CRASH DATA RESEARCH CENTER
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CALSPAN ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION
EVENFLO CONVERTIBLE CHILD SAFETY SEAT
SCI CASE NO: CA05-062

VEHICLE: 1998 FORD CONTOUR
LOCATION: NEW YORK
CRASH DATE: NOVEMBER, 2005

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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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16. Abstract

This investigation focused on the crash dynamics and injury sources of a 3 year old female restrained in a forward facing mode in an Evenflo Convertible Child Safety Seat (CSS). The CSS was positioned in the rear left of a 1998 Ford Contour and was restrained in the vehicle by the 3-point manual lap and shoulder safety belt. The Ford Contour departed the left side of the road, tripped and rolled over. The Ford came to rest in an open field 34 m (110 ft) west of the road and had rolled over three complete revolutions (12 quarter turns). During the course of the rollover, the unrestrained 20 year old male driver was ejected and sustained fatal blunt force head injuries. The crash occurred during the nighttime hours and was not discovered until the next morning by concerned family members (approximately 9.5 hours post-crash). The 3 year old child was found alert and secured in the CSS. She sustained a scalp laceration and a left forearm fracture. The child was transported to a pediatric trauma center, treated and released.

The crash was identified through the local news media by the Calspan Special Crash Investigations Team. The Crash Investigation Division of the National Highway Traffic Safety Administration was notified of the crash on November 28, 2005 and an on-site investigation was assigned due to the agency's high interest in child passenger safety. Cooperation with the investigating police department was established, and the vehicle and child safety seat were available for inspection. The on-site portion of the investigation took place December 2, 2005.

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BACKGROUND

This investigation focused on the crash dynamics and injury sources of a 3 year old female restrained in a forward facing mode in an Evenflo Convertible Child Safety Seat (CSS). The CSS was positioned in the rear left of a 1998 Ford Contour and was restrained in the vehicle by the 3-point manual lap and shoulder safety belt. The Ford Contour departed the left side of the road, tripped and rolled over. The Ford, **Figure 1**, came to rest in an open field 34 m (110 ft) west of the road and had rolled over three complete revolutions (12 quarter turns). During the course of the rollover, the unrestrained 20 year old male driver was ejected and sustained fatal blunt force head injuries. The crash occurred during the nighttime hours and was not discovered until the next morning by concerned family members (approximately 9.5 hours post-crash). The 3 year old child was found alert and secured in the CSS. She had sustained a scalp laceration and a left forearm fracture. The child was transported to a pediatric trauma center, treated and released.

Figure 1: Final rest position of the Ford.

The crash was identified through the local news media by the Calspan Special Crash Investigations Team. The Crash Investigation Division of the National Highway Traffic Safety Administration was notified of the crash on November 28, 2005 and an on-site investigation was assigned due to the agency's high interest in child passenger safety. Cooperation with the investigating police department was established, and the vehicle and child safety seat were available for inspection. The on-site portion of the investigation took place December 2, 2005.

SUMMARY

Crash Site

This single-vehicle crash occurred during the nighttime hours of November, 2005. At the time of the crash, the weather was not a factor. The crash occurred off-road of a two-lane north/south local asphalt roadway. There was a right curve for northbound traffic upstream from the crash site. The radius of curvature measured 302 m (990 ft). The road was level through the curve and transitioned to a negative 2 percent slope at the point of road departure. A 1.6 m (5.3 ft) wide gravel shoulder, a road side ditch and an open field bordered the west side of the road. The depth of the ditch measured 51 cm (20 in) below the level of the road. The 4.6 m (15 ft) wide positive back slope of the ditch transitioned into the open field that had an elevation 61 cm (24

in) above the road. The speed limit in the area of the crash was 89 km/h (55 mph), with a posted 72 km/h (45 mph) advisory speed for the curve. **Figure 2** is a northbound trajectory view at the exit of the curve. **Figure 3** a trajectory view at the point of roadside departure taken during the police investigation.

Figure 2: Trajectory view exiting the right curve.

Figure 3: On-scene trajectory view at the roadside departure.

