

DOT HS-800 962

MULTIDISCIPLINARY ACCIDENT STUDY— PACIFIC NORTHWEST



Contract No. DOT-HS-199-2-319

November 1973

Final Report

PREPARED FOR:

U.S. DEPARTMENT OF TRANSPORTATION

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

WASHINGTON, D.C. 20590

Document is available to the public through
the National Technical Information Service,
Springfield, Virginia 22151

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

157A
6081
572

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. DOT HS-800 962	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle ✓ MULTIDISCIPLINARY ACCIDENT STUDY - PACIFIC NORTHWEST		5. Report Date November, 1973	
		6. Performing Organization Code 830	
7. Author(s) Eleanor L. Myers, Robert Cronin, Nancy David, Mary Ann Robertson		8. Performing Organization Report No. SRI Project 1839	
9. Performing Organization Name and Address Stanford Research Institute 333 Ravenswood Avenue Menlo Park, California 94025		10. Work Unit No.	
		11. Contract or Grant No. DOT-HS-199-2-319	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. Type of Report and Period Covered Final Report April 1, 1972-June 30, 1973	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract The Stanford Research Institute Crash Analysis Team investigated 39 vehicle accidents in depth as part of the study, "General Multidisciplinary Accident Study: Pacific Northwest." Summary statistics and clustering data analysis techniques are used in the examination of primary and contributing causes of the 39 accidents and resultant injuries. Analytic results are given for human, environmental, and vehicle factors. The 39 accidents are evaluated with respect to compliance to current Federal Motor Vehicle Safety Standards and Highway Safety Program Standards. Recommendations for the revision of standards are made.			
17. Key Words		18. Distribution Statement Unlimited available through the National Technical Information Service, Springfield, Virginia 22151	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 416	22. Price

ABSTRACT

The Stanford Research Institute Crash Analysis Team investigated 39 vehicle accidents in depth as part of the study, "General Multidisciplinary Accident Study: Pacific Northwest."

Summary statistics and clustering data analysis techniques are used in the examination of primary and contributing causes of the 39 accidents and resultant injuries. Analytic results are given for human, environmental, and vehicle factors.

The 39 accidents are evaluated with respect to compliance to current Federal Motor Vehicle Safety Standards and Highway Safety Program Standards. Recommendations for the revision of standards are made.

CONTENTS

ABSTRACT	iii
LIST OF ILLUSTRATIONS	ix
LIST OF TABLES	xi
ACKNOWLEDGMENTS	xiii
SUMMARY	xv
I INTRODUCTION	1
A. Objectives and Scope	1
B. Organization of the Report	2
II INVESTIGATION TECHNIQUES	5
A. Accident Investigation Approach	5
B. Some of SCAT's Unique Tools	5
C. Library and Literature Search	7
D. Statistical Analysis	8
E. Information Retrieval Forms	8
III THE STUDY AREA	9
IV DISCUSSION OF RESULTS	15
A. Accident Causes	15
1. Vehicle Defects	16
2. Environmental Factors	17
3. Human Contributions	18
a. Age and sex	18
b. Use of Drugs or Alcohol	20
4. Injuries Sustained and Their Causes	23
a. Head and Neck Injuries	24
b. Thorax Injuries	36
c. Abdominal Injuries	36
d. Spine and Pelvic Injuries	37

IV DISCUSSION OF RESULTS (Continued)

e.	Extremity Injuries	37
f.	Burns	38
B.	Analysis Techniques Used by SCAT.	38
C.	Clustering Results	40
1.	Examination of Variables	42
a.	Human Factors	43
b.	Vehicle Characteristics	44
c.	Accident Environment.	45
d.	Other Variables	46
2.	Examination of Clusters	47
a.	Type of Road Variables	50
b.	Impact and Injury Variables	53
c.	Rain Conditions	57
d.	Number of Previous Citations, Use of Alcohol or Other Drugs	58

V EFFECTIVENESS OF SAFETY STANDARDS 63

A.	Federal Motor Vehicle Safety Standards	63
1.	Hydraulic Brake Systems (MVSS 105)	63
2.	Tire Selection and Rims--Passenger Cars (MVSS 110)	64
3.	Theft Protection (MVSS 114).	64
4.	Occupant Protection in Interior Impact (MVSS 201).	65
5.	Impact Protection for the Driver from the Steering Control System (MVSS 203)	66
6.	Steering Control Rearward Displacement (MVSS 204).	67
7.	Glazing Materials (MVSS 205) and Windshield Mounting (MVSS 212)	68
8.	Anchorage of Seats (MVSS 207)	69
9.	Occupant Crash Protection (MVSS 208)	70
10.	Side-Door Strength (MVSS 214)	72
11.	Exterior Protection (MVSS 215)	78
12.	Roof Crush Resistance (MVSS 216)	80
13.	Fuel Tanks, Fuel Tank Filler Pipes, and Fuel Tank Connections (MVSS 301)	82
B.	Highway Safety Program Standards	85
1.	Motorcycle Safety (HSPS 3)	86
2.	Driver Education (HSPS 4)	86

V	EFFECTIVENESS OF SAFETY STANDARDS (Continued)	
3.	Driver Licensing (HSPS 5)	88
4.	Alcohol in Relation to Highway Safety (HSPS 8)	89
5.	Identification and Surveillance of Accident Locations (HSPS 9)	91
6.	Traffic Records (HSPS 10)	91
7.	Highway Design, Construction, and Maintenance (HSPS 12)	92
8.	Traffic Engineering Services (HSPS 13)	94
9.	Police Traffic Services (HSPS 15)	97
VI	CONCLUSIONS	99
A.	Human Factors	99
1.	Inattention	99
2.	Emergency Handling of Vehicles	99
3.	Bad Habits	100
4.	Alcohol and Drugs	100
5.	Self-Knowledge	100
B.	Environmental Factors	101
1.	Intersections	101
2.	Obstructions	101
3.	Road Design	101
C.	Vehicle Factors	102
D.	Clustering Results	103
VII	RECOMMENDATIONS	105
A.	Recommendations Pertaining to Human Factors	105
B.	Recommendations Pertaining to Environmental Factors	105
C.	Recommendations Pertaining to Vehicle Factors	106
D.	Recommendations Pertaining to Clustering Results	107
	REFERENCES	109
	APPENDICES	
A.	FORMS USED IN ACCIDENT ANALYSIS	A-1
1.	Information Cards	A-1
2.	Information Sheet	A-2
3.	Form A	A-3
4.	Information Retrieval Forms	A-4

APPENDICES (Continued)

B.	SELECTED VARIABLES FOR ANALYSIS	B-1
C.	DISCUSSION OF CDC	C-1
D.	SUMMARY OF CAUSES OF ACCIDENTS	D-1
E.	CASE SUMMARIES	E-1

Form DOT F1700.7

ILLUSTRATIONS

1	Flow Diagram of the Events in the Analysis of an Accident . .	6
2	The Study Area	10
3	Times of Day of Accidents, Age and Sex of Drivers	19
4	Injury and Fatal Accident Pattern by Time of Day	20
5	Times of Day of Accidents, Occupations of Drivers	21
6	Most Prevalent Vehicle Parts Contacted by Human Body Areas	25
7	Partially Compressed Mesh-Type Energy Absorber on a 1969 Dodge Dart	67
8	Rearward Displacement of the Steering Column on a 1960 Corvair	68
9	1973 Oldsmobile Omega That Was Impacted Laterally by a 1972 Chevrolet Nova	73
10	1972 Gremlin That Was Impacted by a 1964 Ford Falcon	74
11	Driver's Seat Displacement in a Gremlin	75
12	Separation of the Front End of a 1965 Ford Mustang That Was Impacted Laterally by a 1973 Ford LTD	76
13	A 1972 Toyota Corolla Station Wagon That Was Impacted Laterally by a 1972 Cadillac Eldorado	77
14	1972 Pinto That Was Impacted in the Rear by a 1973 Pinto . .	79
15	The 1973 Pinto That Impacted the 1972 Pinto	80
16	1972 BMW 2002 after Rollover	81
17	1970 Chrysler after Rollover	82
18	The Jaguar E-Type Fuel Filter Mounted Just Behind the Right Front Wheel	83
19	1970 Volkswagon Karmann-Ghia Fuel Filler in Right Front Fender	84
20	Gash in Fuel Tank of 1971 Plymouth Fury	85
21	Poorly Designed Ramp	94

22	Barricade in Curb Lane	95
A-1	Cards with Notification Information	A-1
A-2	Form A	A-3
A-3	Form B	A-5
A-4	Form C	A-7
A-5	Form D	A-8
A-6	Form E	A-9
A-7	Form F	A-10
C-1	Reproduction of SAE J224a on Collision Deformation Classification	C-2

TABLES

1	Population Percentages and Accident Rates.	11
2	Estimated Percentage of Accidents that SCAT Investigated . .	11
3	Percentages of Types of Accidents	12
4	Anatomical Distribution of Accidents	23
5	Injury Descriptions and Contact Surfaces	26
6	Clustering Results for Driver Restraint Usage,	43
7	Cluster Configuration.	48
8	Clusters Compared by Type of Road: Freeways and Expressways	51
9	Clusters Compared by Type of Road: City Streets, Intersections and Expressways	52
10	Clusters Compared by Type of Road: Rural and Mountain Roads City Streets, and Intersections	54
11	Clusters Compared by Impact: Area of Impact Near Driver . .	56
12	Clusters Compared by Impact: Area of Impact Not Near Driver	57
13	Clusters Compared by Rain Conditions	58
14	Clusters Compared by Number of Previous Citations, Use of Alcohol or Other Drugs: Previous Citations a Factor, Drinking or Drugs Not a Factor	59
15	Clusters Compared by Number of Previous Citations, Use of Alcohol or Other Drugs, Previous Citations Not a Factor, Drinking or Drugs a Factor	59
16	Clusters Compared by Number of Previous Citations, Use of Alcohol or Other Drugs: Previous Citations Not a Factor, Drinking or Drugs Not a Factor	61
17	Energy Absorbers	66
18	Use of Restraint Systems	72
19	Accidents, Citations, License Suspensions, and Driver Education for All Drivers in SCAT-Investigated Accidents . .	87

20	Highway Design, Construction, and Maintenance in Six Cases	93
21	Traffic Control Devices in Eight Cases	96
22	Police Traffic Services in Seven Cases	98

ACKNOWLEDGEMENTS

This report describes the investigation and reporting efforts of the SRI Crash Analysis Team (SCAT), a multidisciplinary group of Stanford Research Institute staff members and consultants.

The SRI Crash Analysis Team was comprised of the following: James Cronander, principal investigator; Eleanor L. Myers, Robert H. Cronin, and Mary Ann Robertson, investigators and analysts; and Nancy A. David, mathematician-statistician. The medical consultants were Drs. Donald A. Nagel, Raymond Reedy, and Robert Cox. Rita Denny also deserves most generous thanks for her patience and attention to administrative details.

This investigation has also drawn on the skill and experience of many private and government agencies. In particular, SRI is indebted to the members of the police and traffic engineering departments of Atherton, Cupertino, Los Altos, Menlo Park, Mountain View, Palo Alto, Redwood City, San Jose, Sunnyvale; the Santa Clara County Sheriff's Office; the Santa Clara County Communications Center; and the many hospitals, tow services, vehicle storage yards, and body shops that provided aid.

SUMMARY

The Stanford Research Institute Crash Analysis Team (SCAT) investigated 39 vehicle accidents in depth under the contract "General Multidisciplinary Accident Study: Pacific Northwest."

Accidents meeting contractual requirements relating to severity and to involvement of late-model vehicles were carefully analyzed in order to determine accident causes, to identify injury causes, and to evaluate the effectiveness of relevant safety features, Federal Motor Vehicle Safety Standards and Highway Safety Program Standards. SCAT developed investigative techniques to facilitate collection of pertinent information.

The study gives particular attention to accident causation. Driver error was regarded as the primary cause in 37 of the 39 accidents. A vehicle defect (locked steering) and an environmental problem (nonfunctioning traffic signals) were primary causes in the other two.

Secondary causes, those contributing to accidents, were vehicle factors such as bald tires, tire incompatibility, road-wheel oscillation, improper repair of the vehicle, wide C-pillar blocking visibility, and directional instability due to rear wheel lock-up. Environmental secondary causes were such things as phantom vehicle maneuvers, wet and slippery pavement, obstruction from trees and construction equipment, intersections without traffic controls, and poor road design and maintenance.

Primary human causes of accidents included inattention to the driving task, disregarding signals, following too closely, excessive speeding for conditions, misjudging other vehicle motions, losing control in panic situations, and losing consciousness. Nine out of a total of 79 drivers studied had used alcohol or other drugs. Four drivers had a blood alcohol level over 0.15 percent (legally intoxicated under California law).

Of the drivers at fault, 28 out of 37 were male. Drivers that were found to be at fault fell into four age groups. Males tended to be at fault in the age groups of 17 to 28 and 48 to 62 whereas a proportionately larger number of females were at fault in the groups of 28 to 48 and over 70. Of the young drivers (16 to 19 years old), 46 percent had received citations, and 23 percent had been in previously reported accidents. Their restraint useage was higher than national figures, and they had all taken driver training. Older drivers (70 years and older) seemed to be typical of all drivers SCAT investigated.

Injury causation was also studied. Seventy-six of 114 people suffered injuries. Eight were fatalities. Injuries by severity and anatomical areas are related to points of vehicle contact. Some of our findings are included here: head injuries were often minor injuries resulting from contact with windshields; neck injuries consisted of sprains of various types often occurring without known contact; thorax region injuries were a result of pulmonary edema and congestion, intrusion into the occupant compartment, or contact with the steering-wheel column; abdominal, spinal and pelvic injuries resulted from contact with seat belts, doors, and seat backs; many knee injuries occurred despite the use of lap restraints (contacts were with the lower instrument panel and steering column).

Clustering, a methodology for the categorization of multivariate data into groups to determine important subpopulations, interrelationships, and characteristics was developed and used to examine SCAT's traffic accident data. Forty-five variables to describe each data case (information about the vehicle, environment, and driver) were selected. The statistical analysis resulted in eight clusters. Interpretation of some of these clusters produces the following information: for accidents occurring on freeways and expressways at speeds of over 50 mph, single vehicle rollovers, loss of control, driver error, traversable medians, and environmental defects were injury-correlated factors; accidents

occurring in the rain tended to involve drivers under 30 who did not use the route regularly; where rain was heavier, injuries and vehicle damage were more severe and more vehicles were involved; drivers with many previous citations and drivers who had been drinking or using drugs used restraints less than other drivers. Attention was paid to the choice of variables used for accident analysis and adaptation of clustering techniques. This is one possible approach to segregating Highway Safety Research Institute (HSRI) accident data in order to determine the causes of death and injury on the road.

Federal Motor Vehicle Safety Standards relevant to accidents investigated by SCAT were examined. The standards on theft protection, protection for the driver from steering control system impact, and steering control rearward displacement appear to be satisfactory, and no changes are suggested. Slight upgrading is recommended for standards on tire selection and occupant protection in interior impact. In particular, it is recommended that the standard on hydraulic brake systems be upgraded to require stable braking at maximum deceleration; that the standard on glazing materials provide for better material for side windows to reduce injuries from flying glass; that the standard on anchorage of seats be modified to specify a test procedure that allows for the inertia forces of the seat plus occupant; and that the standard on fuel systems be extended to minimize damage and fuel leakage in rear-end and lateral collisions and to provide protection to fuel systems vulnerable to damage from below. The need for the standard on side-door strength is clear, but it was not possible to evaluate the effectiveness of the standard in preventing injury. The standard on occupant crash protection is in a different category than other vehicle safety standards because its effectiveness depends on voluntary use of restraints. Restraint use may depend on convenience and comfort, design factors that are under the control of the manufacturer, not the standard.

National Highway Safety Program Standards were also analyzed in relationship to the accidents investigated. The standard on motorcycle safety, that requires riders to wear helmets to reduce head injuries, should be enforced by all states. Driver education and driver licensing standards are not completely meeting the needs they were designed for. High-school trained drivers were in more accidents, had their license suspended more times, and had proportionately more traffic citations than drivers without driver education and driver training. Age is an important factor here, however, since those who had had driver's training were under 30 years old. Some drivers are driving without licenses, while others should have had their licenses reevaluated. Accident locations are being identified, but appropriate measures are not always being taken. The accuracy of traffic records is questionable when information is incorrectly recorded or when minor accidents are not reported. While most design, construction, and maintenance problems of roadways are known, there are problems in funding and in the citizen reluctance to incur new traffic or noise.

Conclusions and recommendations are given throughout the report.

I INTRODUCTION

This is the final report of research conducted by the Stanford Research Institute Crash Analysis Team (SCAT) under Contract DOT-HS-199-2-319 with the Department of Transportation, National Highway Traffic Safety Administration, Washington, D.C. This report documents research activities conducted during the period from 1 April 1972 through 30 June 1973.* The study is entitled, "General Multidisciplinary Accident Study: Pacific Northwest."

A. Objectives and Scope

The project was conducted to investigate in depth a limited number of accidents involving late-model vehicles. The study of each accident included careful analysis of three groups of factors--the human, environment, and vehicle factors. Within each of these three groups, factors were investigated for pre-crash, crash, and post-crash effects. Through the interaction of individuals possessing expertise in relevant disciplines, the objectives of the contract were carried out.

The objectives of this research were

- To determine accident causes.
- To identify injury causes.

* Individual reports on each case, SRI 2-001 through SRI 2-040, were issued throughout the study period. For example, the first case is reported as "Multidisciplinary Accident Investigation: Case No. SRI 2-001," U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, D.C. 20590. Summaries of all the individual cases are reprinted in Appendix E of this, the final report.

- To clinically evaluate the effectiveness of relevant safety features.
- To clinically evaluate relevant Federal Motor Vehicle Safety Standards.
- To clinically evaluate relevant Federal Highway Safety Program Standards.
- To detect early design and function problems of the vehicle and the highway.

The studies consisted of a reasonable and balanced distribution of fatality, injury, and property damage producing collisions characteristic of the area. For a collision where the only damage was to property, it was stipulated that at least one vehicle had to be damaged enough to need towing from the scene.

Conclusions and recommendations given in this report are based on the in-depth investigation of 39 accidents, and they are not necessarily statistically valid for the entire population of motor vehicle accidents.

B. Organization of the Report

Section II covers investigation techniques. These include notification procedures and tools developed to facilitate data collection. The traffic reference library, literature searches, and statistical analysis are also discussed there.

Characteristics of the study area are discussed in Section III. Background accident data for the study area are compared with the accidents investigated by SCAT.

A detailed discussion of results is in Section IV. Emphasis is placed on accident causation and occupant injuries. The clustering technique of data analysis is described briefly, followed by a detailed description of its application to accident data.

In Section V, Federal Motor Vehicle Safety Standards and Federal Highway Safety Program Standards are discussed. In some cases recommendations for amendments to the standards are given.

Conclusions are in Section VI, and Recommendations are in Section VII.

II INVESTIGATION TECHNIQUES

A. Accident Investigation Approach

Stanford Research Institute Crash Analysis Team's (SCAT) basic procedures for selecting and studying accidents in depth were the same as other multidisciplinary teams across the country. Figure I shows the flow of events from team notification of an accident through the case report.

The team is notified of an accident by the police or county communications offices or it learns of an accident by monitoring police radios. If the team responds, they report to the officer in charge upon arrival at the scene of the accident and assist wherever possible. If no further assistance is needed, the scene is marked, photographs and measurements are taken, sketches are drawn, and any other information about the accident is obtained when time permits. As soon after the accident as feasible, the team inspects all vehicles, contacts and interviews accident victims and witnesses, and collects all supplemental data. After all information about the accident has been obtained, the accident is analyzed in terms of human, environment and vehicle factors. A report of the findings is then written and submitted to the National Highway Traffic Safety Administration (NHTSA). If the team is not notified at the time of an accident but is later requested to investigate, it obtains and reviews the accident report before a decision is made to investigate.

B. Some of SCAT's Unique Tools

Low-level aerial photography was an excellent tool providing a reference to intergrate all inputs from a well-marked scene. It was most useful in cases where the road configuration was difficult to measure

on the ground, e.g., freeways and congested intersections. Flights were scheduled to photograph several scenes to reduce the cost per photograph.

To simplify notification and collection of accidents and to balance the number of property-damage-only cases, a pager alert system was implemented with Santa Clara County Communications. The dispatcher rang the SCAT pagers each time an ambulance was sent to a traffic accident and reported the time and location of the accident. SCAT notified the dispatcher whether response would be made and kept the dispatcher informed of on-scene arrival and departure times using the two-way radio in the SCAT truck. The dispatcher kept SCAT informed of ambulance status and hospital destination, and he informed police on the scene of SCAT's intention to respond to the scene.

Cards bearing information on SCAT's project were distributed to police officers and tow truck drivers to assist them in notifying SCAT of accidents. The same card was given to drivers involved in the accidents so that they could contact the team if necessary. (See Figure A-1 in Appendix A for a sample of the card.) Along with the card went a short explanation of the purpose and objectives of the accident study. The information sheet is quoted in full in Appendix A. SCAT designed accident response pads (Form A) to record information obtained from monitoring police radio calls, phone calls from police, or calls from Santa Clara County Communications. Pads were located near all communications equipment and were used by the team to record the accident information. (For a sample of Form A, see Figure A-2 in Appendix A.)

C. Library and Literature Search

During the contract time, a Traffic Reference Library with a classification system based on National Highway Traffic Safety Administration (NHTSA) field groups was established. To date, 758 items have been catalogued.

Team interest prompted an SRI-funded contract with the McDonnell Douglas Automation Company (San Francisco office) to use the automated Highway Safety Literature Retrieval System developed and maintained for NHTSA. The system was used to develop backup material for selected cases and for other projects not under SCAT.

D. Statistical Analysis

A program of statistical analysis supported by SRI internal funds was initiated for the purpose of examining methods of categorizing traffic accident data. A description of the approach and recent results using data collected by the team can be found in Section IV of this report.

E. Information Retrieval Forms

Information retrieval forms designed to facilitate the data collection effort were developed and used along with those provided by NHTSA. Examples are in Appendix A. They are as follows:

- Form B was used on the scene. One form was used for each vehicle involved.
- Form C was used when examining the vehicle (away from the scene) for contact points. It was very useful in reconstructing occupant kinematics. Either side could be filled out first. When vehicle areas of contact were established first, it helped in questioning occupants about minor injuries they had overlooked. When injuries were obtained first, Form C helped in identifying vehicle areas of contact related to the injuries.
- Form D was used for collecting driving record information.
- Form E was used for recording dispatch times from police and ambulance logs.
- Form F, the human factors interview sheet, was used during all interviews with drivers or next of kin.

III THE STUDY AREA

The study area in which SCAT investigated accidents was divided into four groups. The groups are defined by distances to cities from the base of operation, SRI in Menlo Park. Figure 2 shows the four groups and relates the 39 accidents investigated by SCAT. The accidents which occurred in unincorporated jurisdictions within all four groups are also given.

SCAT-collected data may be examined for representativeness within the study area by comparison with 1971 police-reported accident data.* The population of the study area is approximately one million. In 1971, 6,623 fatal and injury accidents occurred in the study area. The population percentages for the groups in the study area and number of fatal and injury accidents per 1,000 residents are given in Table 1. To estimate the percentage of accidents in the study area that SCAT accidents represent, SCAT accidents are compared with the 1971 fatal and injury accident figures. Table 2 shows the estimated percentage of study area accidents that SCAT investigated.

Table 3 shows an examination of the representativeness of the SCAT type of accident for the fatal and injury accidents of the study area.

* Data are taken from "1971 Report of Fatal and Injury Motor Vehicle Traffic Accidents" published by the California Highway Patrol.

Table 1

POPULATION PERCENTAGES AND ACCIDENT RATES

		Percent of Study Area Population (1971)	Number of Fatal and Injury Accidents per 1,000 Residents (1971)
Group I:	Menlo Park, Palo Alto, Atherton	9	4.6
Group II:	Los Altos, Los Altos Hills, Mountain View, Redwood City	13	6.8
Group III:	Cupertino, Sunny- vale, Santa Clara	22	4.1
Group IV:	Saratoga, Camp- bell, Los Gatos, San Jose	56	8.2

Table 2

ESTIMATED PERCENTAGE OF ACCIDENTS
THAT SCAT INVESTIGATED

	Percent of Accidents
Group I	3.3%
Group II	0.8
Group III	0.4
Group IV	0.2

Table 3

PERCENTAGES OF TYPES OF ACCIDENT

Accident Type	Percent of Fatal and Injury Accidents in Study Area in 1971	Percent of Fatal and Injury Accidents in Study Area That Were Investigated by SCAT
Fatal	2	14
Injury	<u>98</u>	<u>86</u>
Total	100	100
Intersection	36	34
Non-intersection	<u>64</u>	<u>66</u>
Total	100	100
Motor Veh. to Motor Veh.	66	80
Other Motor Vehicle	<u>34</u>	<u>20</u>
Total	100	100

Roughly 10 percent of the SCAT accidents had property damage only, and they are not included in the above figures. Many of the differences noted between the SCAT accidents and 1971 police-reported accidents may be because SCAT investigated a particular accident population. One late-model vehicle had to be involved in the accident, and where no injuries resulted, at least one vehicle had to be damaged enough to require towing from the scene.

Of course, the results that follow must be considered as results for accidents that occurred in San Mateo and Santa Clara Counties in the

metropolitan/rural San Francisco Bay Area. Motor Vehicle registration for these two counties is 372,645 and 689,404 respectively, and there is a total of 5,597 roadway miles.*

* Data are taken from "1971 Report of Fatal and Injury Motor Vehicle Traffic Accidents" published by the California Highway Patrol.

IV DISCUSSION OF RESULTS

Contractual requirements limited the type of accident investigated. Each accident investigated in depth had to involve at least one vehicle made in the last three years. This meant 1970 to 1972 models were used in the portion of the study before January 1, 1973. Models from 1971 to 1973 were used after that date. Another requirement stipulated that an investigated accident result in injuries or property damage such that one or more of the vehicles had to be towed from the scene.

A total of 39 accidents were selected for full, multidisciplinary research. The 37th, involving a 6-car chain-reaction rear-end collision, was counted as 2 accidents, bringing the count up to the contractual requirement of 40 accidents.

Two requests for investigation of fatal accidents were received from the Santa Clara County district attorney's office. SCAT helped reconstruct facts for one of the requests, a multivehicle accident then two-months old, but SCAT did not accept it as a study case because of the deterioration of evidence and missing data. The second request was rejected because of lack of time.

A. Accident Causes

Of the 39 accidents investigated, driver error was regarded as the primary cause in 37. The remaining 2 accidents are attributed to a mechanical defect (SRI 2-004), where the anti-theft steering lock mechanism self-locked while the car was in motion, and to an environmental problem (SRI 2-033) where traffic signals had stopped working.

However, in the majority of accidents, environmental or vehicular factors contributed to the human error.

Appendix B lists and defines the human, vehicle, and environmental variables used to analyze the large amount of data. These variables plus abbreviated data for each case appear on a large matrix accompanying this report. It facilitates an overview of any variable for all cases or all variables for any case.

Vehicle and environmental factors are discussed under clustering results, in relation to safety standards, and finally in Appendix D where causes are summarized.

1. Vehicle Defects

Vehicle defects contributed strongly in five accidents where driver error was the primary cause, and all the defects resulted in loss of control. In three cases tires were at fault: bald tires on a heavy layer of water (SRI 2-018), tire incompatibility leading to instability under hard braking (SRI 2-020), and heavily worn tires combined with high speed on very wet pavement (SRI 2-022). Exhaust fumes from the heater in the last case may have dulled the driver's alertness, even though the driver was not aware of it. Wheel oscillation at high speed on a degraded section of road, coupled with hard braking resulted in a stepvan skidding out of control (SRI 2-005). The fifth accident related to a vehicle defect (SRI 2-008) involved a car with a front suspension lower control arm that was improperly repaired from a previous accident. The defect caused a pull to the right and severe wearing of the right front tire. In addition, loose steering linkage combined with an 8-inch-diameter steering wheel made steering difficult. The left rear tire pressure was low, and the brakes were in poor condition. The driver, aware of the defects, usually "compensated" for them, but he apparently failed to do so in this case when he made a quick maneuver to exit the freeway.

2. Environmental Factors

Environmental factors contributing to accidents were wet and slippery pavement (SRI 2-012, 2-018, 2-019, 2-022, 2-024, 2-026, 2-031), phantom vehicle (not contacted during crash) maneuvers (SRI 2-012, 2-013, 2-017, 2-020, 2-040), maintenance trucks on shoulder (SRI 2-014), congested intersections without traffic controls (SRI 2-011, 2-021), an uncontrolled intersection (SRI 2-039), a tree obstructing a stop sign (SRI 2-009), barricades causing a sudden lane narrowing (SRI 2-040), a poorly designed on-ramp (SRI 2-002), and a degraded road (SRI 2-005).

Phantom vehicles seem to have been a contributing factor in many cases. A quick maneuver by the phantom vehicle would cause another driver to attempt an emergency maneuver that he was not capable of performing. In the cases involving phantom vehicles, the first occurred when a phantom vehicle drove around a stopped car. The car behind the phantom vehicle collided with the rear of the stopped car (SRI 2-012). In the second case (SRI 2-013), the phantom vehicle changed lanes, causing the driver to brake hard and steer left. The driver lost control of his vehicle and spun into another lane where he was sideswiped. In the third case (SRI 2-017), a phantom vehicle suddenly changed lanes and slowed on a freeway overpass. In an attempt to avoid collision, the case driver braked hard and oversteered. His car left the road and overturned on the embankment. In the fourth case (SRI 2-020), a phantom vehicle began changing lanes when another vehicle was in the C-pillar blind spot. The other driver braked hard, oversteered to avoid a collision, drove up an embankment, and her car rolled over. In the fifth case, a phantom vehicle began to change lanes to avoid a barricade (SRI 2-040). The driver of the accident vehicle overreacted and lost control of his car. His car moved across the road, and sideswiped another vehicle.

3. Human Contributions

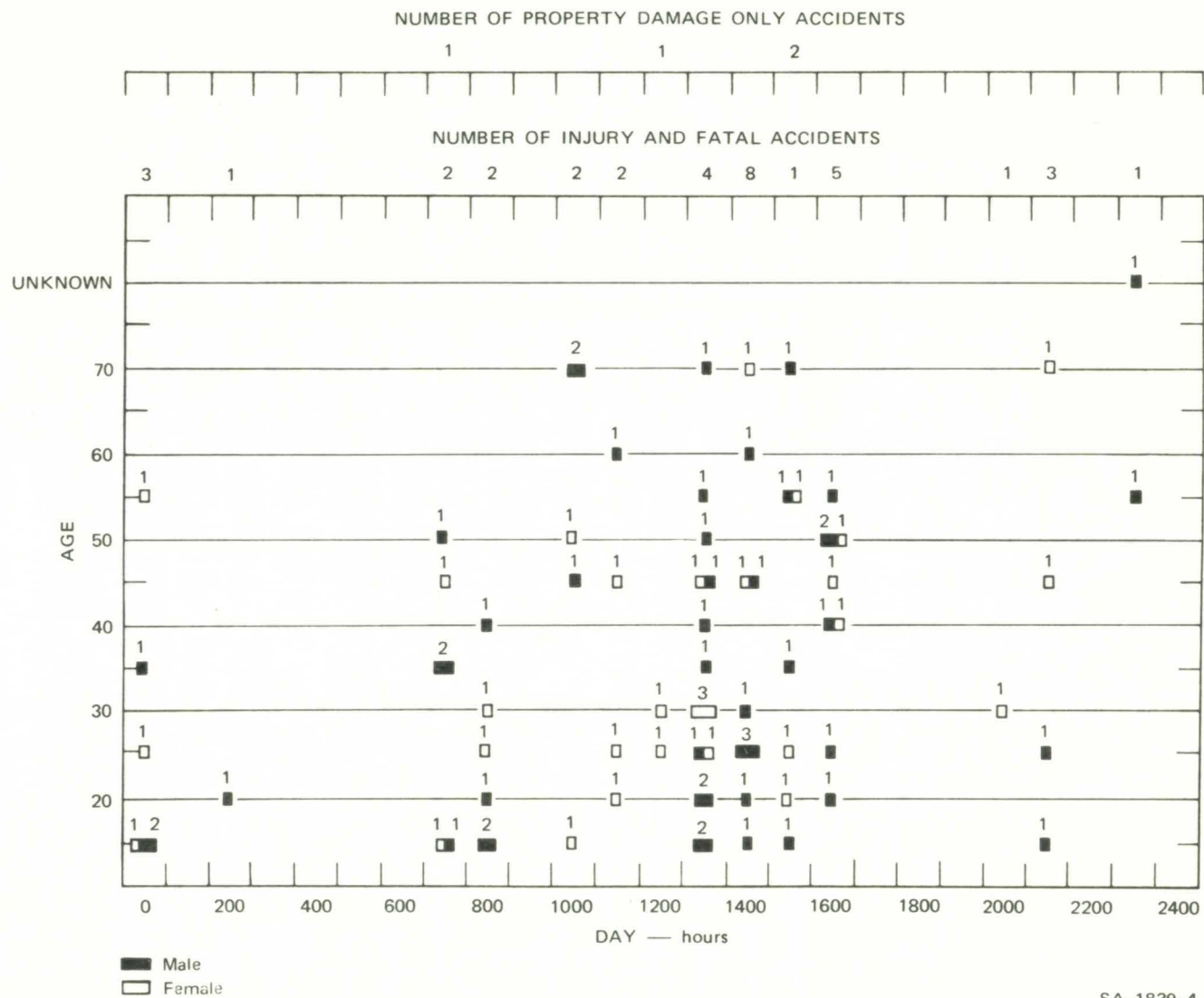
Seventy-nine drivers involved in the 39 accidents were examined by age, sex, occupation, and the times of day of their accidents. Figure 3 shows the times of day that accidents collected by SCAT occurred as well as the age and sex of all drivers. The times of accidents are given on the basis of the 24-hour clock. The number of accidents for a given time period is also indicated. For quick comparison, Figure 4 shows injury and fatal accidents by time of day for the State of California. Figure 4 shows the times of accidents and the occupations of the drivers.

a. Age and Sex

Looking only at data collected for drivers at fault, the team found striking information about the age and sex of drivers who cause accidents. Of the 37 drivers at fault, 28 were male. Males from 17 to 28 and 48 to 62 years of age tended to be at fault. In the 28 to 48 and over 70 age brackets, a proportionately larger number of drivers at fault were females.

Of the six drivers 70 years old and older, four (eight percent of the drivers studied) were at fault. Two had blood alcohol levels of .26 percent and .19 percent; one misjudged the speed of an on-coming car at a high-accident intersection; and the fourth "blackened out" behind the wheel from unknown causes. Two drivers, considered not at fault, crossed the same intersection where the traffic signals had malfunctioned. The human factors profiles of all of these drivers did not reveal anything unique. They had all driven a long time; none had driver education or driver training; and all were retired. The other variables used to examine these drivers showed them to be typical of all age groups.

The 13 very young drivers (16 percent of the total) ranged from 16 to 19 years of age. All but one were unmarried. Nine were students,



SA-1839-4

FIGURE 3 TIMES OF DAY OF ACCIDENTS, AGE AND SEX OF DRIVERS

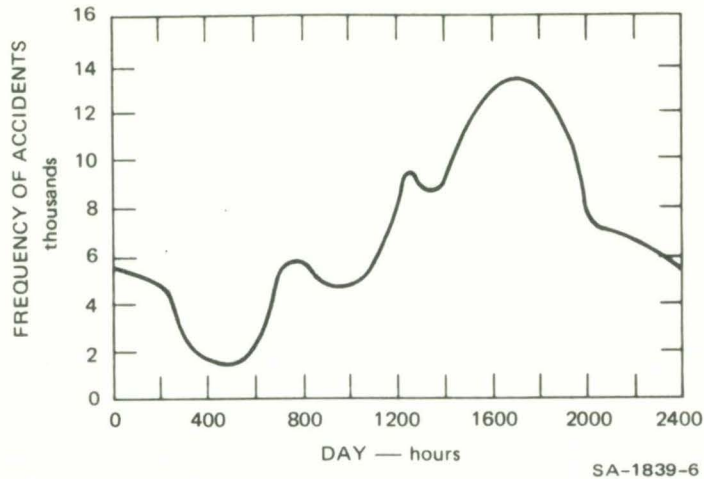


FIGURE 4 INJURY AND FATAL ACCIDENT PATTERN BY TIME OF DAY (FOR CALIFORNIA)

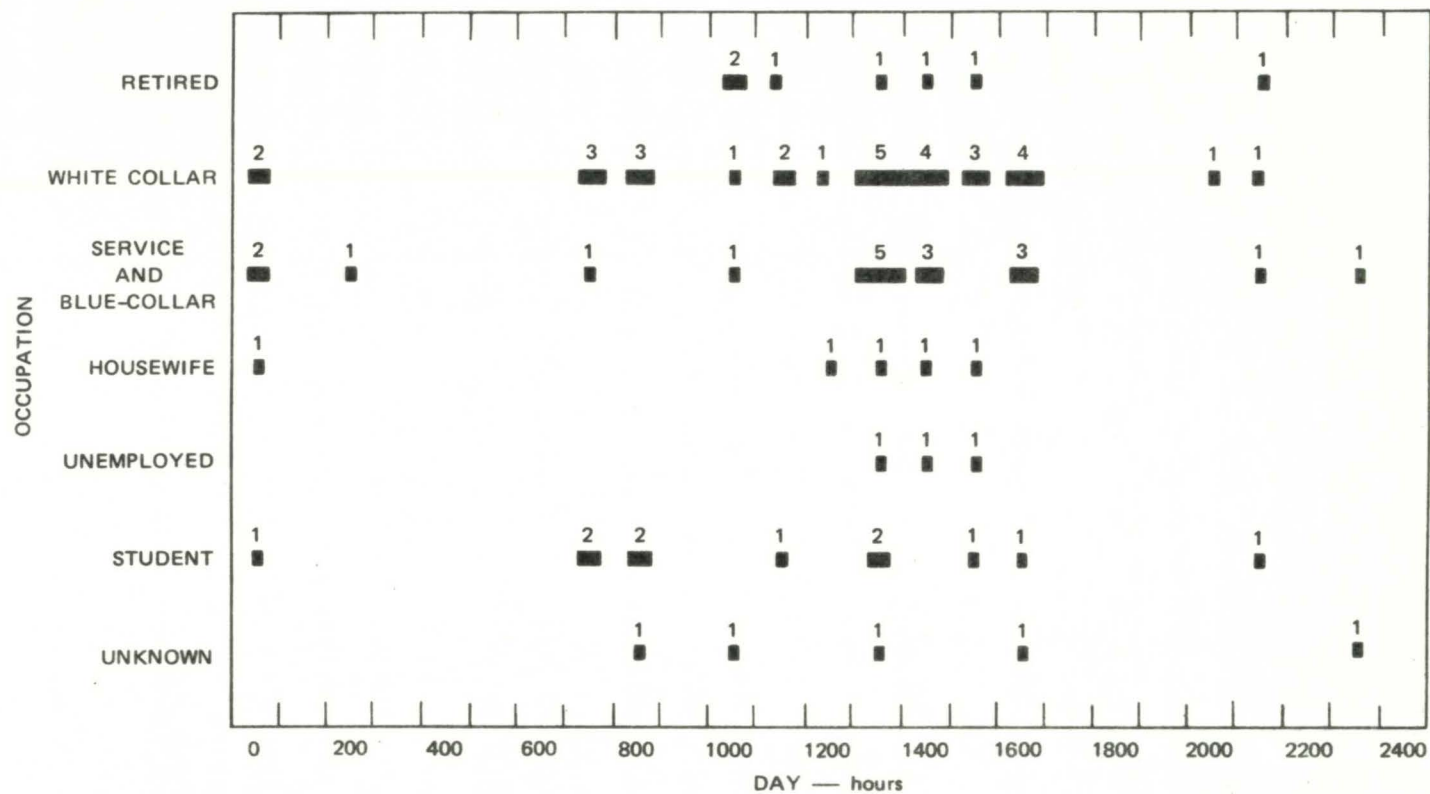
and three were working or in the military service (the occupation of one was unknown). All had taken courses in driver education and driver training. Six had received one or more traffic citations, and three had been in previous accidents reported by police. Two of those three and one with 6 traffic citations (but no accidents) had had their licenses suspended. Most of them could not estimate the number of miles they drove per year.

Six of the 13 very young drivers were found to be at fault. Two for speeding, two for inattention to traffic at intersections, one for drugs and drinking, and one for unsafe driving.

Restraint usage among the very young was as follows: 54-1/2 percent of the drivers with cars equipped with lap restraints wore them; 37-1/2 percent wore upper torso restraints; and 75 percent were using the head restraints. Of the vehicles driven by youth, three were six years old or older and eight were less than three years old.

b. Use of Drugs and Alcohol

Alcohol and drug involvement was a contributing factor for nine of the 79 drivers (11 percent of the total or 24 percent of drivers



SA-1839-5

FIGURE 5 TIMES OF DAY OF ACCIDENTS, OCCUPATIONS OF DRIVERS

at fault). In four of the cases studied (SRI 2-003, 2-013, 2-023, 2-034), drivers had a blood alcohol level greater than California's definition of intoxication of .15 percent. Two drivers (SRI 2-028 and 2-030) noted on the police accident reports as drinking were not considered drunk enough to warrant an alcohol test. Beer and seconal had been consumed by one driver (SRI 2-001), marijuana and beer were suspected in another case (SRI 2-032), and marijuana was suspected in still another (SRI 2-026). Open beer cans were found in two cars (SRI 2-010, 2-039), but there was no indication that the drivers had been drinking from them. All drivers mentioned were considered "at fault." In two of the four cases where the drivers were considered intoxicated by California law, the accidents resulted in four fatalities. In case SRI 2-023, the intoxicated driver and two passengers were killed from smoke and flame inhalation when their car caught fire. In case SRI 2-034, the intoxicated driver died from injuries after striking a car, wooden pole, chain-link fence, and a steel pole. His right front passenger was severely injured (AIS 5*). In the third accident in this category (SRI 2-003), the intoxicated driver's injuries are unknown. The occupants of the other car, however, suffered the following injuries: nondangerous but severe (AIS 3) injuries to the right front passenger; moderate (AIS 2) injuries to the driver; and minor (AIS 1) injuries to the remaining passengers. Where the driver was found to be under the influence of drugs (SRI 2-001), the injuries to the right front passenger were severe (AIS 4), to the driver moderate (AIS 2), and to the rear passengers minor (AIS 1). The other occupants involved in the remaining seven accidents had no or minor injuries.

* AIS or the Abbreviated Injury Scale is a coding of the severity of injuries as follows: 0 is none, 1 is minor, 2 is nondangerous/moderate, 3 is non-dangerous/severe, 4 is dangerous/severe, 5 is critical, 6-9 is fatal and X is unknown severity.

4. Injuries Sustained and Their Causes

There were 114 people involved in the 39 accidents. Of these, 76 people are known to have been injured, and eight died as a result of their injuries. The injuries have been divided into three categories of severity--fatal (F), serious (S), and minor (M).^{*} They are also considered in seven anatomical regions as shown in Table 4. Note that, if one person received fatally severe injuries to three different regions of his body, his fatal injuries would appear three times in the table. Several minor injuries to the same region, such as two or three lacerations and a contusion on the face, were listed only as a single minor injury for that anatomical area (except in the extremities where injuries to both extremities were counted as two minor injuries, such as lacerations of both knees).

Table 4

ANATOMICAL DISTRIBUTION OF INJURIES

	Fatal*	Serious*	Minor*
Head and neck	2	4	57
Thorax	5	4	14
Abdomen	1	4	15
Spine and pelvis	0	0	8
Lower extremities	0	1	68
Upper extremities	0	0	49
Burns	3	0	1

* A fatal injury is a cause of death, regardless of injuries to the other parts of the body; a serious injury threatens life; and a minor injury does not threaten life.

Figure 6 shows the most frequently known contacts with vehicle areas by human body region. It must be noted that the most difficult body regions for which to determine contacts or kinematics were the extremities.

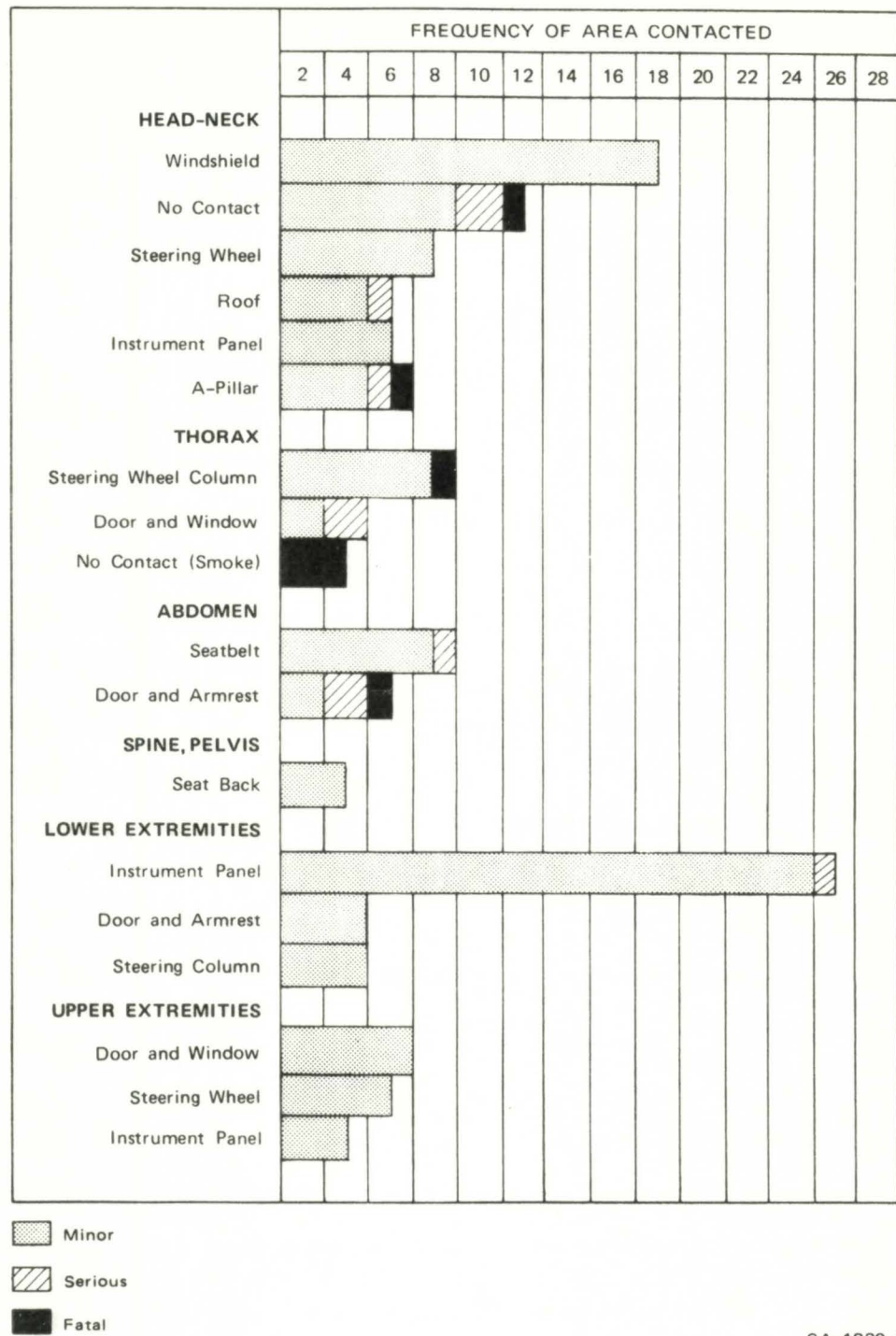
Table 5 shows the various injuries sustained in the cases studied; where possible, the contact surfaces producing the injuries are also shown. These data are used in the following sections for summarized discussions.

a. Head and Neck Injuries

Among the head and neck injuries reported in Table 4, there was one skull fracture that was associated with a subarachnoid hemorrhage which produced death. This injury occurred inside the vehicle where the driver's head struck the right A-pillar. Of the five serious head and neck injuries, one patient died the sixth day after the accident from bronchial pneumonia caused, at least in part, by decreased respiratory function secondary to the patient's unconsciousness and cerebral edema from his head trauma. In this case, the contacting point was thought to be the left side of the roof of the vehicle. Two of the other serious head injuries were cerebral edema probably due to the carbon monoxide poisoning when these victims were trapped inside a burning vehicle. Many of the fifty-seven minor injuries to the head and neck were caused by contact with the windshield, but windshields appeared not to be a source of fatal head injuries.

There were two motorcycles involved in these accidents studied; one motorcycle driver sustained a serious head injury when his head contacted the side of the automobile. Had he been wearing a helmet, this would probably have been a less severe injury. The other motorcyclist was wearing a helmet, and he did not even have a headache after his accident.

