Virginia Commonwealth University
Transportation Safety Training Center
Crash Investigation Team

Special Report 21 – June, 2011

ABSTRACT

This Special Report is a ten year follow-up to *Special Report Number 14*, which was published in 2001 and focused on young drivers. Since the provisional licensing laws were enacted in mid-2001, the number and rate of teen driver crashes has substantially declined. Continued research on adolescent development and teen driver actions has provided insight into possible mechanisms influencing poor judgment and risky behavior, and some programs have been developed to improve parental involvement in young driver education. However, teen drivers still have higher crash rates than the rest of the driving population.

In addition to assessing statistical trends and summarizing the characteristics of fatal teen driver crashes, this Special Report examines four specific events that occurred over a 30 hour period in 2010. Each involved vehicles running off the road and striking fixed objects, resulting in the deaths of two drivers and two teen passengers. Alcohol, time of day, speed, passengers, and high risk behaviors are discussed as underlying factors.

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INTRODUCTION

In a 30 hour period of time during the first warm weekend in late winter, four teen drivers were involved in fatal single vehicle crashes. Members of the Virginia Multi-disciplinary Crash Investigation Team (VMCIT) reconstructed these crashes in an effort to better understand the underlying causes and to identify areas where additional efforts could be focused to reduce the number and severity of teen driver crashes. In two of these cases, the driver died and in a third, the driver sustained life-threatening and permanent debilitating injuries and the passenger died. In the fourth, the driver suffered only minor physical injuries, but he was convicted of involuntary manslaughter in the death of his passenger.

In 2001, the Virginia General Assembly passed provisional licensing laws to address the rising numbers of teen fatalities in motor vehicle crashes. Since then, the general trend has been a reduction in deaths. After the peak in fatal crashes in 2000, the number of teen drivers involved in fatal crashes has shown a generally decreasing trend.

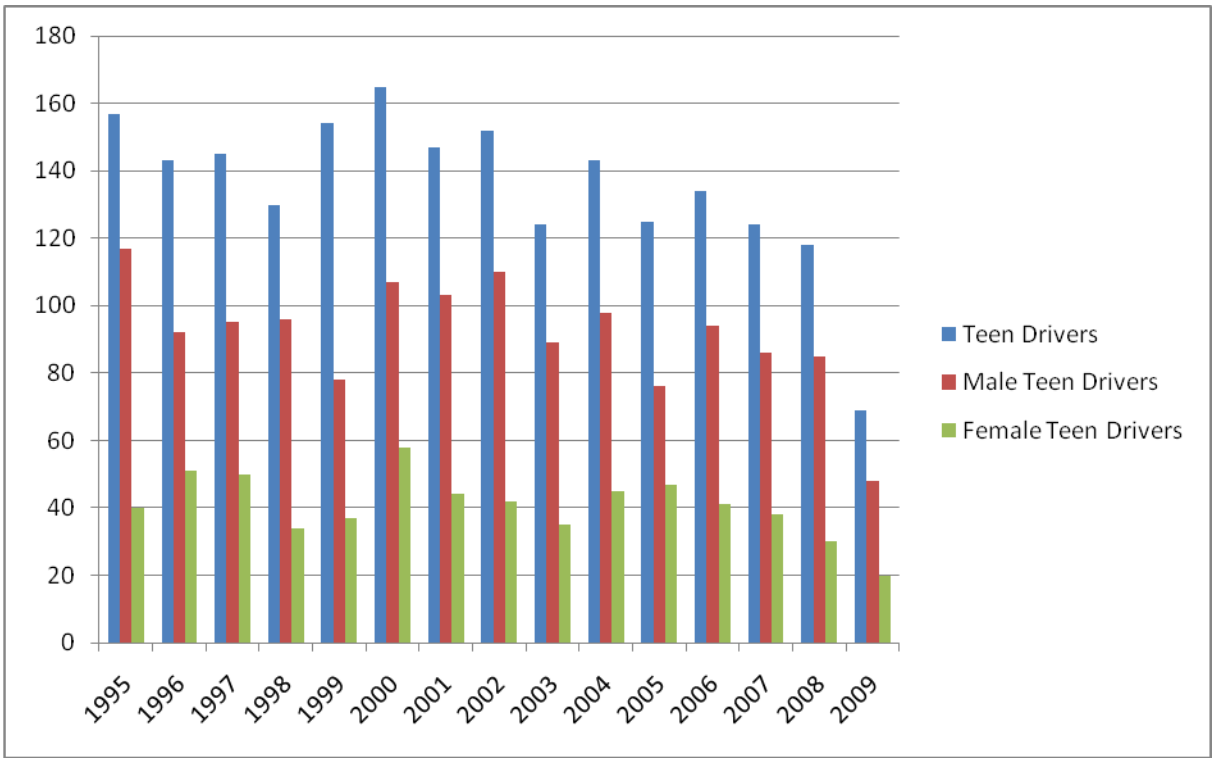


Figure 1: Teen Drivers Involved in Virginia Fatal Crashes by Year and Gender (Virginia Department of Motor Vehicles)

Many factors are likely to have contributed to this decline, including those that followed from the passage and implementation of the provisional licensing law on July 1, 2001. Because the law increased the earliest age at which teens were eligible for licensure and also required a longer period for holding a learner's permit, the number of teen drivers who received licenses dropped significantly (see Figure 2). Although number of licensees began to rise again in 2004, there are significantly fewer teens on the road, compared to ten years ago. The totals for licensed teen drivers decreased again from 2008 to 2009, possibly a result of the economic downturn.

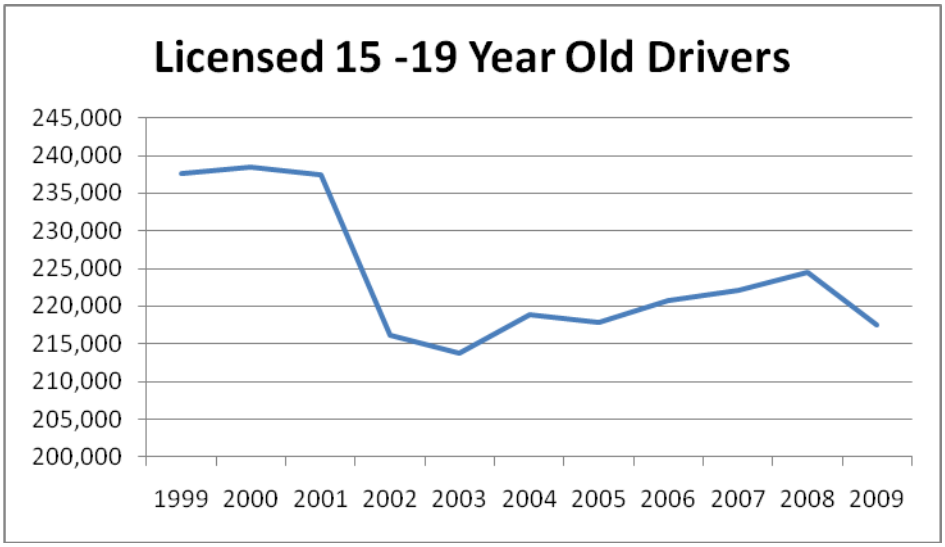


Figure 2: Number of Virginia Licensed Teen Drivers by Year (Virginia Department of Motor Vehicles)

In addition to the numbers of licensed teen drivers decreasing, the fatal crash rate for licensed teens also began generally trending downward, with the steepest decline from 2008 to 2009 (see Figure 3). Again, the economy is likely to have played a role and teens may have had fewer financial resources to support their driving. Despite their lower crash rates, teen drivers are still more likely than drivers of other ages to be involved in fatal crashes. For 2009, the fatal crash rate per 1000 teen drivers was .317 (3 of every 10,000 drivers); for drivers of all other ages combined, the fatal crash rate per 1000 drivers was .177 (Virginia Department of Motor Vehicles, 2009).

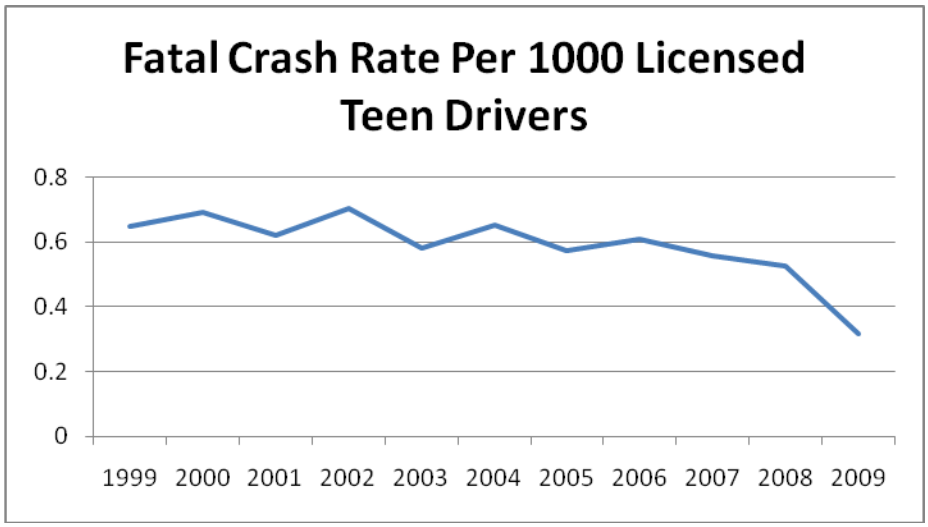


Figure 3: Virginia Fatal Crash Rates for 15 -19-year-old Drivers by Year (Virginia Department of Motor Vehicles)

The latter part of this Special Report provides a summary analysis of all teen driver fatal crashes reported for the year July 1, 2009 through June 30, 2010. Younger drivers are still a high risk group, and behaviors such as speeding and driving while distracted continue to play a role in crash causation. Ongoing research on neurological development in adolescents has revealed that there are some biological influences that may heighten their sensitivity to situational and social cues and affect their willingness to take risks. The case studies that follow are a reminder that teen drivers remain a high risk group with unique characteristics. Combining knowledge from in-depth crash reconstruction, statistical reviews of the over-arching data, developmental research on adolescents and new approaches to driver education may provide insight to improving the safety for our youngest drivers.

CASE STUDY NUMBER 1

Type of Crash: Single vehicle run off road, fixed object collision

Day, Time, Season: Saturday, 12:05 a.m., late winter

Road/Weather: Secondary road; dry and clear

Vehicles Involved: 1994 Honda Civic two door sedan

Occupants: 17-year-old male driver

Severity: One fatality; extensive property damage

SUMMARY:

Just after midnight on a clear, dry Saturday, a 17-year-old male was driving a 1994 Honda Civic. He had been socializing earlier in the evening with friends who lived in a nearby town. He and a teenaged male friend left the group and the Honda driver drove to a drug store parking lot so his friend could pick up his parked vehicle. The Honda driver then began following the friend to his residence, where he planned to spend the night. They had travelled just over 11 miles from the drug store and were about five miles from their destination when the crash occurred.

