TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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CALSPAN ON-SITE AIR BAG/CHILD FATALITY INVESTIGATION
CALSPAN CASE NO. CA98-035
VEHICLE: 1995 MERCURY COUGAR
LOCATION: KENTUCKY
CRASH DATE: APRIL, 1998

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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BACKGROUND

This on-site air bag deployment investigation focused on the death of a 9 year old female right front passenger of a 1995 Mercury Cougar. The Cougar was equipped with frontal air bags for the driver and right passenger positions. The front right area of the vehicle **(Figure 1)** impacted a small deer which resulted in deployment of the frontal air bag system. The child passenger was probably improperly restrained by the manual 3-point lap and shoulder belt system which allowed her torso and head to pitch forward as a result of pre-crash braking. At impact, the child passenger was positioned within the deployment path of the front right passenger air bag **(Figure 2)**. The expanding air bag contacted the child passenger's chest and anterior neck which resulted in abrasions of the mid chest, anterior neck and chin, bilateral pneumothoraces, pneumomediastinum, a possible crush-type injury of the larynx, subluxation of C1 on C2, cerebral edema with midline shift to the right, and small left subdural hematoma. The child passenger was initially transported from the scene of the crash by ambulance to a local hospital where she was evaluated and prepared for air transfer to a children's trauma center. She was pronounced brain dead approximately 16 hours following the crash. All injuries were associated with deployment of the front right passenger air bag.

Figure 1. Frontal damage to the Mercury Cougar.

Figure 2. Profile view of the child passenger's position and the deployed air bag.

The crash occurred in a rural area of Kentucky in April, 1998. NHTSA was initially notified of the crash by an attorney who represents the family of the deceased. The investigation was subsequently assigned to the Calspan Special Crash Investigation team on May 28, 1998, and an on-site investigation was scheduled and conducted on June 10-11, 1998.

SUMMARY

Crash Site

The crash occurred on a rural two lane road in a posted 89 km/h (55 mph) speed zone. The asphalt road surface was straight with a grade of 1 percent, negative to the west. The travel lanes were delineated by a broken yellow centerline with a total width of 6.1 m (20.0') Both edges of the roadway were bordered by grass shoulders with ditches located approximately 1.8 m (6.0') outboard of the shoulders. An agricultural driveway was located at the south edge of the roadway which provided access to a soybean

field **(Figure 3)**. Two deer paths were evident in the wooded area which bordered the north side of the roadway and these paths were located opposite of the agricultural driveway. There were no surface defects noted in the area. At the time of the crash, the asphalt road surface was dry, with clear visibility, and the light conditions were police reported as daylight.

Figure 3. Overall view of the Mercury's trajectory to the crash site.

Pre-Crash

The driver of the 1995 Mercury Cougar and her 9 year old daughter had departed the family farm en route to a family member's residence to pickup the driver's 2 year old daughter. The 9 year old child passenger was seated in the right front of the Cougar. The driver stated that she was properly restrained by the manual 3-point lap and shoulder belt system, however, witness marks within the vehicle and passenger injuries suggested that she was improperly restrained with the shoulder belt positioned behind her back. She was traveling on a rural segment of the two lane roadway in a westerly direction at a driver estimated speed of 80-89 km/h (50-55 mph). The driver noted that the light conditions were daylight at the onset of dusk, however, conditions did not warrant the use of headlights. The setting sun was not a factor regarding visibility.

As the driver was traveling on a straight segment of road surface with a negative grade of 1 percent, she detected a small deer emerge from the wooded area adjacent to the right road edge. She noted that the deer was running on a trajectory that was slightly diagonal to the roadway and entered the roadway directly in front of the vehicle's path of travel. The driver applied a rapid braking force in an attempt to avoid the animal. The left front wheel locked and marked on the dry asphalt road surface. Although not observed during the on-site investigation, the coroner documented a single left front tire mark that he measured at 9.8 m (32.0') in length. Based on a deer path at the scene of the crash and the estimated trajectory of the animal, the vehicle skidded approximately 4.9 m (16') in a tracking mode to impact. The equivalent velocity loss due to braking over the 4.9 m (16') of skidding was approximately 29 km/h (18 mph).

