Child safety seat fatality/ Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS05002
1993 Eagle Vision
Oregon
January, 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 be 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 on-site investigation focused on a rear-facing infant seat that was installed in the second row middle seat of a 1993 Eagle Vision. The Eagle Vision was occupied by a 32-year-old female, restrained driver and a two-month-old male restrained in the rear facing ISS. The driver was in the eighth month of her pregnancy. The child had been placed in an Evenflo Discovery infant safety seat. The first other vehicle was a 1998 Dodge Caravan driven by a 35 year-old male. The second other vehicle was a 1995 Ford Bronco driven by a 20 year-old male. A 26 year-old male was also present in this vehicle. This three-vehicle crash occurred in January, 2005 at 0815 hours in northeast Oregon. The crash occurred on a straight section of a two lane, undivided state highway. The Eagle Vision was traveling northbound. The other two vehicles were traveling south. For unknown reasons, the Eagle Vision crossed the centerline and entered the southbound lane. The Eagle Vision was struck in the front end by a 1998 Dodge Caravan as the Vision crossed into the opposing lane of travel. The Vision continued traveling in the opposing lane of travel until striking a 1995 Ford Bronco in a head-on configuration. The driver of the Eagle Vision and the rear seat child occupant were both fatally injured.

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Dynamic Science, Inc.
Crash Investigation
Case Number: DS05002

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BACKGROUND:

Description

This on-site investigation focused on a rear-facing infant seat (ISS) that was installed in the second row middle seat of a 1993 Eagle Vision. The Eagle Vision was occupied by a 32-year-old female, restrained driver and a two-month-old male restrained in the rear facing ISS.

The Eagle Vision was initially struck in the front end by a 1998 Dodge Caravan. This occurred as the Vision crossed into the opposing lane of travel. The Vision continued traveling in the opposing lane of travel until striking a 1995 Ford Bronco in a head-on configuration.

This child safety seat fatality case was identified by NHTSA from a news report. DSI was notified on January 27,2005. DSI located the vehicle and child safety seat and was assigned the case on February 1, 2005. Field work was completed on February 4, 2005.

Figure 1. Frontal damage, 1993 Eagle Vision

Figure 2. Approach to area of impact - north

SUMMARY

Crash Site

This three-vehicle crash occurred in January, 2005 at 0815 hours in northeast Oregon. The crash occurred on a straight section of a two lane, undivided state highway. The roadway was asphalt construction. The travel lanes are separated by a dashed yellow line. Both road edges are delineated by solid white fog lines. There are paved asphalt shoulders on both road edges. The posted speed limit is 89 km/h (55 mph).

At the time of the crash, the temperature was 3.0 degrees C (37.4 degrees F), there was 100% humidity, the winds were out of the NE at 7.4 km/h (4.6 mph), and there were patches of fog. The sun was approximately 5 degrees above the horizon with an azimuth 122 degrees E of N.

Pre-Crash

The case vehicle is a 1993 Eagle Vision four-door sedan driven by a 32 year-old female. The driver was in the eighth month of her pregnancy. A 2 month-old male child occupied the second row middle seat position. The child had been placed in an Evenflo Discovery infant safety seat. The first other vehicle was a 1998 Dodge Caravan driven by a 35 year-old male. The second other vehicle was a 1995 Ford Bronco driven by a 20 year-old male. A 26 year-old male was also present in the vehicle.

Figure 3. Area of impact - south

The Eagle Vision was traveling northbound, while the other two vehicles were traveling south. For unknown reasons, the Eagle Vision crossed the centerline and entered the southbound lane.

Crash

The Eagle Vision first struck the left corner of the Dodge Caravan (Event #1). The driver of the Caravan subsequently lost control of his vehicle. It veered off the roadway to the right and came to rest in a roadside ditch facing southwest. The Eagle Vision continued on and then struck the front of the Ford Bronco in a head-on configuration (Event #2). It appears that the frontal air bags in the Vision deployed during this impact. The WinSmash program computed a total Delta V of 43.0 km/h (26.7 mph). The longitudinal and lateral components were -42.3 km/h (-26.3 mph) and -7.5 km/h (-4.6 mph), respectively.