The two vehicles were travelling on a two lane secondary road through a residential/partly rural area. The road is asphalt and was in fair condition when examined by members of the VMCIT. Some of the pavement was cracking and some of the pavement edges were crumbling. The road is level and on a slight "S" curve. The width of the pavement is approximately 21 feet 2 inches, with grass shoulders. It is approximately 4 feet 8 inches from the edge of pavement to the ditch on the southbound lane and approximately 3 feet from the edge of pavement to the ditch northbound lane. The road is controlled by signs and pavement markings. The signs were in good condition; however, the pavement markings, double yellow center lines, were in poor condition. There is no overhead lighting and the speed limit is 45 MPH. The average daily traffic is 1500 vehicles for this section of road (VDOT, 2009b).

Based on the statement of the driver of the lead vehicle, both cars were exceeding the speed limit, travelling at an estimated 65 MPH. He indicated that they had approached the curve "a little fast" and that the Honda moved to pass his car on the left. The Honda driver began to lose control while passing his friend, which is evident by two short scuff marks located in the northbound lane. These marks were created by friction from tires that were both rotating and slipping on the road surface. Although the Honda driver began to regain control, the vehicle ran off the left side of the roadway. It travelled approximately 69 feet before the left front impacted a fence post at the end of a chain link fence. The Honda continued forward 36 feet, crossing a driveway, and struck a tree that was 12 inches in diameter in a small overlap frontal configuration with the left side of the vehicle. The vehicle rotated nearly 180 degrees counter-clockwise and came to rest 18 feet from the tree.

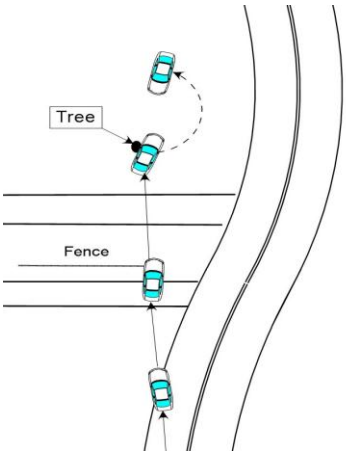


Figure 4

Photo #1: Crash scene looking south.

The Honda was severely damaged as a result of the crash. The contact damage area measured 124 inches (10.33 feet) along the car's left side, beginning at the left front marker light and continuing toward the back. The front tire was sheared off. At the "A" pillar, the severe contact damage from the impact with the tree pushed inward into the passenger compartment. The lower left "A" pillar was destroyed and the driver's door was sheared off. The dashboard was pushed away from the driver, to the right, as the tree intruded into the passenger compartment. The driver's seat rotated slightly counter-

clockwise and the tree pushed the seat bottom inward. Three measurements of the seat bottom were taken, assessing the depth from the front edge of the seat to the bight (the area where the back of the bottom seat cushion meets the bottom of the back seat cushion): right—16 inches; middle—9 inches; and left—12 inches. Photographic evidence also showed the seat back was pushed back and to the right, resting against the rear seat bottom. The crush to the driver's compartment was measured from the "B" pillar to the front wheel well. The most significant crush area began 30 inches from the "B" pillar and continued for 42 inches. The maximum crush depth measured 18.5 inches.

Photo #2: Honda damage.

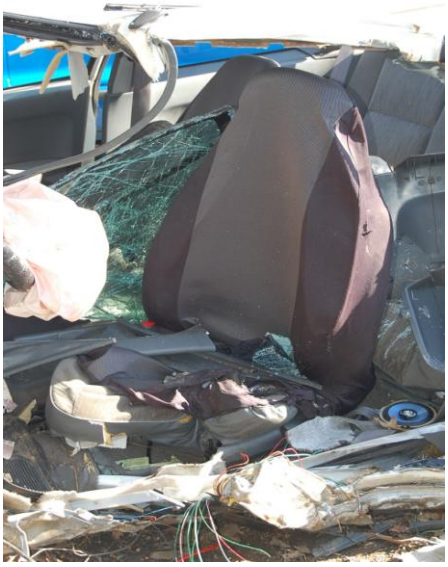


Photo #3: Honda driver seat.

VMCIT members obtained post crash measurements of the vehicle to compare with manufacturer vehicle specifications.

Table 1: Comparison of Honda Data

1994 Honda	Overall Length	Overall Width	Wheel Base
Vehicle Specifications	14.4 Feet	5.58 Feet	8.6 Feet
Post Crash Measurements	14.58 Feet (Left) 13.75 Feet (Right)	5 Feet (Front) Not Measured (Rear)	7.5 Feet (Left) 8.45 Feet (Right)

The Honda driver was wearing his lap/shoulder belt and both driver and passenger airbags deployed during the crash sequence. Given the Honda's speed and angle, it struck the fence and then the tree. The vehicle began crumpling, sliding and rotating. The driver, who weighed 260 pounds, continued to move in the direction of the second impact: forward and slightly to his left, where the tree was intruding into his occupant space. The weave of the seat belt showed visible evidence of friction damage (due to stress/loading) at in an area consistent with a sliding latch that was inserted in the buckle. The belt was extended and also showed evidence of stretching just above the area where it was anchored near the base of the driver's seat. The edge of the belt had frayed significantly at that juncture, in the area where the label had been sewn into the belt; only a few threads held it in place.

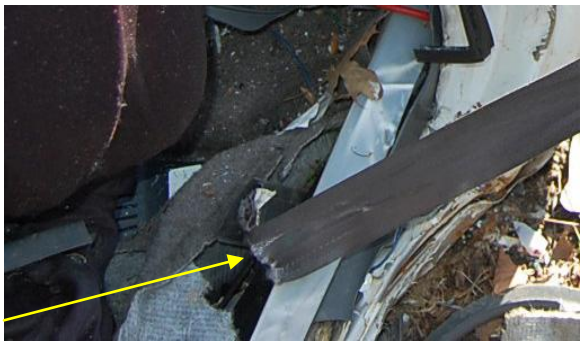


Photo #4: Damage to seatbelt.

Despite the seatbelt and airbags, the dynamics of the crash and the forces involved resulted in fatal injuries. The driver suffered extreme blunt force trauma to his chest, most likely as a result of rapid deceleration in the second collision (with the tree). According to the Medical Examiner's Report, he had "red, abraded contusions" over the sternum area of his chest and, although his ribs remained intact, he had a laceration of the thoracic aorta. This laceration occurred as his heart continued to move forward within the thoracic cavity during impact, placing stress on the aorta. It ruptured along a portion of the aorta between the branching of the left subclavian artery and the first intercostal artery, close to the aortic arch and the heart muscle itself. He quickly bled internally and died at the scene.

In addition to the chest trauma, he suffered fractures to the both the right humerus and left humerus (bones in the upper arms) and the right femur (thigh bone). These fractures were all comminuted, meaning that the bone had more than one fracture line and had broken into more than two segments. These fractures are consistent with extreme force compressing the bones and causing them to shatter in one section along the

length. With respect to the crash dynamics, and based on consultation with an Assistant Chief Medical Examiner, the arm injuries were likely to have occurred after the airbag had deployed and deflated (most likely after the first impact, with the fence post). The driver probably raised his arms in front of his face and chest, automatically assuming a defensive posture as the car continued toward the tree. Upon impact, his body continued forward as the car collapsed and the occupant area was compromised. The seat belt kept his torso in place, but it would have stretched some, allowing his elbows to come into contact with the steering wheel. This would have resulted in the energy forces being transferred to the both arms, leading to the fractures. At the same time, the floor pan was being pushed against his right foot, pushing the extended leg back into the hip socket. His femur fractured at the midshaft of the bone.

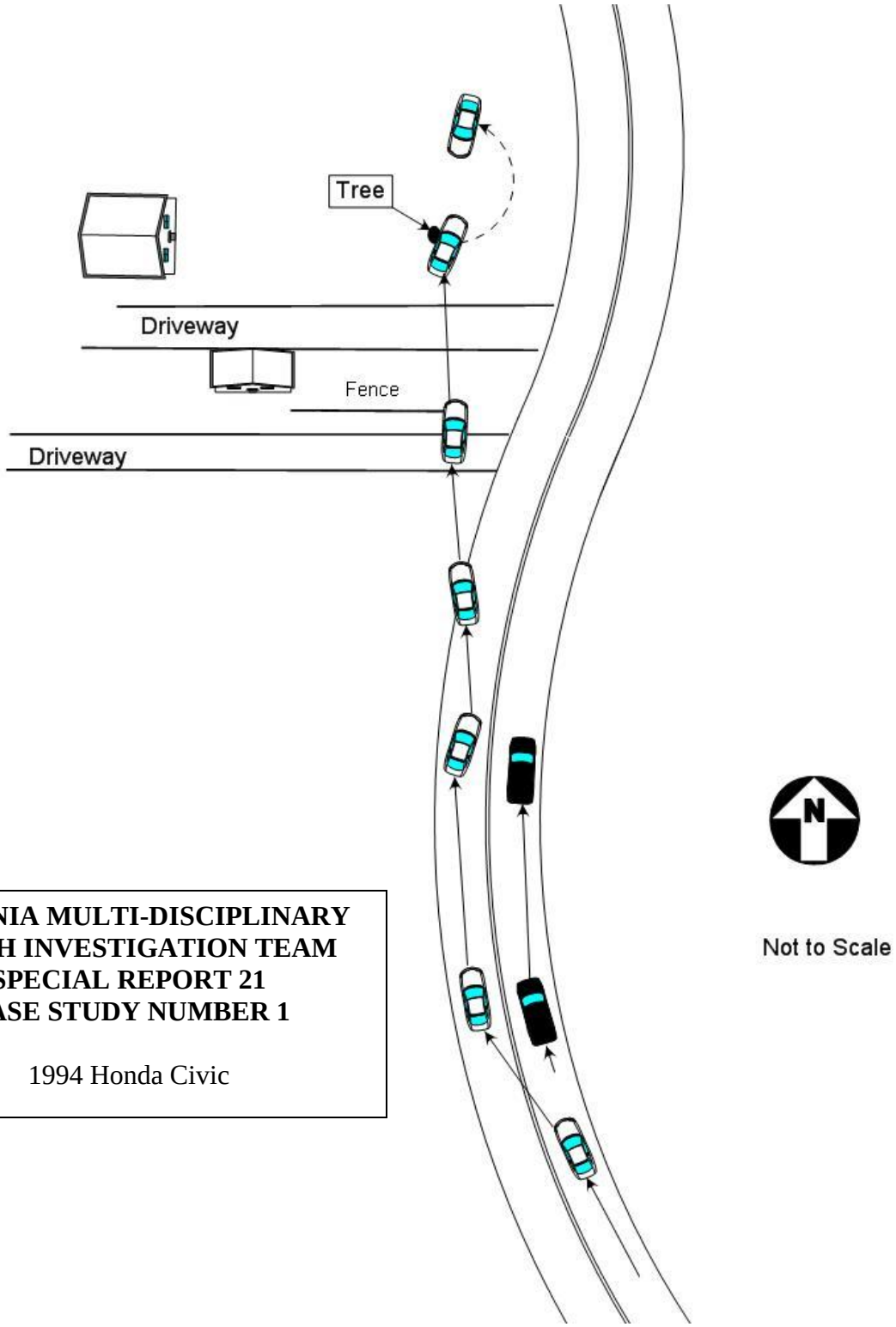
The driver had been licensed to drive in Virginia for two years and four months. He had received a learner's permit at the age of fifteen years and ten months, and then he received a provisional license ten months later. He was a month away from his 18th birthday when the crash occurred, so he was in violation of the curfew restrictions for teen drivers. Those under age 18 are restricted from driving between midnight and 4:00 a.m., except under certain conditions. His driving record did not show any violations or convictions and he had a driver point balance of +1. According to the FR300P report, he was not impaired at the time of the crash. Toxicological analysis of his blood (drawn from the femoral artery) showed no evidence of alcohol or drugs.