Crash

The front center and right area of the Mercury Cougar impacted the left side of the deer as the animal entered the westbound travel lane **(Figure 4)**. The 12 o'clock direction of force impact resulted in an estimated velocity change of 5-8 km/h (3-5) mph. The impact fractured the plastic grille and deformed the leading edge of the hood of the Mercury. The rearward displacement of the fractured grille and the impact with the deer resulted in direct contact to the front right air bag crash sensor and mounting bracket. As a result of the impact induced deceleration and sensor contact, the supplemental frontal driver and passenger air bags deployed. The air bag system probably deployed late in the crash sequence due to the minor severity impact with the deer. The driver stated that at impact, she heard two distinct loud noises. The first was

Figure 4. Point of impact with deer.

a loud thump from the impact with the deer followed by a loud "pop" that she associated with air bag deployment. The deer wrapped onto the hood of the Mercury Cougar and was carried by the vehicle.

Post-Crash

Following the impact, the driver apparently reduced her level of braking force as the vehicle skidded an additional 4.9 m (16') prior to the termination of the left front skid mark. The driver maintained a moderate braking force as she brought the Mercury Cougar to a stop in the westbound lane approximately 25 m (80') west of the estimated point of impact. The deer separated from the vehicle and came to rest in a drainage ditch that paralleled the south (left) road edge approximately 29.3 m (96') west of the point of impact. It should be noted that a conservation officer estimated the weight of the male deer at 38 kg (85 lb).

As she brought the vehicle to a controlled stop, the driver detected a smoke-like substance within the vehicle which contained a foul odor. She immediately suspected that the vehicle was on-fire and opened the power-windows to vent the smoke from the vehicle. The smoke was associated with air bag deployment which consisted of exhaust gases that vented from the frontal driver and passenger air bags. She then noted the final rest position of the child right front passenger who was slumped against the right front seat back and center console. As the smoke vented from the vehicle, the driver noted a westbound pickup truck approaching from the rear of her vehicle. The driver backed the vehicle approximately 30 m (100') and drove into the access driveway at the south road edge.

The driver subsequently touched the hand of her daughter and attempted to talk to her. The child right front passenger was unresponsive. The driver stated that she unbuckled the child's manual belt system and opened the left front door and exited the vehicle. She proceeded around the rear of the Mercury Cougar to the right front door area. The driver opened the right front door to access the right front child passenger. As she opened the door, the female driver of the pickup truck had stopped at the crash scene and approached the Mercury Cougar. This person did not witness the child restrained by the manual belt system. The driver of the Cougar used her cellular telephone and called a family member to report that she had been involved in a crash. She subsequently placed a second call to 911 to report the crash and request assistance.

The local emergency medical technicians (EMT) received the call and arrived on-scene within 10 minutes of the call. The lead EMT evaluated the condition of the child passenger and removed her from the vehicle on a back board and placed her in the ambulance. He maintained an airway and the child was transported to a local hospital where she arrived within 16 minutes of scene departure. The child was evaluated, treated and prepared for air transferral to a children's trauma hospital. At the trauma center, the child was diagnosed with brain death approximately 16 hours following the crash. The driver of the Cougar was not injured.

VEHICLE DATA

The involved vehicle was a 1995 Mercury Cougar XR7, 2 door sedan. The vehicle was manufactured on 1/95 and was identified by vehicle identification number (VIN) 1MELM62W0SH (production number

deleted). The Mercury was originally purchased by the driver and her husband as a new vehicle in May, 1995. The driver stated that the vehicle was not involved in any previous crashes and no problems were reported regarding the air bag system. (Pre-existing damage was noted to the left side area of the front bumper fascia.) Maintenance issues involved routine items such as oil changes and tire replacement**.**

The Cougar was equipped with General XP2000 GT raised white letter P215/70R15 all-season radials that were mounted on OEM alloy wheels. The vehicle was equipped with front disc/rear drum power-assisted brakes, a 4.6 liter V-8 engine and a 4-speed automatic overdrive transmission with a console mounted shifter. In addition to the drive train components, the Cougar was equipped with a tempered glass sunroof, electrically controlled dual outside rearview mirrors, power windows and door locks, a six-way power bucket seat for the driver's position, a manually operated right front bucket seat, and adjustable head restraints for the front seat positions. The Cougar was equipped with a tilt steering wheel that was adjusted to the mid position.