VEHICLE DATA

1998 Ford Contour

The 1998 Ford Contour SE, **Figure 4**, was identified by the Vehicle Identification Number (VIN): 1FAFP6635WK (production sequence deleted). The four-door sedan was equipped with a power train that consisted of a 2.0 liter I4 engine linked to a four-speed automatic transmission. The service brakes were equipped with four wheel ABS. The manual restraint system consisted of 3-point lap and shoulder belts for the five seat positions. The vehicle was equipped with redesigned frontal air bags that deployed as a result of the crash. The odometer read 195,508 km (121,483 miles) at the time of the inspection. The date of manufacture was unknown. The vehicle was equipped with BF Goodrich Touring T/A P205/60R15 tires on OEM steel wheels. The recommended tire pressure was 233 kPa (34 PSI). It should be noted that the rear tires were worn smooth, the tread depth measured zero. The specific measured tire data at the time of the SCI inspection is identified in the following table:

Figure 4: Left front view of the Ford.

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	Flat	6 mm (7/32 in)	No	Debeaded
LR	172 kPa (25 PSI)	0 mm (0 in)	No	None
RF	Flat	6 mm (7/32 in)	No	Debeaded
RR	Flat	0 mm (0 in)	No	Debeaded

CRASH SEQUENCE

Pre-Crash

The 1998 Ford Contour was traveling northbound driven by a 20 year old unrestrained male. The Ford's rear left position was occupied by a 3 year old female restrained within an Evenflo Convertible Child Safety Seat (Unknown Model) in a forward facing mode. The driver's trip plan was to run an errand to a local video store and return to his residence. Reconstruction analysis indicated the driver of the Ford was operating the vehicle in excess of the speed limit [estimated 120 km/h (75 mph)] on the approach to the right curve. The driver steered late, and drove wide through the curve crossing the centerline. The driver overcorrected the vehicle's errant trajectory back to the right, reentered the northbound lane and then over-steered back to the left. The vehicle's rear tires lost traction and the Ford began to rotate counterclockwise. The police investigation documented that the right side tire scuffs began 11 m (37 ft) north of the exit of the curve The vehicle yawed approximately 66 m (216 ft), across the centerline, through the southbound lane and departed the west side of the road, **Figure 5**. The Ford had rotated 115 degrees counter-clockwise at the point of departure. The vehicle's front fascia and right tires furrowed into the ditch and back slope (refer to **Figure 3** above). The vehicle's furrowing tripped the vehicle into a right side leading roll.

Figure 5: On-scene view of the yaw marks.

Crash

The Ford rolled two quarter turns and impacted the ground with the left rear quarterpanel and left C-pillar area. This ground impact was located 21 m (69 ft) from the trip point and was identified by a 2 m x 4 m (8 ft x 16 ft) area of overturned earth. This impact collapsed the left C-pillar and caused 34 cm (13.2 in) of right lateral deformation to the left rear quarterpanel. The left side window glazings and backlight disintegrated upon impact. The unrestrained driver responded to the right lateral impact force direction and loaded the door panel. As the Ford rolled through 1-1/4 revolutions (5 quarter turns), the centrifugal force of the rotation caused the driver to

overload the door panel and it deformed outboard 20 cm (8 in). The outboard deformation created an ejection portal. The driver was ejected and came to rest approximately 40 m (130 ft) north of the second ground contact. The vehicle then rolled an additional 1-3/4 revolution (7 quarter turns) with a trajectory that arced to the northwest. The vehicle impacted the ground at least seven more times during this interval. The vehicle came to rest on its tires 34 m (110 ft) west of the road edge facing west-southwest. The final rest position measured 87 m (287 ft) from the trip point. A schematic of the crash is attached to the end of this narrative report as **Figure 17**.

