Advanced Occupant Protection System Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS03007
2003 Toyota Matrix XR sport utility
Texas
January, 2003

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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 single vehicle Advanced Occupant Protection crash occurred in January, 2003 at 2327 hours in Texas. The crash occurred on three-lane toll road. The speed limit is 89 km/h (55 mph).

The case vehicle was a 2003 Toyota Matrix XR five door sport utility driven by an unrestrained 38-year-old male. The case vehicle was traveling northbound in the far right lane of the toll road. The police report indicates that the driver reached down to pick up some coins. The vehicle apparently went to the right at this point. The driver over-corrected to the left and lost control of the vehicle. The vehicle traveled across the adjacent lanes and struck a concrete wall. The driver and front right passenger air bags deployed at this point. As a result of the initial impact with the wall both front seat belt pretensioners fired and locked the seat belts in the stowed position. As the vehicle engaged the wall, it went into a counterclockwise rotation. The vehicle tripped and began to overturn–first onto its right side then onto its roof. While on its roof, the vehicle continued to rotate until striking the concrete wall with the rear of the vehicle.

The driver sustained abrasions to his left forearm and right forehead, a nasal fracture, a lower back strain, and an unspecified lower leg injury.

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Dynamic Science, Inc.
Accident Investigation
Case Number: DS03007

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BACKGROUND:

Description: This Advanced Occupant Protection System (AOPS) case was identified by the local National Automobile Sampling System (NASS) Primary Sampling Unit. The case was reported to DSI on February 14, 2003. All field work was completed on March 3, 2003.

Investigation Type: On-scene
Crash Location: Texas
Crash Date: January, 2003
Notification Date: February 14, 2003
Field Work Completed: March 3, 2003

SUMMARY:

This single vehicle crash occurred in January, 2003 at 2327 hours in Texas. The crash occurred on three-lane toll road. The concrete roadway was dry and free of reported defects. The northbound lanes are separated from the southbound lanes by a concrete median barrier. The speed limit is 89 km/h (55 mph).

The case vehicle was a 2003 Toyota Matrix XR five door sport utility driven by an unrestrained 38-year-old male (180 cm/71 in, 76 kg/168 lbs). The driver was seated in a fabric covered bucket seat that was adjusted to between the middle and rear most track position with a seat back angle of 67 degrees from horizontal.

Figure 1. Overview of crash scene (north). Struck wall is on the left.

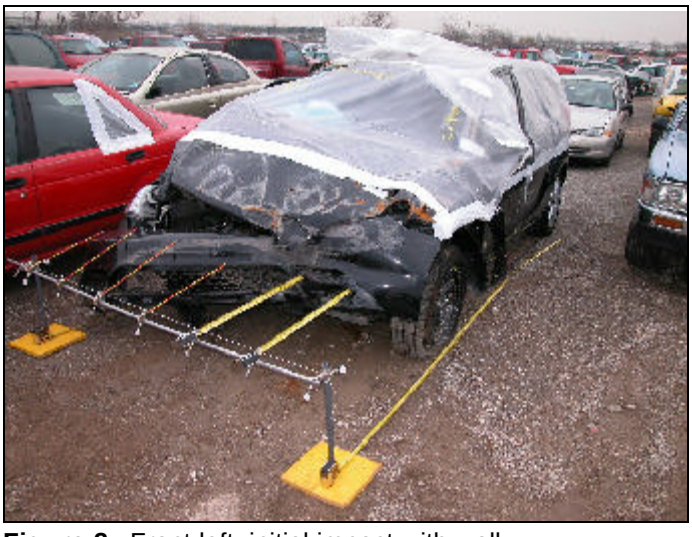

Figure 2. Front left, initial impact with wall

The case vehicle was traveling northbound in the far right lane of the toll road. The police report indicates that the driver reached down to pick up some coins. The vehicle apparently drifted to the right at this point. The driver over-corrected to the left and lost control of the vehicle. The vehicle traveled across the adjacent lanes and struck a concrete wall (12FDEW2). The total velocity change calculated by the Barrier algorithm of the WinSmash collision model was 25.0 km/h (15.5 mph). The longitudinal and lateral components were -24.6 km/h (-15.3 mph) and -4.3 km/h (-2.7 mph), respectively.