VEHICLE DAMAGE

The Mercury Cougar was towed from the scene of the crash and initially stored outdoors. The vehicle was subsequently inspected by the SCI investigator 66 days following the crash. Although deer hair had washed from the vehicle, all impact related damage was intact at the time of the SCI inspection.

Exterior

A front leg contact of the deer was noted to the lower aspect of the front bumper fascia, located 20.3 cm (8.0") right of center. A second rear leg contact was noted to the right corner area of the front fascia. This contact fractured the fascia and was evidenced by fur embedded into the fracture site. The contact began 68.8 cm (27.1") right of center and extended 9.5 cm (3.75") to the front right corner **(Figure 5)**. There was no residual crush to the front bumper system. It should be noted that the bumper was supported by rigid convoluted brackets with no compressible energy absorbing units.

Figure 5. Front right view of the impact damage.

Figure 6. Perpendicular view of the crush profile.

The grill and hood face areas of the Mercury Cougar impacted the left side of the deer as the vehicle continued in a forward direction. The impact fractured the plastic grille and dislodged the right headlamp/turn signal assembly. The grille was displaced into the front right air bag sensor and mounting

bracket. This contact, in combination with probable deer contact, rotated the sensor and mounting bracket approximately 5 degrees in a counterclockwise direction.

The hood face was crushed as a result of engagement with the left side of the deer. The damage began 11.4 cm (4.5") left of center and extended 74.7 cm (29.4") to the right edge of the hood. Maximum residual crush at the hood face was 5.3 cm (2.1") located 20.3 cm (8.0") inboard of the right hood edge **(Figure 6)**. Additional crush values at the hood face were as follows:

- at 15.2 cm (6.0") right of center, the hood face was crushed to a depth of 4.4 cm (1.75").
- at 25.1 cm (10") right of center, the hood face was crushed to a depth of 5.1 cm (2.0").
- at the right corner of the hood face, residual crush was 1.3 cm (0.5").
- the leading edge of the right front fender was crushed to a depth of 2.9 cm (1.125").

The on-scene police photographs of the Mercury Cougar documented deer fur over the entire top surface of the hood and forward third area of the roof. The majority of the fur was washed from the vehicle as a result of exposure during the initial outdoor storage of the Mercury Cougar. The trailing edge of the tempered glass sunroof of the Cougar was slightly displaced in an outward direction, however, it was unknown if this displacement was related to this crash. The Collision Deformation Classification (CDC) for this impact event was 12-FZEW-1.

The center aspect of the windshield was cracked in a star-like configuration at the mounting point of the interior rear view mirror. It appeared that the outer glazing panel of the laminated windshield was fractured, however, the interior panel was not fractured. Therefore, this crack resulted from interior contact of the front right passenger air bag against the rear view mirror. This is further discussed in the *Interior Damage* section of this summary report.

Interior

The interior of the Mercury Cougar sustained minor severity damage that was associated with deployment of the front right passenger air bag against the forward position of the child passenger and occupant contact points. There was no interior intrusion or damage resulting from exterior deformation.

The driver's knees contacted the knee bolster which scuffed the bolster on each side of the steering column **(Figure 7)**. The right knee scuff was located 29.2-33.0 cm (11.5-13.0") left of center and 31.8-34.9 cm (12.5-13.75") below the top surface of the instrument panel. The left knee scuff was located 38.1-43.2 cm (15.0-17.0") left of center and 31.1-35.6 cm (12.25-14.0") below the referenced panel. There was no deformation to the bolster panel.

Figure 8. Driver knee contacts to the bolster.

