Sudden Acceleration Without an Accelerator Input

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Abstract: Videos of real incidents have been found which show that automobile engines can erupt into a nearly full throttle mode without any input from the accelerator pedal, either by the driver, a floor mat, or a sticking accelerator pedal. These videos are described, and internet links are provided to them so the reader can see for himself how high engine revs can cause a sudden acceleration to occur. Links to theories which explain this behavior in vehicles with mechanical throttles and electronic throttles are also provided. This material will help the reader to understand the true nature of sudden acceleration incidents and what the driver is up against when trying to describe a sudden acceleration incident to a dealer or to the NHTSA.

I. Introduction

It is easy to blame the driver for sudden acceleration when he can't prove that his foot was not on the accelerator. It is also easy to blame floor mats or sticky accelerator pedals for sudden acceleration when there is no proof of an alternative cause. But we have discovered several videos on the Internet which show real sudden acceleration incidents in which the accelerator pedal is clearly not being depressed by the driver or by a floor mat. We hope that these videos will help the reader understand the true nature of sudden acceleration incidents and what the driver is up against when trying to describe a sudden acceleration incident to a dealer or to the NHTSA.

II. Videos Showing Sudden Acceleration Incidents Without an Accelerator Pedal Input

In this section we describe several videos of real sudden acceleration incidents which show the accelerator pedal not being depressed during the incident. Still photos extracted from the videos are used to show the video highlights. We give the internet link to each video so that the reader can view the video himself and make his own judgment about what was happening.

Video 1. Korean Taxi Cab in Waiting Line. This three minute video shows a taxi in a waiting line in Soeul, Korea. The taxi is a Hyundai Sonata YF. The sudden acceleration incident is recorded by two cameras: 1) a dashboard camera looking outside the vehicle, and 2) by a second camera looking inside the vehicle at the driver and the empty rear seat. These cameras and a video recorder were likely installed by the cab company to document traffic accidents and to record driver/passenger behavior for insurance and accident liability purposes. They record continuous video and audio, along with GPS location, vehicle speed, and vehicle acceleration.

Figure 1-0:02 on page 9 shows the driver waiting in the taxi line. After about a minute and a half of waiting, the driver exits the vehicle to have a smoke. When he exits the vehicle, he leaves the vehicle running at idle with the transmission in DRIVE and the parking brake on. Figure 1-1:42 shows the driver smoking outside the vehicle. Figure 1-2:07 shows the driver becoming aware that the taxi ahead of him in line has moved forward, so he re-enters the vehicle to inch it forward. He does so by reaching inside to release the parking brake while leaving both feet outside the vehicle. Figure 1-2:08 shows the driver hearing the engine rev up suddenly to full throttle as he is releasing the brake. A passenger disembarking from a nearby taxi also hears the unusually high engine revs and looks toward the taxi in line to determine what is going on. Figure 1- 2:09 shows the taxi beginning to surge forward as the engine is heard revving at wide open throttle (WOT). Four seconds later, Figure 1-2:15 shows the taxi crashing into a bridge pillar with the driver's feet still outside the vehicle as the engine continues to rev at full throttle. The taxi rebounds from the pillar and turns to the right as the engine revs audibly. The turning is probably caused by the left wheel hitting the curbing around the pillar, causing the vehicle to turn to the left when moving forward and to the right while moving backward. Figure 1-2:16 shows the driver doing something like shifting into neutral. This might explain why the vehicle does not surge forward and hit the taxi in front. Figure 1-2:19 shows the driver doing something after which the engine revving starts to decrease. Figure

1-2:37 shows a bystander shutting off the ignition after the engine is running at normal idle. Finally, Figure 1-2:52 shows the driver talking to the bystander after his ordeal is over. Both his feet are still outside the vehicle.