The driver was familiar with the vehicle he drove and with the area. His familiarity with the road, combined with the fact that the two were driving just past their curfew times may have influenced their decision to speed. The Honda driver's pre-crash behaviors—speeding and then passing another vehicle on a narrow, curving road with double solid yellow lines—are risky behaviors which are not unusual in young, inexperienced, and impulsive drivers.

The other teen driver observed his friend's crash. He braked when the Honda appeared to be out of control and saw the vehicle run off the road and strike the fence and tree. The other driver continued further up the road until he found a place to turn around, returning to the scene. The Honda came to final rest in the front yard of a private residence and the friend yelled for help. An unidentified individual called authorities to

notify them of the crash and summon emergency assistance. A local rescue squad unit arrived first and checked the driver, determining that he was deceased. When the investigating Trooper arrived at the scene, she was informed of the situation and contacted a Medical Examiner, as well as a member of the State Police Divisional Reconstruction Team. The driver's body was transported to a local medical facility, and then sent to the District Office of the Chief Medical Examiner for examination. Traffic was light in the area and the roadway was not obstructed, so law enforcement officers did not have to close the road. A tow truck removed the vehicle and the scene was cleared about 7 ½ hours after the crash occurred.

Photo #5: Crash scene looking north.



VIRGINIA MULTI-DISCIPLINARY CRASH INVESTIGATION TEAM SPECIAL REPORT 21 CASE STUDY NUMBER 1

1994 Honda Civic

CASE STUDY NUMBER 2

Type of Crash: Single vehicle run off road, fixed object collision

Day, Time, Season: Saturday, 11:38 p.m., late winter

Road/Weather: Secondary road; dry and clear

Vehicles Involved: 2005 Pontiac G-6 four door sedan

Occupants: 17-year-old female driver

Severity: One fatality; extensive property damage

SUMMARY:

Shortly before midnight on a clear and dry Saturday night, a 17-year-old female was driving her aunt's silver 2005 Pontiac G-6 four door sedan on a rural, two lane secondary road. The young woman, who was alone, was not wearing her lap/shoulder belt. She had been at a party, where she was reported to have consumed alcoholic beverages, although the extent of her drinking was unclear. She left the party to go pick up her aunt at a parking lot but she was reported to have been late for the rendezvous. She had driven about 3 miles toward her destination and had about 1-1/2 miles left in the trip when the crash occurred.

The road is a two lane north-south secondary route located in a rural area. The road is asphalt and was in good condition when examined by members of the VMCIT. The width of the pavement is approximately 15 feet 2 inches and grass shoulders border both edges. A ditch runs parallel to the southbound lane, approximately 7 feet from the edge of pavement. On the northbound side, another ditch lies parallel to the road, approximately 7 feet 2 inches from the edge of pavement. That ditch was filled with water and had a 2 foot drop off into "muck." The road is straight and level, with a slight superelevation. The road is controlled by signs which were in good condition. There are no pavement markings or overhead lighting. The speed limit is 55 MPH. The average daily traffic is 330 vehicles for this section of road (VDOT, 2009a).

The Pontiac entered the curve at a high rate of speed and began to run off the road to the right. The driver then began steering to the left in an attempt to regain control. As the Pontiac came back onto the roadway, the vehicle began to rotate counter-clockwise, a result of speed and over-steering. The vehicle crossed the roadway, running off to the left before striking a large tree, approximately 7 feet from the edge of the roadway. It then rebounded clockwise and struck a smaller tree. The car had travelled approximately 224 feet from first running off the roadway to impacting the tree. The driver was ejected.

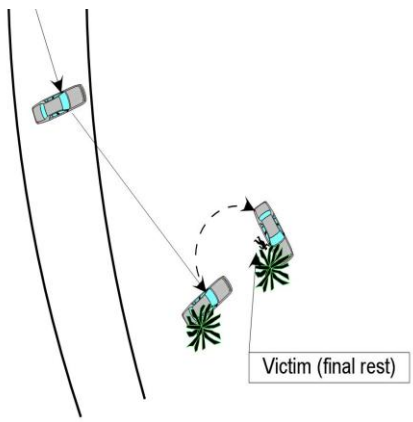


Figure 5

Photo #6: Pontiac at final rest.

Five seconds prior to the algorithm enable (AE) on the airbag control module, the event data recorder showed the Pontiac travelling at 91 MPH with the steering wheel turned slightly to the left.

Table 2: Data Imaged from the Pontiac's Event Data Recorder

Time (in seconds)	Speed (MPH)	Velocity (FPS)	Steering (16 degree increments)	Throttle	Braking
-5	91 MPH	133.4 FPS	Left 16	70%	No
-4	88 MPH	129.0 FPS	Left 64	42%	No
-3	85 MPH	124.6 FPS	Right 32	0%	No
-2	74 MPH	108.4 FPS	Left 96	0%	Yes
-1	47 MPH	68.9 FPS	Right 80	0%	Yes

The vehicle in this crash was severely damaged as a result of striking the trees. It first struck a large tree with the right rear, in line with the axle. This impact pushed the axle outward approximately 16 inches. The trunk and right "C" pillar were crushed inward toward the back seat of the vehicle. The back seat was pushed forward and to the left into the rear of the front right seatback. The right rear and left front windows were broken out during the crash. After impacting the tree, the vehicle rotated clockwise and struck several smaller trees. It sustained damage from the front right corner to the "A" pillar; this damage was a result of impacting one of the smaller trees and was below the windshield line. The driver's compartment was largely undamaged in the crash.

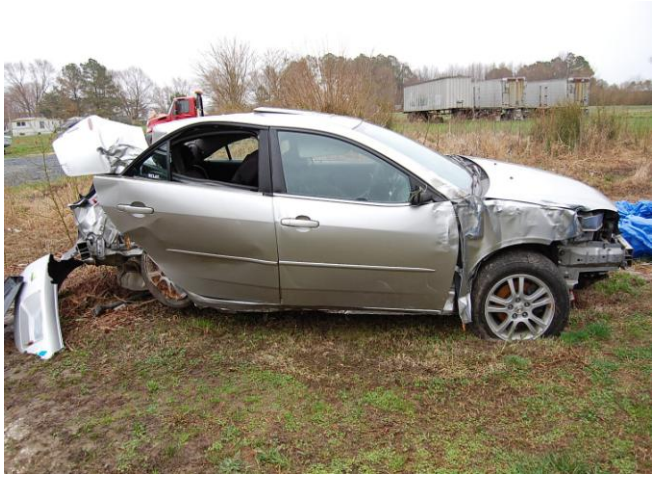


Photo #7: Pontiac post crash damage.

Photo#8: Driver's compartment.

VMCIT members obtained post crash measurements of the vehicle to compare with manufacturer vehicle specifications.

Table 3: Comparison of Pontiac Data

2005 Pontiac	Overall Length	Overall Width	Wheel Base
Vehicle Specifications	15.75 Feet	5.87 Feet	9.53 Feet
Post Crash Measurements	13 Feet (Right) 14.83 Feet (Left)	5 Feet (Front) 4.58 Feet (Rear)	8.5 Feet (Right) 9.1 Feet (Left)

For this young woman, at least three factors likely played a role in her actions: (1) she was inexperienced, (2) she was under the influence of alcohol and (3) risky behaviors were sanctioned by an adult relative.

She had received her learner's permit only eight days prior to the crash. With the permit, she was authorized to drive only if accompanied by a licensed driver 21 years or older (18 years or older if a qualifying family member) and she was subject to the same restrictions as a provisionally licensed driver under age 18. This included limitations on the number of passengers she could carry, a restriction on cell phone use, as well as the teen driving curfew between midnight and 4:00 a.m. Her illegal solo driving was sanctioned by her aunt, who had driven her to the party and left her with the vehicle. After giving the teen her car keys and directing the teen to drive to a meeting point later in the evening, the aunt departed with another person. This adult relative was aware that alcohol was being consumed at the party and had both beer and liquor in the trunk of the Pontiac as well.

The 17-year-old consumed alcoholic beverages with other underage drinkers during the course of the party. Teen acceptance of drinking is a cultural issue that poses many challenges for parents, educators, as well as those in the medical and public safety fields. The amount of alcohol this young woman consumed and the specific duration of her visit are not known. Toxicological analyses conducted on a blood sample taken by the Medical Examiner showed that her BAC was .10%, above the legal limit for conviction of driving under the influence in Virginia. It should be noted, however, that the Medical Examiner did not specify how the sample was extracted and a vitreous humor sample was not taken to validate the findings. It is possible that the sample was contaminated by other bodily fluids, such as contents of a ruptured stomach. For this reason, while the evidence is certain that she did illegally consume alcohol, the specific BAC may not be precise (see *VMCIT Report Number 204*). In addition, no tests were conducted for the presence of other drugs. Consequently, it is difficult to ascertain her level of impairment and how much her judgment may have been affected.