The child passenger was displaced forward as a result of pre-crash braking. Her forward position resulted in an altered deployment path of the front right passenger air bag

as it expanded against her upper chest and anterior neck. The left upper quadrant of the air bag probably contacted the interior rear view mirror which stressed the windshield mounting point of the mirror and separated the mirror from the mount. As a result of the mirror contact, the outer panel of the windshield glazing was fractured in a star-like pattern at the vertical centerline, at the point of the mirror mount. There was no contact evidence on the rear view mirror at the time of SCI inspection.

The deployment path of the expanding front right air bag was altered due to contact with the forward positioned child passenger. The left aspect of the bag contacted the center upper instrument panel adjacent to the radio and heater controls. The contact was evidenced by a scuff mark to the vinyl panel with white fabric fibers adhered to the panel within the scuff mark. The contact was located 8.9-15.2 cm (3.5-6.0") right of center and 3.8-15.2 cm (1.5-6.0") below the top surface of the instrument panel. A patterned cross-hatch whitish air bag transfer was noted to the windshield 41.9-44.5 cm (16.5-17.5") right of center and 20.3-23.5 cm (8.0-9.25") above the top surface of the referenced panel **(Figure 8)**.

Figure 8. Transfer/scuff mark on windshield.

A vertically oriented scuff mark with tissue-like fragments located at the top and bottom areas of the scuff was located at the upper right quadrant of the windshield. The scuff mark was located 58.4-63.5 cm (23.0-25.0") right of center and 30.5-35.6 cm (12.0-14.0") above in instrument panel. The scuff appeared to be related to an upper extremity contact, however, no corresponding soft tissue injury was noted to the child passenger. It was also possible that the mark was a nasal expulsion from the child passenger as the air bag contacted her chest and neck areas.

Several small tissue fragments were noted to the right interior surface of the vehicle. One small fragment was noted to the right sunvisor, located 36.8 cm (14.5") right of center. A second tissue fragment was located on the headliner 50.8 cm (20.0") right of center and 31.5 cm (12.4") rearward of the windshield header.

A horizontally oriented scuff mark/fabric abrasion was noted to the upper rear aspect of the right front door panel. The contact point was located 83.8-89.5 cm (33.0-35.25") rearward of the leading edge of the door panel and 6.4-8.9 cm (2.5-3.5") below the top surface of the door panel.

The padded instrument panel below the front right passenger air bag module cover was compressed in a diagonal "dent" located 35.6-41.9 cm (14.0-16.5") right of center and 48.3-52.1 cm (19.0-20.5") above the floor pan. There was no contact evidence (i.e., tissue/fabric transfer, scuff mark) associated with this area of deformation. It was possible that this compression was pre-existing, or resulted during the extrication of the child passenger. It should be noted in this interior damage section that there was no contact evidence and/or damage to the deployed air bags.

MANUAL RESTRAINT SYSTEMS

The Cougar was equipped with manual 3-point lap and shoulder belts for the four outboard seated positions. The front belt systems consisted of a continuous loop belt webbing that was retracted onto an inertia activated locking retractor. The upper anchorages (D-rings) were in fixed positions on the B-pillars. Both front belt systems displayed routine usage wear marks on the latchplates, however, there was no loading evidence to the webbing and/or hardware components.

The outer aspect of the front right lap belt webbing was stained with a faint reddish transfer that was possibly associated with the blood oozing from the chest and neck abrasions sustained by the child passenger.

AUTOMATIC RESTRAINT SYSTEM

The 1995 Cougar was equipped with a Supplemental Restraint System (SRS) that consisted of frontal air bags for the driver and right passenger positions. The air bag system consisted of two front mounted electro-mechanical crash sensors, an interior mounted diagnostic/control module, a steering wheel mounted driver air bag module, and an instrument panel mounted front passenger air bag module. The system deployed as a result of the front right impact sequence with a small deer.

