

On-scene Investigation / Vehicle to Vehicle  
Dynamic Science, Inc. / Case Number: DS98011  
1998 BMW 740i  
Texas  
March 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 case vehicle, a 1998 BMW 740i driven by a lap and shoulder belt restrained 39 year-old male (183 cm /72 in., 79 kg/175 lbs.), was crossing northbound through a four-leg intersection intending to go west at a speed estimated to be 19 km/h (12 MPH). The middle rear of the case vehicle was occupied by a 5-year-old female (114 cm /45 in., 19 kg /43 lbs.) who was using the lap belt. Vehicle 1 was equipped with front seat automatic safety belt pretensioners and six air bags: a driver's side steering mounted air bag, a passenger side dash-mounted air bag, left and right door-mounted 17 liter (0.60 cu. ft.) torso air bags, and left and right Inflatable Tubular Structure (ITS) type air bags. The other vehicle, a 1997 Jeep Cherokee driven by a lap and shoulder belt restrained 17-year-old female, was traveling westbound on a three-lane divided roadway. A non-contact vehicle was traveling in front of the Jeep. The driver of the case vehicle failed to yield the right of way to the Jeep; he entered the intersection and began a left hand turn to go west after the non-contact vehicle had passed by. The interviewee did not know why the driver did not see the Jeep, but it is possible that the driver would be looking to the east and at that time in the morning the sun would have been low (around 13 degrees) on the horizon. The driver of the Jeep saw the case vehicle and began braking. The front right of the case vehicle (02FZEW1) struck the left of Vehicle 2. The driver's side air bag, the right door mounted air bag, and the right ITS all deployed during this impact. Vehicle 1 sustained a longitudinal delta V of -3.9 km/h (-2.6 MPH) and a latitudinal delta V of -10.8 km/h (-7.1 MPH). These results appear low. Both air bags in the Jeep also deployed. The case vehicle was pushed into a counterclockwise rotation; the Jeep was redirected in a clockwise direction. There was a second, side-slap type impact between the two vehicles. The case vehicle came to rest facing generally south. The Jeep came to rest facing northwest. The driver of the case vehicle reported that he had sustained two small abrasions on his hands, which the interviewee attributes to glass fragments. The middle rear occupant did not report any injuries. The driver of the Jeep sustained a sprained wrist. All parties refused medical attention. Both vehicles were towed from the scene due to damage. The case vehicle sustained \$22,000 in damages and has been totaled by the insurance company.					
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**Dynamic Science, Inc.**  
**Accident Investigation**  
**Case Number: DS98011**

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**BACKGROUND:**

Description: This case was initiated in response to a report of a side air bag deployment. This case is being conducted as an on-scene investigation. NHTSA was notified by State Farm Insurance.

Investigation Type: On scene

Crash Location: Texas  
 Crash Date: March 1998  
 Notification Date: March 1998  
 Field Work Completed: April 1, 1998

**SUMMARY:**

This collision occurred in March 1998 at 0750 hours. The weather was cloudy. The concrete roadway was dry. The speed limit for westbound traffic was 56 km/h (35 MPH). The speed limit for northbound traffic was 48 km/h (30 MPH).

The case vehicle, a 1998 BMW 740i driven by a lap and shoulder belt restrained 39 year-old male (183 cm /72 in., 79 kg/175 lbs.), was crossing northbound through a four-leg intersection intending to go west at a speed estimated to be 19 km/h (12 MPH)<sup>1</sup>. The middle rear of the case vehicle was occupied by a 5-year-old female (114 cm /45 in., 19 kg /43 lbs.) who was using the lap belt. Vehicle 1 was equipped with front seat automatic safety belt pretensioners and six air bags: a driver's side steering mounted air bag, a passenger side dash-mounted air bag, left and



Figure 1. Exterior, case vehicle

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1

Speed after acceleration from a stop over a known distance

$$S = \sqrt{2aD}$$

where

S = speed after acceleration

a = acceleration rate = 4 ft / sec / sec

D = distance = 40 feet

$$S = \sqrt{2ad} = \sqrt{2 * 4 * 40} = 17.9 \text{ feet per second} = 12.2 \text{ MPH}$$

right door-mounted 17 liter (0.60 cu. ft.) torso air bags, and left and right Inflatable Tubular Structure (ITS) type air bags.