Post-Crash

When the driver did not return from his intended errand, the family became concerned about their whereabouts and began to search the area. Due to the off-road location of the vehicle and darkness, a search for the vehicle the night of the crash was unsuccessful. The following morning, the grandparents of the left rear child passenger discovered the crash site. The time interval between the crash and its discovery was an estimated 9.5 hours. The child was found alert and securely restrained within the Child Safety Seat. The grandmother reported that she opened the right rear door and released the vehicle's safety belt to remove the CSS. The child was removed from the vehicle through the right rear door while secured in the CSS. During an interview the grandmother recalled the harness straps appeared "tight" and the chest clip was at the "nipple level". The child and CSS were placed in her vehicle until an ambulance arrived. The child was transported to a pediatric trauma center via ground ambulance, treated, and released the same day. The driver was fatally injured as a result of the ejection. The driver's body was located approximately 20 m (65 ft) southeast of the vehicle.

1998 FORD CONTOUR

Exterior Damage

The exterior damage to the Ford Contour was consistent with a multiple turn rollover event. The vehicle's two side planes, top plane and the all wheels/tires exhibited damage from multiple ground impacts. The scratch pattern was primarily lateral and biased front to rear. The exposed body panel seams on the left side of the vehicle were packed with soil and debris consistent with the direction of the roll. The left window glazings and backlight had disintegrated. The left doors were jammed shut and deformed outboard. The right doors remained closed during the crash sequence and were operational post-crash. The windshield was fractured by the exterior forces of the crash. The most severe damage was vertical damage was located in the left C-pillar area of the roof. The greatest lateral damage was located across the left rear quarterpanel. Refer to **Figures 6 and 7**. The damage at these locations occurred during the first ground impact when the vehicle was rolling between quarter turns 2 and 3. At this time, the vehicle's momentum/energy was the greatest.

Figure 6: Left view of the roof deformation.

Figure 7: Left rear quarterpanel deformation.

The deformation was measured vertically along the left roof rail with a damage length of 114 cm (45.0 in). C1 was located at the junction of the top aspect of the left C-pillar and the left roof rail. C6 was located at the junction of the windshield header and the top aspect of the left A-pillar. The residual vertical crush profile was follows: C1 = 30 cm (12.0 in), C2 = 34 cm (13.2 in), C3 = 29 cm (11.3 in), C4 = 21 cm (8.4 in), C5 = 18 cm (6.9 in), C6 = 14 cm (5.5 in). The maximum crush was located in the left C-pillar area, 10 cm (4 in) forward of C1. The maximum crush measured 38 cm (14.9 in). The maximum right lateral displacement of the left roof rail measured 23 cm (9 in) at left C-pillar.

The vehicle's orientation during the left rear quarterpanel's impact with the ground resulted in a non-horizontal impact force in the 9 o'clock sector. The entire rear clip of the vehicle was swayed to the right resulting in induced buckling of the right rear quarterpanel. The deformation of the left rear quarterpanel was documented at the trim level. The Field L measured 119 cm (47.0 in). C1 was located at the left end of the rear bumper. The residual crush profile (less assumed free space) was as follows: C1 = 21 cm (8.1 in), C2 = 29 cm (11.0 in), C3 = 25 cm (10.2 in), C4 = 34 cm (13.2 in), C5 = 14 cm (5.5 in), C6 = 4 cm (1.5 in). The Collision Deformation Classification of the rollover damage was 00-TDDO3.

Interior Damage

The interior of the Ford Contour was configured with bucket seats for the driver and front right passenger and a three passenger rear bench seat. **Figure 8** is a right view across the front interior. The occupant space in the front compartment was reduced due to the lateral and vertical intrusion of the left roof rail as a result of the rollover impact forces. The left roof rail was intruded laterally 13 cm (5.0 in) due to deformation of the upper aspect of the left B-pillar. The roof rail intruded vertically 13 cm (5.0 in) and was in contact with the head restraint of the driver's seat.

Figure 8: Intrusion of the left rear position.

The driver seat was located in a rear track position and was jammed due to floor pan deformation. The horizontal distance from the driver seat back to the center hub of the steering wheel rim measured 66 cm (26 in). The seat back was reclined 20 degrees. There was no deformation of the steering wheel rim and no displacement of the steering column's shear capsules.