The crash sensors were mounted on brackets that were bolted to the forward aspect of the upper radiator support panel, located at the inboard edge of the headlamp assembly. The left crash sensor was identified by Ford part no. F5SB-14B005-AB with a bar coded identification number of *8W32240230*. This sensor was not damaged or displaced as a result of the deer impact. The right crash sensor was identified by part no. F5SB-14B004-AA. The bar coded identification number was *8X33943101*. The right crash sensor was contacted by displacement and fracturing of the plastic grille assembly that resulted from the impact with the deer. A wipe mark (area where road film was removed) was noted to the leading edge of the sensor and mounting bracket. As a result of the contact, the mounting bracket was rotated approximately 5 degrees in a counterclockwise direction **(Figure 9)**. There was no residual damage to the crash sensor.

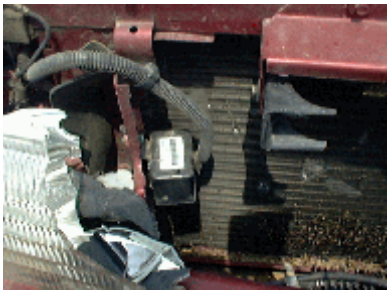

Figure 9. Rotated right crash sensor.

The front driver air bag deployed from a module that was mounted within the 4-spoke steering wheel rim. The steering wheel spokes were located at the 3 and 9 and 4:30 and 7:30 o'clock positions. The air bag was concealed within H-configuration module cover assembly with asymmetrical flaps. The upper flap had a maximum width of 24.1 cm (9.5") with a horizontal tear seam width of 16.5 cm (6.5"). The overall height of the upper flap was 10.2 cm (4.0"). The lower flap shared the same tear seam width with the upper flap and had a maximum width of 18.0 cm (7.1"). The overall height of the lower flap was 4.4 cm (1.75"). There was no damage or evidence of occupant contact to the driver module cover flaps.

The front driver air bag **(Figure 10)** deployed as designed with no tears or perforations noted to the woven nylon-type fabric. The bag was constructed of two panels that were sewn with an internal peripheral seam. The overall width of the driver air bag in its deflated state was 64.8 cm (25.5"). The bag was tethered by four internal straps that were sewn to the face of the bag with a 17.1 cm (6.75") tether reinforcement. The tether straps were positioned at the 12 and 6 and 3 and 9 o'clock positions. Maximum rearward excursion of the driver bag was 27.9 cm (11.0") at the tether locations and 31.8 cm (12.5") at the center of the tether reinforcement. The driver bag was vented by two 1.3 cm (0.5") diameter ports that were located at the 11 and 1 o'clock sectors. The ports were centered 7.3 cm (2.875") inboard of the peripheral seam. There was no damage or occupant contact evidence on the driver bag.

Figure 10. Profile view of the deployed front driver air bag.

The front right passenger air bag **(Figure 11)** was mounted to the right instrument panel in a mid mount configuration. The module assembly consisted of two external cover flaps that were recessed 10.8 cm (4.25") forward of the protruding lower instrument panel. The upper flap was rigid by design which probably directed the deployment path of the air bag in an outward and downward direction. The horizontal width of the flap at the tear seam was 36.8 cm (14.5") with an overall height of 6.6 cm (2.6"). The acronym SRS was molded into the lower right corner of the upper flap. The lower front right air bag cover flap had a overall height of 8.3 cm (3.25") and was hinged at the bottom edge with a hinge width of 32.4 cm (12.75"). The flap tapered outward to the maximum width at the tear seam of 36.8 cm (14.5"). The thickness of the vinyl flap was approximately 4.8 mm (3/16"). The outer edges of the flap were bowed in an outward direction which deflected the center area inboard. There was no damage or contact evidence to the passenger cover flaps.

Figure 11. Deployed front passenger air bag.