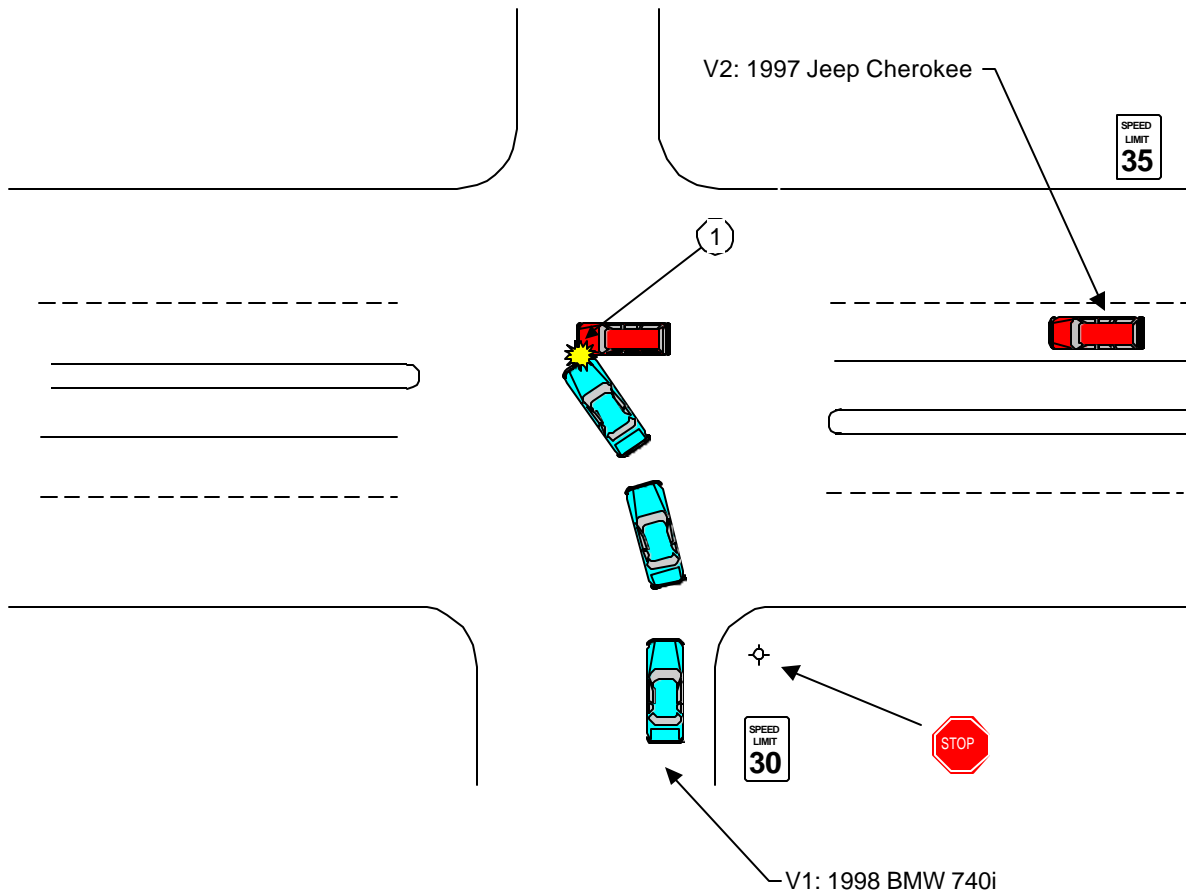
The other vehicle, a 1997 Jeep Cherokee driven by a lap and shoulder belt restrained 17-year-old female, was traveling westbound on a three-lane divided roadway. A non-contact vehicle was traveling in front of the Jeep. The driver of the case vehicle failed to yield the right of way to the Jeep; he entered the intersection and began a left hand turn to go west after the non-contact vehicle had passed by. The interviewee did not know why the driver did not see the Jeep, but it is possible that the driver would had been looking to the east and at that time in the morning the sun would have been low (around 13 degrees) on the horizon.

The driver of the Jeep saw the case vehicle and began braking. The front right of the case vehicle (02FZEW1) struck the left of the Jeep. The driver's side air bag, the right door mounted air bag, and the right ITS all deployed during this impact. The case vehicle sustained a longitudinal delta V of -3.9 km/h (-2.6 MPH) and a latitudinal delta V of -10.8 km/h (-7.1 MPH). These results appear low. Both air bags in the Jeep also deployed. Vehicle 1 was pushed into a counterclockwise rotation; the Jeep was redirected in a clockwise direction. There was a second, side-slap type impact between the two vehicles. The case vehicle came to rest facing generally south. The Jeep came to rest facing northwest.