The reader can watch the complete video at http://www.youtube.com/watch?v=oMfuLcQEOgM. What becomes apparent when watching the video is the sound of the unnaturally high engine revs and the suddenness with which they begin. This sound is totally incompatible with the nearby quiet surroundings, as the disembarking passenger in a second taxi notices at once. It is also clear that the driver is shocked by the initiation of the incident, and that he lacks control over the brake and accelerator pedals. What could cause such a sudden and violent incident? Certainly, the driver was careless in leaving the car in gear and releasing the brake while his feet remained outside. But it is clear that the driver did not cause the incident in the sense that the vehicle's engine began revving at wide open throttle on its own. If this had happened while the driver had both his feet, or even just one foot, inside the vehicle then skeptics would dismiss it as yet another example of sudden acceleration caused by driver error, floor mat entrapment, or accelerator pedal sticking. But this is clearly not the case, because both the driver's feet remain outside the vehicle throughout the incident. And the vehicle was idling normally just before the incident, so what could have pressed on the accelerator pedal if not the driver? Can you explain the cause of this incident? Here are some possible hints. The vehicle likely has an electronic throttle. Also, when the vehicle is idling in gear the alternator is putting out the least amount of current, causing the battery to discharge and the battery voltage to fall. The two cameras and video recorder used to capture the incident add to the load on the vehicle's battery, making its voltage fall faster. There is also a GPS receiver which dissipates enough power to warm the unit.

Video 2. Honda Pilot with Driver's Foot on Brake. This 48-second video made in 2010 using a cell phone shows a 2006 Honda Pilot EX-LS undergoing high engine revs at 5000 RPM, which is close to full throttle. The video catches the high revs in progress while the vehicle transmission is in PARK with the driver's foot firmly on the brake. The high revs began suddenly while the vehicle was moving in DRIVE before the video started. After the high revs started randomly and threatened to cause an accident, the driver was able to stop the vehicle, put it in PARK, and begin filming the video. Figure 2-0:01 on page 10 shows the vehicle's tachometer at 5000 RPM one second after the video starts. You can hear the engine roaring in the background. Figure 2-0:17 shows that the driver's foot is on the brake and not on the accelerator while the engine continues to roar at high RPM. Figure 2-0:20-0:30 shows that the high revs at 5000 RPM continue to be seen and heard for ten more seconds. Figure 2-0:31 shows that the high revving ceases when the driver turns off the ignition 31 seconds into the video. Figures 2-0:41 to 0:48 show that normal idle operation occurs when the ignition is turned back on.

The reader can watch the complete video at http://www.youtube.com/watch?v=9hUucMJu4pc&feature=player_detailpage. You can clearly hear the engine revving at high RPM in the background. What can cause such a sudden and prolonged case of high engine revs at 5000 RPM without an accelerator pedal input? The driver has no motive for trying to deceive the observer. He has had no accident, so there is no motive to cover up any poor driving behavior. And he is an attorney who job is to defend manufacturers against product liability suits, so it would be career limiting for him to use the video as the basis for a sudden acceleration suit against an auto manufacturer. Then why did he make the video? Well, he explains on the web site that he had experienced several similar incidents in the same vehicle earlier, and he wanted to document the problem for the dealer and for NHTSA. So he kept his cell phone handy if an incident occurred again. This explains why the lighting is so poor when he tries to show that his foot is not on the accelerator. He also explains that the same problem occurred in a second 2006 Honda Pilot that he owned, and he later sold both of them to purchase an Acura. So how can we explain this incident? Is it a case of improper idle adjustment, as one reader has alleged? In both vehicles? Another reader notes that the rev limiter kicks in at 5500 RPM. But for this to happen normally, the accelerator pedal would have to be depressed almost to the floor. This is clearly not happening in the video. Can you explain the cause of this behavior? Hint: The vehicle has an electronic throttle.

Video 3. Korean Vehicle with No Accelerator Pedal Input. This 43-second video shows a vehicle undergoing high engine revs at 5000 RPM while PARK. The driver is trying to explain to an observer how the high rev incident occurred, but the conversation is in the Korean language making it difficult to understand what is being said. Evidently, the high revs began suddenly while the vehicle was in DRIVE before the video started. The driver was able to pull over to the side of the road when the incident occurred, and to put the vehicle into PARK. As the engine continued to roar at 5000 RPM, the video recording was started. Figure 3-0:04 on page 11 shows the vehicle's tachometer at 5000 RPM four seconds after the video starts. Figure 3-0:15 shows the transmission shifter in the PARK position. Figure 3-0:18 shows that the driver is not touching the accelerator pedal or the brake pedal while

the engine is roaring at 5000 RPM. Figure 3-0:19 to 0:26 show that the high revving continues to be heard as the driver talks to an observer. Figure 3-0:34-0:37 shows that the high revving continues to be heard as the tachometer registers 5000 RPM. Figure 3-0:40 shows that the transmission remains in DRIVE as the high revving continues to be heard. Figure 3-0:40 also shows that an accessory is plugged onto the cigarette lighter.

