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THE SAFETY RECORD

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GAO Study: Recall System Needs Improvement

Carolyne Thorne; the families of Jackie and Raechel Houck and Levi Stewart – these were not among the stakeholders interviewed by Government Accounting Office investigators in compiling their latest report on problems with automotive recalls. Yet, they are arguably among the many who are most affected by the shortcomings in the current system. Thorne was seriously and permanently injured and Stewart and the Houcks died, because defective and recalled components in their vehicles had not been remedied. Each case illustrates a different type of failure and why the recall system is due for an overhaul, but *NHTSA Has Options to Improve the Safety Defect Recall Process,* published last month, conveys none of this urgency.

This report was yet another outgrowth of the Toyota Unintended Acceleration crisis and the tsunami of recalls. The GAO notes that 2010 saw the largest number of automotive recalls in the history of the National Highway Traffic Safety Administration – largely boosted by the millions of vehicles Toyota recalled for floor mats and sticky pedals. It also acknowledges that the failure to remedy a defect poses a risk to the public – but it does not define the magnitude of this risk.

The GAO frames the issue as a two-fold communication problem: the language used in recall notifications tends to be confusing for the average consumer, and there are problems with notifying secondary owners of vehicles, from individuals to used car dealerships, and primary owners who move. It recommended that NHTSA modify requirements for notification letters and publicize its website. The GAO also recommended that NHTSA make better use of manufacturers' recall completion rate data; and "seek legislative authority to notify potential used car buyers of recalls."

While these suggestions might improve the recall remedy rate, by not taking a closer look at the most harmful results, the GAO missed an opportunity to put a sharper point on its observations and challenge some of the claims made by those the GAO relied upon in formulating its recommendations.

Take the issue of NHTSA and recall completion data. The agency told the GAO that "they evaluate the effectiveness of a recall campaign by comparing a specific recall campaign's progress to similar campaigns based on factors such as the age of vehicles recalled and the number of vehicles recalled." The agency said that "monitoring recalls on a campaign-by-campaign basis provides them with the flexibility necessary to capture the unique aspects of each recall campaign and that by focusing on communication and discussion with manufacturers, the agency can develop solutions to improve completion rates when a campaign is achieving a completion rate that is below its expectation."

In practice, the agency has no set procedures for determining if a manufacturer has adequately met its recall obligations. It rarely holds a hearing on recall non-compliance. In the last decade there were two scheduled – one in December 2008 against BMW for refusing to recall Mini-Cooper S Vehicles for burn hazards from the exhaust pipe tips which protruded at the center rear of the vehicle, and another in October 2009 against U.S. Bus Corporation. (In both cases, the manufacturers acquiesced to the agency's request before the hearing occurred.)

In the latter case, U.S. Bus had filed 21 defect and non-compliance reports to the agency between 2001 and 2007 and followed up with quarterly reports that indicated a very low remedy rate. It took the agency years to notice that the New York school bus manufacturer was not actually making any repairs and take action against it – even though

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The Next Defect Frontier: Electronic Recalls

In August, Toyota Motor Corporation recalled 1.2 million Corolla, Corolla Matrix, and Pontiac Vibe vehicles for improperly manufactured Engine Control Modules. The problem? Cracks at solder points or on varistors on the circuit board that could cause harsh shifting, or a car that won't start or would suddenly stop.

In October 2010, Nissan recalled 2004-2006 Armada, Titan, Infiniti QX56 and model year 2005-2006 Frontier, Pathfinder and Xterra vehicles, because of a compromised engine control module relay within the intelligent power distribution module. The automaker told NHTSA that a diode in the relay could allow silicon vapors to form, causing silicon oxide to develop on the ECM relay and arcing. This, Nissan said, could lead to a sudden engine stall.

On November 17, Volvo recalled more than 6,000 XC70, XC90 and S80 and S60 vehicles within certain chassis ranges because the engine and transmission software calibration was so sensitive, the vehicle could suddenly stall after a stop, and go into a reduced power mode. Volvo had to update the software.

In April 2011, Toyota recalled 307,848 2008 Highlander and Highlander Hybrid and 2007-2008 Rav4 vehicles because simultaneous faults in two roll-angle sensors in the curtain shield airbag assembly could cause inadvertent deployment of the side-air curtain and activation of the seat belt pretensioners. The problem first presented itself in October 2007 but Toyota,

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GAO Study: Recall System Needs Improvement

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the defects were serious and widespread among the nation's fleet of in-service school buses.

Levi Stewart, 18, of Idaho, was killed in a crash caused by a relay rod failure in a Toyota pick-up truck in September 2007. In October 2004, the automaker disclosed to NHTSA that it had recalled Hilux and Hilux Surf vehicles sold in Japan for defective relay rods – but not its U.S. counterparts, Toyota 4Runner, the Toyota Truck and Toyota T100. The rods had a tendency to snap, leaving the driver with no steering controls. Toyota told NHTSA that it had not received any reports of relay rod failures. In fact, Toyota had actually received at least 44 reports in the U.S. since as early as 2000, including crashes involving rollovers and injuries. In September 2005, Toyota finally recalled the defective steering relay rods on 1989-1995 Toyota pickups and 4Runners in the U.S. The repair rate was so low – 30 percent – that Toyota took the unusual step of issuing an owner re-notification in 2007. NHTSA never noticed that so few consumers had gotten the fix. Stewart had bought the used vehicle months before the crash. Stewart's family received the recall re-notification weeks after Levi's death. (Last year, NHTSA fined Toyota for failing to recall the relay rods in 2004, when it recalled them in Japan after prompting from the Stewart's lawyer.)

