On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS02012
2003 Toyota Matrix XR five door hatchback
California
May, 2002

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient Catalog No.
DS02012		

4. Title and Subtitle	5. Report Date
In-Depth Accident Investigation	.
	6. Performing Organization Report No.

7. Author(s)	8. Performing Organization Report No.
Dynamic Science, Inc.	

9. Performing Organization name and Address	10. Work Unit No. (TRAIS)
Dynamic Science, Inc. 530 College Parkway, Ste. K Annapolis, MD 21401	11. Contract or Grant no. DTNH22-94-D-27058

12. Sponsoring Agency Name and Address	13. Type of report and period Covered [Report Month, Year]
U.S. Dept. of Transportation (NRD-32) National Highway Traffic Safety Administration 400 7th Street, SW Washington, DC 20590	14. Sponsoring Agency Code

15. Supplemental Notes

16. Abstract

This crash occurred in California in May 2002 at 2154 hours. The crash occurred in the southbound lanes of a seven lane divided interstate highway. The roadway is comprised of five southbound standard lanes, and two southbound high occupant vehicle (HOV) lanes. The speed limit at this location is 105 km/h (65 mph).

The case vehicle was a 2003 Toyota Matrix five door hatchback driven by a restrained 47-year-old female. The front right of the vehicle was occupied by a restrained 45-year-old female. The make/model of the other vehicle in this case is unknown.

The case vehicle was traveling southbound in the second lane from the right at approximately 89 km/h (55 mph). The other vehicle was traveling southbound in the lane to the left of the case vehicle. The driver of the case vehicle noticed that the other vehicle was weaving and almost colliding with her vehicle. The other vehicle tried to change lanes to the right. As soon as the other vehicle moved to the right, the driver felt a hard impact to the left. The right side of the other vehicle contacted the left front tire/fender area of the case vehicle . The damage appears to have come from the tire of the other vehicle. The case vehicle went out of control and struck a concrete wall on the right side of the freeway with its front end. Both front air bags deployed at this point. Both front seat pretensioners also fired. The case vehicle rotated in a clockwise direction and lightly brushed the rear bumper against the concrete barrier before coming to rest. The driver of the case vehicle sustained a neck strain and a contusion to her left abdomen. The front right occupant sustained neck and upper back strains.

17. Key Words	18. Distribution Statement
Air bag, deployment, minor injury, crash, AOPS, passenger air bag.	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price

Dynamic Science, Inc.
Accident Investigation
Case Number: DS02012

TABLE OF CONTENTS

Background 1
- Description 1
- Investigation Type 1
- Crash Location 1
- Crash Date 1
- Notification Date 1
- Field Work Completed 1

Summary 1

Scene Diagram 4

Detailed Information 5
- Vehicles 5
- AOPS Discussion 6
- Occupants 9
- Injuries and Injury Mechanisms 11
- Occupant Kinematics 12

BACKGROUND:

Description:	This Advanced Occupant Protection case was generated in response to a police report that had been forwarded to the NHTSA. DSI was faxed the report on June 19, 2002 and asked to determine if the case vehicle was still available. Several phone calls were made and it was determined that the vehicle was still available for inspection. DSI was assigned the case on June 19, 2002. The vehicle inspection took place on June 24, 2002.
Investigation Type:	On-scene
Crash Location:	California
Crash Date:	May, 2002
Notification Date:	June 19, 2002
Field Work Completed:	June 24, 2002

SUMMARY:

This crash occurred in California in May 2002 at 2154 hours. The crash occurred in the southbound lanes of a seven lane divided interstate highway. The roadway is comprised of five southbound standard lanes, and two southbound high occupant vehicle (HOV) lanes. The HOV lanes are separated from the standard lanes by flush markings on the roadway. The speed limit at this location is 105 km/h (65 mph). The weather was clear. While the police report indicated that the streetlights were on, it was determined that there were no streetlights in the immediate area of the crash.