There were thirteen minor neck injuries consisting of sprains of various types. There was one fatal neck injury, an atlantal-occipital dislocation with fatal damage to the spinal cord. This dislocation was



SA-1839-7

FIGURE 6 MOST PREVALENT VEHICLE PARTS CONTACTED BY HUMAN BODY AREAS

Table 5

INJURY DESCRIPTIONS AND CONTACT SURFACES

Case Number	Collision Description	Vehicles	Occupants ⁺	AIS [±]	Injuries: Severity,* Descriptions and Contact Surfaces						Restraint Use	Use of Alcohol, Drugs
					Head and Neck	Thorax	Abdomen	Thoracic and Lumbar Spine and Pelvis	Lower Extremities	Upper Extremities		
2-001	Car ran off road, rolled over	'72 Chevrolet Vega	1D	2	M; laceration of right eye, nose bleed (windshield)	M; fractured scapula (right door)			M; fractured left fifth metatarsal (floor or vent)		Lap	2 beers and 5 ppm secobarbital
			1RF	1	M; black eye, concussion (right door)		S; perforation jejunum and ascending colon (seat belt)		M; abrasion left knee (shift)		Lap	
			1LR	1			M; abdominal pain (seat belt)				Lap	
			1RR	1			M; bruises and abrasions (seat belt)				Lap	
2-002	Rear-end	'69 Oldsmobile	1D	0							Lap	
		'69 VW 1500	2D	2	M; concussion, upper lip laceration (steering wheel) M; neck sprain (seat back)		M; contusions (arm rest or steering wheel)	M; lumbar spine sprain (seat back)	M; contusion near ankle (brake pedal)	M; contusion (steering wheel)	None	
		'61 Comet	3D	0							None	
2-003	Oblique head-on at intersection	'71 Pontiac	1D	X	M; cut lip (steering wheel or windshield)						None	Blood alcohol .22%
		'60 Corvair	2D	2	M; concussion, bruised chin, lacerated lip, burns (steering wheel)	M; bruised right breast (steering wheel)			M; bruise and laceration both knees (instrument panel)	M; burns	None	
			2RF	3	M; 4 inch laceration left side of forehead, concussion (windshield); bruise under chin (instrument panel)	M; bruised both breasts (instrument panel)			S; compound fracture right tibia and fibula, abrasion and bruise left and right knees (instrument panel)	M; bruise upper arm and left hand (instrument panel)	None	
			2RR	1	M; black right eye, laceration top of head (seat back)				M; laceration right lower leg (seat back)		None	
			2LR (Lap)	1					M; bruised lower leg		None	

Table 5 (Continued)

Case Number	Collision Description	Vehicles	Occupants [†]	AIS [‡]	Injuries: Severity,* Descriptions and Contact Surfaces						Restraint Use	Use of Alcohol, Drugs
					Head and Neck	Thorax	Abdomen	Thoracic and Lumbar Spine and Pelvis	Lower Extremities	Upper Extremities		
2-003 (Contd)	Oblique head-on at intersection	'60 Corvair	2LR	1	M; contusion left side of forehead (roof)				M; abrasions left lower and medial right lower legs (seat back)	M; abrasion left shoulder (window handle)	None	
2-004	Car/car/guardrail	'71 Pinto	1D	1	M; sore neck (no known contact)	M; sore chest (no known contact)			M; abrasion left knee (instrument panel)	M; sore shoulder	None	
		'68 Chevrolet	2D	0							Unknown	
2-005	Truck, hit guardrail and rolled over	'72 International Harvester	1D	1	M; pulled muscles (roof, side interior)				M; puncture wound calf (spare tire securing bolt)		None	
2-006	Lateral at intersection	'66 Mustang	1D	2	M; concussion, stiff neck (left vent window frame)						None	
		'70 VW 113	2D	1	M; abrasion, black right eye (right front seat back)						None	
2-007	Car/motor-cycle/car, oblique lateral sideswipe	'65 Ford LTD	1D	0							None	
		'72 Honda 750	2D	1	M; chin bruise			M; sore lumbar region (road)	M; laceration left thigh and buttock, bruise and abrasions on knees (car and road) M; sprained ankles	M; left thumb fractured (handle); bruise left elbow and right upper arm (pavement); sore right thumb (handle)	Helmet, leather upper torso garments, leather boots, and gloves	
		'71 Chevrolet Vega	3D	1	M; sore neck (whiplash)	M; sore chest (steering wheel)			M; bruised right knee (instrument panel)	M; bruised right wrist (mirror)	None	
2-008	Car/car/barrier railing	'66 Ford Galaxie	1D	3	M; lacerated lip, bloody nose, mandible fractured (upper instrument panel and steering wheel)	M; fractured sternum (steering wheel)			M; bruised knees (instrument panel)		None	
			1RF	X	M; concussion (windshield)						None	
		'71 Chevrolet Station Wagon	2D	0							None	

Table 5 (Continued)

Case Number	Collision Description	Vehicles	Occupants†	AIS‡	Injuries: Severity,* Descriptions and Contact Surfaces						Restraint Use	Use of Alcohol, Drugs
					Head and Neck	Thorax	Abdomen	Thoracic and Lumbar Spine and Pelvis	Lower Extremities	Upper Extremities		
2-009	Lateral at intersection	'70 Mercury Cougar	1D	0							Lap and torso	
		'69 Ford Mustang	2D	0							Lap	
			2RF	0							Lap, General Motor infant safety seat	
2-010	Head-on	'57 Lincoln	1D	Unknown							None	Open beer can found in Vehicle 1
		'71 Pontiac	2D	1	M; bruised left side of forehead, possible concussion (wind-shield)					M; avulsion of a left-hand finger (air outlet adjuster)	None	
			2RF	1	M; laceration in mouth, bruise on head (mirror)		M; pain		M; bruised right side (heater duct)	M; bruises right side (instrument panel)	None	
2-011	Lateral at intersection	'72 Toyota Corolla	1D	Unknown							Unknown	
		'70 Jaguar	2D	0							Lap and torso	
2-012	Rear-end	'73 Pinto	1D	1	M; tightness in neck (no contact)	M; soreness at sternum (padded steering wheel hub)	M; soreness left side (no known contact)			M; scrape on knuckle of finger (ventilation control)	Lap	
		'72 Pinto	2D	1	M; neck pain, bump back of head (head restraint)						Lap	
			2R	0						M; bump right index finger	Lap	
2-013	Sideswipe (not severe enough to inflate airbag)	'72 Mercury	1D	1			M; left abdomen soreness (seat belt)	M; bruised left lower thoracic area (no known contact)			Lap	
			1RF	1				M; ache spinal column (no known contact)	M; shoulder muscles stiff (no contact)		Lap Air Bag Available	
		'70 Chrysler	2D	0							None	Blood alcohol .17%

Table 5 (Continued)

Case Number	Collision Description	Vehicles	Occupants [†]	AIS [‡]	Injuries: Severity,* Descriptions and Contact Surfaces						Restraint Use	Use of Alcohol, Drugs
					Head and Neck	Thorax	Abdomen	Thoracic and Lumbar Spine and Pelvis	Lower Extremities	Upper Extremities		
2-014	Rollover	'70 VW	1D	2					M: contusion (steering wheel)	M: fractured proximal end, left clavicle, abrasion left shoulder (pavement and torso belt)	Lap and torso	
2-015	Sideswipe at intersection	'65 Rambler	1D	0							Lap	
		'72 Volvo	2D	1						M: sore left shoulder (side interior door)	Lap and torso	
2-016	Oblique head-on at intersection	'71 Pinto	1D	0							Lap and torso	
		'68 Dodge Dart	2D	0							Lap	
			2RCR	0							None	
			2LCR	0							None	
2-017	Rollover	'70 Chrysler	1D	4	M: contusions, abrasions, hematoma on face, head; concussion (contact unknown)	M: pneumothorax left, left 5 ribs fractured (contact unknown)	M: kidney contusion (contact unknown)				None	
2-018	Lateral sideswipe (across the median)	'64 Ford Falcon	1D	4	M: laceration across bridge of nose (steering wheel rim)			M: severe back pain (seat back)			Lap	
		'72 Gremlin	2D	7	F: occipital-atlantal joint dislocated, spinal cord contused, subarachnoid hemorrhage (inertia)	S: bilateral hemothorax, lung contusions (window frame on left door)	S: liver lacerated (left door), spleen lacerated (arm rest). M: contusions (lap restraint)		M: contusion thighs (left door)	M: wrist laceration, abrasions (glass or window frame)	Lap and torso	
			2RF	4	M: concussion, right parietal hematoma (A-pillar, right window)	M: left lung contusion S: pneumothorax (left seat, driver)	M: contusions, pain (lap restraint)	M: fractured left superior pubic ramus (left seat, driver)		M: fractured left humerus (left seat and driver)	Lap	
		'63 Chevrolet	3D	0							Unknown	
2-019	Lateral at intersection	'71 Peugeot	1D	0							Lap and torso	
		'69 Ford LTD	2D	0							Lap	

Table 5 (Continued)

Case Number	Collision Description	Vehicles	Occupants†	Injuries: Severity,* Descriptions and Contact Surfaces							Restraint Use	Use of Alcohol, Drugs
				AIS‡	Head and Neck	Thorax	Abdomen	Thoracic and Lumbar Spine and Pelvis	Lower Extremities	Upper Extremities		
2-020	Rollover	'71 Ford Station Wagon	1D	1		M; contusion center chest (possibly steering wheel)			M; contusions knees (possible steering column or instrument panel, left door)	M; contusion left hand, soreness (contact unknown)	Lap	
2-021	Lateral at intersection	'67 Chrysler	1D	0							None	
		'69 VW	2D	1				M; high back pain (left door)	M; left hip pain, weakness left leg (arm rest, left door)	M; left shoulder pain (door window frame)	None	
		'72 Datsun 240Z	3D	0							Lap	
2-022	Sideswipe/oblique head-on (across the median)	'69 Dodge	1D	2	M; concussion (windshield), right side of neck sore				M; knees scraped, sore left ankle, foot sprained (instrument panel)	M; right hand bruised and sprained, right shoulder sore (probably steering wheel)	None	
			1RF	3	M; concussion, facial lacerations (windshield), neck sore				M; contusions knees (instrument panel)	M; small laceration right hand	None	
		'72 Pontiac	2D	0							Lap	
		'72 Plymouth Station Wagon	3D	1	M; head sore, small laceration forehead (windshield, left A-pillar)				M; soreness, contusion left knee (instrument panel)	M; soreness	Lap	
2-023	Car hit an object and caught fire	'71 Plymouth Fury	1D	9 Body: ext. burns	S; cerebral edema	F; pulmonary congestion and edema from CO poisoning (46% blood saturation from smoke and fire)					None	Blood alcohol .19%
			1RF	9 Body: gen. 4° burns		F; pulmonary congestion and edema from CO poisoning (37% blood saturation from smoke and flame inhalation)					None	

Table 5 (Continued)

Case Number	Collision Description	Vehicles	Occupants [†]	AIS [‡]	Injuries: Severity,* Descriptions and Contact Surfaces						Restraint Use	Use of Alcohol, Drugs
					Head and Neck	Thorax	Abdomen	Thoracic and Lumbar Spine and Pelvis	Lower Extremities	Upper Extremities		
2-023 (Contd)	Car hit object and caught fire	'71 Plymouth Fury	1LR	9 Body: 60% burned	S; cerebral swelling	F; CO poisoning (50% blood saturation) from smoke					None	Blood alcohol .14%
2-024	Rear-end (car/parked truck)	'72 Datsun 1200	1D	1	M; abrasion left forehead (sunvisor and roof)				M; laceration right knee (ignition switch)		Lap and torso (torso restraint failed)	
2-025	Lateral at intersection	'72 Nova	1D	3	M; face contusions, vein laceration (steering wheel rim)	M; contusions left breast (steering wheel)			M; abrasion left knee (instrument panel), contusion right thigh (right door)	M; contusions upper left arm (steering wheel), lower right arm (transmission lever)	Lap	
		'73 Olds Omega	2D	5	M; concussion (left A-pillar), lacerations (eyeglasses)	S; fractured left ribs (door), hemothorax	M; renal contusion, contusion on abdomen (door)		M; left hip contusion (arm rest)	M; wrist, hand lacerations (left window flying glass)	Lap	
2-026	Sideswipe on curve	'71 Toyota	1D	0							Lap	Marijuana suspected
			1RF	0							None	
			1RR	0							None	
		'66 Mustang	2D	1	M; left side of head bumped (left window)				M; knee sore (dash, door and/or steering column)	M; contusion right arm (contact unknown)	Lap	
2-027	Lateral at intersection, rollover	'72 Cadillac	1D	1	M; right neck sore (strain only due to jolt)					M; right shoulder sore (strain only)	Lap	
		'72 Toyota wagon	2D	2	M; concussion (lower dash, left front window), right side of forehead laceration (flying glass)		M; soreness (lap restraint worn high)		M; left leg abrasion (contact unknown)		Lap	
2-028	Lateral at intersection, rollover	'70 Mustang	1D	1	M; contusion left temple (left A-pillar or windshield)				M; contusion both knees (parking brake release and lower instrument panel)	M; contusion right forearm (steering wheel)	None	
		'71 VW Van (rolled over)	2D	1	M; contusions forehead (left side roof rail)	M; left side sore (left door)			M; right knee abrasion (contact unknown)	M; left arm contusions (left door)	None	Alcohol suspected

Table 5 (Continued)

Case Number	Collision Description	Vehicles	Occupants ⁺	AIS [±]	Injuries: Severity, * Descriptions and Contact Surfaces						Restraint Use	Use of Alcohol, Drugs
					Head and Neck	Thorax	Abdomen	Thoracic and Lumbar Spine and Pelvis	Lower Extremities	Upper Extremities		
2-029	Head-on at intersection	'68 Triumph motorcycle	1D	4	S; concussion (Vehicle 2), fractured superior rim left orbit, facial lacerations (Vehicle 2 windshield, right A-pillar)				M; scrapes and abrasions (road), laceration right ankle (motorcycle oil tank mounting bracket)	M; abrasions right arm (ground)	No helmet, wool upper torso garments, leather boots and gloves	
		'71 Peugeot	2D	Unknown							Unknown	
2-030	Rear end/lateral (parked car)	'70 Karman Ghia	1D	1	M; lacerations forehead, bloody nose (steering wheel)				M; knee abrasions (instrument panel)		None	Alcohol suspected
2-031	Oblique sideswipe (on curve)	'69 Dodge Dart	1D	Unknown							Unknown	
		'72 Datsun 240Z	2D	5 [§]	S; brain contusions, hemorrhage (left side, roof of car) [§]					M; abrasions left arm	Lap	
			2RF	Unknown							Unknown	
2-032	Car ran off road/hit object/rolled over	'72 BMW	1D	1	M; forehead laceration (contact unknown)				M; upper left leg sore (contact unknown)		None	Beer and marijuana suspected
2-033	Lateral at intersection	'72 Chevrolet Van	1D	1						M; abrasions, right hand (instrument panel)	Lap	
		'65 Ford Ranchero	2D	1	M; head lacerations				M; left upper leg bruised	M; right shoulder bruised	None	
		'71 Datsun	3D	1	M; left side of head bruised (windshield)				M; right knee bruise, laceration (instrument panel)		None	
			3RF	1					M; left knee bruise (instrument panel)		None	
			3RR	0							None	
			3RCR	0							None	

Table 5 (Continued)

Case Number	Collision Description	Vehicles	Occupants [†]	AIS [‡]	Injuries: Severity, * Descriptions and Contact Surfaces						Restraint Use	Use of Alcohol, Drugs
					Head and Neck	Thorax	Abdomen	Thoracic and Lumbar Spine and Pelvis	Lower Extremities	Upper Extremities		
2-034	Sideswipe/pole/pole (across the median)	'69 Buick	1D	6	F; subarachnoid hemorrhage, fractured calvarium, cortical contusions, pons hemorrhage, cerebral edema	S; fractured right ribs, pulmonary contusions	S; liver lacerations				None	Blood alcohol .26%
			1RF	2	M; laceration right side of forehead		M; pain in abdomen	M; fractured left side of pelvis	M; fractured right fibula, lacerations	M; fractured right humerus and radius and ulna, lacerations (right door)	None	
		'65 Ford	2D	0							None	
		'71 Chevrolet camper van	3D	0							Lap	
2-035	Head-on (across the median)	'73 Ford LTD	1D	2	M; concussion, face contusions, lacerations in mouth	M; left chest contusions (steering wheel)			M; knees and leg contusions (instrument pannel)	M; arm contusions	Lap	
			1CF	2	M; concussion		M; contusions			M; right hand abrasions	Lap	
		'65 Mustang	2D	7	M; scalp laceration (windshield)	F; multiple rib fractured, lung contusions, bilateral hemothorax, sternal fracture (steering column)	S; lacerated liver (steering wheel and column)		M; right leg laceration, abrasion right leg and knee (instrument panel or steering column)	M; right shoulder and arm abrasions, contusion, right hand swollen	None	
			2RF	8	M; front upper teeth fractured, facial lacerations, abrasions (windshield, instrument panel or right A-pillar)	F; multiple rib fractures, lung contusions, right lung partially collapsed, bilateral hemothorax, left chest abrasions and lacerations	F; lacerated liver, & spleen, ruptured right diaphragm, lacerated inferior vena cava near sacrum (right door intrusion)		M; right thigh and knee abrasions, abrasions both ankles	M; right arm lacerations, abrasions, left shoulder abrasions	None	
2-036	Rear-end	'72 Pinto	1D	1		M; sore	M; contusions (seat belt)				Lap	
		'68 Plymouth Station Wagon	2D	0							Lap	

Table 3 (Continued)

Case Number	Collision Description	Vehicles	Occupants ⁺	AIS [‡]	Injuries: Severity, * Descriptions and Contact Surfaces						Restraint Use	Use of Alcohol, Drugs
					Head and Neck	Thorax	Abdomen	Thoracic and Lumbar Spine and Pelvis	Lower Extremities	Upper Extremities		
2-037/ 2-038	Rear-end (multiple)	'73 Plymouth	1D	2	M; superficial lacerations forehead. M; blow to jaw, hematoma, concussion (windshield)		M; soreness, contusions				None	
		'70 Austin American	2D	1	M; head sore (windshield)				M; contusions, soreness right thigh, left leg and foot	M; contusion right arm	None	
			2RF	1	M; lacerations head and face (windshield)				M; contusions	M; contusion	None	
		'68 Chevrolet	3D	1	M; neck stiff (being forced back)				M; contusions knees (instrument panel)		None	
			3RF	1	M; concussion (windshield)				M; left leg twisted		None	
		'72 Ford LTD station wagon	4D	1	M; neck sprained						None	
		'68 Buick	5D	1	M; neck sore						None	
		'70 Plymouth	6D	0							None	
2-039	Lateral at intersection	'62 Chevrolet	1D	1	M; contusions left side forehead						None	Open beer can in Vehicle 1
			1CF	1	M; lacerations left eye and nose (instrument panel)						None	
			1RF	1	M; lacerations head (instrument panel)						None	
			1LR	0							None	
			1CR	0							None	
			1RR	0							None	
		'73 Ford Torino	2D	0							Lap	

Table 5 (Concluded)

Case Number	Collision Description	Vehicles	Occupants [†]	AIS [‡]	Injuries: Severity, [*] Descriptions and Contact Surfaces						Restraint Use	Use of Alcohol, Drugs
					Head and Neck	Thorax	Abdomen	Thoracic and Lumbar Spine and Pelvis	Lower Extremities	Upper Extremities		
2-040	Oblique side-swipe	'72 Olds	1D	0							Lap	
		'67 VW	2D	1	M; bump on head (mirror)				M; right knee contusion (instrument panel)	M; left arm sore, right thumb sprain (steering wheel)	None	
			2RF	1	M; laceration left side of forehead (wind-shield)				M; left knee contusion (instrument panel)	M; right arm sore (strain)	None	

^{*}F is fatal, S is serious (life threatening), and M is minor (not life threatening).

[†]Occupants are identified by case vehicle number and occupant's position in the vehicle, i.e., RF is right front.

[‡]AIS or Abbreviated Injury Scale is a coding of severity of injuries as follows: 0 is none, 1 is minor, 2 is nondangerous/moderate, 3 is nondangerous/severe, 4 is dangerous/severe, 5 is critical, 6-9 is fatal and X is unknown severity.

[§]Died six days after accident of bronchopneumonia due to head injury.

considered to be caused by inertial change because there were no signs of trauma to the patient's head. It may have been aggravated by the use of an upper torso restraint.

b. Thorax Injuries

Of the five fatal injuries received in the thorax region, three were due to pulmonary edema and congestion from flames in a burning vehicle. The two other fatal injuries in the thorax region were due to severe and blunt trauma that produced multiple rib fractures, bilateral hemothorax, lung contusions and collapse. These two victims were unrestrained in a high speed head-on collision in which there was occupant compartment intrusion.

The serious injuries in the thorax region were pneumothorax and hemothorax associated with fractured ribs. One of these occurred in a rollover accident, and the site of contact is unknown. One occurred in a lateral impact on the driver's side where there was occupant space intrusion. Another occurred in a lateral impact at an intersection. In both this case and the previous one, the injured were wearing restraints. The fourth serious injury to the thorax occurred in a sideswipe accident with subsequent pole impact.

The minor injuries to the thorax were primarily from contact with the steering wheel, and the side door.

c. Abdominal Injuries

Fatal and serious injuries to the abdominal region were less frequent than those to the thorax or to the head. In only one of the people evaluated in the study was the injury to the abdomen considered to be fatal. A lacerated liver and spleen, a ruptured right diaphragm, and a lacerated inferior vena cava occurred when there was intrusion into the occupant space

from the high speed impact into the right side of the car. These injuries were associated with fatal injuries to the thorax as well. The serious abdominal injuries, lacerated livers and lacerated spleens, were also associated with fatal chest or head injuries in all but one case. (In one case, a rollover, a passenger suffered a perforated jejunum and descending colon but no fatal chest or head injury, possibly because she used a lap restraint.)

d. Spine and Pelvic Injuries

There were no fatal or serious injuries to the thoracic and lumbar spine or to the pelvis of the 114 people involved in these 39 accidents. The minor injuries included two minor fractures of the pelvis and six complaints of back pain. The contact points producing these injuries were either seat backs or unknown.

e. Extremity Injuries

Injuries of the extremities were in no case fatal. There was one serious injury of the lower extremity, a compounded fracture of the tibia and fibula that is categorized as serious in accord with recommendations for categorizing injuries made by John States, M.D.,¹ and others who have been doing research in this area. The injury occurred when an unrestrained right front-seat passenger went into the instrument panel during an oblique head-on collision. There were 49 minor injuries of the upper extremity and 68 minor injuries of the lower extremities. Of the injuries to the lower extremity, 35 were injuries to the knee. It is interesting to note that injuries to the knee occurred even though occupants were wearing lap belts. Points of contact were either the steering column or the projecting brake release handles and lower instrument panel. The belts were possibly loosely applied or stretched upon impact allowing contact between the knees and the other objects in the vehicle, or there was backward protrusion of the object causing the knee injury. Except for the serious

compound fracture of the tibia and fibula noted above and one other fractured fibula, none of the injuries to the lower extremities included fractures. They were all abrasions, lacerations, and contusions. This is probably due to the fact that most of the accidents studied were relatively low-speed accidents.

Four persons had fractures in upper extremities. One motorcyclist received a Bennett's fracture of the thumb as he moved against the handle bar at impact. One fractured clavicle occurred in a rollover. A fractured left humerus from contact with the left seat and driver and a fractured right humerus and radius and ulna from contact with the right door intrusion occurred in two cases.

f. Burns

Four people in this study were injured with burns. Three of them died. Gasoline from a punctured fuel tank ignited and caused the death of three elderly people in one vehicle. A fourth victim received second- or third-degree burns of her left arm and second-degree burns of her forehead from a fire that was caused by a flare set too close to an accident vehicle that was leaking gasoline.

B. Analysis Techniques Used by SCAT

An objective of SRI's research effort related to SCAT has been to develop a methodology for the categorization of traffic accident data and to examine the usefulness of clustering techniques to meet this goal.²

Categorization methods provide for a logical organization of a data population by assigning all data cases to some subpopulation. Clustering is a categorization technique that is particularly applicable to the division of multivariate data into groups, called clusters, when an unstructured division criterion is desired. Traffic accident data are highly multivariate

in nature and, therefore, highly structured methods may defeat the goal of determining which characteristics of traffic accidents actually are significant. SRI's Basic Clustering Computer Program was used in this study to apply the clustering technique to traffic accident data.³ The program requires no prior knowledge of the data, and data variables may be ranked or numerical values can be used. In this program all data variables are considered simultaneously as clusters are formed from the data.

Essentially, this clustering program is a multivariate extension of the process of graphing data cases with two variables and pictorially dividing the data into clusters on the basis of proximity. The program begins with all data cases in one cluster. The multivariate mean of the data cases is computed, and the data case most different from the mean starts a second cluster. The criterion for allocation of further cases is the total error--the sum of multivariate distances from each data case to the cluster mean of the cluster to which it is assigned. A case is moved to another cluster if the move will reduce total error. This procedure of minimizing total error is designed to minimize distances within clusters and maximize distances between clusters. When it is no longer possible to reduce the total error by moving a data case to another existing cluster, the case that is most different from its cluster mean is designated to start a new cluster. The process is repeated in this manner until some preselected maximum number of clusters has been obtained. The choice of the number of clusters used for analysis is made by the program user. For each number of clusters considered, the configuration for that number of clusters is optimum with respect to minimizing total error.

The clustering process has been shown to indicate whether or not significant subpopulations or interrelationships exist; if they do, newly found characteristics can then be tested using standard multivariate analysis techniques. Clustering can also be viewed as a type of analysis in itself, indicating the basic structure of the data considered.

The clustering process is particularly useful for a moderate number of variables. Because of the large number of variables involved in a Multidisciplinary Accident Investigation (MDAI) analysis, recent SRI effort has been devoted to the examination of the use of factor analysis as a method of reducing the number of variables before clustering techniques are used. Human factors are often difficult to mathematically code, so a factor analysis was performed using a large number of human factor variables and basic accident description variables. Data used for the factor analysis were obtained from the Highway Safety Research Institute (HSRI) data bank's "Collision Performance and Injury Report 3," and they were similar to those collected by SCAT. The number of variables was reduced via factor analysis, and the resulting human factor variables were used for this study. It is noteworthy that no human factors variable was "insignificant" in the clustering (see next section), although some vehicle and environmental variables were.

The HSRI data bank has been used extensively throughout this project for purposes of data retrieval. In addition to pilot studies of the type above, the data bank has also been used during SCAT investigations to determine that certain findings were relatively common or to verify or nullify postulated accident causes.

C. Clustering Results

This clustering methodology was used for an analysis of SCAT data. Since the conditions under which these data were collected were not necessarily representative of the total accident picture, care was also taken to compare the SCAT data to the available local accident population data (see Section III). The results obtained here must be judged only as a very small sample from SCAT's study area. The SCAT accidents tended to have more severe injuries and fewer single vehicle accidents than the study area accidents had as a whole. One car in each SCAT accident was required

to be less than three years old, and either an injury or a towed away vehicle had to be involved.

Each data case in this analysis represents a vehicle investigated by SCAT. One record each was processed for the first and second vehicles in an accident, excluding motorcycles, parked vehicles, and vehicles for which little information was obtained (e.g., vehicles in which accident involvement was very minor and hit-and-run vehicles). Sixty-four vehicles from the SCAT data satisfied these requirements. Forty-five variables were chosen to describe each data case.

At this point it is useful to mention that the Basic Clustering Computer Program and clustering techniques have no sample size requirements because no statistical tests or criteria are involved. Sixty-four data cases with 45 variables each would ordinarily be unacceptable in any statistical analysis technique. Furthermore, data on 64 vehicles do not provide much insight into the total accident picture. (Data for 3,500 accident vehicles are recorded at the HSRI data bank.) The clustering technique was used here to determine what factors were important in our study of 39 accidents.

In order to interpret clustering results, clustered data may be observed in various ways. After individual data cases have been allocated to clusters, the data cases in each cluster may be compared to the total data cases to determine the variable characteristics that are strongly represented in each cluster. Variables that are highly dispersed (most clusters contain markedly different values for a given variable) can be judged to be "important" to the clustering process, and they are therefore worthy of further examination. Individual characteristics in a cluster indicate strong multivariate relationships. Two or more clusters with some variable characteristics that are similar can be examined to determine multivariate correlations.

An eight cluster configuration was chosen because the addition of one more cluster to seven clusters or less provided a new interesting accident group. But for eight clusters or more, the addition of one more cluster only furthered breakdown of existing clusters.

1. Examination of Variables

The 64 vehicle data cases chosen from the 39 SCAT accidents were familiar, and additional information could always be obtained from the raw data. They presented an opportunity to attempt to select "important" variables that might be used by the National Highway Traffic Safety Administration and by us for further work on a larger sample. Statistical tests based on these "important" variables or on other variables chosen in this manner may be used with a sample of sufficient size from the HSRI data bank.

After exercising the Basic Clustering Computer Program for these 64 data cases, the results for the 45 variables used for each data case were examined. An "important" variable is one for which data cases were assigned to clusters (each cluster is a distinct subpopulation of that variable). For example, for driver restraint usage, clusters shown in Table 6 exhibit different characteristics when compared to each other and particularly when compared to the total. Eighty-eight percent of the data cases in Cluster 7, for example, had no use of restraints by drivers. This subpopulation is distinct within a total population where 45 percent use no restraints, and it may be compared to Cluster 8 where 31 percent use no restraints. Variables termed "less important" are those for which subpopulations were less distinct, and variables termed "insignificant" were those for which no subpopulations were evident.

Variables that are termed "important" would be likely candidates for use in further analysis of this type of data. Variables that clustered

Table 6

CLUSTERING RESULTS FOR DRIVER RESTRAINT USAGE

	Percent Of Total	Clusters*							
		1	2	3	4	5	6	7	8
No restraints	45%	29%	84%	40%	14%	100%	40%	88%	31%
Lap only or lap and shoulder†	55%	71%	16%	60%	86%	0%	60%	12%	69%
Relationship of cluster re- straint usage to the total		More	Much less	NSD‡	Much more	None	NSD	Much less	More

* The cluster number has no bearing on the considerations. It is for identification only.

† Lap only and lap and shoulder were combined here, but they were coded separately in the Basic Clustering Computer Program.

‡ Not significantly different from the total.

directly with these "important" variables as well as variables that were "insignificant" in the clustering might be removed from further analysis. Variables that were "less important" to the clustering need to be examined to determine whether or not they should be used.

Below are the variables used and their relative importance for the eight cluster configuration.

a. Human Factors

Variables that were "important" to the clustering were

- Driver error (the most responsible drivers, where driver error was a factor, were identified).

- Driver under the influence of alcohol or other drugs.
- Sex of driver.
- Age of driver.
- Driver's familiarity with route on which accident occurred.
- Number of previous citations recorded.
- Lap and shoulder restraint usage by driver.

Variables that clustered directly with these "important" variables were

- Number of years driving experience (correlated with age of driver).
- Driver education class completion (basically, drivers under 30 had taken the class, and those over 30 had not).

Variables that were "less important" to the clustering were

- Height of driver.
- Weight of driver.
- Number of previous accidents recorded.
- Number of passengers.
- Head restraints used by driver (in up position if adjustable).

There were no variables that were "insignificant" in the clustering.

b. Vehicle Characteristics

Variables that were "important" to the clustering were

- Driver AIS.
- CDC Extent. (Where the CDC rating* indicated that collision was in the general area of the driver, the extent of the vehicle damage was used.)

* Collision Deformation Classification rates damage severity to a vehicle. See Appendix C.

- Weight of vehicle.
- Speed of travel prior to impact.
- Rollovers. (Cases in which the vehicle rolled over were so indicated.)
- Sheet metal crush (maximum of crush for front, rear, left side, right side, roof).
- Passenger compartment damage.
- Loss of control of vehicle by driver.

Variables that clustered directly with these "important" variables were

- Overall AIS for all occupants (correlated with driver AIS).
- Length of vehicle (correlated with weight of vehicle).

Variables that were "less important" to the clustering were

- Number of vehicles in the accident.
- Collision with another motor vehicle or not.
- Collision with other objects (includes ground and secondary collisions).
- Tire tread wear of the worst tire.
- Vehicle defects. (Cases in which vehicle defects were present and related to the accident were so indicated.)

Variables that were "insignificant" in the clustering were

- Model year of the vehicle
- Fuel tank or line damage (including fire).

c. Accident Environment

Variables that were "important" to the clustering were

- Environmental defects. (Cases in which environmental defects other than weather were present and related to the accidents were so indicated.)

- Rain conditions.
- Type of road (rural and mountain roads, city streets and intersections, expressways and expressway ramps, freeway and freeway ramps).
- Shoulder.
- Median.
- Number of accidents per year over the past three years at the accident site.
- Average daily traffic at the accident site (ADT).

Variables that clustered directly with the type-of-road variable were

- Total number of lanes on the roadway
- Number of accesses per 1/4-mile
- Speed limit.

Variables that were "less important" to the clustering were

- Day or night
- Time of day.

A variable that was "insignificant" in the clustering was the day of the week.

d. Other Variables

The 45th variable was the SCAT accident case number. Twenty-five SCAT accidents had two vehicles used for this analysis in accordance with the guidelines above. In only 11 accidents did both vehicles fall in the same cluster, an indication that the analysis emphasis was on vehicles rather than on the total accident.

Generally, the variables that were not "important" accident causation indicators fall into four categories:

- The variables that were repetitive. For example, the number of lanes, number of accesses per 1/4-mile, and speed limit correlated directly to the type of road. Therefore, the use of the type-of-road variable was sufficient for these particular evaluations.
- The variables that were too general. Some of the variables that were not deemed the "important" ones are those that are frequently used as accident measures in current studies and statistical summaries. The number of vehicles in the accident and whether the collision was with a motor vehicle or another object are variables too general to be used as accident measures alone when more enlightening combinations of variables can be used from MDAI data.
- Variables that represent events, such as occurrence of vehicle defects and fuel tank fires, that involve serious consequences but do not apply generally to the traffic accident population. A comparison of when these events occur and when they do not may not be fruitful, and studies might best be carried out within the framework of cases where these events do occur.
- Variables that are not related to accidents or are not related to these 39 accidents.

2. Examination of Clusters

The clusters that were obtained are shown in Table 7. The "important" variables are indicated and characteristics of the clusters may be compared to characteristics of the total group of 64 vehicles. Blanks indicate that no strong characteristics, different from those of the total, were present. Other variables that added information in some clusters are given as well. Characteristics of clusters have been summarized somewhat qualitatively. Quantitative comparisons, such as those presented for driver restraint usage in Table 6, were used to obtain Table 7, but they are not given here since the attempt is to display trends. The trends that are apparent can later be evaluated quantitatively by an appropriate statistical test using a larger sample.

Table 7
CLUSTER CONFIGURATION*

Variables	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Total
Driver error	*	Less	More	Less	More	More	Less	More	76% driver error
Driver under the influence of alcohol or other drugs					67% drinking or drugs involved		50% drinking or drugs involved		12-1/2% drinking or drugs involved
Sex of driver	More male	More male	More male	More male		More male		More female	61% male drivers
Age of driver	All over 30			Mostly under 30	Mostly in 70's	All under 30	Slightly younger than total		44%, 16-29; 26-1/2%, 30-49; 29-1/2%, 50-over
Driver's familiarity with route				More do not use regularly		Do not use regularly		Use regularly	61% use route regularly
Number of previous citations recorded	Fewer	All had many				More			55%, none; 20%, 1; 25%, 2 or more
Driver use of lap and shoulder restraints	More	Much less		Much more	None		Much less	More	45% of drivers used no restraints
Driver AIS [†]	None or minor	None or minor	Minor or moderate	Minor or severe	Severe	None or minor	Minor		33%, no injury; 61% AIS 1-5; 6% AIS over 6 or more (drivers)
CDC extent [‡]		Less severe	Most severe	More severe	Collisions not in area of driver	Less severe	More severe		67% of collisions in area of driver; 29%, 1; 33%, 2-3; 5%, 4
Weight of vehicle	Light or heavy	Heavy		Medium weight	Medium weight	Light	Light		53% under 3,000 pounds
Speed of travel prior to impact	More stopped, some 10-60 mph	Over 50 mph	Over 50 mph	20-70 mph	20-60 mph	Under 40 mph	Under 40 mph	More stopped, some 10-60 mph	19%, 0-19 mph; 70%, 20-49 mph; 11%, 60 mph
Rollovers			All				Some		12-1/2% rollovers
Maximum sheet metal crush		Less	More moderate	More	More	More moderate	More	Less	45% had less than 10"; 38%, 10-19"; 17%, 20" or more
Passenger compartment damage	All had little or none	All had little or none	More severe	None or severe	More severe	All had little or none	More moderate		77%, none or little; 23%, moderate or severe
Less of control of vehicle by driver	Less		All		All			Less	36% lost control of vehicle
Environmental defects	More	None			None		None	Most	73% had none
Rain conditions				Mostly heavy rain		Mostly light rain			83% had clear weather and visibility

Table 7 (Concluded)

Variables	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Total
Type of road	All city street, intersection, expressway	All freeway	Mostly freeway, otherwise expressway		All city street, intersection, expressway	All rural, city street, intersection	All rural, city street, intersection	All city street, intersection, expressway	5%, rural roads; 66%, city street, intersection; 29%, freeway, expressway
Shoulder of road	Worse	Better	Better	Better	Worse	Worse	Better		53% had good shoulders
Median of road	Mostly none	Mostly barrier	All raised or barrier	More raised	More raised	None	Less		56% had no median
Number of accidents per year at accident site		Higher			Lower			Slightly lower	36% had 4 or less accidents per year; 50% had 5-19; 14% had 20 or more
Average daily traffic (ADT) at accident site	All 0-29,000	All 70,000-99,000	Heavier	All 10,000-45,000	All 10,000-45,000	All 0-19,000			52%, 0-19,000; 34%, 20,000-45,000; 14%, 70,000-99,000
Other factors	Medium-tall drivers; overweight [§] for height; less use of head restraints by driver; vehicles were medium in length and were lighter or heavier than others of same length.	Vehicle defects; collisions with other vehicles and other objects.	All single vehicle accidents; collisions with other objects (including ground).	More multiple vehicle accidents.	Drivers of short, heavy stature; [§] all had passengers; had one or more badly worn tires.	All 2-vehicle collisions; no collision with other objects (including ground).	Drivers generally underweight; [§] all night time accidents	Drivers had no previous accidents recorded; less use of head restraints by drivers.	

* Blanks indicate data that approximate that of the total.

† AIS numbering is explained in Appendix B.

‡ CDC is explained in Appendix C.

§ Attributes evaluated according to "The World Almanac and Book of Facts," 1973 Edition, Newspaper Enterprises Association.

In this segregation of the accident population by clusters, it is useful to examine each cluster as a separate entity. An individual cluster indicates a direct relationship of variables. Direct relationships that are comparable by clusters yield multivariate correlations; direct relationships that are not comparable but contain certain unique features in a cluster can provide insight into multivariate correlations.

Some of the multivariate correlations indicated by the clustering are examined in Tables 8 through 16. These tables show data based on Table 7 that have been extracted to examine specific relationships. Many other extractions are, of course, possible.

a. Type of Road Variables

For the two clusters where accidents occurred on freeways and expressways (Table 8) and speeds were over 50 m.p.h., the less serious injuries occurred where the number of accidents per year and ADT were higher and restraint usage was much less than the total. Evidently, injuries were not related to these factors. For the more serious injuries, all were single vehicle rollovers, and all involved loss of control with more driver error than the total. For the less serious injuries, there were no rollovers, loss of control was not a factor, and there was less driver error than the total. For all injuries, the shoulders were better than the total; but for the less serious injuries, the medians were better and there were no environmental defects.

Three clusters (1, 5, 8) exhibited the road type of city streets, intersections, and expressways (Table 9). There, speeds ranged from 0 to 60 m.p.h., and Cluster 1 had the least severe injuries while Cluster 5 had the most. Although ADT, shoulders, and medians do not appear to be injury related, the number of accidents per year and environmental defects decrease as injury increases. Correspondingly, as injuries increase, restraint use decreases, and driver error, loss of control, and

Table 8

CLUSTERS COMPARED BY TYPE OF ROAD:
FREEWAYS AND EXPRESSWAYS

Variables	Cluster 2	Cluster 3
Type of road	All freeway	Mostly freeway, otherwise expressway
Driver AIS	None or minor injuries	Minor or moderate
Number of accidents per year at accident site	Higher accidents per year	
Environmental defects	No environmental defects	
ADT at the accident site	All 70,000-99,000 ADT	Heavier ADT
Loss of control of vehicle by driver		All lost control
Lap and shoulder re- straint usage by driver	Much less restraint usage	
Driver error	Less driver error	More driver error
Shoulder	Shoulders better	Shoulders better
Median	Mostly barrier medians	All raised or barrier medians
Rollovers		All rollovers
Speed of travel prior to impact	Over 50 m.p.h.	Over 50 m.p.h.
Other	No rollovers	All single vehicle rollovers

Table 9

CLUSTERS COMPARED BY TYPE OF ROAD:
CITY STREETS, INTERSECTIONS, AND EXPRESSWAYS

Variables	Cluster 1	Cluster 8	Cluster 5
Type of road	City streets, intersections, and expressways	City streets, intersections, and expressways	City streets, intersections, and expressways
Driver AIS	None or minor injuries		Severe injuries
Number of accidents per year at accident site		Slightly lower accidents per year	Lower accidents per year
Environmental defects	More environmental defects	More environmental defects	No environmental defects
ADT at the accident site	All 0-29,000 ADT		All 10,000-45,000 ADT
Loss of control of vehicle by driver	Less loss of control	Less loss of control	All lost control
Lap and shoulder restraint usage by driver	Better restraint usage	Better restraint usage	No restraint usage
Driver error		More driver error	More driver error
Shoulder	Shoulders worse		Shoulders worse
Median	Mostly no median		More raised medians
Rollovers			
Speed of travel prior to impact	More stopped vehicles, otherwise 10-60 m.p.h.	More stopped vehicles, otherwise 10-60 m.p.h.	20-60 m.p.h.
Other			

speeds increase. Thus, for less severe injuries, high accident locations and environmental defects may have been accident causation factors, while more severe injuries were associated with lack of restraint usage, driver error, loss of control, and higher speeds.

For rural and mountain roads, city streets, and intersections where speeds were under 40 m.p.h., two clusters were obtained (Table 10). Environmental defects, lack of restraint usage, driver error, shoulders, and medians do not appear to be injury-correlated factors. Where injuries were more severe, ADT was much heavier, and some rollovers were involved. All accidents occurred at night.

In summary, for accidents occurring on freeways and expressways at speeds of over 50 m.p.h., single vehicle rollovers, loss of control, driver error, traversable medians, and environmental defects were injury-correlated factors. For city streets, intersections, and expressways with speeds ranging from 0 to 60 m.p.h., lack of restraint use, driver error, loss of control, higher speeds and (to a lesser extent), high accident locations and environmental defects were injury-correlated factors. For rural and mountain roads, city streets, and intersections where speeds were under 40 m.p.h., higher ADT, nighttime driving, and to some extent, rollovers were injury-correlated factors.

b. Impact and Injury Variables

Impact variables--CDC extent, sheet metal crush, and weight of vehicle--are examined as they relate to passenger compartment damage and injuries. (The attempt is not to reach the not-so-startling conclusion that more severe collisions cause more severe injuries, but it is to examine the use of this combination of variables.) For impact in the area of the driver, a trace of impact to injury could be made.

Table 10

CLUSTERS COMPARED BY TYPE OF ROAD:
RURAL AND MOUNTAIN ROADS, CITY STREETS,
INTERSECTIONS

Variables	Cluster 6	Cluster 7
Type of road	Rural and mountain roads, city streets, intersections	Rural and mountain roads, city streets, intersections
Driver AIS	None or minor injuries	Minor injuries
Number of accidents per year at the accident site		
Environmental defects		No environmental defects
ADT at the accident site	0-19,000 ADT	
Loss of control of vehicle by driver		
Lap and shoulder restraints usage by driver		Much less restraint usage
Driver error	More driver error	Less driver error
Shoulder	Shoulders worse	Shoulders better
Median	No medians	Less medians
Rollovers		Some rollovers
Speed of travel prior to impact	Under 40 m.p.h.	Under 40 m.p.h.
Other		All nighttime accidents

First, the passenger compartment damage variable was coded none, small, moderate, or severe. This rather coarse rating correlated strongly in all clusters with the driver AIS, and driver AIS was directly correlated to overall AIS. Next, the passenger compartment damage was examined and related to the impact.

Since CDC extent numbers were only very generally related to area of impact (see Appendix C), and since some vehicles had no impact in the driver area or the CDC extent was for a secondary or tertiary impact, the sheet metal crush (at maximum impact depth) was used as well. Since the sheet metal crush may be dependent on the vehicle, the vehicle weight was included.* Because of the complex physics of vehicle collisions, at least these three variables should be considered.

Table 11 shows clusters where area of impact was near the driver. Clusters 2 and 6 have less severe CDC extent than Clusters 7 and 3. Sheet metal crush also tended to be less than for Clusters 7 and 3. For these four clusters, CDC extent and passenger compartment damage increase together, and for both pairs, 2 and 6, 7 and 3, sheet metal crush is more severe for lighter vehicles. Cluster 4 fits in roughly, but it had another strong characteristic, discussed below, which probably overrode these variables in the clustering. In Table 12, where the area of impact is not near the driver, Cluster 5 shows that injury and passenger compartment damage were at least as severe as in 4 and 3. Sheet metal crush is correspondingly severe. Passenger compartment damage could be attributed to causes other than the CDC extent near the driver (fire and severe CDC extent in other areas).

* Vehicle length corresponded to vehicle weight except in one cluster, and there CDC extent was not a factor.

Table 11

CLUSTERS COMPARED BY IMPACT:
AREA OF IMPACT NEAR DRIVER

Variables	Cluster 2	Cluster 6	Cluster 7	Cluster 4	Cluster 3
CDC extent	Less severe	Less severe	More severe	More severe	Most severe
Maximum sheet metal crush	Less	More moderate	More	More	More moderate
Weight of vehicle	Heavy	Light	Light	Medium weight	
Passenger compartment damage	All had little or none	All had little or none	More moderate	None or severe	More severe
Driver AIS	None or minor injuries	None or minor injuries	Minor injuries	Minor or severe injuries	Minor or moderate injuries

Table 12

CLUSTERS COMPARED BY IMPACT:
AREA OF IMPACT NOT NEAR DRIVER

Variables	Cluster 5
CDC extent	Not in area of driver
Maximum sheet metal crush	More
Weight of vehicle	Medium weight
Passenger compartment damage	More severe
Driver AIS	Severe injuries

In summary, for fixed areas of impact, occupant injuries may be traced through a passenger compartment damage variable and impact variables--CDC extent, sheet metal crush, size of vehicle. In this way specific areas of vehicles that cause injuries upon impact in certain sizes of vehicles may be recognized and recommended for more specific vehicle testing. Areas of impact should be specified by using a larger sample size and CDC ratings that are more closely related than those used here.

c. Rain Conditions

Rain was a significant factor in two clusters. In Cluster 4, accidents occurred in heavy rain, and in Cluster 6, in light rain. Noticeably, these were the only two clusters that had drivers under the age of 30 as a strong characteristic, and they were the only two clusters in which nonfamiliarity with the road was a strong characteristic. Table 13 shows clusters where the rain was heavier, and one can see that injuries and CDC extent were more severe and more vehicles were involved in the accidents. The speeds ranged higher where the rain was heavier, in Cluster 4, but in lighter rain, in Cluster 6, accidents occurred on rural and mountain roads,

Table 13

CLUSTERS COMPARED BY RAIN CONDITIONS

Variables	Cluster 4	Cluster 6
Rain conditions	Mostly heavy rain	Mostly light rain
Driver's familiarity with route on which accident occurred	More do not use route regularly	Do not use route regularly
Driver AIS	Minor or severe injuries	None or minor injuries
CDC extent	CDC more severe	CDC less severe
Speed of travel prior to impact	20 to 70 m.p.h.	Under 40 m.p.h.
Type of road		Rural, city streets, intersections
Age of driver	Mostly under 30	All under 30
Other	More multiple vehicle accidents	All 2-vehicle accidents

city streets, and intersections; the heavier rain cluster included all types of roadways, rural to freeway, roughly in the same proportion as the total.

In summary, accidents occurring in the rain tended to involve drivers under 30 who did not use the route regularly. The fact that these three characteristics clustered so strongly indicates that younger drivers driving in the rain on an unfamiliar route constitute a significant SCAT traffic accident subpopulation. Where rain was heavier, injuries and CDC extent were more severe and more vehicles were involved.

d. Number of Previous Citations, Use of Alcohol or Other Drugs

Table 14 shows clusters in which previous citations were a factor, and Table 15 shows clusters in which driver use of alcohol or other

Table 14

CLUSTERS COMPARED BY NUMBER OF PREVIOUS CITATIONS, USE
OF ALCOHOL OR OTHER DRUGS: PREVIOUS CITATIONS
A FACTOR, DRINKING OR DRUGS NOT A FACTOR

Variables	Cluster 2	Cluster 6
Number of previous recorded citations	All had many previous citations	More previous citations recorded
Driver under the influence of alcohol or other drugs		
Lap and shoulder restraint usage by driver	Much less restraint usage	
Sex of driver	More male drivers	More male drivers
Age of driver		All under 30
Other	Vehicle defects were a factor	

Table 15

CLUSTERS COMPARED BY NUMBER OF PREVIOUS CITATIONS, USE
OF ALCOHOL OR OTHER DRUGS: PREVIOUS CITATIONS
NOT A FACTOR, DRINKING OR DRUGS A FACTOR

Variables	Cluster 5	Cluster 7
Number of previous recorded citations		
Driver under the influence of alcohol or other drugs	67% of drivers	50% of drivers
Lap and shoulder restraint usage by driver	No restraint usage	Much less restraint usage
Sex of driver		
Age of driver	Mostly in 70s	Slightly younger than total
Other	Drivers of short, heavy stature; all had passengers; had one or more badly worn tire.	Drivers generally underweight

drugs was a factor. No clusters shared both characteristics. Drivers with many previous citations were predominantly male, and those with more citations (Cluster 2) used restraints less and were older than those in Cluster 6. Where drinking or drugs were involved, sex was not a factor. Cluster 5, with more drivers drinking or using drugs, had no restraint use and drivers were older than those in Cluster 7.

Comparison of Table 14 (citations), Table 15 (drinking or drugs), and Table 16 (neither), shows drivers using alcohol or other drugs used restraints the least, and those without the characteristic of many previous citations or alcohol and drug use used restraints the most. In Table 14 and 15, lack of care for the vehicle (e.g., failure to correct vehicle defects such as worn tires) may have been an accident factor. Age was not a factor in the construction of these three driver groups, but for each group, younger drivers used restraints more than older drivers. Only for Table 15 was sex of the driver not a strong characteristic. In Table 15 drivers were underweight or overweight, but Table 16 also had overweight drivers.

In summary, drivers who had more previous citations tended to be male, but drivers who had been drinking or using drugs had no strong characteristic with respect to sex. Evidently, drivers who had been drinking or using drugs did not have a larger number of previous citations and vice versa. Drivers with many previous citations and drivers who had been drinking or using drugs used restraints less than other drivers. The drivers who had been drinking or using drugs used restraints the least. Lack of care of the vehicle may have been an accident factor where either of these two driver characteristics were present.

Table 16

CLUSTERS COMPARED BY NUMBER OF PREVIOUS CITATIONS, USE
OF ALCOHOL OR OTHER DRUGS: PREVIOUS CITATIONS
NOT A FACTOR, DRINKING OR DRUGS NOT A FACTOR

Variables	Cluster 1	Cluster 3	Cluster 4	Cluster 8
Number of previous recorded citations	Fewer previous citations			
Driver under the influence of alcohol or other drugs				
Lap and shoulder restraint usage by driver	Better restraint usage		Much better restraint usage	Better restraint usage
Sex of driver	More male	More male	More male	More female
Age of driver	All over 30		Mostly under 30	
Other	Medium tall drivers, overweight for height			No previous accidents

Appendix D

SUMMARY OF CAUSES OF ACCIDENTS

Appendix D

SUMMARY OF CAUSES OF ACCIDENTS

The following is a brief list of the accidents investigated by SCAT with a statement of cause summarized for each.

- 2-001* Seconal and alcohol use prevented driver from maintaining control of the vehicle. His motor reactions were slowed beyond the safe limits for operating the vehicle.
- 2-002*† Because of the poorly designed ramp to a cross street on a higher level, the driver's attention was turned momentarily to the traffic flow from the left rear and away from the car ahead.
- 2-003* Drinking driver (.22 percent blood-alcohol) failed to execute a left turn. The accident severity was increased when a "good samaritan" placed a lighted flare in the puddle of gasoline.
- 2-004‡ The anti-theft steering lock mechanism locked while vehicle was traveling 50 mph. This piece of equipment had not been examined when the car was repaired after an earlier head-on collision.
- 2-005*†‡ Driver lost control of a stepvan when he braked hard because of slowing traffic. This model van is suspected of road wheel oscillations over rough roads and the road surface was in poor condition where the driver braked. The probability that the driver was following too closely for the speed he was traveling cannot be overlooked.

- 2-006^{*†} Driver attempted to make a U-turn from a left turn lane at a nonsignalized intersection. Driver did not see approaching car. He may have been preoccupied with his forthcoming marriage. This intersection was being studied for signalization, and traffic signals have since been installed.
- 2-007^{*} Driver was inattentive to traffic conditions and had to brake hard. The rear wheels locked and driver was unable to control the vehicle.
- 2-008^{*‡} A combination of factors resulted in this accident. Driver 1 was late. His vehicle was degraded severely, one low tire and a small steering wheel made handling more difficult. The driver was aware of all factors except possibly the low tire pressure, and, hence, we attribute the cause to human error.
- 2-009^{*†} The driver, "driving automatically," failed to stop at a stop sign. The stop sign was obstructed by a tree branch until driver was less than 150 feet from the intersection.
- 2-010^{*} This was a hit-and-run. Driver 1 attempted to turn left into a driveway in front of a speeding vehicle. Driver 1 may have been under the influence of alcohol. He abandoned his car at the scene.
- 2-011^{*†} The driver attempted to cross a heavily congested intersection during rush hours. The only way to traverse this intersection at such a time is to ease into it and cause right-of-way traffic to stop.
- 2-012^{*‡} The driver was traveling too fast and too close behind a phantom vehicle to avoid hitting a stopped vehicle that was avoided by the phantom vehicle. Visibility was obstructed because of heavy rain and fogged side and rear windows.

- 2-013*[†] An intoxicated driver (.17 percent blood-alcohol) lost control of his car when a vehicle changed lanes in front of him.
- 2-014*[†] An inattentive driver was suddenly startled to see maintenance trucks on the shoulder very close to the fast lane; he swerved and lost control of his vehicle.
- 2-015* The driver attempted to turn left from a left turn lane at a signalized intersection but misjudged the speed of an oncoming vehicle.
- 2-016* The driver, preoccupied with personal thoughts, did not see the other vehicle and attempted a left turn at a signalized intersection. Other vehicle was going an estimated three mph over speed limit.
- 2-017*[†] A phantom vehicle pulled in front of the driver as the traffic was slowing abruptly. The driver braked hard and steered to the right to avoid a collision, but he lost control of his car.
- 2-018*^{†‡} A combination of factors caused this accident, among them driver inexperience, heavy rain, very slippery road surface and bald rear tires. The slippery road and bald tires would have been sufficient to cause the accident. Bringing a car under control once it has lost traction is difficult even for an experienced driver familiar with emergency maneuvers.
- 2-019*[†] Driver 2 attempted a left turn from a left turn lane at a signalized intersection. He had not anticipated being stopped by a right-turning vehicle that stopped at railroad tracks before completing its turn. The pavement was wet. Driver 1 assumed that Vehicle 2 would not continue to block the lane.
- 2-020*^{†‡} The driver lost control of her vehicle when she was forced to take evasive action to avoid a collision. Hard braking and incompatible tire types contributed to control loss.

- 2-021^{*†} The driver failed to successfully complete the relatively complex driving task of making a left turn onto a heavily traveled multilane road from a side street. He did not see the vehicle approaching from his left.
- 2-022^{*†‡} The driver's attempts to bring his vehicle under control when it began to hydroplane and fishtail failed. Driving onto the muddy median resulted in loss of control. Vehicle crossed freeway median into oncoming traffic. Driver was traveling too fast for road conditions. Tires were worn.
- 2-023^{*†‡} Elderly intoxicated driver (.19 percent blood-alcohol) ran off the road at a slow speed. She ran over a signpost that penetrated the fuel tank, and a fire followed.
- 2-024^{*†‡} The driver lost control of the vehicle on wet pavement on a curve. He was traveling faster than the posted speed limit (speed limit is seven mph below the critical cornering speed). Low left front tire pressure possibly reduced cornering capability of the vehicle.
- 2-025^{*†} The driver, possibly preoccupied with a pending business contact or in a hurry, ran a red light. A possible contributing factor may have been the prior traffic signal (less than 200 feet away) that was not synchronized with the signal he ran.
- 2-026^{*†} The driver lost control of his vehicle traveling at excessive speed on wet pavement on a curve. The speed limit is 6 mph below critical cornering speed on wet pavement.
- 2-027^{*} The driver, possibly preoccupied with finding a gas station open, attempted to turn left at a signalized intersection. He turned in front of a speeding vehicle. (The driver was not used to an automatic transmission.)