The GAO report criticized NHTSA for not using recall repair rate data to analyze trends and institute best recall practices:

"Based on our analysis of NHTSA data, without conducting a broader aggregate level analysis to look for outliers, patterns, or trends, the agency may be missing an opportunity to identify underlying factors that affect recall campaign completion rates."

But it should have also pointed out that cases like U.S. Bus and the Toyota relay rod recall show that NHTSA is not consistently looking at the data to monitor in the short term whether deadly defects are being fixed – which is the purpose of a recall.

NHTSA claimed to the GAO that 70 percent of all recalled vehicles are fixed within the 18-month period during which manufacturers are required to file reports. The GAO, however, found considerable variation in looking at recalls between 2000 and 2008. The average repair rate ranged from 55 to 75 percent, but "within any given year," the report stated, "some manufacturers have safety defect recall completion rates as low as 23 percent to 53 percent per year, whereas other manufacturers have completion rates between 90 percent and 96 percent… Furthermore, some manufacturers have consistently higher or lower rates across the 9 years we included in our analysis."

In probing the problems of notification, the GAO noted another longstanding problem: "there is no single source of information on safety recalls—such as a centralized VIN database—that can be accessed to determine if a car in a dealership's possession has an outstanding recall." This is not just an issue for car dealers – it affects any subsequent owner, like a motorist who purchases a car via a private sale.

The lack of a central database using vehicle identifiers is a particular problem for tires. (In a 2007 white paper **Tire Recalls and Tire Safety: The RFID Solution**, Safety Research & Strategies examined the flaws in the tire recall system and the absence of a mechanism that allows consumers, tire dealers and technicians to easily identify a recalled tire. The report addressed the potential for Radio Frequency Identification Devices to advance recall performance.)

Today's tire recall system was established more than 40 years ago, at a time when recalls and government defect investigations of tires were rare, and manufacturers neither desired nor expected the consumer to be an active participant in the process. The system is based on two components: the Tire Identification Number (TIN) – the primary means of distinguishing a tire by size, plant and date-of-manufacture (often referred to at the DOT number) and tire registration. The regulatory history shows that manufacturers and retailers successfully fought the agency's attempts to make recalls consumer-friendly. Tire sellers are only required to provide consumers with the means to register the tire – either via a paper card or electronically. They aren't required to register the tires they sell, although some do.

Research shows that consumers and tire dealers do not consistently register tires – the manufacturer may not provide the registration cards to retailers; a retailer may not give the card to the consumer; or the consumer may not fill it out. In addition, consumers change addresses and tires change hands when a vehicle is sold.

As for identifying tires, current regulations require manufacturers to mold the complete TIN on only one side of the tire; they can mold a partial number on the other side. But more importantly, manufacturers are *not required* to specify the range of TINs under recall. Some provide the agency with this information; some do not.

The only public repository of tire recall information is located on the NHTSA website. It does not allow users to search tire recalls by the TIN. Rather, a consumer would have to enter the tire's make and model to first determine whether it has been recalled. Then, users have to retrieve the documents the manufacturer filed in support of the recall and find the one that specifies the size and which TIN lots are being recalled – if the manufacturer actually provided it. If they haven't, consumers, tire dealers or other service providers have to contact the tire maker.

All of these gaps allow tire technicians to service tires without detecting they are defective. The GAO did not address these longstanding and systemic failures.

In June 2002, Carolyne Thorne of Montgomery, Alabama, replaced all four of the tires on her 2000 Ford Expedition when the left rear Continental Grabber AW P275/60R17 tire de-treaded at low speed. In August 2002, Continental Tire recalled the original equipment Grabber AWs, because they had a lower-than-specified rubber gauge between the belt edges, leading to a tread separation, resulting in loss of control of the vehicle and a crash. Like many Continental tire owners, Thorne promptly sent in her proof-of-purchase and was reimbursed for her new tires. Thorne took her Expedition into the dealership to check the tires again to ensure that none had been recalled. Thorne also had purchased a lifetime tire maintenance service with Wal-Mart so that her tires would be regularly inspected, balanced and rotated. Between 2002 and 2004, Wal-Mart auto technicians serviced her tires nine times. In April 2004, Thorne's Expedition rolled over on the highway after her left rear tire experienced another tread separation. Thorne, who was wearing her seatbelt, suffered a permanent spinal injury when the Expedition's roof collapsed. When Thorne had her first tread separation crash, a tire technician left the spare on the vehicle and put three of the new Continental P265/70R16 tires on the ground and the fourth in the spare well, under the vehicle. After the recall, no technician had ever noticed that her left rear tire was actually among those that should have been replaced. There is no system in place that would have allowed the technician to check the Tire Identification Number against a list of recalls, nor had Wal-Mart developed one, despite its position as one of the largest tire and service providers in the country.

Even today, Firestone Wilderness and ATX tires, recalled in 2000, still show up in current tire-related crashes. They were often full-sized spares stored under the vehicle, never replaced in the recall, and later rotated into service.