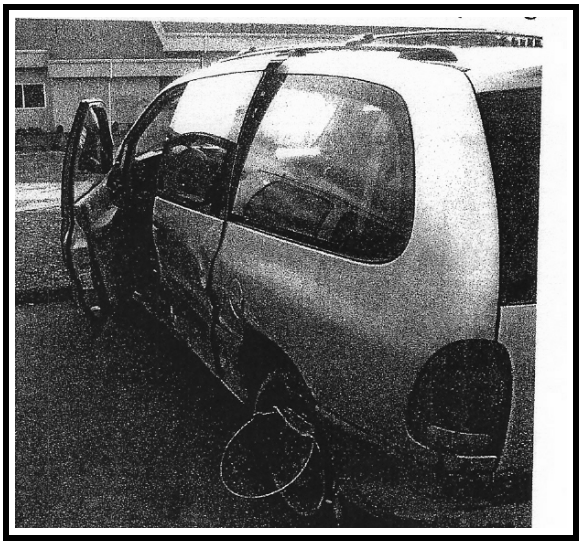

Figure 4. 1998 Dodge Caravan - police photo

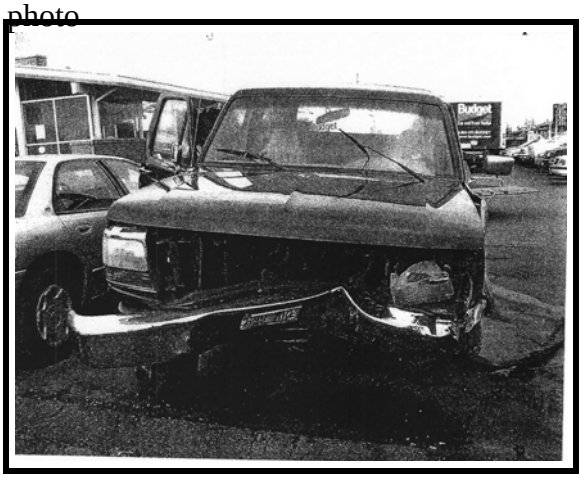

Figure 5. 1995 Ford Bronco - police photo

Post-Crash

The driver of the case vehicle was found entrapped in her seat by the steering wheel and instrument panel. She was extricated and treated at the scene by EMS personnel. They were first contacted at 0758 hours and arrived at 0800 hours. At that time they found her Glasgow Coma Scale (GCS) score to be 15. After having her seat belt cut off and then being extricated by emergency personnel, she was transported to a local hospital by ground ambulance. Upon her arrival, her GCS was found to be 9. An x-ray revealed a dissecting aortic aneurysm with heavy blood loss and she was rushed into emergency surgery. The driver passed

away at 0940 hours that same morning, with death due to probable hemorrhagic shock from probable massive mediastinal disruption.

The ultrasound of the baby indicated that there was no fetal activity and a heart rate roughly counted in the 60s or 70s. From that point it went down to 40 (fetal distress). The unborn child was taken by STAT c-section at 0910 and was pronounced dead at 0930. When taken by c-section the child had no pulse, no respiration, and no tone. After 20 minutes the code was terminated and the male fetus was pronounced dead.

The two month old occupant of the case vehicle sustained what has been described as a massive closed head injury; no other injuries were apparent. A witness stated that the child was found behind the front right seat crying. The medical records indicated that he had sustained multiple skull fractures. These included fractures of the squamousal portions of bilateral temporal bones, both lateral orbital walls, the right orbital roof, right occipital bone, and both posterior parietal bones. There was also an elevated, displaced right occipital fracture, with extracranial herniating of brain parenchyma. There was diffuse bilateral intracranial hemorrhage, filling the ventricles sulci and cisterns. The medical record also indicated that there was the possibility of a small laceration to the right anterior lobe of the liver, but this was not confirmed. Also visible was an area of focal consolidation to the left lower lobe of the lung, which was described as a possible contusion vs. aspiration or atelectasis. The infant was transported from the scene by ground ambulance to a trauma center. Upon arrival he was admitted to the ICU, where his injuries were determined to be inoperable. He was removed from the ventilator at 1630 hours, and had a cessation of heartbeat at 1640 hours. He was at that time pronounced dead—approximately 8 ½ hours post-crash.

The driver of the Caravan did not sustain any injuries. He was transported to a local hospital where he was evaluated and released the same day.

