Advanced Occupant Protection System/Combination Case
Dynamic Science, Inc. / Case Number: 2001-75-113A
2001 Toyota Avalon
Colorado
October, 2001

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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.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient Catalog No.
2001-75-113A		

4. Title and Subtitle	5. Report Date
Combination 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 case was originally initiated in response to a report of an air bag non-deployment with fatal injuries in a 1996 Honda Accord. It has been determined that the air bags did not deploy because they were not replaced after a previous crash. This case continued to be investigated because the second vehicle in the crash (2001 Toyota Avalon) was equipped with an Advanced Occupant Protection System (AOPS). The current crash occurred in October, 2001 at 2147 hours in Colorado.

This two-vehicle crash occurred on a six-lane divided roadway. The roadway is straight. There is a down grade for southbound traffic. The asphalt roadway was dry and free of defects. It was dark at the time of the crash but there were streetlights present and illuminated. The speed limit is 72 km/h (45 mph). The case vehicle is a 2001 Toyota Avalon driven by a restrained 53-year-old male. The other vehicle is a 1996 Honda Accord four-door driven by a restrained 17-year-old female. The other vehicle was traveling northbound in the second lane from the right. The case vehicle was initially traveling southbound. For reasons not known, the driver of the case vehicle crossed over into the path of the case vehicle. The front of the other vehicle struck the front of the case vehicle. Both front air bags in the case vehicle deployed at this point. The other vehicle was reportedly equipped with dual air bags that did not deploy.

The driver of the case vehicle was found entrapped in his vehicle. According to the coroner's report he sustained a fractured neck at C1 with laceration and transection of the spinal cord, right side rib fractures, fracture of the sternum, and a variety of abrasions and lacerations. The driver of the other vehicle was found entrapped in her vehicle. She was declared dead at 2201 hours. According to the coroner's report she sustained fractures to the back of her skull, multiple teeth knocked out, a mandible fracture, right humerus fracture, left femur fracture, a small laceration to the left knee, and a deep laceration to the right knee.

17. Key Words	18. Distribution Statement
Air bag, deployment, injury, fatality, passenger, improper repair,	

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

Form DOT F 1700.7 (8_72) Reproduction of this form and completed page is authorized

Dynamic Science, Inc.
Accident Investigation
Case Number: 2001-75-113A

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BACKGROUND:

Description: This case was originally initiated in response to a report of an air bag non-deployment with fatal injuries in a 1996 Honda Accord. It has been determined that the air bags did not deploy because they were not replaced after a previous crash.

This case continued to be investigated because the second vehicle in the case (2001 Toyota Avalon) was equipped with an Advanced Occupant Protection System (AOPS). The crash occurred in October, 2001 at 2147 hours in Colorado. NHTSA was notified by Zone Center 2 on November 19, 2001 via a Potential Safety Bulletin. DSI was notified on December 18, 2001. This case was conducted as a combination SCI/NASS case.

Investigation Type:	Combination
Crash Location:	Colorado
Crash Date:	October, 2001
Notification Date:	December 18, 2001
Field Work Completed:	NA

SUMMARY:

This two-vehicle crash occurred on a six-lane divided roadway. The roadway is straight. There is a down grade for southbound traffic. The asphalt roadway was dry and free of defects. It was dark at the time of the crash but there were streetlights present and illuminated. The speed limit is 72 km/h (45 mph).

Figure 1. Case vehicle approach to area of impact

The case vehicle is a 2001 Toyota Avalon driven by a restrained 53-year-old male (170 cm/67 in, 100 kg/220 lbs). The Avalon was equipped with a driver's air bag, a front right passenger air bag, a driver's side air bag, and a front right passenger side air bag[1]. The

[1]Vehicle equipped with side air bag bags per VIN

vehicle was also equipped with seat belt pretensioners for the two front seats. The other vehicle is a 1996 Honda Accord four-door driven by a restrained 17-year-old female (157 cm/62 in, 51 kg/112 lbs). According to the vehicle identification number this vehicle was supposed to be equipped with driver and front right passenger air bags.

Figure 2. Front view, case vehicle (Toyota)

The other vehicle was traveling northbound in the second lane from the right. The case vehicle was initially traveling southbound. For reasons not known, the driver of the case vehicle crossed over into the path of the case vehicle. The front of the other vehicle (11FDEW4) struck the front of the case vehicle (12FDEW4). The case vehicle rotated in a counterclockwise direction and came to rest off the roadway facing northwest. The other vehicle was pushed into a clockwise rotation and came to rest on the roadway facing east. Both vehicles were towed from the scene due to damage.