The left doors were jammed shut during the rollover. The driver's door panel exhibited direct occupant contact and loading, **Figure 9**. The door panel was deformed outboard 22 cm (8.5 in) at the beltline. The driver's contact to the door panel began 23 cm (9 in) forward of the B-pillar closure and extended forward 46 cm (18 in). The panel was fractured 58 cm (23 in) forward of the closure over a 10 cm (4.0 in) length and the panel was displaced upwards. The panel displacement measured 6 cm (2.5 in) at the rear aspect relative to the sill. The outboard deformation of the door panel created the driver's ejection path. A 5 cm x 8 cm (2.0 in x 3.0 in) scuff mark located at the outboard aspect of the instrument panel was identified. This mark resulted from probable contact with the driver's lower extremities during the ejection sequence.

Figure 9: View of the driver's ejection path.

The occupant space at the left rear seat position was reduced as a result of the intruded left C-pillar and roof. The intrusion of the left C-pillar was measured at the top aspect of the trim. The magnitude of the intrusion measured 30 cm (12 in) vertical and 23 cm (9 in) lateral. The C-pillar was in contact with the package shelf and the top aspect of the rear seat back. The intrusion measured at the grab handle located on the left roof rail measured 23 cm (9 in) vertical and 23 cm (9 in) lateral. **Figures 10 through 12** depict the relationship between the installed CSS and the residual intrusion. After re-installation, the left C-pillar was in contact with the left wing safety seat shell. The intruded left C-pillar trim contacted and lacerated the left scalp of the child passenger. An 8 cm x 8 cm (3 in x 3 in) area of blood evidence was identified at the top aspect of the trim panel.

Figure 10: View of the relationship between the CSS and the intrusion.

Figure 11: Top aspect of the CSS and intruded trim.

Figure 12: View of reinstalled CSS through the backlight.

Manual Restraint System

The driver's 3-point lap and shoulder restraint consisted a continuous loop webbing, sliding latch plate and Emergency Locking Retractor (ELR). The webbing was stowed in the retractor at the time of the inspection. Extending the webbing from the retractor revealed the retractor's return spring latch was weak and would not respool the webbing. Examination of the belt webbing did not identify any crash related loading evidence. Based on the condition of the retractor and the restraint's inspection, the driver was unrestrained at the time crash consistent with his ejection.

Figure 13: Rear left safety belt.

The rear seat positions in the Ford Contour were each equipped with 3-point lap and shoulder belts. The restraint in the rear left position, **Figure 13**, consisted of a continuous loop webbing, sliding latch plate and a switchable Automatic Locking/Emergency Locking (ALR/ELR) retractor. The webbing was extended from the retractor and was lying on the seat at the time of the SCI inspection. The length of the extended webbing measured 174 cm (68.5 in). The sliding latch plate was located 69 cm (27.0 in) from its exit from the seat bight above the outboard anchor point and the webbing was creased at that location. A 20 cm (8.0 in) section of the webbing exhibited evidence of loading. This webbing section began and ended 47 cm and 67 cm (18.5 in and 26.5 in) above the reference point, respectively, and was consistent with a routing through the forward-facing belt path of the CSS. During the inspection, it was possible to extend the belt webbing further from the switchable retractor. This indicated that the retractor had not been switched to the automatic locking mode during the installation of the CSS. Additionally, the return spring of this retractor was weak and/or was broken. The webbing would not respool onto the retractor. Based on the SCI inspection, the CSS was restrained by the vehicle's safety belt through the forward facing belt path with the retractor in the emergency locking mode. No locking clip was in use.

CHILD SAFETY SEAT DATA

Figure 14 is a front view of the Child Safety Seat (CSS) in use at the time of the crash. The CSS was an Evenflo Secure Choice convertible seat Model No: 2471298P1, manufactured March 21, 2002. The CSS was restrained in the rear left position of the Ford Contour by the vehicle's 3-point lap and shoulder belt in a forward facing mode. The seat was labeled for rear facing use by infants 2 kg to 14 kg (5 lb to 30 lb) and for forward facing use by toddlers 9 kg to 18 kg (20 to 40 lb). The labeled height requirement was 48 cm to 102 cm (19 in to 40 in). Some of the manufacture's labels had been removed. The instruction manual was not present and there was no locking clip.