The GAO report documented that rental car companies, which operate large fleets that are used by, and later sold to the public, are

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The Next Defect Frontier: Electronic Recalls

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which has argued that dual simultaneous faults do not occur in the real world in refuting an electronic cause of unintended acceleration, similarly posited that dual simultaneous faults were highly unlikely to trigger inadvertent deployments. When complaints continued, Toyota concluded that the likelihood of a double fault triggering a deployment was much higher than anticipated and launched a recall.

As automakers continue to migrate mechanically-based components to electronic systems, so do the types of recall campaigns they launch to correct defects. According to a Siemens VDO Automotive report estimate in 2004, electronics was the fastest growing sector in the industry with the total value of such systems expected to reach $3.8 billion in 2010.

In the last 12 months, SRS examined the prevalence of electronic recalls, reviewing 722 recall campaigns since July 2010 to determine how many involve defects associated with electronic systems. Ultimately, defining electronics recalls is challenging – they range from severed cables and fluid leaks into electronic components that result in short circuits to hardware failures to complex software algorithm issues. When defined broadly, electronics recalls comprised more than a quarter of recalls submitted to NHTSA over the last year. Of those, 24 recall campaigns address software defects.

As SRS has previously reported, automakers have known for at least a decade that electronics have their advantages – and their reliability headaches. At a 2004 industry conference, Mercedes Benz's vice president for electrical and electronics and chassis development. Steven Wolfsreid, "railed against the temptation to overload vehicles with electronic functions that are useless to the customer," according to an *Automotive News* story. The German automaker had removed 600 electronic functions from its vehicles because of quality concerns that were damaging its reputation and ticking off its customers. Electronics are challenging to integrate into a vehicle's electrical architecture, he said, and what works well in isolation can be a disaster in combination with other electronic components.

The growth has also seen a corresponding rise in the number of warranty claims and defects. JD Powers data has shown that as the number of electronic functions a vehicle has rises, so do the number of defects. German electronics supplier Robert Bosch affirmed that connection in a trade-pub article, noting "a direct correlation between the number of electronic functions and the number of defects per vehicle."
But identifying the root cause of these electronic failures can be tricky.

The Ford thick film ignition module might qualify as the first high-profile electronic recall. It also bears the distinction of being the first court-ordered recall outside of NHTSA – in part because initially the failure was difficult to identify. This two decades-long saga of failures, investigations and litigation began in 1982, when Ford began to replace its mechanical breaker point ignition system, Duraspark, with an electronic system using a thick film 3 integrated ignition module. This new electronic system was heat-sensitive, yet Ford had placed it in the hottest location under the hood. At temperatures exceeding 125 C, the module would cut out, causing the vehicle to stall at highway speeds. After four years in service, Ford consulted its warranty data to test its durability projections for the component. The automaker found that the return rate far exceeded projections, but many of the returned parts did not exhibit the failure mechanism, because, once the vehicle cooled down, the component would resume working. Ford eventually identified the problem, but failed to act on its knowledge.

In the 1980s, NHTSA launched five investigations, but could not isolate a root cause, in part because Ford withheld documents that would have shown the effect of thermal stress on the ignition modules. A class action lawsuit on behalf of Ford owners prompted NHTSA to open a sixth investigation in 1997, which revealed that Ford had failed to produce documents to the agency. By then, Ford was beyond the agency's grasp; the eight-year statute of limitations on recalls had passed. In 1999, the civil lawsuit ended in a hung jury, but the second phase before a California state judge resulted in a judicially ordered recall. Ford eventually settled the class-action litigation in 2003 by doubling the component's warranty to 100,000 miles.

Another factor in the search for finding root causes is the new connectivity to which Wolfsreid alluded. Many of vehicle systems, such as braking and steering, were previously independent and solely mechanical. Today's vehicles communicate between systems using Controller–area Networks (CAN or CAN-bus). Developed and released by Robert Bosch GmbH in the late 1980s, CANs allow controllers and other components to communicate with each other using a message-based protocol designed for automotive applications. The CAN transmits messages based on a priority system wherein the message with the highest priority will succeed, and the lower priority messages follow.

A 2010 GM recall for the 2005 and 2006 Corvette illustrates how the interconnectivity of components can create unusual defects. The recall addressed an intermittent or open condition in a connector in the Steering Wheel Position Sensor (SWPS) that resulted in a short-duration brake application to a single wheel. In its defect notification, GM stated that in rare cases repeated movement of the steering column could cause signal interruption within the column triggering a "Service Active Handling System" message on the vehicle dash, followed by the application of one or more brakes, which could cause the vehicle to pull one direction or the other.

