Remote Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS98026
1995 Plymouth Voyager
Oregon
June 1998

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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

The crash occurred in June 1998 at 1045 hours. The crash occurred on a two-lane divided interstate highway. There was construction activity ongoing at the time of the crash. The left hand lane was gradually being shut down. The weather was clear and the rain-grooved concrete roadway was dry and free of defects. The speed limit was 89 km/h (55 mph) for trucks and 105 km/h (65 mph) for cars.

The case vehicle, a 1995 Plymouth Voyager driven by an unrestrained 74-year-old female (165 cm/65 in., 100 kg/220 lbs.), was traveling southbound in the #1 lane at an unknown speed. The driver of the case vehicle possessed a medical Department of Motor Vehicle exemption card which allows the person to operate the vehicle without using safety equipment. She wore a medical alert tag indicating that she was insulin dependent.

The other vehicle, a 1976 Freightliner (3-axle, 45,000 GVW) bobtail truck driven by a 34-year-old male, was in the #2 lane and was moving into the #1 lane as vehicles slowed and began the merge. As the Freightliner stopped, the case vehicle changed lanes but did not see that the other vehicle had stopped until it was too late. The driver of the case vehicle braked–leaving 19.8 m (65 ft.) of locked wheel skidmarks, giving the case vehicle a minimum pre-braking travel speed of 65.9 km/h (40.9 mph). The right front of the case vehicle struck the left rear dual tires of the other vehicle. The CDC for the case vehicle was 12FREE1.

The case vehicle sustained an estimated longitudinal delta V of -17.7 km/h (-11.0 mph). Both the driver's and front right passenge's air bags in the case vehicle deployed at this point. The case vehicle rotated clockwise slightly and came to rest straddling the two lanes of travel facing southwest.

17. Key Words	18. Distribution Statement
Air bag, deployment, injury, accident, fatality, driver, female	

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Dynamic Science, Inc.
Accident Investigation
Case Number: DS98026

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BACKGROUND:

Description:	This case was initiated in response to a possible driver's air bag related fatality. The case was identified through FARS. DSI was notified of the case on September 29, 1998. The case is being conducted as a remote investigation. The information below was obtained from the police accident report, police photos, and the medical examiner report.
Investigation Type:	Remote
Crash Location:	Oregon
Crash Date:	June 1998
Notification Date:	September 29, 1998
Field Work Completed:	NA

SUMMARY:

The crash occurred in June 1998 at 1045 hours. The crash occurred on a two-lane divided interstate highway. There was construction activity ongoing at the time of the crash. The left hand lane was gradually being shut down. The weather was clear and the rain-grooved concrete roadway was dry and free of defects. The speed limit was 89 km/h (55 mph) for trucks and 105 km/h (65 mph) for cars.

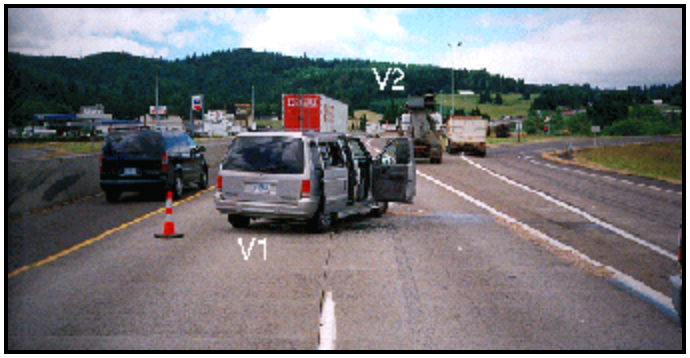

Figure 1. Overview of crash scene.

The case vehicle, a 1995 Plymouth Voyager driven by an unrestrained 74-year-old female (165 cm/65 in., 100 kg/220 lbs.), was traveling southbound in the #1 lane at an unknown speed. The driver of the case vehicle possessed a medical Department of Motor Vehicle exemption card which allows the person to operate the vehicle without using safety equipment. She wore a medical alert tag indicating that she was insulin dependent.

The other vehicle, a 1976 Freightliner (3-axle, 45,000 GVW) bobtail truck driven by a 34-year-old male, was in the #2 lane and was moving into the #1 lane as vehicles slowed and began the merge. As the other vehicle stopped, the case vehicle changed lanes but did not see that the other vehicle had stopped until it was too late. The driver of the case vehicle braked–leaving 19.8 m (65 ft.) of locked wheel skidmarks, giving the case vehicle a minimum pre-braking travel speed of 65.9 km/h (40.9

mph)[1]. The right front of the case vehicle struck the left rear dual tires of the other vehicle. The CDC for the case vehicle was 12FREE1.