The front right passenger air bag was constructed of a typical nylon-type fabric. The top panel of the bag was approximately 30.2 cm (11.875") in width at the inflator manifold and flared out to a maximum width of 86.4 cm (34.0") over a depth of 50.8 cm (20.0"). The face of the passenger air bag was 86.4 cm (34.0") in width and approximately 61.0 cm (24.0") in height in its deflated state. The bag was not tethered by internal straps and/or bands and was vented by a single port located on the inboard side of the bag at the 9 o'clock sector. The vent port was 7.0 cm (2.75") in diameter and was centered 25.4 cm (10.0") outboard of the module cover flaps. Maximum rearward excursion of the passenger bag was 82.6 cm (32.5") from the mid aspect of the cover flaps at the mid aspect of the bag and 57.2 cm (22.5") and the junction of the top panel and face of the bag. Both measurements were recorded with the bag in its fully deflated state. There was occupant contact evidence of the surface of the passenger air bag.

HUMAN DEMOGRAPHICS/OCCUPANT DATA

Driver:	29 year old female
Height:	152.4 cm (60.0")
Weight:	54.4 kg (120 lbs.)
Manual Restraint Usage:	3-point lap and shoulder belt system
Usage Source:	Driver interview
Eyeware:	None
Vehicle Familiarity:	3 years
Route Familiarity:	Travels route frequently
Type of Medical Treatment:	None, not injured

Driver Injuries

Injury	Injury Severity (AIS 90)	Injury Mechanism
Not injured	N/A	N/A

Driver Kinematics

The driver of the Mercury Cougar was seated in a normal postured at impact with both hands positioned on the steering wheel rim and her the seat track adjusted to a mid track position. At the time of SCI inspection, the driver's seat track was adjusted 9.5 cm (3.75") rearward of the full forward position and 11.4 cm (4.5") forward of the full rear position. The seat back support was reclined to an angle of 23 degrees. The driver stated that in her normal driving position, an estimated horizontal distance of 20.3 cm (8.0") was between her chest and the driver air bag module cover. She stated that she was properly restrained by the manual 3-point lap and shoulder belt system, however, there was no loading evidence from the minor severity crash to support belt usage. Routine wear marks were present on the system's latchplate which supported frequent usage.

At impact with the deer, the driver initiated a forward trajectory. Due to her pre-crash seated position and the forward motion, the driver's knees contacted and scuffed the knee bolster. The contact was evidenced by scuff marks on the bolster located on each side of the steering column. No injury resulted form the contact sequence. She probably loaded the manual belt webbing and the deployed air bag with minimal force. The driver stated that she did not contact the deployed front left air bag. There was no loading evidence on the restraint systems and no reported injury.

Right Front Passenger Demographics

Age/Sex:	9 year old female
Height:	142.2 cm (56.0"), estimated by parents
Weight:	27-32 kg (60-70 lb), estimated by father

Manual Restraint Usage:	Lap belt with shoulder belt positioned behind back
Usage Source:	Vehicle inspection, (occupant contact points and passenger kinematics)
Mode of Transport From Scene:	Ambulance
Medical Treatment:	Transported to a local hospital for initial treatment and evaluation and transferred by air to a children's trauma center

Right Front Passenger Injuries

Injury	Injury Severity (AIS 90)	Injury Mechanism
Closed head	160816.5,0	Expanding front right passenger air gag
Small left subdural hematoma	Severe (140652.4,2)	Expanding front right passenger air bag
Massive cerebral edema with midline shift to right	Serious (140674.5,2)	Expanding front right passenger air bag
Right upper lobe pulmonary contusion with bilateral pneumothorax and pneumomediastinum	Serious (441406.3,1)	Expanding front right passenger air bag
Rotary subluxation of C1 on C2	Moderate (650204.2,6)	Expanding front right passenger air bag
Abrasions of the upper chest, anterior neck, and underside of the chin	Minor (490202.1,4; 390202.1,5; 290202.1,8)	Expanding front right passenger air bag
Coles fracture of the left wrist	Moderate (751800.2,2)	Front right passenger air bag module cover flap and/or expanding air bag
Small contusion of the right upper arm	Minor (790402..1,1)	Right front door panel

Right Front Passenger Kinematics

The 9 year old child passenger was seated in the right front position of the Mercury Cougar. She was wearing a green short-sleeve T-shirt and denim jeans. Her mother noted that the T-shirt was a large size for the child passenger. She was not wearing eyeware, however, she did have pierced ears, therefore the

child passenger probably had a small earing in the lobe of each ear. At the time of vehicle inspection, the manually operated right front bucket seat was adjusted to the full rearward track position with the seat back reclined to 18 degrees of vertical. The first responding EMT at the scene of the crash, who serves as the county coroner, noted during his subsequent inspection of the vehicle, that the right front seat track was adjusted one notch forward of the full rear track position. In this position, the horizontal distance between the seat back support and the mid mount front right passenger air bag module was 87.0 cm (34.25").