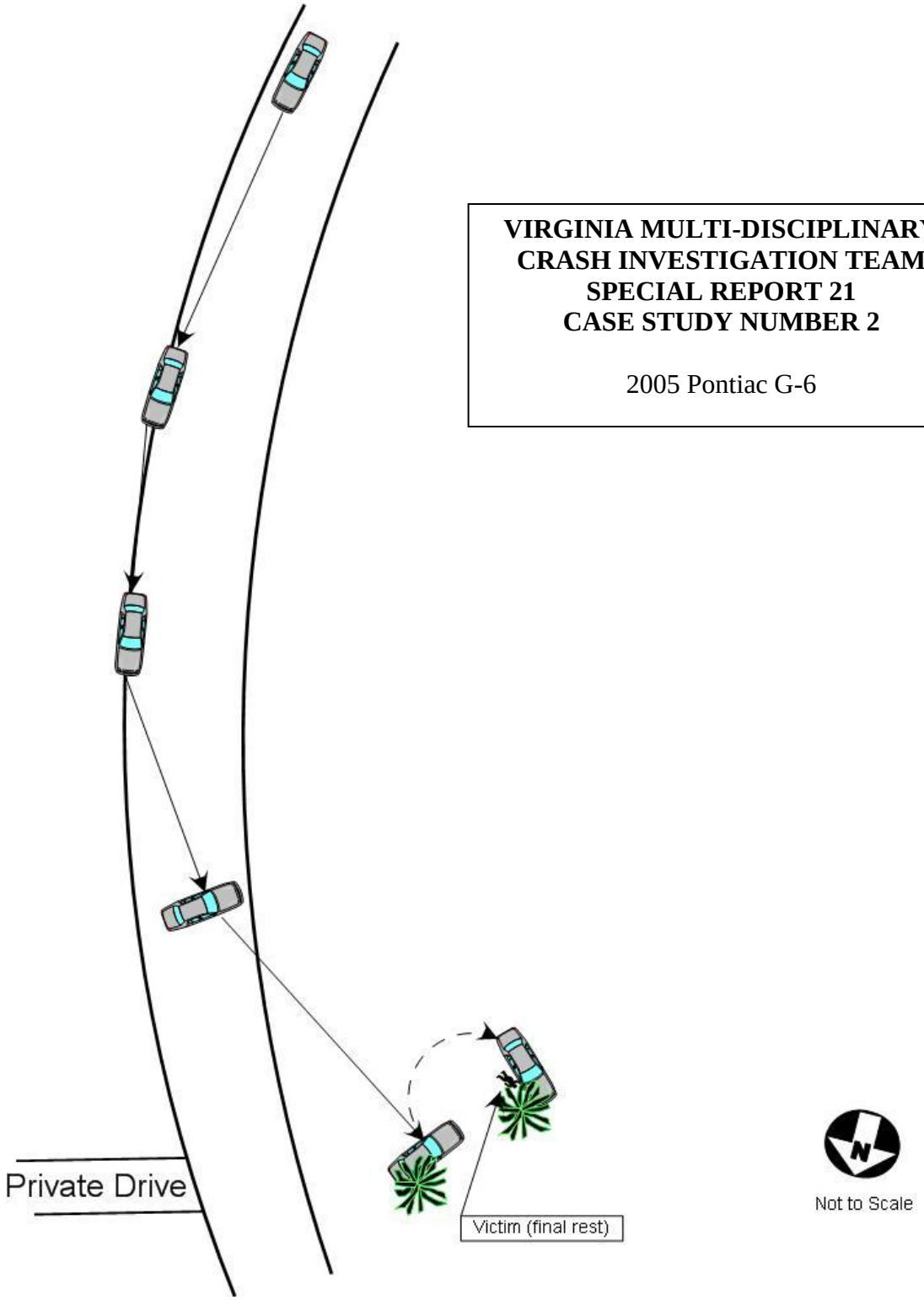
Comments made later by her aunt indicate that the driver was a few minutes late for their appointed meeting, and this may have contributed to her excessive speed on the narrow and curving stretch of roadway. It is unlikely that she had much—if any—

experience driving the vehicle on this road or during dark conditions. The combination of inexperience and willingness to take high risk, augmented by alcohol, led to a series of poor driving decisions that resulted in the crash. Based on Event Data Recorder information imaged from the vehicle, after she negotiated the curve and entered the long straight stretch, the driver was travelling at 91 miles per hour. As the woods gave way to an open field on her right, she may have been aware of the swampy ditch bordering the shoulder. She had the steering wheel turned slightly to the left but had already drifted off the right side of the roadway. When she intensified the steering input at that high speed, the car began to sideslip and headed toward the wooded area to her left. In reaction, the driver turned the wheel sharply to the right. However, by that time, the car was already rotating and slipping and the input had no effect. Only then did the driver switch from the gas pedal to the brake. She turned the wheel sharply right, then reversed steering direction again and spun the wheel to the left almost 180 degrees. A second later, the car impacted the tree.

Like many teen drivers, she was not wearing her lap/shoulder belt. The forces of the crash caused her to be thrown toward the right rear of the occupant space and she was ejected through the right rear window. Evidence on the vehicle (blood spatter and smears) and her injuries indicate that she may have been partially ejected initially and then fell beside the right front corner of the car when it struck the second set of trees and came to final rest. The Medical Examiner's report shows that she had abrasions to both the front and back of her torso, but a skull fracture to the right side of her head was considered the fatal injury. The location of the fracture is consistent with her orientation and direction of movement during the rear end collision with the first tree.

If she had been restrained, this young woman would not have been ejected. Although her occupant space was not compromised, she may still have suffered serious internal injuries from the excessive forces involved. However, her position as driver put her at the furthest distance from the point of impact, so the vehicle itself may have absorbed some of the deceleration energy as her entire seat continued in the direction of the force. Her seat back also would have provided some cushioning and protection, and the head rest, depending on its proximity to her head, may have helped prevent closed head (brain) injury. In the past, members of the VMCIT have investigated crashes with

similar characteristics: high speed, rotation and rear end impacts. Some individuals in the front and rear seats have died while occupants furthest from the point of impact in the same crash survived. Based on the crash dynamics and the energy forces involved, and after discussing this case with an Assistant Chief Medical Examiner, members of the VMCIT have concluded that it is possible that this young woman could have survived if she had been belted.



VIRGINIA MULTI-DISCIPLINARY CRASH INVESTIGATION TEAM SPECIAL REPORT 21 CASE STUDY NUMBER 2

2005 Pontiac G-6

CASE STUDY NUMBER 3

Type of Crash: Single vehicle run off road, fixed object collision

Day, Time, Season: Sunday, 12:04 a.m., late winter

Road/Weather: Urban "T" intersection; dry and clear

Vehicles Involved: 1999 Oldsmobile Alero four door sedan

Occupants: 16-year-old male driver, 16-year-old male passenger

Severity: One fatality (passenger); extensive property damage

SUMMARY:

Just after midnight on clear morning in late winter, a sixteen year old male was driving a silver 1999 Oldsmobile Alero four door sedan. He wore his lap/shoulder belt and was accompanied in the front passenger seat by another 16-year-old male who was unrestrained. The two young men were riding around the neighborhood where the passenger resided and were travelling north on a two lane residential road that ended at a "T" intersection.

Earlier in the evening, the driver and his passenger had been driving around the area and stopping by various homes to socialize with friends. They had originally been accompanied by a third male teenager, but his father had called and they had taken him home as instructed. At one point, the two had been at the passenger's house, where they had been drinking rum shots. They had also gone to a nearby convenience store where they purchased "Four Loko," a caffeinated "energy" drink that contains about 12% alcohol (see *VMCIT Report Number 211*). (The clerk at the store sold them the beverage illegally and was later convicted of selling alcohol to an underage person.) By midnight, both young men were impaired by their alcohol intake. The driver's BAC level was .17%, more than twice the legal limit for adults, and his passenger had a BAC of .16%.

The driver did not have any other defects. His driving record with the Department of Motor Vehicles (DMV) showed that he received a learner's permit when he was 15 years and 8 months old. He was issued a provisional license ten months later,

which he held for less than six months before this crash. No violations or convictions were recorded. With the provisional license at age 16, he was allowed to have one passenger in the vehicle, but he was restricted from driving between midnight and 4:00 a.m. He was in violation of this restriction at the time of the crash.

The street is two lanes and located in a residential area. The pavement is asphalt and was in good condition when examined by members of the VMCIT. It is straight and level. The width is approximately 20 feet 10 inches. There are no shoulders. The street is controlled by signs and pavement markings. The signs were in good condition and the pavement markings, double yellow center lines, were in poor condition, and especially the stop line. There is one overhead light located near the intersection. The speed limit is 25 MPH.

In response to a civic league meeting, the city conducted a speed study on this street. The study was performed over a seven day period. The results of the study indicated the 85th percentile speed of 34 MPH for the northbound lane and 35 MPH for the southbound lane. The city installed two additional 25 MPH signs on this street and placed a speed trailer on the street for a two week period to help educate local drivers about speeding issues. In addition, the city traffic engineering division requested the police department to perform selective enforcement on this street. Other than this fatal crash, a city traffic engineer stated that there had been no reported crashes at this intersection for the past four years.

The Oldsmobile was travelling north approaching a "T" intersection that is controlled by a stop sign. It approached the intersection at a high rate of speed, and continued straight with no evidence of braking. The vehicle passed the stop sign and line, then travelled 32 feet 8 inches to the edge of the pavement, across a small ditch and struck a wooden fence. The vehicle continued forward another 20 feet 2 inches, where the front left of the Oldsmobile impacted a large tree.

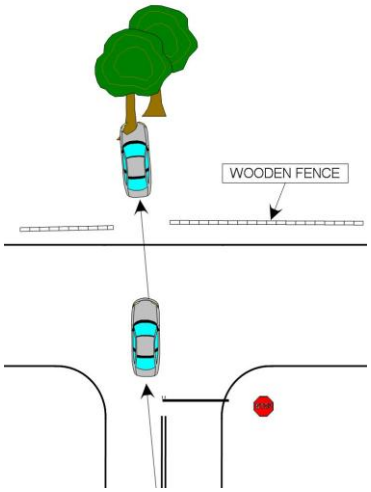


Figure 6

Most of the damage occurred to the vehicle's left front. The major intrusion began at the front left tire, pushing the hood upward and intruding rearward into the engine compartment, exposing the strut assembly. There was induced damage along the left side of the vehicle, pushing the driver's door back slightly. Although the passenger compartment was not severely damaged, both air bags did deploy. The center console sustained induced damage, as did the bottom of the steering column.

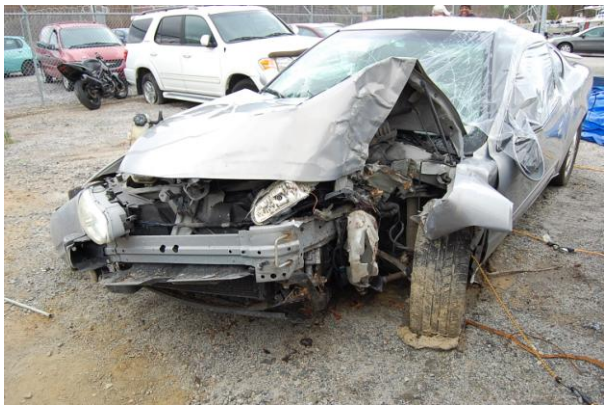


Photo #9: Front view of Oldsmobile showing collision damage from impact with the tree.

Photo #10: Interior view of vehicle.

VMCIT members obtained post crash measurements of the vehicle to compare with the manufacturer's vehicle specifications.

Table 4: Comparison of Oldsmobile Data

1999 Oldsmobile	Overall Length	Overall Width	Wheel Base
Vehicle Specifications	15.55 Feet	5.84 Feet	8.92 Feet
Post Crash Measurements	13.75 Feet (Left) 14.91 Feet (Right)	5.2 Feet (Front) 4.91 Feet (Rear)	8.12 Feet (Left) 9.1 Feet (Right)

During impact with the tree, the unrestrained passenger was thrown forward and to his left, striking his head on the interior of the car. The Medical Examiner reported observing contusions (bruises) to the left side of his face, a large laceration at the base of his chin, abrasions to the top of his left shoulder and contusions in the center of his chest.