The driver of the Bronco did not sustain any injuries. He was transported to a local hospital where he was evaluated and released the same day.

The Eagle Vision was towed from the scene due to severe damage and was later declared a total loss by the insurance company. The Dodge Caravan and the Ford Bronco were also towed from the scene.

VEHICLE DATA - 1993 Eagle Vision

The 1993 Eagle Vision four-door, five passenger sedan was identified by its Vehicle Identification number (VIN): 2E3ED56T6PHxxxxxx. The mileage at the time of inspection was 235,645 km (146,423 miles). The Eagle Vision was introduced in 1993 and featured a "cab forward" design. The vehicle was equipped with a 3.3 liter, six cylinder engine, an automatic four-speed transmission, front wheel drive, power steering, and a tilt steering wheel. The Eagle was equipped with Marshall All Season radial P205/70R15 tires. The specific tire pressure is as follows:

Tire	Tread	Measured pressure	Manufacturer recommended pressure	Restricted	Damage
LF	6 mm (8/32 in)	Flat	241 kPa (35 psi)	Yes	Pulled off rim
LR	6 mm (7/32 in)	186 kPa (27 psi)	241 kPa (35 psi)	No	None
RR	8 mm (10/32 in)	193 kPa (28 psi)	241 kPa (35 psi)	No	None
RF	6 mm (7/32 in)	197 kPa (28.5 psi)	241 kPa (35 psi)	No	None

The seating in the Eagle Vision was configured with cloth covered bucket seats with adjustable head restraints and a rear bench seat. Both front seats and the rear seat were covered with nylon after-market seat covers. The driver's seat was adjusted to the fully forward seat track position. The driver seat back angle at the time of inspection was 24 degrees from vertical; the seat bottom measured 14 degrees from horizontal. The front right seat back angle was 2 degrees from vertical; the seat bottom measured 15 degrees from horizontal. The distance between the face of the seat back and the right instrument panel was 50.0 cm (19.6 in). The rear bench seat back angle on the right measured 11 degrees from vertical, but this measurement varied since the seat back was no longer fixed. The seat bottom angle at this location measured 10 degree from horizontal; the seat bottom had come free and rotated upward at the rear aspect. The rear bench seat back angle on the left measured 12 degrees forward from vertical; the seat bottom angle measured 14 degrees from horizontal.

VEHICLE DAMAGE

Exterior Damage - 1993 Eagle Vision

Damage Description:	The 1993 Eagle Vision sustained major front end damage as a result of the impacts with the Caravan and Bronco. The damage caused by the Caravan was likely minimal, but it could not be separated from the impact damage sustained from the Bronco. The resultant direct damage began at the left bumper corner and extended laterally 134.0 cm (52.7 in) across the entire front end. Four crush measurements were documented at the bumper and above bumper level and then averaged as follows: C1=45.0 cm (17.7 in), C2=46.0 cm (18.1 in), C3=53.5 cm (21.0 in), C4=58.0 cm (31.1 in). The left front tire was separated from the rim and the rim was deformed. The final rim position was at approximately 90 degrees. The wheelbase on the left had been shortened by 19.0 cm (7.5 in). The wheelbase on the right had been shortened by 2.0 cm (0.8 in).	
CDC:	Event 1: 12FL999 Event 2: 12FDEW3	
Delta V (Event 2):	Total	43.0 km/h (26.7 mph)
	Longitudinal	-42.3 km/h (-26.3 mph)
	Latitudinal	-7.5 km/h (-4.6 mph)
	Energy	135,388 joules (99,857 ft lbs)

Figure 6. Left side, case vehicle

Interior Damage - 1993 Eagle Vision

The driver's knee bolster exhibited scuffing to both the left and right aspects due to occupant contact. The center portion of the instrument panel was dislodged and shifted, but part of this likely occurred post-crash, as the stereo/CD player was being removed. The steering wheel rim had completely collapsed to the point that the rim was now 4.5 cm (1.8 in) below the center of the wheel. The glove compartment door was jammed shut at the time of inspection. The windshield had been fractured due to the impact forces. There also appears to have been a crack to the center area of the windshield due to contact from the rear view mirror. The seat back for the front right position was deformed forward. The rear facing portion of the center console that includes the rear air vents was cracked and scuffed. The entire rear seat back was deformed forward at least partially due to loading from cargo in the trunk.