Figure 3. Top of hood, roof, rollover damage

The driver and front right passenger air bags deployed at this point. As a result of the initial impact with the wall both front seat belt pretensioners fired and locked the seat belts in the stowed position.

As the vehicle engaged the wall, it went into a counterclockwise rotation. The vehicle tripped and began to overturn–first onto its right side then onto its roof (00TDDO2). While on its roof, the vehicle continued to rotate until striking the concrete wall with the rear of the vehicle (00BZHW2).

Figure 4. Rear of vehicle–impact with wall

The driver sustained abrasions to his left forearm and right forehead, a nasal fracture, a lower back strain, and an unspecified lower leg injury. He was transported to a local hospital for treatment. The ambulance was notified at 2330 hours and arrived on scene at 2338 hours–11 minutes post-crash. He was transported to a local hospital and then released several hours later.

The case vehicle was towed from the scene. It was later declared a total loss by the insurance company.

Scene Diagram

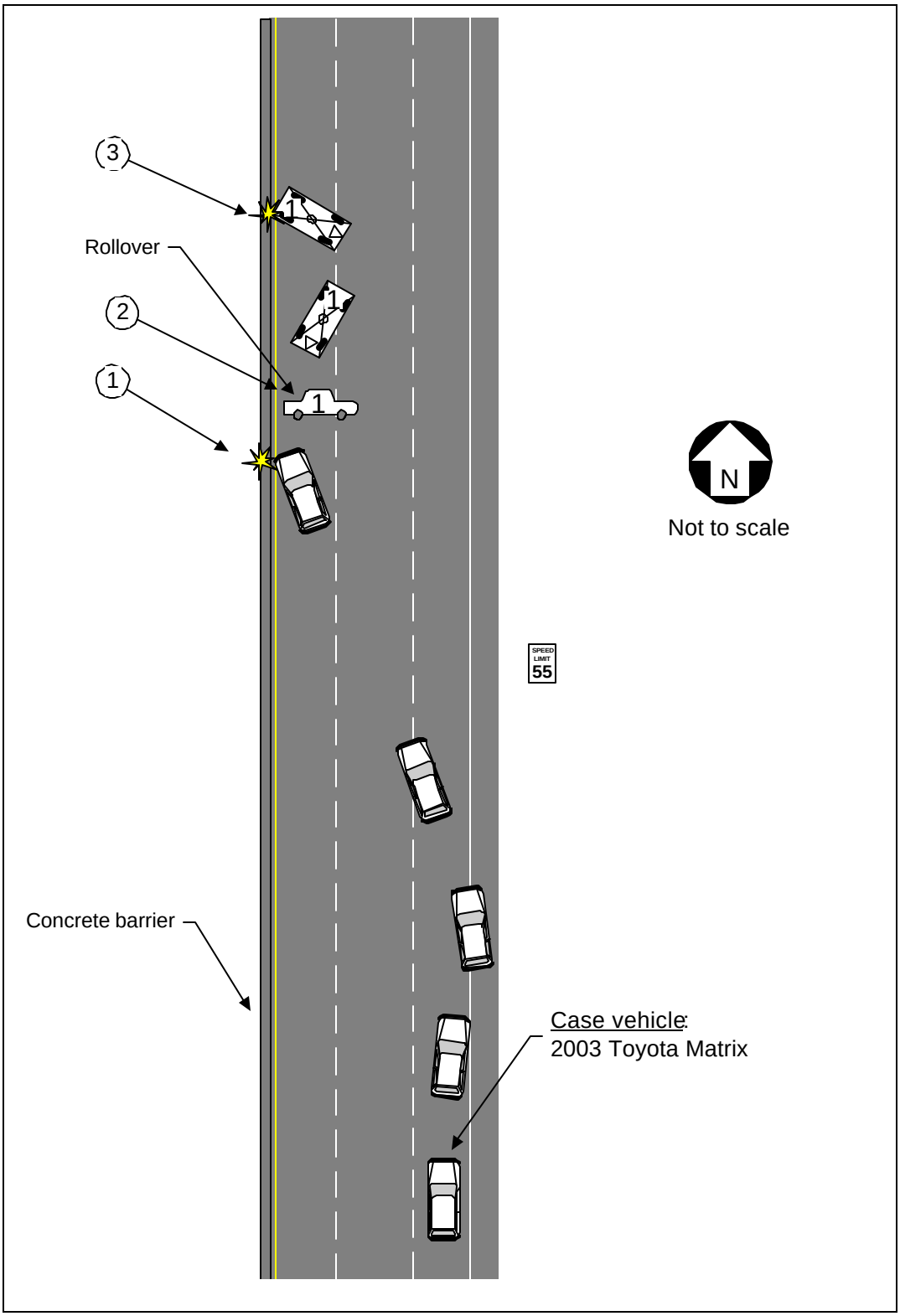

Figure 5. Scene diagram

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	2003 Toyota Matrix XR five door wagon	
VIN:	2T1KR32E23Cxxxxxx	
Odometer:	Unknown, electronic display, no power	
Engine:	1.8 L, 4-cylinder	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Moderate frontal damage to bumper/grille. Rollover damage to right side and roof.	
CDC:	Impact 1: 12FDEW2 (wall impact 1) Impact 2: 00TDDO2 (rollover) Impact 3: 00BZHW2 (wall impact 2)	