The reader can watch the complete video at http://www.youtube.com/watch?v=8sYqFriw0aU. The make and model year of the vehicle are unknown, so it is difficult to tell whether the vehicle has an electronic throttle. Nevertheless, it remains clear that the vehicle is undergoing high revs at 5000 RPM without an accelerator input as a result of a sudden acceleration incident. Can you explain the cause of this behavior? Hint: The driver has an accessory plugged into the cigarette lighter.

Video 4. Cadillac DeVille with No Pedal Inputs. This 2:09-minute video made on 3 October 2012 shows a 2000 Cadillac DeVille DTS with 40,000 miles on it undergoing high revs at 3800 RPM while in PARK. The high revs began as a sudden acceleration incident a few minutes (100 yards) after driving away from a dealership at which it just had a new water pump put on it. The driver quickly braked and pulled into a parking lot, then threw the vehicle into PARK and got out. The vehicle was still undergoing high revs when the owner, who was following in a second vehicle, stopped, got out, and approached the first vehicle. At that point the vehicle ignition was turned off. The video was made by the owner using a cell phone while waiting for the dealer to tow the vehicle back.

The video begins by showing the vehicle with the hood up and the engine off. The owner has opened the hood to see if the dealer's repairs might have caused some obvious problem. But the owner could find nothing to cause the high revs. Figure 4-0:42 on page 12 shows the owner restarting the engine, at which time it roars back to life at 3800 RPM. Figure 4-0:51 shows the engine continuing to roar at high RPM after the driver has exited the vehicle while leaving it in PARK. Figure 4-0:54 shows the tachometer at 3800 RPM with no pedal input. Figure 4-0:59 shows that the engine has shut off on its own within a few seconds after hitting the rev limiter at 4000 RPM. Figure 4-1:01shows the engine being restarted, after which it goes immediately to high revs again. Figure 4-1:05 shows the tachometer oscillating between 3500 and 3900 RPM with no accelerator input. Figure 4-1:13 shows that the engine is revving at 3800 RPM with no accelerator pedal input. Figure 4-1:29 shows that the engine is shut off manually while at 3800 RPM. The next day, after the vehicle was towed to the dealership, when the dealer started it up again the vehicle exhibited the same behavior as shown in the video.

The reader can watch the complete video at http://www.youtube.com/watch?v=dXLzsEm1-0Y. Although the make and model year of the vehicle are known, it is not known whether the vehicle had an electronic throttle. Nevertheless, it remains clear that the vehicle is undergoing high revs at 3800 RPM without an accelerator pedal input as a result of a prior sudden acceleration incident. Is this just a case of a bad idle adjustment? Or is there a different reason for this behavior?

Case 5. Kevin Haggerty Incident. This is actually not a video, but a deposition made for testimony before a congressional subcommittee. Therefore, the person giving testimony is subject to prosecution if the deposition is false. On 28 December 2009 Mr. Kevin Haggerty was driving his 2007 Toyota Avalon on Route 78 in New Jersey when he experienced a sudden acceleration while driving at high speed. He was not able to stop his vehicle by pressing on the brake pedal, so he slowed the car down by putting it into neutral. Since the Toyota dealership was close by, he decided to drive to the dealer to show them the problem. He drove approximately five miles by alternating from neutral to drive and pressing very firmly on the brakes. On his way there he called them and asked for the service manager to meet him outside. As he pulled into the front of the dealership, he put the car into neutral and exited the car. With the brakes smoking from the excessive braking and the car's RPM's racing, the Toyota service manager entered his car. He confirmed that the gas pedal was not obstructed, that the mats were properly in place, and that the RPM's were very high. He then contacted a Toyota field technician to come to the dealership and look at Mr. Haggerty's car. He arrived within a few hours. The dealership kept Mr. Haggerty's car for 1-1/2 weeks. When he was told the car was ready to be picked up, he asked what problem they had found. He was told by the service manager that "per Toyota" they replaced the throttle body and accelerator assembly including 1 or 2 of the sensors. This appeared to have solved the problem. He later sold his vehicle to another dealer after they made him a generous offer on a new vehicle.

