTSA to initiate rulemakings on a host of issues related to electronic throttle control.[213] Some of the key provisions would require minimum performance standards for electronic systems in passenger vehicles; the establishment of a brake override system; and "new standards that (1) prevent unintended acceleration by requiring that all vehicles be equipped with a technology that would allow a vehicle to come to a full stop with normal braking pressure when the throttle is open and (2) require that redundancies be built into electronic throttle control systems to enable a driver to maintain control even if there is a failure in the system."[214]

Concerns

Bias Towards Mechanical Causes and Human Error

NHTSA's bias toward mechanical interference and driver error continues to be a concern. The conclusions of the so-called Silver Book, the 1989 report, *An Examination of Sudden Unintended Acceleration*, have rippled into the SUA investigations that have followed, up until those of today. In 1995, for example, an ODI bulletin board analyzing the department's then-current goals and challenges noted under the heading Existing Problems: "Have passive screen areas: certain complaint issues (engine stalling, transmission park to reverse, sudden acceleration, etc.) are frequently reported but passively screened because ODI has not successfully pursued recalls in those areas."[215]

In the case of Toyota SUA, NHTSA appears to be as focused today on driver error and floor mats as they were in 2004. We continue to hear stories of investigators bringing up driver error and floor mat interference as explanations for SUA events – even if those theories don't fit the available evidence; without seeking further evidence; or in the face of directly contrary evidence.

For example, after his conversation with Scott Yon and Steve Chan about pedal misapplication in relation to the Yago crash of 2004, Las Vegas police officer Corey Moon begins speculating that "the gas pedal locations of this vehicle, it seemed to me the pedals were extremely close. Furthermore, they appeared to be at the same height. It seemed to me a person could easily push on both pedals at the same time, and not know it. This would lead to a driver accelerating while braking."[216] Did NHTSA attempt to explore the pedal placement theory by comparing the pedal locations in MY 2001 and 2002 Camry vehicles before passing this speculation on to Officer Moon? If this examination was done, it has not been noted in the public record.

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[213] Waxman-Rush Discussion Draft Summary, Motor Vehicle Safety Act of 2010; U.S. House Committee on Energy and Commerce; April 19, 2010

[214] Waxman-Rush Discussion Draft Summary, Motor Vehicle Safety Act of 2010; U.S. House Committee on Energy and Commerce; April 19, 2010

[215] Existing Problems; ODI display; National Highway Traffic Safety Administration; December 1995

[216] State of Nevada Traffic Accident Report; Yago Crash; Corey Moon, Investigator; Las Vegas Metropolitan Police Department; January 22, 2004

In 2008, as the agency investigated errant floor mats in Camry and Lexus vehicles, Toyota's Technical and Regulatory Affairs Assistant Manager Chris Santucci recounted to his boss, Chris Tinto, the reaction of other ODI investigators to agency's probe:

> "I ran into a lot of different investigators and ODI staff and when asked why I was there, when I told them for the ES350 floor mats, they either laughed or rolled their eyes in disbelief."[217]

In 2009, Santucci described NHTSA's struggle in crafting a Toyota Information Request that would allow them to deny the Pepski petition to examine non-floor mat-related SUA and long duration incidents:

> "But [NHTSA investigators] are concerned that if they ask for these other reports, they will have many reports that just cannot be explained, and since they do not think that they can explain them, they don't really want them."[218]

In July, ODI accepted an invitation by Dr. Todd Hubing to attend a demonstration at Clemson's I-CAR. Dr. Hubing demonstrated how he could substantially increase a Toyota engine's rpm via a single-point failure, without setting a DTC. After the group adjourned to a conference room for a discussion, ODI investigator Jeffrey Quandt did not comment or ask any questions about the failure of the ECU to set a trouble code. He instead began to talk about NHTSA's theory that Toyota SUA was the result of floor mat entrapment.[219]

Also in July, Dr. Gilbert sent a letter to William Collins of NHTSA's VRTC expressing doubt that NHTSA had the lab equipment or the requisite knowledge to isolate intermittent electronic faults. He advised them to obtain vehicles that had multiple events, and expressed his dismay that the agency had passed on examining such a vehicle, instead purchasing a vehicle that had one event three years earlier that had since been re-sold and serviced. He, too, noted NHTSA's inability to look beyond its favored theories.