The case vehicle sustained an estimated longitudinal delta V of -17.7 km/h (-11.0 mph). Both the driver's and front right passenger air bags in the case vehicle deployed at this point. The case vehicle rotated clockwise slightly and came to rest straddling the two lanes of travel facing southwest.

Figure 2. Final rest, case vehicle

The driver of the case vehicle sustained multiple fractures of the ribs along the left lateral chest, a sternum fracture, a "V" shaped laceration to the posterior elbow that measured 3 x 1 cm and was flapped inferiorly, a distal fracture of the right forearm involving both the radius and the ulna, and two 2 x 3 cm abrasions to the posterior surface of the left forearm. The medical examiner report describes the rib fractures to be "...essentially a crushing type injury" and describes the cause of death as being severe blunt trauma to the chest. The driver's left breast had been surgically removed some time in the past. No invasive autopsy was performed.

Upon arriving at the scene, state troopers found the driver of the case vehicle to be unresponsive. EMS personnel found her still seated in the vehicle. She was having trouble breathing (snoring respirations) but they attributed this to her slumped over position. She was given oxygen and a neck collar was placed on her. After extrication, she was found to not be breathing on her own.

[1]Calculated using the delta V as the impact speed combined with the speed to slide to stop.

She was transported to a local hospital by ambulance. On arrival at the hospital she was still in respiratory failure and shortly thereafter went into cardiac arrest. Despite full ACLS[2] protocol, the driver did not respond and she died shortly thereafter. A brief chronology of events follows:

Event	Time
Crash:	1045
EMS contacted:	1050
EMS arrival:	1059
Time of death:	1134

The case vehicle was towed from scene due to damage. The other vehicle was driven from the scene. The driver of the other vehicle did not report any injuries.