The reader can find Mr. Haggerty's deposition at http://onlinepubs.trb.org/onlinepubs/UA/101012Haggerty.pdf. We have included it here even though it is not a video because the testimony of the Toyota dealer's service manager is

considered to be just as good an eyewitness account as a raw video. What can cause such a sudden and prolonged case of high engine revs without an accelerator pedal input? Hint: Mr. Haggerty's Avalon had an electronic throttle.

These five incidents show beyond a doubt that sudden acceleration can occur without the accelerator pedal being depressed by the driver, by a floor mat, or by an accelerator pedal sticking. If such an incident were to happen to you, how would you describe what happened to a policeman, reporter, auto dealer, or the NHTSA? Would anyone believe that you did not touch the accelerator when you do not have a video to prove it? This is the situation that everyone faces after being involved in a sudden acceleration incident.

III. Videos Showing the Beginning of a Sudden Acceleration Incident with an Accompanying Audio Recording

Most videos of sudden acceleration incidents show the vehicle undergoing some form of erratic behavior that ends in a non-fatal crash. Since most videos show the vehicle from the outside, it is difficult to tell how the sudden acceleration originated, and what was happening to the driver at the time it started. However, some videos made using dashboard cameras contain audio information as well, and this audio information can be very revealing. For example, it may show that the driver is startled by the engine suddenly going into a higher rev mode without his input. The following videos show this happening. If you listen carefully you will hear the engine erupt suddenly into a high rev mode, and in some cases hear the driver's reaction when this happens.

Video A - Taiwan SUA Incident Around a Bus. This 1:10 minute video dated 9 May 2012 shows the view from a dashboard camera inside a Taiwanese passenger car following a city bus. If you turn up the sound, you can hear the audio recorded by the camera. At the start of the video you can hear the radio playing inside the car over the sound a normal engine and somewhat high road noise. Clearly, the driver has her foot on the accelerator pedal to maintain speed. Twelve seconds into the video at 0:12 you can hear the engine erupt suddenly into a full throttle mode. Three seconds later, at 0:15, you can hear the driver scream in fear as the vehicle passes a bus while going at full throttle. The full throttle mode continues another 23 seconds until 0:38, at which time it ceases. It is not known whether the driver was able to stop the runaway vehicle by putting the transmission into neutral or whether the high revs merely stopped on their own. No accident occurs as a result of the incident.

You can view the incident yourself at http://www.liveleak.com/view?i=52d_1351147586. What is remarkable about the video is the sound of the engine suddenly erupting at full throttle and the exclamation of the driver three seconds later. The driver is clearly startled by the sudden high revving of the engine. The high revving is unlikely to have been caused by driver confusion because there was no traffic to avoid and thus no reason to apply the brakes at the time the high revs started. And you can tell that the driver did not cause it deliberately by the verbal expression of relief when the incident is over.

Video B – Hyundai Sonata Incident in Daegu, Korea. This 29 second video was made on 6 May 2012 in Daegu, Korea. It shows a 2009 Hyundai YF sedan starting abruptly from a standstill, forcing the driver to weave through heavy traffic before eventually slamming into the back of a stationary vehicle at 80 mph. The driver's wife is heard yelling "Oh my God, what is going on?" during the wild ride. You can hear the engine rev up instantaneously at 0:07 seconds into the video and roar at full throttle until the crash occurs 22 seconds later. The crash injured 17 people, including the driver who suffered fractured fingers and ribs, and his wife, who required surgery for internal bleeding. Hyundai Motors has since released a statement saying that the vehicle is being inspected by the Korean National Forensic Service.

You can view the incident yourself at http://www.youtube.com/watch?v=McmPVJQLDXQ. You can hear better audio of the same incident at the following internet sites: http://www.youtube.com/watch?v=3bXQ5m11lw8, http://www.youtube.com/watch?v=RVFU85Iws0o, http://www.youtube.com/watch?v=hagoiuDqveE, or http://tubezen.com/download.php?&vq=aedWuuIrU7s. Perhaps the driver could have avoided a crash by putting the vehicle into neutral and braking. However, the fact remains that the vehicle accelerated on its own, for what driver would have deliberately risked driving so fast in traffic and causing a crash of this magnitude?