Figure 7. Bilateral knee contacts

Figure 8. Rear seat movement/deformation

Upon completion of the inspection, the tow operator mentioned that there had been cargo distributed throughout the case vehicle interior. He specifically mentioned a heavy jack stand. Although this item would have inflicted serious injury if it had struck any of the occupants, there were no visible contacts anywhere on it to indicate that this had indeed occurred; no blood, oil, hair or tissue transfers were visible. The medical record likewise showed no visible signs of external trauma to the infant. There were no open wounds, abrasions, contusions, etc. which would have supported the theory of a large, heavy flying object striking the baby.

The front-left seat back was deformed along the center and right quadrants. This deformation appears to have been the result of something, initially located in the rear of the case vehicle, moving forward longitudinally in the direction of the force, and striking this seat back. There were no signs of occupant interaction; no hair, blood or tissue were visible to the front-right seat back area.

There were no physical indications anywhere across the infant seat to indicate that any blunt force had been applied to any of its planes. No deformations, dents, gouging or stress marks, which would have been an indication of flexion or torquing, were visible. The child seat base, which was detachable and independent of the child seat, was firmly affixed to the body of the

infant seat at the time of the inspection. There were no indications that the infant seat had become detached from the base during the crash events.

The child seat had been removed by the first witness to arrive at the case vehicle prior to the reconstructionist arriving on-scene.

MANUAL RESTRAINT SYSTEMS - 1993 Eagle Vision

The 1993 Eagle Vision was configured with manual 3-point lap and shoulder belts for each of the four outboard seating positions. Each lap and shoulder belt was configured with emergency locking retractors. The driver's safety belt was equipped with a sliding latch plate; the remaining outboard safety belts were equipped with locking latch plates. The second row middle seat was configured with a manual lap belt. The webbing for the driver's seat had been cut during extrication. The latch plate was still in the buckle at the time of the vehicle inspection. The shoulder belt anchorages for both front seats were in the full down position. There was scuffing found on the front right belt webbing near the bottom anchor. The second row right seat belt latch exhibited scratching to the latch plate that was consistent with historical usage. The buckle for the second row middle lap belt could not be accessed at the time of the vehicle inspection. It was located below and behind the seat bight and was wedged under the seat bottom. The second row left seat belt latch exhibited scratching to the latch plate that was consistent with historical usage.

Figure 9. Floor jack that was initially in trunk of case vehicle

Figure 10. Driver's seat belt latch and buckle

Figure 11. Second row middle lap belt

SUPPLEMENTAL RESTRAINT SYSTEM - 1993 Eagle Vision

The 1993 Eagle Vision was equipped with single stage frontal air bags for the driver and front right passenger positions. The frontal air bags deployed as a result of the longitudinal deceleration during the impact with the Ford Bronco.

The driver's air bag deployed from the center of the steering wheel hub through symmetrical H-configuration module cover flaps. Each flap measured 16.0 cm (6.3 in) in width and 7.0 cm (2.8 in) in height. The deployed driver's air bag measured 44.0 cm (17.3 in) in its deflated state. The air bag was tethered by a single internal tether. The air bag was internally vented. There were 12 horizontal folds. An irregular cloth transfer was present on the lower left quadrant that measured 9.0 cm (3.5 in) in height and 17.0 cm (6.7 in) in width.

The front right passenger's air bag deployed from a top-mount module with a rectangular cover flap that was hinged at the forward aspect. The module cover flap measured 35.0 cm (13.8 in) in width and 15.0 cm (5.9in) in height. The deployed front right passenger air bag measured 53.0 cm (20.9 in) in width and 60.0 cm (23.6 in) in height. The air bag had a maximum deployed excursion of 65.0 cm (25.6 in). The air bag will come into contact with the seat back.

Figure 12. Deployed driver's air bag

Figure 13. Deployed front right passenger's air bag

CHILD SAFETY SEAT - Evenflo Discovery

An Evenflo Discovery infant safety seat was positioned in the second seat middle seat position of the Eagle Vision in the rear facing configuration. The model number was 3162356 P1 and the date of manufacture was November 15, 2004. It was designed with a carry handle, a stay-in-vehicle base, a head support, and a three-point internal harness. The dimensions for the seat were 46.3 x 43.2 x 71.7 cm (18.25 x 17.0 x 28.25 in). The manufacturer recommends usage in the rear facing mode for children between 2.3-9 kg (5-20 lbs). A label on the infant seat outlined the recommended use of the infant seat as follows:

> Place this infant restraint in rear facing position when using it in a vehicle.
>
> Use only with children who weigh between 5 and 20 pounds (2.3 and 9 kg) and whose height is 26 inches (66 cm) or less.