> "One of my concerns about the current investigations is the limited knowledge as it relates to electronic abnormalities and diagnostic protocols found in Toyota and other makes of vehicles. This is my area of expertise, and has been for 30 years. Based on my experience and testing, review of complaints, and continued interviews of owners who have experienced SUA events, it is increasingly clear that there is more to the problem than floor mat interference, sticky pedals, and driver error. Even Toyota has admitted that these are not the problems in many cases; however, they seem to interest the NHTSA the most. [220]

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[217] URGENT UPDATE on ES350 Investigation; E-mail; Chris Tinto; Toyota; August 24, 2007
[218] Re: Re-opening of NHTSA "Investigations" of Sudden, Unintended Acceleration Events Involving Vehicles Equipped with Toyota's Electronic Throttle Control System; Edgar F. Heiskell; June 30, 2010
[219] Re: Re-opening of NHTSA "Investigations" of Sudden, Unintended Acceleration Events Involving Vehicles Equipped with Toyota's Electronic Throttle Control System; Edgar F. Heiskell; June 30, 2010
[220] Letter from David Gilbert to William Collins; David Gilbert; July 16, 2010

"It is also apparent that at this point, the NHTSA may not have done enough in-depth electronics research, investigation, or testing to determine how electronics can affect vehicle performance and more specifically-how it can cause an SUA event. Simply plugging in scan tools and reviewing data is not going to be enough to truly investigate the SUA issue. While the current VRTC test fleet vehicles are varied and useful for evaluation of "known" defective components and DTC validation, I want to emphasize again that they are not likely to exhibit the type of intermittent electrical abnormalities that may be the source of SUA. The best chance the NHTSA has at getting to the root of the problem is through the purchase and testing and evaluation of a substantial number of consumer's vehicles known to have recent and frequent histories of SUA. These vehicles must not have been altered or in Toyota's possession.[221]

"Vehicles with a history of SUA should be prepared to capture "real time" electronic data as a possible way to find the source(s) of intermittent failures. Scan tool data is diagnostically useful, but is computer processed information that should be verified by other means (such as a scope). Due to the elusiveness of some intermittent electronics problems, variations of driving and testing procedures should be explored in those test vehicles. It is my experience that intermittent electrical problems can take extended amounts of time for diagnosis – I can't emphasize this enough. Sufficient time must be allotted for thorough investigation of the most appropriate test vehicles. It is equally important in any electronics investigation to have ample space and the appropriate specialized equipment. During my tour, I was surprised at the numerical lack of testing equipment for diagnostic analyses. I would hope that with the expansiveness of electronics in today's vehicles, there is much more diagnostic capacity and equipment currently located at other NHTSA testing facilities. [222]

"It is equally important that the NHTSA consider a task force of educationally diversified investigative teams of technicians, with specific expertise or backgrounds in ETC to thoroughly validate the DTC detection capabilities in these electronically controlled vehicles. Detection capabilities should include multiple types and combinations of induced problems. I would also emphasize that what was noticeably absent is an identifiable plan or a specific testing procedure to investigate vehicle electronics for fault detection, intermittent faults, and failure mode (fail-safe) operational characteristics of the electronic throttle controls. Determining electronics fault detection and component failure operational characteristics could prove most useful for establishing the baseline limits for normal electronic throttle control system operation. Due to their inconsistent nature, it would be beneficial to establish a protocol for testing and investigation of intermittent faults."[223]

Transparency

[221] Letter from David Gilbert to William Collins; David Gilbert; July 16, 2010
[222] Letter from David Gilbert to William Collins; David Gilbert; July 16, 2010
[223] Letter from David Gilbert to William Collins; David Gilbert; July 16, 2010

Just before he would appear before a Congressional committee, Akio Toyoda, president of the Toyota Motor Corporation, penned an opinion piece in *The Wall Street Journal*, in which he vowed to re-establish trust with the company's customers: "In short, I pledge that Toyota will set a new standard for transparency and speed of response on safety issues."[224]

NHTSA and Toyota continue to pledge openness. Neither has followed through. Toyota often refuses to share test results with consumers who have experienced an SUA event. The automaker continues to ask for confidentiality in the current agency investigations.