- 2-028^{*†} The driver drove through a red light, and another driver was having difficulty seeing the lane line because of wet pavement.
- 2-029^{*} The driver attempted to turn left at a signalized intersection in front of a motorcycle. His reason is unknown.
- 2-030^{*} Driver was emotionally upset; her vision was blurred from crying. She was inattentive to driving.
- 2-031^{*‡} Traveling at excessive speed in a turn on wet pavement, the driver braked and locked the wheels.
- 2-032^{*} The driver fell asleep at the wheel in the early morning, drove off the road, penetrated a chain link fence, and rolled his car over. The driver had been drinking beer; he also may have been smoking marijuana.
- 2-033^{*†} Malfunctioning traffic signals caused inadequate or improper response from drivers entering an intersection. Drivers 1 and 3 failed to slow down, and Driver 2 failed to check for cross traffic.
- 2-034^{*} An intoxicated driver (.26 percent blood-alcohol) lost control of his vehicle at high speed.
- 2-035^{*} The driver's inexperience in handling a car and possibly other unknown causes resulted in the vehicle crossing a median into opposing traffic.
- 2-036^{*} The driver's inattention to traffic and preoccupation with pending activities resulted in her rear-ending a vehicle stopped for a traffic signal.
- 2-037/38^{*} An elderly driver blacked out and caused a multiple car, rear-end accident to vehicles stopped for a traffic signal.

2-039*† Drivers approached uncontrolled intersection at excessive speed.

2-040*† Inadequate warning for street excavation caused a phantom vehicle to swerve. The driver overreacted to the phantom vehicle.

* Human error.

† Environmental problem.

‡ Vehicle defect.

Appendix E

CASE SUMMARIES

All case summaries in this appendix are reprinted sections from the complete reports of individual cases investigated by SCAT. The individual reports, prepared for the U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, D.C. 20590, are titled by case number under the common title "Multidisciplinary Accident Investigation." For example, the first report is entitled "Multidisciplinary Accident Investigation: Case No. SRI 2-001."

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-001

I CASE SUMMARY
(Car-Ran Off Roadway, Rollover)

Identification

This accident occurred on State Route 9 at milepost 2.12, 2.2 miles east of State Route 35 in rural Santa Clara County, California on an open roadway, May 26, 1972, 9:50 p.m., Friday. One car ran off the road on a curve, went down an embankment, impacted trees and rolled over, IP (injury producing) AIS* 4. Figure 1 is a plan view of the accident scene.

Ambience

The accident occurred at night, clear sky, full moon, 58°F, relative humidity 80 percent, wind N.W. 5 mph, dry pavement.

Highway

State Route 9 is a two-lane arterial mountain road 23 ft wide. Other characteristics include: eastbound lane 12 ft 9 in. wide, asphalt pavement, south shoulder 2 ft 11 in. wide dirt, no guardrail or curb, constant radius turn, outside radius 182 ft eastbound downgrade ~5 percent, no lighting, one access per one-quarter mile, and numerous trees (wooded area). In the period from January 1, 1969, to December 31, 1971, there have been five accidents--two injury producing and three property damaging--between mileposts 2.06 and 2.15; traffic volume 290-330 vehicles (at peak hours), 1650-1750 (peak month average daily traffic, ADT), 1200-1300 (annual ADT) for 1969.†

Traffic Controls

State Route 9 has: no posted speed limit; broken yellow and white lines dividing the east and westbound lanes; road edge delineator for westbound lane, but none for eastbound; no signs; and no signals. The outside of the turn marked with paddle markers.

* States, J. D., "The Abbreviated and the Comprehensive Research Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc., New York, 1969, pp. 282-294.

† State of California, Division of Highways 1969 Traffic Volumes on The California State Highway System (Sacramento, 1969) p. 23.

Vehicles

Vehicle No. 1 was a 1972 Chevrolet Vega 2300, 2-door red sedan, with 1751 miles, no inspection sticker, no power accessories, padded dashboard, sunvisors and steering wheel spokes, 3-point torso restraints for driver and front seat passenger, and lap belts for rear seat occupants. There was no evidence of precrash defects, and warrantee maintenance had been performed.

There was crash damage to front bumper, grille, hood and left front suspension. There also was a cracked windshield, rollover damage to sides and roof, front seat backs bent during impact by rear seat occupants, steering wheel and floor-mounted shift lever displaced to the left, and deflated front left tire. CDC* (Primary) 12-FDEN-2, (Secondary) 00-TPGO-2. Total loss.

Occupants

Driver No. 1 was in the left front; he was a 17-year-old male, 67-1/2 in. tall, weighing 130 lbs. His driving experience had been irregular for one year (could borrow father's car occasionally). Other information obtained included: trip plan social to social (mileage unknown, no particular ETA); vehicle driven twice before; area familiar both as driver and passenger; driver education in sophomore year high school; physical condition of the driver: corrective glasses, smokes cigarettes, no physical limitation; mental condition unknown; blood alcohol test negative (had consumed equivalent of one and one-half beers); drug test 5-ppm secobarbital, no other drugs; lap restraint used, upper torso restraint not used.

Injuries to the driver included a minor laceration over right eyebrow; nose bleed; nondisplaced transverse fracture of lateral aspect of scapula (at glenoid "neck"); and transverse fracture of left proximal fifth metatarsal.

AMA-AIS 2

The right front occupant was a 14-year-old female approximately 62-in. tall, weighing approximately 88 lbs. Her physical condition unknown. Lap restraint was used; however, the upper torso restraint was not used.

* Collision Deformation Code.

Her injuries included a "blue" right eye with minor abrasion above, minor abrasion on left knee, superficial abrasions on abdomen, perforation of jejunum and serosal tear of ascending colon, and rhus dermatitis (poison oak) on neck. She was unconscious at least 25 minutes with amnesia of accident.

AMA-AIS 4

The left rear occupant was a 14-year-old female, "tall and slender," weighing approximately 115 lbs. Her physical condition was unknown. Lap restraint was used.

Her injuries consisted of complaints of pain in abdominal area.

AMA-AIS 1

The right rear occupant was a 16-year-old male, 71-1/2 in. tall, weighing 135 lbs. His physical condition was unknown. Lap restraint was used.

His injuries included abrasions and bruises in the abdominal area.

AMA-AIS 1

Applicable Standards

State of California Highway Transportation's Agency, Planning Manual of Instructions, Part 8 - Traffic: Sec. 8-604.2 "Guard Rails on Embankments" and Sec. 8-605.2 "Guide Marker Spacing."

The following Traffic Safety Program Standards (TSPS) and/or Motor Vehicle Program Standards (MVPS) were relevant to this case:

TSPS 4.4.4 Driver Education

TSPS 4.4.5, VII A Driver Licensing

TSPS 4.4.12 Highway Design, Construction and Maintenance

TSPS 4.4.15 Police Traffic Services

TSPS 4.4.16 Debris Hazard Control and Cleanup

MVSP 208, Occupant Crash Protection, and 209, Seat Belt Assemblies in Passenger Cars

Description

Preocrash

Vehicle No. 1 was proceeding east (downhill) on State Route 9 at a driver-estimated speed of 35 mph. The vehicle entered a 190° turn to the left, and traveled approximately 560 ft in the turn before driving onto the dirt shoulder. Driver No. 1 was under the influence of drugs.

Crash

Vehicle No. 1 left the shoulder, went over a dirt "curb" 18-in. high and then went down a steep embankment. The vehicle impacted a first tree on the left, breaking off a large branch, and then impacted a second tree head on. The second tree contacted the front of the vehicle about 12-in. left of center. The vehicle spun 180° in a counterclockwise direction (as viewed from above), rolled over first on its left side, then onto its roof, and came to rest on its right side, farther down the embankment, having broken a limb off a third tree.

Postcrash

Driver of westbound vehicle saw Vehicle No. 1 leave the road. He stopped and flagged down another motorist, who notified the California Highway Patrol. Driver No. 1 and the rear seat passengers were able to leave the vehicle unassisted through the left side window. The right front passenger, who was more seriously injured, was removed from the vehicle by a sheriff's deputy and then taken by ambulance to a hospital. After some delay, Vehicle No. 1 was winched up to the road and towed away.

Causal Factors, Conclusions, and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-crash	Crash	Post-crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.
(*indicates
positive factor)

Explanation

- | | |
|----|---|
| 1 | Driver No. 1 driving while under the influence of secobarbital.
<u>Recommend:</u> Driver training include effects of drugs in addition to alcohol on driver's performance. |
| 1 | Driver No. 1 had history of secobarbital drug abuse.
<u>Recommend:</u> Driver licensing programs include licensee's medical history as an evaluative factor. |
| 1 | Driver No. 1 failed to control vehicle in curve, took no evasive action. |
| 1 | Front seat occupants did not use available upper torso restraints. |
| *1 | All occupants used lap restraints. |

Matrix Cell No.
 (*indicates
positive factor)

Explanation

- | | |
|----|--|
| 2 | RR passenger braced against right front seat back, possibly aggravating RF passenger's injuries. |
| 3 | Postaccident traffic control not adequate due to lack of personnel. |
| *3 | Witness stopped at scene to aid victims, told another motorist to notify ambulance. |
| *3 | Sheriff unit in vicinity went directly to scene, although not in his jurisdiction. |
| *3 | Driver No. 1 turned off ignition when he heard ignition switch buzzer activated by open left door. |
| *3 | Blood samples for blood alcohol and drug analysis were drawn. |
| 3 | A single blood level test for drugs was conducted. In order to determine blood levels, a series of tests should be run to permit backward extrapolation to determine the level at the time of the crash. |
| 7 | Absence of guardrail allowed vehicle to go down embankment. |
| 7 | Spacing of guide markers (paddle markers) too large for radius of curvature of accident curve as defined by California Highway Transportation Agency Planning Manual. |

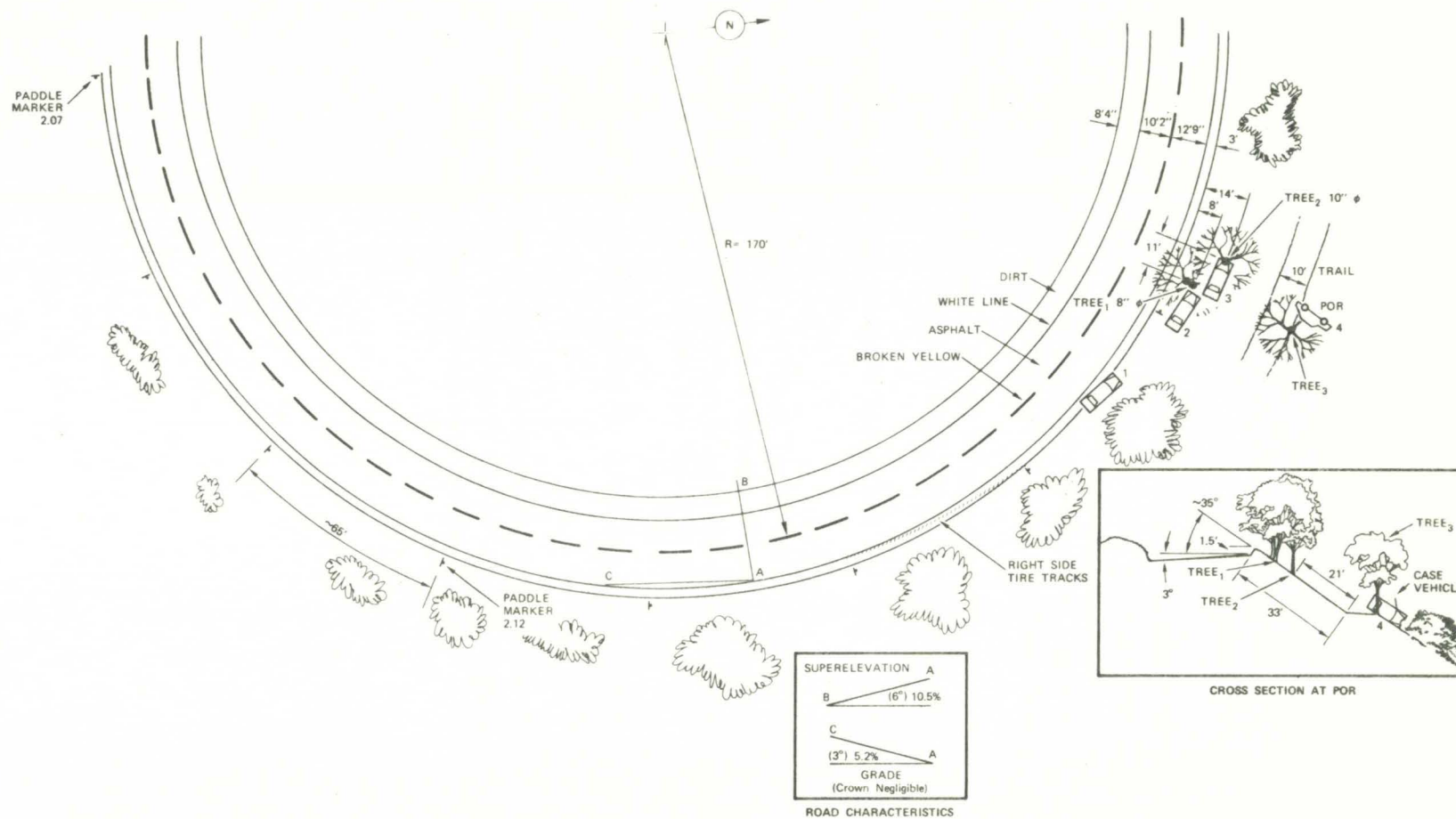


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-002

I CASE SUMMARY

(3 Car Rearend Collision)

Identification

This accident occurred on the merging portion of the ramp carrying traffic from eastbound Oregon Expressway to southbound Alma Street in Palo Alto, California, June 5, 1972, 4:30 p.m., Monday involving 3 cars, rearend collision, injury producing, AIS* 2. Figure 1a is a plan view of the accident scene.

Ambience

Day, clear sky, 80°F, 41% relative humidity, dry pavement.

Highway

Alma Street is a 4 lane major arterial street, 51' wide, 5' paved shoulder adjacent to northbound lanes, no shoulder for southbound lanes, no divider, 8" concrete curbs on east side; 6" concrete curb on west side, asphalt paving, straight level, negligible superelevation, less than 1 access per $\frac{1}{4}$ mile on west side of street, numerous accesses (driveways and streets) on east side of street.

The ramp from eastbound Oregon Expressway is 18.5' wide, one lane, concrete, no shoulder, 8" high and 1.75' wide curbs, retaining wall on east and west side, straight, 6% grade ascending from 21' below Alma and then leveling off at grade with Alma approximately 40' from nose of gore on east side of ramp, negligible superelevation. This is followed by an asphalt merging lane.

At the ramp terminal where it merges with Alma, there have been seven rearend collisions all occurring between 4:20 p.m. and 6:50 p.m. on working days, from 1969 through January 1972; two were injury producing.**

* States, J. D., "The Abbreviated and the Comprehensive Research Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc., New York, 1969, pp. 282-294.

** Information from City of Palo Alto.

Traffic Controls

Traffic controls on Alma consisted of a posted speed limit of 35 mph, double yellow lines and yellow reflective markers dividing opposing lanes, broken white lines and clear reflective markers separating traffic lanes, a "merging traffic" sign on Alma before the ramp, and no signals in the vicinity of the accident scene. A "no turn" sign is on the west side of the ramp after leveling of merging lane.

Vehicles

Vehicle 1, 1969 Oldsmobile Toronado, light blue, 2-door hardtop, odometer reading 21,340 miles, no inspection stickers, power steering and brakes, padded dash, steering wheel spokes and sunvisors, 4-point lap and torso restraints, no evidence of pre-crash defects, clean and well maintained, with new radial-ply tires.

Bumper and grille pushed back, hood buckled, hood latch jammed, damage to headlight concealing mechanism. CDC* 12-FDEW-1.

Vehicle 2, 1969 Volkswagen 1500, light blue, 2-door sedan, odometer reading 71,892 miles, California Highway Patrol Inspection Sticker, expires December 31, 1972, no power accessories, padded dash and sunvisors, 3-point restraints, no evidence of pre-crash defects, driver claims preventive maintenance checks every 3,000 miles.

Damage of rear bumper, rear fenders, engine compartment lid and taillights, damage to headlights, front bumper, trunk lid, and front fenders. The fuel tank was slightly deformed, and the driver's seat separated from tracks, bent steering wheel rim. CDC* (primary) 06-BDEW-3, (secondary) 12-FDEW-2.

Vehicle 3, 1961 Comet 2-door sedan, blue, no restraint system. Because of the minor involvement of this vehicle, no further data were collected.

Rear bumper and fuel tank dented, trunk lid latch loosened. CDC* 06-BDLW-1.

Occupants

Driver 1, was a 41-year-old male, 73", 240 lbs., driving experience 24 years at an average of 14,000 miles/year. His trip plan was work to automobile garage and then home. The vehicle was purchased 10 months prior to the accident as a used car from an Oldsmobile dealer. The driver was "fairly" familiar with the area although it was not his usual route home; no driver education; "excellent" physical condition; lap restraint only.

* Collision Deformation Classification

Injuries: None

Driver 2, 49-year-old female, 62", 130 lbs., driving experience 26 years at an average of 20,000 miles/year. The trip plan was work to home; vehicle was purchased new and driven for 4 years; driver used same route to and from work for 4 months; driver education at commercial driving school 26 years ago; "good" physical condition but "has been having many emotional problems"; seat all the way forward, no restraints used.

Injuries: Concussion; severe neck sprain; lumbar spine sprain; nose bleed at scene; upper lip laceration; minor contusions of right arm (inside upper), left arm (inside elbow), at crest of ilium, right leg (outside near ankle) and left leg (top of ankle).

AMA-AIS 2

Driver 3, 50-year-old male, 68", 205 lbs., driving experience 30 years (no estimate of miles/year); trip plan work to home; vehicle purchased as used car and driven for 3-4 years; usual route taken to and from work. No driver education course; physical and mental condition unknown; no restraints available.

Injuries: None

Applicable Standards

The following Traffic Safety Program Standards (TSPS) and/or Motor Vehicle Safety Standards (MVSS) were relevant to this case:

TSPS 9 Identification and Surveillance of Accident Locations

TSPS 10 Traffic Records

TSPS 12 Highway Design, Construction and Maintenance

MVSS 207 Anchorage of Seats

Description

Pre-crash

Vehicles 1, 2, and 3 were eastbound on Page Mill Road (Oregon Expressway) to southbound Alma Street. Vehicles 2 and 3 traveled inclining portion of ramp. When Driver 3 reached the ramp terminal where he could merge with traffic, he stopped. Vehicle 2, following Vehicle 3 was slowing down. Driver 1 traveling the ramp at a self-estimated speed of 25 mph turned his attention from Vehicle 2 ahead to check the southbound traffic flow on his left. Upon looking forward, Vehicle 2 had stopped. Driver 1 applied brakes, skidded and impacted Vehicle 2.

Crash

Driver 2 was forced back against the seat by the vehicle acceleration, breaking the seat mounts. Vehicle 2 was then propelled forward into the rearend of Vehicle 3 causing Driver 2 and seat to move forward where she contacted the steering wheel.

Postcrash

Vehicle 1 was driven to right side of ramp to prevent blocking the traffic. Driver 3 sat for a "brief moment", then drove his car to right side of road. Drivers 3 and 1 met at Vehicle 2. Driver 3 assisted Driver 2 wipe blood from face, then shouted to onlooker across traffic to call the police. One policeman arrived and checked Driver 2 who was pinned in vehicle. Ambulance and second policeman arrived. To remove Driver 2 from car, policeman and ambulance driver lifted front seat with driver intact, moved both against rear seat and then lifted driver onto stretcher. Ambulance proceeded to hospital. The second policeman on the scene directed traffic. The towing service cleared glass and towed Vehicle 2 from scene. Drivers 1 and 3 drove their vehicles from the scene.

Causal Factors, Conclusions, and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-crash	Crash	Post-crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.
(*indicates
positive factor)

Explanation

- | | |
|----|--|
| 1 | Driver 1, inattention to vehicles directly ahead. Creeping effect of both Vehicles 2 and 3 may have given Driver 1 impression of merging. |
| 2 | Driver 2 was not wearing restraint system. |
| *3 | Drivers 1 and 3 moved vehicles to right of roadway to prevent blocking traffic. |
| 5 | Vehicle 2 was equipped with high seat back, but because it did not prevent spinal injuries, could not be a positive factor. |
| 5 | Vehicle 2 driver's seat was dislodged from floor mounting. Motor Vehicle Safety Standard 207. |
| 7 | Design of ramp with 6 percent upgrade, retaining walls and only about 140 ft. at grade transition causes sight distance problems to the rear. TSPS 12. |
| *7 | City of Palo Alto identified accident site as part of an interchange accident problem through use of accident records. TSPS 9 and 10. |

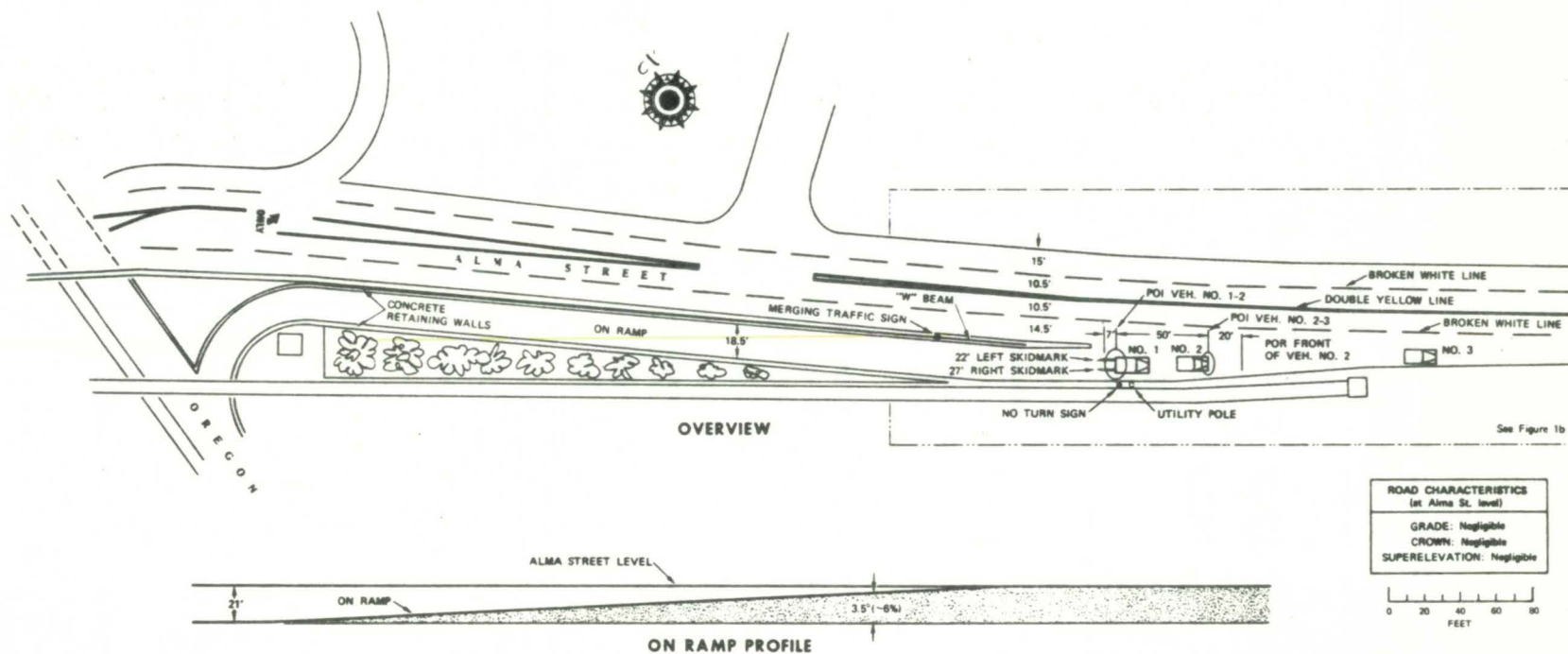


FIGURE 1a COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-003

I CASE SUMMARY

(Car/car - Oblique Head-on)

Identification

This accident occurred at the intersection of Senter Road and Capitol Expressway in San Jose, California, July 6, 1972, 12:40 a.m., Thursday. Vehicle 1 attempted a left turn in front of Vehicle 2 traveling in the opposite direction. Collision was left headlight to left headlight. A bystander, attempting to help, placed a flare which ignited fuel leaking from Vehicle 2 fuel tank. IP (injury producing) AIS* 3. Figure 1 is a plan view of the accident scene.

Ambience

The accident occurred at night, 55 °F, relative humidity 90 percent, wind 10 knots from WSW, dry pavement.

Highway

Senter Road is a two-lane arterial road which has been widened to 4 lanes plus left turn lane on either side of the intersection with Capitol Expressway. Other characteristics include: no median divider, asphalt surface, concrete curbs, straight and level, negligible crown, mercury vapor illumination, 27 accesses and 25 poles in the last $\frac{1}{4}$ mile traveled by Vehicle 1, 13 accesses and 26 poles in the last $\frac{1}{4}$ mile traveled by Vehicle 2. Capitol Expressway is a six-lane expressway 114 feet wide, with raised median divider, asphalt paving, concrete curbs at road edges and median, level and curving slightly on either side of intersection, negligible crown, 400 watt mercury vapor luminaires. Fifty-two accidents at intersection from 1970 to May 1972, 40 property damage only, 12 injury producing, 0 fatalities; traffic volume, standard day inbound to the intersection: 13,377 on Senter; 32,513 on Capitol.**

* American Medical Association Abbreviated Injury Scale (see GM Form in Appendix B for complete description of AIS).

** City of San Jose, Department of Public Works, Traffic Engineering Division, 1972 figures.

Traffic Controls

Senter Road: speed limit 35 mph, double yellow lines between northbound and southbound lanes, broken white lines between traffic lanes, left pointing arrow and word "ONLY" painted on pavement, pedestrian crossing delineated by solid yellow lines, no signs. The intersection has fully traffic actuated signals with inductive loop detection on all phases, and following timings:⁺ on Senter, green 12-16 seconds, yellow 3.5 seconds; on Capitol, green 17-30 seconds, yellow 4 seconds; on Capitol left turn signals, green 4.5 to 7.5 seconds, yellow 3 seconds. There is no left turn signal for Senter Road. Controller type is 5 phase solid state type 90 controller.

Vehicles

Vehicle 1, car, 1971 Pontiac Firebird 2-door hardtop, green with black vinyl roof, odometer reading 4221 miles, no inspection sticker, power brakes and power steering, padded instrument panel, steering wheel spokes and sun visors, 4-point restraints, no evidence of pre-crash defects, Driver 1 stated the car was taken to the garage where it had been purchased 1 month prior to accident for a new gas gauge and because the transmission was "hanging up in low."

Damage: Bumper-grille pushed in and distorted, left front fender buckled, leading edge of optional air scoop fiberglass hood damaged, entire front end of car displaced to the left, windshield cracked by occupant contact, small dent in lower part of instrument panel, steering wheel rim bent slightly. CDC* 01 FDEW-2.

Vehicle 2, car, 1960 Corvair, 2-door Coupe, gray, odometer illegible due to fire, no inspection sticker, no power accessories, no padded components, no restraints, no evidence of pre-crash defects, routine maintenance performed one month prior to accident.

Damage: Front end of vehicle pushed in on left side, wheelbase shortened 12 inches on left side, windshield missing, dashboard distorted, steering column rearward movement, damage to front seat backs due to occupant contact, extensive fire damage to interior. CDC* 11-FYEW-3.

* Collision Deformation Classification Society of Automotive Engineers
Technical Report J224a.

+ As measured at the scene

Occupants

Driver 1 was a 58-year-old female 63¹/₂", 110 lbs., driving experience 3 years (could not estimate average miles/year). Her trip plan was daughter's home to home. Vehicle was purchased 10 months prior to accident as a used car. Driver was "somewhat familiar" with area but does not drive route at night.

Driver 1, took a commercial driving course 3 years ago. After "learning to drive", she obtained her California license. Physical and mental condition: blood-alcohol analysis was .22%. No restraint system was in use.

Injuries: Police report states only a cut lip. From vehicle interior evidence her head contacted the windshield and various dents around the console indicate contusions on right side of person.

AIS X (injured, but severity not known)

Driver 2, 18-year-old female, 64", approximately 128 lbs., 1 year driving experience (average yearly mileage unknown) trip plan friends to home (approximately six miles ETA unknown), owned and driven vehicle for 1 year, drives road at least once-a-week, driver education in high school approximately two years prior to accident, physical condition: contact lenses (worn the night of accident), no flu, cold, or menstrual period; other conditions unknown; mental condition unknown; no medications, no alcohol; no restraints used (not available).

Injuries: Bruise left lower face near chin, one half inch laceration (requiring stitches) under chin, approximately 5-inch bruise on right breast, abrasions and 1.3 inch laceration on medial aspect left knee (requiring stitches), bruise medial area left knee, laceration on lateral lower left leg, bruises and stellate laceration below right knee, bruises lower legs, second degree burns on forehead and left cheek, second and third degree burns on left upper arm, second degree burns on dorsal surface left hand, concussion (doesn't remember the accident).

AIS 1

Right front passenger, 17-year-old female, 63", weight unknown (estimated at 175 lbs.), no restraints used (not available).

Injuries: Approximately 4" laceration from below arch of left eyebrow obliquely to the left to approximately one inch inside hairline, lacerations in center of forehead at hairline, bruise and swelling under chin, bruise lateral right upper arm, bruises and soreness on right and left breast, approximately 3 inches diagonal bruise from approximately midline to lateral aspect of anterior proximal left lower arm, bruise and lump on dorsal left upper arm, left hand knuckles sore, abrasions and bruises on left knee, vertical laceration on proximal lateral left lower leg (near knee), bruises on midportion lateral left lower leg, abrasions on right knee, compound comminuted fracture of distal third right tibia and fibula, approximately 3" transverse laceration at fracture site, concussion (doesn't remember the accident).

AIS 3

Right Rear Passenger, 10-year-old female, approximately 56" and 120 lbs., no restraints used (not available).

Injuries: Bruise at right eye (eye "black and blue"), laceration on right lower leg, small laceration on top of head under hair.

AIS 1

Left Rear Lap Passenger, 4-year-old female, height and weight unknown, seated on lap of left rear passenger, no restraints used (not available).

Injuries: Bruise on lower leg.

AIS 1

Left Rear Passenger, 10-year-old female, 56", 119 lbs., holding Left Rear Lap Passenger on right leg, no restraints used (not available).

Injuries: Contusions and abrasions lateral left lower leg and medial right lower leg, abrasion on left shoulder, contusion of left side of forehead.

AIS 1

Applicable Standards

TSPPS 4 Driver Education

MVSS 204 Steering Control Rearward Displacement

MVSS 301 Fuel Tanks, Fuel Filter Pipes, and Fuel Tank Connections

MVSS 302 Flammability of Vehicle Interior Materials

Description

Preocrash

Vehicle 1 was southbound on Senter in lane S2 and Vehicle 2 was northbound on Senter in lane N2. Vehicle 1 began to make a left turn in the left turn lane at the intersection with Capitol Expressway. It is assumed that the signal light was green. Apparently Driver 2 took no evasive action; there were no skidmarks. Driver 1 ability to drive was degraded by 0.22% blood/alcohol.

Crash

Vehicle 1 started the turn and was impacted in the area of the left headlight by Vehicle 2. The collision caused Vehicle 1 to spin approximately 95° counterclockwise (as viewed from above) before coming to rest. Vehicle 2 rotated about 35° clockwise. The speed of Vehicle 1 was estimated as 20 mph; of Vehicle 2, as 36 mph. Driver 1 received a cut lip. The occupants of Vehicle 2 moved forward at impact. The right front passenger hit the dashboard and windshield receiving multiple lacerations and contusions. She broke the right tibia and fibula, probably upon falling to the floor. Driver 2 received multiple contusions and lacerations on her knees. The rear passengers in Vehicle 2 received contusions and some lacerations from impact with the sides of the vehicle and the seatbacks of the front seats. The direction of impact to Vehicle 1 was 1 o'clock. Vehicle 1 grille and bumper were damaged on the left side; the frame at the front was bent to the left. The windshield was cracked and the steering wheel rim slightly bent. The direction of impact to Vehicle 2 was 11 o'clock. The front end was severely crushed moving the left front wheel back about 12 inches. The windshield was entirely separated and the opening distorted.

Postcrash

Witnesses removed four of the occupants from Vehicle 2 but were unable to remove Driver 2 until after she was burned by a fire caused by a flare placed near the front of the vehicle where the fuel tank was leaking. Fire units put out the fire. Ambulance attendants gave first aid at the scene as was required. The westbound lanes of Capitol were blocked off by flares; some were placed on Senter to keep cars from going north. The tow units cleaned up the glass debris.

Causal Factors, Conclusions, and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-crash	Crash	Post-crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Cause(s)

- | | |
|---|---|
| 1 | Driver 1 made an unsafe left turn, not waiting for the on-coming Vehicle 2 to go through the intersection (definite). |
| 7 | There is no left turn signal for Senter Road (definite). If a signal had been present the accident might not have occurred, depending on the driver reaction. |

Severity Increasing Factor(s)

- | | |
|---|---|
| 1 | Driver 2 did not take evasive action (probable).
(Driver 2 did not remember the accident). |
|---|---|

Relevant Conditions

- 1 Driver 1 was intoxicated (.22% blood/alcohol). This condition affected her judgment and reaction to the situation (probable).

Injury Causation

- 5 Vehicle 2 (1960 Corvair) was not equipped with seat belts (Driver 2 did not install them) (definite).
- *2 Driver 2 did not receive chest injuries (only bruises on right breast) even though steering column moved back 4.8 inches (definite).

Post-Crash Factors

- *3 Witnesses aided injured in exiting Vehicle 2.
- 3 A flare was placed too close to leaking fuel tank in front of Vehicle 2 causing a fire (probable).
- 5 Fuel tank of Vehicle 2 was damaged causing fuel leakage (definite).

Recommendations

- 5 It is recommended that consideration be given to a requirement for retroactive installation of complete restraint systems.
- 1 Continued effort in alcohol program is recommended.
- 5 Protection of fuel tank and fittings to prevent post crash hazard is recommended.

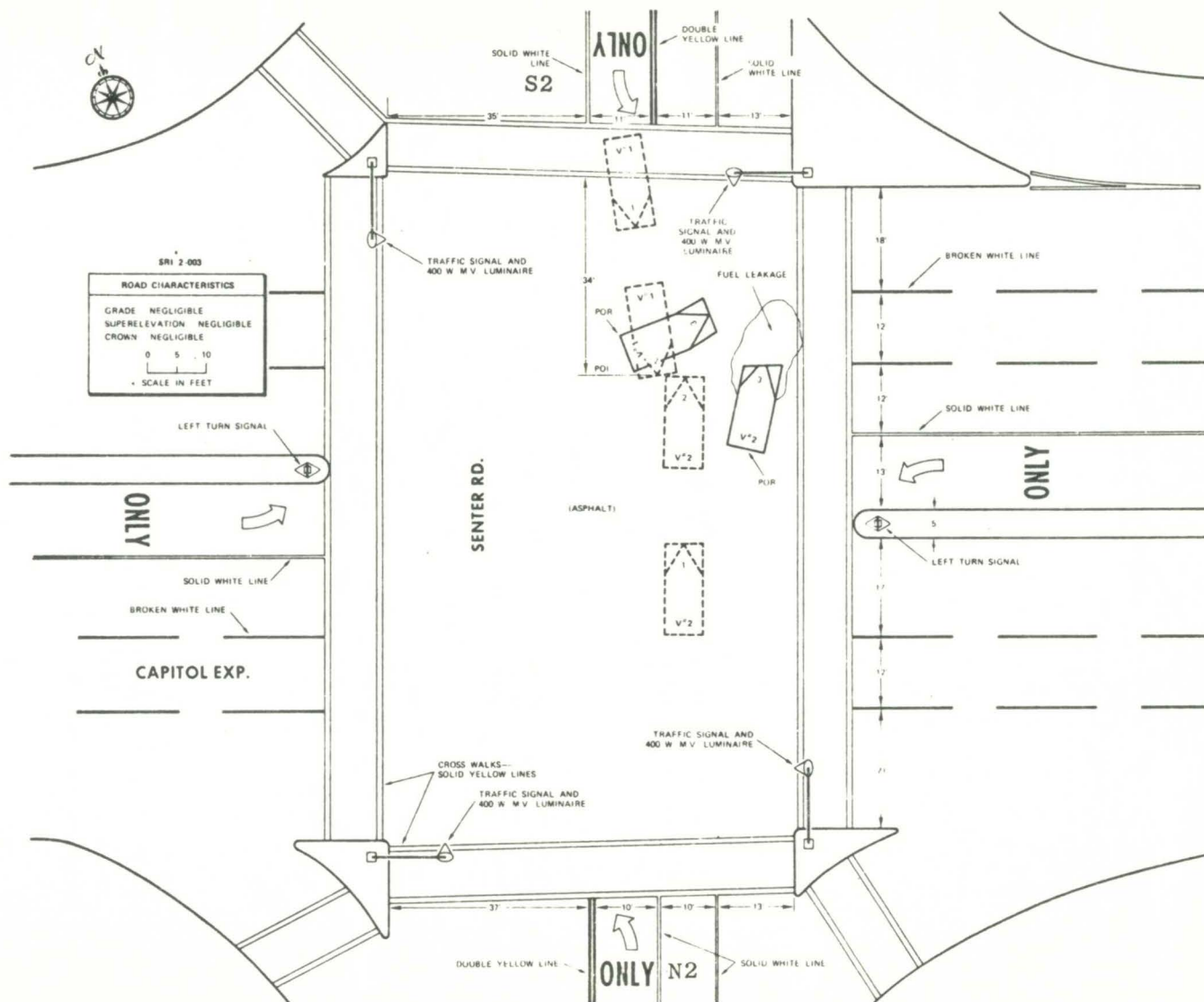


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-004

I CASE SUMMARY

(Car/Car/ Guardrail)

Identification

This accident occurred on U.S. 101 in San Jose, California, open roadway, July 27, 1972, 1345 hours, Thursday, 2 cars, one with inoperative steering, one car spun out and contacted other car and median guardrail. Injury producing. AIS* 1. Because the principal interest in this case is a vehicle defect, human and environmental factors have been de-emphasized.

Ambience

Day, no precipitation, 76°F, 48% humidity, wind 5 mph from 300°, visibility 12 miles, dry pavement, coefficient of friction 0.5-0.6 estimated.

Highway

U.S. 101 freeway 88 ft. wide, 6 lanes, W-beam median guardrail, asphalt paving, approximately 1,500' radius left curve, negligible grade and crown, 1 access per quarter mile.

Traffic Controls

Speed limit 65 mph, lanes delineated by broken white lines, raised buttons and reflectors.

Vehicles

Vehicle No. 1, 1971 Ford Pinto, 2-door, green, odometer reading 12,183 miles, padded dashboard, steering wheel hub and sunvisors, 3-point restraints, malfunctioning steering lock, no evidence of other defects, maintenance unknown, involved in serious accident November 6, 1971.

*

States, J.D., "The Abbreviated and the Comprehensive Research Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc., New York, 1969, pp. 282-294.

Damage: Left and right rear corners crushed. CDC* 08-LBME-2 (primary)
05-RBME-1 (secondary)

Vehicle No. 2, 1968 Chevrolet Impala, unavailable for inspection.

Damage: (Owner's description of damage) slight damage to left front fender, broken headlight and headlight surround.

Occupants

Driver 1, 34-year-old female, 66-1/2", 125 lbs, driving experience 16 years at an average in the last two years of 25,000 miles/year. Trip plan: Driver 1, employed by tow agency, was delivering Vehicle 1 from auto auction sale on Tully Road to dealer on N. 1st Street. Driver 1 has driven most types of cars including Pintos but, this was the first time she had driven this Pinto (Vehicle 1). She is very familiar with the area and usually drives that highway several times a week. No driver education; physical and mental health was not obtained, no restraints used.

Injuries: Soreness in neck, right shoulder, back, ribs in middle front below breasts and left leg. Abrasion on left knee. AMA-AIS 1.

Driver 2 was a 53-year-old male, height and weight unknown, driving experience unknown, trip plan unknown, vehicle familiarity unknown, road familiarity high, driver education unknown, physical and mental condition good, restraint use unknown, no injuries.

Applicable Standards

The following Motor Vehicle Program Standard was relevant to this case:

MVSS #114 Theft Protection: This standard negatively affects vehicle safety when the steering locking device malfunctions and locks during vehicle operation.

* Collision Deformation Classification, Society of Automotive Engineers
Technical Report J224a.

Description

Precrash

Vehicle 1 was proceeding northbound in lane N2 on U.S. 101 at a driver-estimated speed of 50 mph, and Vehicle 2 was traveling in lane N3 at approximately the same speed behind vehicle 1. Driver 1 turned on the turn signals in preparation for a lane change to the right. Driver 1 apparently made a quick steering correction to the left before the steering locked because of malfunction in the anti-theft steering lock. Subsequent application of the brakes in the absence of steering control was probably responsible for putting Vehicle 1 in a counter clockwise spin in front of Vehicle 2 which was traveling in N1.

Crash

Vehicle 2 impacted the left rear fender of Vehicle 1 after Vehicle 1 had spun about 135° counter clockwise as seen from above. Vehicle 1 then impacted the median guardrail with the right rear fender and continued to spin, finally coming to rest pointing in the original direction of travel.

Postcrash

A tow driver stopped and radioed for the California Highway Patrol. He also placed some flares. Driver 1 was taken to hospital emergency room by the tow driver, was admitted for observation. Vehicle 1 was towed from the scene, and Vehicle 2 was driven away.

Vehicle 1 was examined by SCAT. It was determined that the "self-locking" steering characteristic on this car was caused by the partial collapse of the energy absorbing steering column. It seems likely that the collapse occurred in a previous accident involving this vehicle, which occurred on November 6, 1971.

Causal Factors, Conclusions, and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-crash	Crash	Post-crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Causes

- | | |
|---|---|
| 4 | Vehicle was involved in previous accident which resulted in partial collapse of steering column. (probable) |
| 1 | Driver 1 inadvertently pressed steering lock activator button while operating turn signal (probable). |
| 4 | Steering self-locked (definite) |

Relevant Condition

- | | |
|---|--|
| 1 | Driver 1 was not completely familiar with Vehicle 1 (probable) |
|---|--|

Recommendations

- | | |
|---|--|
| 4 | Body shops repairing vehicles equipped with energy absorbing steering columns with steering locks which have been damaged in frontal collisions should be notified of the necessity for examining steering columns for partial collapse and other pertinent dimensional changes. |
|---|--|

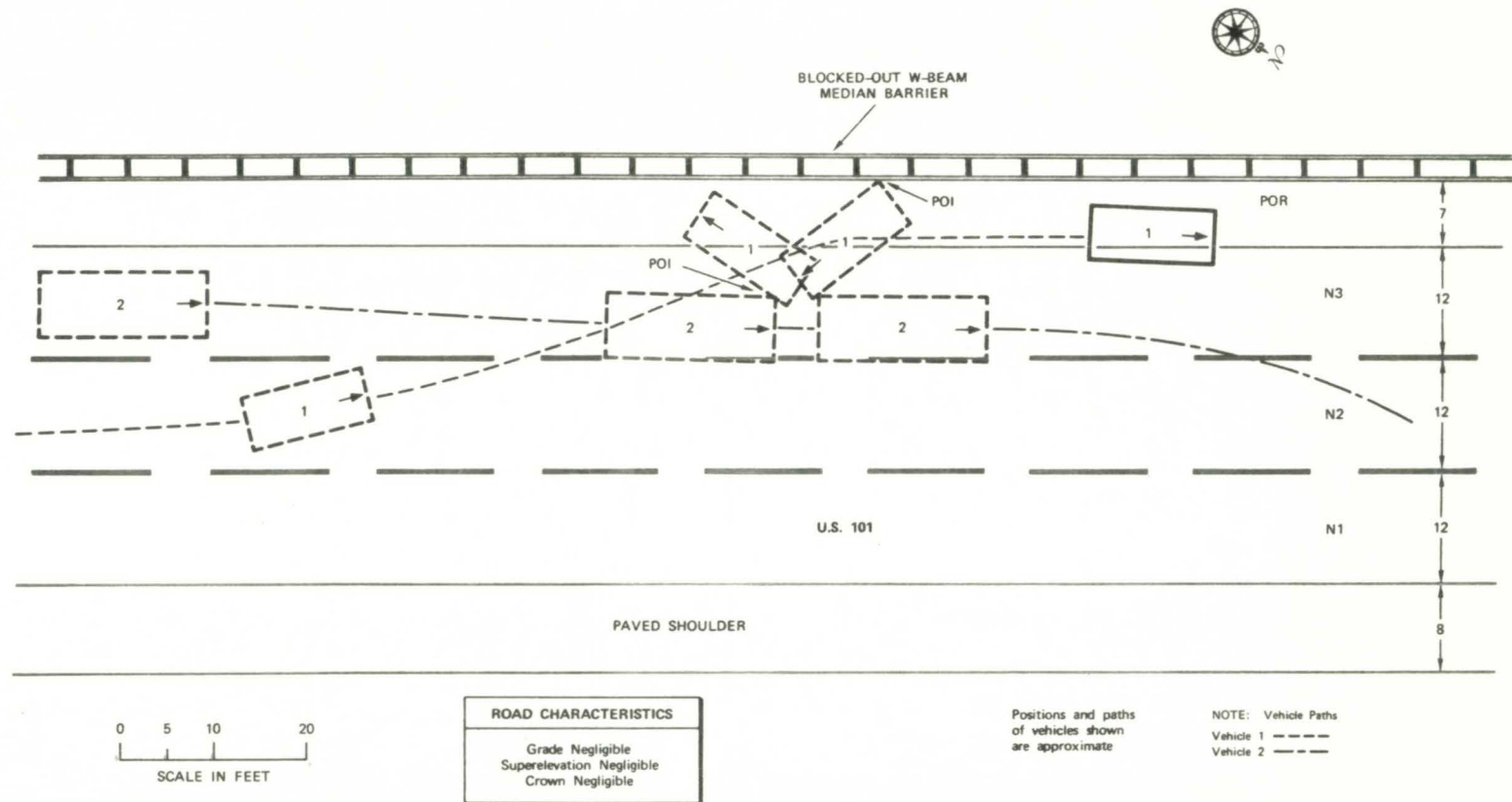


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-005

I CASE SUMMARY

(MV - Truck/Guardrail - Rollover)

Identification

This accident occurred on State Route 17 in San Jose, California, open roadway in an industrial area on August 3, 1972, at 1400 hrs, Thursday, one truck impacted median guardrail and rolled over, IP (injury producing) AIS *1.

Ambience

Day, clear sky, 73°F, 63% relative humidity, roadway dry.

Highway

Route 17 is a freeway 112 ft wide, 6 lanes, blocked out W-beam median guardrail, concrete roadway with asphalt shoulders, straight, 1 access per quarter mile. Number of accidents for Northbound 17, one quarter mile north and south of accident site: 1969, 12 (4 injury producing); 1970, 3 (2 injury producing); 1971, 11 (1 injury producing).

Traffic Controls

Speed limit 65 mph. Lanes delineated by broken white lines, raised buttons and white reflectors, solid white right hand edge line and solid yellow left hand edge line.

Vehicles

Vehicle No. 1, truck, 1972 International Harvester DM106, six doors (one on the left side, three on the right side and two on the rear), white over red, step van, 3,260 miles, no power accessories or padded components, lap restraint only, no known defects, maintenance unknown. Major damage to right front with rhombic deformation to entire body along its longitudinal axis with the top displaced to the right as viewed from the rear. Minor damage to left and right sides. CDC† 02-RFME-3 (primary), 00-LDAO-1 (secondary).

* States, J.P., "The Abbreviated and the Comprehensive Research Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

† Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

Occupants

Driver 1, 28-year-old male, 74", 200 lbs., 12 years driving experience, averages 20,000 miles annually, occupation: truck driver. Trip plan was from customer (equipment delivery) to International Harvester garage, no ETA. Driver 1 was assigned accident vehicle when it was purchased new by his employer approximately three weeks prior to the accident. Driver 1 had driven the accident vehicle over 3,000 miles during this time and he estimated that half of this was with the vehicle loaded and half unloaded. Driver 1 stated that the accident vehicle "handled differently" than the previous vehicles he had driven. Driver 1 was familiar with the road and traveled it daily during the two months preceding the accident. Driver 1 completed a high school drivers education course at the age of 16. His physical health is good, mental condition unknown. Lap restraint available, but not used.

Injuries: Puncture wound on inside calf of right leg; pulled muscles in head, neck, left shoulder and back. AMA-AIS 1.

Applicable Standards

The following Traffic Safety Program Standard (TSPS) was relevant to this case:

TSPS #12 Highway Design, Construction and Maintenance. This standard is relevant to this case because the accident vehicle traversed a degraded section of roadway in the approximate area it went out of control. Possible non-compliance.

Description

Pre-Crash

Vehicle 1 was northbound in Lane N2 on Highway 17 at a driver estimated speed of 55 to 60 mph. A car, traveling in front of Vehicle 1 braked, Driver 1 applied his brakes and at this time, Vehicle 1 swerved uncontrolled to the right into Lane N1 forcing the driver to the left of the vehicle. Vehicle 1 then went into a centrifugal skid to the left, causing Driver 1 to move to his right out of the driver's seat. Vehicle 1 skidded across Lanes N2 and N3 while rotating counterclockwise (as viewed from the top).

Crash

Vehicle 1 impacted the median guardrail with its right front and continued to rotate counterclockwise, impacting the guardrail with its right rear. The right front of Vehicle 1 rebounded away from the guardrail with the front pivoting counterclockwise about the vehicle's rear. The vehicle then rolled onto its left side coming to rest at a right angle to the guardrail with its front facing towards Lane N1. During the dynamics Driver 1 contacted the roof of the vehicle and the spare tire behind the driver's seat where he punctured his right leg on the spare tire securing bolt.

Post-Crash

Driver 1 climbed out of the vehicle through the right front door. A southbound California Highway Patrol motorcyclist stopped, reported the accident and gave Driver 1 a pressure bandage for his right leg. Two CHP units responded, set flares and directed traffic. A tow truck righted Vehicle 1 and towed it from the scene. Driver 1 was taken to the hospital emergency room by private car.

Causal Factors, Conclusions, and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9

Accident Avoidance Injury Prevention Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Causes

- | | |
|---|---|
| 7 | The road surface is in poor condition in the approximate area where the loss of control was initiated, causing Vehicle 1 to swerve to the right when the brakes were applied. (probable) |
| 4 | DOT Memorandum 43-32 (August 16, 1972) states that the previous year model of Vehicle 1 has the possible problem of "wheel oscillations over rough surfaces." International Harvester indicated there had been no change in design of steering components in question on the case vehicle from the previous year. This or a related condition may have occurred and contributed to the loss of control; no brake defects were found. (possible) |

Matrix Element Description (Continued)

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Severity Increasing Factors

- | | |
|----|---|
| 2 | Driver not using available restraints which allowed him to be displaced from the driver's position, preventing him from attempting to bring Vehicle 1 under control. (definite) |
| 4 | Vehicle 1 driver's seat configuration does not give driver adequate lateral support which allowed the unrestrained driver to be displaced from the driver's seat. (probable) |
| 8* | Guardrail prevented Vehicle 1 from travelling into the path of opposing traffic. (definite) |

Injury Causation

- | | |
|---|--|
| 2 | Driver 1 not wearing available restraint which may have reduced his injuries. (probable) |
|---|--|

Post-Crash Factors

- | | |
|----|--|
| 9* | Tow truck righted Vehicle 1, cleaned area and towed vehicle from scene in short period of time (about 5 min.), thus reducing exposure time of traffic to hazardous situation. (definite) |
|----|--|

Recommendations

- | | |
|---|--|
| 4 | Drivers of delivery trucks and other vehicles where the driver frequently leaves the vehicle may have a tendency not to use available restraints. It is suggested these vehicles be fitted with contoured seats that give lateral support. |
|---|--|

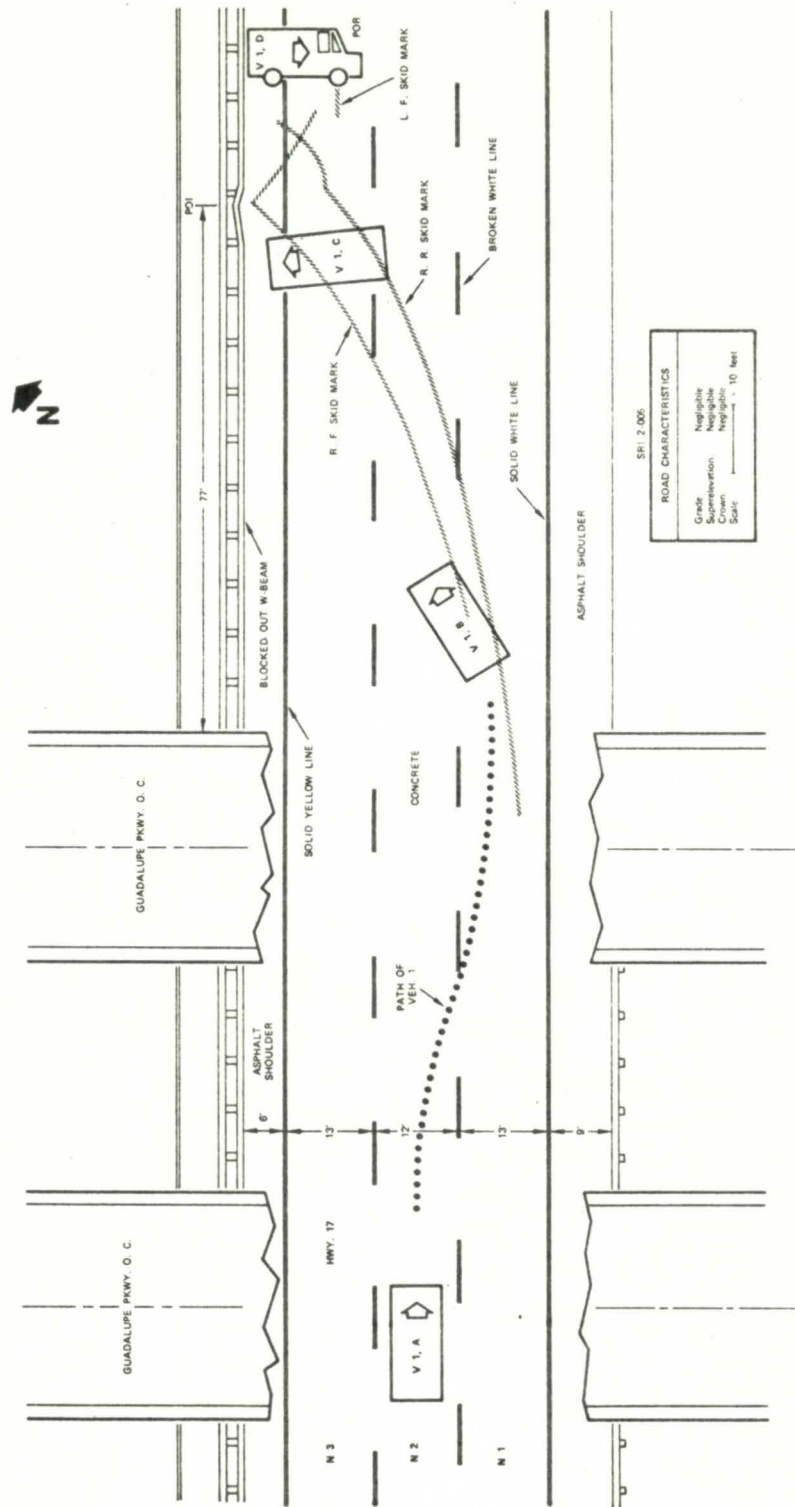


FIGURE 1. COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-006

I CASE SUMMARY

(Car/Car - Lateral)

Identification

This accident occurred at the intersection of Tully Road, Alvin Street, and Lanai Street in San Jose, California, commercial area, August 5, 1972, Saturday, 0005 hrs. Vehicle 2 attempted a U-turn and was impacted in the right side by Vehicle 1. IP (Injury Producing) AIS 1*. Figure 1 is a plan view of the accident scene.