The driver of the case vehicle reported that he had sustained two small abrasions on his hands, which the interviewee attributes to glass fragments. The middle rear occupant did not report any injuries. The driver of the Jeep sustained a sprained wrist. All parties refused medical attention.

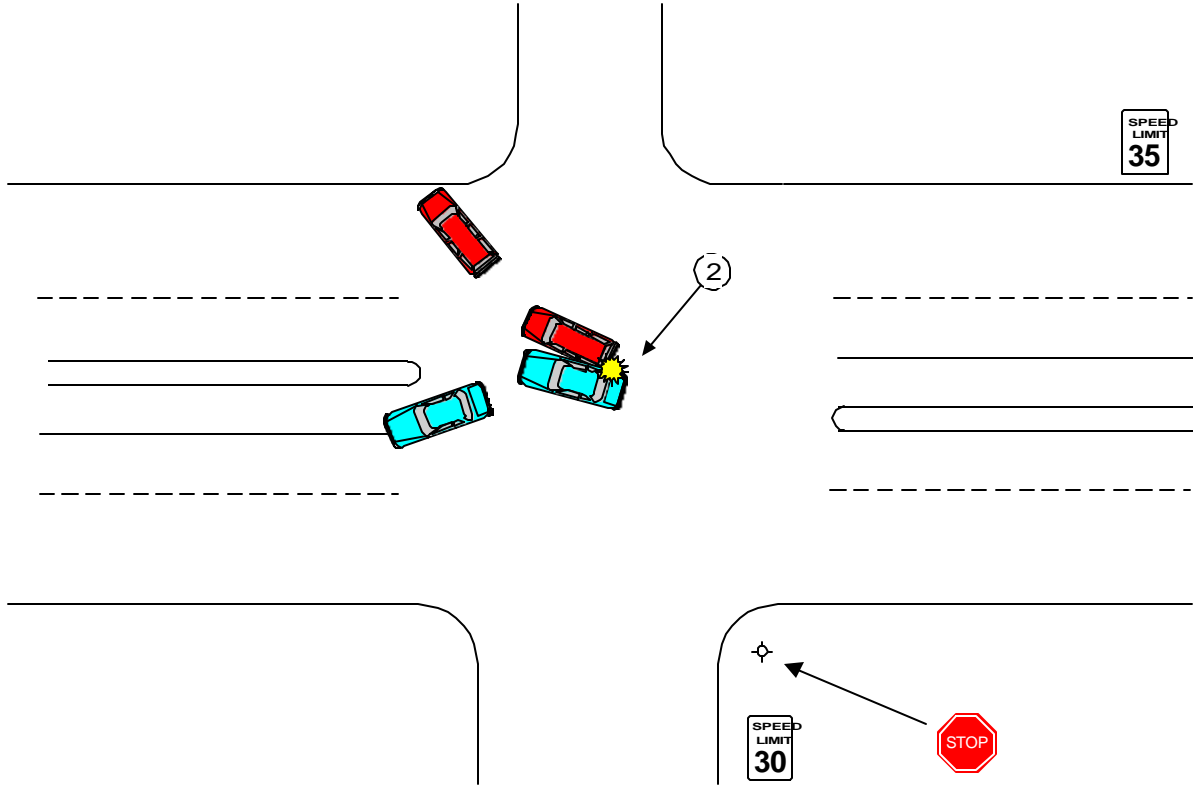
Both vehicles were towed from the scene due to damage. The case vehicle sustained \$22,000 in damages and has been totaled by the insurance company.

Scene Diagram



Case: DS9811

0 20' 0" 40' 0"





**DETAILED INFORMATION****Vehicles**Case vehicle

Description:	1998 BMW 740i four-door	
VIN:	WBAGF8329WDxxxxx	
Odometer:	733 miles	
Engine:	8 cyl	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Moderate rearward and lateral crush to the right front corner. Hood buckled. Secondary impact to the right rear door area. Vehicle totaled by insurance company.	
CDC:	Impact #1: 02FZEW1 Impact #2: 03RPEW2	
Estimated speed	19 km/h (12 MPH)	
Delta V:	Total	11.4 km/h (7.5 mph)
	Longitudinal	-3.9 km/h (-2.6 mph) <sup>2</sup>
	Latitudinal	-10.8 km/h (-7.1 mph)
	Energy	17,684 joules (13,050 ft-lbs)