Video C – Kia Optima K5 Incident in Korea. This 23 second video was made on 18 January 2012 in Korea. It shows a Kia Optima K5 sedan starting abruptly from a standstill, causing the driver to pass through an intersection and crash into a service station. Clearly, the driver is trying to turn left because the road straight ahead through the

intersection is one way against him. However, he can't turn left as desired because a truck from the one way street has turned across his path, and the truck is slowing down to avoid a pedestrian. Normally, a driver in this circumstance would apply the brakes to fall behind the truck as it passes through the intersection. This driver appears to be trying to do this. But for some reason the engine is now revving at such a high speed that the driver can't brake as intended. He manages to avoid hitting the truck, but then finds himself on a course into the filling station. He tries to stop, but cannot, and crashes into the station office.

You can view the incident recorded by the dashboard camera at http://www.youtube.com/watch?v=hW0g_ncExrc. The audio in this recording clearly reveals that the engine has jumped into a high rev mode even before the vehicle enters the intersection, but the vehicle is being held back by the driver applying the brakes. The high revs continue until the brakes no longer can hold the vehicle back. The same incident was recorded by two additional video cameras in the filling station. These videos can be viewed at http://www.youtube.com/watch?v=eQi85MTiSL0 and http://www.youtube.com/watch?v=8oe8IULNV7o. These videos show that the vehicle barely misses the moving truck, and that the vehicle continues into the service station at high speed. Either the driver has ceased to apply the brakes, or the brakes are ineffective in stopping the vehicle. Rather than focusing on the brakes, however, we ask why did the vehicle encounter a high rev mode in the first place? Did the driver deliberately floor the accelerator pedal and keep it floored throughout the incident? Or did the vehicle undergo a sudden acceleration that could not be controlled by the driver?

It is difficult to believe that a vehicle's engine can spontaneously erupt into a high rev mode without an input from the driver's accelerator pedal. Therefore, the natural reaction is to think that the driver is unwittingly mistaken when he claims that he did not touch the accelerator pedal. For example, maybe the driver thought he was pressing on the brake, but instead was pressing on the accelerator pedal. Or maybe the driver was pressing on the accelerator pedal at the same time that he was pressing the brake. Or maybe something else was pushing on the accelerator pedal, such as a floor mat that traps the pedal. Or maybe the accelerator pedal stuck down on its own because of friction in the pedal. If these conditions can be eliminated by means of a video or by eye witness testimony, then the natural reaction is to believe that the driver is deliberately trying to deceive the viewer by some hidden means. This belief is usually accompanied by questioning the driver's motives, suggesting that the driver is trying to cover up for causing an accident, or is trying to seek some financial gain by suing the dealer or auto manufacturer when nothing has really happened at all.

The difficulty in believing that sudden acceleration can occur without an input from the driver's accelerator pedal lies in the inability to conceive of a physical mechanism by which it can occur. It is natural for the human brain, when presented with a new problem, to explain the problem in terms of what one already knows. Therefore, if there is no physical explanation for how sudden acceleration can occur without an accelerator input, the only other alternative is to explain it by some other means already known from experience. Realizing this, we now provide a physical explanation for how high engine revs can occur without an accelerator input.

IV. Physical Explanation for Sudden Acceleration without an Accelerator Input

In this section we discuss two physical mechanisms for how high engine revs, i.e. sudden acceleration, can occur without an input from the accelerator pedal. The two mechanisms correspond to two different ways of connecting the accelerator pedal to the throttle valve: 1) a mechanical linkage, which corresponds to most automobiles prior to CY2000, and 2) an electronic throttle, which corresponds to most automobiles after CY2000. There is some overlap in time, however, and one can find some cars prior to CY2000 that have an electronic throttle, and some cars after CY2000 that still have a mechanical linkage.

Physical Explanation for Sudden Acceleration in Cars with a Mechanical Linkage. In this case, the physical mechanism involves the electronic cruise control module. In some cars, such as Fords before 1995, this module is powered up at all times, even when the cruise control unit is not turned on by the driver. If a particular ground wire is not making good contact (say by a corroded wire), and if a second wire is shorted to ground (say by chafing due to engine vibration), then the cruise control unit can cause the engine to go to full throttle. When this happens, the accelerator pedal is actually pulled down to the floor without being touched by the driver. You can see this happen in a video aired on Dateline NBC in August 2009 with Stone Philips reporting. The video can be viewed at https://dragtimes.com/video-viewer.php?v=SWJJKYnd9h0&feature. This video is the third segment of a four

segment series. The complete series of videos entitled "Dateline NBC - Sudden Acceleration Investigation" can be found at:

