Child Safety Seat Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS06013
2006 Ford Mustang
California
June 2006

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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 child safety seat that was installed in the right rear position of a 2006 Ford Mustang. The Ford Mustang was occupied by a 23-year-old male driver, a 19-year-old female front right seat occupant, and a 2-week-old male rear right seat passenger, restrained in the rear facing child seat. The crash occurred south of an intersection of two city streets. The other vehicle was a 1992 Honda Accord that was being driven by a male. There were two additional male occupants in this vehicle. The Ford Mustang was traveling south at reported high speed. For unknown reasons, the Mustang crossed into the northbound lane, struck the Honda Accord, and flipped onto the hood of the Accord. The driver of the Mustang sustained a neck and clavicle fracture. He was hospitalized and placed under arrest. The 19-year-old female occupant was trapped in the vehicle and was declared dead at the scene. The 2-week-old child occupant was transported to the hospital. CT scan revealed a hemorrhage along the left frontoparietal cortex. He was admitted for observation. The driver of the Honda sustained a compound leg fracture. The other two occupants of this vehicle complained of pain. Both vehicles were towed from the scene.

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Crash Investigation
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BACKGROUND

This on-site investigation focused on a rear-facing child safety seat that was installed in the right rear position of a 2006 Ford Mustang. The crash occurred in an urban area of southern California. The Ford Mustang (see Figure 1) was occupied by a 23-year-old male driver, a 19-year-old female front right seat occupant, and a 2-week-old male rear right seat passenger, restrained in the rear facing child seat. The crash occurred south of an intersection of two city streets. The other vehicle was a 1992 Honda Accord that was being driven by a male. There were two additional male occupants in this vehicle. The Ford Mustang was traveling south at reported high speed. For unknown reasons, the Mustang crossed into the northbound lane, struck the Honda Accord, and flipped onto the hood of the Accord. The driver of the Mustang sustained a neck and clavicle fracture. He was hospitalized and placed under arrest. The 19-year-old female occupant was trapped in the vehicle and was declared dead at the scene. The 2-week-old child occupant was transported to the hospital. CT scan revealed a hemorrhage along the left frontoparietal cortex. He was admitted for observation. The driver of the Honda sustained a compound leg fracture. The other two occupants of this vehicle complained of pain. Both vehicles were towed from the scene.

Figure 1. Damaged 2006 Ford Mustang

This child safety seat case was identified by NHTSA through an on-line news article. DSI was notified on June 8, 2006 with instructions to locate the vehicle and child seat. The investigating officer was contacted. The case vehicle and the child safety seat were in his possession. DSI was assigned the case on June 13, 2006. The investigating officer indicated that the inspection could take place once he finished his investigation. Field work was completed on July 29, 2006.

SUMMARY

Crash Site

This two-vehicle crash occurred south of a four-leg intersection. The southbound approach to the intersection is essentially straight. Immediately after the intersection, the roadway begins a sharp right hand curve. The north/south roadway was configured with two lanes in each direction that were separated by a double-yellow painted center line. There is a 6.3% down grade in the southbound direction, and a 6.8% up grade in the northbound direction. The asphalt roadway was dry and free of any obstructions at the time of the crash. The speed limit is 72 km/h (45 mph).

Figure 2. Approach to area of impact (south)

Pre-Crash

The 2006 Ford Mustang was traveling southbound in the first lane from the right and had passed through the four-leg intersection (see Figure 2). The Ford Mustang was occupied by a 23-year-old male driver, a 19-year-old female front right seat occupant, and a 2-week-old male rear right seat passenger, restrained in the rear facing child seat. The 1992 Honda Accord was traveling northbound in the first lane from the right (see Figure 3). The Honda Accord was being driven by a male. There were two additional male occupants in this vehicle.

Figure 3. Approach to area of impact (north)

As the Mustang passed through the intersection, the driver began braking and steered sharply to the left, possibly in an effort to avoid striking the western curb. The Mustang began a counterclockwise rotation. The Mustang had rotated approximately 45 degrees before it crossed the double yellow center line, and was at a greater than 90 degree angle as it entered the northbound travel lane.