Figure 1. Approach to area of impacts–south

The case vehicle was a 2003 Toyota Matrix five door hatchback driven by a restrained 47-year-old female (152 cm/60 in, 52 kg/115 lbs). The front right of the vehicle was occupied by a restrained 45-year-old female (157 cm/62 in, 64 kg/140 lbs).

The make/model of the other vehicle in this case is unknown.

Figure 2. Front right, case vehicle

The case vehicle was traveling southbound in the second lane from the right at approximately 89 km/h (55 mph). The other vehicle was traveling southbound in the lane to the left of the case vehicle. The driver of the case vehicle noticed that the other vehicle was weaving and almost colliding with her vehicle. The other vehicle tried to change lanes to the right. As soon as the other vehicle moved to the right, the driver felt a hard impact to the left. The right side of the other vehicle contacted the left front tire/fender area of the case vehicle (09LFEW1). The damage appears to have come from the tire of the other vehicle. The driver of the case vehicle steered to the right and lost control. The case vehicle began a clockwise rotation, left the roadway on the right and struck a concrete barrier on the right side of the freeway with its front end (10FDEW2). The maximum crush on the bumper was 31 cm (12.2 in) at C1. The total velocity change calculated by barrier algorithm of the WinSmash collision model was 33.0 km/h (20.5 mph). The longitudinal and lateral delta V components were -21.2 km/h (-13.2 mph) and 25.3 km/h (15.7 mph), respectively. Both front air bags deployed at this point. Both front seat pretensioners also fired. The case vehicle rotated in a clockwise direction and lightly brushed the rear bumper (09BLLS1) against the concrete barrier before coming to rest.

The driver of the case vehicle sustained a neck strain and a contusion to her left abdomen. The front right occupant sustained neck and upper back strains.

The case vehicle was towed from the scene due to disabling damage and was later declared a total loss.