The child passenger was noted by several persons who were close to the family as a dedicated seat belt user. The driver (mother) noted during the SCI interview, that the child passenger always wore her seat belt and encouraged others in the vehicle to buckle-up. The mother further noted that on occasion, the child passenger would place the shoulder belt webbing under her right arm or behind her back. On this trip, the mother stated that the child was seated in an upright attitude against the seat back support with the shoulder belt positioned across her chest.

The SCI inspection of the interior surfaces of the Mercury Cougar, right front manual belt system, deployed front right passenger air bag, and the evaluation of the medical data, resulted in the following reconstruction of the child passenger's pre-crash position, manual restraint usage, kinematics, and injury mechanisms.

Based on the evidence within the vehicle, the child passenger was in a seated position on the right front seat cushion. Due to her estimated height of 137.2 cm (54.0"), her knees probably did not clear the leading edge of the seat cushion, therefore her pelvic region was probably positioned forward of the seat back support which would have lowered her seated height in the vehicle. Based on this presumed position, the shoulder belt webbing would have rode high across her body, therefore she probably placed the shoulder belt webbing behind her back with the lap belt restraining her within the vehicle.

On the approach to the crash site, the driver detected the deer as it exited the wooded area and attempted to run across the road from the vehicle's right to left. The driver yelled out "deer" and applied the brakes in an attempt to avoid the impending impact. Although the driver could not recall if the braking action resulted in skidding, the coroner detected 9.8 m (32') of skid mark that was located at the inboard aspect of the westbound travel lane, suggesting the mark was related to the left front tire of the Cougar. (The skid mark was not present at the time if the SCI inspection of the crash scene.)

The pre-crash braking actions displaced the child right front passenger forward, causing her to jackknife over the lap belt. As the child initiated her forward motion in response to the braking maneuver, she extended her left arm forward in an attempt to brace against the mid instrument panel. This bracing action positioned her left hand against, or within a close proximity to the mid mount module cover flaps. At impact with the deer, the frontal driver and right passenger air bag system deployed. It should be noted that although the air bag system deployed, the longitudinal velocity change was minimal, estimated at 5-8 km/h (3-5 mph), therefore the occupants were not significantly displaced by the impact. However, due to the low delta V associated with the impact, the air bag system probably deployed late in the crash which allowed the child passenger to be positioned forward as a result of pre-impact braking actions. At

deployment, the child's upper torso was positioned in a close proximity to the expanding air bag with her face above the level of the mid mount module.

The initial deployment of the front right passenger air bag resulted in contact with the extended left hand of the child passenger. The lower module cover flap and/or the expanding air bag membrane contacted the palmer surface of the child's hand which extended the hand in a rearward direction, resulting in an EMT identified Coles fracture of the wrist. Due to the severity of the child's injuries, the wrist fracture was not medically explored, but noted to be deformed and fractured. There was no abrasion or contusion associated with the hand contact.

The continued expansion of the air bag membrane resulted in contact with the bag as it deployed in a rearward direction. The bag membrane, in a partially folded state, contacted the child passenger in the upper anterior chest, anterior right neck, and under the chin area. This bag contact produced soft tissue abrasions to the contacted areas and accelerated the child in a rearward direction. The continued expansion of the air bag against the child's chin hyperextended the head which resulted in rotary subluxation of C1 on C2. Air bag contact with the upper chest region resulted in a pulmonary contusion of the upper right lobe with bilateral pneumothorax and pneumomediastinum.
The extension and rearward acceleration of the head resulted in a massive cerebral edema with a midline shift to the right and a small left cerebral hematoma. The EMT stated that the soft tissue abrasions of the neck and chin were more pronounced on the right, therefore it was possible that the child occupant's head was turned slightly to the left at deployment. This scenario would support the midline shift to the right and the left subdural hematoma.