Crash

It does not appear that the driver of the Honda Accord was able to brake or take any avoidance actions. The front of the Accord struck the right side of the Ford Mustang (03RYEW4). See Figure 4 for an overview impact area. The missing vehicle routine of the WinSmash program computed a total delta V of 43.0 km/h (26.7 mph) for the case vehicle. The longitudinal and lateral components were 7.5 km/h (4.6 mph) and -42.3 km/h (-26.3 mph), respectively. The impact severity was moderate. The impact tripped the Mustang and caused it to roll two quarter turns onto the hood of the Accord, where it came to rest (see Figure 5).

Figure 4. Overview of impact and final rest area (east)

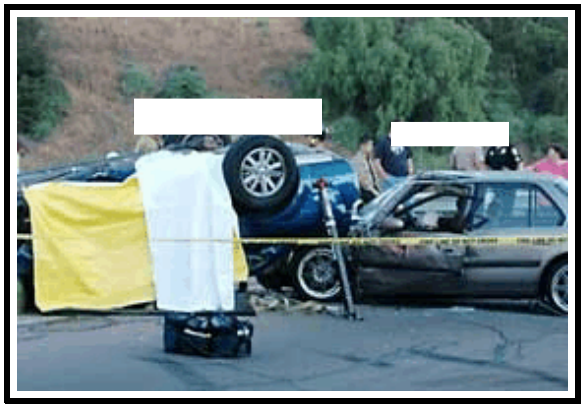

Figure 5. Final rest (news photo)

Post-Crash

The driver of the Mustang sustained a right clavicle fracture, a cervical spine fracture, a right lung contusion, and a concussive head injury. He required extrication by EMS personnel due to his injuries. He was transported to an area hospital, treated and then placed under arrest on various felony charges. He arrived at the hospital with a Glasgow Coma Scale (GCS) score of 15. He was hospitalized for a total of four days.

The front right female passenger was entrapped in the vehicle. She was declared dead at the scene. She sustained a basilar skull fracture, a brain stem injury, bilateral mandible fractures, and multiple contusions and abrasions.

According to the investigating police officer, the 2-week-old male right rear seat occupant was found upside down still harnessed to the child seat and the child seat was still anchored to the vehicle. According to the officer, the child seat was loosely anchored to the vehicle and seemed to be hanging further down than it should have been. The child was transported from the scene to a local hospital. There were reports of brief periods of apnea prior to arrival at the emergency room. On presentation at the emergency room the child appeared well with no further episodes of apnea. He arrived with a GCS score of 15–GCS appropriate to age. The decision was made to obtain a CT scan and admit the child into the intensive care unit as a precaution, given the history of apnea and the crash events. The CT scan revealed a hemorrhage along the left frontoparietal cortex. He was admitted for observation.

The driver of the Honda sustained a compound leg fracture. The other two occupants of this vehicle complained of pain. Both vehicles were towed from the scene.

VEHICLE DATA -2006 Ford Mustang

The 2006 Ford Mustang two-door coupe was identified by the Vehicle Identification Number (VIN): 1ZVFT80N565xxxxxx. The vehicle's odometer could not be read since there was no power to the instrument panel. The Ford Mustang was equipped with a 4.0 liter, six cylinder engine, a 5-speed manual transmission, rear wheel drive, front and rear power disc brakes, power rack and pinion steering, and a tilt steering column. The Mustang was configured with BF Goodrich TA P215/65R16 tires. The manufacturer's recommended tire pressure was 241 kPa (35 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Unknown	6 mm (8/32 in)	No	Rim scuffs
LR	Unknown	5 mm (6/32 in)	No	None
RR	Unknown	6 mm (8/32 in)	No	Tire abraded
RF	Unknown	5 mm (6/32 in)	No	Rim bent

The seating in the 2006 Ford Mustang was configured with fabric covered front bucket seats with adjustable head restraint and a rear bench seat with separate back rests. Both front seats were adjusted to the middle track position. The seat bottom angles for the front seats was 30 degrees. The seat back angle for the driver's seat was unknown–it had been moved. The angle for the front right passenger's seat was 65 degrees.