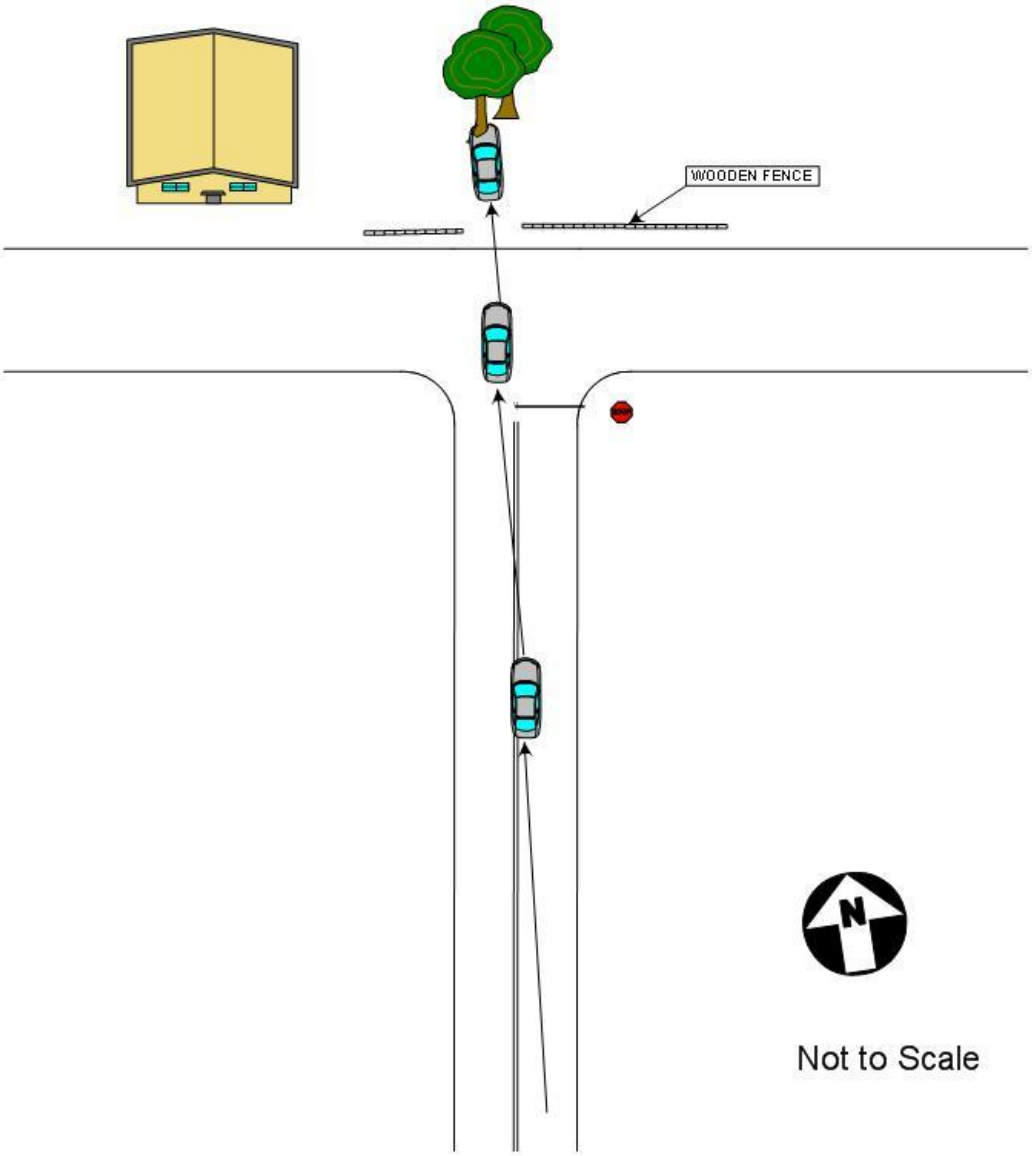
He did not indicate that the passenger suffered any fractured bones and he found no blood upon aspiration of fluid from the left and right pleural spaces (area of the lungs). This latter finding would indicate that any chest injury was not significant enough to produce bleeding into the lungs. The passenger's cervical spine was intact and there was no report of blood from the nose or ears. The Medical Examiner concluded that he died from a closed head injury, which indicates a brain injury resulting from the rapid deceleration during impact with the interior of the car. The toxicology analysis showed his BAC at .16%, but it was based on a single sample of his blood. The Medical Examiner did not record where the sample was drawn for this victim and the vitreous humor was not sampled, so there is no way to validate the results. However, without a report of crushing injuries to the chest and/or abdomen, it is more likely that the blood sample was not compromised by other internal bodily fluids.

Because he was restrained during the collision, the driver suffered only minor injuries. He was transported to a local hospital for evaluation. He had a bruised knee and some redness on his face. His BAC was determined to be approximately .17%, more than twice the legal limit for adults. After being released into police custody, he was transported to a juvenile detention center, where he remained for several months. He pleaded guilty to aggravated involuntary manslaughter and driving under the influence of alcohol, and he was sentenced to a juvenile detention center (which was suspended). He was also required to perform 500 hours of community service and to educate others about the dangers of drinking and driving.

Photo #11: Crash location approaching intersection.

VIRGINIA MULTI-DISCIPLINARY CRASH INVESTIGATION TEAM SPECIAL REPORT 21 CASE STUDY NUMBER 3

1996 Oldsmobile Alero



CASE STUDY NUMBER 4

Type of Crash: Single vehicle run off road, fixed object collision

Day, Time, Season: Sunday, 4:20 a.m., late winter

Road/Weather: Secondary road; dry and clear

Vehicles Involved: 2004 Toyota Sienna minivan

Occupants: 18-year-old male driver, 19-year-old male passenger

Severity: One fatality (passenger); extensive property damage

SUMMARY:

At about 4:20 a.m. on a dry and clear Sunday morning, an 18-year-old male was driving a 2004 Toyota Sienna minivan on a residential secondary road. He was accompanied in the front passenger seat by his 19-year-old male cousin and both wore their lap/shoulder belts. The two had been riding around the area and appeared to be headed to the driver's house a short distance away.

The road, a two lane north-south route, is asphalt and was in good condition when examined by members of the VMCIT. It is approximately 21 feet 1 inch wide. Although the road is generally curvy with hills, it is straight prior to the location of the crash. After the crest of a hill, there is an approximately 6 percent downgrade, and the slope steadily decreases over several hundred feet to near level at the crash site. There are no shoulders. Signs and pavement markings control the road: the signs were in good condition and the pavement markings, double yellow center lines, were in fair condition. There is no overhead lighting and the speed limit is 35 MPH. The average daily traffic is 2500 vehicles for this section of road (VDOT, 2009c).

The Toyota was travelling north on the two lane road at a high rate of speed. It crested a small hill and became airborne, landing approximately 66 feet north of the hillcrest. After continuing forward for about 177 feet, the driver ran off the roadway to the right and overcorrected, at which time the vehicle began to yaw. It rotated counter-clockwise, crossing the northbound and southbound lanes. The minivan then ran off the

roadway to the left, striking a large tree with the right side. The vehicle's movement was suddenly stopped by the tree, which resulted in the left side of the vehicle lifting up as first the right side and then the top of the minivan impacted the tree. After rebounding and rotating clockwise, it came to rest off the left side of the roadway, facing north. The Toyota travelled approximately 153 feet from the point where the driver ran off the road to the right to where it crossed the road and struck the tree.

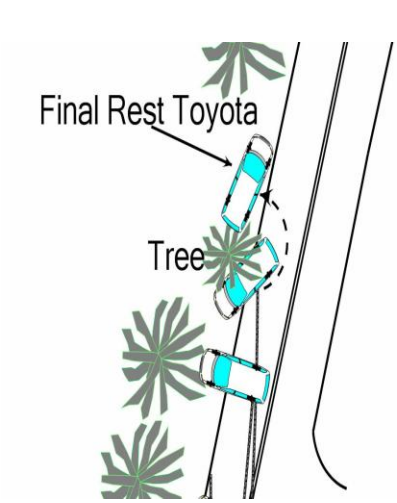


Figure 7 ***Photo #12: Toyota minivan at final rest.***

Measurements of the yaw marks taken by the investigating police department showed a speed ranging from 66 MPH to 91 MPH, using a chord of 30 feet and a middle ordinate of 0.26 and 0.14 feet.

VMCIT members examined the Toyota post crash and noted the major damage was to the right side of the minivan. The tree had intruded into the passenger compartment near the "A" pillar, pushing the roof of the vehicle upward. The intrusion measured approximately 4 feet, below where the sunroof once was, and the side curtain air bag was deployed. The front passenger door was removed by the rescue squad: however, photographic evidence shows that that the door was pushed open and down. The sliding door on the right side was pushed rearward, exposing the passenger

compartment. The crush along the right side covered a lateral area 79 inches (6.6 feet) long with a maximum crush depth of 4.8 feet.

VMCIT members obtained post crash measurements of the vehicle to compare with manufacturer's vehicle specifications.

Table 5: Comparison of Toyota Data

2004 Toyota	Overall Length	Overall Width	Wheel Base
Vehicle Specifications	16.7 Feet	6.23 Feet	9.94 Feet
Post Crash Measurements	16 Feet (Left) 14.3 Feet (Right)	5.75 Feet (Rear) None Taken (Front)	10 Feet (Left) 9.6 Feet (Right)

Photo #13: Side/front view of Toyota.

About 20 minutes prior to the crash, the driver had been stopped by a police officer for speeding. The officer had been watching for possible impaired drivers when he observed the Toyota travelling 57 MPH in a 35 MPH zone. The officer noted that the driver did not display any behavioral signs of alcohol use and he did not see any other indicators, so he cited the young man for speeding. He overheard the driver asking his

older cousin if he knew how to pay the ticket without his parents finding out and the passenger replied that he had "done it before online." After receiving the ticket, the driver departed and the officer began completing his paperwork. He was entering the summons into the county's computerized system when he received the call about the crash.

This young driver had not yet graduated from high school and lived with his parents. However, they had been out of the state for several days, visiting other family members. The parents had a good relationship with the school and had advised a guidance counselor about their travel plans, providing contact information in the event of a problem or emergency. The driver was a special education student who, according to school officials, appeared to be a generally happy individual. However, he had experienced a few personal setbacks during the previous couple of weeks. He had failed to make the cut for the school soccer team and he was failing a class required for graduation at the end of the year. In addition, his parents had refused to purchase a truck that he had wanted.

The driver had received his driver's license only six months prior to the crash, at 17 years, 9 months of age. Prior to that, he held a learner's permit for just under a year. His driving record did not show any convictions and he had a driver point balance of +1. The driver was required to wear corrective lenses, but it is unknown if he had on glasses or contact lenses at the time of the crash. According to the investigating officer's crash report, the driver did not have any defects that may have contributed to the crash and medical tests later confirmed that he was not under the influence of alcohol.

It is interesting to note that the passenger had a suspended license at the time of the crash and had a poor driving record (-12 driver point balance). Although under the 21 year age limit for drinking, toxicology tests showed that his BAC was .08%. No other samples of fluids, including vitreous humor, were submitted for toxicological testing, and no tests for other substances were conducted.