The much-heralded NHTSA-NASA reports on Toyota Electronic Throttle Controls open other windows into the complexities of electronic defects. While Secretary of Transportation Ray LaHood and Toyota pronounced their electronics exonerated by NASA in unintended acceleration incidents, a read of the scientific findings shows something very different. One prominent issue found by NASA that can lead to real-world UA was the identification of "tin whiskers" in the Accelerator Pedal Position Sensor (APPS) of Toyota potentiometer-type accelerator pedals. Whisker formation was first discovered in the 1940s in cadmium coatings, but the problem intensified in
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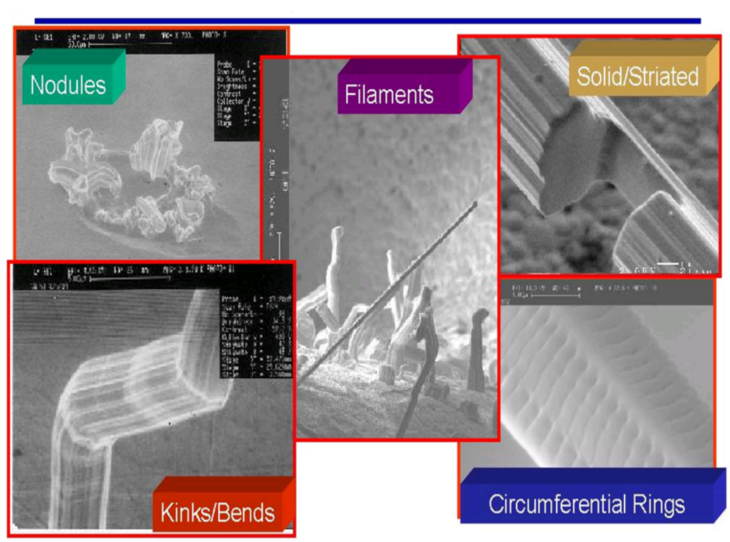
Metal Whiskers Shapes and Sizes
Source: NASA; http://nepp.nasa.gov/whisker/background/index.htm



Child Safety in Real World Crashes: U.S. Standards Lag

FMVSS 213 Child Restraint Systems is an inadequate standard with a compliance test that bears no resemblance to what happens to children in a crash, according to a slew of child safety researchers at this year's Enhanced Safety of Vehicles Conference. Some of the world's top researchers, including those from child restraint manufacturers, seat belt manufacturers and the National Highway Traffic Safety Administration, called for a strengthened standard that requires in-vehicle testing and dynamic side impact test procedures for child restraint systems.

The current FMVSS 213 requires sled-testing of 12 month-old, three- and six year-old dummies. The last substantive amendment to the rule was promulgated in 2003, to meet the demands of the Transportation Recall Enhancement, Acountability and Documentation (TREAD) Act of 2000. The Final Rule updated the bench seat in the sled buck; changed the sled pulse to provide a wider test corridor to make it easier for more test facilities to reproduce; improved the child test dummies; and included testing for child safety seats rated for children weighing up to 65 pounds. In announcing the Final Rule, the agency said that it didn't do more for a variety of reasons related to time and money. The tight deadlines set by the TREAD Act made it impossible for NHTSA to develop and validate a side impact test, the agency said – although it vowed to continue research into such a component. The agency said that it did not believe that updating the seat assembly and revising the crash pulse would "affect dummy performance to an extent that benefits would accrue from such changes."

Eight years later, child safety researchers say that without updating the seat assembly to simulate the rear seat compartment – or better still – require in-vehicle dynamic testing, the standard does little to raise the bar. The current FMVSS 213 sled buck has no front seat back or side components for the dummy or the child restraint to interact with. Research presented by Suzanne Tylko of Transport Canada shows that the lack of surface for the dummy or child restraint to impact renders head injury prediction useless. For example, the Transport Canada tests with rear-facing infant seats documented injurious head and child restraint impacts with vehicle components that would not show up in the compliance sled tests.

In addition, the U.S. has no side impact test standard for child restraints, and child restraints are not included in the current NCAP tests, unlike many other countries. Currently, Australia is the only country with mandatory side impact test requirements for child dummies, and Europe's ADAC has a consumer test with child dummies in side impacts. Research presented at the meeting document the poor side impact protection for properly restrained child dummies.

At the conference, NHTSA presented some of that promised research into developing a dynamic side impact test procedure for child restraint systems. The agency evaluated the test seat cushion, the door panel, and armrest components to design a side impact sled test representative of real-world crashes. A comparison of sled buck characteristics to the fleet show seat cushion stiffness for the 213 sled test is too soft, dramatically altering dummy kinematics. In addition, the height of the seat dramatically affects the Head Injury Criterion (HIC). Position of the dummy with the head totally or mostly higher than the windowsill had lower HICs, while the head mostly or totally below the windowsill produced higher HICs.

In examining child restraints, NHTSA pointed out that the stiffness of the side wings provided for head protection, contributed to containment of the dummy, and reduced the injury measures. Their testing showed that larger wings with more padding produced lower HIC values in the forward facing seats but did not contribute to lower injury values in rear facing seats. (Transport Canada tests of infant seat tests noted that most do not have energy-absorbing padding in the head area that would dramatically reduce the HIC.)

Researchers from supplier Takata Corporation tested forward facing child restraint systems in vehicle-to-vehicle oblique side crash tests to investigate head contact of restrained children with the vehicle interior. In side impact, the car exhibited both roll and yaw, causing the dummy to move up relative to the seat and toward the door, and the dummy head to contact the glass and window sill, resulting in high HIC scores. They developed sled tests with side vehicle components to simulate the full vehicle crash tests.

Britax engineers stressed that their "Key Safety Objective" was to provide energy absorption for the whole dummy body and avoid head contact. Britax has developed side impact countermeasures that it says anticipate child seat-to-door contact focusing on improvement in head containment in booster seats.

Volvo documented serious head and face injuries in real-world oblique crashes, noting that pre-crash vehicle maneuvers and initial poor belt fit for properly restrained child occupants were a big part of the problem. Volvo testing repeatedly documented head contact with the side window and the front seat backs in oblique testing showing that properly restrained children can sustain head injuries from interior impact with the vehicle. Their real-world driving maneuver and braking studies demonstrated that shoulder belts are routinely far out on the shoulder exacerbating the problem. Volvo claimed the vehicle manufacturer bore significant responsibility for this because it is not just the child restraint that protects the child; the vehicle plays a significant role. Vehicle side structure, for example, can limit motion of the dummy out of belt during normal driving. Also improvements in vehicle belt design, including pretentioners and load limiters, adapted to children, can improve protection.