VEHICLE DAMAGE

Exterior Damage - 2006 Ford Mustang

The 2006 Ford Mustang sustained severe right side damage as a result of the impact with the Honda Accord (see Figure 6). The direct damage began 59.0 cm (23.2 in) forward of the rear axle and extended 188.0 cm (74.0 in) forward along the right side plane. The maximum lateral crush was located at the C4 location. The right side door was deformed and jammed shut. The combined direct and induced damage began 12.0 cm (4.7 in) rearward of the rear axle and extended 263.0 cm (103.5 in) forward along the right side plane. The right A and B pillars were deformed laterally. The roof had induced buckling damage. The side glass on the right side was disintegrated. The windshield was fractured. The right wheel based was shortened by 27.0 cm (10.6 in). Six crush measurements were documented at the mid door level as follows: C1 = 0 cm (0 in), C2 = 13.5 cm (5.3 in), C3 = 40.0 cm (15.7 in), C4 = 68.0 cm (26.8 in), C5 = 40.0 cm (15.7 in), C6 = 0 cm (0 in).

The Mustang also sustained moderate damage to the hood, roof and deck lid from the rollover event (see Figure 7). The direct damage measured 410.0 cm (161.4 in) longitudinally and 125.0 cm (49.2 in) laterally. The maximum crush was along the backlight header and rear roof areas.

CDC:	Impact 1: 03RYAW4 Impact 2: Unknown (rollover event)[1] Impact 3: 00TDDW3	
Delta V (impact 1):	Total	43.0 km/h (26.7 mph)
	Longitudinal	7.5 km/h (4.6 km/h)
	Latitudinal	-42.3 km/h (-26.3 mph)
	Energy	154,496 joules (113,950 ft lbs)

Figure 6. Right side, 2006 Ford Mustang

Figure 7. Right side roof area

[1]Event added to enable EDCS entry

Interior Damage - 2006 Ford Mustang

The 2006 Ford Mustang sustained moderate interior damage as a result of passenger compartment intrusion and occupant contacts. The right door, A pillar, B pillar sustained lateral intrusion. The front right seat was compressed 24.0 cm (9.4 in), as measured to the outside edge.

The front right door was jammed shut. All of the side glass on the right side was disintegrated during the impact with the Honda. The windshield was fractured and holed in front of the front right passenger seat position. The hole measured 36.0 cm (14.2 in) wide by 16.0 cm (6.3 in) high, but this likely due to heat sag. The backlight was disintegrated. This likely occurred during the rollover event. The right instrument panel was buckled due to intrusion.

There were circular marks to the interiors of both front doors that were likely related to extrication efforts.

There were blood drops and smears found on the right instrument panel, the right door panel, the center console, and the right seat back. There was a significant area of pooled blood on the interior roof, just above the front right seat occupant.

The specific passenger compartment intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
RF	Door panel	34.0 cm (13.4 in)	Lateral
RF	Window frame	34.0 cm (13.4 in)	Lateral
RF	B pillar	14.0 cm (5.5 in)	Lateral
RF	Lower A pillar	30.0 cm (11.8 in)	Lateral
RF	Seat back	24.0 cm (9.4 in)	Lateral
RF	Sill	34.0 cm (13.4 in)	Lateral
LF	Center console	4.0 cm (1.6 in)	Lateral
LR	Roof/backlight header	6.0 cm (2.4 in)	Vertical
RR	Roof/backlight header	5.0 cm (1.9 in)	Vertical

MANUAL RESTRAINT SYSTEMS - 2006 Ford Mustang

The 2006 Ford Mustang was configured with manual 3-point lap and shoulder belts for each of the four seating positions. Both front seats were equipped with retractor pretensioners. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The driver's belt exhibited signs of historical usage. The remaining safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The front right safety belt had been cut off the front right seat occupant by emergency personnel.

Figure 8. Seat belt webbing routing

The rear right safety belt was used to anchor a rear facing infant safety seat (see Figure 8). At the time of the vehicle inspection, the latch had been unfastened but the webbing was still trapped between the infant seat and the base.

Supplemental Restraint System - 2006 Ford Mustang

The 2006 Ford Mustang was equipped with dual-stage frontal air bags and safety belt retractor pretensioners for the driver and front right passenger position. The front air bags were located in the center of the steering wheel hub and the right instrument panel. There were no air bag deployments. The pretensioners did not actuate.