Both the driver and his passenger wore their lap/shoulder belts. However, as the Toyota began rotating counter-clockwise, they would have leaned to the right, with the lap portion of their belts restraining the lower trunk areas of their bodies. When the right side of the minivan struck the tree, the passenger's head and right side would have been

in close proximity to the area of intrusion. The passenger side curtain airbags deployed, absorbing some of the impact forces and stopped his rightward movement. The driver's upper body would have continued moving to the right, in the direction of the force. The passenger's upper body then flailed to the left in a rebound, where his head struck the driver's head, possibly for a second time.

The officer who had written the ticket 20 minutes prior was notified of the crash while he was completing his paperwork. He was a short distance away and found both occupants still inside the minivan when he arrived at the scene. The passenger was lying partially upright between the driver and passenger's seats. The driver's head rested on the passenger's chest. Both had suffered severe head trauma—the passenger died at the scene and the driver was unresponsive. Rescue and additional emergency personnel arrived within minutes. Patrol officers closed the road and detoured traffic around the area. An emergency helicopter was summoned to airlift the survivor to a trauma center. Officers were able to identify the driver and then the passenger. The investigating police department's crash reconstruction team was notified and responded to the scene. They measured and photographed the scene and roadway evidence. The minivan was towed and the roadway was re-opened approximately 4 ½ hours after the crash.

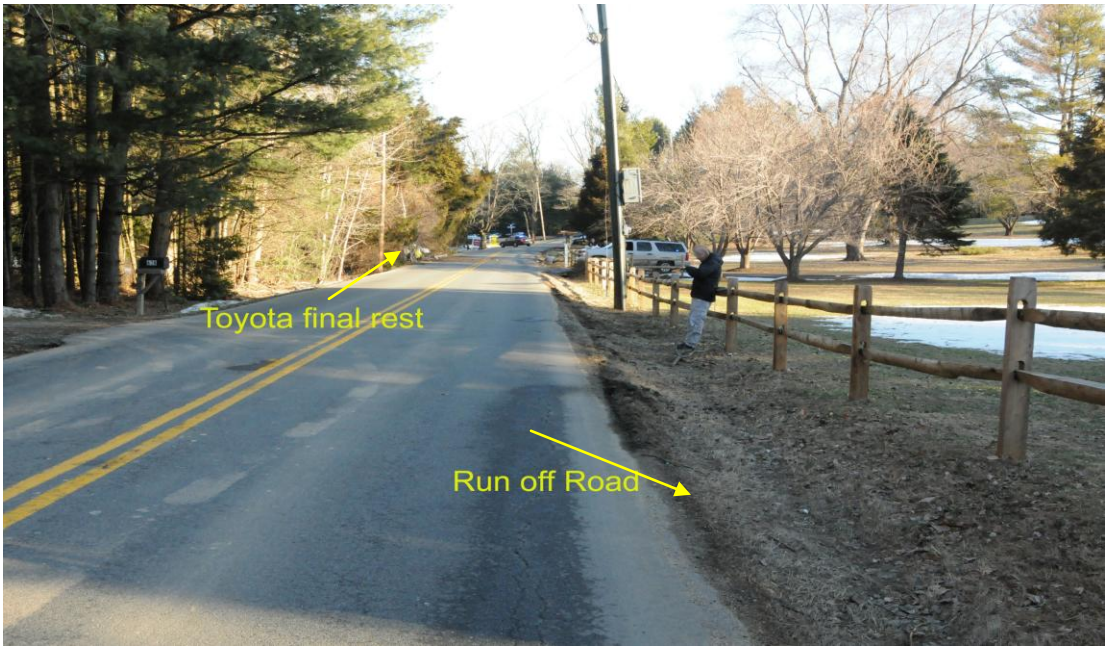
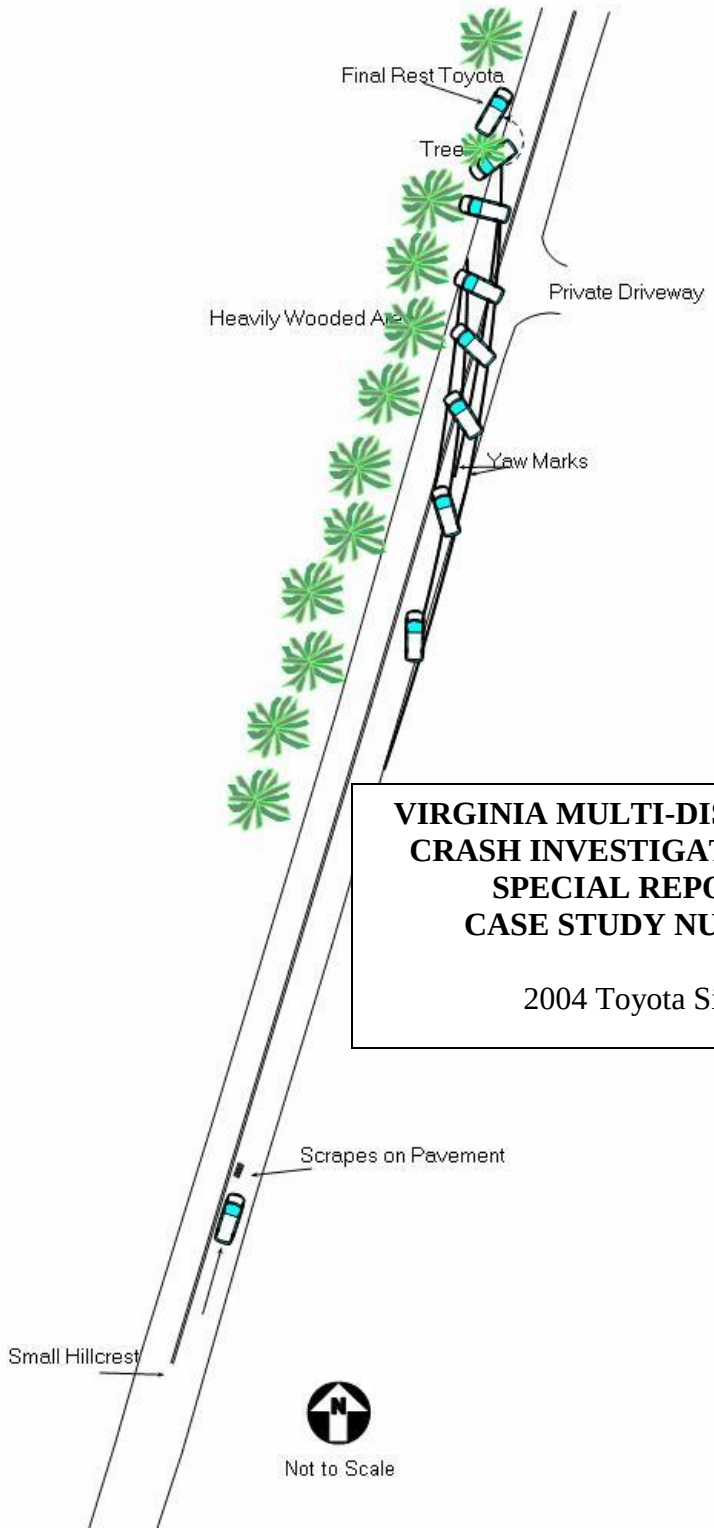


Photo #14: Location where Toyota first ran off road and final rest.

The driver remained in a coma for several months. His brain damage was seriously debilitating, and he was moved to a specialized medical facility in a nearby state. His family put their house up for sale in order to relocate, so they could be closer to him.



VIRGINIA MULTI-DISCIPLINARY CRASH INVESTIGATION TEAM SPECIAL REPORT 21 CASE STUDY NUMBER 4

2004 Toyota Sienna

DISCUSSION

Provisional Licensing Laws in Virginia

In January, 2001, in response to increasing fatalities involving drivers between the ages of 16 and 20 years, the VMCIT released *Special Report Number 14*. The study identified factors that contribute to higher crash rates for younger drivers and recommended changes to licensure laws and driver's education requirements that carried a high potential for reducing young driver crashes and saving lives. That year, the Virginia General Assembly revised driver licensing laws, creating a provisional license category for younger drivers which included additional requirements and restrictions. Many of the changes were consistent with recommendations from *Special Report Number 14*. The revisions were signed by the Governor and became effective on July 1, 2001.

Licensing Recommendations from *Special Report Number 14*

Recommendation A

> Increase the present six month time requirement between the issuance of a learner's permit and a driver's license for drivers under the age of 18 years. A three to six month increase in the required interval would give novice drivers more opportunity to obtain additional driving experience in the company of a licensed driver.

Changes made to §46.2-335.2:

Those less than 19 years old must have held a learner's permit for nine months (earliest age for permit: 15 years 6 months). This increased the required interval from three to six months and the earliest age for licensure from 16 years to 16 years, 3 months.

Recommendation B

Establish a graduated and/or provisional type of license for drivers under the age of 18 years. These licenses could include limiting the number of (teen) passengers riding with a newly licensed driver, restricting the hours during which they may operate a vehicle, and/or other appropriate measures. Such actions could help reduce the exposure of younger, inexperienced drivers to high risk conditions.

Changes made to §46.2-334.01:

In the past, only those with learner's permits had passenger limits. In 2001, passenger limits for provisional drivers were included, with exceptions for family and household members:

Licensed less than 1 year: limited to one passenger under age 18

Licensed over 1 year, driver under 18 years: limited to three passengers under age 18.

Curfew: Previously, no curfews were placed on younger drivers. Now, those under age 18 may not operate a motor vehicle between midnight and 4:00 a.m., with some exceptions.

Recommendation C

Strengthen Virginia's present safety restraint statute by the enactment of a primary restraint use law for all vehicle occupants, front and rear seated positions.

No changes made to Code of Virginia.

Recommendation D

Discontinue the practice of allowing driver education instructors to grant temporary driving privileges to learner's permit holders upon completion of driver education classes. Currently, teen drivers are given full driving privileges on a temporary basis until they can appear before a judge to

receive their regular driver's license. Allowing permit holders to legally drive unsupervised only after attending the ceremony and formal instruction from the judge reinforces the responsibilities and serious consequences of driving.

No changes made to Code of Virginia.

<u>Recommendation E</u>

Require those with learner's permits to complete a specified number of miles and/or hours of supervised vehicle operation during both night and day conditions before obtaining a driver's license. This measure gives novice drivers more time and experience behind the wheel before they are fully licensed.

Changes made to §46.2-335:

In 2008, the General Assembly revised the requirements: drivers under age 19 now must complete and document 45 hours of supervised driving experience, including 15 hours of driving after sunset, in addition to completing a driver's education program.

<u>Recommendation F</u>

Increasing driver education training beyond the current requirements of 50 periods of classroom and behind-the-wheel training to allow for more behind-the-wheel training and simulation training.

No changes made.

Additional Changes to §46.2-334.01, effective July 1, 2007:

Those with provisional licenses may not use cell phones while driving, except in a driver emergency or when the vehicle is lawfully parked or stopped.