Segment 1: https://dragtimes.com/video-viewer.php?v=XiFFlYMM2YY&feature
Segment 2: https://dragtimes.com/video-viewer.php?v=qmqT7tZap38&feature
Segment 3: https://dragtimes.com/video-viewer.php?v=SWJJKYnd9h0&feature
Segment 4: https://dragtimes.com/video-viewer.php?v=95Q9q6dJZUo&feature

If the reader watches the entire series of four videos, he will find the answers to many other questions about sudden acceleration in cars with mechanical throttles. He will hear a Secret Service motorcade driver explain how his presidential limousine sudden accelerated and crashed into a tree on the White House lawn. He will hear the chauffeur of Mrs. William Clay Ford, of the company's founding family, retell the story of how a sudden acceleration occurred while Mrs. Ford was in the car. He will hear a Ford executive recall his own sudden acceleration incident in a Ford vehicle. He will hear that Ford gave its dealers technical hotline reports describing the cause of the sudden acceleration. And he will hear Ford's denial that any defect exists, even after one if its executives stated in a written memo that sudden acceleration could occur by this means. He will also see a mechanic in a Boston service shop describe how a sudden acceleration incident occurred in their shop, and see the mechanic simulate the defect that caused it. And he will hear the service manager, Larry Miller, at the Harlan Motor Company Ford dealership in Okmulgee, Oklahoma, explain how he found the defect originally in 1990. Mr. Miller then describes how the defect occurs in the field by pointing to solder joints on the actual electronics module. After that, he will hear that when the mechanism was tested by Ford, it took 175 pounds of pressure on the brake pedal to stop the vehicle. Finally, he will hear Mr. Michael Brownlee, former Director of Defects Investigation for NHTSA, say that when he directed that the NHTSA report entitled "An Examination of Sudden Acceleration" be written in 1989, he did not know that the cruise control module in Ford vehicles was powered up all the time. He states that he now has a lot more questions he would like to ask Ford, which might cause the government to take a second look at the 1989 study. This is a startling admission for someone formerly employed by the NHTSA, who nearly always takes the side of the manufacturers on sudden acceleration issues.

Physical Explanation for Sudden Acceleration in Cars with a Electronic Throttles. In the case of vehicles with electronic throttles, the cause of sudden acceleration is still to be determined. Therefore, we provide two alternative theories which might explain how sudden acceleration can occur without an input from the accelerator pedal. These theories are: 1) tin whiskers, and 2) negative voltage spikes.

Tin Whiskers. This theory was discussed in the NASA report on sudden acceleration performed for the NHTSA in 2011. It builds on a theory originated by Dr. David Gilbert of Southern Illinois University in 2010. Dr. Gilbert noted that cars with electronic throttles have two accelerator pedal sensors which detect how far the accelerator pedal is being depressed. They supply redundant information to the vehicle's computer such that if one sensor fails, then the other sensor can detect the problem and either register an error or shut down the engine. They are designed to supply slightly different voltage outputs to the computer, with the outputs becoming higher as the accelerator pedal is presser down further. A problem can arise, however, if the sensor output voltages become too close to each and if they get partially shorted to the nearby +5V sensor power supply. Then both sensor outputs go immediately to an output voltage close to +5V and the vehicle undergoes a sudden acceleration with no DTC's recorded. Tin whiskers can cause these two types of electronic faults: 1) one tin whisker can short the two accelerator pedal sensor outputs together with just the right resistance to defeat the diagnostic test software, and 2) another tin whisker can raise the two sensor outputs toward +5V with just the right resistance to cause an acceleration. Alternatively, the second type of fault may be a caused by fretted power connector or a partially broken ground wire.

The reader can learn more about the tin whisker theory by reading the first four documents in Table 1. Toyota's refutation of the theory can be found in the remaining documents in Table 1.