Ambience

Night, no precipitation, 58°F, 60% relative humidity, dry pavement.

Highway

Tully Road is a 6-lane major arterial road, 106 ft. wide with a concrete median divider 8" high, 15 ft. wide, narrowing to 5 ft. to accommodate left turn lanes at Alvin and Lanai Streets. It is asphaltic concrete pavement with a 2 foot crown, mercury vapor luminaires; in the last $\frac{1}{4}$ mile traveled by Vehicle 1 there are 5 poles and 2 accesses, in the last $\frac{1}{4}$ mile traveled by Vehicle 2 there are 2 roads, 7 driveways, 10 poles and 1 tree; accident history: 1970, 12(8 IP); 1971, 18(3 IP); 1972 (Jan-May), 8(3 IP).

Traffic Controls

Speed limit 40 mph, broken white line and reflective markers separating traffic lanes, solid white lines delineating the left turn lanes, no signals at intersection.

Vehicles

Vehicle 1, car, 1966 Ford Mustang, 2-door hardtop, yellow. Vehicle unavailable for inspection before being repaired, odometer reading, inspection data, padded components, power accessories unknown, lap restraints.

* American Medical Association Abbreviated Injury Scale (AIS) (See Appendix A for complete description.)

Damage: Left side of bumper and grille pushed back, hood buckled, hood latch jammed, left front fender buckled, left front suspension bent.
CDC* 11-FLEW-1.

Vehicle 2, car, 1970 Volkswagen 113, 2 doors, green, sedan, odometer reading 53,371 miles, no inspection sticker, no power accessories, padded dashboard and sun visors, 3-point restraints, no evidence of pre-crash defects.

Damage: Right door, B-pillar, roof, quarter panel and rear fender pushed in, right front seat damaged, right side of rear seat deformed, right side glass broken. CDC 03-RPAW-2.

Occupants

Driver 1: 18½-year-old male, 70", 150 lbs., 3 years driving experience (no estimate on number of miles/year), trip plan: friend's home to his (mother's) home (no ETA), familiar with area and route "driving it every time he is in San Jose" (interviewer estimated 2 or 3 times since returning from overseas), driver's education in sophomore year of high school (1969) and driver's training in 1970 in Northern California. Physical condition: "good". Mental condition: unknown. Restraints not used.

Injuries: Knocked unconscious for about 30 seconds; back of neck and shoulders were stiff. AMA-AIS 1.

Driver 2: 18½-year-old male, 68", 135 lbs, 3 years driving experience (could not estimate number of miles/year), trip plan: from home to hamburger drive-in (3 to 4 miles) and back home (no ETA). Five to six months experience with vehicle on work days (round trip 50 miles daily), drives route to drive-in every weekend and a portion of the route to work, driver training course beginning freshman year of high school and completed first semester of sophomore year with simulator and actual driving training (1968-1969). Physical condition: "good". Mental condition: life style altered recently due to forthcoming marriage (within 2 weeks). Restraints not used.

Injuries: Abrasion over right eyebrow, black and blue and swollen right eye. AMA-AIS 1.

Description

Pre-Crash

Vehicle 2 was westbound on Tully Road approaching the freeway overpass where Tully Road crosses U.S. 101. Vehicle 2 entered the left turn lane with the intention of making a U-turn and going east on Tully. Vehicle 1 was eastbound on Tully in Lane E3. Driver 1 saw Vehicle 2 in the left turn lane as he came over the crest of the overpass, but did not see Vehicle 2 start to make a U-turn; Driver 1 saw Vehicle 2 broadside in front of him and applied his brakes hard, attempting to steer to the right (SCAT could find no skid marks at scene).

*

Collision Deformation Classification, Society of Automotive Engineers
Technical Report J224a.

Matrix Cell Description (Continued)

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Causes

1 Driver 2 attempted unsafe U-turn in front of Vehicle 1 (definite)

1 Driver 1 saw Vehicle 2 in left turn lane but didn't see him start his U-turn.(definite)

Relevant Condition

1 Driver 2 may have been preoccupied with personal matters (such as his upcoming marriage) and was therefore less attentive to his driving (possible)

Recommendations

7 The intersection has recently been recommended for signalization. A study should be made following the installation of signals to see if the accident rate is reduced.

Crash

Vehicle 1 impacted Vehicle 2 in the right side. Since Vehicle 2 was moving at the instant of impact Vehicle 1 was rotated more than 90° to the right and came to rest in Lanes E2 and E3. Driver 1 hit his head on the left vent-window frame. The impact caused Driver 2 to hit the right front seat back with the right side of his face. Driver 2 could not operate the brakes of his car, so Vehicle 2 rolled up the curb on the south side of Tully and came to rest.

Post-Crash

Driver 2 stepped out of his vehicle and ran over to Vehicle 1. Driver 2 and a police officer were at Vehicle 1 when Driver 1 regained consciousness. Driver 1 was able to get out of his car and stated that he did not want an ambulance. One tow truck arrived, and the tow driver swept the glass from the road, towed Vehicle 2 into a service station and then towed Vehicle 1 from the scene. The tow truck returned and removed Vehicle 2 from the service station. Drivers 1 and 2 left the scene in private vehicles.

Causal Factors, Conclusions and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9

Accident	Injury	Restoration
Avoidance	Prevention	and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Cause

- | | |
|---|---|
| 1 | Driver 2 did not keep attention on oncoming vehicles while making a U-turn (he saw traffic on overpass, but didn't notice Vehicle 1 until too late). (definite) |
|---|---|

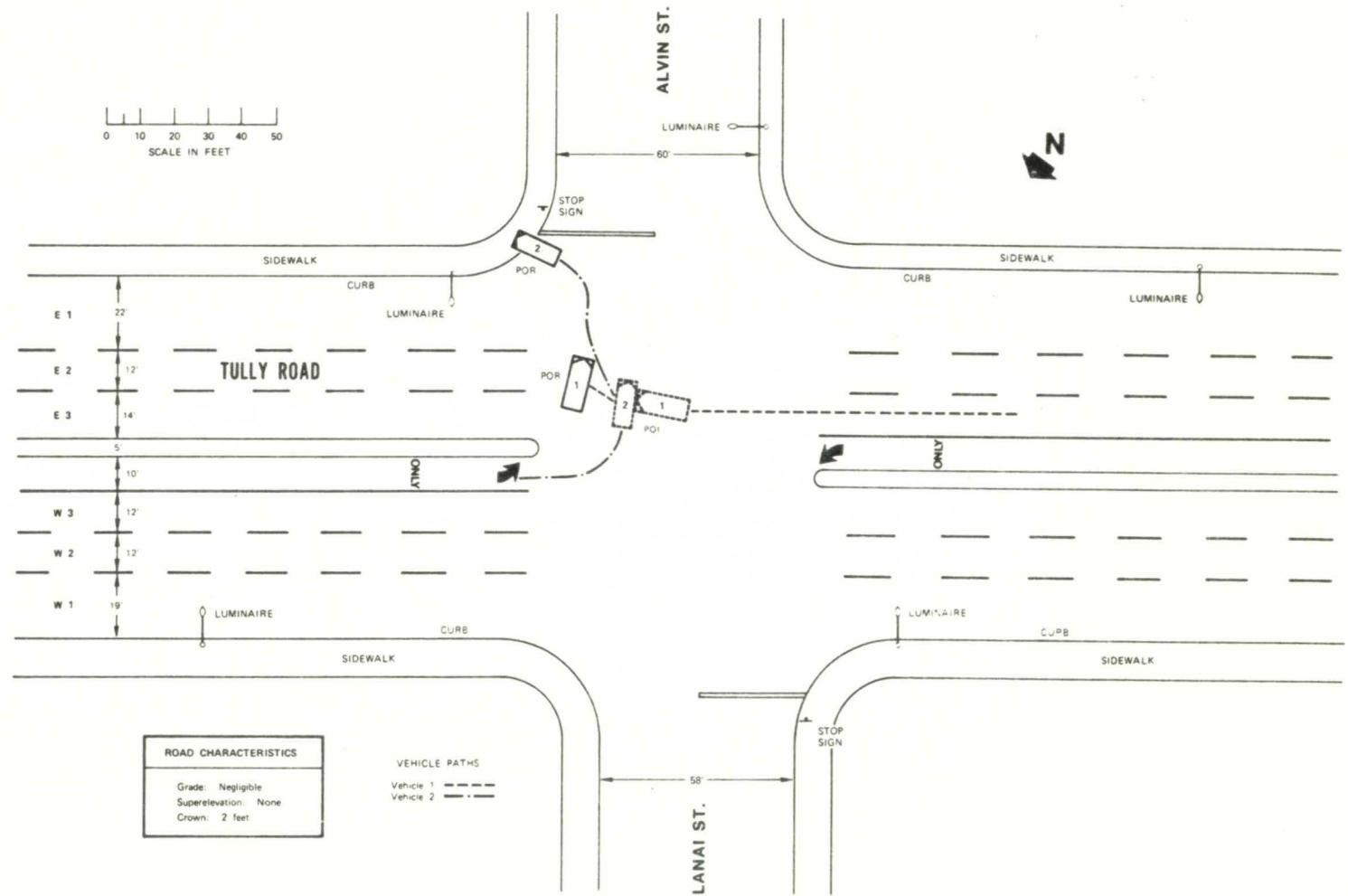


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-007

I CASE SUMMARY

(Car/Motorcycle/Car - Oblique Side Impact - Sideswipe)

Identification

State Highway 17, northbound lanes, 2100 ft north of Alameda overcrossing, San Jose, California, open roadway, industrial area, August 14, 1972, 1350 hours, Monday, 2 cars - 1 motorcycle - oblique side impact, IP (injury producing) AIS* 1.

Ambience

Day, no precipitation, 76°F, 54% relative humidity, wind 10 knots from 280°, visibility 30 miles, dry pavement, coefficient of friction 0.5-0.6 estimated.

Highway

Freeway, 88 ft wide, 6 lanes, 16 ft wide median with blocked-out W-beam guardrail and expanded metal anti-glare material, Portland cement concrete surface, asphalt paved shoulder, 8" high asphalt curb; straight, 2% upgrade, negligible crown, 1 access per $\frac{1}{4}$ mile (approx.). Number of accidents for northbound Highway 17, between Alameda and Coleman interchanges: 1969, 20(6 IP); 1970, 20(8 IP); 1971, 29(12 IP).

Traffic Controls

Speed limit 65 mph, lanes separated by broken white lines, raised buttons and white reflectors.

Vehicles

1. Car, 1965 Ford LTD 2-door hardtop, light blue, 93,072 miles, no inspection sticker, power steering and power brakes, padded dashboard, lap belts only, rear wheel brake cylinders leaking, lubrication sticker 90,954 miles (6 weeks before accident).

* American Medical Association Abbreviated Injury Scale (see Appendix B for complete description of AIS).

Damage: Left door pushed in, left B-pillar bent, left rear fender dented and left taillight broken. CDC* 08-LPMW-2.

2. Motorcycle, 1972 Honda CB750, metallic brown, 2,485 miles, no evidence of pre-crash defects.

Damage: Front wheel rim bent, front fork bent, damage to engine and exhaust pipes on right side, headlight casing and right side turn signal lights damaged, instruments damaged, handlebars rotated forward, rear fender and taillight damaged.

3. Car, 1971 Chevrolet Vega 2-door coupe, green 10,682 miles, no inspection sticker, no power accessories, padded dash, sunvisors, steering wheel spokes, lap and torso restraints, no evidence of pre-crash defects, lubrication sticker 8419 miles (May 2, 1972).

Damage: Moderate crush to right front corner, broken right headlight, sideswipe damage to entire left side below belt line, other minor damage to right door and rear fender, cracked windshield. CDC* 02-FREE-2 (primary), 11-LFMS-1 (secondary).

Occupants

Driver 1, 55-year-old male, 67-1/2", 181 lbs., driving for 39 years at approximately 22,000-25,000 miles annually (90% of mileage is business driving due to salesman occupation), trip plan lunch with friend at restaurant to office, collision occurred approximately 1/2 mile from origin. Driver 1 purchased Vehicle 1 in 1965 when it was less than 1 year old with approximately 13,000 miles on the odometer; he owned and drove it for approximately 7 years. Driver 1 drove the area in which the accident occurred approximately 2-3 times per week. Driver 1 received no formal driver education but learned to drive from acquaintances. Physical and mental condition good. Seat belts not used.

Injuries: none.

Driver 2, 27-year-old male, 70", 160 lbs., driving automobiles for 12 years at approximately 22,000 miles annually, more when law enforcement occupation requires field patrol, 10 1/2 years experience riding motorcycles, mostly on dirt, present motorcycle (Vehicle 2) purchased new and driven 2400 miles on highways. Trip plan was home to work, approximately 5-3/4 miles, travels road often but varies route to work. One semester of high school driver education (held after school) but learned to drive approximately 2 years prior to course. Had a motorcycle training course consisting of about 22 hours in handling, operation and demonstration. Physical condition: severe laryngitis and cold for three days prior to accident, "back pain problem", and ulcer. Mental condition: good. Restraints not applicable. Safety equipment used (helmet, heavy leather jacket, gloves and boots.)

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J 224a.

Injuries: Bennett's fracture lateral aspect of proximal end of first metacarpal bone (thumb) on left hand, laceration and abrasion with 4 cm diameter avulsion of skin on direct lateral aspect of left thigh and buttock region, bruise at left elbow, bruise and soreness upper right arm, sore right thumb, soreness in back, bruise on chin, numerous abrasions on knees, ankles and forearms, sprained ankles. AIS 1.

Driver 3, 18-year-old male, 56½", 160 lbs., driving for 2 years at approximately 10,000 miles annually, trip plan home to shopping center, approximately 13 miles, expected time of arrival as long as travel time required, collision occurred approximately 5 miles from origin, had driven vehicle for approximately 1 year, very familiar with road. Driver 3 received one semester of driver education in his sophomore year in high school which included use of a simulator. Physical and mental condition good. Seat belts not used.

Injuries (according to Driver 3): bruise on right wrist, soreness on neck (whiplash) and chest, bruise on right knee. AIS 1.

Applicable Standards

The following Motor Vehicle Safety Standard was relevant to this case:

MVSS #105 Hydraulic Brake Systems. Possible braking instability, Vehicle 1.

Description

Pre-Crash

Vehicle 1 entered the northbound lanes of State Highway 17 from the Alameda on-ramp and accelerated in Lane N1 (slow lane). Vehicle 2 and Vehicle 3 were traveling at 60-65 mph in Lanes N2 and N3, respectively. Vehicles 2 and 3 were behind Vehicle 1. Driver 1 reacted to the sudden slowing of the car in front of him by applying his brakes hard and locking the rear wheels. Driver 1 may have also steered to the left. Vehicle 1 swerved to the left into Lane N2.

Crash

As Vehicle 1 swerved across Lane N2 it was impacted by Vehicle 2 (motorcycle) in the left door. Driver 2 impacted Vehicle 1 with his right shoulder and then went over the roof of Vehicle 1. Vehicle 2 then sideswiped Vehicle 3. The right front fender of Vehicle 3 impacted the left door of Vehicle 1. Vehicle 3 was forced into the median area and contacted the guardrail resulting in damage to the left side of Vehicle 3. Vehicle 3 came to rest

adjacent to the guardrail and just ahead of Vehicle 2. Vehicle 1 was driven to the shoulder. Driver 2 landed on his left thigh and leg and then slid in the median area directly in front of Vehicle 3, receiving a laceration and avulsion of the skin on the left thigh.

Post-Crash

Witness 2, driving in Lane N3 behind Vehicle 3, saw the accident and stopped in Lane N3 adjacent to Driver 2 to assist him. Drivers 1 and 3 exited unassisted from their right doors. A passing California Highway Patrol (CHP) unit saw the accident and radioed his dispatcher. Two more CHP units and an ambulance responded to the scene. The ambulance took Driver 2 to the hospital emergency room. Two tow trucks arrived and removed the three vehicles from the highway.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Cause

- | | |
|---|---|
| 1 | Driver 1 was unable to control vehicle in locked-wheel skid (definite) |
| 1 | Driver 1 was either inattentive to traffic conditions ahead, or was following too closely, leading to panic stop situation (probable) |
| 1 | Driver 1 may have turned to the left to avoid vehicle in front (possible). |

Matrix Element Description (Continued)

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Cause

4 Vehicle 1 rear wheels locked first, leading
to braking instability (probable)

Relevant Conditions or Modifying Factors

7 Traffic on freeway was heavy (definite)

Injury Causation

*2 Driver 2 (motorcycle rider) was wearing
leather jacket and gloves, high boots and approved
crash helmet, which protected him (definite)

2 Driver 2's lack of leather pants allowed injury
to left leg due to sliding on pavement (definite)

5 Driver 2 was ejected from his vehicle (definite)

*8 Guardrail kept Vehicle 3 from going into
opposing lanes of traffic (definite)

Recommendations

4 Stability requirements for vehicle braking
systems (MVSS #105) should be strengthened.

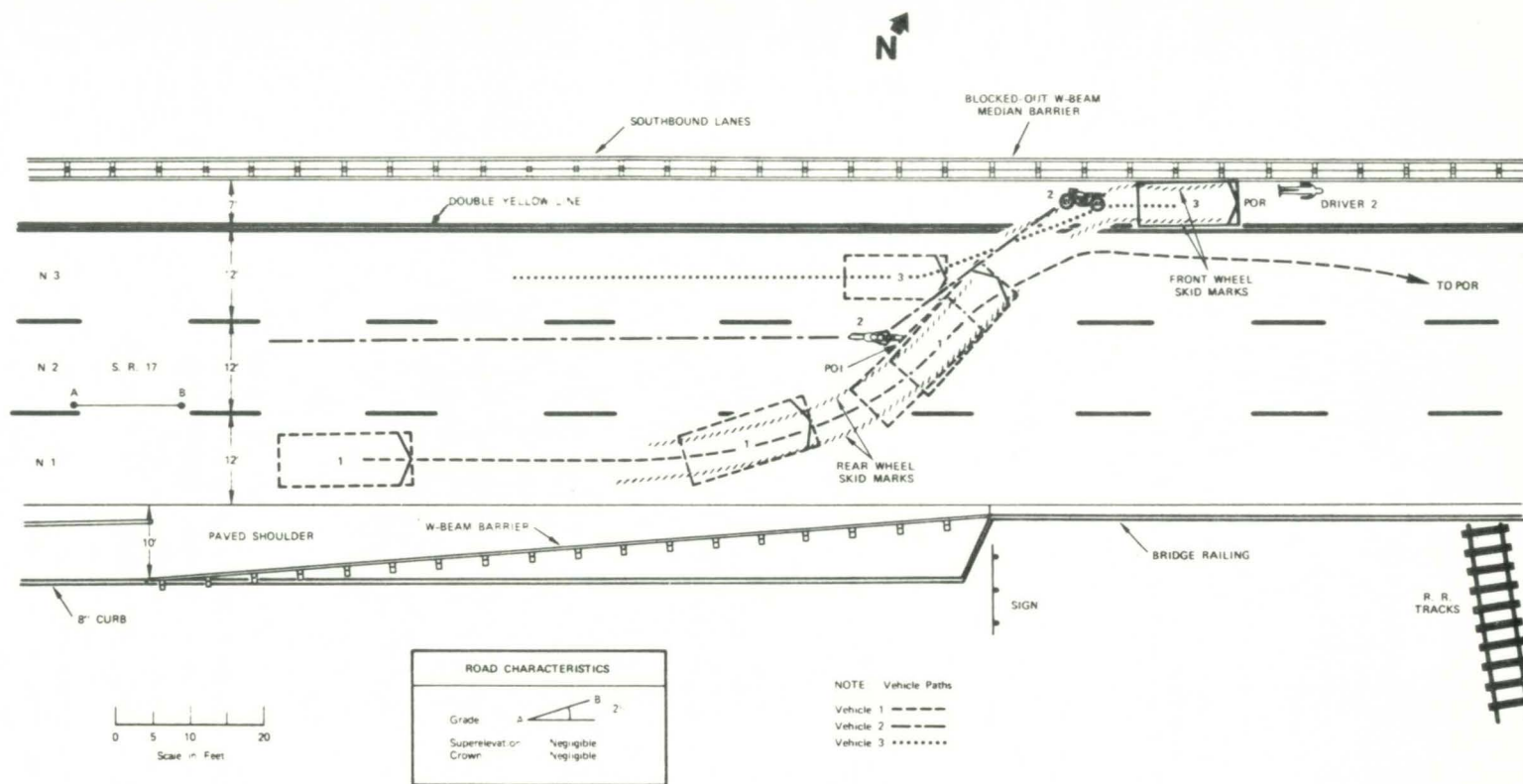


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-008

I CASE SUMMARY

(Car/Car/Retaining Wall)

Identification

This accident occurred on State Route 17 in San Jose, California, open roadway in an industrial area on August 16, 1972, at 1430 hrs, Wednesday, one car impacted another car causing both vehicles to impact a barrier railing, IP (injury producing) AIS* 3.

Ambience

Day, clear sky, 81⁰F, 52% relative humidity, roadway dry.

Highway

Northbound Route 17 is 42 feet wide with 3 lanes in that direction, blocked out W-beam median guardrail, asphalt roadway and inside shoulder, straight, with a northbound Route 17 to northbound Route 280 connector originating from the righthand side of Route 17. The northbound Route 280 connector ramp is 26 feet wide, 2 lanes with directional arrows painted on the lanes, lanes 1 and 2 begin a loop to the right beyond gore point, lane 2 also continues straight to exit on Stevens Creek Blvd, concrete and metal barrier railing 27" high on outside shoulder (Figure 9). Accident history between January 1970 to August 9, 1971 were 21: 18 property damage only, 3 injury. 12 were rear end, 2 hit object, 3 hit object and overturned, 2 overturned, 1 broadside and 1 undetermined.

Traffic Controls

Speed limit on Highway 17 is 65 mph. Lanes delineated by broken white lines, raised buttons and white reflectors. The northbound Route 280 connector is delineated by solid white lines and raised white reflectors, ramp speed limit 35 mph, changing to 25 mph at the loop.

Vehicles

Vehicle 1, car, 1966 Ford Custom Galaxie 500, four doors, light blue, 108,803 miles, power steering, padded dashboard, lap restraints only, defective right front suspension system, left exhaust system tailpipe broken after muffler, shock absorbers degraded, no front bumper, maintenance--driver maintained. Major damage to front and right side. CDC 09-LFMN-1 (primary), CDC 03-RFMN-1 (secondary)

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

** Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a

Vehicle 2, car, 1971 Chevrolet Townsman, four-door station wagon, green, 24,000 miles, power steering and brakes, padded components, lap, upper torso, and head restraints, no known defects, maintenance--lube, oil and filter 7-20-72. Minor damage to left and right front corners. CDC 09-LFMN-1 (primary), CDC 03-RFMN-1 (secondary)

Occupants

Driver 1, 20-year-old male, 72", 140 lbs., 4 years driving experience at an average of 20,000 miles/year for the last two years; trip plan was friend's home in San Jose to Concord (his home town) where he was going for an "interview." ETA is unknown; when he left San Jose he was "behind schedule." Has owned Vehicle 1 about 2 years, familiarity of both route and area are unknown but through the conversation it is believed he was somewhat familiar with the route. High school driver education. Physical and mental health unknown, restraint not in use.

Injuries: Bloody nose at scene, laceration of the lip, sternal fracture, mandible fracture body, bruised knees. AIS 3.

Right Front Passenger (Vehicle 1) was a female. Little is known. She had met Driver 1 at the friend's home just prior to their departure. From the interviews she was apparently under age and running away from home. She left the scene of the accident, hitched a ride back to the point of origin (of trip plan) to inform friends of the accident. She was not wearing seat belts and had been talking to the driver at the time of the accident.

Injuries: Concussion; other injuries, if any, unknown. AIS X.

Driver 2, male, 27 years old, 72", 180 lbs, 12+ years of education, 10 years driving experience at an average of 50,000 miles/year last year and 24,000 this year, traveling salesman, trip plan home 0900 hours to various places of business, then home about 1615 hours, last stop before accident was an unscheduled stop in San Jose (7-8 miles from accident) before going to a client in Santa Clara, ETA of about 1500 hrs. Vehicle 2 is a company owned car given to Driver 2 to drive one year ago, area and route are very familiar, drives that portion of route several times every day, high school driver education 1961, no surgery or major illnesses, attitude towards driving "it is a part of the job," restraint system not in use.

Injuries: None.

Standards

The following Traffic Safety Program Standard (TSPS) was relevant to this case:

HSPS 1. Periodic MV Inspection. Driver 1 was knowingly driving a vehicle that was mechanically degraded.

Description

Pre-Crash

Vehicle 1 was traveling northbound on Highway 17 in the center lane at a driver estimated speed of 65 mph. Realizing he (Driver 1) had forgotten his wallet, he applied brakes and started changing lanes to exit at the first available off-ramp. When Driver 1 applied brakes, Vehicle 1 swerved 90° to the right, crossing Lane N1 of the freeway and Lanes L2 and L1 of the connector ramp to Highway 280. Vehicle 2 had been in Lane N1 of Highway 17 and was in Lane L1 of the connector ramp when Driver 2 noticed Vehicle 1 approaching him. Driver 2 applied brakes and steered slightly right.

Crash

Vehicle 1 hit Vehicle 2 with Vehicle 1's right B-pillar pushed in by Vehicle 2's left front corner, Vehicle 1 then impacted the barrier railing and spun about 90° clockwise (as viewed from the top). Vehicle 2 impacted the barrier railing with its right front corner. Vehicle 1's occupants moved forward. Driver's head contacted upper dash and possibly steering wheel, his sternum contacted the steering wheel and his knees contacted the lower dash. Right front passenger's head contacted the windshield. Other kinematics unknown. Driver 2 does not remember contacting any part of the car.

Post-Crash

Driver 1 exited Vehicle 1 through the left front door, then the RF passenger exited the same door. Passenger began walking or running down the road. Driver 2 exited Vehicle 2 through left front door. A car drove by and offered to call the CHP then stopped to pick up the RF passenger. Truck driver dropped flares out of window and continued on. State service truck stopped, placed call to CHP and helped set out flares. CHP arrived, pushed Vehicle 2 to side of ramp. SCAT arrived on scene. Driver 2 drove from scene. Tow truck arrived and towed Vehicle 1 from the scene. Driver 1 was driven from the scene by SCAT but was picked up by a friend a short distance away.

Causal Factors, Conclusions, and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principle Causes

- | | |
|---|--|
| 4 | Vehicle 1 was poorly maintained. (definite) |
| 4 | Vehicle had been in previous accident resulting in frame damage and improper repair by owner. (definite) |

Severity Increasing Factor(s)

- | | |
|---|--|
| 1 | Driver 1 was behind schedule. (definite) |
| 4 | Low left rear tire pressure. (definite) |

Relevant Conditions

- | | |
|---|--|
| 4 | 8" diameter steering wheel may have aggravated control difficulty (possible) |
| 4 | Right front portion of A-frame was not securely bolted (probable) |

Injury Causation

- | | |
|---|---|
| 2 | Seat belts not being worn by Driver 1 or passenger (definite) |
|---|---|

Post-Crash Factors

- | | |
|----|--|
| *3 | Truck driver dropped flares to drivers (definite) |
| *3 | State truck driver stopped, called CHP over two way radio and helped set out flares (definite) |
| *8 | Barrier railing prevented vehicles from going over side of ramp. (definite) |

Recommendations

- | | |
|---|---|
| 6 | Vehicles should be inspected after accidents for repairs and road worthiness. |
| 6 | Repairs should be made by qualified repairman. |

E-51

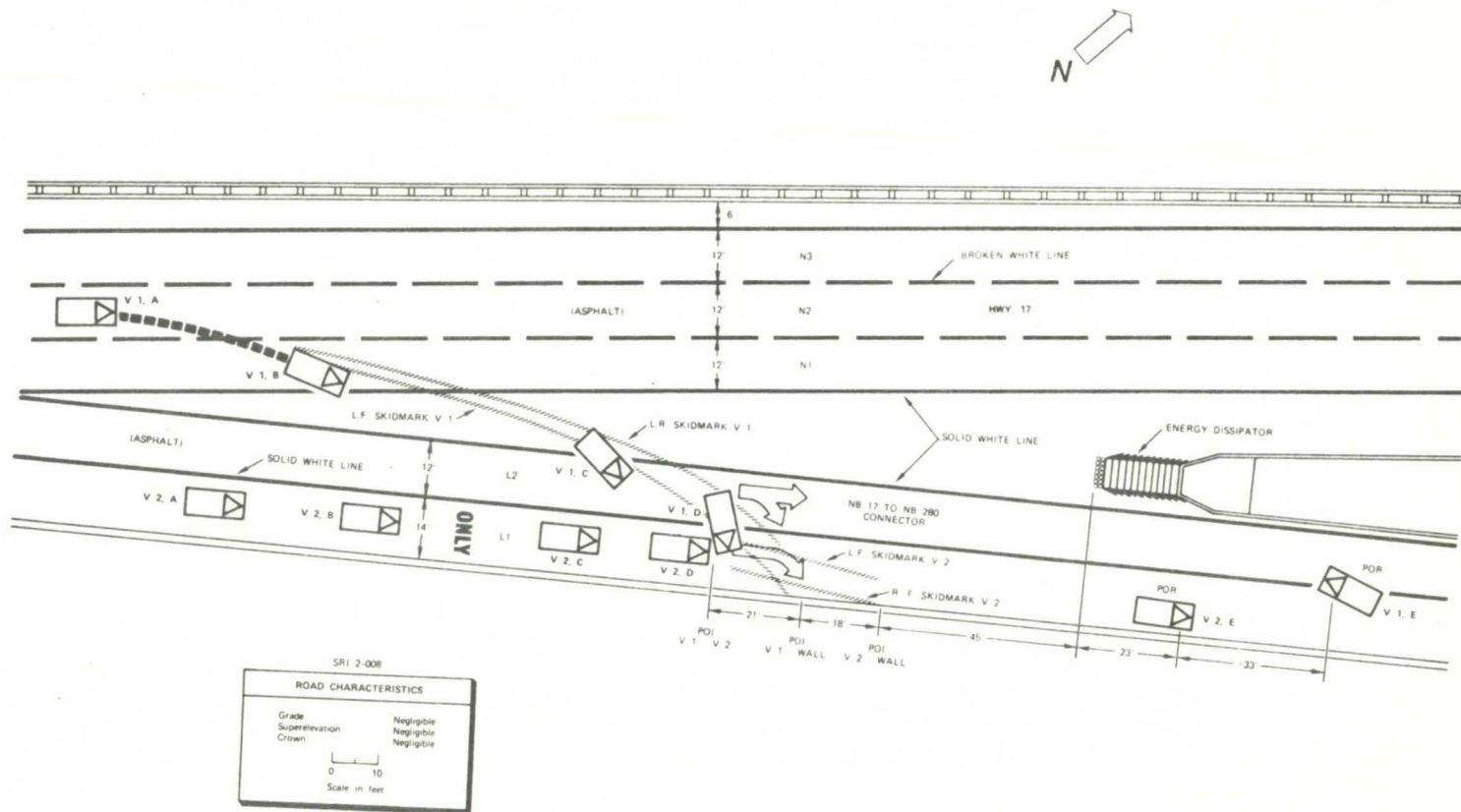


FIGURE 1. COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-009

I CASE SUMMARY

(Car/Car - Lateral Impact)

Identification

This accident occurred at the intersection of Colorado Avenue and Ross Road, Palo Alto, California, residential area, October 12, 1972, 1225 hours, Thursday. Vehicle 2 drove through a stop sign and was impacted in the right door by Vehicle 1. PD (property damage only). Figure 1 is a plan view of the accident scene.

Ambience

Day, cloudy, approximately 65°F, 79% relative humidity, visibility good, dry pavement.

Highway

Colorado Avenue is a collector road, 35 feet wide, one eastbound and one westbound lane with adjacent bicycle lanes, asphalt, cement barrier curb and gutter, straight, 15 driveway accesses on south side and 1 road intersection on north side within 1/4 mile, 23 poles and trees on south side within 1/4 mile of accident site.

Ross Road is a local road, varying between 32 (from gutter to gutter) and 38 feet wide with one northbound and one southbound lane, asphalt, 3.25 foot cement rolled gutter, straight, approximately 16 driveways and 1 road access on west side and 1 road access on east side within 1/4 mile, 19 poles and trees on west side within 1/4 mile of accident site.

Six right angle accidents occurred at the intersection from 1965 to mid-1972; all involved drivers on Ross failing to yield to approaching Colorado traffic after stopping at stop sign; each claimed they didn't see the other vehicle.

Traffic Controls

Speed limit unmarked on Colorado and Ross (presumed to be 25 mph due to residential area). Broken yellow line separating opposing traffic on Colorado; solid green lines delineating bicycle lanes on both sides of Colorado. White solid limit lines at stop signs on Ross on either side of Colorado.

Vehicles

1, car, 1970 Mercury Cougar XR-7, 2-door hardtop, light yellow, odometer reading unknown, inspection data unknown, power steering and brakes, padded components unknown, luxury model, lap and upper torso restraints, high seatbacks in front, defects unknown (none reported by owner), maintenance unknown.

Damage: left front fender and headlight area. CDC* 11-FYEW-1.

2, car, 1969 Ford Mustang, 2-door hardtop, yellow, odometer reading 36,806, no inspection sticker, power steering, padded dashboard, sun visors, lap and upper torso restraints, head restraints, driver-reported high speed vibration (70 mph), side windows loose in retainers (epoxy seal problem), recent general servicing (36,054 miles).

Damage: right front door pushed in near right A-pillar, right side of windshield cracked. CDC* 03-RPMW-2.

Occupants

Driver 1, 34-year-old female, 62", 180 lbs., occupation computer programmer, 18 years driving experience at more than 17,400 miles per year (figure based on roundtrip to work only) during recent years, trip plan lunch to work, collision occurred approximately 2 miles from work, purchased car when it had less than 1,000 miles on it, drives lunch-to-work route daily, driver education in high school at age 16, physical and mental conditions unknown, lap and upper torso restraints used.

Injuries: none.

Driver 2, 29-year-old female, 58-1/2", 92 lbs., occupation housewife, 13 years driving experience at estimated 5,000 miles/year, trip plan grocery store for groceries to home (distance from store to home 1.3 miles, no ETA), collision occurred 0.3 miles from store, owned vehicle 2-1/2 years (drives on errands), drives road often, no driver education (learned to drive from father), physical condition good, mental condition "nothing unusual" (some worries about recently purchased home), lap belt used.

Injuries: none.

Right Front Passenger, Vehicle 2, 16-month-old female, 27-3/4", 17 lbs. 4 oz., strapped into GM Infant Safety Carrier seatbelted to right front seat facing backwards.

Injuries: none.

Standards

The following Traffic Safety Program Standard was relevant to this case:

TSPS 13 Traffic Control Devices: the stop sign for Driver 2 was obscured by a tree branch from a distance of 300 feet from the sign to 150 feet. No other warning signs or pavement markings (such as "STOP AHEAD") were present.

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a.

Description

Pre-Crash

Vehicle 1 was eastbound on Colorado Avenue at driver estimated speed of 25 mph; Vehicle 2 was southbound on Ross Road at driver estimated speed of 35 mph. Driver 1 noticed Vehicle 2 not stopping at stop sign on Ross road and therefore applied her brakes, and sounded the horn. Vehicle 1 left 26 feet of locked wheel skid prior to impact. Driver 2 said she was "driving automatically" and apparently did not see the stop sign. She continued through the intersection, heard the horn and looked to her right. She may have applied her brakes when she heard the horn.

Crash

Vehicle 1 impacted Vehicle 2 in the right front door near the A-pillar at a 64° angle, damaging the left corner of Vehicle 1. Vehicle 1 skidded to the right and Vehicle 2 continued driving forward stopping within 70 feet. Neither driver nor the right front passenger of Vehicle 2 were injured.

Post-Crash

Driver 1 drove her vehicle to the right side of Ross Road, south of the intersection, and exited through the left door. Driver 2 exited through the left door after checking the baby. An ambulance was requested and took Driver 2 and the baby to emergency room for a checkup.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Cause

1 Driver 2 drove through a stop sign without stopping (definite)

7 Stop sign was obscured wholly and partially by a tree branch from 300 to 150 feet before the intersection; information, therefore, did not penetrate the consciousness of Driver 2 (probable)

Severity Increasing Factors

*1 Driver 1 realized Driver 2 was not going to stop at sign, applied brakes, and sounded horn (definite)

Relevant Conditions or Modifying Factors

1 Driver 2 was inattentive to driving and says she was "driving automatically" (definite)

1 Driver 2 may have been distracted by baby (right front passenger) or by recalling items not purchased at grocery store (possible)

Injury Causation

*5 Right front passenger (baby) of Vehicle 2 was strapped into infant restraint system and was uninjured (definite)

*5 Safety glass in right door window of Vehicle 2 "crumbled" properly and even though it came into passenger compartment, it did not lacerate right front passenger (definite)

Recommendations

7 Stop sign located closer to curb or the tree branch obscuring the stop sign for southbound Ross Road should be trimmed.

E-57

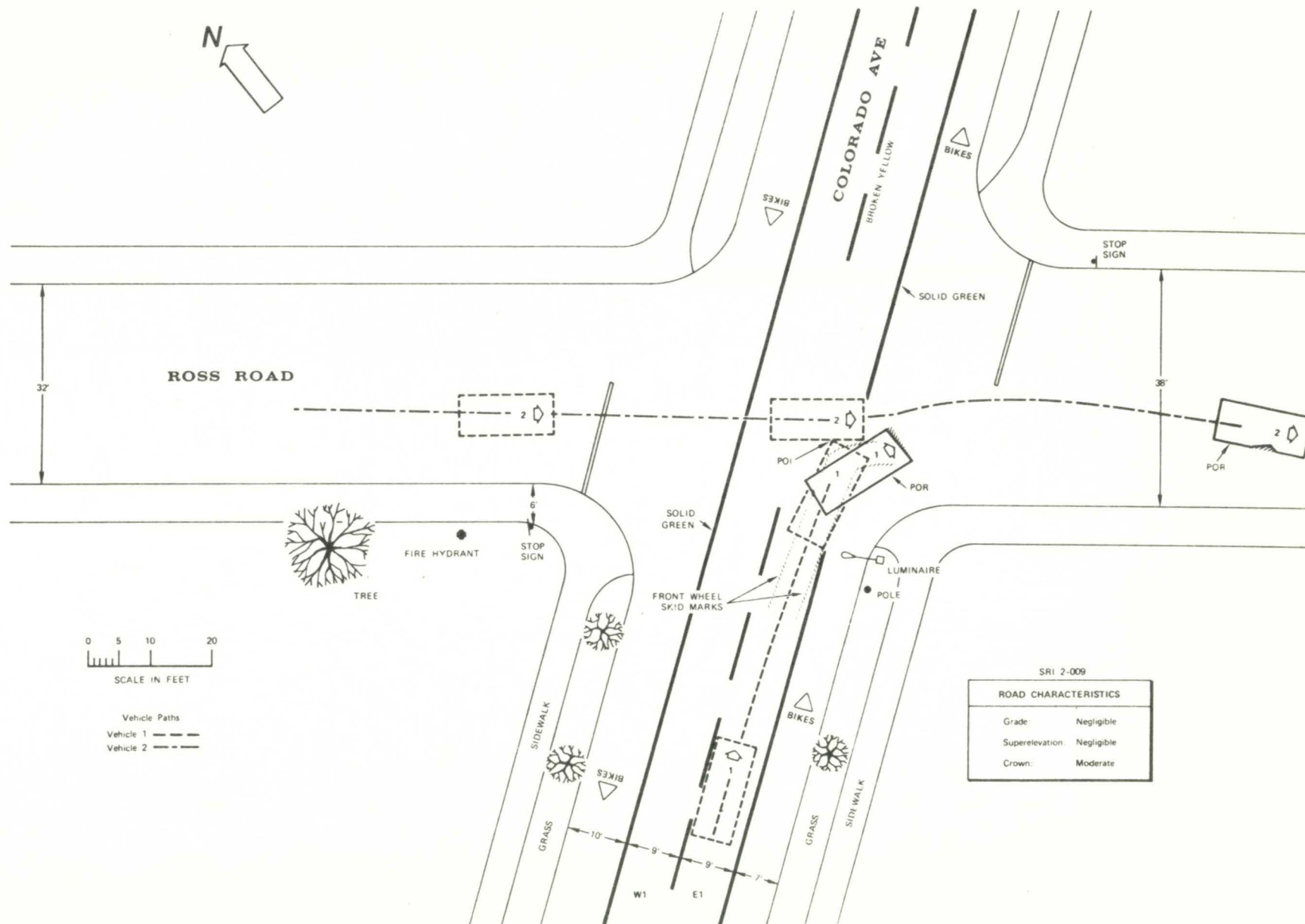


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-010

I CASE SUMMARY

(Car/Car - Headon)

Identification

Alma Street, 3100 block, Palo Alto, California, open roadway, residential area, October 15, 1972, 2300 hrs, Sunday, 2 cars headon, IP (injury producing) AIS* 1.

Ambience

Night, no precipitation, 58⁰F, 90% relative humidity, calm, visibility 10 miles, dry pavement, coefficient of friction 0.6 estimated.

Highway

Major arterial, 51.5 ft wide, 4 lanes undivided, asphaltic concrete surface, curb on east side, dirt shoulder on west side, straight, level, moderate crown, mercury vapor luminaires, 20 poles and trees, 12 driveways and 2 streets in the last $\frac{1}{4}$ mile traveled by Vehicle 1, 65 poles and trees, 16 driveways and 1 street in the last $\frac{1}{4}$ mile traveled by Vehicle 2. Eleven accidents from 1967 - October 1972 (not including this one) in the 3100 block. The average daily traffic for both directions is approximately 27,000 vehicles (1969).

Traffic Controls

Posted speed limit 35 mph, solid double yellow lines with raised amber reflectors dividing northbound and southbound lanes, broken white lines with clear reflectors separating curb and center lanes, no signals in vicinity of accident site.

Vehicles

1. Car, 1957 Lincoln Premiere 2-door hardtop, white over ocher, over 100,000 miles, California Highway Patrol inspection sticker (expired), power brakes and power steering, padded upper dashboard, no restraints, interior in poor condition, front seat back hinges broken and supported by makeshift brace, lubrication sticker dated 6-27-69.

* American Medical Association Abbreviated Injury Scale (see Collision Performance and Injury Report in Appendix B for complete description of AIS).

Damage: Hood, grille and bumper crushed, damage heaviest on right side. Right front suspension bent, right front wheel bent. No interior damage observed. CDC* 01-FZEW-2.

2. Car, 1971 Pontiac Catalina 2-door hardtop, metallic burgundy, 8,892 miles, no inspection sticker, power steering and power brakes, padded dashboard and sunvisors, 4-point restraints, no evidence of pre-crash defects, maintenance performed 4 days before accident.

Damage: Grille, front bumper and left front fender crushed, hood buckled, left front suspension bent, left front wheel bent. Damage also to headlight switch, inside control for outside rear view mirror, heater ducts, inside rear view mirror. Windshield cracked by occupant contact. Energy-absorbing steering column compressed 1.75 inches. CDC* 11-FYEW-3.

Occupants

Vehicle 1. Driver, male, no other information available. At the time of the completion of this report hit-and-run driver had not been apprehended.

Injuries: unknown, probably minor.

Vehicle 2. Driver, male, 58 years old, 66 in. (168 cm.), 159 lbs., chef, 11th grade education, 24 years driving experience, estimates miles/year at about 40,000, no driver education, previously owned 1966 Mercury; owned present vehicle 10 months, no restraints utilized, hands at 9-3 o'clock wheel position; trip plan origin motel (3 miles from accident scene), destination movie theatre to pick up daughter, ETA shortly after 2300, previously lived in area of accident and drove street of accident daily; pre-crash activity - talking, radio was on; medication - reserpine 0.25 mg for high blood pressure, no side effects.

Injuries: Bruise left forehead with possible concussion, avulsion left 4th finger. AIS 1.

Vehicle 2. RF passenger, female, 50 years old, 66 in. (168 cm.), 163 lbs., housekeeper, wife of Driver 2, no restraints utilized.

Injuries: Cut inside mouth at right side of lip, various bruises on right side of extremities, complaint of pain right side of stomach area, soreness over entire body. AIS 1.

Standards

The following Highway Safety Program Standards and Motor Vehicle Safety Standards were relevant to this case:

HSPS 2. Motor Vehicle Registration. Vehicle 1 was registered to a man who said he had sold it to someone whose name he couldn't recall. Neither he nor the buyer had filed a notice of transfer with the Department of Motor Vehicles, thus violating several sections of the California Vehicle Code and making it difficult for the police to find the new owner and possible hit-and-run driver.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a

HSPS 15. Police Traffic Services. The investigating department has no procedures manual for investigating accidents. An omission and inaccuracy were noted on the police report suggesting a need for more careful work. De-emphasis of traffic in police departments and problems with followups in other jurisdictions were also noted.

MVSS No. 111. Rearview Mirrors. Vehicle 2, breakaway mirror mounting prevented (lessened?) injury.

MVSS No. 203. Impact Protection for the Driver from the Steering Control System. Vehicle 2, energy absorbing steering column compressed 1.75 inches.

MVSS No. 204. Steering Control Rearward Displacement. Vehicle 2 engine compartment telescoping unit compressed 4.1 inches.

Description

Pre-Crash

Vehicle 1 was southbound on Alma in Lane S2 (center lane), speed unknown. Vehicle 2 was northbound on Alma in Lane N2 at a calculated speed exceeding 50 mph. Vehicle 1 slowed and started to turn left towards a driveway. Driver 2 reacted by applying his brakes and leaving 83 ft. of locked front wheel skid marks up to the point of impact. He did not try to steer out of the situation. He shouted to his wife, "We're going to hit!" His wife braced for the impact.

Crash

The two cars impacted in Lane N2 as shown in Figure 1 (collision diagram). The right front fender of Vehicle 1 first contacted the left front fender of Vehicle 2, and the front ends of the vehicles crushed until contact was made across the front of both vehicles. The impact deviated Vehicle 2's path to the right and spun Vehicle 1 around more than 180° to the left, as shown in Figure 1.

The impact caused Driver 1 to move forward and to the right in his car. Driver 1 contacted the rear view mirror and knocked it crooked. No other occupant contact points were evident in Vehicle 1. Driver 2 moved forward and to the left. Contact was made with left door hardware, dashboard controls, windshield, steering wheel and heater ducting, resulting in minor bruises and cuts. The right front passenger in Vehicle 2 also moved forward and left and made contact with the dashboard, rear view mirror and heater ducting. This passenger complained of bruises and soreness. The rear view mirror mounting separated.

Damage to both vehicles was similar. Both vehicles had extensive crushing in the grille, front bumper and hood. Damage was heaviest on the right of Vehicle 1 and the left of Vehicle 2. The right front suspension and right front wheel were bent on Vehicle 1, and the left front suspension and left front wheel were bent on Vehicle 2.

Post-Crash

After the cars came to rest Driver 1 stepped out of his car and walked over to Vehicle 2. He looked in the right front window and then ran north on Alma and was not seen again. Palo Alto Police responded to the scene and searched for Driver 1 unsuccessfully. Tow trucks arrived and removed the vehicles to a side street. Tow operators did a poor job of sweeping up glass and other debris. The occupants of Vehicle 2 were taken away by relatives who lived nearby. No first aid was required.

Causal Factors, Conclusions, and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9

Accident Avoidance	Injury Prevention	Restoration and Cleanup
-----------------------	----------------------	----------------------------

Matrix Element Description

Matrix Cell No.

(* Indicates positive factor)

Explanation

Accident Causation

Primary or Principal Causes

1 Driver 1 attempted unsafe left turn in front of Vehicle 2 (definite)

Severity Increasing Factor

1 Vehicle 2 was exceeding speed limit (probable)

Relevant Conditions

1 Driver 1 suspected of being under influence of alcohol (possible)

Matrix Element Description (Continued)

Matrix Cell No.

(* Indicates positive factor)

Explanation

Injury Causation

- | | |
|----|---|
| 2 | Driver and passenger of Vehicle 2 were not wearing available restraints, which would have reduced their injuries (definite) |
| *5 | The steering column of Vehicle 2 collapsed 1.75 inches thereby reducing driver's injuries (probable) |
| *5 | Engine compartment telescoping unit of Vehicle 2 collapsed 4.1 inches preventing rearward displacement of steering wheel (definite) and reducing driver injuries (probable) |
| *5 | Rear view mirror mount separated reducing Passenger 2A injuries (possible) |

Recommendations

- | | |
|---|--|
| 1 | Efforts to deal with the problem of the drinking driver should be continued. |
|---|--|

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-011

I CASE SUMMARY

(Car/Car - Lateral Impact)

Identification

This accident occurred at the intersection of Ravenswood Avenue and Alma Street, Menlo Park, California, commercial, October 25, 1972, 0752 hrs., Wednesday. Vehicle 1 stopped at a stop sign and then accelerated into the intersection impacting the right front fender of Vehicle 2. PD (property damage only). Figure 1 is a plan view of the accident scene.

Ambience

Day, clear, 45°F, 86% relative humidity*, no wind, visibility good, dry pavement.

Highway

Ravenswood Avenue is a minor arterial, 42 feet wide, four lanes, no median, asphalt, curb, straight, slight crown, three driveways, two sets of railroad tracks; 1 railroad crossing gate, and five poles on the south side of the road within 1/4 mile of the accident site.

Alma Street is a minor arterial, 88 feet wide on the south side of Ravenswood, four lanes, 22' median planted divider, asphalt, curbs, straight, no crown; three median accesses and 10 poles and trees on the west side of the northbound lanes, and four driveways and roads and 17 poles and trees on the east side of the northbound lanes within 1/4 mile of the accident site.

There have been 32 accidents at this site between 1969 and February 1972.

Traffic Controls

Speed limit is 25 mph on Ravenswood Avenue and on Alma Street. Opposing lanes of traffic on Ravenswood are separated by solid double yellow lines; lanes in one direction are separated by solid white lines. The railroad tracks are denoted by a "crossbuck sign" RAILROAD CROSSING, two horizontal red flashing lights, a railroad-highway grade-crossing gate and a double solid white line. The intersection with Alma is marked with words KEEP CLEAR. Crosswalks on the south and north side are denoted by solid white lines.

* Figures from Palo Alto Junior Museum weather station.

Alma Street is divided by a median. The lanes in each direction are separated by broken white lines. Parking places on the east side are denoted by solid white "crosses" on the pavement. The word ONLY with symbol arrows denoting left and straight and straight and right turns are on the pavement approximately 300' and 25' from the intersection with Ravenswood. The word STOP is on the pavement immediately before the crosswalk. Lane-use control signs with left and straight arrows and the word ONLY and straight and right turn arrows and the word ONLY are located next to the pavement marks on both sides of the northbound lanes. A stop sign is located at Ravenswood. KEEP INTERSECTION CLEAR signs are located below the lane-use control sign on both sides of the northbound lanes. A red WRONG WAY sign facing Ravenswood and a BIKE ROUTE sign are adjacent to the lane-use control signs on the west side. A ONE WAY sign for the northbound lanes is located near the end of the median.