Figure 3. Left side, case vehicle, initial impact

Scene Diagram

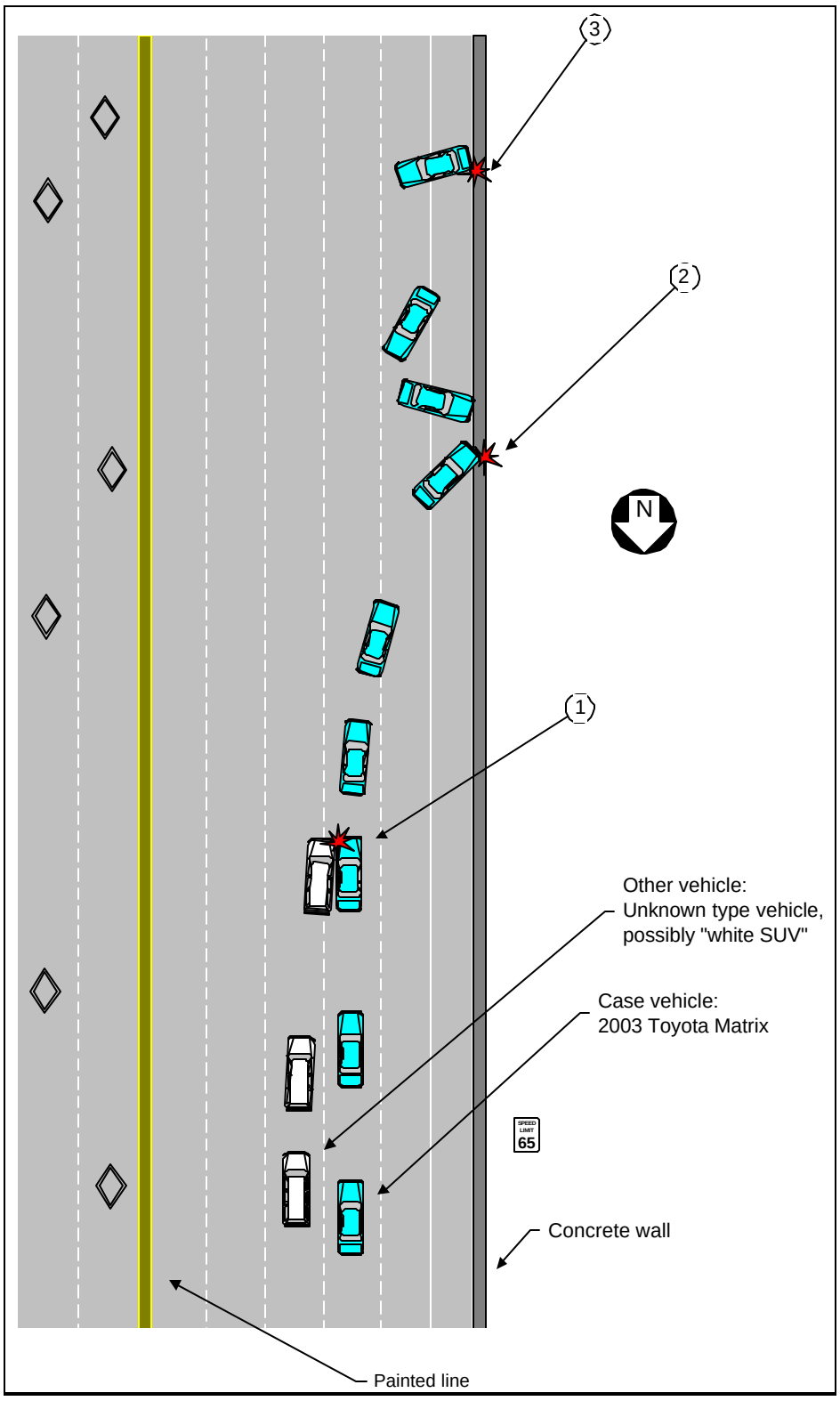

Figure 4. Scene diagram

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	2003 Toyota Matrix XR five door hatchback	
VIN:	2T1KR32E53Cxxxxxx	
Odometer:	Unknown	
Engine:	1.8 L, L4	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Moderate frontal damage. Bumper moved to right. Light contact to left fender from impact with other vehicle. Light contact to rear from swiping contact to barrier.	
CDC:	Impact 1: 09LFEW1 Impact 2: 10FDEW2 Impact 3: 09BLLS1	
Delta V (Impact 2):	Total	33.0 km/h (20.5 mph)
	Longitudinal	-21.2 km/h (-13.2 mph)
	Latitudinal	25.3 km/h (15.7 mph)
	Energy	133,396 joules (98,388 ft lbs)

Figure 5. Front, case vehicle

The case vehicle sustained 67 cm (26.4 in) of direct contact to the left fender area from the initial impact with the unknown vehicle. The principle direction of force was within the 9 o'clock sector and was an estimated 280 degrees. As a result of the impact with the barrier, the vehicle sustained 160 cm (63 in) of direct contact along the bumper fascia. Measurements were taken to the bumper reinforcement bar. The maximum crush was 31 cm (12.2 in) and was located at C1. The principle direction of force was within the 10 o'clock sector and was an estimated 310 degrees. The impact energy was managed by the forward structures of the vehicle. The damaged components included the bumper fascia and reinforcement bar, lower radiator, and grille. As a result of the second impact to the barrier, the vehicle sustained 42 cm (16.5 in) of direct contact to the left rear bumper. This was a swiping type contact. The principle direction of force was within the 9 o'clock sector and was an estimated 270 degrees. There was no measured change in the wheelbase dimensions. The windshield was cracked by the deploying passenger air bag. There was no additional glazing damage and all the doors remained closed and operational.

Figure 6. Rear bumper contact

Figure 7. Front bumper, case vehicle

AOPS Discussion

The case 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. Seat mounted side air bags were available as an option for this vehicle, but were not present on this vehicle.