NHTSA has likewise shielded much from public view. Last February, it opened two Timeliness Queries in two Toyota recalls, but posted none of the information online. When it levied its largest civil fine ever on Toyota, the news broke without the agency supplying its precise rationale or supporting materials. Documents have been provided to individual reporters, rather than supplied to all as public information. This bunker mentality is directly contrary to the executive directive to maximum openness issued by President Obama, upon taking office two years ago. It has forced news agencies, safety advocates and other interested parties to file Freedom of Information Act requests for any substantive information, producing a huge backlog, which effectively keeps the information under wraps.

Conclusions

After examining public records related to SUA in Toyota vehicles, Safety Research & Strategies has concluded:

- The problem of Toyota SUA is controversial and complicated. It is occurring among a wider range of Toyota models and model years than has been investigated or remedied. This conclusion is strongly supported in the data.

- There appear to be multiple root causes to the multi-faceted problem of SUA in Toyota vehicles. Pedal entrapment and driver error appear to be the root causes of some SUA events. Sticking accelerator pedals do not appear to address SUA events as reported by drivers. There may be other mechanical root causes, such as a stuck throttle or other problems with the throttle body.

- Neither Toyota nor NHTSA has identified all of the causes of SUA in Toyota and Lexus vehicles. Both have adopted the simplest, mechanical explanation for these incidents.

[224] Back to Basics For Toyota; The Wall Street Journal; February 22, 2010

- The diagnostic fault detection and fail-safe capabilities in some Toyota vehicles with ETC do not always activate when certain critical faults occur -- this includes electronically and mechanically-based failures. If faults are not detected and fail-safes not activated, unwanted events can occur. A complete evaluation of Toyota's fault-detection strategies, particularly in context of the throttle system, will help ascertain the full extent of this problem and potential countermeasures.

- Toyota has insisted that its electronic systems cannot fail without offering scientific evidence to support its contention. Instead, it has blamed drivers and suppliers. This contention is further contradicted by Toyota dealer and technical evaluations that have replicated events that cannot be explained by the recalls or driver error.

- NHTSA has not yet conducted a thorough investigation of all possible causes. It has been hampered by decisions to limit data and exclude data which didn't fit its hypotheses. The agency may lack expertise and resources. It has been unduly influenced by its past experiences investigating SUA in mechanical throttle systems. Toyota's electronic system is significantly different and more complex than the older, mechanical systems.

- EDRs may offer evidence to help understand some crashes, but the data must be used in conjunction with other evidence. EDR data were not designed to and can not be used to determine crash causality. Data and translation errors can and do occur routinely. The data recorded and how they are translated in Toyota vehicles is proprietary. The lack of scientific validation, transparency and independent verification of the data further hamper its use.

- Toyota's field inspection process is not designed to examine potential problems with the complex electronic systems in their vehicles. Their evaluations appear to involve cursory evaluations to support a public relations campaign that asserts they can find no problems with electronics.

- Toyota's past recalls may have been effective in resolving some of the root causes. Complaints of SUA events continue to be reported. These incidents should be examined closely,

- An effective brake override system may mitigate many of the SUA events, regardless of their root cause.

- Toyota and NHTSA continue to operate in secrecy, despite pledges of transparency.

Note: Safety Research & Strategies provides consulting to law firms representing plaintiffs in litigation against Toyota. This report was researched and authored by Safety Research & Strategies and reflects the opinions and findings of the authors only.