[2]American Heart Association, Advanced Cardiac Life Support

Scene Diagram

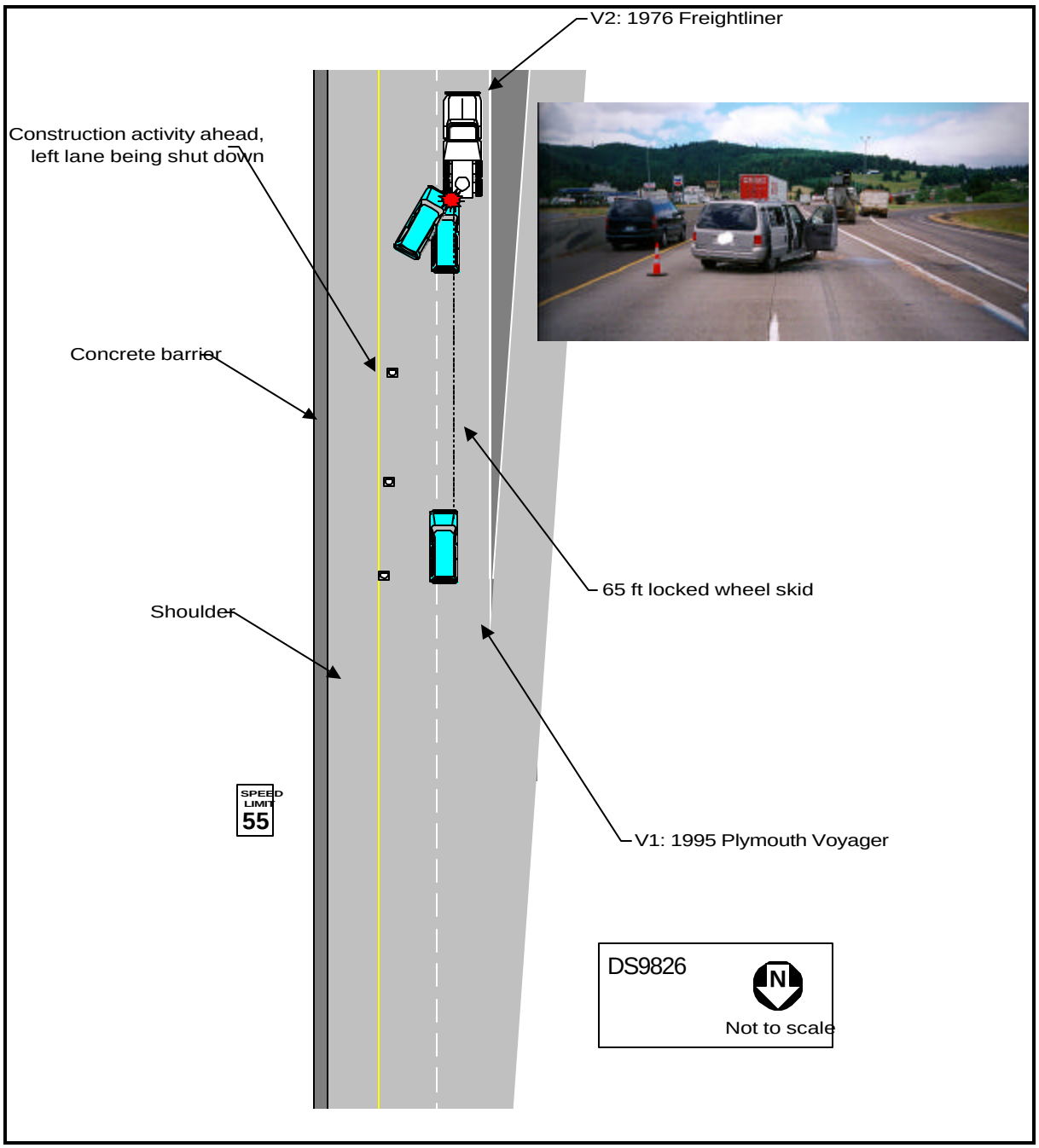

Figure 3. Scene Diagram

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	1995 Plymouth Voyager	
VIN:	2PAGH453GSRxxxxxx	
Odometer:	Unknown	
Engine:	3.0 L V-6	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	Minor rearward crush to front bumper, primarily to the right front. Windshield damage to left side.	
CDC:	12FREE1	
Delta V:	Total	17.7 km/h (11.0 mph)
	Longitudinal	-17.7 km/h (-11.0 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	19,609 joules (14,467 ft-lbs)

The case vehicle was equipped with a driver's side, steering wheel mounted air bag and a top-mount passenger side air bag. The top-mount, passenger air bag module cover is vaguely rectangular in shape.

Figure 4. Exterior, case vehicle

Other vehicle

Description:	1976 Freightliner (3-axle, 45,000 GVW) bobtail truck	
VIN:	CA5102P0xxxxx	
Odometer:	Unknown	
Engine:	Diesel	
Reported Defects:	None noted	
Cargo:	None noted	
Damage Description:	Minor contact damage to left rear dual and mud flap.	
TDC:	06DLLN1	
Delta V:	Total	NA
	Longitudinal	NA
	Latitudinal	NA
	Energy	NA

Figure 5. Exterior, other vehicle

Figure 6. Exterior, other vehicle

Occupants

Case vehicle	Occupant 1
Age/Sex:	74/Female
Seated Position:	Front left
Seat Type:	Pedestal style bucket seat
Height:	165 cm (65 in.)
Weight:	100 kg (220 lbs)
Occupation:	Not working prior to crash
Pre-existing Medical Condition:	Insulin dependent
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Normal, upright
Hand Position:	Both hands on SW, likely in the 11 and 1 o'clock positions
Foot Position:	Right foot on brake, left presumably on floor.
Restraint Usage:	None used
Air bag:	Deployed as a result of impact

Other vehicle

Age/Sex:	34/male
Seated Position:	Front left
Seat Type:	Unknown
Height:	183 cm (72 in.)
Weight:	113 kg (250 lbs.)
Occupation:	Truck driver
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	> 15 years
Body Posture:	Normal, upright
Hand Position:	Unknown
Foot Position:	Unknown–vehicle stopped–right foot presumed to be on brake
Restraint Usage:	Lap belt used

Injuries and Injury Mechanisms

Case vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Multiple fractures, left lateral chest–"a crushing type" injury.[3]	450260.4,2	807.4	Air bag
	Sternum fracture	450804.2,4	807.2	Air bag
	Radius fracture, right	752802.1,1	813.44	Air bag module cover
	Ulna fracture, right	753202.2,1	813.44	Air bag module cover
	V-shaped laceration to the posterior elbow, 3 x 1 cm, flapped posteriorly	790600.1,1	881.0	Air bag module cover

[3]Coded as "flail (unstable chest wall) NFS"