Vehicles

Vehicle 1, car, 1972 Toyota Corolla Deluxe 1600, 2-door sedan, light blue, 10,675 miles on the odometer, no inspection sticker, power brakes, automatic transmission, padded dashboard, sunvisors, lap and upper torso restraints, high seatbacks in front, no known defects, lubrication and oil change at 7157 miles (8-8-72).

Damage: right front fender, headlight, bumper and grille area, left front fender pushed to right, wheelbase on right side shortened approximately 4 inches, torn fiber parcel tray below instrument panel lower section. CDC* 11-FDEW-2.

Vehicle 2, car, 1970 Jaquar E Type 4.2, 2-door hardtop, dark green, 32,163 miles on odometer, no inspection sticker, power brakes, air conditioning, padded dashboard, sunvisors, center armrest, lap and upper torso restraint (three-point system), head restraints, no known defects, maintenance at 30,291 miles (8-18-72).

Damage: right front fender in front of A-pillar pushed in, slight deformation and scuffing on right door. CDC 02-RYEW-2.

Occupants

Driver 1, 46-year-old female, height estimated at 65", weight estimated at 170 lbs., nurses aide, driving experience unknown (no record of California driver's license), trip plan home (3 miles from accident site) to work (total 3½ miles), vehicle familiarity unknown (purchased in May 1972), road familiarity unknown, driver education unknown, physical and mental condition unknown, restraint use unknown.

Injuries: unknown (none noted in police report).

(Note: Driver 1 would not talk to the Team.)

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J334a.

Driver 2, 16-year-old female, 64 inches (162 cm.), 110 lbs., high school student, 2 months driving experience plus driver's education with simulator experience, owned present car 2 months (previously belonged to father), lap and upper torso belt worn; trip plan origin home (11 miles from accident site), destination school to attend her first class, ETA before 0840 ($\frac{1}{2}$ mile from accident site). Has driven route of accident before but varies route; pre-crash activities, listening to radio; physical condition: flu for five days prior to accident. No medication taken. Mental attitude, good.

Injuries: none.

Standards

The following Standards were relevant to this case:

HSPS 5 Driver Licensing. Driver 1 was driving without a license and had no record of having been issued one.

MVSS 301 Fuel Tanks, Fuel Tank Filler Pipes, and Fuel Tank Connections-- Passenger Car (effective 1-1-68). The side impact to Vehicle 2, a 1970 Jaguar, caused a fitting on the fuel line to the fuel strainer (located near the A-pillar) to loosen and thus spill fuel while the engine was running.

Description

Pre-Crash

Vehicle 1 was northbound in Lane N2 on Alma Street. Driver 1 stopped at the stop sign for the intersection and then proceeded into the intersection. Vehicle 2 was eastbound in Lane E2 of Ravenswood Avenue at driver estimated speed of 20-25 mph. Driver 2 saw Vehicle 1 start up from the stop sign.

Crash

Vehicle 1 impacted Vehicle 2 at a 45° angle (due to intersection configuration) in the right front fender in front of the A-pillar, damaging the right front fender, headlight, bumper and grille of Vehicle 1. Vehicle 1 rotated 45° and moved to the right. Vehicle 2 moved to its left and Driver 2 applied her brakes. Vehicle 2 rotated 30° clockwise when viewed from above and skidded sideways leaving 16' of skids which showed up on the two words "CLEAR" and "CLEAR" but not on the asphalt. Both vehicles came to rest. Neither driver was injured.

Post-Crash

Driver 2 exited from her left door and walked over to Vehicle 1 suggesting that Driver 1 start her car and move it out of the intersection. Driver 1 was unable to start it. Driver 2 returned to Vehicle 2 and drove it to an adjacent parking lot and then returned to Vehicle 1. Driver 1 tried to start the car again, exited and then both drivers pushed it out of the intersection. Driver 2 telephoned the police and was told that a car had already been dispatched. According to communication logs, the police were not dispatched until 10 minutes after receiving notification of the accident. Vehicle 1 was towed from the scene and

Driver 1 was picked up by a friend and driven to work. Driver 2's father drove Vehicle 2 to an auto body shop and then took Driver 2 to school. A leakage was noted at the right A-pillar and was later learned to be fuel leaking from a loosened fuel line fitting at the fuel strainer.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Cause

1 Driver 1 failed to yield to oncoming traffic in the intersection. (definite)

Relevant Conditions or Modifying Factors

7 Intersection is congested during rush hours. (definite)

1 Congestion at the intersection causes drivers attempting left turns from Alma onto Ravenswood during rush hours to ease out into the intersection forcing through traffic to yield. (definite)

Post-Crash Factors

6 The impact in front of the right A-pillar of Vehicle 2 caused a fuel line fitting on the fuel strainer to loosen and allow fuel spillage while the engine was running. (definite)

Matrix Cell Description (Continued)

Matrix Cell No.

(* indicates positive factor)

Explanation

Post-Crash Factors (Continued)

3

The father of Driver 2 drove the vehicle in this condition to a nearby body shop without determining the leaking substance. (definite)

Recommendations

6

Even though no fire resulted from the fuel spillage from Vehicle 2, the location of the fuel strainer makes it vulnerable to lateral impacts.

FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-012

I CASE SUMMARY

(Car/Car - Rear End)

Identification

This accident occurred adjacent to the intersection of Watkins Street on El Camino Real, Atherton, California, commercial, November 13, 1972, 1430 hrs, Monday, 2 cars--rear end, PD (property damage only). Figure 1 is a plan view of the accident scene.

Ambience

Day, heavy rain, 58^OF, humidity 100%, wind 10 knots from SSE, visibility less than $\frac{1}{4}$ mile, road surface wet, estimated coefficient of friction 0.5 or less.

Highway

El Camino Real, major arterial road, total pavement width 79 ft, 6 lanes, median divider consisting of a pair of solid double yellow lines 4 ft apart with concrete median blocks, asphaltic concrete surface, 8.5 ft asphalt shoulder on west side, no shoulder on east side but N1 lane 18 ft wide, straight, level, 8" crown, 8 driveways, 4 streets, and 12 poles in last $\frac{1}{4}$ mile traveled by both vehicles, accident history for intersection: 1969, 8 accidents (1 injury producing); 1970, 2 (1 IP); 1971, 3 (1 IP); 1972 to October, 2, for a total of 15 accidents (3 injury producing) from 1969 through October 1972.

Traffic Controls

Posted speed limit 35 mph, lanes separated by raised buttons and broken white lines, traffic signals at intersections 1700 ft north and 2700 ft south of accident location.

Vehicles

1. Car, 1973 Ford Pinto Runabout 2-door coupe, dark green, 422 miles, no inspection sticker, no power accessories, padded dashboard, steering wheel hub and sunvisors, 3-point restraints with detachable upper torso restraint for both front seat occupants, integral head restraints, 5 mph bumper, no evidence of pre-crash defects, too new for maintenance.

Damage: Grille broken, hood and left front fender buckled, left headlight broken, hood latch released, bumper slightly bent. Left door prevented from opening fully by front fender. No interior damage observed. CDC* 12-FDMW-1

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a

2. Car, 1972 Ford Pinto Squire, 2-door station wagon, yellow with simulated wood, 312 miles, no inspection sticker, no power accessories, padded dashboard, steering wheel spokes and sunvisors, 3-point restraints with detachable upper torso restraint for both front seat occupants, integral head restraints, no evidence of pre-crash defects, too new for maintenance.

Damage: Tailgate pushed in, rear bumper bent, fuel tank dented and leaking, both rear fenders buckled, glass on right side between B and C pillars shattered, B-pillars moved forward about $\frac{1}{4}$ inch, right roof side rail buckled, floor of rear compartment buckled, tailpipe bent. CDC 06-RDEW-2.

3. "Phantom vehicle," car, unknown make, contributed to accident occurrence, but not contacted by either Vehicle 1 or Vehicle 2.

Occupants

Vehicle 1. Driver, male, 26-years-old, 66" (168 cm), 165-170 lbs, single, occupation messenger-bond investigator-customer service, equivalent 2 years college, 7 years driving experience, estimated miles/year last year 15,000 personal and 15,000 company, previous year, 6,000-8,000, driver education in high school 1962-3, personal car 1966 Sunbeam Alpine. Accident vehicle: company owned, 6 days. Trip plan: round trip from business office in Redwood City to Stanford (accident occurred 2.5 miles from destination), no ETA, purpose pick up a check, area familiarity 1-2 times/week, glasses required, lap restraint used, radio on.

Injuries: soreness at sternum, left side of abdomen, tightness in neck and shoulders, scrape on knuckles of right 4th finger. AIS* 1.

Vehicle 2. Driver, female, 39-years-old, 63 $\frac{1}{2}$ " (161 cm), 100 lbs, married, housewife, BA degree, 22 years driving experience, about 10,000 miles/year, driver education in high school 1950, trip plan: beauty parlor (less than $\frac{1}{2}$ block from accident) to home, no ETA. Vehicle owned two weeks, driven 312 miles, drives road everyday, that particular area once/week, lap restraint only.

Injuries: "whiplash" bump on back of head 2" from top, slight soreness of inside left arm. AIS 1.

Vehicle 2. Right front passenger, female, 9-years-old, 51" (129 cm), 65 lbs, daughter of Driver 2, lap restraint only.

Injuries: "Bump" on right index finger. AIS 0.

Standards

The following Motor Vehicle Safety Standards were relevant to this case:

MVSS No. 215 Exterior Protection. Vehicle 1, although equipped with bumper guards, completely underrode Vehicle 2's rear bumper, and caused damage to fuel tank.

* American Medical Association Abbreviated Injury Scale (AIS) (See Appendix A for complete description)

MVSS No. 301 Fuel Tanks, Fuel Tank Filter Pipes, and Fuel Tank Connections. Vehicle 2's fuel tank vulnerable to damage in rear end collisions, not covered by standard.

Description

Pre-Crash

Vehicle 2 (Pinto Squire) entered northbound El Camino less than 1 block south of Watkins and proceeded in Lane N3 (see Figure 1, Collision Diagram), stopping at Watkins in preparation for making a U-turn. Vehicle 1 (Pinto Runabout) and Vehicle 3 (phantom vehicle) were northbound in Lane N3 at a speed of approximately 25-30 mph. Vehicle 1 was following 3-4 car lengths behind Vehicle 3, according to Driver 1. Vehicle 3 suddenly changed lanes to avoid collision with stopped Vehicle 2. Driver 1 was unable to see to change lanes because his rear window was fogged up. Driver 1 applied his brakes hard and locked the wheels.

Crash

Vehicle 1 skidded into the rear of Vehicle 2. The front bumper of Vehicle 1 went under the rear bumper of Vehicle 2, the bumper guard denting Vehicle 2's fuel tank causing a fuel leakage. The grille, hood, and left headlight of Vehicle 1 were damaged. Driver 1 contacted steering wheel hub but was not injured. Driver 2 hit her head on the head restraint causing local swelling. The RF passenger in Vehicle 2 was not injured.

Post-Crash

Driver 1 turned off the ignition and stepped from his car. He walked to Vehicle 2 and talked with Driver 2. Police were called by a person who heard the crash. The police directed traffic and assisted Drivers 1 and 2 in removing the vehicles from the road. Tow trucks arrived, and the tow drivers swept the glass from the road. Leaking fuel from Vehicle 2 was washed away by the heavy rain. Both cars were towed from the scene.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Cause

- | | |
|---|---|
| 1 | Driver of Vehicle 3, phantom vehicle, made sudden lane change to avoid collision with stopped Vehicle 2. (definite) |
| 7 | Phantom vehicle obstructed Driver 1's view of Vehicle 2. (definite) |
| 1 | Driver 1 was following too closely to phantom vehicle for conditions. (probable) |
| 1 | Driver 1 had attention only on vehicle directly in front of him and not on others beyond. (probable) |

Severity Increasing Factor

- | | |
|---|---|
| 7 | Rain was falling and pavement was wet. (definite) |
|---|---|

Relevant Conditions

- | | |
|---|---|
| 4 | Side windows and backlight of Vehicle 1 were fogged up, preventing Driver 1 from seeing if lane change was possible. (definite) |
|---|---|

Injury Causation

- | | |
|----|--|
| 5 | Driver 2 contacted head restraint, which caused local swelling on back of head. |
| *5 | Driver 1 reported only soreness of sternum from contacting steering wheel hub. |
| *4 | Seat belt buzzer system caused Driver 2 to use the lap belt. She claims "you have to use the seat belt because of that horrible buzzing."
(It had no effect on injury or noninjury in this case however.) |

Recommendations

- | | |
|---|--|
| 4 | Vehicles should be equipped with rear window defrosters as standard equipment. |
|---|--|

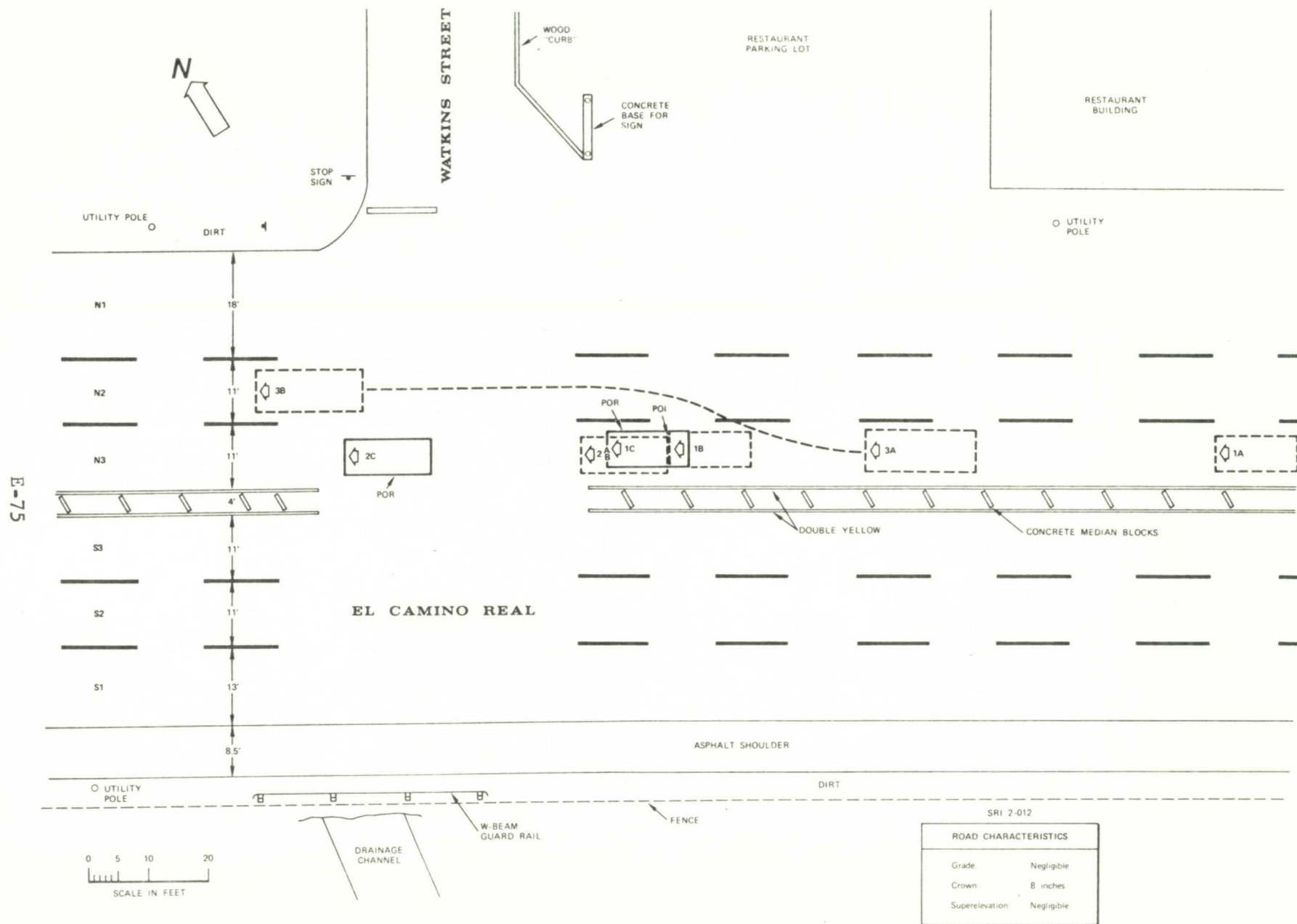
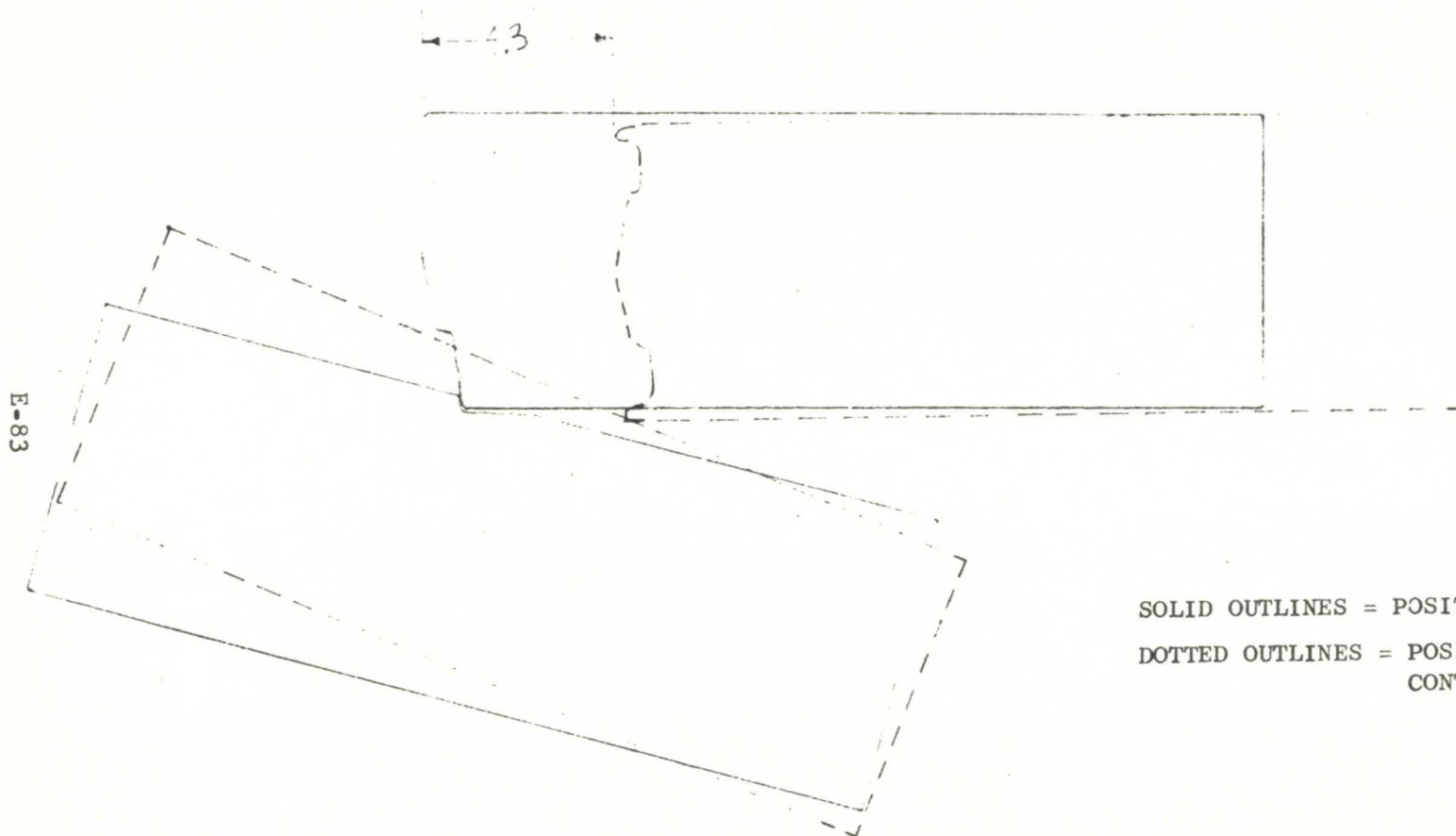


FIGURE 1 COLLISION DIAGRAM



SOLID OUTLINES = POSITION OF VEHICLES AT REST
DOTTED OUTLINES = POSITION OF VEHICLES AT FIRST
CONTACT

FIGURE 2. COLLISION CONFIGURATION

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-014

I CASE SUMMARY

(Single Car--Rollover)

Identification

Interstate Highway 280, southbound lanes, 3500 ft. north of El Monte exit, Los Altos Hills, California, open roadway, residential area, November 30, 1972, 1435 hours, Thursday, 1 car rollover, IP (injury producing) AIS* 2.

Ambience

Day, no precipitation, 61°F, 66% relative humidity, clear, 5 miles visibility with haze and smoke, wind 330° at 6 miles/hour, dry pavement.

Highway

Interstate 280, freeway, 150 ft. wide, 8 lanes, median divider is 15 ft. wide dirt and gravel bank with bushes, northbound lanes approximately 5 ft. below southbound lanes, asphaltic concrete surface, paved shoulders adjacent to fast and slow lanes, asphalt curb on right edge, straight, 4% downgrade, negligible crown, last on ramp three miles from accident scene, no poles or trees close to roadway.

Fourteen accidents occurred on southbound 280 one-half mile north and south of this accident from 1969 through 1971: 7 injury; 1 fatal; 10 involved hit objects; 3 overturned; and 1 rear-end.

Traffic Controls

Speed limit 65 mph, double yellow line and amber reflectors delineating edge of fast lane, broken white lines, raised white buttons and "retromarker" reflectors separating lanes, solid white delineator at edge of slow lane, no signs, no signals.

Vehicle

Car, 1970 Volkswagen Squareback, 2-door station wagon, orange, 40,707 miles, California Highway Patrol inspection sticker exp. date 12-31-72, no power restraints, no evidence of pre-crash defects but possible low left rear tire pressure, routine maintenance performed 8 days before accident.

Damage: Rollover damage to roof and sides, right rear wheel bent severely, windshield, backlight, and right rear side window separated, driver's side window shattered. CDC** 00-TZGO-1

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

** Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a

Occupant

Vehicle 1. Driver, male, 48 years old, 71" (180 cm), 170 lbs, seaman, 12th grade education, 28 years driving experience, average of 5,000 miles/year, no driver education, previously owned '59 VW, has owned present vehicle about 3 years, three-point restraint system utilized, trip plan San Francisco union hall and mother's home, destination home, no ETA, accident occurred 33-35 miles from San Francisco, 6½ miles from destination, drives route once/week when home (4-5 months/year), 2nd day back from sea duty, pre-occupied with thoughts, no medication, physical health good.

Injuries: Undisplaced fracture of the proximal end of left clavicle; contusions on thighs, chest, left calf. Abrasions on left shoulder and left index finger. Sore and stiff over entire body. (X-ray slide included in Appendix B.) AIS 2.

Standards

HSPS 16. Debris Hazard Control and Cleanup. Cleanup operations were minimal with broken glass left on the shoulder of the road.

MVSS No. 201. Occupant Protection in Interior Impact. Padded sunvisor prevented more severe hand injury.

MVSS No. 205. Glazing Materials. This prevented the windshield from shattering over driver.

MVSS No. 208. Seat Belt Installation. The use of the complete restraint system held the driver in place probably preventing more severe injuries.

Description

Pre-Crash

Vehicle 1 was southbound in Lane S4 on Interstate Highway 280 at a driver estimated speed of 65-70 mph. Driver 1 was preoccupied with his thoughts as he negotiated a curve at the crest of a hill. As he rounded the curve, he was startled to see a highway maintenance truck (Truck 1) on the narrow left shoulder of the road. He swerved to the right and then to the left in order to return to Lane S4 when he saw a second smaller maintenance truck (Truck 2) parked about 90 feet ahead of the first truck. He applied his brakes and swerved again to the right.

Crash

The vehicle began to oversteer strongly as a result of the steering and braking. A possible contributing factor was low air pressure in the left rear tire. The vehicle started to spin until it was almost broadside to its direction of travel, and then rolled over (Figure 1). The vehicle continued to spin in a clockwise direction as viewed from above, rolled onto its right side and impacted the curb at the edge of the road. The impact crushed the lower right rear corner of the body and bent the right rear wheel rim, causing the tire to deflate. The vehicle then slid along the curb as evidenced by orange paint on the curb. It then went into the dirt area at the edge of the road and, right side up again, rolled

or slid into a 6-foot high shrub and onto an above-ground sprinkler pipe adjacent to the shrub before coming to rest. The driver, with full restraint systems worn snugly, stayed in the seat. As the car rolled and slid on its left side the weight of the driver shifted his upper torso probably causing the fracture of the clavicle and the scraping of his left shoulder on the pavement. An indentation in the left sunvisor was probably caused by his hand contacting it. His upper thighs contacted the steering wheel when the car was upside down, causing contusions.

Post-Crash

Division of Highways maintenance men from Truck 2, who had seen the accident, took flares and a first aid kit and proceeded across the road to Vehicle 1. The flares were not used, however, because Vehicle 1 was well off the roadway. Driver 1 removed his restraints and exited the car through the left door. Three cars stopped but were asked to leave the scene by the maintenance men with one being asked to call the Highway Patrol. Meanwhile, a resident in a house overlooking the freeway had called the police. Two Santa Clara Sheriff's units arrived. They placed a gauze bandage on Driver 1's shoulder wound and called the Highway Patrol. One CHP unit arrived at the scene. The maintenance men left. A tow truck arrived and pulled Vehicle 1 back to the road, damaging another shrub in the process. Driver 1 was taken to his doctor by the CHP.

Causal Factors, Conclusions and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factors)

Explanation

Accident Causation

Primary or Principal Causes

- | | |
|---|---|
| 7 | Division of Highways maintenance trucks parked in median close to fast lane. (definite) |
| 1 | Driver 1 overreacted to presence of trucks in median. (definite) |

Severity Increasing Factor

- | | |
|---|---|
| 4 | Left rear tire pressure low. (possible) |
|---|---|

Relevant Conditions

- | | |
|----|--|
| *9 | Traffic was light. (definite) |
| 7 | Median parking area is only 8 feet wide, the same width as a large truck. (definite) |
| 1 | Driver 1 was preoccupied with his thoughts. (definite) |

Injury Causation

- | | |
|----|--|
| *2 | Driver 1 was wearing his restraint system. |
| *5 | High seat backs afforded protection from loose objects flying around in rear. (probable) |
| 5 | Shoulder restraint caused fractured clavicle. (probable) |
| *5 | Restraint system prevented driver from being ejected. (possible) |

Recommendations

- | | |
|---|--|
| 7 | Highway maintenance trucks should park completely away from travel lanes. |
| 7 | Consideration should be given in highway design to space needed by maintenance trucks. |

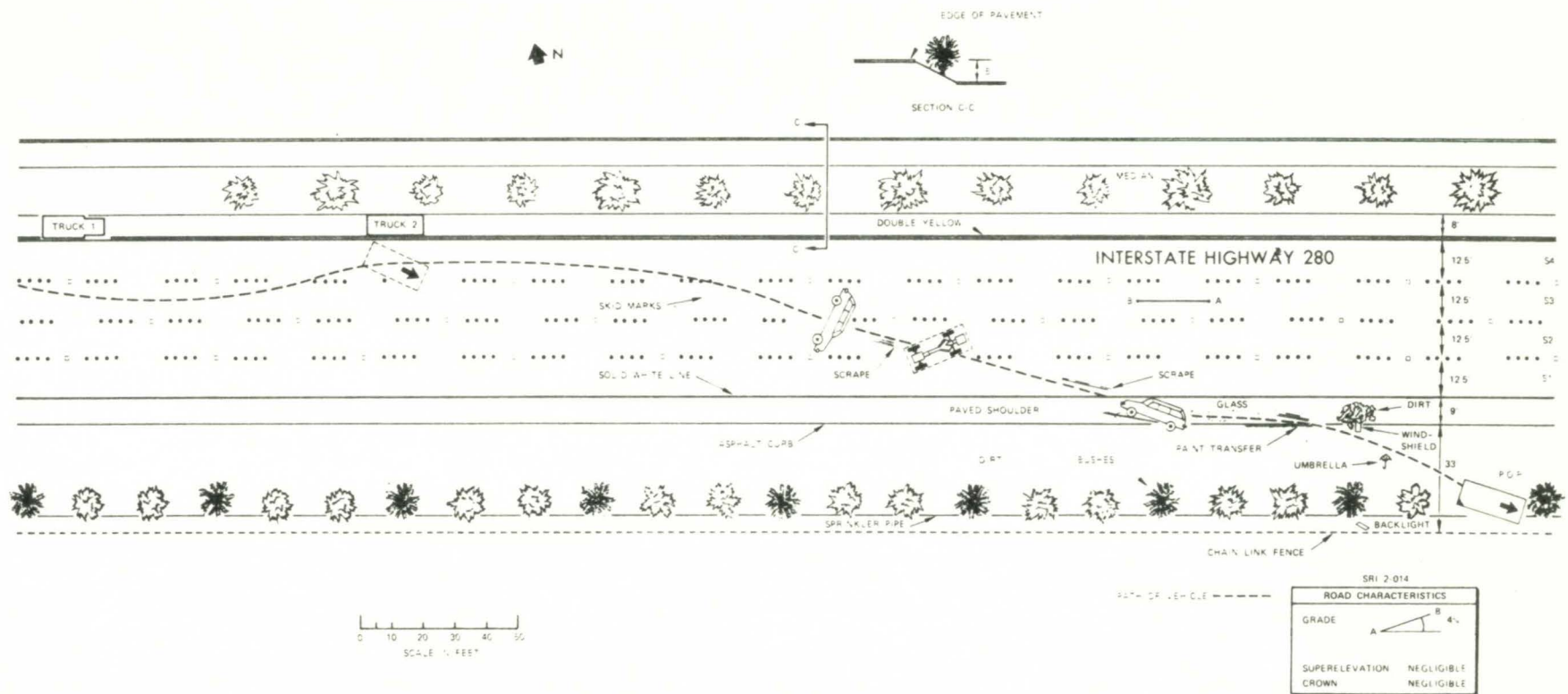


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-015

I CASE SUMMARY

(Car/Car/Fence - Sideswipe)

Identification

This accident occurred at the intersection of Alma Street and Churchill Avenue, Palo Alto, California, residential, December 18, 1972, 1420 hrs., Monday, 2 cars - sideswipe, IP (injury producing). AIS* 1. Vehicle 1 was waiting to turn left from northbound Alma; Vehicle 2 was southbound on Alma and Driver 2 looked back to try to change to slow lane to avoid left fender of Vehicle 1 in his lane. When he looked forward, Vehicle 1 had started the turn and impacted Vehicle 2 in left front, left front fender, and left door. Figure 1 is a plan view of the accident scene.

Ambience

Day, 60°F, wind 340° at 2 mph, 1-1/2 miles visibility with light fog, partly cloudy. Dry pavement.

Highway

Alma Street, major arterial, 45 ft. wide, 4 lanes plus left turn lanes at Churchill intersection, no divider, asphaltic concrete surface, concrete curbs on both sides, straight, no grade or superelevation, 8" crown, 14 driveways, 2 streets and 43 poles/trees in last 1/4 mile traveled by Vehicle 1, 13 driveways, 2 streets and 40 poles/trees in last 1/4 mile traveled by Vehicle 2.

Churchill Avenue is a minor arterial 36 feet wide, 2 motor vehicle lanes and 2 bike lanes, has railroad grade crossing near Alma Street. The road slopes from level on Churchill before the intersection 4% upward to the raised track bed. Accident history of intersection: 1969, 10 (1 injury producing); 1970, 10 (1 I.P.); 1971, 11 (1 IP); 1972, (to October) 8 (5 IP); total 39 (8 IP); 31% of the accidents involved N/B Alma vehicles turning left to W/B Churchill and colliding with S/B Alma vehicles (same as this accident).

Traffic Controls

Posted speed limit on Alma 35 mph, travel lanes separated by broken white lines and raised reflectors, north and southbound lanes divided by solid double yellow lines and amber reflectors, left turn lanes delineated by solid white lines, white pedestrian crosswalk lines and green bike lane marking at Churchill, no signs, traffic signals actuated by Churchill traffic (otherwise stays green

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

for Alma), cycle lengths: Alma, initial green 8 seconds, vehicle extension 3 sec, maximum green 65 sec (on weekdays 7-9 a.m., 11:30-1:30 p.m., 4-6 p.m.), yellow 4 sec, all red 2 sec; Churchill, initial green 6 seconds, vehicle extension 3.5 sec, maximum green 55 sec (above times), yellow 3 sec. Railroad crossing signal also activates traffic signals since crossing is close to Alma.

Vehicles

Vehicle 1, car, 1965 Rambler Classic 550 4-door sedan, tan, 36,727 miles, no inspection sticker, no power accessories, no padded components except "add-on" head restraints, lap restraints only, no apparent defects, routine maintenance performed.

Damage: Severe localized crush to left front fender, left end of front bumper, and inner fender well. Battery case cracked and leaking acid. No visible interior damage. CDC* 12-FLEE-2.

Vehicle 2, car, 1972 Volvo 164E, 4-door sedan, dark blue, 6,723 miles, no inspection sticker, power steering and power brakes, padded dashboard and sunvisors, head restraints, 3-point restraints with single inertia reel for lap and shoulder belts, no apparent defects, routine maintenance performed.

Damage: Sideswipe damage from left headlight to left B-pillar, maximum penetration 8 inches. Windshield cracked, and upper and lower A-pillar damaged. Under-dash mounted air conditioning unit dropped down, apparently because of impact, not occupant contact. CDC 11-LYES-2 (primary), 11-FLMS-1 (secondary).

Occupants

Driver 1, 74-year-old female, height 63", weight 120 lbs., retired, driving experience 50 years at estimated 5,000 miles/year, trip plan home to department store (2-1/4 miles, accident occurred 3/4 mile from home), owned vehicle since 1965, not usual route (has turned left at intersection only 3 times before). Learned to drive from neighbor, wears glasses, lap restraint used, no injuries.

Driver 2, 32-year-old male, 72", 195 lbs., occupation medical doctor, 18 years driving experience at estimated 20,000 miles annually due to long commute distance to work (previous year driving at 12,000 miles), trip plan home to film processor to electronics store to home: a total round trip of 6-3/4 miles (last leg, store to home, 2-3/4 miles) with ETA slightly after time accident occurred (Driver 2 was 3/4 miles from store when accident occurred) uses route daily, learned to drive from father, had cold previous weekend, no mental problems or real worries ("just day-to-day stresses"), used three-point inertia reel system, head restraint adjusted in middle position.

Injuries: sore left shoulder, no bruises. (Occupant contact left knee hit by air conditioning unit which fell out at impact, no bruises.) (Former break at neck of humerus not aggravated.) AIS 1.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

Standards

HSPS 9. Identification and Surveillance of Accident Locations. Once identified, solutions must be sought for accident locations.

HSPS 13. Traffic Control Devices. Traffic control solutions for this intersection should be studied to determine the best cost-benefit improvements.

MVSS 208. Occupant Crash Protection. The inertia reel restraint system on Vehicle 2 is comfortable and seems to encourage restraint use.

Description

Pre-Crash

Vehicle 1 was northbound on Alma approaching Churchill. Driver 1 intended to make a left turn on Churchill. She entered the intersection from the left turn lane and stopped with her front bumper partially obstructing Lane S2. Vehicle 2 was southbound on Alma in Lane S2 at a driver-estimated speed of 35 mph. Driver 1 misjudged the speed and/or distance of Vehicle 2, and started up, attempting to complete her left turn when Vehicle 2 was only 60-70 ft. away. Driver 2 had already started moving to the right slightly to go around Vehicle 1, when he saw Vehicle 1 start to turn in front of him. Driver 2 applied his brakes with his left foot and simultaneously floored the accelerator with his right foot. The front wheels locked. Vehicle 2 left approximately 20 feet of skidmarks.

Crash

The vehicles impacted left front corner to left front corner. Vehicle 2's path was deflected as shown in Figure 1, and Vehicle 2 was damaged along the left side from the front end to the B-pillar. Vehicle 1's front fender was crushed and buckled. Vehicle 1 was pushed backward slightly by the impact, and Vehicle 2 continued skidding and came to rest against a small chain-link fence post at the southwest corner of the intersection. Driver 1 did not recall hitting the interior of her vehicle. Driver 2's left shoulder impacted the inside of the left door. The air-conditioning unit was knocked off and impacted Driver 2's left knee.

Post-Crash

Driver 1 exited through left door, leaving her car in the intersection and walked over to Driver 2 to see if he was all right. Driver 2 was shaken and decided to remain seated in his vehicle, which was not obstructing traffic. A neighbor asked Driver 2 if he was hurt, and even though he said no, she called an ambulance.

The first police to arrive were plain clothes men. They directed traffic until a uniformed officer arrived, who began his investigation after traffic was under control. A tow truck removed Vehicle 1 from the intersection to the side of the road. A second truck pulled Vehicle 2 away from the fence. Debris was swept up. Driver 1 was charged with violation of CVC 21801A, failure to yield. She forfeited bail.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Clean-up

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Cause

1 Driver 1 attempted unsafe left turn in front of Vehicle 2. (definite)

Relevant Conditions

1 Driver 1 did not travel this route often. (definite)

7 Congestion and delay at intersection leads drivers to accept lower than normal safe gaps for turning movements. (probable)

Injury Causation

*2 Driver 2 was wearing restraints. (definite)

*5 Vehicle 2 was equipped with a convenient 3-point restraint system using an inertia reel. (definite)

Post-Crash Factors

6 Both vehicles came to rest blocking traffic. (definite)

Matrix Element Description (Continued)

Matrix Cell No.

(* indicates positive factor)

Explanation

Recommendation

7

Obtain funding to systematically study the capacity-service-safety relationships for this and similar locations in the city and to present recommendations for improvements to the city council.

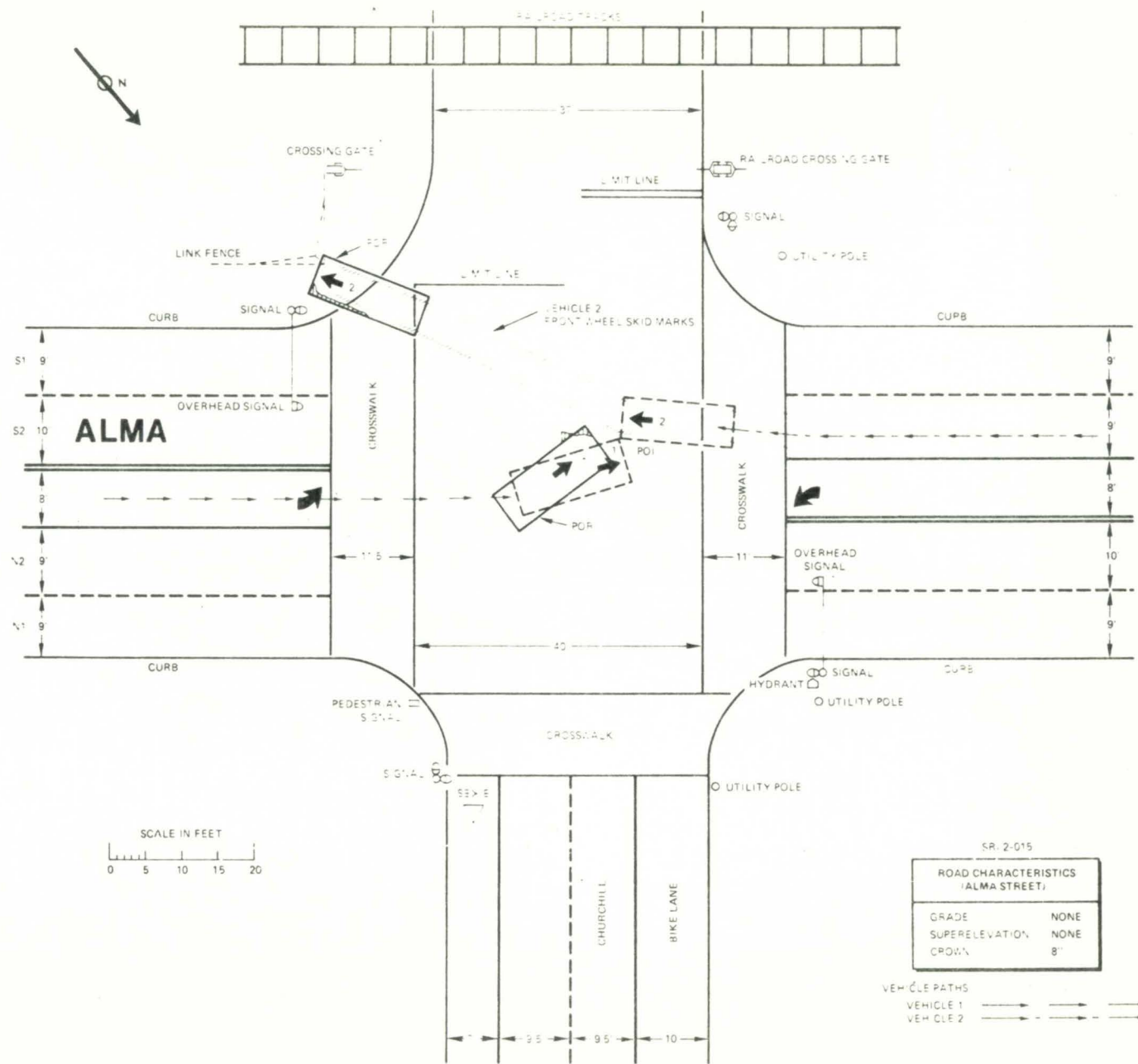


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-016

I CASE SUMMARY

(Car/Car-Intersection Oblique Headon)

Identification

This accident occurred at the intersection of Lytton Avenue and Alma Street, Palo Alto, California, commercial area, January 3, 1973, 1515 hours, Wednesday. Vehicle 1 attempted a left turn in front of oncoming Vehicle 2. Impact was oblique headon. PD (property damage only). Figure 1 is a plan view of the accident scene.

Ambience

Day, precipitation negligible, 51°F, 61% relative humidity, cloudy, visibility good, wind 270° at 10 mph, dry pavement.

Highway

Alma Street, major arterial, 52 ft wide north of intersection with Lytton, 50 ft wide south of intersection, 2 traffic lanes and 2 bike lanes north of intersection, 4 traffic lanes south of intersection, no divider, asphaltic concrete pavement, Portland cement concrete curbs, straight, level, 4-6 in. crown, 3 streets, 9 driveways and 60 poles/trees in last 1/4 mile traveled by Vehicle 1, 3 streets, 7 driveways and 20 poles/trees in last 1/4 mile traveled by Vehicle 2. Number of accidents at intersection: 1969, 7(2 injury producing); 1970, 4; 1971, 6; 1972(to July), 2 (2 IP); for a total of 19(4 IP) from 1969 to July 1972.

Traffic Controls

Posted speed limit 25 mph, double yellow lines separating northbound and southbound lanes, solid white pedestrian crosswalks and green lines marking bike lanes, pavement arrows designate right turn only lane, traffic signal actuated by Lytton traffic (otherwise stays green for Alma), cycle lengths: Alma, initial green interval 32.5 sec, no vehicle extension, no maximum interval, yellow 4 sec; Lytton, initial green 4.5 sec, vehicle extension 4.5 sec, maximum interval 31 sec, yellow 4 sec.

Vehicles

Vehicle 1, car, 1971 Ford Pinto 2-door coupe, red, 24,144 miles, no inspection sticker, no power accessories, padded dash and sunvisors, 3-point restraints, no evidence of pre-crash defects, routine maintenance performed.

Damage: Front bumper bent, hood buckled, grille shattered, air conditioning condenser and radiator pushed back, possible distortion of body affecting fit of doors, no interior damage observed. CDC* 01-FDEW-2.

Vehicle 2, car, 1968 Dodge Dart 270 2-door hardtop, green, 57,981 miles, no inspection sticker, no power accessories, padded dash and sunvisors, 4-point restraints, no evidence of pre-crash defects, routine maintenance performed.

Damage: Left front fender buckled, front bumper bent, headlight mounting broken, no interior damage observed. CDC 12-FLEW-1.

Occupants

Vehicle 1, driver, male, 18 years old, 69 in., 235 lbs., single, hobby--photography, student (college freshman), 6 months driving experience, driven 6,000 miles (in case vehicle) in 6 months, commercial driving course at 16 years, two behind-the-wheel refresher courses before passing driving test, was out of the state for health reasons spring 1972 (details unknown), has weight problem, under no medication, is confused about his future, was preoccupied in thought at time of accident, pre-crash activity--ate late lunch 30 minutes before accident; trip plan--Menlo Park, destination drug store to shop, no ETA, accident occurred 1-3/4 miles from origin, has driven route 2-3 times/week for 4 months, torso and lap restraints utilized.

Injuries: none.

Vehicle 2, driver, female, 29 years old, 66 in., 110 lbs., housewife, married, bachelor's degree, hobbies--gourmet cooking and skiing, 13 years driving experience, average 2,600 miles/year, no driver education, owned Dodge (case vehicle) 5 years, also drives '61 or '62 Mercury, hands at 10 - 2 o'clock wheel position; trip plan - origin nursery school (2-3/4 miles from accident), destination - baby sitter's to pick up child, ETA 1530 hours; drives route once/week, resident of peninsula 2 years, pre-crash activities - participating in nursery school afternoon activity, talking to children in car, general feeling of well being, lap restraint utilized, available torso restraint not worn.

Injuries: none.

Right Center Rear Passenger, Vehicle 2, female, 4 years old, 40 in., 29 lbs., standing on floor, daughter of driver.

Injuries: none.

Left Center Rear Passenger, Vehicle 2, male, 4 years old, 41 in., 35-40 lbs., standing on floor, friend of driver.

Injuries: none.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

Standards

The following Highway Safety Program Standards and Motor Vehicle Safety Standards were relevant to this case:

HSPS 10. Traffic Records. Some information on police report incorrect.

MVSS 207. Anchorage of Seats. Passengers in back and Driver 2 were uninjured because locking device prevented seat back from coming forward.

Description

Pre-Crash

Vehicle 1 was southbound on Alma approaching Lytton. Vehicle 2 was northbound on Alma in Lane N2 approaching Lytton. Vehicle 1 slowed to make a left turn onto Lytton. Driver 2 saw Vehicle 1 but assumed that it would stop. When Driver 2 saw that Vehicle 1 was not stopping, she applied her brakes. Vehicle 2 left 28 ft of locked-wheel skidmarks up to the POI.

Crash

The left front corner of Vehicle 2 impacted the front end of Vehicle 1 about one ft. to the right of center. Vehicle 1 was pushed backward about 4 ft. The grille, bumper, hood, air conditioning condenser and radiator of Vehicle 1 were damaged. Vehicle 2 sustained moderate damage to the left front fender and left headlight area.

Post-Crash

Both vehicles were at rest in the middle of the intersection. Traffic was able to move around them. Both drivers got out of their vehicles, and Driver 1 called police, who arrived and began directing traffic. Both cars were towed from the scene. Driver 1 walked from the scene, and Driver 2 and her passengers left the scene with Driver 2's husband. Driver 1 was cited for violation of CVC 21801A, failure to yield.

Causal Factors, Conclusions and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Causes

1

Driver 1 attempted unsafe left turn. (definite)

Relevant Conditions

1

Driver 1 preoccupied with his thoughts. (definite)

Injury Causation

* 2

Driver 1 was wearing lap and shoulder restraints.
(definite)

* 2

Driver 2 was wearing lap belt. (definite)

*5

Locking seat backs in Vehicle 2 prevented
standing rear passengers from coming into front
seat area upon impact.

Recommendations

1

It is difficult to imagine any measure that
could be taken to alleviate the problem of the
inattentive or preoccupied driver.

E-101

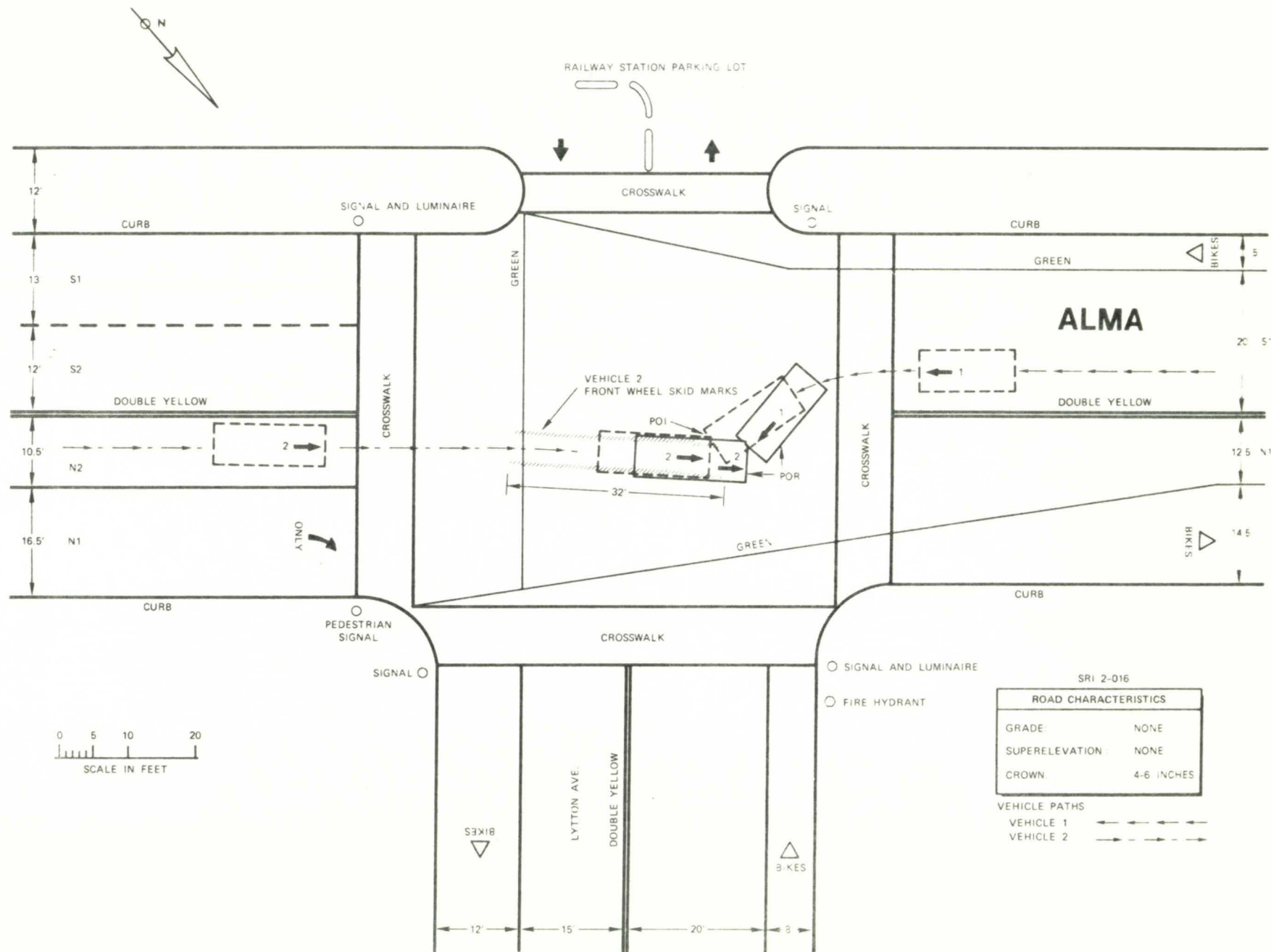


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-017

I CASE SUMMARY

(Car - Rollover)

Identification

This accident occurred on southbound U.S. Route 101 (Bayshore Freeway) on the overpass at Ellis St. (approx. milepost 47.0), Mt. View, California, open roadway, commercial area, January 16, 1973, 1610 hours, Tuesday, 1 car ran off the road, went down an embankment and rolled over, IP (injury producing). AIS* 4. Figure 1 is a plan view of the accident scene.

Ambience

Day, 61°F, 76% relative humidity, winds out of the west at 10 knots, cloudy, visibility good, dry pavement.

Highway

U. S. 101 is a freeway, 150 ft wide including shoulders, 6 lanes, 56 ft wide dirt median divider with post and cable barrier, Portland cement concrete surface, 8 ft wide asphaltic concrete shoulder with 8 in. curb, 26° slope dirt embankment slopes down from curb, straight roadway, 3% downgrade, one off-ramp, 3 poles, no trees in last ¼ mile traveled by Vehicle 1. Number of accidents for southbound U.S. 101 between mileposts 46.5 and 47.5: 1969, 12(4 injury producing); 1970, 17(7 IP); 1971, 21(3 IP).

Traffic Controls

Speed limit 65 mph, lanes separated by broken white lines with white buttons and raised reflectors, sign at last off-ramp, no signals.

Vehicle

1. Car, 1970 Chrysler New Yorker, 2-door hardtop, tan, 21,773 miles, no inspection sticker, power steering and power brakes, padded dashboard and sunvisors, head restraints in down position, 4-point restraints, seat belts on floor behind seat, no evidence of pre-crash defects, complete tune-up performed 3 months before accident.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Damage: Roof and both A-pillars crushed, windshield cracked, numerous scrapes and dents on sides, separated motor mount, evaporative emission control line disconnected and leaking fuel. Both left side wheels bent from curb contact, left front tire deflated. All side window glass shattered. No observable damage from occupant contact. CDC* 00-TPGO-5, primary; CDC 09-LBMW-1, secondary.