Table 1. Documents describing the tin whisker theory

	Title	Author	Source
	Tin Whisker Theory Explained		
1	Toyota Electronic Throttle Control Investigation	Dr. David Gilbert	http://www.safetyresearch.net/Library/Preliminary_Report022110.pdf
2	NHTSA-NASA Study of Unintended Acceleration in Toyota Vehicles, Appendix C: Hardware	NASA	http://www.nhtsa.gov/UA
3	Electrical Failure of an Accelerator Pedal Position Sensor Caused by a Tin Whisker and Discussion of Investigative Techniques Used for Whisker Detection	Henning Leidecker et. al.	http://nepp.nasa.gov/whisker/reference/tech_papers/2011-NASA-GSFC-whisker-failure-app-sensor.pdf
4	Tin whisker analysis of Toyota's electronic throttle controls	M. Pecht et. al	http://www.autosafety.org/sites/default/files/imce_staff_uploads/Tin_whisker.pdf
	Tin Whisker Theory Refuted		
5	Toyota webcast refuting Dr. Gilbert	Toyota	http://www.autoblog.com/2010/03/08/toyota-hits-back-at-david-gilberts-no-fault-code-demonstratio
6	Evaluation of the Gilbert Demonstration	Exponent Inc	http://pressroom.toyota.com/images/document/GILBERT-Evaluation_of_the_Gilbert_Demonstration_1_.pdf
7	Evaluation of Dr. Gilbert's Demonstration	Dr. Christian Gerdes	http://pressroom.toyota.com/images/document/Exponent_ProfGilbert_8Mar10.pdf
8	Testing and Analysis of Toyota and Lexus Vehicles for Concerns Related to Unintended Acceleration – Interim Report, 4 February 2010	Exponent Inc	http://democrats.energycommerce.house.gov/Press_111/20100222/Exponent.Report.February.2010.pdf
9	Exponent Report on ETCS-I – Final Report, 24 September 2012	Exponent Inc	http://pressroom.toyota.com/article_display.cfm?article_id=3597
10	Exponent EMI Final Report with Appendices, 24 September 2012	Exponent Inc	http://pressroom.toyota.com/article_display.cfm?article_id=3598

Negative Voltage Spikes. This theory was developed by the author of this paper in July 2012. In all vehicles with electronic throttles, an electric motor is used to open and close the throttle under the control of a microcontroller that senses the driver's command to accelerate by stepping on the accelerator pedal. The electric motor is powered from the vehicle's 12 volt supply voltage, and is commanded to increase or decrease the throttle valve by rapidly switching the motor's supply voltage on and off at a rate that is proportional to the driver's depression of the accelerator pedal. Since the motor's speed and torque are related to the supply voltage, the motor's operation gets weaker as the supply voltage decreases below its normal value, even though the driver's input may remain unchanged. This can cause a noticeable sluggishness in the engine response of the vehicle. To prevent this from happening, it is common throughout the automotive industry to apply a correction to the switching rate of the motor to compensate for the decrease in the motor's responsiveness at lower supply voltages. This is done by having the microcontroller sense the vehicle's supply voltage periodically and then multiplying the accelerator pedal output by the inverse ratio of this supply voltage, so that as the supply voltage decreases, the switching rate to the throttle motor increases. This eliminates the changes in the engine response due to changes in supply voltage. It all works correctly as long as the supply voltage changes slowly, as it normally does. However, a problem arises when there are negative voltage spikes on the voltage supply line. When this occurs, it is possible for the microcontroller to sense the vehicle's supply voltage at the same time that a negative spike is occurring. This causes the microcontroller to apply a voltage correction to the accelerator output which suddenly increases the throttle motor's response even though the voltage spike may no longer be present to decrease the supply voltage to the throttle motor. This creates an unstable control loop which leads to a sudden increase in the throttle motor's normal response producing a lurch, a sudden surge, or a sudden acceleration. The duration of a sudden acceleration incident can last as long as the incorrect voltage correction coefficient is active, which is the time it is stored between voltage samples. This can be up to a half an hour or so. The reader can learn more about this theory and how it explains

many of the observations associated with sudden acceleration by reading the papers in Table 2. This theory is not ruled out by the NASA study or by any of the Toyota/Exponent reports. It has not been tested yet.

Table 2. Documents describing the negative voltage spike theory

	Title	Author	Source
1	An Electronic Cause for Sudden Unintended Acceleration	R. Belt	http://www.antony-anderson.com/Cruise/belt-hypo/main.pdf
2	A Detailed Electronic Mechanism for Sudden Unintended Acceleration	R. Belt	http://www.antony-anderson.com/Cruise/belt-hypo/A%20Detailed%20Electronic%20Mechanism%20for%20Sudden%20Unintended%20Acceleration.pdf