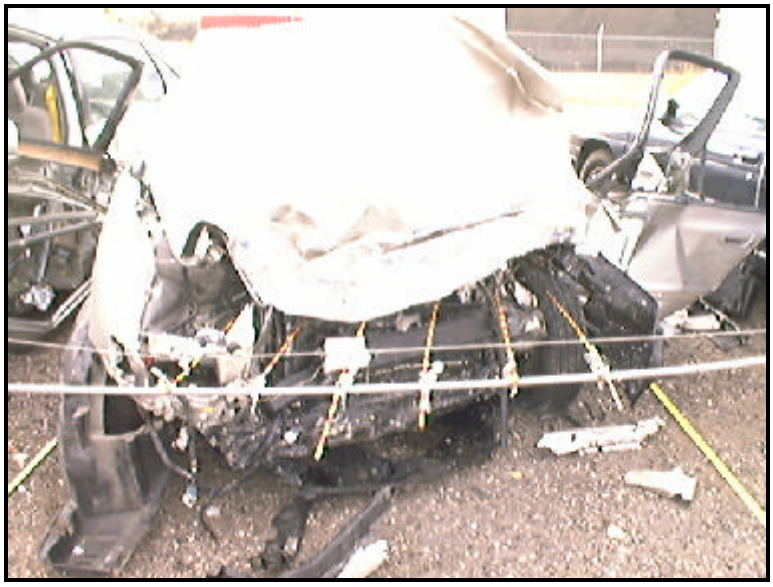

Figure 3. Front view, other vehicle (Honda)

The case vehicle sustained a longitudinal delta v of -75 km/h (-47 mph) at impact. Both front air bags in the case vehicle deployed at this point. The other vehicle sustained a longitudinal delta v of –78 km/h (-48 mph) and a lateral delta v of 45 km/h (28 mph). The case vehicle sustained 158 cm (62 in) of direct contact across the front end. The maximum crush occurred 15 cm (6 in) to the right of C3 and had a depth of 82 cm (32 in). The other vehicle sustained 98 cm (39 in) of direct contact across the front end. The maximum crush occurred at C1 and had a depth of 89 cm (35 in.).

The 53-year-old driver of the case vehicle was seated in a bucket seat. The seat track was adjusted to the middle track position. The seat back was slightly reclined. He was using the available lap and shoulder belt. The seat belt anchorage adjustment was in the full up position.

The 17-year-old driver of the other vehicle was seated in a fabric covered bucket seat. The seat track was in an unknown position. The seat back was slightly reclined. She was using the available lap and shoulder belt. The seat belt anchorage adjustment was in the full down position.

The driver of the case vehicle (Toyota) was found entrapped in his vehicle. No resuscitation or emergecny extrication efforts were undertaken. According to the coroner's report he sustained a fractured neck at C1 with laceration and transection of the spinal cord, right side rib fractures, fracture of the sternum, and a variety of abrasions and lacerations. The cause of death was listed as a "fractured neck and spinal cord injury secondary to blunt force trauma sustained in the motor vehicle accident".

The driver of the other vehicle (Honda) was found entrapped in her vehicle. She was found with her knees up against her chest and between her and the vehicle instrument panel. No resuscitation or emergency extrication efforts were undertaken. She was declared dead at 2201 hours. According to the coroner's report she sustained fractures to the back of her skull, multiple teeth knocked out, a mandible fracture, right humerus fracture, left femur fracture, a small laceration to the left knee, and a deep laceration to the right knee. The cause of death was listed as "severe head injuries due to blunt trauma from a motor vehicle crash".