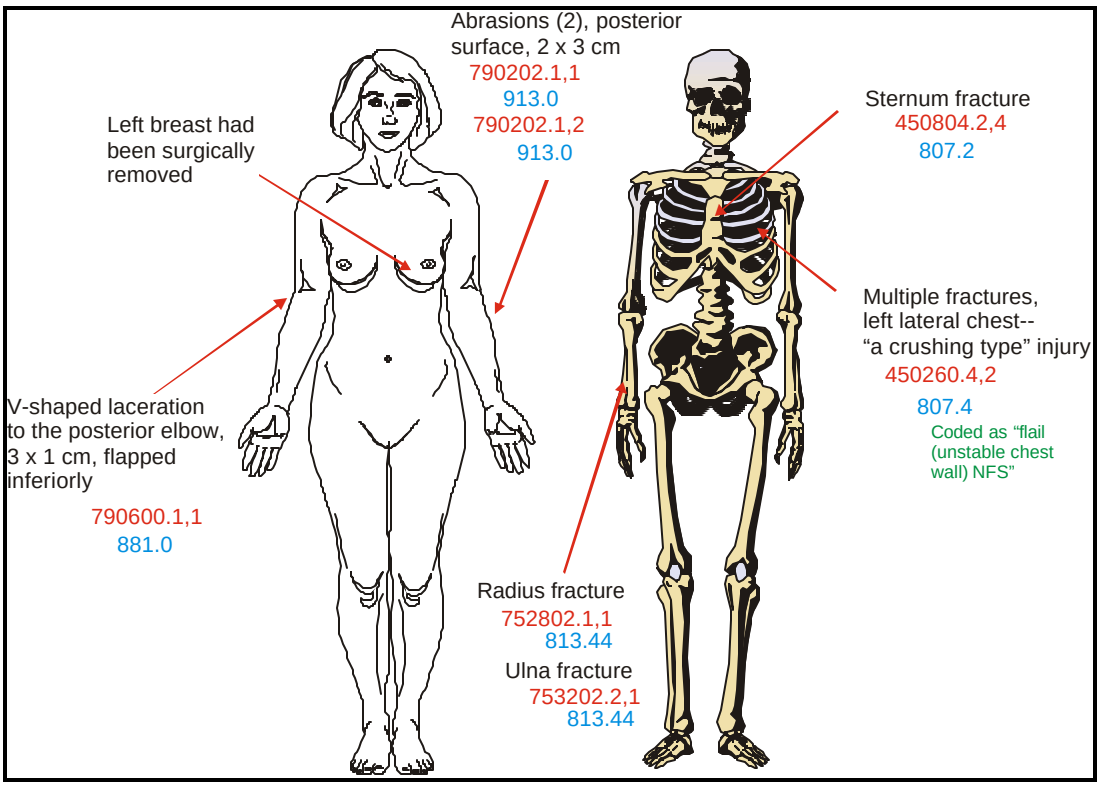

Figure 7. Driver injuries (ME report, no invasive autopsy)

Other vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Not injured			

Occupant Kinematics

Figure 8. Interior, case vehicle

It appears likely that the driver had both hands on the steering wheel prior to impact. Her right foot was firmly pressing the brake. The pre-impact braking, plus the driver's unrestrained status and large girth, would have put this unrestrained occupant close to the steering wheel hub. At impact, the air bag began to deploy. The driver's distal right forearm appears to have been contacted by the upper module cover and fractured during deployment, while the laceration to the elbow occurred during contact with the lower module cover. This loading on the right may have made the deployment somewhat asymmetrical. As the air bag deployed fully, it struck the driver more toward the left side, causing the left side rib fractures. EMS personnel believe the sternum fracture likely came from CPR efforts. Based on the limited information available, it does not appear that there was any substantial loading of the steering wheel rim. The police indicated that the driver struck her head on the windshield. This appears unlikely; there was no residual evidence of a head strike. One possible explanation for the windshield damage would be from the driver's left forearm. If the driver was unable to retain her grip on the steering wheel her arm would have been forward of the steering wheel and above the deploying air bag. This would cause her arm to be lifted into the windshield, causing the windshield damage and the two abrasive injuries to the posterior portion of her forearm.

Calculations

CASE NUMBER: ds9826

Comments: pre-impact braking

*** * MINIMUM SPEED W/ KNOWN DRAG FACTOR * ***

$S = \sqrt{30 \times D \times f}$

$S = \sqrt{30 \times 65.00 \times 0.70}$

$S = \sqrt{1365.00}$

$S = 36.94$

S = The Speed in MPH.
30 = A Constant.
D = The Distance in Feet.
f = The Adjusted Accel/Drag Factor.

INPUTS:	
The Acceleration/Drag Factor is:	0.70
The Distance in Feet is:	65.00

RESULTS:	
The Speed in MPH is:	36.94
The Velocity in FPS is:	54.15

CASE NUMBER: ds9826

Comments: combined speeds (delta v + pre-impact braking)

*** * COMBINED MINIMUM SPEEDS W/ KNOWN SPEEDS * ***

$S = \sqrt{S^2(1) + S^2(2) + \ldots S^2(n)}$

$S = \sqrt{(36.94)^2 + (17.70)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2}$

$S = \sqrt{364.56 + 313.29 + 0.00 + 0.00 + 0.00 + 0.00 + 0.00 + 0.00}$

$S = \sqrt{1677.85}$

$S = 40.96$

S = The Speed in M PH.
S² = The Individual M in. Speed.
(1), (2), (n) = The # of the individual speed.

INPUTS:	
Speed #1 in M PH is:	36.94
Speed #2 in M PH is:	17.70

RESULTS:	
The Speed in M PH is:	40.96
The Velocity in FPS is:	60.04

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