Occupant

Vehicle 1. Driver, male, 56 years old, 73", 155 lbs, quality engineer, 7th grade education, hobby--fishing, 39 years driving experience, averaging 21,000 miles/year, no driver education, usually drives Plymouth Cricket, owned '70 Chrysler for 2½ years, no restraints used, trip plan: San Francisco place of work (left at 1530) to home in Santa Clara, ETA 1630 hours, accident occurred 34 miles from origin - 7-3/4 miles from destination, drives route everyday for 9 years, no medication taken, physical health good, general feeling of well being.

Injuries: Pneumothorax (left), 5 ribs fractured (left side), kidney contusion, possible concussion, multiple abrasions, hematoma and contusions on face and head. AIS 4.

Standards

The following Highway Safety Program Standards and Motor Vehicle Safety Standards were relevant to this case:

HSPS 16. Debris Hazard Control and Cleanup. Broken glass and a small amount of gas spillage were not cleared from the on-ramp.

MVSS No. 205^{**}. Glazing Materials. This prevented driver from receiving serious lacerations from broken glass.

MVSS No. 206^{**}. Door Locks and Door Retention Components. All doors remained closed lessening probability of ejection.

MVSS No. 301. Fuel Tanks, Fuel Tank Filler Pipes, and Fuel Tank Connections. Vapor return lines damaged from below, leaked fuel when vehicle was upside down.

Description

Pre-Crash

Vehicle 1 was southbound on U.S. 101 in Lane S1 at a driver-estimated speed of 55 mph. Driver 1 had allowed "30 ft" of clearance between his car and the car ahead. According to Driver 1 a phantom vehicle changed into Lane S1 ahead of Vehicle 1. At this same time the traffic in all lanes was slowing abruptly. The phantom vehicle braked, and Driver 1 braked hard and steered to the right to avoid a collision. Vehicle 1 began to spin as it veered to the right.

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a.

** Positive factors.

Crash

Vehicle 1 impacted the curb at the edge of the road. The left side wheels were bent by the impact, and the left front tire deflated. The car went down the embankment and rolled over. Driver 1 was unrestrained and moved around inside the front seat area of the car. The vehicle came to rest upside down adjacent to the on-ramp. The roof was crushed 10 in., and fuel was leaking from a damaged vapor return line.

Post-Crash

A truck which had been following Vehicle 1 stopped. The driver ran down the embankment and opened the left front door of Vehicle 1. Driver 1 crawled out. A tow truck passing by the scene with another car reported the accident. The California Highway Patrol arrived on scene and began directing traffic on the on-ramp. A tow truck arrived. Vehicle 1 was righted and towed from the scene. Driver 1 left in the tow truck, but was later admitted to the hospital.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Causes

- | | |
|---|---|
| 7 | Phantom vehicle changed lanes in front of Vehicle 1 and then braked. (definite) |
| 1 | Driver 1 braked hard and steered to the right. (definite) |

Matrix Element Description (Continued)

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Severity Increasing Factor

4

Vehicle 1 spun out. (definite)

Injury Causation

2

Driver 1 was not wearing available restraints, however, it could not be determined whether driver would have received more severe injuries had he worn them.

Post-Crash Factors

*3

Witness stopped and opened door to allow Driver 1 to exit. (definite)

Recommendations

5

Fuel lines should not be vulnerable to impacts from below.

1

The feasibility of conducting courses on vehicle handling in emergency situations for drivers should be investigated.

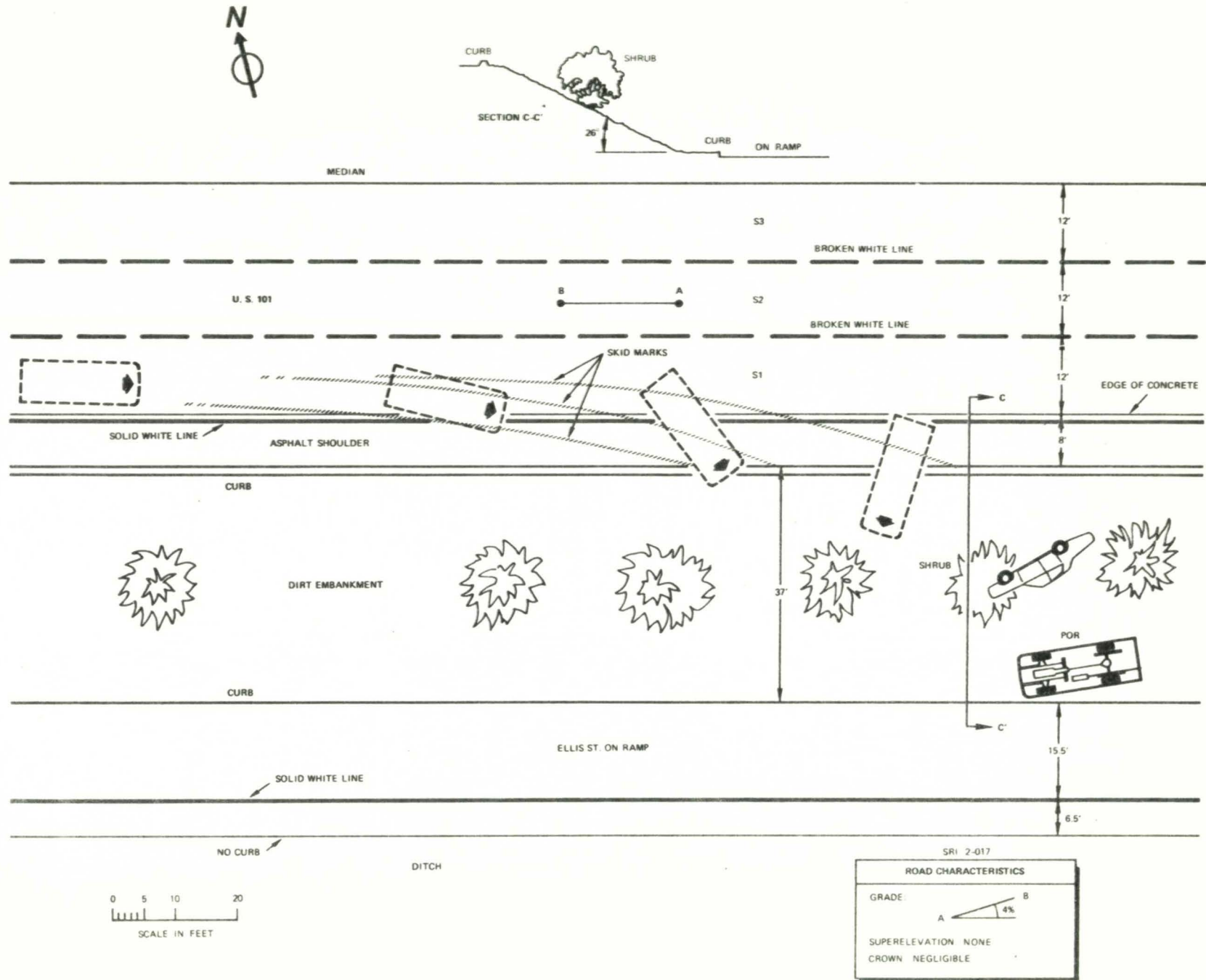


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-018

I CASE SUMMARY

(Car/Car/Car--Lost Control/Lateral/Sideswipe)

Identification

Foothill Expressway, Los Altos, California, open roadway, residential area, January 16, 1973, 0808 hours, Tuesday, 3 cars--Vehicle 2 went out of control, crossed divider and was impacted laterally by Vehicle 1. Vehicle 1 was in turn sideswiped by Vehicle 3, Fatal, AIS* 7. Figure 1 is a plan view of the accident site.

Ambience

Day, heavy rain, 56°F, strong winds, visibility 25-50 yards, road surface had heavy layer of water but not flooded.

Highway

Expressway, limited access with widely separated signalized intersections, total pavement width 75 ft, 4 lanes, 8 ft wide median divider with 8 inch high curbs and low pyracantha bushes, asphaltic concrete surface treated with "slurry seal" (slippery when wet), paved shoulders, no curb, straight and level, very slight crown, no super-elevation, no accesses and 3 poles/trees in last 1/4 mile traveled by Vehicles 1 and 3, 1 access and 3 poles/trees in last 1/4 mile traveled by Vehicle 2.

Number of accidents between intersections with Magdalena and Loyola (total distance of 0.7 mile): 1969, 3 (1 injury producing); 1970, 2; 1971, 4 (2 IP); 1972, 3 (2 IP).

Traffic Controls

Speed limit 45 mph, solid white edge lines, traffic lanes separated by broken white lines, "KEEP CLEAR" on pavement adjacent to fire station, "NO TURNS" sign on median and "NO RIGHT TURN" sign on shoulder at fire station, traffic signals activated only when fire trucks leave station.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Vehicles

Vehicle 1, car, 1964 Ford Falcon Sprint, 2-door convertible, burgundy, 94,004 miles, no inspection sticker, no power accessories, padded dash and sun visors, lap belts, left rear and right front tires almost bald, routine maintenance performed, but vehicle was somewhat run down in appearance.

Damage: Grille and front bumper crushed, hood and left front fender buckled, left front suspension bent, windshield cracked, indentations in left door, right front fender crushed by Vehicle 3. Vinyl covering over dash padding cracked left of steering wheel. CDC* 12-FDEW-2 (primary), 05-RFEW-2 (secondary).

Vehicle 2, car, 1972 AMC Gremlin, 2-door coupe, green, 13,549 miles, no inspection sticker, power accessories unknown (hood jammed), padded dash and sun visors, integral head restraints, 4-point restraints, rear tires heavily worn, routine maintenance performed.

Damage: Severe crush to left side of body, partial separation of left B-pillar, left front seat and steering wheel pushed to right, left rear wheel and brake drum bent, windshield broken, all other glass except right rear quarter shattered, engine mounts separated. Passenger compartment reduced in size. CDC 09-LZAW-3

Vehicle 3, car, 1963 Chevrolet, suffered minor damage to the grille and left front fender. One headlight broken. Vehicle was unavailable for inspection. Estimated CDC 11-FLEE-1

Occupants

Vehicle 1, driver, male, 17½ years old, 67½", 138 lbs, single, student (high school senior), hobby--skiing, 1½ years driving experience, driven 9,000-10,000 in last 11 months, owned case vehicle 11 months, high school driver education at 16 years, drives route daily, trip plan: origin home, destination doctor's office, ETD 0755 hours, ETA 0820 hours, accident occurred 1.8 miles from origin, psychological condition: "felt really good," lap restraint worn tightly.

Injuries: Extensive laceration across bridge of nose, severe back pain.
AIS 4

Vehicle 2, driver, male, 17½ years old, 67", 157 lbs, single, student (high school senior), part time work as repairman and janitor, hobbies--science fiction, photography, active in Boy Scouts and church, 6 months driving experience, average number of miles unknown, drove route 2-3 times/week, high school driver education at 16½ years, drove case vehicle 6 months, no physical problems, no psychological

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

problems detected, trip plan: origin home, destination school, ETA 0810, accident occurred 2.7 miles from origin, lap and probably upper torso restraints utilized.

Injuries: occipital condyle dislocated (displaced forward 0.5 cm) from atlas vertebra, ligaments partially torn, spinal cord below medulla slightly contused, subarachnoid hemorrhage, right liver lobe stellate tear, severely lacerated, 2 cm and 3 cm lacerations in spleen, bilateral hemothorax, hemoperitoneum, retroperitoneal hematomas, contusions of lung, 1" diameter contusions on lower right abdomen and on opposite side, 3" lacerations from base of left thumb to medial side of wrist (1/2" deep to intact muscles and tendons), 2" long abrasion back of left hand, 3" by 2" contusion medial lower left thigh, 1" diameter contusion lateral left thigh. AIS 7, Fatal.

Vehicle 2, right front passenger, female, 15½ years old, 61", 95 lbs, sister of driver, lap restraint utilized.

Injuries: Cerebral concussion, (final primary diagnosis), displaced fracture of left humerus, pneumothorax with left lung contusion, fractured left superior pubic ramus, 4 to 5 cm right parietal hematoma, abdominal pain, contusions on left side. AIS 4.

Vehicle 3, driver, female, 34 years old, 62", 105 lbs, married, works part time, driving experience unknown, vehicle familiarity unknown, driver education unknown, road familiarity unknown, trip plan: origin home, destination work, ETA unknown, physical and mental condition unknown, restraint use unknown.

Injuries: None noted on police accident report, none mentioned to insurance agent. (Note: Driver 3 was shaken by the experience of seeing Driver 2 and refused to talk about the accident.)

Standards

The following Highway Safety Program Standards and Motor Vehicle Safety Standards were relevant to this case:

HSPS 1. Periodic Motor Vehicle Inspection. Both Vehicles 1 and 2 had tires with less than 1/32 inch tread.

HSPS 12. Highway Design, Construction and Maintenance. Foothill Expressway may not have a surface of adequate skid resistance given the 45 mph speed limit.

MVSS 105. Hydraulic Braking Systems. Vehicle 2's rear wheels locked up on braking.

MVSS 214. Side Door Strength. Driver 2 had fatal injuries from side intrusion.

DescriptionPre-Crash

Vehicle 1 was westbound on Foothill Expressway in Lane W2 at a driver-estimated speed of 40 mph. Vehicle 2 was eastbound in Lane E2 at 25-30 mph (speed estimated by witness). Witness saw a vehicle ahead of Vehicle 2 slow down. Driver 2 applied his brakes. The bald rear tires skidded on the wet pavement, and the car started to spin to the left (counterclockwise). It crossed the divider and had slid and spun 270° when it was impacted by Vehicle 1. Driver 1 said that he braked when he saw Vehicle 2 on the divider, but was unable to avoid collision.

Crash

Vehicle 1 impacted Vehicle 2 at estimated 35 mph. (Vehicle 2 was at estimated 5 mph). At the point of impact the front bumper of Vehicle 1 extended from the middle of the left door almost to the rear bumper of Vehicle 2. Vehicle 1 pushed in Vehicle 2's door and B-pillar, and bent the left rear wheel and brake drum. Vehicle 2 pivoted around the left front corner of Vehicle 1 rotating counterclockwise as viewed from above. It rotated 180° before coming to rest with its rear wheels in the median and the front wheels in Lane W2. Vehicle 1 was forced to the right by the impact into the path of Vehicle 3, which had been behind Vehicle 1 in Lane W1. Vehicle 3 impacted Vehicle 1 in the right front fender, pushing it in ahead of the front wheel. Vehicle 3 suffered only minor damage to its left front fender, grille and left headlight area.

When Vehicle 2 started fishtailing, the right front passenger contacted her head on the right front window causing hematoma of the parietal area. During the spin she probably received a concussion from impact with the right A-pillar.

Upon impact of Vehicle 1 and 2, Driver 1 contacted the steering wheel with the bridge of his nose receiving a 3" laceration. Driver 2 was probably turned toward the left door. His torso was violently accelerated and the inertia of the head caused the skull to dislocate at the cervical spine (occipital-atlantal joint). This caused damage to the spinal cord (contusions) which caused respiratory embarrassment. This injury was probably the cause of death. As Vehicle 1 intruded, the left door contacted Driver 2's upper torso causing lung contusions, lacerated liver and spleen and bilateral hemothorax. The seat bent inward and pushed Driver 2's body against the right front passenger causing Driver 2's retroperitoneal hematomas.

The right front passenger upon impact of Vehicles 1 and 2 was thrown to the left against the left seat and driver. She sustained a displaced transverse fracture of the left humerus, left lung contusion with pneumothorax, and fractured superior pubic ramus.

Post-Crash

Vehicle 2 came to rest with its rear wheels in the median and its front wheels in Lane W2. Vehicles 1 and 3 came to rest in the traffic lanes as shown in Figure 1.

Driver 1 got out of his car, walked to the median and sat down. Driver 3 left her car, looked in Vehicle 2 and then went to the nearby fire station where she phoned her husband. Firemen, having heard the collision, came over to investigate. Driver 2 was checked for vital signs, but none were found. The right front passenger of Vehicle 2 was extricated. Driver 1 and right front passenger 2 were taken to the hospital by ambulance. Driver 2 was left in Vehicle 2 until the coroner arrived almost one hour later. Driver 2 was removed from Vehicle 2 and taken to the morgue. Vehicles 1 and 2 were towed from the scene, and Vehicle 3 was driven away.

Causal Factors, Conclusions and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationPrimary or Principal Causes

7	Vehicle ahead of Vehicle 2 slowed down. (definite)
1	Driver 2 applied brakes, locking rear wheels. (definite)
4	Vehicle 2 crossed median divider into oncoming traffic. (definite)

Matrix Element Description (Continued)Matrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationSeverity Increasing Factors

- | | |
|---|--|
| 1 | Driver 2 was unable to control Vehicle 2 in skid. (definite) |
| 4 | Rear tires of Vehicle 2 were almost bald; front tires were new. (definite) |
| 7 | Heavy rain was falling and road surface was covered with water. (definite) |
| 4 | Worn tires on Vehicle 1 limited braking ability. (definite) |

Relevant Conditions

- | | |
|---|--|
| 4 | Vehicle 2 had history of rear brake locking on dry pavement. (definite) |
| 7 | Heavy rain and dark clouds reduced visibility. (definite) |
| 1 | Driver 2 was inexperienced (definite) and incapable of handling vehicle under emergency maneuvering situations. (probable) |

Injury Causation

- | | |
|----|---|
| 5 | Severe intrusion of Vehicle 1 into passenger compartment of Vehicle 2 caused Driver 2's injuries. |
| *2 | Driver 1 was wearing a lap restraint. (definite) |
| 2 | Driver 2 was wearing lap restraint (definite) and upper torso restraint (probable) |
| 2 | RF passenger of Vehicle 2 was wearing lap restraint. (probable) |

Matrix Element Description (Concluded)Matrix Cell No.

(* indicates positive factor)

ExplanationPost-Crash Factors

*9

Accident occurred in front of fire station; firemen were on scene immediately for extrication, first aid, assistance. (definite)

Recommendations

1

Popular myth that best tires should go on the steering axle should be countered by public education.

4

If Vehicle 2 had been equipped with an antiskid braking system, this accident might have been reduced to a less serious rear end collision or prevented altogether. Such systems are presently available as an option on a few expensive automobiles. They should be made optional equipment on all passenger vehicles.

4

The state of California should establish a program of periodic motor vehicle inspection for all cars.

4

Motor Vehicle Safety Standard No. 105--Hydraulic Brake Systems--should be upgraded to reflect the present state of the art.

E-116

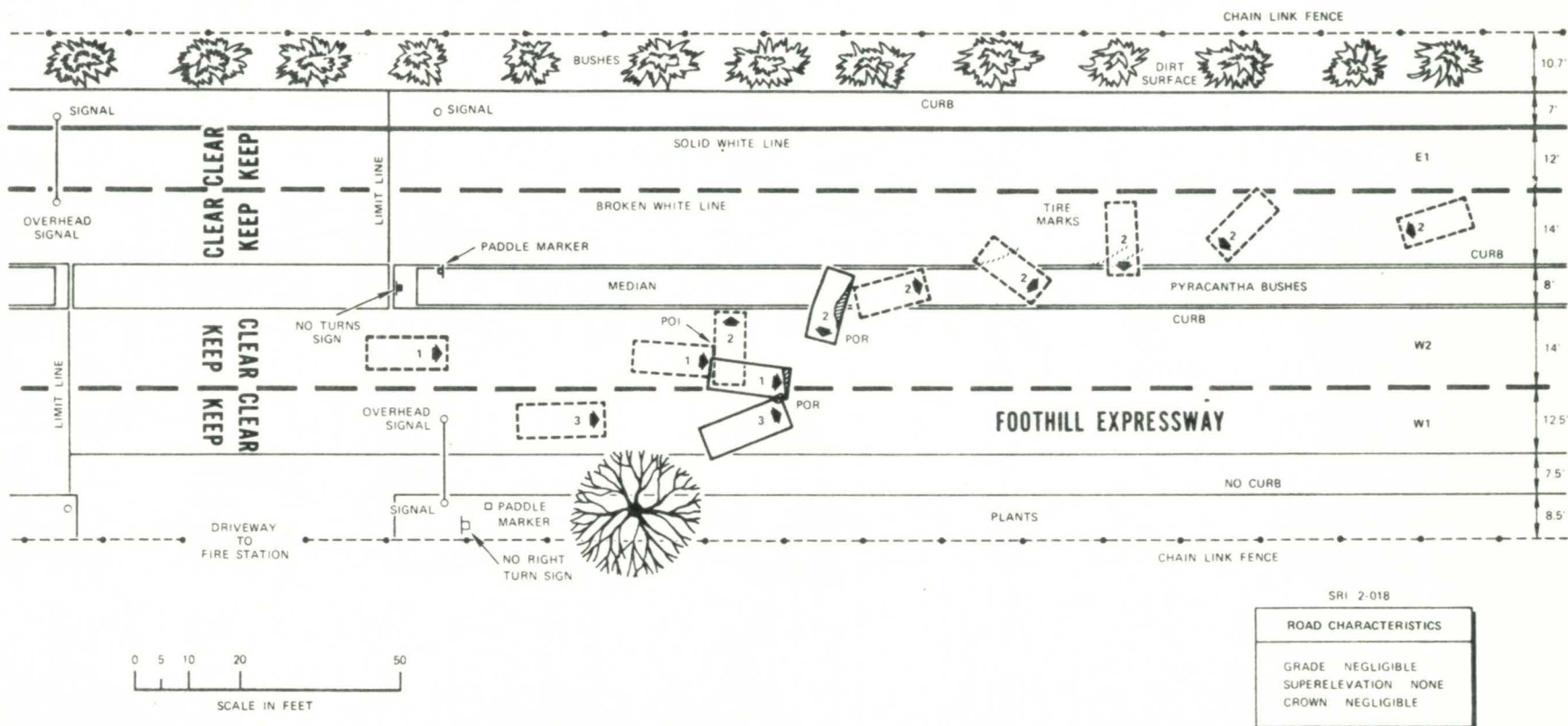


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-019

I CASE SUMMARY

(Car/Car - Lateral)

Identification

This accident occurred at the intersection of Alma Street and Churchill Avenue, Palo Alto, California, residential, February 6, 1973, 1547 hours, Tuesday, 2 cars - lateral, PD (property damage only). Vehicle 2 was impacted by Vehicle 1 while completing a left turn.

Ambience

Day, light rain, 62°F, 88% relative humidity, no wind, good visibility, cloudy, wet pavement.

Highway

Alma Street, major arterial, 45 ft wide, 4 lanes plus left turn lanes at Churchill intersection, no divider, asphaltic concrete surface, concrete curbs on both sides, straight, no grade or superelevation, 8" crown, 13 driveways, 2 streets and 40 poles/trees in last 1/4 mile traveled by Vehicle 1, 14 driveways, 2 streets and 43 poles/trees in last 1/4 mile traveled by Vehicle 2.

Churchill Avenue is a minor arterial 36 ft wide, 2 motor vehicle lanes and 2 bike lanes, has railroad grade crossing near Alma Street. The road slopes from level on Churchill before the intersection 4% upward to the raised track bed. Accident history of intersection: 1969, 10(1 injury producing); 1970, 10(1 IP); 1971, 11(1 IP); 1972, 12(6 IP); total 43 (9IP); 35% of the accidents involved N/B Alma vehicles turning left to W/B Churchill and colliding with S/B Alma vehicles (same as this accident).

Traffic Controls

Posted speed limit on Alma 35 mph, travel lanes separated by broken white lines and raised reflectors, north and southbound lanes divided by solid double yellow lines and amber reflectors, left turn lanes delineated by solid white lines, white pedestrian crosswalk lines and green bike lane marking at Churchill, no signs, traffic signals activated by Churchill traffic (otherwise stays green for Alma), cycle lengths: Alma, initial green 8 seconds, vehicle extension 3 sec, maximum green 65 sec (on weekdays 7-9 a.m., 11:30-1:30 p.m., 4-6 p.m.), yellow 4 sec, all red 2 sec; Churchill, initial green 6 sec, vehicle extension 3.5 sec, maximum green 55 sec (above time periods), yellow 3 sec. Railroad crossing also activates traffic signals since crossing is close to Alma.

Vehicles

Vehicle 1, car, 1971 Peugeot 504 4-door sedan, maroon, 30,177 miles, no inspection sticker, power disc brakes, padded dash, steering wheel hub and sun visors, 3-point restraints, adjustable head restraints, no evidence of pre-crash defects, routine maintenance performed.

Damage: Moderate crush to front end, front bumper attachments separated. No interior damage. CDC* 12-FDEW-1

Vehicle 2, car, 1969 Ford LTD 4-door hardtop, black vinyl over tan, 81,211 miles, no inspection data, power steering and power brakes, padded dash and sunvisors, 4-point restraints, adjustable head restraints, no evidence of pre-crash defects, routine maintenance performed.

Damage: Right rear fender pushed in, right rear tire cut and deflated. No interior damage. CDC* 03-RBEW-1

Occupants

Vehicle 1, driver, female, 57 years old, 66", 130 lbs., divorced, 3 children living at home and 1 child away from home, living in area 12 years, BA degree in political science, real estate broker, hobby--reading, 25 years driving experience, averages 21,000 miles/year, no driver education, drives area 1-2 times daily, owned case vehicle 17 months, takes prescribed medication - scripton for arthritic condition and thyroid extract for thyroid, trip plan: origin office, destination high school to pick up daughter (distance of 4 miles, accident occurred 1 mile from origin), driver was late in leaving office, "felt energetic day of accident," lap and upper torso restraint utilized.

Injuries: none

Vehicle 2, driver, male, 56 years old, 68½", 160 lbs, married, 2 children living away from home, has lived in area 28 years, 3 years college, real estate broker, hobbies--hunting, fishing, skiing, 40 years driving experience, average 27,000 miles/year, no driver education, drives area 2-3 times/week, owned case vehicle 3 years, no medication, trip plan origin home, destination lumber yard to pick up lumber (distance of 1.5 miles, accident occurred 0.8 miles from origin), no ETA. Lap restraint was utilized.

Injuries: none

Standards

HSPS 9. Identification and Surveillance of Accident Locations. Once identified, solutions must be sought for accident locations.

HSPS 13. Traffic Control Devices. Traffic control solutions for this intersection should be studied to determine the best cost-benefit improvements.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

MVSS No. 215. Exterior Protection. Bumper on Vehicle 1 provided very little protection to headlights and front end sheet metal.

Description

Pre-Crash

Vehicle 1 was southbound on Alma in Lane S1 at a driver-estimated speed of 35 mph (speed limit 35 mph). Vehicle 2 was in the northbound left-turn lane waiting to turn onto westbound Churchill. A southbound vehicle (No. 3) turned right onto westbound Churchill. There was a gap in southbound traffic at this time and Driver 2 proceeded to turn left, thinking he could complete his turn safely in front of oncoming Vehicle 1. However, Vehicle 3 stopped at the railroad tracks (see Figure 1) forcing Vehicle 2 to stop in front of Vehicle 1. Driver 1 applied her brakes.

Crash

Vehicle 1 impacted Vehicle 2 in the right rear fender. Impact speed was 5-10 mph. Vehicle 2 was moved sideways slightly by the impact. The right rear tire was cut by sheet metal and quickly deflated. The fender was pushed in 3 inches. The front end of Vehicle 1 was pushed in 5 inches near the right side, less on the left. All but one bumper mounting failed, causing one end of the bumper to fall to the ground.

Post-Crash

Driver 2 drove his car across the railroad tracks and parked it at the curb. Then he walked back to Vehicle 1 and asked Driver 1 if she could drive her car. Driver 2 then held up one end of Vehicle 1's front bumper while Driver 1 slowly drove her car across the tracks and stopped behind Vehicle 2. Driver 1 went across the street and called her insurance company. She was going to call the police, but a patrol car arrived at the scene first. When SCAT arrived at the scene, Driver 2 was changing his tire and prying the fender away from the tire so that he could drive away. A tow truck was called for Vehicle 1. There was no glass or other debris to be cleaned up.

Causal Factors, Conclusions and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Clean-up

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Causes

- | | |
|---|---|
| 1 | When Driver 2 started his left turn, he assumed that the vehicle which had turned ahead of him would not stop. (definite) |
| 7 | Vehicle 3 (phantom vehicle) stopped, forcing Vehicle 2 to stop in the intersection. (definite) |
| 1 | Driver 1 anticipated that Vehicle 2 would complete its turn. When it did not, she could not stop. (probable) |

Severity Increasing Factor

- | | |
|---|--|
| 7 | Pavement was wet, reducing Vehicle 1's ability to stop quickly. (definite) |
|---|--|

Relevant Condition

- | | |
|---|---|
| 1 | Driver 1 was late and may have been driving faster than usual as a result. (possible) |
|---|---|

Injury Causation

- | | |
|----|--|
| *2 | No injuries. Driver 1 was wearing restraints. (definite) |
|----|--|

Post-Crash Factors

- | | |
|----|---|
| *3 | Driver 2 helped Driver 1 move her car out of the intersection. (definite) |
|----|---|

Recommendation

- | | |
|---|--|
| 7 | Obtain funding to systematically study the capacity-service-safety relationships for this and similar locations in the city and to present recommendations for improvements to the city council. |
|---|--|

E-121

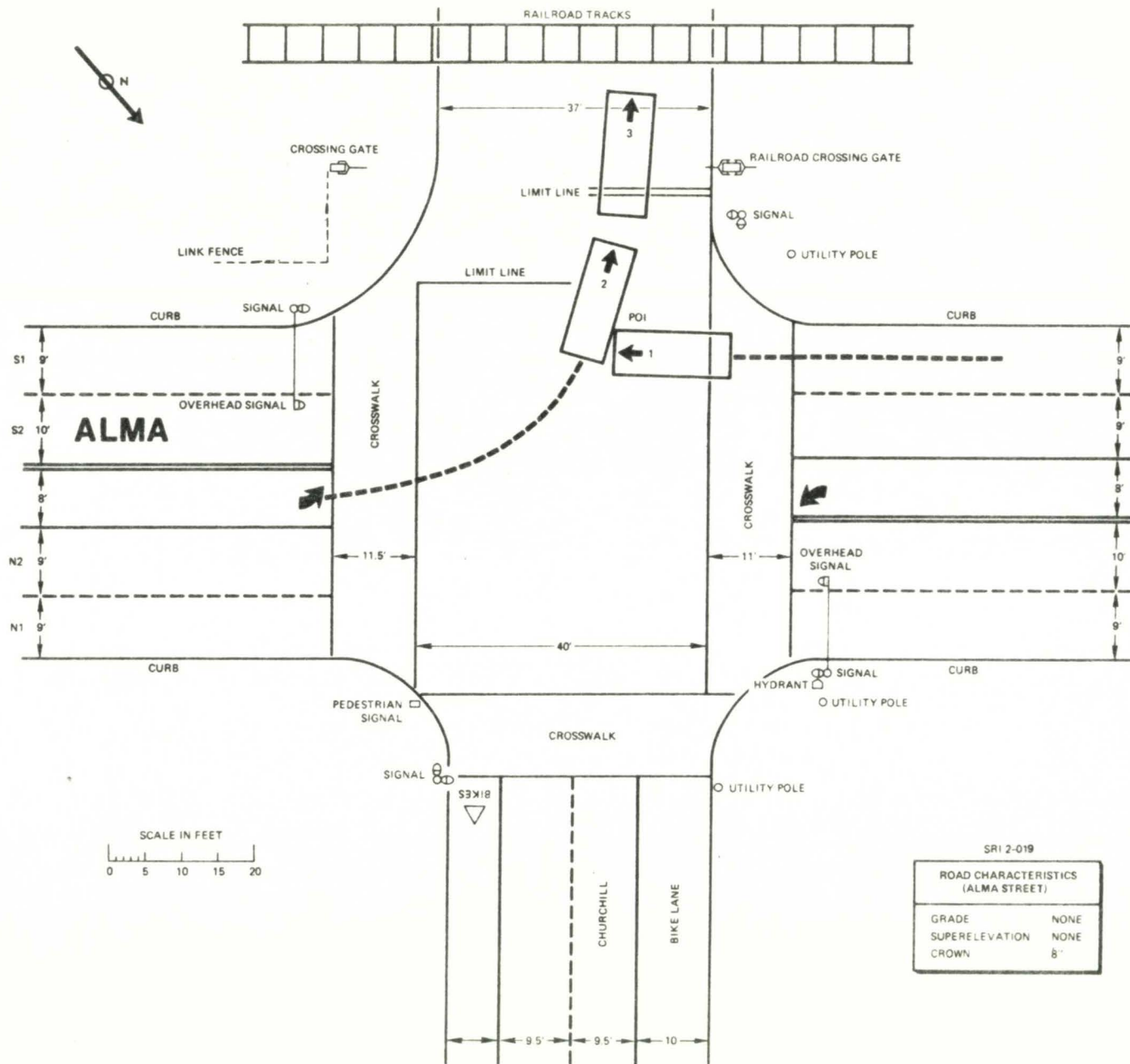


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-020

I CASE SUMMARY

(Phantom Car/Car--Rollover)

Identification

This accident occurred on Foothill Expressway in Palo Alto, California, open roadway, residential area, February 20, 1973, 1620 hrs, Tuesday. IP (Injury Producing). AIS* 1. This concerns a single vehicle rollover. Figure 1 is a plan view of the accident scene.

Ambience

Day, no precipitation, 71⁰F, 54% relative humidity, wind from the north at 3-7 mph, visibility 2 miles, dry road surface.

Highway

Foothill Expressway, 75 ft wide, 4 lanes, 8 ft wide median with curbs, asphaltic concrete surface, 7.5 ft paved shoulder and curb at edge of shoulder, straight, 3% upgrade, negligible crown, no accesses, no trees and no poles in last 1/4 mile traveled by Vehicle 1. From 1969 to 1972, there were 4 accidents on a section of Foothill Expressway 1-1/8 miles long containing the site of this accident.

Traffic Controls

Posted speed limit 45 mph, traffic lanes separated by broken white lines and raised reflectors, solid white line between slow lane and shoulder, no signs or signals near accident site.

Vehicles

Vehicle 1, car, 1971 Ford Torino 500 4-door station wagon, green, 35,365 miles, California Highway Patrol inspection sticker expired 12-31-72, power steering and power brakes, padded dashboard and sunvisors, 3-point restraints with detachable upper torso restraints, adjustable head restraints, radial-ply tires on front wheels, bias-ply snow tires on rear wheels, routine maintenance performed.

Damage: Roof buckled over front seat, windshield header buckled, upper A-pillars bent, roof luggage rack damaged, windshield broken, very slight damage to front fenders and left rear fender. No interior damage due to occupant contact. CDC**00-TPGO-4.

*American Medical Association Abbreviated Injury Scale (see Collision Performance and Injury Report in Appendix B for complete description of AIS).

**Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

Vehicle X, car, 1965 Ford Galaxie 4-door sedan (did not contact Vehicle 1 but changed lanes causing Driver 1 to attempt evasive action resulting in the accident).

Occupants

Driver 1, 44-year-old female, 63", 125 lbs, widowed, no children, occupation--operating room nurse, trip plan--work to friend's home, a distance of 3.5 miles (accident occurred 1.3 miles from work) to return borrowed items. Purchased vehicle new in April 1971, driven 22 months for 35,000 miles, drives route rarely (perhaps quarterly), no driver education, physical and mental condition good (just returned to work from week off, had a very good day), lap restraint worn snugly.

Injuries: bruise at base of sternum, medial right knee, lateral left knee, base of left thumb, left wrist and forearm sore, tiny laceration second finger left hand. AIS 1.

Driver X, 49-year-old female, 65". Involved as "phantom vehicle" driver, no direct contact with Vehicle 1.

Standards

The following standards are relevant to this case:

MVSS No. 216, Roof Crush Resistance. The roof crushed 11 inches, but mostly over the unoccupied right front seat.

HSPS 15. Police Traffic Services. Officer reported Vehicle 1 as a 1971 Dodge rather than a 1971 Ford Torino.

Description

Pre-Crash

Vehicle 1 was eastbound in Lane E1 of Foothill Expressway at an estimated speed* of 52 mph. Vehicle X, eastbound in Lane E2 started to change lanes in front of Vehicle 1. To avoid a collision, Driver 1 braked hard and steered onto the paved shoulder. The vehicle became unstable and swerved back into Lane E1. Driver 1 over-corrected, and Vehicle 1 skidded to the right.

Crash

Vehicle 1 impacted the 30° embankment obliquely. The right front wheel went up the bank first, tipping the car over to the left. The left front wheel rolled up the bank about two feet, and the left front fender penetrated the soft dirt of the embankment as the car rolled over and came to rest on its roof.

*Speed estimated by SCAT from skid marks. Driver estimated speed at 35-40 mph.

Post-Crash

Driver 1's first attempt to turn off the ignition was unsuccessful. She put the transmission into park, and then turned off the ignition. Persons stopped at the scene and assisted her in exiting. Driver 1 was unable to release the belt (she said she was too shaken). The door was unlocked and opened (someone cut the seat belt webbing) and Driver 1 exited feet first. Driver 1 was wrapped in a blanket. Driver X had continued about one-half mile beyond the scene, called the police and returned to the scene.

A tow truck righted Vehicle 1 and removed it. Glass debris and spilled fluid were not swept up. One police unit took Driver 1 to the hospital for a check-up.

Causal Factors, Conclusions, and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* Indicates positive factor)

Explanation

Accident Causation

Primary or Principal Causes

1	Driver X looked in rear view mirror and thought it was safe to change lanes; wide upper C-pillar probably blocked view of Vehicle 1. (probable)
1	Driver 1 overreacted to movement of Vehicle X. (definite)
1	Driver 1 was unable to control vehicle in emergency situation. (definite)
7	Vehicle X started to change lanes and threatened to collide with Vehicle 1. (definite)

Accident Causation

Severity Increasing Factor

- | | |
|---|--|
| 4 | Vehicle 1 had radial-ply tires on the front wheels and bias-ply snow tires on the rear wheels leading to instability while braking. (probable) |
| 1 | Vehicle 1 was traveling at least 10 mph over the speed limit. (probable) |
| 7 | Oblique impact with embankment caused vehicle to overturn. |

Injury Causation

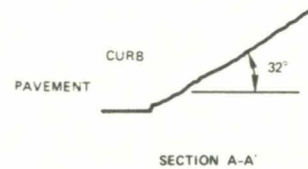
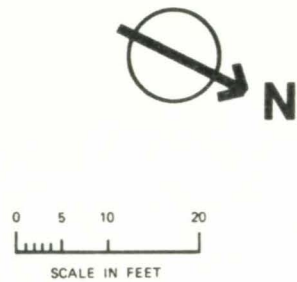
- | | |
|----|---|
| *1 | Driver 1 was wearing lap belt. (definite) |
|----|---|

Post-Crash Factors

- | | |
|----|--|
| *3 | Unknown person cut Driver 1's seat belt so she could get out of her car. |
|----|--|

Recommendations

- | | |
|---|---|
| 4 | Recommend that purchasers of radial-ply tires be informed of dangers of mixing different kinds of tires, especially snow tires. |
| 1 | The feasibility of conducting courses on vehicle handling in emergency situations should be investigated. |
| 4 | Improved rear vision equipment for vehicles with wide upper C-pillars is suggested. |



SRI 2-020

ROAD CHARACTERISTICS	
GRADE:	3%
CROWN:	NEGLECTIBLE
SUPERELEVATION:	NEGLECTIBLE

E-127

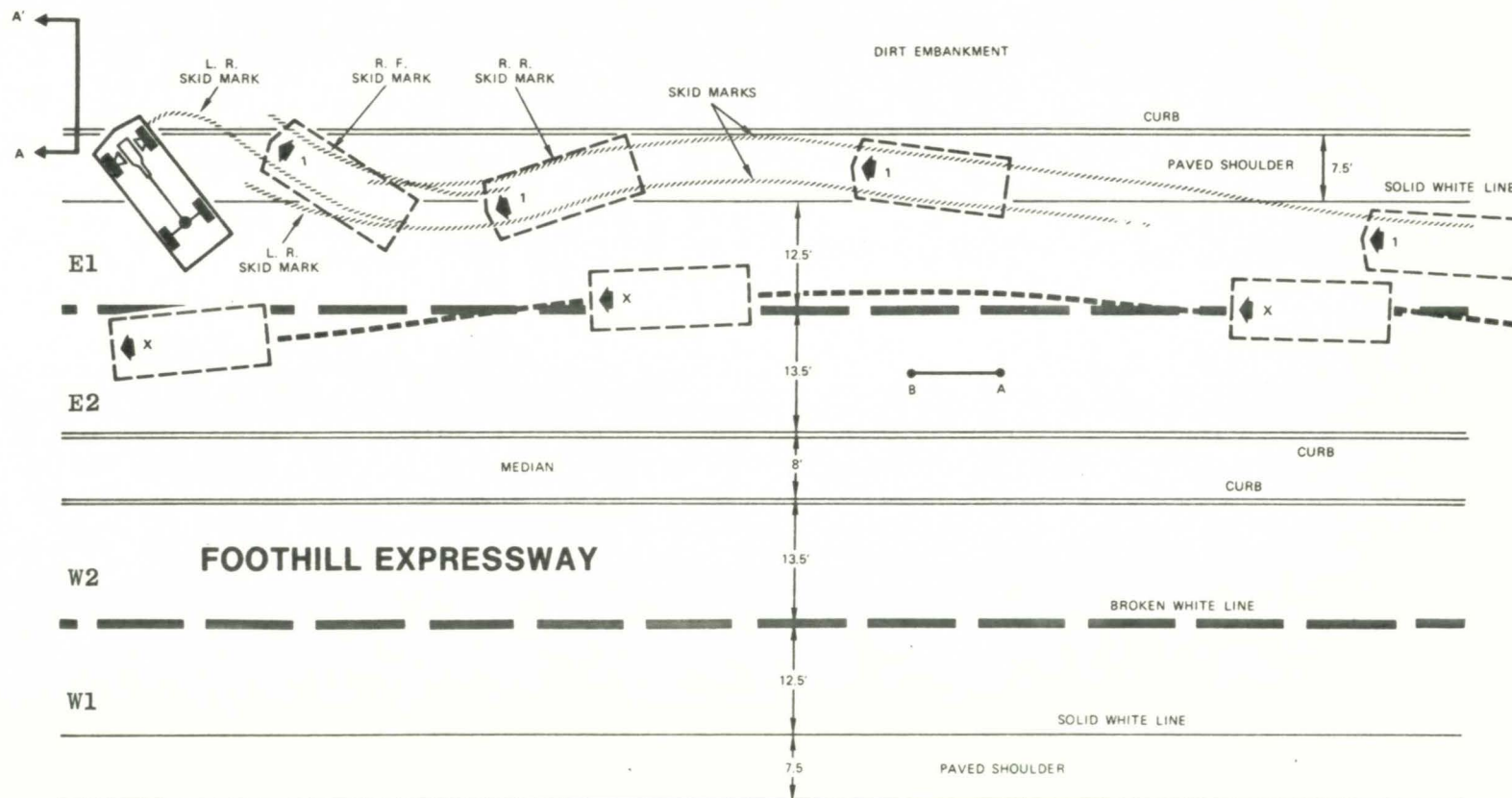


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-021

I CASE SUMMARY

(3 Cars--Lateral Impact)

Identification

This accident occurred at the intersection of El Camino Real and Portage Road, Palo Alto, California, commercial, February 22, 1973, 1600 hours, Thursday, 3 cars--lateral impact, IP (injury producing). AIS* 1. Westbound Vehicle 1 was proceeding across northbound traffic to turn left; Vehicle 2 was proceeding northbound. Vehicle 1 impacted Vehicle 2 in the right side, which forced Vehicle 2 into southbound Vehicle 3 waiting to turn left. Figure 1 is a plan view of the accident scene.

Ambience

Day, 67°F, 68% relative humidity, no precipitation, visibility good, winds 010° at 3 mph, dry pavement.

Highway

El Camino Real, major arterial, 104 ft wide, 6 lanes, median variable width with curbs, asphaltic concrete pavement, curbs at road edges, straight, level, slight crown, 2 streets, 10 driveways and 18 poles in last 1/4 mile traveled by Vehicle 2, 1 street, 3 driveways, 1 railroad crossing and 11 poles in last 1/4 mile traveled by Vehicle 3.

Portage Road, local, 35.5 ft wide, 2 lanes, no divider, asphaltic concrete pavement, curbs at road edges, straight, level, slight crown, "T" intersection with El Camino Real, 1 street, 11 driveways and 12 poles in distance traveled by Vehicle (1/8 mile).

In 1969, 3 accidents were reported at the intersection of Portage and El Camino Real. No accidents were reported during 1970-1972.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc

Traffic Controls

El Camino Real: Speed limit 35 mph, lanes separated by broken white lines, white buttons and raised reflectors, pavement marking indicating railroad crossing in northbound lanes of El Camino Real just south of Portage, limit line at Portage stop sign, railroad crossing, and "NO TURNS" signs on El Camino, STOP sign on Portage, traffic signal at El Camino and Hansen Way 107 ft south of Portage.

Vehicles

Vehicle 1, car, 1967 Chrysler Newport Custom 2-door hardtop, green, 73,812 miles, California Highway Patrol inspection sticker (expiration date December 31, 1973), power steering, power brakes, padded dashboard, lap restraints, no evidence of pre-crash defects, routine maintenance performed.

Damage: Slight damage to right end of front bumper and grille, right front fender buckled, entire front end of vehicle displaced slightly to right. CDC* 11-FREW-1.

Vehicle 2, car, 1969 Volkswagen 2-door sedan, red, 61,705 miles, no inspection sticker, no power accessories, padded dash and sunvisors, 3-point restraints, integral head restraints, no evidence of pre-crash defects, very low tire pressures, maintenance unknown.

Damage: Right door and B-pillar pushed in 10 inches, B-pillar partially separated, right door glass shattered, left rear fender pushed in 12 inches, left end of rear bumper buckled. CDC 03-RPHW-3 (primary), 10-LBEW-3 (secondary).

Vehicle 3, car, 1972 Datsun 240Z, 2-door coupe, orange, 10,732 miles, no inspection sticker, power brakes, padded dash and sunvisors, 3-point restraints with detachable torso restraints, integral head restraints, no evidence of pre-crash defects, routine maintenance performed.

Damage: Slight damage to left front fender, cracked left headlight surround, broken left front shock absorber in strut-type suspension. No interior damage due to occupant contact. Horn button fell off on impact. CDC 10-LFEE-1.

Occupants

Vehicle 1, driver, male, 52 years old, 67 inches, 180 lbs, married, has lived in area 20 years, occupation bearing inspector, high school diploma equivalent, hobby--reading; 33 years driving experience, no driver education, drives 15,000-

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a.

20,000 miles/yr, previously owned 1963 Chrysler, owned present Chrysler (case vehicle) 2 years, previous accident 2 months prior; trip plan--origin work (1 block from accident scene), destination home (9.8 miles), ETD 1600 hours, ETA 1625 hours, driven route for two weeks, wears glasses, no restraints utilized.

Injuries: None

Vehicle 2, driver, female 51 years old, 64 inches, 140 lbs; years driving experience unknown, average number of miles/year unknown; trip plan--possibly on her way to work from home, driver education unknown, physical and mental condition unknown, evidence restraint system was not in use.

Injuries: Multiple contusions. Complaint of pain entire left side with weakness, high back pain, minimal tenderness of left shoulder and hip with collapsing weakness of left leg. AIS 1.

Vehicle 3, driver, male, 25 years old, 71 inches, 170 lbs., occupation electronics technician; 8 years driving experience at estimated 30,000 miles per year, trip plan--work to automobile dealer service department, a total of $1\frac{1}{4}$ miles (accident occurred one block from destination), owned vehicle since October 1972 ($4\frac{1}{2}$ months), area familiarity unknown, no driver education (self taught), physical and mental condition good, lap restraint utilized.

Injuries: None

Standards

HSPS 13. Traffic Control Devices. Signalization for the intersection has been studied in anticipation of greater traffic volume due to blocking off of a nearby street.

MVSS No. 205. Glazing Materials. Side windows on lateral impacts tend to shatter, spraying glass into the occupant compartment.

MVSS No. 214. Side Door Strength. Passenger compartment intrusion would have injured a right front **passenger** of Vehicle 2.

MVSS No. 111^{*}. Rearview Mirrors. Mirror broke away on contact eliminating head injury.

* Positive factor

Description

Pre-Crash

Vehicle 1 was westbound on Portage and had stopped at the stop sign at El Camino Real. Vehicle 2 was northbound in Lane N3 of El Camino Real at a witness-estimated speed of 25 mph. Vehicle 3 was stopped in the southbound left turn lane. Driver 1 did not see Vehicle 2 as he proceeded to cross the northbound lanes of El Camino to turn left.

Crash

The right front corner of Vehicle 1 impacted Vehicle 2 just behind the right A-pillar and pushed the door in. As Vehicle 2 moved to Driver 1's right, the B-pillar and quarter panel were pushed in. Vehicle 2 rotated slightly clockwise (as viewed from above) and slid into Vehicle 3, which was stationary. Vehicle 2's left rear fender and rear bumper impacted the left front corner of Vehicle 3. Vehicle 3's left front fender was damaged slightly, but the left front wheel received most of the force damaging the left front suspension.

Post-Crash

Driver 1 parked his car parallel to the median and went for help. A nearby tire dealer called the police and an ambulance. Driver 2 was taken to the hospital by ambulance. Vehicles 2 and 3 were towed from the scene and Driver 1 drove away. Driver 3 left scene in private auto. Driver 1 was cited and fined for failure to yield right of way.

Causal Factors, Conclusions and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9

Accident Avoidance	Injury Prevention	Restoration and Cleanup
-----------------------	----------------------	----------------------------

Matrix Element Description

Matrix Cell No.

(* indicates positive factors)

Explanation

Accident Causation

Primary or Principal Causes

1	Driver 1 did not see Vehicle 2 approaching. (definite)
---	---

Relevant Conditions

7	Route usually taken by Driver 1 was blocked off. (definite)
---	---

7	Heavy traffic on El Camino Real, especially southbound. (definite)
---	--

Injury Causation

2	Driver 2 was not wearing restraint system. (probable)
---	--

E-134

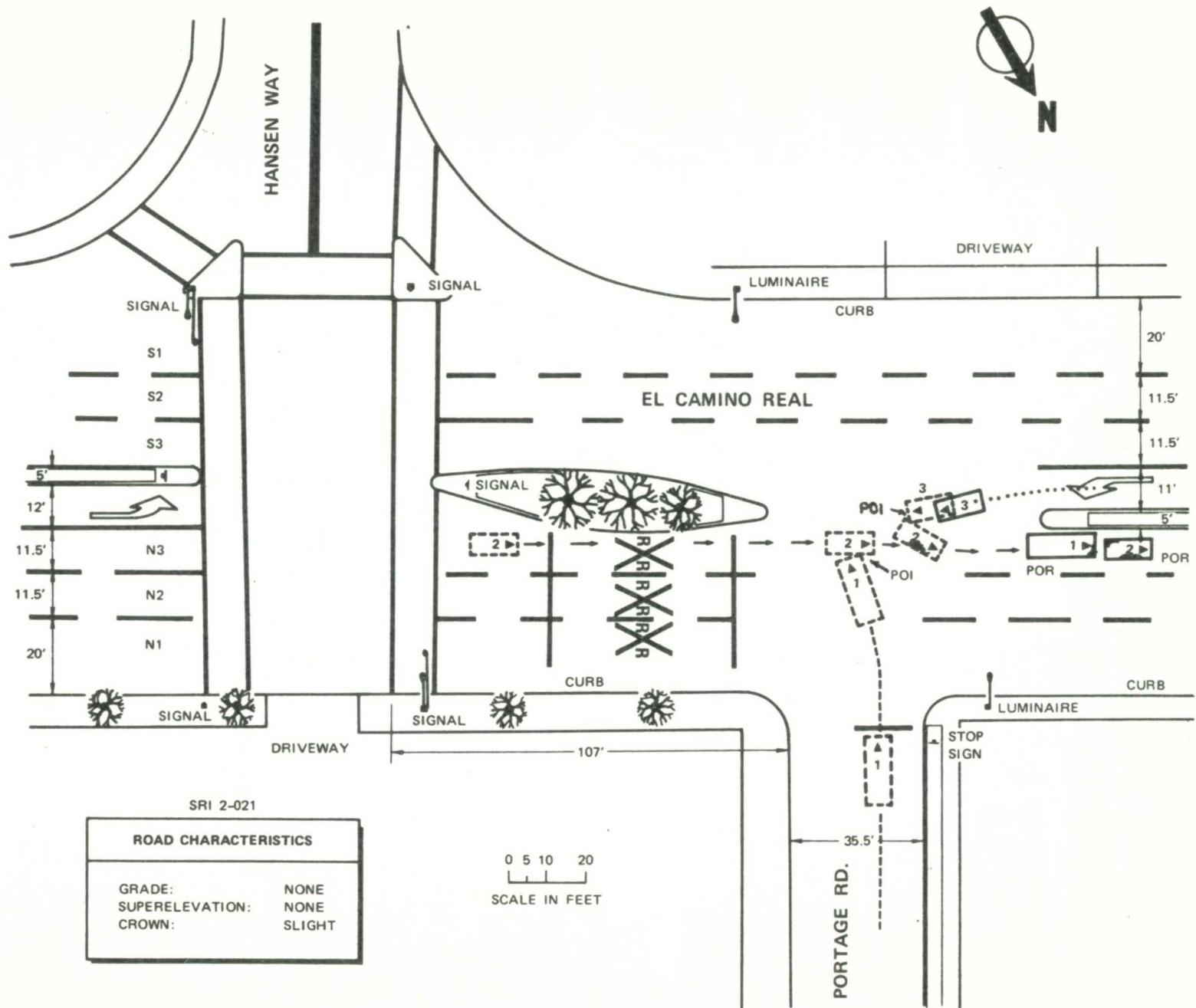


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-022

I CASE SUMMARY

(Car/Car/Car - Sideswipe/Oblique Headon)

Identification

This accident occurred on northbound Interstate 280 (milepost 19.10) approximately 0.7 miles north of Page Mill Road off-ramp, unincorporated area of Santa Clara County, California, open roadway, rural area, February 26, 1973, 0820 hrs., Monday, 3 cars - sideswipe/oblique headon, IP (injury producing) AIS* 3. Southbound Vehicle 1 hydroplaned, Driver 1 steered toward median, vehicle spun and headed towards northbound lanes, was hit in left rear by Vehicle 2, rotated, was hit in left front by Vehicle 3. Figure 1 is a plan view of the accident scene.