Figure 9. Driver's seated area

Figure 8. Front right occupant's seated area

At impact with the wall, the driver's and right front passenger's air bags deployed. The circular driver's front air bag was mounted in the steering wheel hub and measured 48 cm (18.9 in) in diameter. The air bag was equipped with two vents ports–located at the 10 and 2 o'clock positions-- and two tethers. The "Y" type module cover opened at the designed tear points and there was no damage to the cover. There was no damage to the air bag nor were any occupant contacts found. The rectangular front right air bag was mounted in the top of the instrument panel and measured 42 cm (16.5 in) wide by 60 cm (23.6 in) high. The air bag was equipped with two vents–located at the 3 and 9 o'clock positions. The single module cover flap opened at the designed tear points and there was no damage to the cover. There was no damage to the air bag nor were any occupant contacts found.

The front seat belt pretensioners at both outboard seats also fired at this time. Scuffing was found on the belts at the location where they loop into the D rings. The trim panels for both B-pillars were displaced laterally.

Figure 10. Loading marks, front left seat belt

Figure 11. Loading marks, front right seat belt

Other vehicle

Description:	Unknown SUV - possibly white - HIT and RUN	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	None reported	
Cargo:	Unknown	
Damage Description:	Unknown	
CDC:	Unknown	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

Occupants

Case vehicle	Occupant 1	Occupant 2
Age/Sex:	47/Female	45/Female
Seated Position:	Front left	Front right
Seat Type:	Bucket, fabric covered, seat adjusted between middle and rear most track position	Bucket, fabric covered, seat adjusted between middle and rear most track position
Height:	152 cm (60 in)	157 cm (62 in)
Weight:	52 kg (115 lbs)	64 kg (140 lbs)
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Unknown	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel, steering right, then left	NA
Foot Position:	Right foot on brake, left on floor	Both on floor
Restraint Usage:	Lap and shoulder belt used, pretensioner did fire	Lap and shoulder belt used, pretensioner did fire
Air bag:	Front air bag available and did deploy	Front air bag available and did deploy

Other vehicle

Age/Sex:	Unknown
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	Unknown
Alcohol/Drug Involvement:	Unknown
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Unknown

Injuries and Injury Mechanisms

Case vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Cervical strain	640278.1,6	847.0	Driver's frontal air bag
	Contusion, left abdomen	590402.1,2	922.2	Seat belt webbing
RF Occupant:	Cervical strain	640278.1,6	847.0	Passenger's frontal air bag
	Thoracic strain	640478.1,7	847.1	Impact forces

Other vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Unknown, presumed to be uninjured			

Occupant Kinematics

The 47-year-old female driver of the case vehicle was seated in a normal, upright position. The fabric covered bucket seat was adjusted to between its middle and rear most track position. She was wearing the available lap and shoulder belt. The driver was looking straight ahead. As the other vehicle changed lanes to the right, its right side struck the left front of the case vehicle. This was a minimal impact. The driver reacted to the impact by steering sharply to the right and braking. The case vehicle began a clockwise rotation and the driver attempted to steer back to the left. By this time the case vehicle had departed the roadway. The front of the case vehicle struck a concrete barrier. At impact, the driver's air bag deployed. The driver of the case vehicle reacted to the 10 o'clock direction of force by moving forward and the left. She loaded the lap and shoulder belt webbing–sustaining an abdominal contusion. Her face engaged the deployed air bag. She did not sustain any facial injuries, but the flexion/extension associated with the air bag contact resulted in a neck strain.

The 45-year-old female front right passenger of the case vehicle was seated in a normal, upright fashion. The fabric covered bucket seat was adjusted to between its middle and rear most track position. She was wearing the available lap and shoulder belt. The front of the case vehicle struck a concrete barrier. At impact, the front right passenger's air bag deployed. The front right occupant of the case vehicle reacted to the 10 o'clock direction of force by moving forward and the left. Her face engaged the deployed air bag. She did not sustain any facial injuries, but the flexion/extension associated with the air bag contact resulted in a neck and upper back strain.