Teen Drivers in Fatal Crashes: Statistical Information

Since the peak in fatal crashes in 2000, the number of teen drivers involved in fatal crashes has shown a generally decreasing trend. Many factors are likely to have contributed to this decline, including those that followed from the passage and implementation of the provisional licensing law on July 1, 2001. In an effort to better understand the characteristics of these crashes, the VMCIT has been analyzing police reports (FR300P) for teen driver fatal crashes that occurred since 2001. For the time period July 1, 2009 through June 30, 2010, the most current fiscal year for which data were analyzed, 84 people died in 77 teen driver crashes. In three of these crashes, more than one driver was a teen; in total 80 teen drivers were involved. Fifty-seven drivers were male and 23 were female, proportions that are consistent with previous years (see Figure 5).

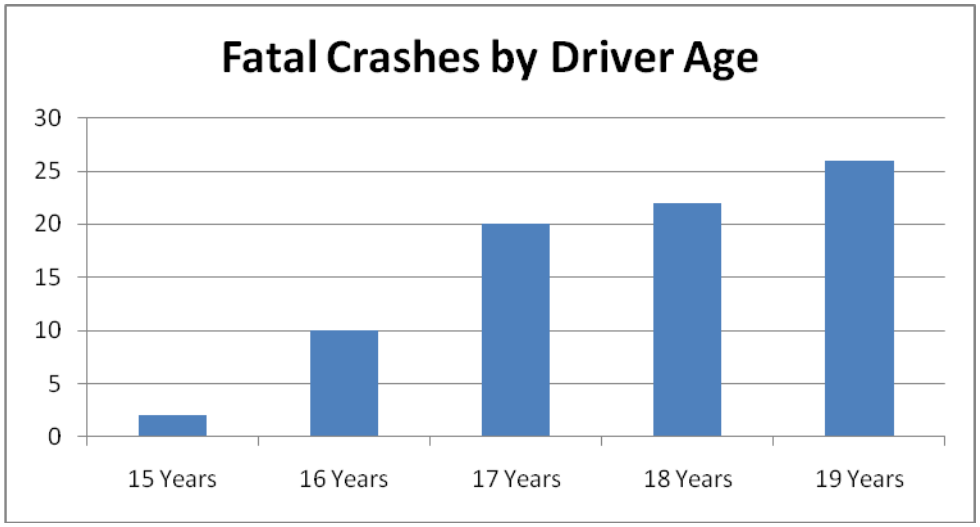


Figure 8: Fatal Crashes by Driver Age (FY 2009-2010)

The age distribution for these drivers can be seen in Figure 8. Older teen drivers have higher frequencies of involvement in fatal crashes. This group is likely to spend more time driving, so their exposure may be higher. Additionally, 18 and 19-year-olds

are no longer restricted in the number of passengers they may legally transport or in the hours during which they may legally drive.

Consistent with this factor, the older teens had a much higher frequency of being involved in crashes between 8:00 p.m. and midnight, compared with earlier in the day, as illustrated in Figure 9.

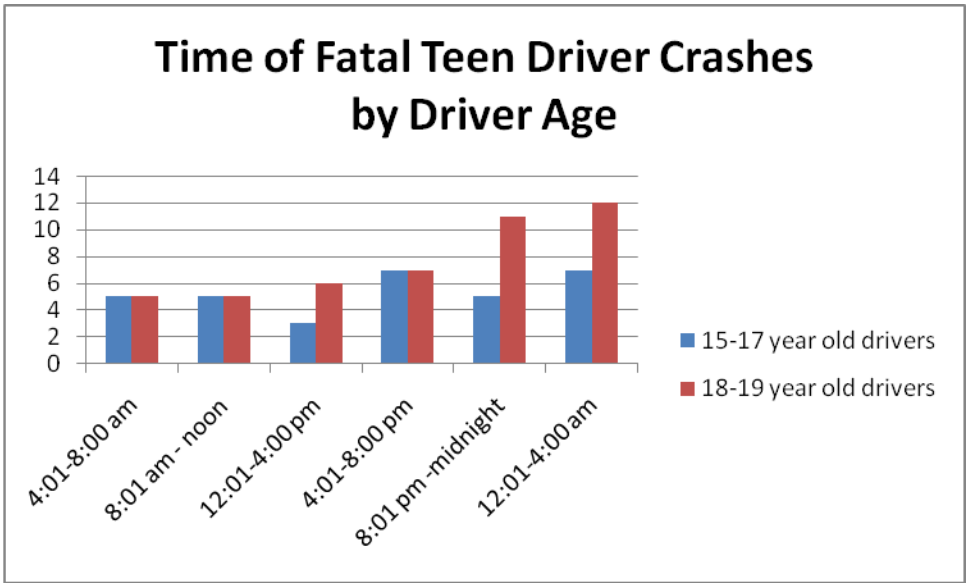


Figure 9: Time of Teen Driver Fatal Crashes in Virginia by Driver Age (FY 2009-2010)

There is slightly less variation in the crash times for the 15 through 17-year-old drivers, although it should be noted that the same number of drivers were involved in fatal crashes during the after school to early evening hours (4:00 to 8:00 p.m.) as were in crashes during the "curfew" hours of midnight to 4:00 a.m.. These two time segments had the highest frequencies for this age group and the data suggest that the midnight to 4:00 a.m. period is still the riskiest time for any young driver to be on the road. In the case studies presented earlier, all the crashes occurred close to or within this high risk time segment. Two of the crashes occurred while the drivers (16 and 17 years old) were in violation of the driving curfew. Another 16-year-old driver crashed less than half an hour prior to midnight. The other driver, an 18-year-old, crashed at 4:20 a.m.

The presence of passengers has been long been identified as a contributory influence in crashes, especially those involving younger drivers. Passengers can be

distracters and they can influence the driver's decision to engage in risky behavior, especially in the case of male teen passengers with male teen drivers (Simons-Morton, Lerner & Singer, 2005). In the analysis of the fiscal year 2009-2010 teen driver fatal crashes, 45 drivers were alone, while 35 of the 80 drivers carried a total of 60 passengers. The provisional licensing law restricts the number of passengers a 16 or 17-year-old driver may transport, based on the length of time that individual has had a license. If the license was granted less than a year earlier, they may legally carry only one passenger. After that, until the age of 18, the driver may transport up to three passengers. Although there is no way to ascertain exactly how long a driver has been licensed based solely on FR300P data, we can easily conclude that no driver at 15 or 16 years of age has been licensed for more than a year. All 17-year-old drivers must at least meet the three passenger restriction. Closer examination of the passenger information on the crash reports showed that at least three 16-year-old drivers involved in fatal crashes most likely violated the restriction by transporting three or four passengers, while two 17-year-olds carried four passengers each. All five of these drivers were considered to be at fault in their crashes. One 15-year-old carried three passengers, although this driver was not deemed at fault in the crash. For the cases in this report, two male drivers each carried a single male passenger, and these individuals were the sole fatalities. In both cases, the passengers were under the influence of alcohol and underage for drinking. That information and other findings indicate that they were complicit in encouraging risky behaviors on the part of the drivers transporting them.

Typically, in 50 to 60 percent of the teen driver fatal crashes, the vehicle runs off the road, and about a third of these crashes include over-correction on the part of the driver. In the FY 2009-2010 crashes, these proportions were consistent: 48 or 62.3% were run-off-road crashes and in 13 of those (27.1%), the driver over-corrected at some point in the crash sequence (determined from analysis of the coded information and evaluation of the crash diagram and narrative on the FR300P reports). The four cases presented in this special report were all run off road/fixed object collisions, and two involved over-correction.

In addition to addressing the issue of running off the road, analysis of the crash data revealed that the most common underlying factor for teen driver fatal crashes was

excessive speed. Thirty-seven (46.25%) of these teen drivers were exceeding the maximum safe speed or the speed limit prior to crashing. Speed played a role in three of the four crashes discussed in the case studies. Figure 6 provides frequency totals for each category, but it should be noted that in many cases, multiple causative factors were recorded. Failure to maintain control of the vehicle is another common factor in crash causation. This is reflected in the combination of wrong side of road and "Other" categories in Figure 10.

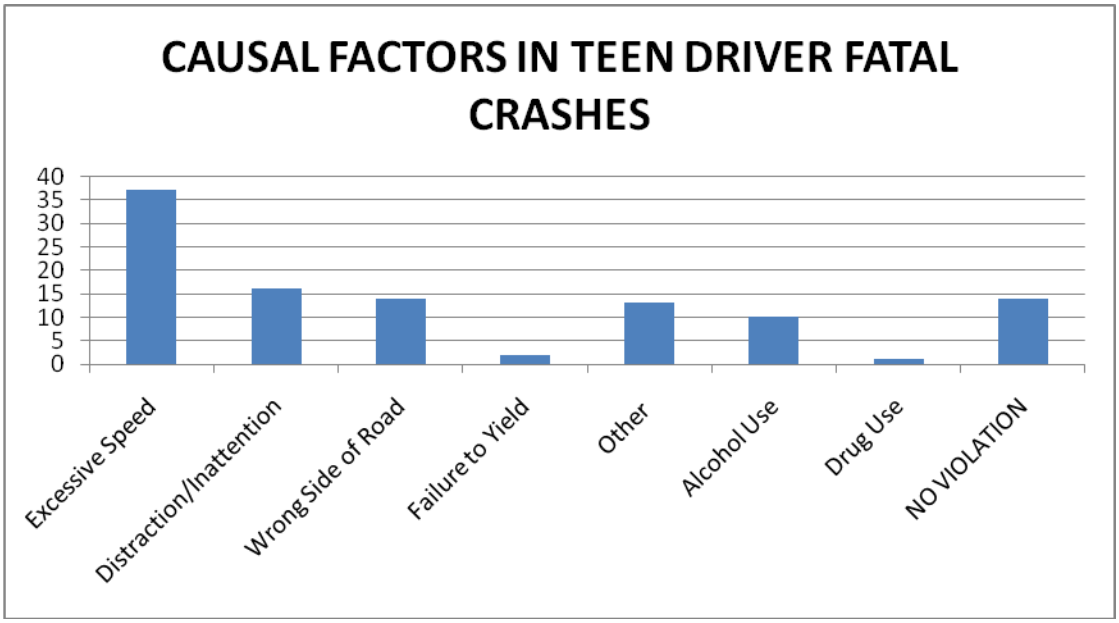


Figure 10: Causal Factors in Teen Driver Fatal Crashes in Virginia (FY 2009-2010; sample size = 80 drivers)

Speeding, for example, may have played a role in the vehicle failing to stay right of the center line (wrong side of road), or a driver may have failed to yield due to driver distraction. In one of the cases investigated for this report, both speed and alcohol use were factors. Further analysis of teen driver crash data may yield information as to how the various factors interact and impact crash type and severity. The "NO VIOLATION" category identifies crashes in which the teen driver was not considered at fault. This occurred for only 21.25% of the drivers.

Alcohol use was a factor with 10 teen drivers—12.5% of a group of drivers for whom any alcohol consumption can result in the loss of their license, fines and a possible jail sentence. Two of the drivers discussed earlier in this report had not only consumed

alcohol illegally, their BAC's were above the legal limit for anyone driving (.08%) and there was evidence that these young people were accustomed to alcohol use. In one case, drinking was sanctioned by an adult central in the teen's life.