Delta V (Impact 1):	Total	26.0 km/h (16.2 mph)
	Longitudinal	-25.6 km/h (-15.9 mph)
	Latitudinal	-4.5 km/h (-2.8 mph)
	Energy	36,149 joules (26,662 ft-lbs)

The case vehicle sustained 154 cm (61 in) of direct contact across the entire front end. The residual crush as measured along the bumper and backing bar was as follows: C1=13 cm (5 in), C2=26 cm (10 in), C3=24 cm (9 in), C4=17 cm (7 in), C5=14 cm (6 in), and C6=0 cm (0 in). The maximum crush was at C2. The principle direction of force was within the 12 o'clock sector and was an estimated 10 degrees.

Safety systems discussion

The vehicle was equipped with multistage driver's and front right passenger's air bags, 3-point front seat belts with adjustable shoulder anchors, front seat belt pretensioners with force limiters, emergency locking retractor for the driver's seat belt, and switchable automatic / emergency locking retractors for the remaining seat positions.

The driver and front right passenger air bags deployed as a result the wall impact; both front seat belt pretensioners fired and locked the seat belts in their stowed positions.

Figure 7. Driver's seated position

The driver's air bag module was a three part design and located in the center hub of the steering wheel rim. The single top flap measured 15 cm (6 in) wide and 6 cm (2 in) high. Each of the bottom two flaps measured 8 cm (3 in) wide and 6 cm (2 in) high. There was no contact evidence on the cover flaps. The diameter of the air bag measured 70 cm (28 in) in its deflated state. There was a single tether and two vent ports. The ports were at the 11 and 1 o'clock positions.