The common thread running through these presentations: U.S. standards for rear seat occupant protection are severely lacking, especially for children, because they do not replicate the injury potential that occurs in real world crashes. This was reinforced by data provided by Kristy Arbogast, Associate Director of Engineering for The Center for Injury Research and Prevention at Children's Hospital of Pennsylvania, who once again documented that the injury risk is greater for all rear row occupants as compared to those in the front seats. In previous research presented at the Association for the Advancement of Automotive Medicine, Arbogast looked at the effect of reported deformation of the front seat back rearward on the injury risk to children seated in the rear in a rear-impact crash. CHOP researchers examined State Farm Insurance cases from 2000-2006 of 1,035 restrained child occupants under 12 years old, seated in a second-row outboard position in rear crashes to quantify the overall injury risk in relation to the presence of a front seat occupant and reported front seat-back deformation. Researchers found 2.3 percent of the children sustained an AIS 2+ injury; 71 percent of those crashes contained a front seat occupant, and eight percent of the cases reported front seat-back deformation.

NCAP Test Protocols Evaluating Dynamic Child Safety

- Latin NCAP – incorporates 18 mo and 3 yo dummies in the frontal tests and child seat fit and vehicle instructions are viewed to make sure a seat can be installed safely and securely
- Euro NCAP – incorporates 18 mo and 3 yo dummies in the frontal tests
- JNCAP - child seats are tested in the frontal impacts, also includes a child restraint and rear seat belt usability evaluation, and rear seat passenger protection as a part of the frontal offset test
- ANCAP – incorporates 18 mo and 3 yo dummies in the frontal offset tests
- USNCAP – includes child restraint usability ratings only - no dynamic test ratings with child restraints in the vehicles

Handing Over Safety

National Highway Traffic Safety Administrator David Strickland opened the Enhanced Safety of Vehicles Conference several weeks ago on a skeptical note about Google Inc.'s fleet of automated Toyota Priuses.

"More people feel that the task of driving belongs to the driver," Strickland said. "And do you really want to sort of hand over your safety to a machine?"

Every other year, the world's auto manufacturers, component suppliers, engineers and designers gather at the ESV to present the latest innovations in safety-related technology, automotive data and research. So, it is no small irony that Strickland poses this question in their midst, because whether the public wants to or not, its safety is already in the hands of the machines.

Electronic throttle control, known in the industry as drive-by-wire or E-Gas, actually debuted on passenger vehicles in BMW's 7 series in 1988. Nearly a quarter of a century later, today's vehicles have up-ended the traditional relationship between the driver and the auto. Direct inputs from the driver manipulating mechanical parts via cables and gears have been replaced by indirect commands. It doesn't look all that different. The pedals and levers are still there, but under the hood, the landscape has changed. Driver commands are no longer direct. They are interpreted by sensors and software that open the throttle and assist steering and braking, among other tasks. The car "key" in your hand is no longer the key – the computer code inside it is.

And yet, the regulations governing all of this wizardry are still stuck in a bygone technological age. The two biggest auto safety crises in the last decade – Ford/Firestone tire tread separation rollovers and Toyota unintended acceleration – both grew to mammoth proportions as public safety issues in large part due to antiquated and non-existent safety standards.

In the 1990s, America's most popular and best-selling SUV, the Ford Explorer, equipped with original equipment Firestone tires, was prone to fatal rollovers after tread separations at highway speeds. The Firestone Radial ATX and Wilderness radial tires met all of the federal regulations at the time. Those standards, however, were written when bias-plies were the norm. There were no federal standards for occupant protection in rollovers and there was no minimum stability requirement for SUVs, a new breed of station wagon based on high, narrow truck platforms. Industry fought off any regulations, even as the rollover death tolls in these trucks began to reach epidemic levels.

Then a series of gruesome high-profile crashes and news stories about the safety of Ford Explorers and Firestone tires triggered Congressional hearings. The Transportation Recall Enhancement, Accountability and Documentation (TREAD) Act in 2000 compelled NHTSA to update standards. In doing so, the agency had to educate itself about tire technology. The result was a tougher standard that produced more robust tires. That has been followed by a standard to strengthen roofs, and a stability metric used by the government in rating the rollover propensity of vehicles. While the latter wasn't a federal motor vehicle safety standard, industry improved its product to harness the marketing power of five-star ratings.

A decade later, the lack of a regulatory framework laid the foundation for an eerily similar scenario. Complaints of unintended acceleration dogged Toyota for six years, but NHTSA's defect investigators can find nothing wrong. Toyota vehicles meet the federal accelerator controls standard, FMVSS 124 – only it was penned in 1972 when throttles still had cables. The agency attempts to upgrade the standard, but again, industry fights off any changes. Then, a high-profile crash kills California Highway Patrolman and his family. The media questions the safety of Toyota's electronics in some of the most popular vehicles produced by the number-one automaker in the world. The NASA Engineering Safety Center's evaluation of Toyota's electronic architecture finds numerous flaws and a possible cause of unintended acceleration in some vehicles, only to be dismissed by the Secretary of Transportation as unlikely. The debate about the role of electronics in unintended acceleration continues.