**Figure 4.** Exterior, case vehicle

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<sup>2</sup>Calculated using WinSmash 1.0, results are low



**Figure 5.** Exemplar view of case vehicle



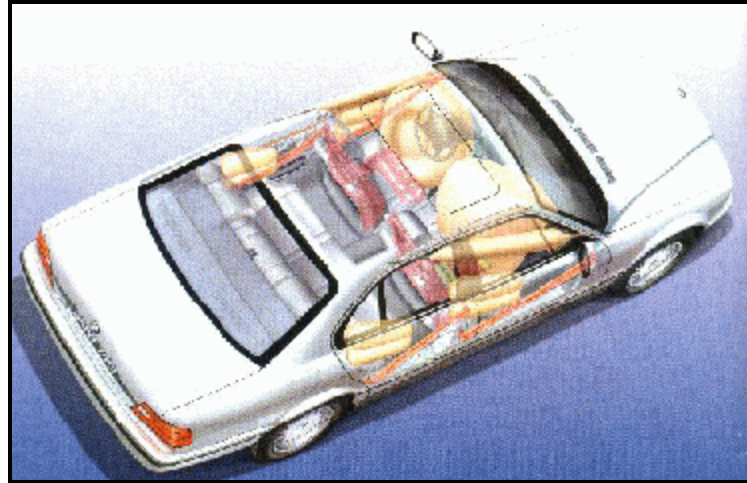
**Figure 6.** Exterior, case vehicle

## Safety Equipment:

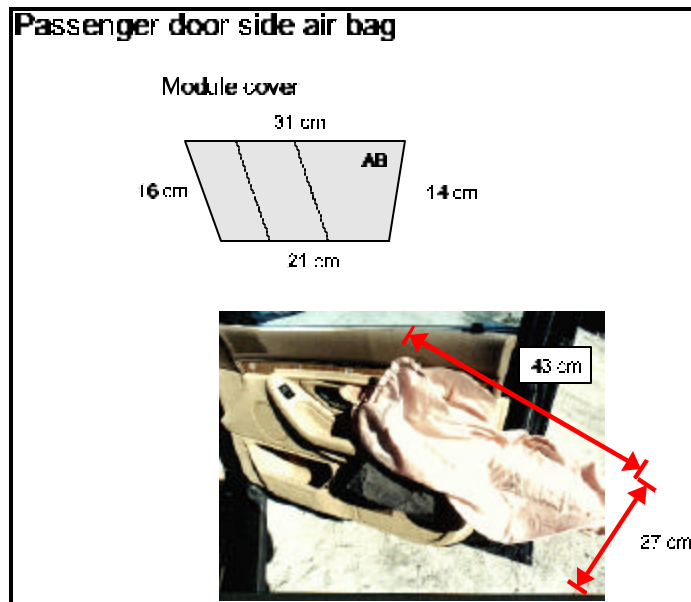
The case vehicle was equipped with front seat automatic safety belt pretensioners and six air bags: a driver's side steering mounted air bag, a passenger side dash-mounted air bag, left and right door-mounted 17 liter (0.60 cu. ft.) torso air bags, and left and right Inflatable Tubular Structure (ITS) type air bags. The front air bags include a "smart" dual-threshold deployment system (i.e., when the belts are in use, the air bag will not deploy at a lower crash severity). The front air bags are set to deploy at a delta V in

excess of 29 km/h (18 MPH) for a belted occupant and 19 km/h (12 MPH) for an unbelted occupant. Also, if the front passenger seat is not occupied, that air bag is not normally triggered. There is a sensor which determines if a weight greater than 7 kg (15 lbs.) is present on the seat. In this case, this position was not occupied and there was no front passenger air bag deployment. The side air bags are set to deploy with a delta V in excess of 15 km/h (9 MPH)—regardless of whether or not the seat position is occupied. The ITS is entirely concealed above the front doors and within the A-pillar and roof cladding or upholstery. The ITS is a hollow, flexible, essentially airtight tube 152 cm (60 in.) long and 3.8 cm (1.5 in.) in diameter. At one end, this tube is anchored inside the vehicle's A-pillar, near the bottom of the pillar. At the other end, it is anchored in the roof just above the rear door. Upon side impact, the inflator, mounted on one end of the tube, inflates the tube with an inert gas. A relatively airtight inner tube of silicon material manages the inflation; a woven Polyamid outertube manages the tube's shape. The diameter increase forced by inflation causes the length to decrease.