Figure 14. Evenflo Discovery Infant Safety Seat

At the time of the infant seat inspection, the harness straps were routed through the bottom set of slots.

Infant Seat installation

This infant seat was designed with a detachable base which allowed the shell to be removed while leaving the base still attached by way of the vehicle's seat belt.

The first individual that arrived at the crash site indicated to his wife that the ISS was still firmly affixed to the case vehicle seat, but that the infant was found laying beside the ISS. It appears most likely that the infant had been placed onto the ISS without being restrained by the use of its 3-point internal harness. The medical report noted as well that it was questionable as to whether the child was restrained properly. There were no integumentary injuries to the torso or legs which would have supported the theory that the child had been properly restrained, but had somehow slid out from the 3-point harness during the crash sequence.

Figure 15. Possible stress marks to ISS seat back

Infant Seat Damage

The ISS did not show any visible signs of damage, except for small discolorations on the seat back that might be stress marks. There were no obvious or slight deformities to any portion of the ISS which would have indicated that it had been loose in the rear seat of the case vehicle, and unattached during the crash sequence. There was no deformation to the webbing of its internal harness, a possible indication that the infant had been buckled into the 3-point system and somehow slipped out from underneath it as the crash progressed. Nor did the infant sustain any injuries/bruising from the ISS harness which would have been likely. The retainer clip was noted to still be buckled.

VEHICLE DATA - 1998 Dodge Caravan

Description:	1998 Dodge Caravan minivan	
VIN:	2B4GP439WRxxxxxx	
Odometer:	Unknown	
Engine:	3.0 liter, 6 cylinder	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Moderate left side damage	
CDC:	12LDE99 - per police photo	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

VEHICLE DATA - 1995 Ford Bronco

Description:	1995 Ford Bronco 4x4 sport utility vehicle	
VIN:	1FMEU15N8SLxxxxxx	
Odometer:	Unknown	
Engine:	5.0 liter, V8	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Moderate front end damage. Towed from the scene.	
CDC:	12FYEW1 - per police photo	
Delta V:	Total	26.0 km/h (16.2 mph)
	Longitudinal	-26.0 km/h (-16.2 mph)
	Latitudinal	0.0 km/h (0.0 mph)
	Energy	44,347 joules (32,709 ft lbs)

OCCUPANT DEMOGRAPHICS - 1993 Eagle Vision

	Driver	Occupant 2
Age/Sex:	32/Female	6 week-old/Male
Seated Position:	Front left	Second row middle
Seat Type:	Fabric covered bucket seat, seat track adjusted to full forward position	Fabric covered bench seat
Height:	152 cm (60 in)	Unknown
Weight:	59 kg (131 lbs)	8 kg (17.6 lbs) - estimated by hospital
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	Presumed > 10 years	NA
Body Posture:	Normal, upright	Supine, in infant seat
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	3-point lap and shoulder belt available, used	In an ISS but not restrained by its 3-point internal harness
Air bag:	Steering wheel mounted frontal air bag, deployed	NA

OCCUPANT DEMOGRAPHICS - 1998 Dodge Caravan

	Driver
Age/Sex:	35/Male
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used, per police

OCCUPANT DEMOGRAPHICS - 1995 Ford Bronco

	Driver	Occupant 2
Age/Sex:	20/Male	26/Male
Seated Position:	Front left	Front right
Seat Type:	Unknown	Unknown
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	Unknown	NA
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt used, per police	Unknown

OCCUPANT INJURIES - 1993 Eagle Vision

Driver: Injuries obtained from the medical examiner report, emergency room records, and operative report.