Unlike the Explorer rollover fiasco, Toyota UA has not yet resulted in legislation that would focus NHTSA on a much-neglected area of safety regulation. The Motor Vehicle Safety Act of 2010 would have, among other things, compelled the agency to write an electronic systems performance standard. But the bill died in 2011. Rulemaking is the process by which NHTSA develops its institutional understanding of vehicle technology and functional outcomes. Without that critical step, automakers are left to their own devices; the agency is left behind.

We handed safety over to the machines long ago – and that's not always a bad thing. Electronics can improve safety. Features like Electronic Stability Control, for example, make vehicles less prone to rollovers and save lives. But there are still no minimal requirements for the safety of electronic architectures in vehicles. Allowing automakers to install electronic systems without those requirements ensures that the crashes will continue, as will crises – at great cost to planned safety priorities.

This commentary by Safety Research & Strategies President , Sean Kane, includes views he presented in June to the National Academy of Sciences Committee on Electronic Vehicle Controls and Unintended Acceleration.

New Study Supports Case for Stronger Seats

Revisiting an old and contentious issue with contemporary data, researchers from Garthe and Associates compared the real world effectiveness of seats with Integrated Restraints (IR) to standard seats, and found that standard seats without integrated restraints have increased failure and deformation rates, as well as higher MAIS injury risk compared to seats with Integrated Restraints. The authors pointed out that seats with IR have strengthened frames so they can support seat belt loads in frontal crashes, making them much stronger than standard seats. The researchers concluded that stronger seats deform less and result in less severe injuries in real world rear impact crashes.

The study, co-authored by Elizabeth Garthe and Nicholas Mango, challenged research published in the 1980s and 1990s by automotive experts testifying on behalf of the manufacturers to bolster the position that strong seats are hazardous and yielding seats are safe – even though occupants can ramp up a yielding seatback in a rear end collision, injuring themselves and the occupants behind them. A literature review on seat strength research referenced such studies claiming that standard seats are as effective in reducing injuries in rear crashes as seat belts and airbags are in frontal collisions, and that stiffer seats increase injuries in rear impacts.

Using NASS CDS data from 1997-2007, Garthe and Associates investigated this premise, using Delta V, AIS Codes and the Seat Deformation/ Failure codes. They directly compared front row seats with IR – confirmed from NHTSA's 2008 online list – cab reinforced seats and seats without integrated restraints in rear impacts. NHTSA data

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Summer Fun? Waterpark Injuries and Deaths

Earlier this month, a Georgia man died at the bottom of a water slide at a popular Atlanta-area attraction. Sergio Edwards, 21, reportedly a strong swimmer, was found unconscious at the bottom of Lake Lanier Islands Resort's Fun Dunker. The police officials called his death accidental, but had yet to pinpoint a cause.

Waterparks gained popularity in the1980s, and today there are some 1,000 such facilities, according to the World Waterpark Association. In 2010, these facilities attracted 79 million people looking for entertainment and relief from the heat. Yet, Edwards' death underscores that waterparks are also a source of drowning and a range of non-submersion injuries. According to 1998-2007 emergency room data from the National Electronic Injury Surveillance Survey (NEISS), 3,819 people sought treatment for injuries sustained at waterparks – making waterpark attractions the leading sub-category of amusement park injuries. Roller coasters and flume rides were second with 3,344 injuries over the same time period. The vast majority of complaints, 1,605, came from injuries while careening down a waterslide.
The medical community has also documented the types of injuries park patrons are likely to sustain. In 2007, researchers documented amusement park injuries seen in two Pennsylvania hospital emergency rooms during 2006. They noted that out of 325 discharge diagnoses, 15 percent occurred on water-related rides; with 18 percent extremity fractures, 18 percent lacerations, 15 percent extremity sprains, 15 percent head injury/ concussions, and six percent extremity contusions.

One contributor to these injuries is the velocity patrons attain while rushing down the water slides. A 2007 Australian study looked at their exit velocities at an open water slide and found that people hurtled down the chute at velocities ranging from 1.69 m/s (6.1 km/ hour) to 5.63 m/s (20.3 km/hour) – exceeding speeds sufficient to crush cervical vertebrae and creating the potential for a severe head injury from impact with a solid object, such as the sides of the slide or the bottom of the pool.

One of the most serious consequences of these impacts is a spinal cord injury. In 2008, a trio of Turkish doctors documented in the Clinical Journal of Sports Medicine four cases of spinal cord injuries sustained at waterparks. In each case, the men were injured by sliding head-first down the chute. The subsequent injuries were analogous to those sustained by individuals diving into shallow water:

"Cervical spine injuries are the most common complications due to recreational aquapark activities, and they are almost irreversible. Over 90 percent of these accidents result in quadriplegia, causing tremendous impact to the patient and society. Spine injuries due to diving into water mostly affect young men, and almost 50 percent of these patients present with complete [Spinal Cord Injuries]."

Some of the first medical journal articles on waterpark injuries tagged design features as a culprit of injuries. A 1988 *Southern Medical Journal* article by Charles Saunders cited a Centers for Disease Control study in which 94 percent of injuries occurred in one section of the slide. A second study associated injuries with sharp turns in the slide, and sliding over the seams or other rough surfaces of the slide. Saunders concluded that waterslide operators should be required to seal exposed seams and smooth rough edges, eliminate sudden tight turns, install non-slip surfaces and cover intake drains with secure grating.