Child Safety Seat

BabyTrend Latch-Loc

A BabyTrend Latch-Loc rear facing infant safety seat was positioned in the rear right seat of the Ford Mustang (see Figure 9). The model number was 6001 and the date of manufacture was July 20, 2004. The infant seat was configured with a five-point safety harness. The seat is designed to be used with or without the stay-in-vehicle base. The seat was being used with the stay-in-vehicle base. The seat is designed to be used rear facing. The manufacturer recommends the use of the child seat for infants who weigh between 2.2 - 10 kg (5-22 lbs) and whose height is 72.4 cm (28.5 in) or less. The child in this crash was within the weight recommendations (4 kg/9 lbs). His height is not known.

Figure 9. BabyTrend Latch-Loc infant safety seat

The Ford Mustang was equipped with two tether anchors on the rear package shelf behind each rear seat position. The child seat was configured with a rigid LATCH system and a rear tether strap. Neither feature was being used at the time of the crash.

At the time of the child seat inspection, the harness straps were routed through the top slots. The child seat base was anchored to the vehicle using the manual 3-point lap and shoulder belt in the rear right seat position. The seat belt was equipped with a switchable retractor that appears to have been in the emergency locking retractor mode.

The child seat was damaged during the crash due to lateral loading. The seat base to child seat attachment point on the left side of the seat (on the right side as installed in the vehicle) was deformed (see Figures 10-13). The base release lever moved but would not release the base. This prevented the child seat from being removed from the child seat base. Since the seat belt was routed between the child seat and the base, this prevented the child seat from being removed from the vehicle. Rescue personnel were able to unbuckle the vehicle safety belt, but the sliding latch could not pass between the child seat and the base. The child seat and base were removed from the vehicle by this investigator by cutting the vehicle safety belt.

Figure 10. Base release lever

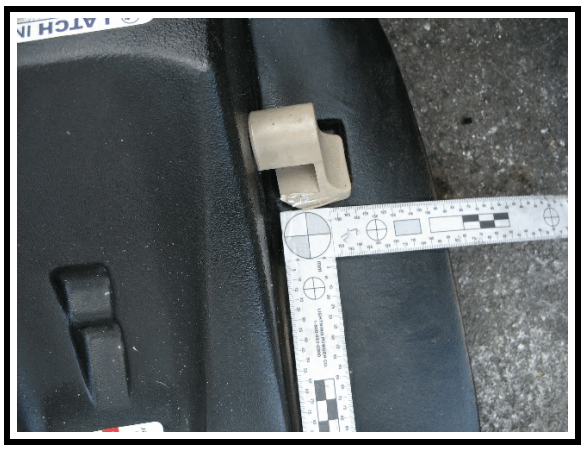

Figure 11. Damage to base attachment

Figure 12. Misalignment of seat and base

Figure 13. Child seat and base attachment point

VEHICLE DATA - 1992 Honda Accord

Description:	1992 Honda Accord four door sedan	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Moderate front end damage. Damage to hood and possibly windshield from rollover contact with Ford Mustang.	
CDC:	Unknown	
Delta V (impact 1, missing vehicle routine):	Total	52.0 km/h (32.3 mph)
	Longitudinal	-51.2 km/h (-31.8 mph)
	Latitudinal	9.0 km/h (5.6 mph)
	Energy	98,941 joules (72,975 ft lbs)

OCCUPANT DEMOGRAPHICS - 2006 Ford Mustang

	Occupant 1	Occupant 2	Occupant 3
Age/Sex:	23/Male	19/Female	2 weeks/Male
Seated Position:	Front left	Front right	Second row, right
Seat Type:	Fabric covered bucket seat with folding back. Adjusted to middle track position.	Fabric covered bucket seat with folding back. Adjusted to middle track position.	Fabric covered bench seat.
Height:	Unknown	155 cm (61 in)	Unknown
Weight:	Unknown	47 kg (104 lbs)	4 kg (9 lbs)
Occupation:	Unknown	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted	None noted
Alcohol/Drug Involvement:	Yes	NA	NA
Driving Experience:	Unknown	NA	NA
Body Posture:	Upright	Upright	Seated in CSS
Hand Position:	Both hands likely on steering wheel, actively steering	Unknown	NA
Foot Position:	Right on brake.	Unknown	NA
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used	Lap and shoulder belt used with child safety seat
Air bag:	Steering wheel mounted front air bag, did not deploy	Passenger frontal air bag, did not deploy	NA