In turn, the tube no longer fits inside the area where it is stored; it pulls out of the headliner and forms a soft, straight tube, 12.9 cm (5.1 in.) in diameter and stretched in a straight line from the lower



**Figure 7.** Overview of air bag locations. Note: rear torso air bags are an option.



**Figure 8.** Passenger door side air bag

windshield pillar to the roof. According to BMW literature on the ITS, the tube is designed to stay inflated for approximately 6 seconds after deploying.

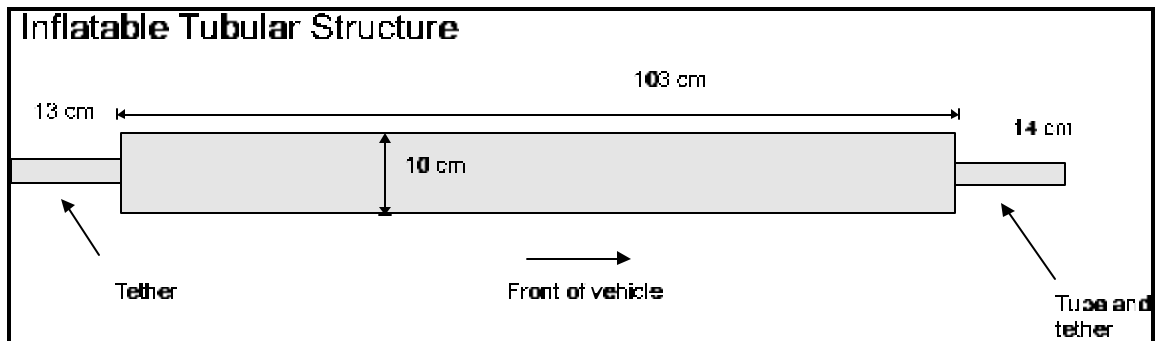


Figure 9. Inflatable tubular structure



Figure 10. Inflatable tubular structure

**DETAILED INFORMATION****Vehicles**Other vehicle

Description:	1997 Jeep Cherokee 4 x 2		
VIN:	1J4FT68S9VL5xxxxxx		
Odometer:	Unknown		
Engine:	4.0L 6 cyl		
Reported Defects:	Unknown		
Cargo:	Unknown		
Damage Description:	Left front corner, per police		
CDC:	Unknown		
Delta V:	Total	17.2 km/h (11.3 mph)	
	Longitudinal	-14.9 km/h (-9.8 mph)	
	Latitudinal	8.6 km/h (5.7 mph)	
	Energy	30,335 joules	
		(22,387 ft-lbs)	

**Occupants**

<u>Case vehicle</u>	Occupant 1	Occupant 2
Age/Sex:	39/Male	5/Female
Seated Position:	Left front	Middle rear
Seat Type:	Bucket	Bench
Height:	183 cm (72 in.)	114 cm (45 in.)
Weight:	79 kg (175 lbs.)	19 kg (43 lbs.)
Occupation:	Investment banker	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	> 20 year	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Unknown	Unknown
Foot Position:	Right on accelerator	Unknown
Restraint Usage:	Lap and shoulder used properly	Lap used properly
Airbag:	Deployed	NA

**Occupants**

<u>Other vehicle</u>	Occupant 1
Age/Sex:	17/Female
Seated Position:	Left front
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Student
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Approx. 1 year
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown-right presumed to be on brake
Restraint Usage:	Lap and shoulder used per police
Air bag:	Deployed

## Injuries and Injury Mechanisms

### Case vehicle

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Abrasion, left hand	790202.1,1	914.0	Air bag
	Abrasion, right hand	790202.1,2	914.0	Air bag

Middle rear occ.: Not injured

### Vehicle 2

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Wrist strain	751420.1,9	842.00	Unknown

## Occupant Kinematics

The driver of the case vehicle was seated in the left front. He was wearing the available lap and shoulder belt in the proper fashion. Both hands were on the steering wheel and his right foot was on the accelerator. At impact, the air bag deployed. The driver shifted slightly forward and to the right. The deploying air bag abraded his hands in some fashion. There was a secondary impact which moved the driver slightly to the right. The middle rear occupant was wearing the available lap belt in the proper fashion. She moved in a pattern similar to the driver, first to the front and right during the initial impact, and then to the right during the second impact. She did not report any injuries.