Ambience

Day, visibility poor due to heavy rain and wind spray across road, wet pavement.

Highway

Interstate 280 is a full freeway, 160' wide, eight lanes, planted dirt median changing from 32' to 27' wide in area of accident with 7' wide cement drainage gutter in one-third of median, total median (including shoulder) varies from 47' to 40', no barrier, 6' paved shoulders adjacent to dirt median, asphaltic concrete surface, 9' paved shoulders on east edge and 10' shoulder on west edge of roadway, guardrail on west edge of southbound lanes, slight curve (3750' radius) grade approximately 4%, no accesses per 1/4 mile, no poles or trees. Accident history: 29 accidents occurred in the 2.23 miles between interchanges to north and south of the accident site, 1969-71. Fifteen were hit object accidents. Thirteen of the 29 were injury accidents. Average daily traffic is 30,000 vehicles both directions (1971); peak hour is 3000 vehicles both directions (1971).

Traffic Controls

Speed limit 65 mph, 12' lanes divided by Botts dots and retromarker reflectors, double yellow lines separating lanes from inner shoulders, solid white lines separating lanes from outer shoulders.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Vehicles

Vehicle 1, car, 1969 Dodge Dart, 4-door, brown, sedan, 32,238 miles on odometer, no inspection data, no power accessories, automatic transmission, padded dash and sunvisors, lap, upper torso, and head restraints, "heat vent" noted by occupants to have gas leak, right front tire underinflation wear, left front and right rear heavy inside wear, no gas cap for fuel tank filler pipe, maintenance performed at 25,557 miles (date unknown), damaged left front fender, left front wheel rim, suspension, steering shaft separated, tire cut, left rear fender adjacent to tail light, CDC* 12-FYEW-4 (primary), CDC 11-LBMS-1 (secondary). Second collision damage to windshield at left front and center right positions, knee impressions in instrument panel adjacent to glove box and ashtray.

Vehicle 2, car, 1972 Pontiac LeMans Sport 400, 2-door, yellow, convertible, mileage approximately 9,000 miles, no inspection sticker, power steering and brakes, padded sunvisors and dash, lap restraints only, head restraints, no defects noted, lubrication, oil change, etc., on 12-20-72, two months prior to accident, at 5,447 miles. Damage to left rear outer panel, liner and outer wheel housing, floor extension, tail lamp and bumper. No second collision damage. CDC 10-LBMS-1 (estimated).

Vehicle 3, car, 1972 Plymouth Custom Suburban, 5-door, burgundy/brown station wagon, 25,429 miles on odometer, CHP inspection sticker (expired December 31, 1972), power steering, brakes, seat, tailgate window, padded sunvisors, instrument panel and arm rests, lap, upper torso and head restraints equipped, front tire irregular tread wear due to incorrect alignment, maintenance unknown, left front fender damage, left front wheel bent, steering gear separated, left front door buckled, second collision damage in left upper corner of windshield, CDC 12-FYEW-2.

Occupants

Driver 1, 22-year-old male, 76-1/2", 160 lbs., occupation musician, 5 years driving experience at driver-estimated 1,000 (sic) miles per year, trip plan cousin's home in Boulder Creek to Los Angeles to deliver vehicle to friend approximately 400 miles, had driven vehicle approximately 1100 miles on trip from Seattle, Washington, to Boulder Creek, California, on Thursday, Friday, and Saturday prior to accident, had never driven road before, one quarter course in driver education in high school in fall 1967 at age 17 (included simulator use), physical and mental condition good (got up around 0700, packed, ate no breakfast), nearsighted corrected by glasses, restraints equipped but not used.

Injuries: Right neck sore behind jaw, right shoulder sore, right medial knee scraped, left lateral knee sore, swollen and abraded, left ankle and foot arch sprained, back of right hand bruised and sprained, unconscious approximately 1/2 minute. AIS 2.

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a.

Right Front Passenger, Vehicle 1, 20-year-old female, 66-1/2", 120 lbs., restraints equipped but not used, perhaps sitting sideways facing toward driver with head resting against seat back, dozing occasionally.

Injuries: Concussion with unconsciousness and post-traumatic amnesia, numerous facial lacerations on left side of face (left eye lid, cheek, forehead), soreness in front neck at adam's apple region, hyperextension of neck with muscular strain, bruises both knees, small laceration back of right hand. AIS 3.

Driver 2, 29-year-old female, 65-1/2", 110 lbs., occupation high school teacher and counselor, 14 years driving experience at 16,000-20,000 miles per year (100 miles a day commute to work), trip plan home to work, a distance of 50 miles (accident occurred 14 miles from home), left home 0800, ETA 0900 hours, owned vehicle since September 1972 (five months), not regular route to work (however drives it about once a month), 90% freeway and daytime driving, learned to drive at age 15-1/2 years in high school, both driver education and driver training, no physical or mental problems, was happy about going to meet friend before work, lap restraint used snugly.

Injuries: none

Driver 3, 41-year-old male, 73", 218 lbs., occupation electronics engineer, 24 years driving experience with maximum 25,000 miles per year (1972), trip plan home to work, a distance of 14-1/4 miles (accident occurred approximately 5 miles from work), left home 0800 hours, expected time of arrival 0820 hours, owned vehicle since February 1972 (purchased new), used route almost daily, 80-90% driving on freeways, 80-90% driving in daytime, learned to drive from elder step-brother at age 17 years, cold and flu month prior to accident, penicillin type antibiotic medication, occasional high blood pressure (no medication), back problem, no mental problems morning of accident (morning was "routine"), lap restraint worn snugly.

Injuries: Top of head sore, small hairline laceration left forehead, right shoulder, upper arm and neck stiff and sore day after accident, soreness in right middle back, left hip and knee stiff day after accident, bruise on left lateral and top knee. AIS 1.

Standards

The following standards are relevant to this case:

HSPS 12. Highway Design, Construction and Maintenance. One section of the median is narrow enough with a large enough traffic volume to meet California warrants for a median barrier. None exists at this point.

HSPS 15. Police Traffic Services. The investigating officer incorrectly stated that Vehicle 1 was northbound in Lane N3 (police report Lane N2) when collision occurred. Actually Vehicle 1 had been southbound and crossed the median. This incorrect reporting will mean that the report will not be coded and entered into the accident records system as a crossing median type of accident.

MVSS 208. Occupant Protection. Occupants in Vehicle 1 did not use equipped restraints. Driver 3 stated the seat belt buzzer system reminded him to use lap restraint when he got into his car the morning of the accident. His windshield impact was minor; the windshield impact of unbelted right front passenger in Vehicle 1 resulted in facial lacerations and unconsciousness from concussion.

Description

Pre-Crash

Vehicle 1 stopped for gas approximately 25 miles from origin, a friend's home, and then continued six more miles to Interstate 280. Vehicle 1 headed southbound for Los Angeles, moving into Lane S2 and then into S4, the fast lane. Driver 1 noticed the speedometer read 70 mph. It was raining very hard. Vehicle 1 had been in the fast lane approximately 30 seconds when it began to hydroplane and fishtail. Driver 1 relaxed his foot on the accelerator but did not brake. He decided to steer into the median in order to avoid heavy traffic to the right and to slow the vehicle. Vehicle 1 began to rotate counterclockwise (when viewed from above). Northbound Driver 2, traveling at 60 mph in Lane N4, saw Vehicle 1 coming across the median and accelerated, hoping to avoid it.

Crash

After having traversed the median Vehicle 1 was traveling at an estimated 45 mph when its left rear bumper hit Vehicle 2's left rear fender. Vehicle 1 continued to spin and moved further into Lane N4 where it was impacted by Vehicle 3, traveling at estimated 60 mph, left front to left front. Vehicle 1 came to rest partially in the median as shown in Figure 1. Vehicle 2 stopped further down the road in the median and Vehicle 3 came to rest in Lane N3. A fourth vehicle (red Volkswagen) may have impacted Vehicle 3 slightly in the rear. (Driver's name was not noted in police report.) Vehicle 1 received major damage to the left front with maximum sheet metal crush of 45 inches. Left front wheel and suspension were bent and steering shaft separated. Vehicle 2 received left rear fender and bumper damage. Vehicle 3 received left front damage. The steering shaft broke at or near the pot joint.

Unrestrained Vehicle 1 occupants impacted the windshield and were both knocked unconscious. Right front passenger received left side facial lacerations. Both impacted their knees on the dashboard. Driver 2 was not injured. Restrained Driver 3 impacted his head in the upper left corner of the windshield and received minor lacerations from left door window flying glass. His left knee was bruised.

Post-Crash

Driver 2 exited and ran back to the accident site. Driver 3 stopped his car in Lane N3 and remained inside for awhile and then exited from the right door. Driver 1 remained inside his vehicle with the right front passenger until the ambulance arrived. The right front passenger was treated for shock, bandaged and then taken to emergency. Vehicle 3 was removed from Lane N3 by a maintenance truck with a chain, clearing all lanes. Driver 2 talked with police and then continued to work. Driver 3 left with the tow driver. Vehicles 1 and 3 were towed from the scene.

Causal Factors and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationPrimary or Principal Cause

4	Vehicle 1 hydroplaned and "fishtailed." (probable)
1	Driver 1 decided to go into median to slow vehicle. (definite)

Severity Increasing Factor

7	Lack of median barrier allowed Vehicle 1 to cross into opposing lanes. (definite)
---	---

Matrix Element Description (Continued)Matrix Cell No.

(* indicates positive factor)

ExplanationRelevant Conditions

- | | |
|---|---|
| 1 | Driver 1 was driving at 70 mph. (probable) |
| 4 | Vehicle 1 right front tire had underinflation wear and left front and right rear had inside wear; RF inflation 18 psi; rear inflation 24 and 25 (post-crash measurements). (definite) |
| 7 | Heavy rain made road surface very wet. (definite) |

Injury Causation

- | | |
|----|---|
| 2 | Vehicle 1 occupants were not wearing restraints allowing impact of windshield and concussions. (definite) |
| *4 | Vehicle 3 seat belt buzzer system reminded Driver 3 to use his lap restraint; his injuries were minor. (definite) |

Post-Crash Factors

- | | |
|----|---|
| *9 | Maintenance truck removed Vehicle 3 from traffic lanes with chain prior to arrival of tow truck. (definite) |
|----|---|

Recommendations

- | | |
|---|--|
| 7 | Accident site should be considered for addition of median barrier (meets state volume and width warrants in one section) |
|---|--|



Stanford Research Institute Multidisciplinary
Accident Investigation Team SRI 2-023

I CASE SUMMARY

(Car/Sign/Guywire/Post-Crash Fire)

Identification

This accident occurred on Ravenswood Avenue 150' west of Middlefield Road, Menlo Park, California, open roadway, residential area, February 25, 1973, 2107 hrs., Sunday, 1 car--hit object/fire, Fatal AIS* 9. Figure 1 is a plan view of the accident scene.

Ambience

Night, estimated temperature 53°F, estimated 68% humidity, dry pavement.

Highway

Ravenswood Avenue is a minor arterial, approximately 45' wide, two lanes changing to three lanes before intersection with Middlefield, asphaltic concrete surface, concave cement gutter both sides of street, curbs near driveways only, straight, luminaires near intersection, 37 poles and trees, 18 driveways, 1 road in last 1/4 mi. Three accidents near location from 1969 through portion of 1973.

Traffic Controls

Speed limit 25 mph, lanes divided by broken yellow lines and solid double yellow lines (near intersection), word ONLY with right turn arrow painted in right lane near intersection, NO PARKING signs approximately 3-3/4' from pavement edge, LIMITED TRUCK ROUTE sign adjacent to power pole support.

Vehicle

Vehicle 1, car, 1971 Plymouth Fury III, 2-door, black vinyl over white, hardtop, odometer reading (fire destroyed) but estimated as 8360 miles from maintenance sticker, no inspection sticker noted, power brakes and steering, padded dash and sunvisors, lap and upper torso restraints, no defects noted, routine maintenance on January 3, 1973 at 7,385 miles.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Damage: Front pushed in 12" on right side from impact with pole, entire front distorted. Interior fire damaged, exterior paint burned. No second collision interior damaged noted. CDC* 12-FREN-1 (primary), CDC 12-UBXN-1 (secondary).

Occupants

Driver 1, 71-year-old female, 64", 150 lbs., probably housewife, years driving experience unknown, trip plan probably taking rear passenger home after dinner, vehicle probably owned and driven for 16-1/2 months and 8360 miles, familiarity unknown but lived in area 8 years, physical and mental condition unknown but no evidence of immediate pre-accident failure, blood alcohol 0.19 gm%. Restraint not used.

Injuries: external injuries unknown due to burns; cause of death pulmonary congestion and edema from carbon monoxide poisoning with 46% blood saturation due to smoke inhalation. Contributing conditions included acute alcoholism, and extensive burns on the body. Cerebral edema also present. AIS 9.

Vehicle, right front passenger, 81-year-old male, 70", 200 lbs., restraints not used.

Injuries: death due to generalized fourth degree thermal burns with flame and smoke inhalation and 37% carbon monoxide saturation, pulmonary congestion and edema. AIS 9.

Vehicle 1, left rear passenger, 76-year-old female, 62", 130 lbs., restraints not used. Blood alcohol 0.14 gms %.

Injuries: death due to carbon monoxide poisoning with 50% blood saturation from smoke inhalation; extensive burns over 60% of body. AIS 9.

Standards

The following standard was specifically relevant to this case:

MVSS 301. Fuel Tanks, Fuel Tank Filler Pipes, and Fuel Tank Connections-- Passenger Car (Effective 1-1-68). Fuel tank was apparently punctured by steel sign after car knocked down pole. Leaking fuel was ignited.

Description

Pre-Crash

Vehicle 1 was eastbound on Ravenswood Avenue at unknown speed, probably 30 mph or less. Driver 1 allowed Vehicle 1 to drift right and impact the curb. The vehicle continued traveling with the right side wheels on the sidewalk. A witness reported seeing "backfiring and sparking from the back end" of the car.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

Crash

Vehicle 1 impacted a no parking sign mounted on a small steel pole. The pole was knocked down and the car drove over the sign. The edge of the sign cut a large hole in the fuel tank, and the leaking fuel was ignited. The same witness reported very profuse sparking, and said it looked "like a flamethrower." Vehicle 1 continued ahead and ran into a guywire supporting a utility pole. The guywire lifted the front end of the car up and tilted it to the left. The witness passed as Vehicle 1 hit the guywire. She continued further on to avoid the pole in case it fell.

Post-Crash

The witness stopped, ran back to the car and attempted to speak with the driver. She said a man was conscious and when she asked if he could get out he said he couldn't. The back and lower parts of the car were in flames. A neighbor called the police. The witness attempted to find tools to cut the vehicle top. (She thought it was a convertible.) When she returned the top and remainder of the car were on fire. Firemen arrived and put out the fire. The occupants were dead from pulmonary congestion, carbon monoxide poisoning and burns. The vehicle was towed from the scene for removal of the bodies. A cutting torch was necessary to open the passenger door; a tow truck hooked up to the driver's door and pulled it open.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factors)

ExplanationAccident CausationPrimary or Principal Cause

1 Driver 1 lost control of vehicle (definite)

Severity Increasing Factors

8 "No Parking" sign punctured vehicle fuel tank
allowing fuel to escape (probable)

5 Unknown ignition source caused fuel fire (definite)

Relevant Condition

1 Driver 1 was intoxicated with blood alcohol 0.19 gms %
(definite)

Injury Causation

2 Death was due to smoke inhalation and CO
poisoning from the fire; occupants were also
extensively burned (definite)

Post-Crash Factors

*3 A witness attempted to help the occupants but
was unable to do so (definite)

3 Vehicle occupants did not get out of vehicle,
perhaps because of alcohol intoxication, physical
age and/or because they were stunned from impacting
poles, and guy wire (possible)

Recommendation

8 Traffic control signs should be evaluated for
ability to puncture fuel tanks and for
probability of this occurrence

E-147

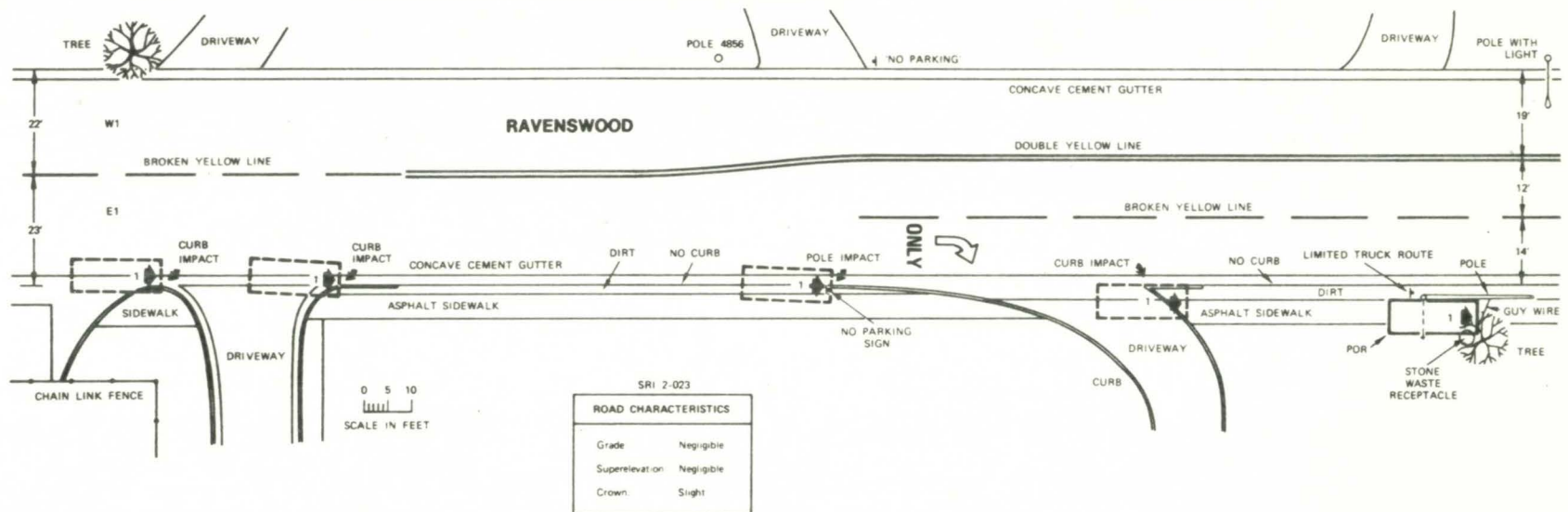


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-024

I CASE SUMMARY

(Car/Parked Truck--Rearend)

Identification

This accident occurred on Bohannon Drive in Menlo Park, California, open roadway, industrial area, February 26, 1973, 1625 hrs, Monday, car into parked truck, IP (injury producing) AIS* 1. Figure 1 is a plan view of the accident.

Ambience

Day, light rain, calm, visibility 5-6 miles, road wet, estimated coefficient of friction 0.4-0.5.

Highway

Bohannon Drive is a local road, 27 ft wide, 2 lanes, no divider, asphaltic concrete pavement. At the POI there is a shallow cement gutter on the north side of the street and a gravel shoulder on the south side. Bohannon curves to the left for eastbound traffic just before the POI. Grade and superelevation are negligible, and crown is approximately 2 inches. Vehicle 1 turned onto Bohannon 300 ft from the POI. In that distance there are 8 poles and 7 driveways (both sides of the street).

From 1969 to 1972 there were 3 accidents near the case accident; 1 was in a parking lot and the other 2 were at intersections respectively 300 ft west and 1000 ft east of the case accident site.

Traffic Controls

Speed limit (not posted) 25 mph, no pavement markings, no signs. There is a traffic signal at the intersection of Bohannon and Marsh Road, 300 ft from the POI.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Vehicles

Vehicle 1, car, 1972 Datsun 1200, 2-door coupe, white vinyl over green, 13,138 miles, no inspection data, no power accessories, padded dash and sunvisors, 3-point restraints, head restraints, left front tire pressure low, left torso restraint anchor bolt loose leading to failure (see below), warranty maintenance performed in Nov. 1972 (3 months prior to accident) according to owner.

Damage: Damage to front end, heaviest on right side, 17 inches maximum crush, right front fender and hood buckled, wheelbase 2 inches shorter on right side, right roof side rail buckled slightly. Steering wheel rim bent, left upper torso restraint anchor bolt pulled out of roof structure, turn signal lever broken off, sunvisor bent. CDC* 12-FDEW-2

Vehicle 2, truck, 1965 International Travelall 1000, 4 doors, white over green, 86,618 miles, no inspection sticker, power steering and power brakes, no padded components, no restraints, no evidence of pre-crash defects, maintenance unknown, damage to rear bumper, tailpipe and lower left D-pillar area. CDC 06-BLEE-2

Occupants

Driver 1, 22-year-old male, 66", 160 lbs., graduate student and teaching assistant, driving experience approximately 10 years at driver estimated 15,000 to 20,000 miles per year, trip plan Santa Clara University to errands to Bohannon to pick up roommate (to take roommate to Burlingame, nearby town), departed 1430 hours, expected time to pick up roommate 1600 hours, total trip University to Bohannon 17-1/4 miles, accident occurred about one block from destination, vehicle belongs to roommate, Driver 1 drives it and another Datsun 1200 occasionally (does not own a vehicle), drives on accident route approximately once per month, other driving 75% freeway (with half of that at night), learned to drive in Nevada from mother at age 12, first California license at age 17, has attended 6 weeks traffic school due to violations, physical and mental condition good, lap and upper torso restraint used, head restraint adjusted for head height.

Injuries: Bleeding abrasion upper left forehead, laceration right knee. AIS 1.

Owner 2, 49-year-old male, was not in the parked vehicle at the time of the collision. Owner 2 parks in that location every Monday and Thursday at about the same time to visit the post office.

Injuries: none

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a

The following Motor Vehicle Safety Standard was relevant to this case:

MVSS No. 209, Seat Belt Assemblies. Upper torso restraint anchorage failed because bolt loosened.

DescriptionPre-Crash

After having stopped for a red light at Marsh Road and Bohannon Drive, 300' from the accident site, Vehicle 1 made a left turn from southbound Marsh onto Bohannon. Driver 1 accelerated and shifted to fourth gear, but shifted back to third on approaching a 150 ft radius left curve. Driver 1 estimated his speed at 30 mph. The road was wet from a light rain and the calculated critical cornering speed was 32 mph. Vehicle 1 did not follow the curve. Driver 1 turned the wheel more following a smaller radius turn. He applied the brakes reducing the cornering ability of the car and causing it to go straight.

Crash

The right front fender of Vehicle 1 impacted the left rear corner of Vehicle 2, which was parked at the side of the road. SCAT estimates that the speed of impact was approximately 15 mph. Driver 1 was wearing lap and torso restraints, but the torso restraint anchor bolt had loosened, leaving only 3 threads engaged. These stripped and allowed Driver 1's forehead to impact the sunvisor. His right knee impacted the ignition switch.

Post-Crash

Driver 1 exited from his car. He contacted his roommate, whom he was intending to pick up, to advise him of the accident. When the police arrived he was given a bandage for his knee laceration. A tow truck responded to the scene, and the tow driver cleared the scene of most debris. Vehicle 1 was towed from the scene, and Vehicle 2 was driven away.

Causal Factors and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationPrimary or Principal Cause

- 1 Driver 1 was driving too fast for wet road surface and curve. (probable)

Severity Increasing Factor

- 7 Vehicle 2 was parked on shoulder. (definite)

Relevant Conditions or Modifying Factors

- 1 Vehicle 1 exceeded critical cornering speed for wet roadway. (probable)
- 7 Road surface was wet. (definite)
- 4 Low left front tire pressure reduced cornering capability of vehicle. (possible)

Injury Causation

- 5 Upper torso restraint anchor bolt had loosened, leaving only three threads engaged; these failed upon impact, detaching restraint and allowing Driver 1 to impact sunvisor. (definite)

Recommendations

- 4 Restraint anchor bolts should be installed with lock washers or other devices to prevent loosening.

- 1 Drivers should have opportunity to drive vehicles on wet skid pads to become familiar with their behavior.



Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-025

I CASE SUMMARY

(Car/Car--Lateral)

Identification

This accident occurred at the intersection of Foothill Expressway and San Antonio Road, Los Altos, California, urban, March 1, 1973, 1050 hours, Thursday. 2 cars--lateral, IP (injury producing) AIS* 5. Figure 1 is a plan view of the accident scene.

Ambience

Day, 73°F, 55% relative humidity, visibility good, clear, wind SW at 3 mph, dry pavement.

Highway

Foothill Expressway, 77 ft wide, 4 lanes, median 17 ft wide with curbs, asphaltic concrete pavement, 8 ft paved shoulder adjacent to eastbound lanes, 8" high Portland cement concrete curbs both sides of road, straight, level, negligible crown, no accesses and 6 poles/trees in last 1/4 mile traveled by Vehicle 1.

San Antonio Road is a major arterial road which makes a "Y" intersection with Foothill Expressway (see Figure 1), 71 ft wide, 4 lanes plus 1 left turn lane, median 4 ft wide with curbs, asphaltic concrete pavement, 8 inch curbs on both sides, straight, level, negligible crown, 2 roads, 11 driveways and 15 poles/trees in last 1/4 mile traveled by Vehicle 2.

Number of accidents at intersection: 1969, 5(3 injury accidents); 1970, 4(4); 1971, 4(3); 1972, 5(3); total, 18(13).

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Traffic Controls

Speed limit, Foothill Expressway 45 mph, San Antonio Road 35 mph, through traffic lanes separated by broken white lines, left and right turn lanes delineated by solid white lines, solid white limit lines, solid white line delineating paved shoulder, arrows on pavement indicating traffic direction, one way signs for each direction of Foothill Expressway.

The intersection has fully traffic actuated signals with the following cycles: on Foothill Expressway, minimum green 12 seconds, 6 second interval, maximum green 45 seconds, 4.3 second yellow; on San Antonio Road, minimum green 6 seconds, 5 second interval, maximum green 32 seconds, 3.5 second interval. Green returns to Foothill Expressway (recall on).

Vehicles

Vehicle 1, car, 1972 Chevrolet Nova 350, 2 door sedan, green, 5344 miles, no inspection sticker, power steering and power brakes, padded dash and sunvisors, 3-point restraints with detachable upper torso restraints, adjustable head restraints, no evidence of pre-crash defects, routine maintenance performed 6 weeks prior to accident.

Damage: Grille and front bumper pushed back, hood and left front fender buckled, radiator punctured, no interior damage due to occupant contact. CDC* 12-FDEW-2.

Vehicle 2, car, 1973 Oldsmobile Omega, 2-door sedan, burgundy, 1618 miles, no inspection sticker, power steering and power brakes, padded dash and sunvisors, 3-point restraints with detachable upper torso restraints, adjustable head restraints, no evidence of pre-crash defects.

Damage: Left side of car pushed in from front axle to rear axle. Maximum penetration 17 inches. Left door glass shattered, windshield cracked. Front seat pushed to right, and dashboard buckled. Left side tires cut by fender sheet metal. CDC 10-LDAW-3.

Occupants

Vehicle 1, driver, female, 51 years old, 65", 138 lbs., married, 12th grade education, sales clerk in department store, hobbies--bridge and reading, trip plan: origin - home, destination - work, ETA 1055 hours, trip distance 15 miles, accident occurred 6½ miles from origin, has driven 4 years at an average of 8,300 miles/year, driven route daily for one year, has driven case vehicle 7 months and

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a.

5,000 miles, no driver education, most of driving is done during daytimes on an expressway, no other accidents, one traffic violation, wears glasses. Lap restraint worn tightly.

Injuries: Multiple facial contusions with laceration of vein on left near eyebrow; contusions and soreness inside left upper arm, left breast area, lower right arm, and outer area of right thigh; abrasion left knee. AIS 3.

Vehicle 2, driver, male, 49 years old, 72 in., 175 lbs., vice president of finance and life insurance co., married, no children, hobby--sports: scouting and recruiting, 17 years driving experience, drives 25,000 miles/year, commercial driver education course 1956, trip plan: origin--San Francisco Airport, ETD 1010 hours, destination Los Altos on business, no ETA, accident occurred 28 miles from origin about $3\frac{1}{2}$ miles from destination, vehicle was rented, driven Vehicle 2 a total of 28 miles, number of miles driven that type of vehicle 128 miles, driven route twice before, lap restraint worn tightly, ingested 2 Aprosolines for hypertension $2\frac{1}{2}$ hours before accident, wears glasses.

Injuries: Cerebral concussion; multiple left fractured ribs; renal contusion; hemothorax; lacerations: $\frac{1}{4}$ " left wrist, $\frac{1}{2}$ " right wrist, over right eye; abrasions on both hands and wrists, small multiple abrasions over body; contusions: left lateral thorax, left abdomen. AIS 5.

Standards

The following Motor Vehicle Safety Standards were relevant to this case (* indicates positive factor):

MVSS No. 214--Side Door Strength. Vehicle 2 had side door strengthening. It is not known for certain if this prevented him from being fatally injured. Driver 2 was injured by intrusion of the door.

MVSS No. 205--Glazing Materials. This standard was met, however lacerations of both wrists resulted from spraying glass.

MVSS No. 208*--Occupant Crash Protection. Both drivers were wearing lap restraints.

Description

Pre-Crash

Vehicle 1 was westbound on Foothill Expressway in Lane W2. Driver 1 had previously stopped for a traffic light and was driving slowly (about 25 mph) as she approached San Antonio Road. When the signal at San Antonio changed to green, she accelerated. Vehicle 2 was southbound on San Antonio Road at a driver-estimated speed of 40 mph. As Vehicle 2 slowed for the intersection the light turned yellow and then red. Vehicle 1 entered the intersection. Neither driver tried any evasive action.

Crash

Vehicle 1 impacted Vehicle 2 in the left side just behind the left front wheel. Vehicle 2 continued to move relative to Vehicle 1 so that the left door and quarter panel of Vehicle 2 were also pushed in. Vehicle 2 rotated to the left from the impact, and Driver 2 continued to turn left, making a complete U-turn. Driver 2 brought his car to rest facing north in Lane S2 of San Antonio Road. Vehicle 1 was deflected to the left by the impact and was brought to rest across Lane E1 of Foothill Expressway.

Post-Crash

A passerby placed flares in Lane E1 and advised Driver 1 to stay seated in her car. Police arrived on scene, and a physician who was driving by stopped and rendered assistance. An ambulance responded to the scene, and Driver 2 was helped out of his car by the ambulance attendants under physician's directions. Driver 2 received first aid and was helped to the ambulance. Both drivers left the scene in the ambulance. Two tow trucks responded to the scene and removed the vehicles. The tow drivers did not completely clear the scene of debris. The reporting officer recommended a citation for CVC 21453a, disregarding signal, be issued to Driver 2 but the District Attorney refused due to insufficient evidence.

Causal Factors, Conclusions and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationPrimary or Principal Causes

1 Driver 2 proceeded through the intersection after the traffic light had turned red. (probable)

Severity Increasing Factor

*3 Driver 2 steered his car to the side of the road after impact eliminating some traffic problems that could have developed. (definite)

*3 Witness set emergency brake in Vehicle 2 preventing further movement. (definite)

Relevant Conditions

1 Driver 2 was unfamiliar with the route and intersection. (definite)

Injury Causation

*2 Driver 2 was not wearing upper torso restraint, possibly reducing injuries to his left side. (possible)

2 Driver 1 was wearing lap restraint keeping her in the seat but was not wearing upper torso restraint which would have prevented facial and chest injuries. (definite)

5 Vehicle 1's intrusion into Vehicle 2 caused major injuries to Driver 2.

5 Glass from the left side window of Vehicle 2 shattered and sprayed over Driver 2 causing multiple abrasions. (definite)

Matrix Element Description (Continued)ExplanationPost-Crash Factors

- | | |
|----|--|
| *3 | Medical doctor was on scene to render first-aid and help in the removal of Driver 2. |
| 9 | Glass was left on scene because of inadequate broom. (definite) |

Recommendations

- | | |
|---|---|
| 1 | Driver education programs should emphasize that risk-taking behavior increases markedly when drivers are in a hurry, "behind schedule," under time pressure of any sort, and that accident probabilities increase in a corresponding way. |
|---|---|

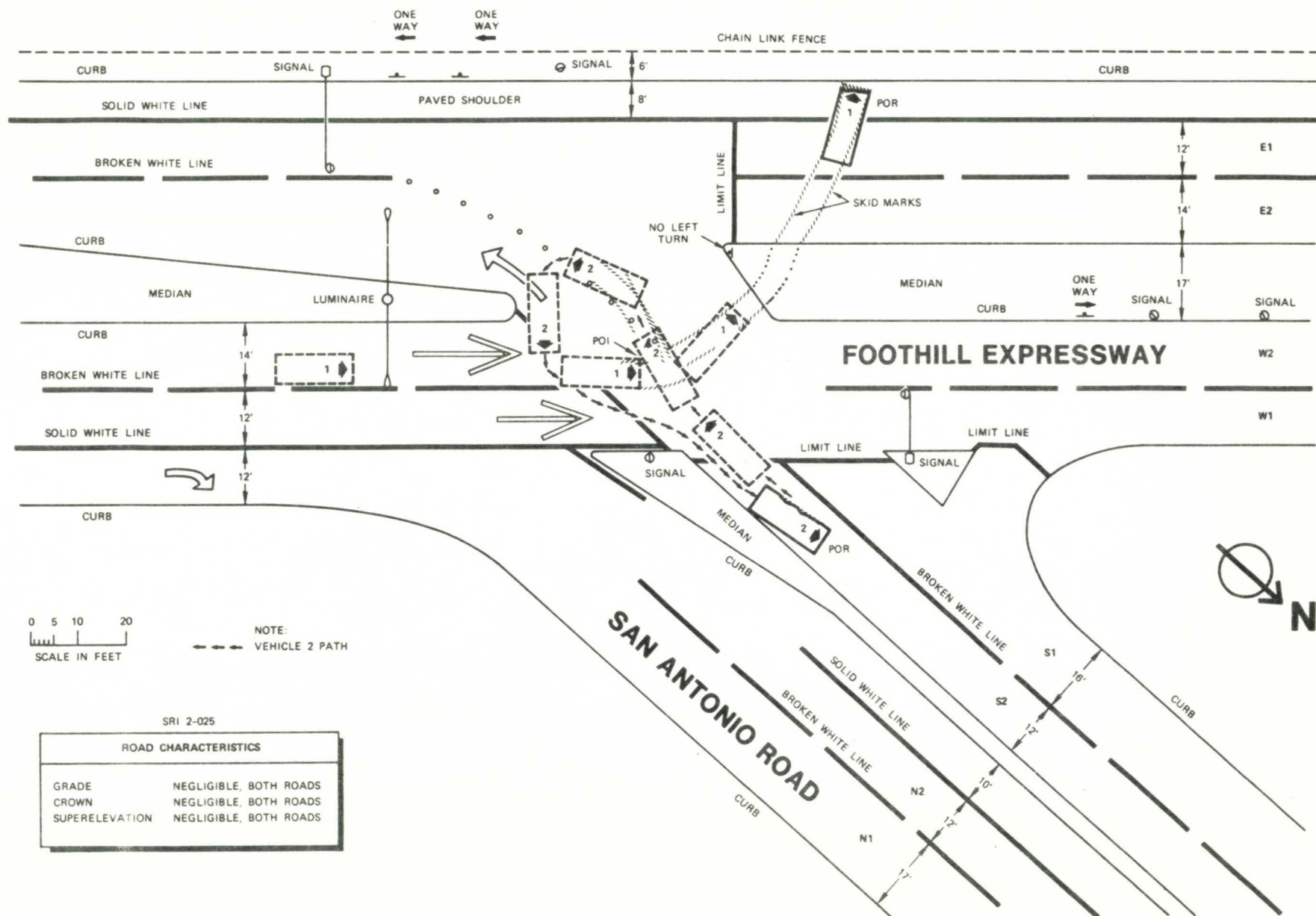


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-026

I CASE SUMMARY

(Car/Car--Sideswipe)

Identification

This accident occurred on Alexis Drive in the 2900 block, approximately 1/10 mile west of the intersection with Page Mill Road, Palo Alto, California, open roadway, residential area, March 3, 1973, 1400 hrs, Saturday, 2 cars--sideswipe, IP (injury producing) AIS* 1. Vehicle 1 lost traction on a curve and impacted Vehicle 2, left front to left side. Figure 1 is a plan view of the accident scene.

Ambience

Day, 55°F, raining, wet pavement, wet coefficient of friction estimated at 0.5.

Highway

Alexis Drive is a residential local road, approximately 30' wide, 2 lanes, asphalt, 6" wide and high concrete curb, 3' concrete gutter on each side, 151' radius, right hand westbound curve with grade varying from 15% to 5-1/2%, negligible crown, negligible superelevation (not banked), 1 road, 2 driveways and 8 poles and trees on the north side of street, and 5 poles and trees on the south side of street for westbound Vehicle 1; 5 driveways and 13 poles and trees on the south side, and 5 driveways and 14 poles and trees on the north side of street of eastbound Vehicle 2. The accident history of the area showed three accidents, one each in 1970, 1971 and 1972. Each involved southbound vehicle going downhill running off the road to the right. Two had minor injuries, the third none.

Traffic Controls

Speed limit posted at 25 mph, lanes delineated by broken yellow line on Los Altos Hills area of road, and by solid white line to just beyond point of impact (POI) on Palo Alto portion of road.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Vehicles

Vehicle 1, car, 1971 Toyota Corolla, 2-door brown vinyl over gray coupe, 29,330 miles on odometer, no inspection sticker, no power accessories, padded sunvisors and dashboard, lap and upper torso restraints, integral head restraints, handling problems on turns (especially right turns) noted by Driver 1, no maintenance sticker.

Damage: Left front fender crumpled, left headlight broken, front bumper bent, left tie rod broken, left front suspension members bent, wheelbase 4 inches shorter on left side. CDC* 11-FLES-1 (primary).

Vehicle 2, car, 1966 Ford Mustang, 2-door, green hardtop, 37,770 miles on odometer (vehicle used for around town driving only), no inspection sticker, power steering, padded dash, lap restraints, fluid leakage around left rear and right front brake backing plates, driver noted lubrication and brakes relined within 3-4 months before the accident.

Damage: Sideswipe damage to left door, quarter panel and rear fender, left rear wheel bent, axle pushed back, wheelbase 4 inches longer on left side. CDC 11-LZES-1 (primary).

Occupants

Driver 1, 19-year-old male, 74-1/2", 145 lbs, occupation U.S. Navy enlisted, three years legal driving experience (seven years total driving experience) now averaging more than 20,000 miles per year, trip plan home of right rear passenger to home of another friend for social visit, total of about 4-1/2 miles (accident occurred 1/4 mile from destination), drives vehicle occasionally (it belongs to his sister) and has many complaints about its handling (usually drives parents 1969 Ford LTD or his own 250 Suzuki motorcycle), drives road occasionally to visit friends (has complaints about the curve), high school driver education (one semester at age 15-1/2), no simulator use, no physical problems other than rash on feet ("stress fatigue" from standing), no fatigue (slept until 0900), possible marijuana use (when looking at list of pharmacological agents said "yeah, every time" for marijuana but when asked if it had just been smoked, answered "no, but about to"), lap restraint worn snugly.

Injuries: none

Right front passenger, Vehicle 1, male, height over 72", weight unknown, other information unknown.

Injuries: none

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a.

Right rear passenger, Vehicle 1, 19-year-old male, height and weight estimated at 74" and 170 lbs, other information unknown.

Injuries: none

Driver 2, 63-year-old male, 70", 150 lbs, occupation management in oil business, 50 years driving experience, averaging 10,000 miles per year, trip plan golf game to home, total of 3-1/2 miles (accident occurred 3/4 mile from country club), owned vehicle since 1968, drives road about 1-1/2 times per week to country club, learned to drive from family, no physical problems, mildly disappointed that golf game had to be cut short due to rain, lap restraint worn snugly.

Injuries: bump on left side of head between forehead and ear, bruise underneath right upper arm, slight pain in left and right knees; pain developed next day in right chest under right arm. AIS 1.

Standards

HSPS 4 was relevant to this case. It is suggested that advanced driving emergency situation programs be considered for inclusion in high school driver education and training.

Description

Pre-Crash

Driver 1 was en route with friends from the home of one friend to the home of another. Vehicle 1 entered Alexis Drive, shifted from second to third, and began ascending the 15% grade northbound at driver estimated 35 mph. As the car came over the crown of the hill it lost traction on wet pavement (critical cornering speed 31 mph on wet pavement) and went into the southbound lane. Driver 2 had left the country club en route home. As he approached the curve southbound at 25 mph he saw Vehicle 1 coming towards him with the left wheels on the center line. Driver 2 steered toward the right and thought Vehicle 1 might miss him. Driver 1 applied the brakes, saw Vehicle 2, wanted to swerve to avoid but could not.

Crash

Vehicle 1 impacted Vehicle 2 in the left side. Vehicle 2 skidded sideways, impacted the curb with the right wheels, then continued skidding before stopping approximately 130' from the point of impact. (Driver 2 thinks he used the brake.) Vehicle 1 rotated about 45° counterclockwise coming to a stop approximately across the southbound lane. At impact, the occupants of Vehicle 1 hit their heads on the roof interior. Driver 2 hit the left side of his head on the window glass, his left knee on the door or lower dash, and his right knee on the steering column or lower dash.

Post-Crash

Driver 2 was dazed. Driver 1 exited. Driver 2's left door was jammed so he exited through the right door. Police were called and arrived shortly along with an ambulance. Driver 2 was taken to the hospital for examination. Vehicle 2 was towed from the scene. Driver 1 elected to leave his car at the scene and arrange for a tow later. Driver 1 and his friends were picked up by friends and continued to their destination.

Driver 1 was cited for violation of California Vehicle Code 21650, failure to drive in right half of roadway. He forfeited bail of \$14 on 3-31-73.

Causal Factors and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationPrimary or Principal Cause

1 Excessive speed in curve. (probable)

Severity Increasing Factor

*1 Driver 2 took evasive action, so that collision was sideswipe instead of head on. (definite)

Matrix Cell No.

(* indicates positive factor)

ExplanationRelevant Condition

7

Pavement was wet from recent showers. (definite)

Post-Crash Factor

3

Occupants of Vehicle 1 pushed their car to the side of the road. (definite)

Recommendations

1

Drivers should be educated in vehicle handling with relationship to locking wheels and controlling vehicle in skids.

FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-027

I CASE SUMMARY

(Car/Car--Lateral with Rollover)

Identification

This accident occurred at the intersection of Old Middlefield Road and Rengstorff Avenue in Mt. View, California, intersection, March 9, 1973, Friday, 0735 hours. Vehicle 2 attempted to turn left in front of Vehicle 1 traveling in the opposite direction. Collision was followed by rollover, IP (injury producing) AIS* 2. Figure 1 is a plan view of the accident scene.

Ambience

Day, 48°F, 87% relative humidity, clear, dry pavement.

Highway

Old Middlefield Road, major arterial, 70 ft. wide, 4 lanes, no divider, asphaltic concrete pavement, 8 inch Portland Cement concrete curbs, straight, level, slight crown, 1 road, 32 driveways and 21 poles/trees east of POI, 33 driveways and 23 poles/trees west of POI (both sides of street).

Rengstorff Avenue, major arterial, 70 ft. wide, 4 lanes, no divider, asphaltic concrete pavement, 8 inch Portland Cement concrete curbs, straight, level, slight crown.

Accident history of intersection: 1969, 12 (3 injury producing); 1970, 12(2IP); 1971, 14(6IP); 1972, 22(11IP); total 60 accidents 1969-72.

Traffic Controls

Posted speed limit on Old Middlefield 40 mph, opposing lanes separated by solid double yellow lines, adjacent traffic lanes separated by broken white lines, pedestrian crosswalks delineated by solid white lines, no signs at intersection.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Signal cycle lengths: Old Middlefield, initial green 10 seconds, vehicle interval 6 seconds, maximum green 32 seconds, yellow 4 seconds; North Rengstorff, initial green 5 seconds, vehicle interval 4 seconds, maximum green 28 seconds, yellow 3.5 seconds. Recall on for Old Middlefield.

Vehicles

Vehicle 1, car, 1972 Cadillac Eldorado 2-door sedan, beige, 16,664 miles, no inspection sticker, power steering and power brakes, padded dash and sunvisors, 3-point restraints with detachable upper torso belts, adjustable head restraints, no evidence of pre-crash defects, routine maintenance performed 3 weeks before accident.

Damage: Front bumper, grille and hood damaged, right front fender buckled, bumper guard bent. Radiator leaking. No interior damage. CDC* 11-FDEW-1.

Vehicle 2, car, 1972 Toyota Corolla 1600 Deluxe 2-door station wagon, yellow, 619 miles, no inspection sticker, power brakes, padded dash and sunvisors, 3-point restraints with detachable upper torso belts, integral head restraints, no evidence of pre-crash defects.

Damage: Right front fender, right door and right quarter panel pushed in, right door jammed, right side glass broken, windshield cracked, dashboard buckled, pavement scrapes from rollover on left side. CDC 02-RYAW-3 (primary), 00-LPHO-1 (secondary).

Occupants

Driver 1, 38 years old, male, 69", 165 lbs., married, law degree, occupation - practicing attorney, hobbies--photography, music, collecting coins and antiques, little league, trip plan: origin home, destination airport to catch a plane for a business trip, ETA 0800 hours, accident occurred $3\frac{1}{2}$ miles from origin, $12\frac{1}{2}$ miles from destination, 22 years driving experience at an average of 18,000 miles/year, no driver education, route driven daily for 10 years, owned case vehicle 1 year, driven case vehicle - 15,000 miles, no permanent or transient physiological problems. Lap restraint utilized.

Injuries: soreness on right side of neck and top of right shoulder. AIS 1.

Driver 2, 39 years old, male, 68", 146 lbs., single, B.A. degree in sociology, occupation - psychologist's technician, hobbies--music and camping; trip plan: origin home, destination work, ETA 0800 hours, accident occurred 0.5 miles from origin, 4.7 miles from destination; 9 years driving experience, no driver education,

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a

average 16,000-18,000 miles/year, route driven daily, area very familiar, owned case vehicle 2 weeks, driven case vehicle 619 miles; borderline diabetic, overactive thyroid presently under treatment, recovering from flu, nervous, "unconventional" in his life style but in a conventional way.

Injuries: Cerebral concussion, lacerated right forehead, imbedded glass right forehead, soreness right to center abdomen, abrasion left lower leg. AIS 2.

Standards

The following Highway Safety Program Standards and Motor Vehicle Safety Standards were relevant to this case: HSPS 9, Identification of Surveillance of Accident Location and HSPS 13, Traffic Emergency Services.

Description

Pre-Crash

Driver 2 was northbound on Rengstorff. He drove into a service station on the southeast corner of Rengstorff and Old Middlefield. Finding it closed, he drove through and made a left turn onto Old Middlefield. He prepared to make a left turn onto southbound Rengstorff in order to go to another service station on the southwest corner. Vehicle 1 was eastbound on Old Middlefield in Lane E2 at a witness-estimated speed of 45 mph. As Vehicle 1 approached the intersection, Vehicle 2 turned on his left turn signal and proceeded to turn left. Driver 1 applied his brakes approximately 30 ft. before entering the intersection. Vehicle 1 left approximately 75 ft. of skidmarks up to the POI plus 5 ft. of skidmarks beyond that to POR.

Crash

Vehicle 1 impacted Vehicle 2 in the right side, pushing in the front fender, door and quarter panel. Vehicle 2 rolled over onto its left side, and Vehicle 1 spun approximately 90 degrees and came to rest in the middle of the intersection.

Post-Crash

Driver 1 stepped out of his car, walked over to the curb and sat down. A witness helped Driver 2 climb out through the broken right door window. Another witness, who had had Red Cross first aid training, examined Driver 2 for possible injuries. Police, an ambulance, and tow trucks responded to the scene. Driver 2 was taken to the hospital in the ambulance, and Driver 1 left in a private car. Both cars were towed away.

Causal Factors, Conclusions and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Causes

- | | |
|---|---|
| 1 | Driver 2 attempted an unsafe left turn in front of oncoming Vehicle 1. (definite) |
| 1 | Driver 2 was possibly thinking more of locating a gas station that was open than traffic conditions. (possible) |

Severity Increasing Factor

- | | |
|----|--|
| 1 | Driver 1 was speeding. (possible) |
| *4 | Driver 2 would not have been wearing lap restraint had there not been a buzzer warning system. |

Relevant Conditions

- | | |
|---|---|
| 1 | Driver 2 was not used to an automatic shift. (definite) |
|---|---|

Matrix Element Description (Continued)

Matrix Cell No.

(* indicates positive factor)

Explanation

Injury Causation

2

Driver 2 was wearing his lap restraint (definite) which suppressed his body movement, however it was being worn incorrectly which causes soreness to the abdomen. (definite)

2

Driver 2 was not wearing his upper torso restraint which would have lessened or prevented his head injuries. (probable)

Post-Crash Factors

*3

Witness helped Driver 2 out of vehicle. (definite)

Recommendations

1

Public education in the use of the entire restraint system and the proper way it should be worn.

4

Side window glass should be improved to prevent showering occupants with glass in lateral impacts.

E-174

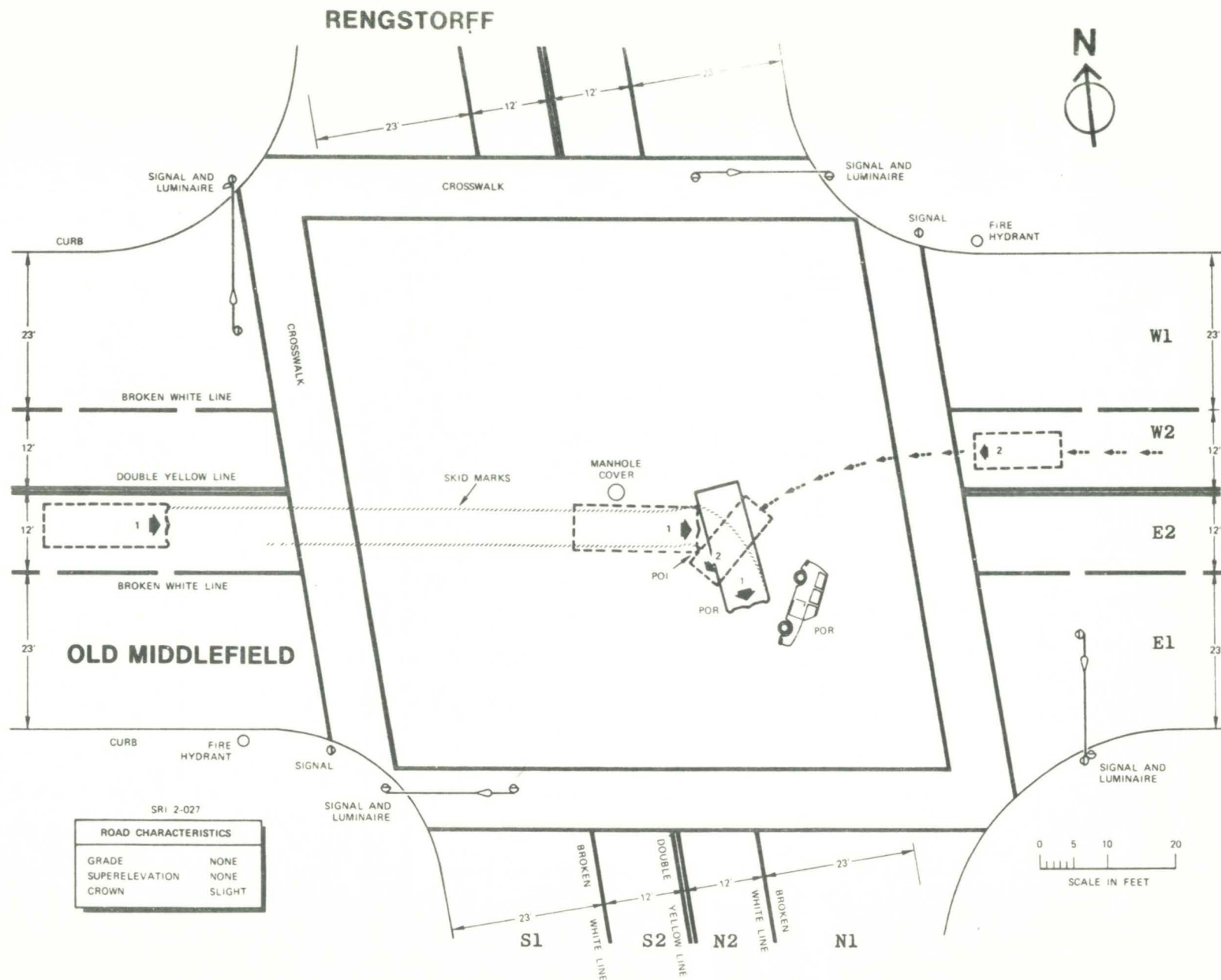


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-028

I CASE SUMMARY

(Car/Van - Intersection Lateral)

Identification

This accident occurred at the intersection of Middlefield Road and East Meadow Drive, Palo Alto, California, residential, March 11, 1973, 0030 hrs., Sunday, 2 cars - lateral, IP (injury producing) AIS* 1. Vehicle 2 apparently drove through a red light and Vehicle 1 impacted it in the right side causing it to roll over. Figure 1 is a plan view of the accident scene.