Scene Diagram

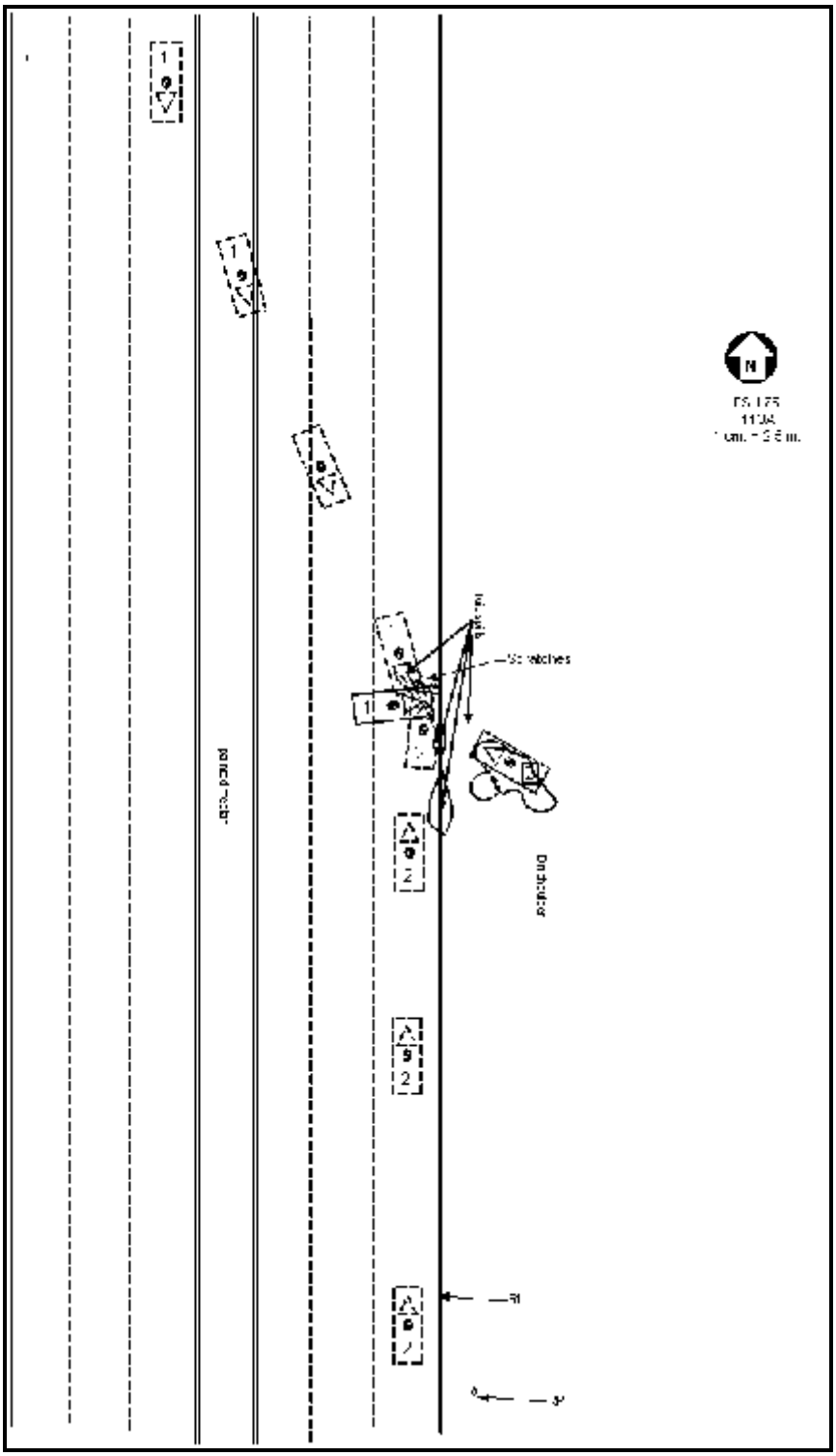

Figure 4. Scene diagram (heading for V1 should be 140 degrees)

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	2001 Toyota Avalon four-door sedan	
VIN:	4T1BF28B81Uxxxxxx	
Odometer:	Unknown	
Engine:	3.0 L 6 cyl.	
Reported Defects:	None	
Cargo:	14 kg (31 lbs)	
Damage Description:	Major front end damage.	
CDC:	12FDEW4	
Delta V:	Total	76 km/h (47 mph)
	Longitudinal	-75 km/h (-47 mph)
	Latitudinal	-13 km/h (-8 mph)
	Energy	265,427 joules (195,771 ft lbs)

Figure 5. Front right, case vehicle (Avalon)

The case vehicle was equipped with cloth fabric-covered bucket seats at the front outboard seat positions. The front left seat was adjusted to the middle track position at the time of the inspection. This seat position was equipped with a lap and shoulder belt. The shoulder belt adjuster was in the full up position. The seat belt was being used at the time of the crash. The front right seat was adjusted to the middle track position. This seat position was equipped with a lap and shoulder belt. The shoulder belt adjuster was in the full up position.

The case vehicle was equipped with a driver's air bag and a front right passenger's air bag. The driver's air bag was circular in shape and measured 55 cm (22 in) and had circular vent ports at the 10 and 2 o'clock positions. The air bag had two tethers. Neither the air bag nor the H-configuration air bag module cover were damaged. The front right passenger's air bag was rectangular in shape and measured 43 cm (17 in) high by 52 cm (21 in) wide and had circular vent ports at the 9 and 3 o'clock positions. There were no tethers. There was no damage or visible contact to the air bag or the module cover.