Injury	OIC CODE	Injury Mechanism	Confidence Level
Large aortic transection	420210.5,4	Steering wheel	Probable
Massive placenta abruption (9.9 cm / 3.9 in. long tear which extends from the margin to the cord insertion site)	543400.3,8	Steering wheel	Probable
Multiple rib fractures - closed	450210.2,9	Steering wheel	Probable
Superficial abrasions across the chest	490202.1,0	Seat Belt	Certain
Contusion across the chest	490402.1,0	Seat Belt	Certain
Superficial abrasions across the lower and upper abdomen	590202.1,0	Seat Belt	Certain
Contusion across the abdomen	590402.1,0	Seat Belt	Certain

Second row, right occupant: Injuries obtained from post emergency room records, and radiology reports.

Injury	OIC CODE	Injury Mechanism	Confidence Level
Left subarachnoid hemorrhage	140684.3,2	Seat back	Probable
Left pulmonary contusions	441202.3,2	Unknown	Unknown
Epidural hematoma	140630.4,9	Seat back	Probable
Subdural hematoma	140650.4,9	Seat back	Probable
Diffuse cerebral edema	140660.3,9	Seat back	Probable
Bilateral extensive intracranial hemorrhage with rightward midline shift	140646.5,3	Seat back	Probable
Fractures, squamousal portion of bilateral temporal bones	150402.2,1 150402.2,2	Seat back	Probable
Fractures, right lateral wall and roof orbit	251202.2,1 251202.2,1	Seat back	Probable
Fracture, left lateral orbit wall	251202.2,2	Seat back	Probable

Fracture, both posterior parietal bones	150402.2,1 150402.2,2	Seat back	Probable
Displaced right occipital fracture with extracranial herniation of brain parenchyma	150404.3,1	Seat back	Probable

OCCUPANT INJURIES - 1998 Dodge Caravan

Driver: Transported to a local hospital where he was evaluated and released the same day.

OCCUPANT INJURIES - 1995 Ford Bronco

Driver: Transported to a local hospital where he was evaluated and released the same day.

Front right occupant: Transported to a local hospital where he was evaluated and released the same day.

OCCUPANT KINEMATICS - 1993 Eagle Vision

Driver kinematics

The pregnant, 32-year-old female driver of the Eagle Vision was seated in an upright posture. The fabric covered bucket seat was adjusted to the full forward track position. The seat was covered by a nylon after-market cover. The seat back was slightly reclined. She was wearing the available 3-point manual lap and shoulder belt. The shoulder belt anchorage was in the full down position. Due to the fact that she was 33 weeks along in her pregnancy, it is unclear as to where the lap portion of the seat belt webbing was located across her body.

Figure 16. Driver's seated position

During the forward impacts, the driver moved toward the longitudinal forces. While doing so, the driver loaded the rigid knee bolster with both knees. The driver was located in very close proximity to the steering wheel, and its deploying air bag. Due to her interaction with these components, the steering wheel rim had completely collapsed to the point where the rim was 4.5 cm (1.8 in) below the center of the wheel. The driver was found entrapped between the dash and the steering wheel, and had to be extricated by emergency personnel. She subsequently expired, as did her unborn son.

Second row right occupant kinematics

From all indications, the ISS was affixed to the case vehicle's second row middle seat by the use of the case vehicle's lap belt. The child had been placed onto the ISS, but was likely not restrained by its 3-point internal harness. During the initial front-left offset frontal impact, the vehicle rotated in a slight CCW yaw before impacting the second vehicle head-on. An eyewitness indicated that the ISS was firmly attached to the case vehicle when he observed it. The ISS itself shows no signs of having become a projectile in the vehicle interior during the crash. Although the rigid center console between the two front seats sustained damage from some object, it must be noted that there were a number of cargo items inside the vehicle that flew about during the crash. At impact with the Ford Bronco, the case vehicle decelerated rapidly and nosed downward. The vehicle seat bottom shifted upward and the seat back was deformed forward by impact forces and cargo within the trunk. The ISS rotated forward to some degree. Essentially, the ISS seat back was now more horizontal than vertical and likely acted as a ramp. Since the back of the front-right seat had sustained damage, it appears plausible that the infant struck this as he was ejected from the ISS and propelled to final rest.

Figure 17. Second row right seat occupant seating position

Figure 18. Back of front right seat

This occupant was subsequently removed from the vehicle by the first bystander to arrive on the scene. The infant was then transported to a trauma center, where he expired later that same day.

Attachment 1. Scene Diagram