Underage drinking is an issue that has been highlighted by the media, the Centers for Disease Control (CDC) and other organizations such as Mothers Against Drunk Driving (MADD) and Students Against Drunk Driving (SADD) over the years. One of the more recent concerns has been the marketing of alcohol products to younger consumers, including the promotion of alcoholic energy drinks, which were recently banned by the Federal Drug Administration. These products, including brand names such as "Four Loco" and "Joose," did not disappear after the ban. The "energy" components of the beverages (such as caffeine, taurine and guarana) were removed, while the names, packaging and alcohol content remained essentially intact. In addition, other companies have entered the market. These fruity beverages are often sold in cans with bright colors and dynamic graphics, designed to appeal to a younger demographic group. Although one website that advertises these products states that the brightness of the cans is no greater than that of other brands, it is apparent that the logos and design were created to look like soft drinks and to appeal to a younger audience. Of greater concern, is the alcohol content and the can size. These types of beverages have higher alcohol content than most brands of beer, ranging from 6 to 12% alcohol by volume—most at 10 to 12% alcohol—while the majority of beer brands contain 4 to 6% alcohol. Although some are available in smaller glass bottles, these beverages tend to be marketed in tall cans, holding as much as 24 ounces. The cans contain the equivalent of four servings; however, the labels do not indicate serving size (and these types of beverages are exempt from federal labeling requirements for serving size). As a consequence of larger containers, consumers may be more likely to drink greater quantities. The higher alcohol content increases the risk of higher levels of intoxication, especially for inexperienced and/or unwary drinkers.

In one of the case studies, the driver was videotaped illegally purchasing "Four Loko" at a convenience store a few hours prior to the crash. This was not the only type of alcoholic beverage he had consumed that evening, however. While these fruity alcohol beverages gained a lot of media and government attention, especially just prior to

the alcoholic energy drink ban, they are not the sole concern with regard to underage drinking. Teen drinking has long been an area of focus with regard to public health and safety, yet the culture in general sends mixed messages to young people. In many instances, drinking is glamorized in the entertainment media; in other instances, alcoholism and driving after drinking are portrayed as destructive. When looking for role models, teens are often told to "do as I say, not as I do." Parents often do not provide consistent messages, in some cases allowing minors to drink at home, even during "supervised" (illegal) parties, while forbidding the behavior elsewhere. Other adults may encourage drinking even in situations where they are not supervising the minors, as occurred in one of the cases investigated for this report.

Further complicating the situation for young adults is the legal system, which does not allow for the acquisition of any skill or firsthand knowledge of alcohol use prior to age 21. One day, an individual is permitted no use; on the 21st birthday, he or she is not only permitted to drink, but expected to make sound, responsible decisions regarding a substance with which he or she has (supposedly) had no experience. The idea that such nothing/everything expectations are unrealistic was discussed with VMCIT members by a university health care provider who sees daily evidence of the conflict. We do not expect teens to be perfect drivers on the day they are eligible to complete the application for a driving permit. We require them to hold a learner's permit, to gain some experience on the road and "behind the wheel," in addition to classroom training, prior to giving them a full license. When it comes to alcohol consumption, however, we expect them to abstain. We give them classroom education with regard to hazards, and then we "cut them loose" at 21. It should come as no surprise that teens experiment with alcohol use. In addition to satisfying curiosity, it is a way to gain experience with an accepted adult practice.

Updating Our Understanding of Teen Driver Decision-Making

This special report includes the results of four fatal crash investigations. Although the specifics varied, these cases highlight the fact that many of the factors identified ten years ago continue to play a role in teen driver fatal crashes in Virginia:

- Inexperience, leading to
  - Greater chance of underestimating dangerous situations, such as speeding
  - Failure to identify hazards
- Immaturity, which influences
  - Poor judgment
  - Prone to peer pressure
  - Failure to think ahead about potential consequences of risky behavior.

One factor commonly ascribed to teen drivers—and mentioned in *Special Report # 14*—is the idea that teens, by virtue of their youth and inexperience, believe that they are invincible or immortal. Over the past decade, research has shown that this "Myth of Immortality" is not an accurate description of their beliefs or cognitive processes—it is itself a myth. Teens do tend to show an "optimistic bias," meaning they think they are at less risk than other teens in similar situations, but this bias is the same as for adults. More importantly, teens tend to *overestimate* risk and perceive themselves as vulnerable compared to adults (Reyna & Farley, 2006).

Neuroscientific research on brain and cognitive development has added a physiological component to the ongoing behavioral research on developmental patterns in adolescent judgment and decision making. While teens are similar to adults in their logical reasoning and information processing, their decisions appear to be influenced by a different interplay of emotional and cognitive processes, typically resulting in different behavioral outcomes. During adolescence, physiological development of different areas of the brain are not linear, with the regions associated with approach or avoidance responses (limbic regions) developing ahead of regions that are important to self-

regulation (prefrontal areas) (Casey, Jones, & Somerville, 2011). Areas associated with reward and incentives are especially sensitized. This research suggests that adolescents:

- Are strongly susceptible to social and situational cues, which increases their likelihood of taking risks when peers are present,
- Are emotionally pre-disposed to seek out new and exciting experiences, and
- Are more likely to respond to and learn from positive consequences than negative consequences (Albert & Steinberg, 2011).

Teens may actually think more about risky decisions and they don't have an automatic negative response to risky situations. For this younger demographic group, the perceived benefits in a specific situation often carry more weight than risks. These findings have implications for influencing the behavior of teen drivers:

> …traditional interventions stressing accurate risk perceptions are likely to be ineffective or backfire because young people already feel vulnerable and overestimate their risk.
>
> In addition, research shows that experience is not a good teacher for children and younger adolescents, because they tend to learn little from negative outcomes (favoring the use of effective deterrents, such as monitoring and supervision), although learning from experience improves considerably with age.
>
> Experience in the absence of negative consequences may increase feelings of invulnerability and thus explain the decrease in risk perceptions from early to late adolescence, as exploration increases.
>
> Finally, novel interventions that discourage the deliberate weighing of risks and benefits by adolescents may ultimately prove more effective and enduring. Mature adults apparently resist taking risks not out of any conscious deliberation or choice, but because they intuitively grasp the gists of risky situations, retrieve appropriate risk-avoidant values, and never proceed down the slippery slope of actually contemplating tradeoffs between risks and benefits (Reyna & Farley, 2006).

CONCLUSIONS

The provisional licensing law that became effective mid-2001 appears to have had a beneficial impact on reducing the number of fatal crashes involving teen drivers in Virginia. However, we continue to see the senseless loss of life purely as a result of poor decisions on the part of young drivers, and often with the sanction of peers and adults around them. These four crashes exemplify key concerns about Virginia's youngest licensed drivers. With their inexperience, they often fail to identify hazards in the environment and may not react correctly in emergency situations. In addition, they tend to act impulsively at a time when their ability to make good judgments is underdeveloped. As a consequence, they respond too easily to peer influences (whether as indirect cues or direct pressure) and they take risks, such as speeding, "hill hopping" and illegal passing. Underage drinking, an area of mixed messages within the culture, only reduces teens' ability to make good judgments. While teens tend to be overly susceptible to short term rewards, they may fail to fully grasp the severity of potential negative consequences.

These cases highlight the worst-case scenarios for teen drivers and their families and friends. To further reduce the fatalities, injures and property losses that result from motor vehicles, it may be helpful to engage parents and adult role models more fully in the driver education process. Parents must verify that their child has completed the required number of supervised driving hours in light and dark conditions, and there is information available in published and online formats. However, parents may not be fully prepared to coach their novice drivers. In an effort to more fully educate and engage parents in their role as instructor and mentor, Prince William County Public Schools began requiring parents or guardians to attend a 90 minute traffic safety program with their student driver. Only students whose parents or guardians had attended the program were eligible to receive their Driver Education Certificate of Completion card (DEC-1 card), necessary to becoming licensed for those under 18. This program has been implemented in the county's schools since 2004 and the crash rate for first year student drivers has declined significantly, dropping from an initial 17% to 2.19% in 2009. On July 1, 2010, the General Assembly amended §22.1-205, which references

requirements for driver education programs, to codify and expand this mandatory program for all school systems in Planning District 8 (Prince William, Fairfax, Loudoun and Arlington Counties, as well as the cities of Alexandria, Falls Church, Manassas and Manassas Park). If the experience in Prince William County Schools is a consistent, crash rates for teen drivers should fall in these localities as well.

In addition to addressing parental supervision and influence, research based on naturalistic driving studies is identifying new factors that are related to risky driving. When teens drove vehicles that they owned, rather than ones they shared with other family members, they were four times more likely to speed (Klauer, Simons-Morton, Lee, Ouimet, Howard & Dingus, 2011). There is little published research on the relationship between driving behaviors and vehicle ownership or vehicle model type, and this may be a fertile area to consider in light of the influence situational cues play in adolescent decision-making.

Finally, we must look closely at the cultural attitudes toward traffic safety. These include a casual approach to driving, a fatalistic view of crashes as pre-destined, as well as the glamorization of high risk behaviors and drinking among teens and young adults. While it takes time for young people to develop good judgment and driving skill, there are ways to shift attitudes—and ultimately behavior—toward a safer driving culture. Positive social norm approaches can influence perceptions and acceptance of high risk behaviors, including underage drinking and risky driving activities like speeding, hill hopping and driving while impaired. Research in traffic safety culture in early developmental stages, but this area offers a perspective that could change not only the way teens drive in the present, but set new patterns that carry over into their adult driving attitudes and habits.

RECOMMENDATIONS

1. The Virginia General Assembly should strengthen the present safety restraint statute by the enacting a primary restraint use law for all vehicle occupants, front and rear seated positions.

2. The Virginia Department of Motor Vehicle (DMV) and the Virginia Department of Education (DOE) should continue to monitor the outcomes of the mandatory traffic safety programs for student drivers and their parents//guardians in Planning District 8 schools.

   a) If the program proves to be as successful in reducing first year driver's crash rates, as it has been Prince William County Schools, the General Assembly should consider broadening the scope of §22.1-205 to include all school systems and should consider ways to fund such a requirement.

   b) In addition to evaluating the impact on crash rates for first year drivers, the DMV and the DOE should evaluate the longer term effectiveness of the program, to determine if crash rates continue to be lower for this cohort of younger drivers.

3. The DMV, the DOE and other agencies or groups that focus on highway safety should consider identifying ways to use positive social norms to alter the perception of high risk driving. These may include media campaigns as well as curriculum changes.

4. The DMV, the DOE, the Alcohol and Beverage Control Board and other agencies or groups that focus on highway safety should consider identifying ways to use positive social norms to alter the perception of underage drinking. These may include media campaigns as well as curriculum changes.

5. The Virginia Department of Transportation (VDOT) and/or the city public works department should consider making the following changes to the roads described in this report:

a) Case Study Number 1: (VDOT) Review the pavement markings on this road and remark where necessary

b) Case Study Number 2: No recommended changes

c) Case Study Number 3: (The city) Review the pavement markings on this street and remark where necessary, especially the stop line

d) Case Study Number 4: (VDOT) Review the pavement markings on this road and remark where necessary.

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