But human behavior is also a factor. In 1998, British researchers published the results of a controlled experiment in safety management at a pair of enclosed, 90-meter long waterslides at a community swimming pool. The paper, published in Injury Prevention, illustrated the difficulties in maintaining safety at waterparks. The poll management installed a traffic-light controlled system to maintain order on the slides, instituted an organization-wide safety culture, and focused on improving user behavior. These efforts failed.

"Despite a battery of safety features including closed circuit TV, citizen's band radios, a traffic light controlled system, part time supervision, and warning notices, the system was found to be inherently "unsafe" as operated. It placed a small but significant percentage of users in a hazardous situation whereby consecutive riders could collide with each other while in the flume even when conforming with all instructions. The realized risk might have been even higher were not staff and users adopting their own precautionary measures."

Author David Ball concluded that the risk of injury was high, leaving operators liable for failing in their duty of due care.

New Study Supports Case for Stronger Seats

(*Cont. from p. 5*)
document more than 500 different vehicle models and model years that contain seats with IR in an occupant position. Garthe and Associates also compared the failure rates of each of these seats in rear impacts to failure rates from seat belt restraints in frontal impacts.

They found the following:

In rear impact crashes, standard seats deformed or failed 25 percent of the time (as determined by NHTSA coding in NASS CDS).

Seats with IR and cab-reinforced seats had no seat failures and lower deformation rates than standard seats.

The median speed for seat failure/ deformation in rear impact crashes was 27 kph.

23 percent of rear impact crashes occurred at Delta Vs at or greater than 27 kph.

Higher seat deformation/failure rates observed with standard seats were associated with higher percentage of occupants sustaining MAIS 3 injuries.

No occupant in a seat with an IR sustained more than a MAIS 1 injury in a rear impact regardless of Delta V.

Half of all occupants in rear impacts seated in standard seats sustained injuries resulting in MAIS 3 at Delta Vs of 19 kph or less.

Seats with IR significantly reduced the rate of injury in rear impact crashes over standard seats. Standard seats were 1.4 times more likely to be injured than occupants in seats with IR.

No occupant in a cab-reinforced seat in a rear crash experienced an MAIS 2,and one experienced an MAIS 3 in a crash with a Delta V > 30 kph. All of the other crashes with occupants in cab-reinforced seats sustained injuries of MAIS 1 or less.

In rear impacts, occupants experienced seat failures or deformations 69 times more than seat belt systems failed in frontal impacts.

In Delta V crashes of 20 kph, which was the median rear impact crash severity, the percentage of occupants in standard seats with MAIS 3 injuries was more than nine times that of restrained occupants in frontal crashes.

Occupants reach MAIS 3 at half the Delta V in rear crashes (19 kph) compared to belted occupants in frontal crashes (38 kph).

Overall, Garthe and Mango concluded that seats with IR were associated with reduced injury rates for all injury levels in rear impact crashes. Further, they found that IRs may provide injury protection comparable to existing restraints in frontal crashes and reduce the potential for injury to rear seat occupants from the falling seat.

(*Cont. on p. 8*)

Exponent's Proprietary Historical Database of Injury Mitigation Technologies shows little effect on Vehicle Mass, Price and Fuel Economy

Exponent, a research firm supporting the automobile industry in litigation, has been collecting data to build a database of available injury mitigation technologies by vehicle make, model and year. The Menlo Park, CA firm presented surprising research at last month's Enhanced Safety of Vehicles Conference using this resource, showing that vehicles do not sacrifice fuel efficiency to safety technology; side impact airbag effectiveness; and how the evolution of safety technology could be the basis for rulemaking.

The database documents what safety features were provided as standard and optional equipment and when they were introduced. The database was assembled using Ward's Light Vehicle Specifications from 1996-2010 and NHTSA's NCAP database from 1990-2010 as well as Exponent's own individual technology surveys.

Specific technologies include depowered or advanced technology air bags, side impact air bags, rollover airbags, automatic occupant classification and air bag suppression, electronic stability control, advanced belt restraints including energy management and pretensioners, tire pressure monitoring, and built in child restraints, among other safety features.

Robert Lange, former safety executive for General Motors, now Exponent's vice president of vehicle engineering, used this data in three papers he presented. In one, he concluded that there was little association between the addition of new safety technologies and changes in the overall vehicle mass, price and fuel economy because they have been largely offset by operational efficiencies or advanced designs and weight reductions elsewhere in the vehicle.

The second paper examined the evolution of safety technology as chronicled by the Exponent database. Lange observed that as injury control technologies were developed, they tended to be introduced in limited numbers of vehicle models and that the number of applications grow with model penetration over time resulting in substantial use in five years. He argued that most features preceded rulemaking mandates and that many could serve as a basis for justifying rulemaking.

In a third paper, Exponent used the database to assess the side impact airbag effectiveness on fatality reduction. Following the implementation history made possible by the master database, Exponent researchers developed a matrix of Head Curtain Airbag Availability from 1998 - 2009 for various make/model combinations. This allowed them to directly compare percent reduction in Fatality Rate within model pairs year-to-year with and without side impact airbags. They found improvement in occupant protection in near side crashes for torso and head curtain bags. Torso bags were 16 percent effective in reducing the probability of near side impact fatal injury and head curtain air bags were about 33 percent effective in reducing near side impact fatal injury.