V. Conclusion

Videos of real incidents show that automobile engines can erupt into a nearly full throttle mode without any input from the accelerator pedal, either by the driver, a floor mat, or a sticking accelerator pedal. The reader can see and hear a taxi cab engine go to full throttle while the driver's feet remain outside the vehicle. The reader can hear the engines of three other vehicles roaring at nearly full throttle after a sudden acceleration incident has occurred while seeing that nothing is touching the accelerator pedal. The reader can hear the engines of three other vehicles erupt at nearly full throttle while watching the start of new sudden acceleration incidents. If these videos seem to contradict the reader's intuition, explanations are provided for how such incidents can occur so the reader can improve his intuition. For automobiles with a mechanical throttle, the reader can hear Stone Philips explain on a 2009 Dateline NBC show how a defect in the cruise control module can cause the engine to suddenly rev up and produce a sudden acceleration. He can then see how the defect is created and how it can make the accelerator move up and down without an input from the driver. For automobiles with electronic throttles, in which the cause of sudden acceleration is not yet proven, the reader can read about two competing theories of sudden acceleration, both of which are able to produce high engine revs suddenly without an input from the accelerator pedal. After viewing these videos and reading these explanations, the reader will understand what a driver faces when undergoing a sudden acceleration and when trying to explain it to someone later. And he will understand that it is possible for it to happen to himself.

VI Acknowledgments

The author would like to thank Randy Whitfield of the Quality Control Systems Corporation for the idea of using internet videos as a means of showing the true nature of sudden acceleration.

0:02 Waiting in taxi line. Driver is boored.

1:42 Taking a smoke break while engine idles normally.

2:07 Taxi ahead moved. Gets back in cab to move it up in line. Feet are still outside the vehicle.

2:08 Releases hand brake to move up in line while feet are still outside the vehicle. Hears engine immediately rev to WOT. Passenger in another taxi also hears engine rev up.

2:09 With engine revving at WOT taxi surges forward.

2:15 Taxi runs into pillar as WOT revs continue to be heard.

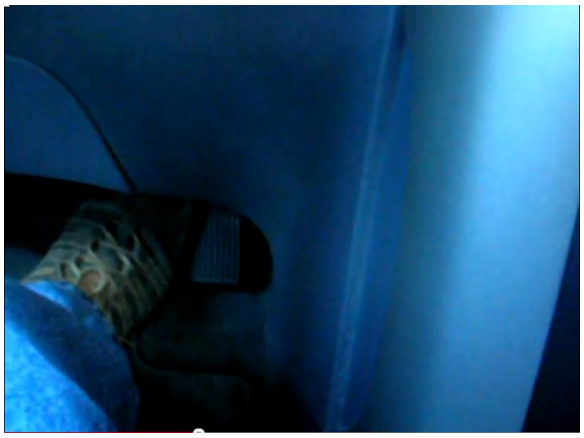
2:16 Driver shifts into neutral?

2:19 Driver does something and engine revving starts to decrease.

2:37 Bystander shuts off ignition after engine is running at normal idle

2:52 Shocked driver thanks bystander afterward. His feet are still outside the vehicle.

0:01 High revs continue to be heard in PARK after beginning randomly while in DRIVE.



0:17 Driver shows that foot is on the brake and not on accelerator while high revving continues to be heard.

0:21 to 0:30 Revs at 5000 RPM continue to be heard.

0:31 High revs cease when ignition is turned off.

0:41 to 0:48 Normal idle operation occurs when the ignition is turned back on.

0:04 High revs continue after starting in DRIVE. "P" on right shows transmission is in PARK.

0:15 Gearshift is in PARK while high revving continues to be heard.

0:18 No foot on accelerator as high revs continue to be heard.

0:19-0:26 High revving continues to be heard as the driver talks to an observer.

0:34-0:37 High revving continues to be heard.

0:40 High revving continues to be heard as gearshift remains in PARK. An accessory is seen plugged into the cigarette lighter.

0:42 Engine restarted after just undergoing a sudden acceleration followed by putting the vehicle in PARK. Engine roars back into high revs again.

0:54 Tach shows 3800 RPM with no pedal input.

1:01Engine is restarted and immediately goes to high revs again.

1:13 Shows engine revving at 3800 RPM with no accelerator pedal input.

0:51 Engine continues to roar at high RPM after driver has exited the vehicle while leaving it in PARK.

0:59 The engine shuts off after hitting the rev limit at 4000 RPM.

1:05 Tach oscillates between 3500 and 3900 RPM with no accelerator input.

1:29 Engine is shut off manually while at 3800 RPM.