The case vehicle had longitudinal intrusion through the toe pan and instrument panel. The upper half of the steering wheel rim was deformed by occupant contact.

Other vehicle

Description:	1996 Honda Accord four-door sedan	
VIN:	1HGCD563XTAxxxxx	
Odometer:	Unknown	
Engine:	2.16 L 4 cylinder	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Major front end damage.	
CDC:	11FDEW4	
Delta V:	Total	90 km/h (56 mph)
	Longitudinal	-78 km/h (-48 mph)
	Latitudinal	45 km/h (28 mph)
	Energy	265,637 joules (195,926 ft-lbs)

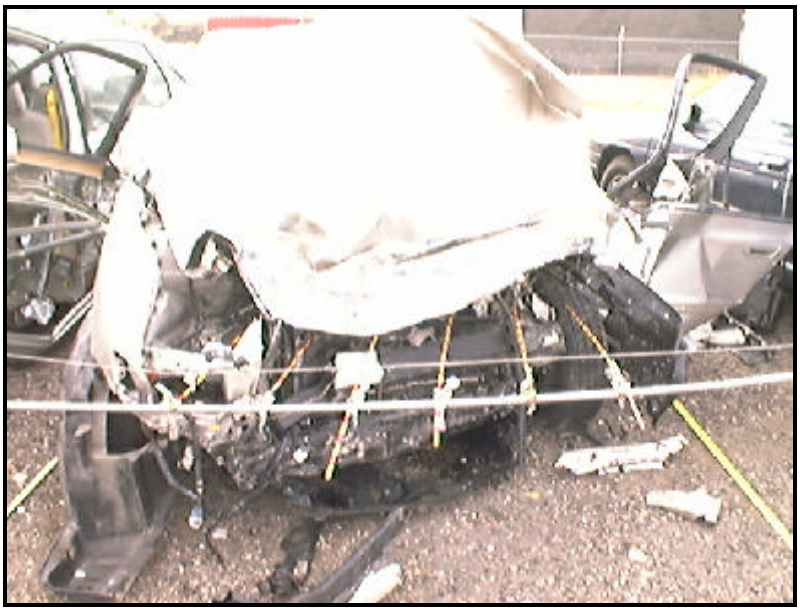

Figure 6. Front, other vehicle (Accord)

Vehicle History (other vehicle)

Figure 7. Air bag module, other vehicle

Efforts were undertaken to ascertain the history of the Honda. Inquiries were made to commercial vehicle history companies, the states of Michigan and Colorado, and to one of the vehicle's previous owners. The following table represents a compilation of data found from these various sources. Briefly, the Honda was originally used as a leased vehicle. It was then sold at an auction to a dealer. This dealer sold it to a private party. This party was involved in a frontal crash in which both front air bags deployed. The vehicle was declared a total loss and sent to a salvage yard. It was sold at an auction to a dealer. It was purchased by the father of the deceased driver of the Honda. This party made repairs that were sufficient to certify the vehicle as "roadworthy" in the state of Colorado. The list of repairs do not include replacement of the air bag. To make a vehicle roadworthy the party must certify that the vehicle meets the requirements set forth in state statutes 42-4-201 through 233. These statutes were reviewed and there does not appear to be any requirement to replace the air bag. The party that signed the certification was listed as the owner of the Honda vehicle at the time of the crash.

Date reported	Odometer	Comments
08/96		Registered as a commercial vehicle in state of Michigan
08/96	272 km (169 miles)	Title or registration issued. Registered as lease vehicle in state of Michigan.
01/99	33,209 km (20,636 miles)	Sold at auction. Auction announced as fleet/lease.
02/99		Title or registration issued in state of South Dakota.
11/99	Unknown	Owner reported that she was involved in a T-bone type collision and both frontal air bags deployed. Vehicle was declared a total loss.
12/99	61,262 km (38,068 miles)	Salvage title[2]/certificate issued in state of Colorado.
01/00		New owner certified to the state of Colorado that the vehicle is "now roadworthy to travel the streets and highways of the State of Colorado". A list of parts and repairs to make the vehicle roadworthy included: headlight, hood repair, fender repair, bumper and glass (see Attachment 1).

[2]Per Carfax: States issue salvage titles when an insurance company takes possession of a vehicle as a result of a claim. This generally occurs after a vehicle has been declared a total loss. States issue junk titles to indicate that a vehicle is not road worthy and cannot be titled again in that state.