Figure 14: View of the Evenflo CSS.

The CSS was configured with a 5-point harness system. The harness was routed through the top slots. Both harness straps were folded over, roped, and creased. At the time of the inspection, the straps had been fully extended offering the greatest slack. This adjustment was probably made during the removal of the child from the CSS by EMS. Blood evidence was identified on the left strap and was probably indicative of the adjusted location of the straps. The blood evidence was located 48 cm (19 in) above the seat's base, **Figure 15**. The harness retainer clip was located 30 cm (12 in) above the seat base. The shell of the seat was intact; there were no fractures. The left wing of the seat exhibited minor stress marks as a result of its contact with the intruded left C-pillar, **Figure 16**.

Figure 15: View of the blood evidence and probable strap adjustment.

Figure 16: Minor stress marks on left wing of the CSS shell.

OCCUPANT DEMOGRAPHICS

	Driver	***Rear Left Passenger***
Age/Sex:	20 year old/Male	3 year old/Female
Height:	Unknown	91 cm (36 in)
Weight:	Unknown	15 kg (32 lb)
Seat Track Position:	Rear track	Fixed bench
Restraint Use:	None	Restrained within a 5-point harness in a CSS
Usage Source:	SCI inspection, PAR	SCI inspection, First responder, PAR
Medical Treatment:	None, fatally injured	Transported via ground ambulance, treated and released

DRIVER INJURY

Injury	***Injury Severity (AIS 98 Update)***	***Injury Mechanism***
Blunt force head injury	Unknown (115099.7,0)	Ground contact after ejection

Note: the above injury data was police reported.

DRIVER KINEMATICS

The 20 year old male driver was seated in a rear track position and was unrestrained. The driver lost directional control of the Ford upon exiting a right curve and the vehicle yawed counterclockwise across the road. The vehicle departed the left side of the road, furrowed into the back slope of the road side ditch and tripped into a right side leading roll. The vehicle rolled between 2 and 3 quarter turns and impacted the ground with the left C-pillar area and left rear quarterpanel. The driver responded to the impact force by contacting and loading the left front door panel. The vehicle continued its violent roll and the centrifugal force of the rotation caused an overload of the door panel. The door deformed outboard creating an ejection portal. As the vehicle rolled through 1-1/4 revolutions (5 quarter turns) the driver was ejected. The driver was throw approximately 40 m (130 ft) and sustained fatal blunt force head trauma upon ground contact. He expired at the scene of the crash.

REAR LEFT CHILD PASSENGER INJURY

Injury	***Injury Severity (AIS 98 Update)***	***Injury Mechanism***
Left face linear laceration from the left ear to forehead requiring four staples	Minor (290600.1,2)	Intruding left C-pillar trim
Left facial contusion around the left eye	Minor (290402.1,2)	Intruding left C-pillar
Left forearm fracture, NFS	Moderate (751900.2,2)	Interior contact, probable

Note: the above injury data was based on police reported information and an interview with the passenger's grandmother. The requested medical records were not available.

REAR LEFT PASSENGER KINEMATICS

The 3 year old female child was restrained by a 5-point harness system in a convertible CSS in a forward facing mode. As the Ford Contour rolled violently through the multiple turn rollover event, the child likely loaded the harness straps with her shoulders due to the centrifugal force of the rotation. The shell of the seat provided a volume of protection for the child and minimized her potential injuries.

Upon the first impact with the ground, the left C-pillar area and the roof intruded downward into the left rear occupant space. The left C-pillar contacted the left wing of the CSS indicated by the stress marks in the CSS shell. The trim panel covering the C-pillar lacerated the child's left face and caused a facial contusion about her left eye. During roll sequence, the child's forearm probably flailed and was fractured by an unidentified interior contact as the vehicle impacted the ground.

The child came to rest secured within the CSS. Due to the night time hour of the crash and rural setting, the incident was not discovered until the following morning by concerned family members. The child was still secured in the CSS and was conscious. She was removed from the vehicle through the right rear door while secured in the CSS by the grandmother. She was transported via ambulance to a pediatric trauma center, where she was then treated for her injuries and released.