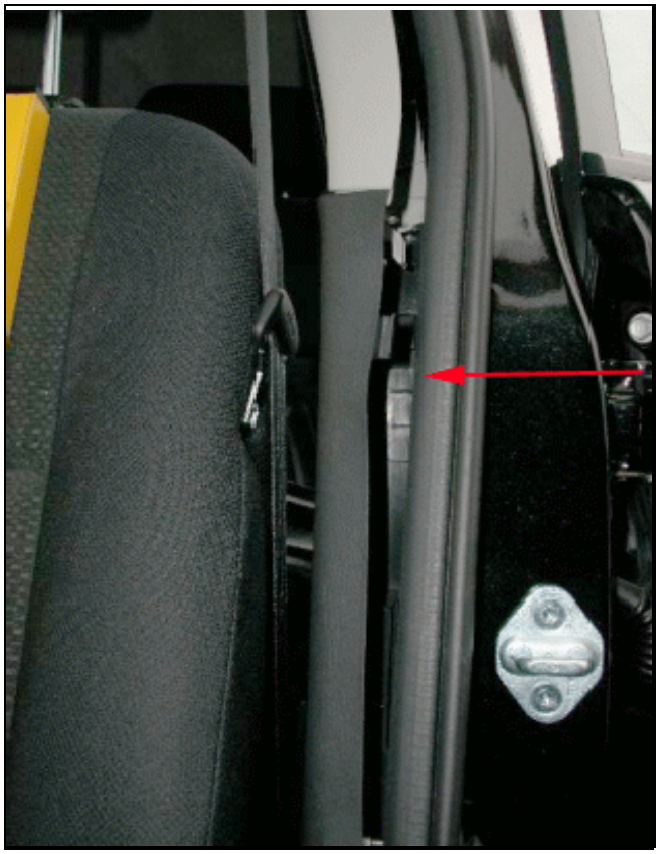

Figure 8. Driver's seat belt–locked in stowed position

The front right passenger air bag was a top mount design located in the right aspect of the instrument panel. The module consisted of two flaps in an H design. The upper flap measured 20 cm (8 in) wide by 7 cm (3 in) high. The lower flap measured 20 cm (8 in) wide by 8 cm (3 in) high. The deflated air bag measured 42 cm (17 in) wide by 63 cm (25 in) high. The bag had a maximum excursion of 73 cm (29 in).

This contractor obtained permission to harvest the air bag control module. The module was removed and sent to NHTSA for downloading by the Toyota Motor Company on March 5, 2003. The air bag module was manufactured by TRW. The part number is 207771-105. No readout data has been provided and the module has apparently been misplaced.

Occupants

Case vehicle	Occupant 1
Age/Sex:	38/Male
Seated Position:	Front left
Seat Type:	Fabric covered bucket seat. Seat adjusted to between middle and rear most track position. Seat back angle of 67 degrees from horizontal.
Height:	180 cm (71 in)
Weight:	76 kg (168 lbs)
Occupation:	Waiter
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Presumed to be greater than 10 years.
Body Posture:	Normal, upright
Hand Position:	Both hands on steering wheel, unknown clock position
Foot Position:	Right foot on brake, left on floor
Restraint Usage:	Lap and shoulder belt available, not used
Air bag:	Steering wheel mounted air bag, deployed

Injuries and Injury Mechanisms

Case vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Nasal fracture	251000.1,4	802.0	Air bag
	Abrasion, left forearm	790202.1,2	913.0	Air bag
	Abrasion, right forehead	290202.1,7	910.0	Air bag
	Lumbar strain	640678.1,8	847.2	Impact forces
	Lower left leg injury	890099.1,2	Unknown	Unknown

Occupant Kinematics

Figure 9. Driver's air bag

The 38-year-old male driver was seated in a normal, upright fashion. The fabric covered bucket seat was adjusted to between the middle and rear most track position. The seat back was at a 67 degree angle from the horizontal. The driver was not wearing the available lap and shoulder belt. He was wearing a short sleeve shirt and was not wearing glasses of any kind. Just prior to the crash, the driver leaned to the right and looked down trying to find coins for an upcoming toll plaza. He was reaching into the center console with his right hand. His left hand remained on the steering wheel. The vehicle veered to the right. The driver steered sharply to the left and lost control of the vehicle. At impact, both frontal air bags deployed and both pretensioners fired. The seat belts were locked in their stowed positions. The driver responded to the 12 o'clock direction of force by moving forward. His face engaged the front of the deployed driver's air bag–causing the nasal fracture. Both inner forearms contacted the deploying air bag–causing bilateral abrasions. As the vehicle began its counterclockwise rotation, the driver shifted to the left and engaged the door panel. As the vehicle tripped onto its right side and then onto its roof, the driver came out of his seat and eventually came to rest on the roof near the windshield header (see scuffs in Figure 10). There were blood drops found on the roof but these were likely related to the earlier nasal fracture. There were no indications of any steering wheel damage or steering column movement.

Figure 10. Roof/windshield header (scuffs)

Figure 11. Roof (blood drops)