OCCUPANT DEMOGRAPHICS - 1992 Honda Accord

	Driver	Occupant 2	Occupant 3
Age/Sex:	Unknown/male	Unknown/male	Unknown/male
Seated Position:	Front left	Unknown	Unknown
Seat Type:	Unknown	Unknown	Unknown
Height:	Unknown	Unknown	Unknown
Weight:	Unknown	Unknown	Unknown
Occupation:	Unknown	Unknown	Unknown
Pre-existing Medical Condition:	Unknown	Unknown	Unknown
Alcohol/Drug Involvement:	None	NA	NA
Driving Experience:	Unknown	NA	NA
Body Posture:	Unknown	Unknown	Unknown
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	Unknown	Unknown	Unknown

OCCUPANT INJURIES -2006 Ford Mustang

Driver: Injuries obtained from ER records, Radiology records, Operative Report and Post-ER records.

Injury	OIC Code	Injury Mechanism	Confidence Level
Fracture, comminuted, right clavicle	752200.2,1	Seat back	Possible
Fracture, cervical spine, odontoid (dens), C2	650228.3,6	Roof	Possible
Contusion, right lung	441402.3,1	Seat back	Possible
Awake on admission, with prior unconsciousness, length of time NFS	160406.2,0	Roof	Possible

Front right occupant: Injuries obtained from Autopsy Report.

Injury	OIC Code	Injury Mechanism	Confidence Level
Complex basilar skull fracture (comminuted/ring-type/hinged)	150206.4,8	Right side window frame	Possible
Brain stem injury involving hemorrhage (pons, medulla)	140210.5,8	Right side window frame	Possible
Injury to the cerebellum resulting in subarachnoid hemorrhage	140470.3,6	Right side window frame	Possible
Injury to the cerebrum resulting in subarachnoid hemorrhage	140684.3,9	Right side window frame	Possible
Fractured mandible NFS, bilateral	250600.1,3	Right side window frame	Possible
Fractured (chipped) left upper lateral incisor	251404.1,2	Right side window frame	Possible
Abrasion, left temple	190202.1,2	Unknown	Unknown
Contusion, right breast	490402.1,1	Door	Probable
Multiple abrasions, right abdomen	590202.1,1	Door	Certain

Abrasion, left hip	590202.1,2	Center console	Probable
Abrasion, left elbow	790202.1,2	Unknown	Unknown
Abrasion, left arm	790202.1,2	Unknown	Unknown
Abrasion, left wrist	790202.1,2	Unknown	Unknown
Multiple abrasions, left hand	790202.1,2	Unknown	Unknown
Multiple abrasions, right forearm	790202.1,1	Flying glass	Possible
Contusion, right forearm	790402.1,1	Door	Probable
Multiple lacerations, minor, right hand	790602.1,1	Flying glass	Possible
Multiple contusions, left thigh	890402.1,2	Center console	Probable
Abrasion, left knee	890202.1,2	Center console (lower, towards front)	Possible
Multiple contusions, left lower leg	890402.1,2	Center console (lower, towards front)	Possible
Multiple abrasions, left ankle	890202.1,2	Center console (lower, towards front)	Possible
Fractures, displaced, distal right femur, shaft	851814.3,1	Door	Certain
Multiple contusions, right thigh	890402.1,1	Door	Certain
Multiple abrasions, right thigh	890202.1,1	Door	Certain
Multiple contusions, right lower leg	890402.1,1	Door	Certain
Abrasion, right knee	890202.1,1	Door	Probable
Abrasion, right ankle	890202.1,1	Sill	Probable
Abrasion, top of right foot	890202.1,1	Sill	Probable
Multiple lacerations, minor, liver	541822.2,1	Door	Certain

Laceration, minor, spleen	544222.2,2	Seat back (compression from door)	Possible
Laceration, moderate, right kidney	541624.3,1	Door	Probable
Multiple fractures, ribs, R1, R2, R6, R10, R11, R12	450230.3,1	Door	Certain
Contusions, lungs, bilateral	441410.4,3	Door	Certain
Multiple fractures, displaced, pubic bone, bilateral	852604.3,5	Door	Certain

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

Injury	OIC Code	Injury Mechanism	Confidence Level
Hemorrhage along the left frontoparietal cortex	140629.4,2	Child safety seat interior	Probable

OCCUPANT INJURIES - 1992 Honda Accord

Driver: Injuries obtained from news accounts/investigating officer.