In his presentation, Bob Lange noted that the database is not publicly available.

(Source: *Installation Patterns for Emerging Injury Mitigation Technologies, 1998 Through 2009*; Robert Lange, Harry Pearce, Eric Jacuzzu; Exponent)

ABS – 4 wheel	Collision warning frontal	Safety power windows
ABS – rear wheels	Collision warning rear	Seat belt energy management
Airbag – advanced features	Crash data recorder	Seat belt pretensioners
Airbag on/off switch	Daytime running lights	Side air bag
Auto crash notification	Dynamic head restraints	Stability control
Auto dim mirrors	Head curtain air bag	Tire pressure monitoring
Automatic door locks	Head curtain air bag rollover detection	Traction control
Brake assist	Lane departure warning	Trunk release
Built in child seat	Rear center lap-shoulder belt	
Camera	Rear seat head restraints	

GAO Study: Recall System Needs Improvement

(*Cont. from p. 2*)

not required to remedy a defect. The companies interviewed by the GAO said that they had systems in place that prioritized recalls. If the defect concerns safety, the rental company takes it out of service immediately until the repair is complete. If the defect is not "safety-related," the vehicle can be rented, but is put in the queue for service. (By definition, if a manufacturer has filed a defect and noncompliance notice with NHTSA, which initiates a recall, the problem must be safety-related.) In practice, this system is far from ironclad, if it actually exists.

Last year, a jury awarded $15 million to the parents of Jackie and Raechel Houck, who died in a head-on crash with a heavy truck in 2004. The Houck sisters had rented a 2004 PT Cruiser from Enterprise, which was recalled for the replacement of a power steering hose that could leak and ignite, causing an under-hood fire. Enterprise had been informed of the recall a month earlier, but did not repair the vehicle, renting it out to four other customers before putting the Houcks in it. Managers in training testified that it was a company practice to overbook vehicles to get customers in the door.

Rental car companies suggested that NHTSA and the manufacturers categorize the potential for harm for each defect and create national standards that would inform the public if a vehicle can be operated pending completion of a recall or if a vehicle needs to be grounded until serviced. NHTSA said that they opposed classifying defects this way for fear that consumers would ignore too many recalls.

"This could result in fewer consumers remedying their vehicles due to the fact that NHTSA has categorized the recall as 'less serious,' and therefore, consumers may perceive the safety risk to be decreased," the report said.

In response, "NHTSA agreed to consider our recommendations," the report said.

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Editor: **Sean Kane**
Contributors:
Ellen Liberman
Salena Zellers
Tony Di Viesti
Melanie MacDonald
Lauri Ontso
Ann Boudreau
Marilyn Charest
Felix Click
Sharon Mitchell

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The Next Defect Frontier: Electronic Recalls

(*Cont. from p. 3*)

2003, as manufacturers switched from lead to tin solder to satisfy a European Union directive for environmentally-friendly products. According to NASA "Tin whiskers are electrically conductive, crystalline structures of tin that sometimes grow from surfaces where tin (especially electroplated tin) is used as a final finish. Tin whiskers have been observed to grow to lengths of several millimeters (mm) and in rare instances to lengths in excess of 10 mm. Numerous electronic system failures have been attributed to short circuits caused by tin whiskers that bridge closely-spaced circuit elements maintained at different electrical potentials." They are complex and their behaviors are still not fully understood. According to NASA, which maintains laboratories and experts who study whiskers, "Tin whiskers pose a serious reliability risk to electronic assemblies."

As studies continue into the role of tin whiskers in Toyota pedals, some industry experts suggest that they may also be playing a role in other malfunctions of electronic components like the circuits in engine control units and electronic throttle bodies. Expect this topic to heat up as the role of tin whiskers in the automotive environment becomes the subject of further technical examination.

Interconnectivity and the intermittent nature of these electronic issues creates a whole new level of diagnostic and forensic challenges for engineers and technicians and greater challenges for regulators examining potential safety-related defects – particularly in absence of baseline regulations for safety-critical systems.

New Study Supports Case for Stronger Seats

(*Cont. from p. 6*)

This latest study can be added to the pile indicating the need for an updated seatback strength regulation. The rule has remained essentially untouched since the agency published the Final Rule establishing Federal Motor Vehicle Safety Standard 207 in 1967. In 1974, NHTSA proposed merging seatback and head restraints (FMVSS 202) regulations under one safety standard, acknowledging the relationship between these components of seating systems. But, four years later, the agency abandoned the effort in favor of merging upgrades to head restraints and seatbacks into a more comprehensive occupant protection regulation. In 1989, Dr. Kenneth J. Saczalski petitioned NHTSA to strengthen the requirements of FMVSS 207. In 1990, seat and seat belt expert Alan Cantor petitioned the agency to amend FMVSS 207 to prohibit occupant "ramping" up the seat back during seat deformation. In 1992, the agency initiated a seatback strength research project to gather information for future rulemakings.

In 2002, NHTSA published its rulemaking priorities for 2002-2005 and included improved seat strength and head restraints among its priorities, but proposed no new rulemaking. Two years later, NHTSA listed the improvement of seating systems as one of three priorities for improving vehicle crashworthiness, but did not begin a rulemaking. Nonetheless, in 2004, NHTSA published a notice terminating further rulemaking, and said it would continue research with the goal of unifying FMVSS 202 and 207 into a single rear impact protection standard.