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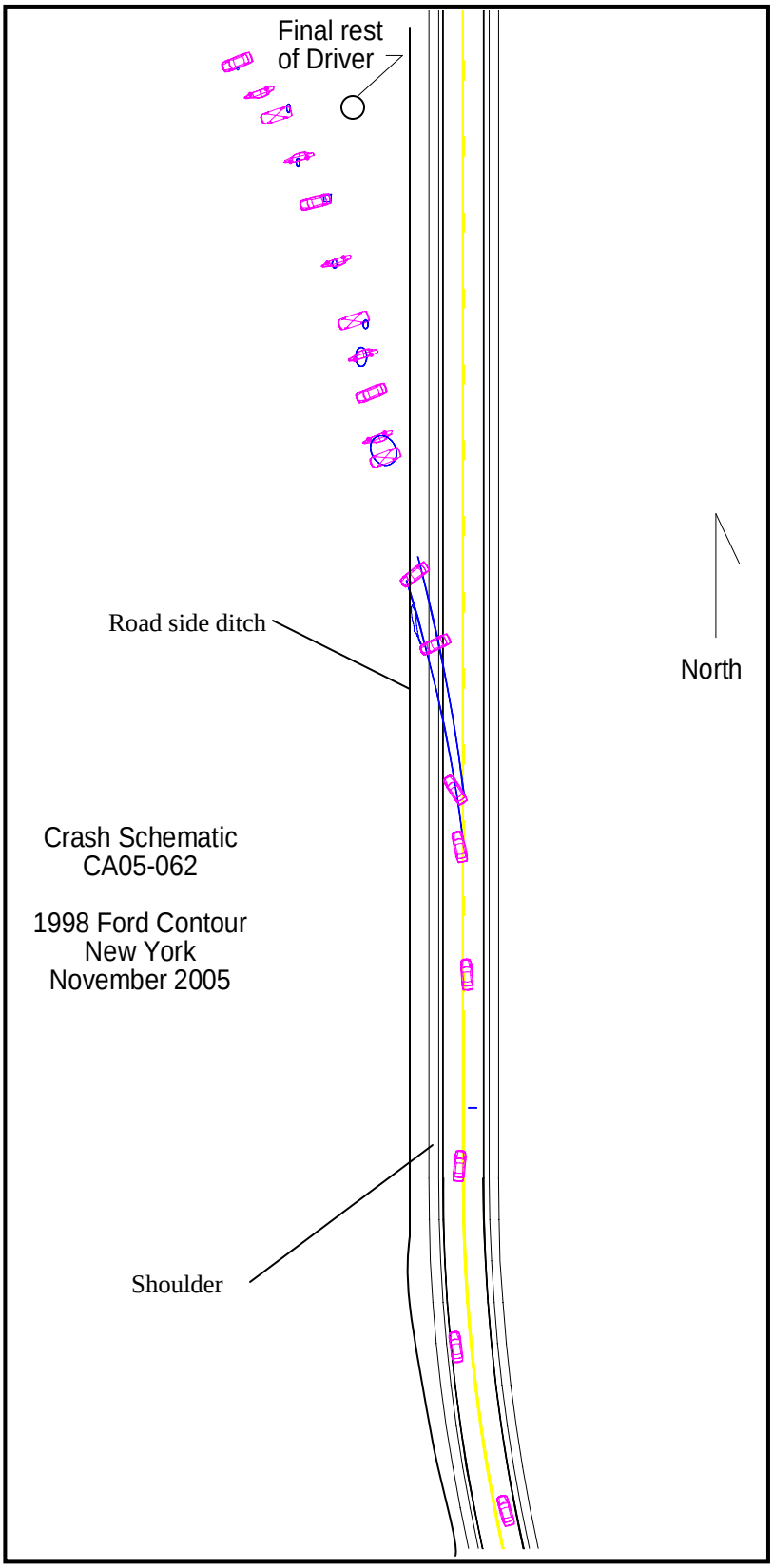

Figure 17: Crash Schematic