Injury	OIC Code	Injury Mechanism	Confidence Level
Compound leg fracture, unknown aspect	852002.2,9	Unknown	Unknown

Occupant 2: Complained of pain.

Occupant 3: Complained of pain.

OCCUPANT KINEMATICS - 2006 Ford Mustang

Driver Kinematics

Figure 14. Driver's seated position

The 23-year-old male driver was likely seated in an upright posture and was restrained by the manual lap and shoulder belt (see Figure 14). The fabric covered bucket seat was adjusted to the mid track position. The seat bottom angle this seat was 30 degrees. The seat back angle for the driver's seat was unknown–it had been moved. Prior to impact, the driver was actively steering both left and right. He was also braking–likely with his right foot. Both hands were likely on the steering wheel during the active steering efforts. As the driver lost control of the vehicle and it began a counterclockwise rotation, the driver began pitching to the right. At impact, the driver initiated a lateral and slightly rearward trajectory to the right in response to the 3 o'clock (100 degree) direction of force. His right hip likely engaged the center console to some extent. As the vehicle overturned, the driver continued the movement to the right and then to the top as the vehicle came to rest on its roof. The driver of the Mustang sustained a right clavicle fracture, a cervical spine fracture, a right lung contusion, and a concussive head injury. The head and neck injuries were most likely as a result of contact with the right seat back. He required extrication by EMS personnel due to his injuries. He was transported to an area hospital, treated and then placed under arrest on various felony charges. He was hospitalized for a total of four days.

Front Right Occupant Kinematics

Figure 15. Front right occupant seated position

The 19-year-old female front right occupant was likely seated in an upright posture and was restrained by the manual lap and shoulder belt (see Figure 15). The fabric covered bucket seat was adjusted to the mid track position. The seat bottom angle for this seat was 30 degrees; the angle for the front right passenger's seat back was 65 degrees. Prior to impact, the driver was actively steering both left and right. As the driver lost control of the vehicle and it began a counterclockwise rotation, the front right occupant began pitching to the right. At impact, the front right occupant initiated a lateral and slightly rearward trajectory to the

right in response to the 3 o'clock (100 degree) direction of force. This occupant's entire right side torso likely engaged the right door as a result of both the direction of force and intrusion through the right side plane. Her left hip likely engaged the center console to some extent. As the vehicle overturned, the front right occupant continued the movement to the right and then to the top as the vehicle came to rest on its roof. She was trapped in the vehicle and fatally injured.

Figure 16. Front right seat position, shows lateral door intrusion

Second Row Right Occupant Kinematics

The 2-week-old male child was restrained in the rear facing infant seat by the five point harness. The infant seat was installed in the rear right position of the Ford Mustang using the vehicle lap and shoulder belt (see Figure 17). The fabric covered bench seat had a seat back angle of 69 degrees and a seat bottom angle of 21 degrees. Based on the post-crash harness adjustment, it appeared that the child was held relatively tightly in place. The child remained in the child seat after the rollover.

Prior to impact, the driver was actively steering both left and right. As the driver lost control of the vehicle and it began a counterclockwise rotation, this occupant began pitching to the right. At impact, this occupant initiated a lateral and slightly rearward trajectory to the right in response to the 3 o'clock (100 degree) direction of force. He likely contacted the inside shell of the infant seat with the left side of his body and the left side of his head. According to the investigating police officer, this occupant was found upside down still harnessed to the child seat and the child seat was still anchored to the vehicle. According to the officer, the child seat was loosely anchored to the vehicle and seemed to be hanging further down than it should have been. He was removed from the infant seat by rescue personnel. The child seat remained in the vehicle. The child was transported from the scene to a local hospital. A CT scan revealed a hemorrhage along the left frontoparietal cortex. He was admitted for observation.

Figure 17. Second row right occupant seated position

Attachment 1. Scene Diagram