01/00	61, 423 km (38,168 miles)	Salvage title/certificate issued in the state of Colorado – passed emission certification on this date
10/01	98,088 km (60,950 miles)	Month of crash in state of Colorado.

Occupants

Case vehicle (Toyota)	Occupant 1
Age/Sex:	53/Male
Seated Position:	Front left
Seat Type:	Fabric covered bucket seat. Seat in middle track position.
Height:	170 cm (67 in)
Weight:	100 kg (220 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	Atherosclerotic coronary disease, diverticulosis-colon[3], and liver disease.
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown, presumed to be > 20 years
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt available, used. It is not known if the pretensioners fired or not.
Air bag:	Steering wheel mounted air bag, deployed. Side air bag did not deploy.

[3]A condition in which a person has small sacs or pouches in the wall of an organ such as the intestine.

Other vehicle (Honda)

Age/Sex:	17/Female
Seated Position:	Front left
Seat Type:	Fabric covered bucket seat.
Height:	157 cm/62 in
Weight:	51 kg/112 lbs
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Normal, upright
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt available, used
Air bag:	None available

Injuries and Injury Mechanisms

Case vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Brain stem transection	140218.6, 6	851.60	Steering wheel rim and hub
	Cervical spine cord laceration, complete cord syndrome C-3 or above with fracture	640272.6,6	806.01	Steering wheel rim and hub
	Right side rib fractures	450210.2,1	807.00	Steering wheel rim and hub
	Sternal fracture	450804.2,4	807.20	Steering wheel rim and hub
	Scalp laceration	190602.1,6	873.0	Left B pillar
	Abrasion, left elbow	790202.1,2	913.0	Left side interior surface
	Abrasion, left knee	890202.1,2	891.0	Knee bolster

Other vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Multiple posterior skull fractures	150402.2,6	800.00	Unknown
	Multiple dislodged teeth	251402.1,8	525.1	Steering wheel rim and hub
	Mandible fracture	250600.1,9	802.20	Steering wheel rim and hub
	Right humerus fracture	752600.2,1	812.20	Steering wheel rim and hub
	Left femur fracture	851800.3,2	821.0	Knee bolster
	Small laceration, left knee	890602.1,2	891.0	Knee bolster
	Large, deep laceration, right knee	890602.2,1	891.0	Knee bolster

Occupant Kinematics

The 53-year-old male driver of the case vehicle was seated in an upright, normal fashion. The driver was heavy, but not very tall (170 cm/67 in, 100 kg/220 lbs). The case vehicle was equipped with a driver's air bag, a front right passenger air bag, a driver's side air bag, and a front right passenger side air bag. The vehicle was also equipped with seat belt pretensioners for the two front seats. The driver was wearing the lap and shoulder belt. The shoulder belt adjuster was in the full up position. The case vehicle was equipped with cloth fabric-covered bucket seats at the front outboard seat positions. The front left seat was adjusted to the middle track position at the time of the inspection.

Figure 8. Lower steering wheel rim and knee bolster

At impact, the driver responded to the 12 o'clock direction of force by moving straight forward loading the lap and shoulder belt. The driver's knees engaged and deformed the knee bolster. The driver's chest, rotated slightly to the right by the torso belt, engaged the air bag/steering wheel–deforming the steering wheel and causing the rib and sternum fractures. The driver's head continued forward, hyper flexing, as the driver essentially wrapped himself around the steering wheel and the torso belt. The hyper flexion likely caused the cervical spine and brain stem injuries.

Figure 9. Frontal air bags/deformed steering wheel

Attachment 1. Statement of repair to make roadworthy

Salvage Title # [redacted] Date: [redacted]-00

AFFIDAVIT

This is to certify that the Hon, 96, 1HGCG265XJA[redacted]
MAKE YEAR SERIAL NUMBER

is now roadworthy to travel the streets and highways of the State of Colorado.

The vehicle was purchased on 11/5/00 from [redacted] PORTS, for the sum of $ 4,200

The following parts were used to make the vehicle roadworthy and copies of the bills have been seen by the County Clerk's office.

Headlight, hood repair, fender repair, bumper, glass

In order to make the vehicle roadworthy, the following labor was done:

Headlight, bumper, hood repair, painting, fender repair, Grader, ...

I did the work on the vehicle myself X or I had ______ of ______ do the work on the vehicle.

Attached is a physical inspection for the above vehicle and I am applying for a Colorado title in the name of [redacted]

I SWEAR UNDER PENALTY OF PERJURY THAT THE FACTS STATED ABOVE ARE TRUE AND CORRECT TO THE BEST OF MY (OUR) KNOWLEDGE.

[redacted]
Signature of Applicant