In addition to the above injuries, the child passenger was noted to have sustained a soft tissue contusion of the right upper arm. A horizontally oriented whitish scuff mark was noted to the upper rear aspect of the right front door panel. The scuff mark probably resulted from right arm contact as the child passenger was displaced in a rearward direction resulting in the upper arm contusion.

There was no contact evidence on the air bag membrane to support interaction with the child passenger. Her forward position at deployment was evidenced by an altered deployment path of the expanding air bag membrane. The vinyl covering of the upper mid instrument panel was scuffed with white air bag fibers adhered to the vertical surface. This air bag contact pattern was located 8.9-15.2 cm (3.5-6.0") right of center and 3.8-15.2 cm (1.5-6.0") below the top surface of the instrument panel. A patterned cross-hatch air bag fabric transfer was noted to the windshield, located 41.9-44.5 cm (16.5-17.5") right of center and 20.3-23.5 cm (8.0-9.25") above the top of the instrument panel. These transfers support forward displacement of the expanding air bag as the bag encountered the out-of-position forward child passenger.

A vertically oriented scuff mark was documented to the right upper quadrant of the windshield with tissue-like fragments at the bottom and top areas of the mark. This contact was possibly related to a right hand/forearm contact, however, there was no abrasion or injury documented to the upper extremity that was consistent with this transfer. A second possible scenario for this transfer was a nasal expulsion as the

air bag contacted the chest, anterior neck, and chin of the child passenger. The transfer did not resemble a spray-type deposit, but a contact with a body area.

The child passenger came to rest on the right front seat in a slumped attitude resting against the inboard aspect of the seat back support with her left elbow resting on the center console. The child passenger's head was to her left, resting on her left shoulder and against the seat back. This position was noted by the first responding EMT to the scene of the crash. He further noted that the soft tissue abrasions of the chest and neck were oozing, but not resulting in a significant blood loss.

The top surface of the lap belt webbing exhibited a faint reddish stain that was possibly related to the above drainage of the abrasions. This would support the use of the lap belt webbing while the injuries and kinematics support the lack of shoulder belt usage.

MEDICAL TREATMENT

The first arriving EMT on-scene provided the majority of the emergency treatment for the child passenger in the vehicle. He arrived on-scene approximately 10 minutes from the call for his services. As he arrived on scene, the vehicle was parked off-road in the access driveway for the soybean field. The right front door of the vehicle was open and the driver (mother) was standing in the door area over the final rest position of the child. The EMT stated that the mother was gently shaking the child in an attempt to wake her from her unconscious state. He immediately directed the mother away from the child, noted the final rest position of the child and accessed the integrity of the interior of the vehicle (checked for damaged components as possible contact points).

The EMT up-righted the child's head, braced the head in this position, and tilted the head to establish an airway. He stated that the child passenger was attempting to breathe, however, her airway appeared to be obstructed. He immediately placed the child passenger on a backboard and placed her in the ambulance. The EMT noted a deformity of the anterior throat which he suspected was a trachea injury. As he attempted to intubate the child passenger, he encountered an obstruction of the throat which he diagnosed as a crushed trachea with crushing of the cricoid cartilage. He was able to open the airway with his fingers, however, he noted that the severity of the injury was "like holding back water with your fingers". He maintained an airway with his fingers and departed the scene in the ambulance approximately 16 minutes following arrival.

The child was transported by ambulance to a local hospital where she arrived within 15 minutes of scene departure. At the hospital, she was evaluated, treated, and prepared for air transfer to a children's trauma center. The child subsequently arrived at the children's trauma center approximately 5.5 hours post-crash and was further evaluated. She was pronounced brain dead approximately 10 hours following her arrival and maintained on life support for possible organ donation. She was removed from the support late in the evening at the request of the family who declined donation.