Ambience

Night, 42°F, cloudy, damp pavement.

Highway

Middlefield Road is an arterial running northwest-southeast at the intersection but referred to as north-south, 61' wide at accident site, four through lanes, left turn only lanes at intersection, bike lane on west side of Middlefield Road, asphalt, concrete gutter and barrier curb on east and west side of Middlefield, straight, slight crown, luminaire on northeast and southwest corners, 16 driveways, 1 road, and 20 poles and trees in $\frac{1}{4}$ mile on west side of Middlefield (Driver 1's right side approach), and 11 driveways, 1 road and 15 poles and trees on east side of Middlefield (Driver 1's left side approach).

East Meadow Drive is a collector road referred to as east-west at the accident site, 47' wide, two through lanes, bike lanes on north and south sides, rolled concrete gutter and curbs adjacent to sidewalks, straight, slight crown, 12 driveways and 12 poles and trees in $\frac{1}{4}$ mile on north side of East Meadow (Driver 2's right side approach) and 12 driveways, 1 road, and 18 poles and trees on south side of East Meadow (Driver 2's left side approach).

The accident history: 1969, 17 (6 injury producing); 1970, 8 (3 IP); 1971, 1 (0 IP); 1972, 4 (1 IP); total 30 (10 IP) 1969-72. Seventeen accidents involved turning movements; 9 of those were northbound vehicles turning left to westbound versus southbound vehicles.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Traffic Controls

The speed limit on Middlefield and East Meadow is 25 mph. Through lanes on Middlefield are delineated by broken white lines. The left turn only lane is separated from the southbound lanes by a solid white line and denoted by "ONLY" and a left turn arrow painted on the pavement. The northbound and southbound lanes are separated by solid double yellow lines. The bike lane on the west side of Middlefield is separated from the southbound lanes by a solid green line and denoted by a solid green triangle and "BIKES" painted on the pavement. Crosswalks at the intersection are delineated by solid white lines.

Through lanes on East Meadow are separated by broken yellow lines. The bike lanes on the north and south side are delineated by solid green lines and denoted by solid green triangles and "BIKES" painted on the pavement.

The intersection has semi-traffic actuated signals with the following timing: The green interval on Middlefield is terminated after a 35 second minimum green time when there is traffic on East Meadow waiting for a green signal. There is a 4 second yellow. There is a 10 sec. delay for East Meadow traffic to allow right turns on red without changing the light to green; if a vehicle remains within the detector loop longer than the 10 sec., the green will be activated. Initial green time is 6 sec. with 3 sec. extensions to a maximum of 28 sec. green time and 3.5 sec. yellow on East Meadow. The pedestrian cycle on East Meadow is 8 sec. walk and 15 sec. pedestrian clear.

Vehicles

Vehicle 1, car, 1970 Ford Mustang 2-door white convertible, 31,741 miles on odometer, California Highway Patrol random vehicle inspection sticker with 6-30-73 expiration date, power steering and brakes, padded dashboard and sunvisors, lap restraints, integral head restraints. No known defects, oil changed at 30,905 miles on February 10, 1973, 1 month prior to accident.

Damage: Entire front end crushed, hood buckled, radiator damaged.
CDC* 12-FDEW-2.

Vehicle 2, car, 1971 Volkswagen Type 2 Van, 3 doors and tailgate, white over blue, 36,971 miles on odometer, no inspection sticker, power brakes, padded dashboard and sunvisors, lap and upper torso restraints, head restraints not equipped (not required), defects, routine maintenance unknown.

Damage: Right rear sliding door pushed in 7 inches, right rear wheel rim bent, upper pillars bent to right by rollover, roof buckled, pavement scrapes on left side and roof, left rear suspension bent, dent in front near left A-pillar, windshield and rear window separated. CDC 03-RPEW-3.

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a.

Occupants

Driver 1, 25-year-old female, 62", 113 lbs., occupation secretary, 10 years driving experience averaging 10,000-12,000 miles annually, trip plan friend's home to own home after dinner, departure approximately 0025 hrs., expected arrival 0035 hrs., total of 3 miles, collision occurred 3/8 mile from origin, owned and driven vehicle 15 months and about 15,000 miles, drives accident route about 3 times per week, driver education and training in high school, no physical problems, general feeling of well being throughout the day, restraints not used.

Injuries: contusion at left temple, contusion on anterior right forearm, contusions on right knee and left lateral knee. AIS 1.

Driver 2, 36-year-old male, 76", 180 lbs., occupation product manager in environmental engineering corporation, 21 years driving experience at 12,000-15,000 miles per year (although seven years averaged 50,000 miles/year) in cars, trip plan party to take mother-in-law to Driver 2's home (she was visiting Driver 2 and his family) and then return to party, distance from home to party 7 miles, accident occurred 7/8 mile from home, drives accident intersection several times per week especially on weekend, learned to drive from father, purchased vehicle new in December 1970 and driven for 36,000 miles over 2-1/4 years, slight alcohol usage (4 drinks) on evening of accident (not enough in officer's opinion to arrest for drunk driving), restraints not used.

Injuries: contusions on right forehead and left temple, left side sore in area of eighth rib, anterior left arm contusions from shoulder to wrist, abrasion on right knee. AIS 1.

Standards

No standards are relevant to this case.

DescriptionPre-Crash

Driver 1 was proceeding from her boyfriend's home to her home. She had turned right onto S/B Middlefield Road $\frac{1}{4}$ mile from the East Meadow intersection. Traveling at a self-estimated speed of 25 mph in Lane S1, she approached the intersection and noticed the signal was green. Driver 2 having taken his mother-in-law to his home was returning to a party. He had turned right onto W/B East Meadow $\frac{1}{4}$ mile from the intersection and was traveling at an unknown speed in Lane W1. As Driver 1 entered the intersection she saw Vehicle 2 approaching from her left. She applied her brakes leaving no skid marks on the damp pavement.

Crash

Vehicle 1 impacted Vehicle 2 behind the right front wheel. Vehicle 2 moved to the right relative to Vehicle 1 damaging the right rear wheel, then began to roll over and spin clockwise. As Vehicle 2 continued to spin, it slid onto the sidewalk impacting a utility pole guy wire. This impact righted the vehicle and it came to rest a few feet away. Vehicle 1's path was deflected slightly to the right and came to rest at the southwest corner of the intersection. Vehicle 1 received 10 inches of front end crush; the hood was buckled. Unrestrained Driver 1 received a contusion on the left temple and dorsal right forearm; the left lateral knee and right knee received contusions due to contact with the parking brake release and lower instrument panel. Unrestrained Driver 2 received contusions on the left temple and left anterior arm from shoulder to wrist, probably from impact with the side interior of the left door during rollover. His right knee received an abrasion and right forehead a contusion.

Post-Crash

Driver 1 exited through the left door which had temporarily jammed. Emotionally shaken by the experience, she sat on the curb and began crying. Firemen from the fire station on the corner of the accident intersection called police and began to check Driver 1 for vital signs as he regained consciousness. An ambulance responded and took both Driver 1 and Driver 2 to the hospital.

Driver 2 was charged with failure to stop for a red light, CVC 21453A. He could not remember anything about the accident and, therefore, did not know how to plead. He decided to allow the judge to read the report and make the decision in the case. A plea of not guilty was entered in court on April 5 and the judge found Driver 2 guilty on April 6 and fined him \$19.

Causal Factors and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationPrimary or Principal Cause

1

Driver 2 drove through a red light. (probable)

Severity Increasing Factor

1

Driver 1 was worried about staying in her proper lane and apparently did not scan the intersection approaches before entering. (possible)

Relevant Conditions

1

Driver 2's attention may have been on his conversations with his mother-in-law who he had just dropped off at his home. (possible)

Injury Causation

2

Both drivers were unrestrained. (definite)

Recommendations

7

The use of an in-vehicle driver aid to alert driver to signal status on approaching intersections should be studied with regard to solving the driver inattention problem.



FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-029

I CASE SUMMARY

(Motorcycle/Car - Head-on)

Identification

This accident occurred at the intersection of Foothill Expressway and Main Street, Los Altos, California, urban, March 12, 1973, 0745 hours, Monday, motorcycle car - head-on, IP (injury producing) AIS* 4. Figure 1 is a plan view of the accident scene.

Ambience

Day, 45°F, 49% relative humidity, light winds, good visibility, dry pavement.

Highways

Main Street, local, south of Foothill Expressway: 36 ft wide, 2 traffic lanes, 2 turn lanes, no divider, asphalt concrete pavement, curbs near intersection, straight, level, slight crown. North of Foothill Expressway: 49 ft wide, 2 through traffic lanes, 3 turn lanes, raised median 10 ft at widest area, asphalt concrete pavement, curbs, straight, level, slight crown. Number of accidents at intersection: 1969, 3 (1 injury producing); 1970, 7 (3 IP); 1971, 1 (1 IP); 1972, 3 (1 IP); total 1969-72 14(6 IP). Nine accidents involved one driver disregarding a signal.

Traffic Controls

Main Street: 25 mph, opposing lanes separated by double yellow lines, southbound lanes separated by broken white lines, left and right turn lanes indicated by white pavement arrows and word ONLY; straight lane indicated by straight pavement arrow. Green information sign FOOTHILL EXPRESSWAY, white KEEP RIGHT and LEFT LANE MUST TURN LEFT signs and yellow diamond sign with red reflectors in center island all for southbound Main. Pedestrian crosswalks delineated by solid white lines.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Traffic signal cycle lengths: Main, initial green 6 seconds, vehicle interval 3.5 seconds, maximum green 28 seconds, yellow 3.3 seconds; Foothill Expressway, initial green 15 seconds, vehicle interval 7 seconds, maximum green 45 seconds, yellow 4.3 seconds; minor movement controller cycle (for left turn phase on Foothill), initial green 4 seconds, vehicle interval 3 seconds, maximum green 20 seconds, yellow 3 seconds. Recall is ON for Foothill.

Vehicles

Vehicle 1, motorcycle, 1968 Triumph Trophy 250, white/black, 8737 miles, no inspection sticker, no evidence of pre-crash defects.

Damage: front wheel bent, front fork bent and twisted, fuel tank dent, rear brake pedal bent, seat came loose, fins on diode heat sink broken. (No CDC for motorcycles.)

Vehicle 2, car, 1971 Peugeot 504 4-door sedan, green, 22,764 miles, no inspection sticker, power brakes, padded dash and sun visors, 2-point restraint system, no evidence of pre-crash defects, routine maintenance performed one month before accident.

Damage: right front fender dented, windshield cracked, RF wheel opening damaged, denting and scraping on right upper C-pillar and both doors. CDC* 02-LFEW-1.

Occupants

Vehicle 1 motorcycle. Driver, male, 16 years old, 70 inches, 160 lbs., single, high school junior, hobby--working on motorcycles, trip plan home to friend's house to school, ETD 0730, ETA 0815, accident occurred 1 mile from origin, driver education in high school, riding motorcycles for ~2 years, owned case vehicle 6 months, drives route twice-a-day, could not estimate number of miles he rides per year. Good physical condition. Smokes marijuana daily, returned home one week prior to accident after family disagreement. Was not wearing helmet or goggles.

Injuries: fracture of superior rim of left orbit; 3-cm laceration, left front hair line area; cerebral concussion, bulging left tympanic membrane without discoloration, small cut on outer left ear, various abrasions on left side of face; lacerations and abrasions left side neck ~8 inches long; tender left shoulder, burn abrasions on right arm, scrapes on both shins, 2-cm laceration medial right ankle. AIS 4.

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a.

Vehicle 2, car. Driver, male, 53 years old, 68 inches, 190 lbs., married, occupation: accounting (management), trip plan: probably home to work. Accident occurred ~3 miles from home, route familiarity: probably very familiar, owned case vehicle 14.5 months. Driver's attorney would not consent to SCAT's questioning Driver 2.

Injuries: Unknown--possibly none.

Standards

The following Highway Safety Program Standards and Motor Vehicle Safety Standards were relevant to this case:

HSPS 3. Motorcycle Safety. California law does not require safety helmets be worn which would have eliminated most of Driver 1's injuries.

Description

Pre-Crash

Vehicle 1 was southbound in Lane S1 on Main Street. Vehicle 2 turned right onto Main Street ~100 ft south of the intersection. Vehicle 2 now northbound in Lane N1 proceeded to turn left onto Foothill Expressway. Driver 2 did not notice Vehicle 1 approaching. When Driver 2 did notice Vehicle 1, he thought he would speed up, hoping that Vehicle 1 would be able to go behind him.

Crash

Vehicle 1 impacted Vehicle 2 in the right front wheel. The front wheel of the motorcycle turned to the right and was caught in Vehicle 2's wheel opening. Driver 1 was thrown forward, contacted his head and face on the upper rim of the windshield frame and the windshield, then fell to the ground next to the right rear wheel of Vehicle 2. The motorcycle moved upward and swung to the left, causing damage to the right front fender and minor denting to both right doors of the cars. The motorcycle came to rest on end with its front wheel on the ground and its rear wheel above ground resting on the side of Vehicle 2; fuel was leaking from the tank.

Post-Crash

The motorcycle was laid on the ground by witnesses who noticed leaking fuel. Police and an ambulance were called. Driver 1 was taken to the hospital. Two tow trucks arrived, debris was cleared and vehicles were removed from the scene. Driver 2 was not cited. (Complaint for failure to yield was refused for lack of evidence.)

Causal Factors, Conclusions and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* Indicates positive factor)

ExplanationAccident CausationPrimary or Principal Causes

1 Driver 2 failed to see Vehicle 1 approaching intersection. (definite)

Severity Increasing Factor

1 Driver 2 misjudged the speed of the motorcycle once it was seen. (possible)

6 Fuel leaked from Vehicle 1 at its upended position of rest. (definite)

*3 Witnesses laid Vehicle 1 down to stop fuel leakage. (definite)

Relevant Conditions

7 Sun on the windshield prevented Driver 2 from seeing Vehicle 1 approaching. (possible)

2 Driver 1 was not wearing a safety helmet. (definite)

Matrix Element Description (Continued)Matrix Cell No.

(* Indicates positive factor)

ExplanationRecommendations

- | | |
|---|--|
| 1 | With the increasing number of motorcycles on the highway, motorists should be informed or trained in looking for motorcycles when they make their maneuvers. |
| 1 | Motorcyclists should be required to wear safety helmets. |
| 4 | Motorcyclists should be required to drive with headlight on at all times. |

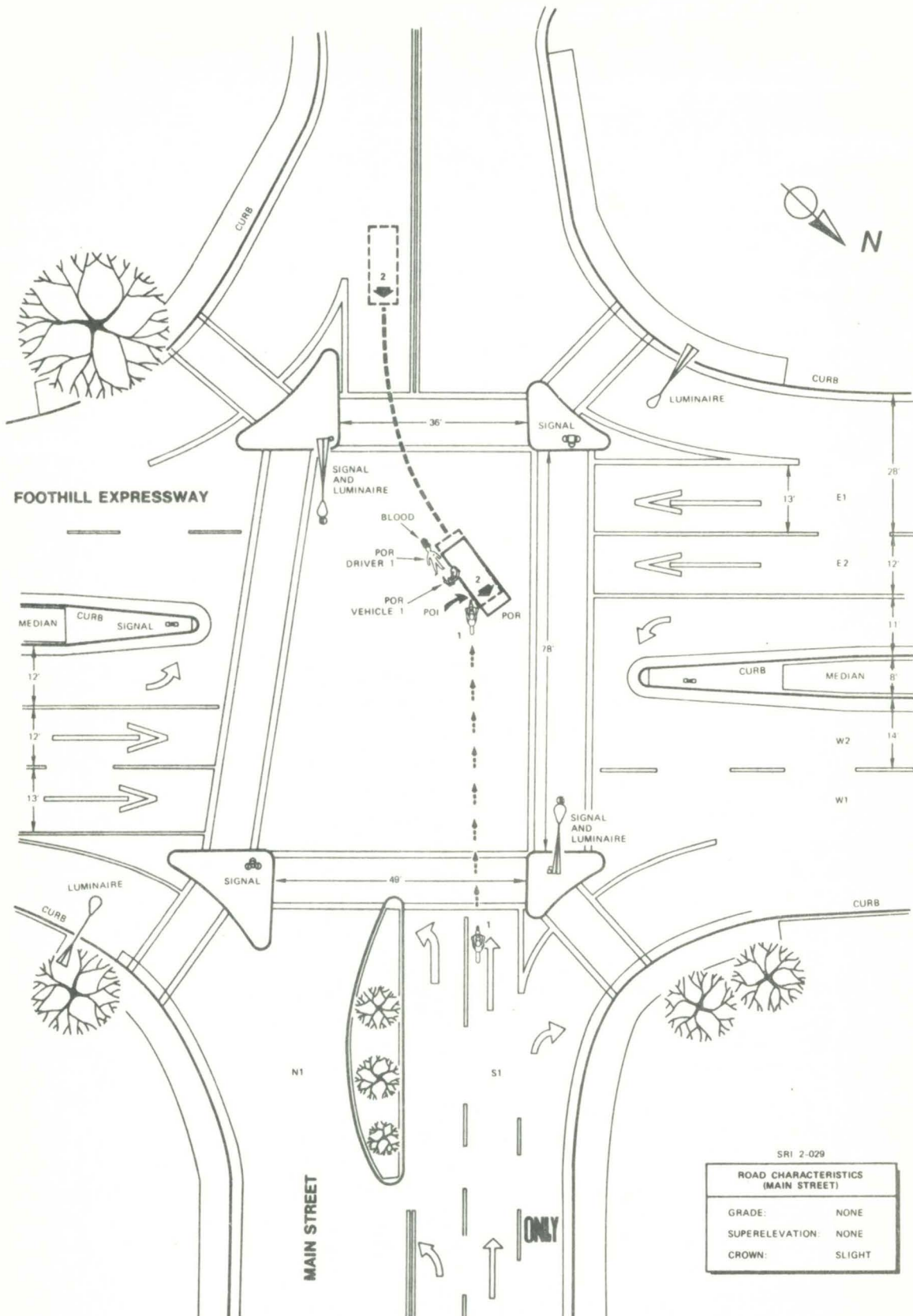


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-030

I CASE SUMMARY

(Car/Parked Car - Rear End--Lateral)

Identification

This accident occurred on Alma Street in the 3100 block, Palo Alto, California, open roadway, residential area, March 13, 1973, 2030 hrs., Tuesday, 2 cars--car into parked car. IP (injury producing) AIS*1. Figure 1 is a plan view of the accident scene.

Ambience

Night, 57°F, calm, dry pavement.

Highway

Alma Street is a major arterial, 51.5 ft wide, 4 lanes undivided, asphaltic concrete surface, curb on east side, dirt shoulder on west side, straight, level, moderate crown, mercury vapor luminaires, 65 poles and trees, 16 driveways and 1 street in the last 1/4 mile traveled by Vehicle 1. Twelve accidents from 1967 to October 1972 in the 3100 block. The average daily traffic for Alma near the 3100 block is 15,242 vehicles northbound and 13,469 vehicles southbound (Wednesday, July 5, 1972); the volume for the hour ending at 2100 is 622 vehicles northbound and 526 vehicles southbound.

Traffic Controls

Post speed limit 35 mph, solid double yellow lines with raised amber reflectors dividing northbound and southbound lanes, broken white lines with clear reflectors separating curb and center lanes, no signals in vicinity of accident site. Parking is permitted on the east side of the street.

Vehicles

Vehicle 1, car, 1970 Volkswagen Karmann Ghia, 2-door, orange, convertible, 18,528 miles on odometer, no inspection sticker, no power accessories, padded dash and sunvisors, lap and upper torso restraints equipped, head restraints, left and

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

right front tires showed underinflation wear, oil change and vehicle diagnosis performed at 12,000 miles on May 11, 1972, damage to right front fender and door, wheelbase shortened by 2.5 inches on right side, fuel leakage from filler neck, occupant contact on instrument panel, windshield, sunvisor, CDC* 12-FREE-5.

Vehicle 2, car, 1964 Chevrolet Impala, 4-door, white, hardtop, odometer reading 120,106, inspection data unknown, power steering and brakes, padded dash and sunvisors, lap restraint equipped, defects unknown, maintenance unknown, damage to left rear door and left rear fender. CDC 06-BLEE-4.

Occupants

Driver 1, 31-year-old female, 66", 110 lbs., married, occupation artist (formerly a secretary) and housewife, hobbies include sewing, reading and gardening, three years driving experience at 5,000 miles per year, trip plan home to gas station to undecided destination, accident occurred 2½ miles from home, owned vehicle three years and driven about 15,000 miles (husband drives it occasionally), drives accident route about once per week, other driving 10% freeway, very little at night (she says she "can't see anything"), learned to drive at commercial driving school in Nebraska (approx. 1 class lecture and three sessions behind the wheel), received first license in Nebraska in 1970, asthmatic condition (better since moving to California), argument with husband prior to accident (reason for taking the drive "to cool off"), reporting officer observed odor of alcohol (no tests given), restraints not used.

Injuries: laceration right upper forehead, bloody nose, abrasions on left and right knees. AIS 1.

Vehicle 1, a small dog was also present in front seat of vehicle. No injuries.

Vehicle 2 was parked at the curb and unoccupied. The owner is a 46-year-old male. He rarely parks the vehicle on the street.

Standards

The following Motor Vehicle Safety Standard (MVSS) is relevant to this case:

MVSS 301. Fuel Tanks, Fuel Tank Filler Pipes, and Fuel Tank Connections. Fuel leaked from filler pipe of Vehicle 1 after collision.

Description

Pre-Crash

Driver 1 had just had an argument with her husband and had left the house to "cool off." She stopped at a gas station and then proceeded northbound in the slow lane (N2) at estimated 35 mph. She was emotionally upset and crying. Two and one-

* Collision Deformation Classification, Society of Automotive Engineers, Technical Report J224a.

fourth miles from home she said she heard a loud noise which she assumed was a blowout but really was her initial impact with the left rear of parked Vehicle 2.

Crash

Vehicle 1's right front fender impacted parked Vehicle 2 in the left rear. Vehicle 1 spun clockwise as viewed from above, and impacted Vehicle 2 in the left rear door. Driver 1's nose hit the steering wheel causing a nosebleed and her head hit the windshield causing a laceration. Both knees hit the lower instrument panel receiving abrasions.

Post-Crash

Driver 1 says she became hysterical. The police suggested that she go to the hospital but she declined. Her husband was called and came to pick up her. She went to the doctor the following day.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Cause

1

Driver 1 did not have her attention on her driving (probable)

Severity Increasing Factor

7

Vehicle 2 was at side of road legally parked (definite)

Matrix Element Description (Continued)Matrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationRelevant Conditions or Modifying Factors

1

Driver 1 was emotionally upset and crying due to an argument with her husband. (definite)

Injury Causation

2

Driver 1 was not wearing restraints. (definite)

Recommendations

1

Drivers emotionally upset should be discouraged from driving.

FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-032

I CASE SUMMARY

(Car--Ran off Road/Hit Object/Rollover)

Identification

This accident occurred on U.S. Route 101 (approximately milepost 43.3) and Wildwood Avenue, Sunnyvale, California, freeway and local road, agricultural and residential area, March 25, 1973, 0230 hrs., Sunday, car ran off road, impacted and went under freeway fence, rolled over on local road, IP (injury producing) AIS* 1. Figure 1 is a plan view of the accident.

Ambience

Night, 55°, calm, good visibility

Highway

U.S. Route 101 is a full freeway, 134' wide (includes shoulders), six lanes, 42.5' median with cable barrier 15' from the southbound lanes, northbound lanes asphaltic concrete, southbound lanes portland cement concrete, 8.5' paved shoulder and 11' dirt area to right of northbound lanes and 7' paved shoulder to right of southbound lanes, straight, level, no accesses within 1/4 mile, no poles or trees within 1/4 mile, accident history between mileposts 42.8 and 43.8, northbound: 1969, 17 (6 injury producing); 1970, 5(1 IP); 1971, 8(4 IP). One each of the IP accidents in 1969 and 1971 were fatals.

Wildwood Avenue is a local road, 32' wide in the area of the accident site, two lanes, curb and concrete gutter on both sides, separated from U.S. 101 by chainlink freeway fence.

Traffic Controls

Speed limit 65 mph on U.S. 101, lanes delineated by broken white lines with white Bott's dots and retromarkers, double yellow lines separating fast lanes from median area, solid white line separating northbound lanes from paved shoulder on

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

right, "Sunnyvale City Limit" sign on wooden posts in dirt area to right of paved shoulder adjacent to northbound lanes.

Wildwood Avenue lanes separated by broken yellow line.

Vehicle

Vehicle 1, car, 1972 BMW 2002 2-door blue sedan, 24,664 miles on the odometer, no inspection sticker, power brakes, padded dash, lap and upper torso restraint (with inertia reel), head restraints, owner/driver stated front end out of alignment (pulled to right), changed oil, plugs, points on day of accident.

Damage: dents and scrapes on right side and top from fence, pavement scrapes on roof and left side, left rear suspension bent, right rear suspension control arm pivot separated, left door glass shattered. CDC 01-RDES-1 (primary), 00-LPAO-1 (secondary), 12-FCEN-1 (tertiary).

Occupants

Driver 1, 21-year-old male, 69", 140 lbs., occupation telephone installer, hobbies include listening to records and growing plants, 5 years driving experience at 20,000 miles per year, trip plan friend's (social) to home, distance of 12-1/2 miles, collision occurred 4-3/4 miles from home, purchased vehicle new in July 1972 (8 months prior to accident) and driven for 24,664 miles, drives accident route about 4 times a year, 40% driving on freeways and in daytime, driver education in high school (including use of simulator), general feelings of well being, had "a couple of beers" and probably smoked marijuana, restraints not used.

Injuries: lacerations on forehead, soreness in left upper leg near hip, both eyes black. AIS 1.

Standards

The following Motor Vehicle Safety Standard was relevant to this case:

MVSS 301. Fuel Tanks, Fuel Tank Filler Pipes, and Fuel Tank Connection. Contact with the fence posts ripped off the side-mounted fuel filler cap and fuel spilled when Vehicle 1 rolled over.

Description

Pre-Crash

Driver 1 apparently fell asleep and allowed Vehicle 1 to drift off the pavement onto the 22 ft wide dirt shoulder. Driver 1 woke up and tried to steer to the left to get back on the road but was unable to do so before reaching the point where the shoulder narrows to 13 ft.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

Crash

Vehicle 1 impacted the fence and slid along the fence for approximately 20 ft and knocked down several fence support posts. Vehicle 1 then passed under the fence and began to spin as it entered Wildwood Avenue. It apparently rolled over one complete turn plus 90 degrees, finally coming to rest on its left side pointing opposite to its original direction of travel.

Post-Crash

City of Sunnyvale police responded to the scene and requested an ambulance. Vehicle 1 was righted, Driver 1 was assisted from the vehicle and was taken to the hospital by ambulance. A California Highway Patrol unit was called to the scene when it was determined that the accident originated on U.S. 101, and was therefore under CHP jurisdiction. A tow truck arrived on scene, and the tow driver swept up some of the loose debris before removing the vehicle. A large amount of glass was left on the road.

Causal Factors and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationPrimary or Principal Cause

1 Driver 1 fell asleep while driving (definite)

Severity Increasing Factors

1 Driver woke up when vehicle left the road, but was unable to avoid collision (probable)

7 Shoulder narrows at point of impact (definite)

Matrix Element Description (Continued)Matrix Cell No.

(* indicates positive factors)

ExplanationAccident CausationRelevant Condition

1

Driver 1 had been drinking beer (definite)
and may also have smoked marijuana (probable)

Injury Causation

2*

Although unrestrained, Driver 1 received only
minor injuries (definite)

Recommendations

8

Fences along side of freeways should be
strengthened to prevent penetration.



SRI 2-032

ROAD CHARACTERISTICS	
GRADE	NONE
SUPERELEVATION	NONE
CROWN	NEGLIGIBLE

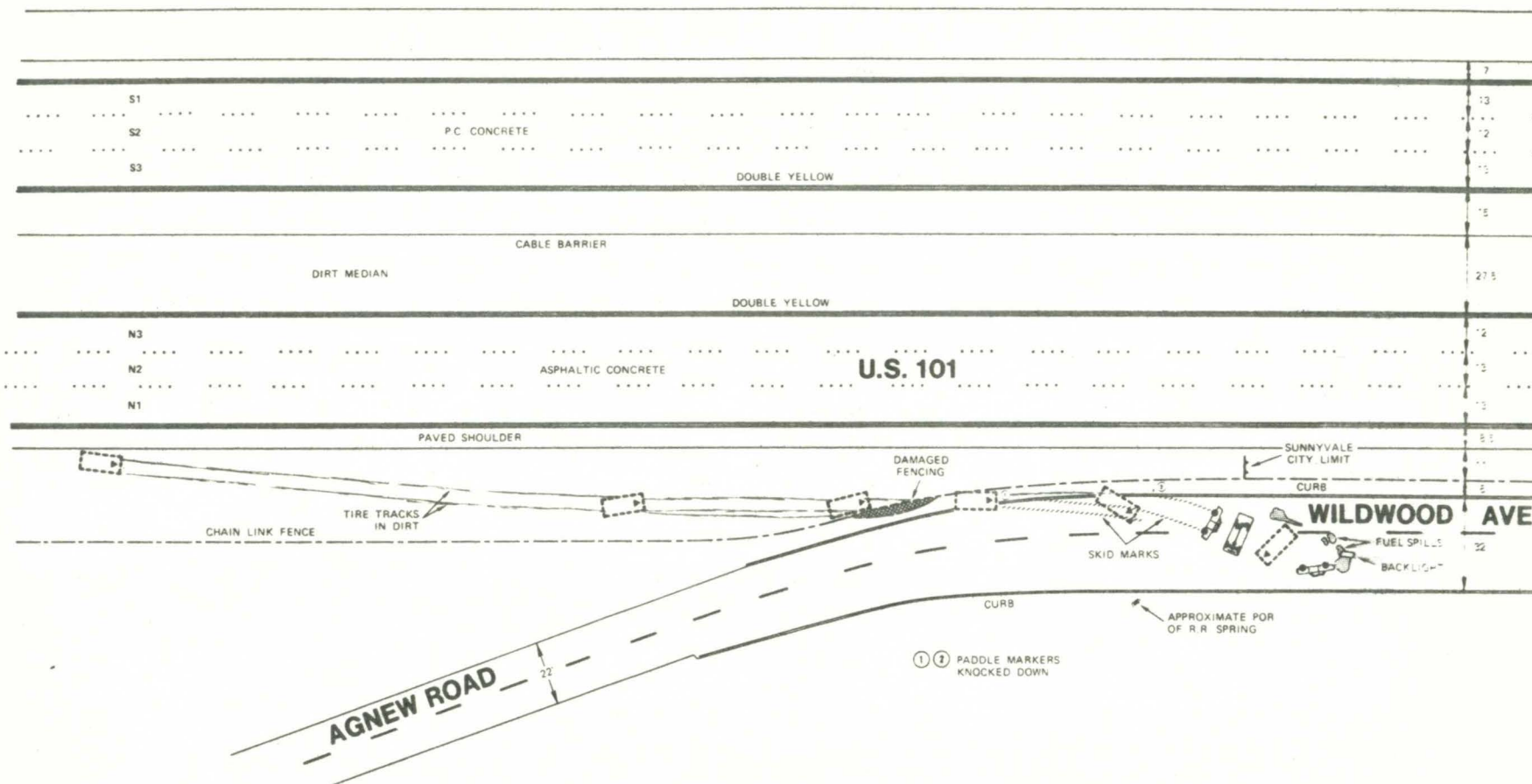


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-033

I CASE SUMMARY

(Van/Pickup Car/Car - Lateral Intersection)

Identification

This accident occurred at the intersection of State Route 237 and North 1st/Taylor Street, San Jose, California, intersection, agricultural area, March 26, 1973, 1030 hrs., Monday, van and car into pickup car, IP (injury producing) AIS* 1. Figure 1 is a plan view of the accident.

Ambience

Day, 67°F, relative humidity 68%, wind 0-3 mph from south, pavement dry.

Highway

State Route 237 is an east-west expressway, divided in the area of the accident, 110' wide, 4 through lanes, 20' wide dirt median with curb to left of left turn lane, asphaltic concrete surface, 4' paved shoulder on south edge of 237, straight, slight crown, no accesses and 2 poles in last 1/4 mile, traveled by Vehicles 1 and 3.

North First/Taylor Street is a local road northwest of the intersection and a minor arterial southeast of the intersection. It is approximately 45' wide, two lanes, no divider, asphaltic concrete, straight, 4 driveways and 17 poles and trees in last 1/4 mile traveled by Vehicle 2.

The accident history for the intersection: 1970, 13 (4 Injury Producing); 1971, 28 (8 IP); 1972, 26 (4 IP); total 1970-72, 67 (16 IP). Over one-half of accidents were rear enders with eastbound predominant; slightly more than one quarter were right angle with most involving southbound vehicles.

Traffic Controls

The speed limit on 237 is 55 mph and on Taylor is 40 mph. Through lanes on 237 are separated by white Botts dots. The south edge of the road is delineated by a solid white line and the left turn channel on the north edge of the eastbound lanes

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

is separated from through lanes by a solid white line and marked by a white turn arrow and the word ONLY. Solid white limit lines extend from traffic islands to the extension of the left turn channel solid white line. After the intersection double yellow lines separate the north edge of the eastbound lanes from the dirt median.

Lanes on Taylor Street are separated by double yellow lines. Solid white limit lines extend from traffic islands to the double yellow lines.

Yellow rectangular SIGNAL AHEAD sign with flashing yellow lights on overhead mast arm and white painted words SIGNAL AHEAD about 800 feet before and green TAYLOR ST/FIRST ST information sign on left side just before left turn channel on Route 237 at intersection with North First. Yellow diamond SIGNAL AHEAD sign about 500 feet ahead and green MILPITAS/237/MOUNTAIN VIEW information sign on right side of Taylor St. just before intersection with Route 237.

The signals at the intersection are set and maintained by the State Division of Highways. At the time of the accident the signals were not working.

Vehicles

Vehicle 1, van, 1972 Chevrolet Chevy Van 10, 5 doors, green, 21,096 miles, California Highway Patrol inspection sticker, expiration date December 31, 1972 (random motor vehicle inspection program), power steering, padded dash and sunvisors, lap restraint equipped, no head restraints required or equipped, irregular tire tread wear noted on left front and rear and right front tires (cupping), routine maintenance performed on February 26, 1973, at 20,234 miles.

Damage: to left front from impact with Vehicle 2 and to front from impact with signal pole, CDC* 12-FCAN-4 (primary) and 11-FLEE-2 (secondary).

Vehicle 2, pickup car, 1965 Ford Falcon Ranchero, 2 doors, white, 70,503 miles on odometer, no inspection sticker, no power accessories, no padding, equipped with lap restraints but belts not pulled through seat back, left front and left rear shock absorbers degraded, routine maintenance performed at 70,128 miles (date unknown).

Damage: to right front fender at wheel and left rear behind wheel, roof damage from shifting cargo, CDC 02-FREW-4 (primary), 03-RBEW-3 (secondary), 00-TPGN-1 (tertiary).

Vehicle 3, car, 1971 Datsun 510 4-door, white, sedan, 25,711 miles on odometer, no inspection sticker, air conditioning, padded dash, sunvisors, lap and upper torso restraints, head restraints, no known defects, routine maintenance on March 17, 1972 at 12,551 (more recent unknown).

Damage: to left front fender, CDC 11-FYEW-2.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a

Occupants

Driver 1, 70-year-old male, 64", 134 lbs., retired oil worker, widowed, 54 years driving experience, at 14,000 miles per year, trip plan home to town of Modesto to visit family, a distance of 60 miles, no ETA, accident occurred 5 miles from home, purchased vehicle new in November 1971, has driven for 21,000 miles. Drives accident route about once per month, learned to drive in Texas "by getting behind the wheel," obtained first license in California in 1928. Physical and mental condition good, wears bifocal glasses, takes pills "to keep his blood thin," had heart attack in 1966, lap restraint used.

Injuries: chest sore, right hand abrasion. AIS 1.

Driver 2, 70-year-old male, 67", 143 lbs., occupation retired, married with eight grown children, 52 years driving experience, could not estimate miles per year, trip plan returning from an auction to home a distance of 7-1/2 miles, accident occurred 1 mile from the auction, purchased vehicle used six months prior to accident from car dealer, drives accident route perhaps twice a year, taught self to drive, physical and mental condition unknown, restraints not used.

Injuries: lacerations on head, bruised right shoulder area, bruised and sore left upper leg. AIS 1.

Driver 3, 18-year-old female, 65", 124 lbs., married, probably 1 year driving experience, trip plan home in Saratoga to Modesto to pick up two vehicles, a distance of 75 miles (accident occurred 15 miles from origin), borrowed Vehicle 3 from mother-in-law, probable high school driver education, physical and mental problems unknown, restraints not used.

Injuries: bruise on left side of head from windshield impact, and on right knee; laceration on right knee. AIS 1.

Vehicle 3, right front passenger, 20-year-old female, 67", 130 lbs., restraint not used.

Injuries: bruise on left knee. AIS 1.

Vehicle 3, right rear passenger, 20-year-old female, 62", 120 lbs., restraint not used.

Injuries: none

Vehicle 3, center rear passenger, 1-1/2 year old female, 30", 25 lbs., no restraints.

Injuries: none.

Standards

The following standards were relevant to this case:

HSPS 15, Police Traffic Services. Police reported traffic signal malfunctioning about 1 hour prior to accident but did not perform traffic control.

HSPS 13, Traffic Engineering Service. Malfunctioning traffic signal was reported but action not taken immediately.

DescriptionPre-Crash

Vehicle 2 was southbound on Taylor St. approaching State Route 237. Driver 2 noticed that the signal was not working, so he stopped at the intersection. He said that drivers to his left (westbound on 237) stopped and motioned him to go ahead. Vehicles 1 and 3 were both eastbound on 237 approaching Taylor/N. First followed by a witness. Vehicle 1 was in the slow lane going 40 mph and Vehicle 3 was in the fast lane going 50 mph. The witness noticed that the signal wasn't working and slowed down. Vehicle 2 proceeded into the intersection. Driver 3 noticed it and applied her brakes, leaving 18-20 ft of skid marks. Driver 1 took no evasive action.

Crash

Vehicles 1 and 3 impacted Vehicle 2 almost simultaneously, Vehicle 1 with its left front corner to Vehicle 2's right front fender and Vehicle 3 left front corner to Vehicle 2 right rear fender. Vehicle 2 was deflected to the left and came to rest in Lane E1 adjacent to a traffic island. Vehicle 1 was deflected to the right, impacted the curb of the island and the signal and luminaire pole receiving damage to the center front. Vehicle 1 continued across the island, impacted another curb and came to rest in weeds. At impact, loose cargo in the bed of Vehicle 2 hit Vehicle 3's windshield. Vehicle 3 spun to the right and came to rest in Lane N1. Upon impact with the pole, lap belted Driver 1's chest hit the steering wheel and his right hand slid up the upper dashboard receiving an abrasion. Unrestrained Driver 2 probably moved toward the right of the vehicle. He received a bruised right shoulder and lacerations in his head. His left outer thigh was bruised. Driver 3 hit the left side of her head and the right knee received a laceration and contusion. The unrestrained right front passenger hit her left knee on the dashboard. The right rear passenger grabbed the baby and laid down on top of her on the seat; neither was injured.

Post-Crash

A witness stopped and went over to occupants in Vehicle 3. Each driver waited a short period before exiting from his vehicle. Driver 3 was "hysterical" according to the witness who tried to calm her down. Police and ambulance arrived. Driver 2 was removed to the hospital, examined and released. Tow trucks responded to remove all three vehicles. Fire truck responded to wash down the roadway. California Division of Highways personnel responded to turn off the hot wires from the knocked down pole and to put other signals on a flashing mode. Police took Vehicle 3 occupants home and SCAT drove Driver 1 home.

Causal Factors and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factors)

ExplanationAccident CausationPrimary or Principal Causes

- | | |
|---|---|
| 1 | Eastbound Drivers 1 and 3 did not slow at intersection, even though signals were not working (definite) |
| 1 | Southbound Driver 2 stopped, was motioned on by cars to his left and proceeded into intersection (probable) |

Relevant Conditions

- | | |
|---|--|
| 7 | Signals at intersection were out (and not flashing) (definite) |
| 7 | Police officer reported signal malfunction an hour prior to accident but did not remain at scene to control traffic (definite) |

Matrix Element Description (Continued)Matrix Cell No.

(* indicates positive factors)

ExplanationInjury Causation

2

Occupants in Vehicle 3 were not wearing restraints (definite)

Post-Crash Factors

3*

Witness helped calm down Driver 3 (definite)

Recommendations

7

Police officers should carry warning devices, such as large signs, to place at intersections containing malfunctioning signals before the maintenance personnel arrive

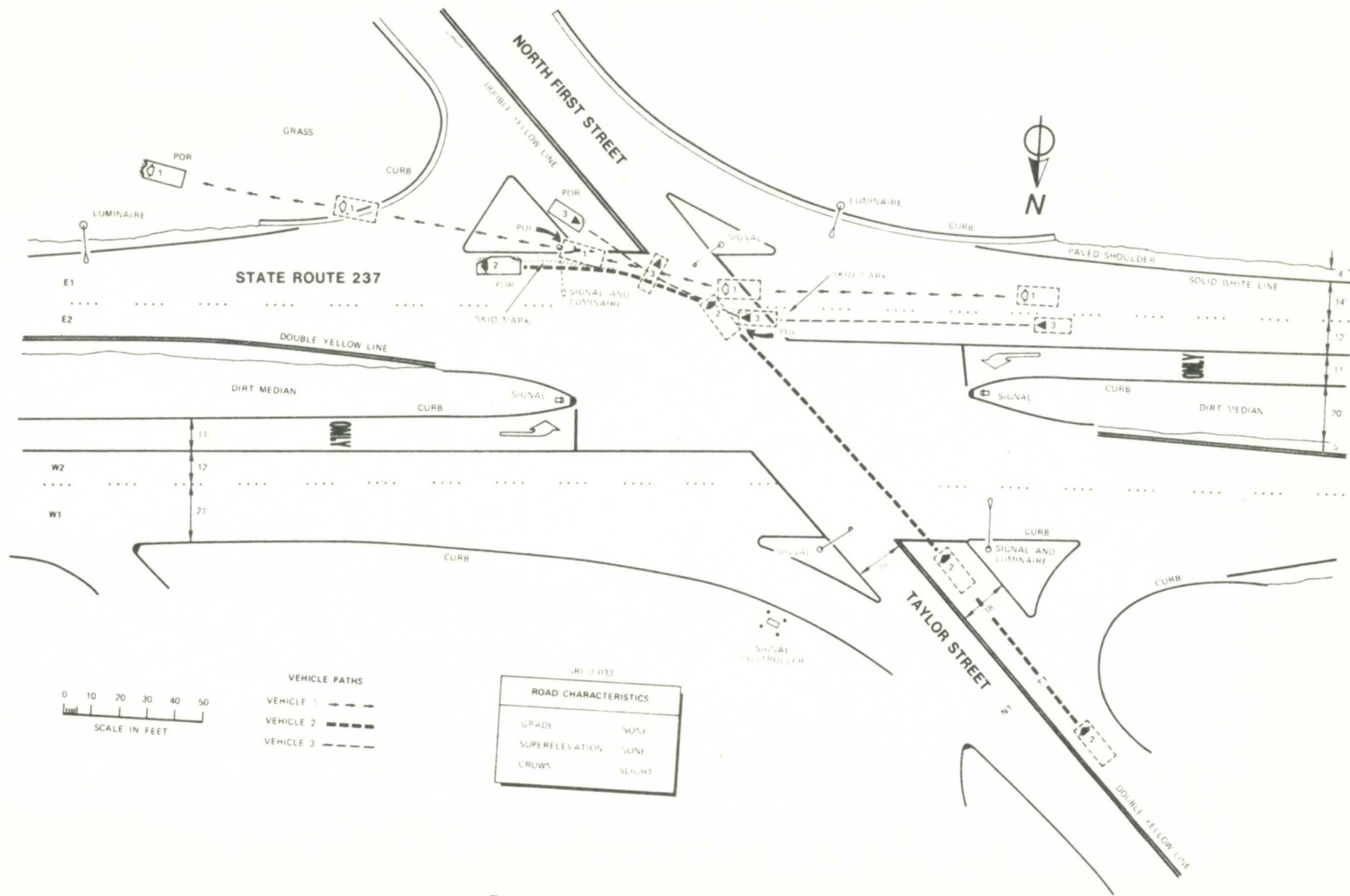


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-034

I CASE SUMMARY

(Car/Car - Sideswipe, Car/Pole/Pole, Pole/Camper)

Identification

This accident occurred on Willow Road between Bayshore Freeway and Chester St., Menlo Park, California, mixed commercial, hospital and residential area, April 5, 1973, 1516 hours, Thursday. Vehicle 1 hit median, sideswiped Vehicle 2, crossed median, impacted and broke utility pole, slid into chain link fence and impacted steel sign pole. Utility pole impacted camper driving in opposite direction. Fatal AIS* 6. Figure 1 is a plan view of the accident scene.

Ambience

Day, 78°F, 65% relative humidity, light wind, good visibility, dry pavement.

Highway

Willow Road, major arterial, approximately 67 ft wide (varies slightly), 4 lanes plus left turn lanes, raised Portland cement concrete median 4 ft. wide, asphaltic concrete pavement, P.C. curbs both sides, straight, level, slight crown, 6 accesses and 13 poles/trees (both sides of street) in last 1/4 mile traveled by Vehicle 1, 11 driveways, 3 streets and 31 poles/trees (both sides of street) in last 1/4 mile traveled by Vehicle 3.

Accident history: 1969, 5 (1 Injury Producing); 1971, 10 (4 IP); 1972, 5 (0 IP). Three year total, 20 (5 IP).

Traffic Controls

Speed limit 35 mph, traffic lanes separated by broken white lines, left turn lanes delineated by solid white lines, arrows on pavement (see Figure 1), MERGING TRAFFIC, KEEP RIGHT; and speed limit signs, no signals.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Vehicles

Vehicle 1, car, 1969 Buick Skylark Custom, 4-door hardtop, black vinyl over blue, 57,429 miles, no inspection sticker, power steering, padded dash and sunvisors, 4-point restraint system, maintenance unknown.

Damage: moderate damage to right front fender from sideswiping Vehicle 2, severe damage to front end and grille from utility pole, damage to right front and rear fenders from fence, and major deformation of right A-pillar and right front door from steel sign post. CDC* 02-RPAN-4 (primary), 12-FCEN-1 (secondary), 01-FREE-1 (tertiary).

Vehicle 2, car, 1965 Ford Galaxie 500, 2-door hardtop, metallic tan, 27,867 miles, no inspection sticker, power steering and power brakes, padded dash, lap restraints, owner complaint of steering "acting funny," possible alignment or power steering problem, maintenance unknown.

Damage: Minor sideswipe damage from left lower C-pillar to left A-pillar. CDC 07-LZMS-1

Vehicle 3, camper-van, 1971 Chevrolet Chevy Van 30, white, odometer not functioning, (driver estimates "maybe 600"), no inspection sticker, power steering and power brakes, padded dash and sunvisors, lap restraints, no maintenance performed.

Damage: Dent in right front corner of hood, right upper A-pillar buckled, windshield leader and roof side rail over right front door bent, windshield out, other dents on right side of camper body. CDC 12-FDHN-6.

Occupants

Vehicle 1, driver, male, 70 years old, 66", 190 lbs., retired construction worker, driving experience over 32 years, trip plan home to drug store 0.8 miles, collision occurred 0.2 miles from destination, annual mileage estimated at 10,000 miles, driven vehicle approximately 4 years and approximately 57,000 miles, drives accident route daily, driver education unknown (improbable), physical condition high blood pressure, but complained "about his head" the day of the accident, blood alcohol 0.26 grams % (autopsy finding), driving record shows one violation and one accident, restraints not used.

Injuries: subarachnoid hemorrhage, fractured calvarium, cortical contusions, right occipital lobe, petechial hemorrhage pons, cerebral edema, right fractured ribs 1-5, right pulmonary contusions, multiple lacerations liver, contusion and swelling right side of head. AIS 6.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

Vehicle 1, right front passenger, female, 65 years old, 63", 198 lbs., wife of driver, no restraint used.

Injuries: transverse fracture right fibular head, oblique deep laceration lower right fibular head down to muscle fasciae and 3 cm. L-shaped laceration medial part of right proximal medial tibia (dirty with chips of blue paint and contusions), transverse fracture right humerus shaft (upper third), transverse fracture right radius and ulna shaft (lower third), minor oblique laceration 10 cm. above right eyebrow, nondisplaced fracture left pelvis pubic and ischial rami, superficial transverse lacerations of left wrist, one 2 cm. proximal to palm exposing tendons and one 4 cm. to proximal border of palm, abdominal pain and tenderness. AIS 2.

Vehicle 2, driver, female, 23 years old, 63", 140 lbs., single with 3 children, unemployed (worked as electronics assembler), 13th grade education, hobbies--dancing and watching the roller derby; trip plan: origin - home, destination - V.A. hospital to buy Easter baskets, ETD 1430-1445 hours, no ETA, total distance 2 miles, accident occurred 1 block from destination; has driven 10 years, drives an (SCAT estimated) average of 12,000 miles/year, high school driver education, drives route 3 times per week, owned case vehicle 6 months, driven it about 6,800 miles, no previous accidents, 1 traffic citation (with violation of promise to appear)(not a moving violation), no physiological or psychological problems noted. Lap restraint not in use.

Injuries: none

Vehicle 3, driver, male, 39 years old, 72", 170 lbs., divorced, 15th grade education, occupation advertising/publishing executive, hobbies skiing and camping, trip plan origin work, destination San Francisco on business, ETD 1505 hours, ETA 1630 hours, total trip distance about 40 miles, accident occurred 0.8 mile from origin, has driven 23-24 years, average 8,000 miles per year, no driver education, drives route 3 times per week, owned case vehicle 1 month, estimated he drove it about 600 miles, no physiological problems, no previous accidents, 1 traffic citation. Lap restraint worn.

Injuries: 3/16" blood blister on left index finger. AIS 0.

Standards

The following Highway Safety Program Standard and Motor Vehicle Safety Standards were relevant to this case:

MVSS No. 205, Glazing Material. Windshield prevented utility pole from penetrating the occupant compartment of Vehicle 3.

MVSS No. 208, Occupant Crash Protection. Had right front passenger in Vehicle 1 been wearing a lap restraint, she would not have come forward on the seat in the final POI which may have prevented her legs from being trapped in the bent floor.

HSPS 16, Debris Hazard Control and Cleanup. The live utility wire was deactivated and work began immediately to repair the damage. Special extrication equipment was brought in for the trapped occupants of Vehicle 1.

Description

Pre-Crash

Vehicles 1 and 2 were westbound on Willow Road. Vehicle 1 was behind Vehicle 2. As Vehicle 1 came over the crest of the overpass across Bayshore Freeway it veered left and hit the median curb, and then veered to the right. Vehicle 1's speed is estimated to have been 50-60 mph. Driver 2, seeing the erratic movements of Vehicle 1 in her rear view mirror moved to the right and slowed down. At this time Vehicle 3 was eastbound on Willow at a driver-estimated speed of 30-35 mph.

Crash

Vehicle 1 continued to veer right until it sideswiped Vehicle 2. Vehicle 2 stopped, and Vehicle 1 swerved to the left and crossed the median, leaving centrifugal skid marks. Speed was calculated to be 58 mph. It impacted a utility pole on the south side of Willow and sheared it off at the ground. Then Vehicle 1 spun counterclockwise as seen from above, penetrated a chain link fence, impacted a steel sign pole, and came to rest with the sign pole imbedded in the right front door. Meanwhile, the utility pole fell in front of Vehicle 3, and Vehicle 3 impacted the pole as it was almost horizontal and just below windshield height. The pole came to rest on the sidewalk. Upon impact with steel pole, Driver 1 moved to the right hitting his head on the right A-pillar with the pole behind it. This caused a fracture and brain damage with hemorrhage and intercranial pressure which led to death. The right front passenger received fractures from contact with the right door area and pole impact.

Post-Crash

Driver 3 stopped his vehicle in the street. An unknown witness called police, who arrived and requested ambulance and fire-rescue units. The occupants of Vehicle 1 were removed with difficulty. Driver 1 was pronounced dead at the hospital. The right front passenger was taken to the hospital. Tow trucks removed Vehicles 1 and 3. Vehicle 2 was driven away.

Causal Factors, Conclusions and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationPrimary or Principal Causes

- | | |
|---|---|
| 1 | Driver 1 lost control of Vehicle 1 (definite) |
| 1 | Driver 1 was drunk (BA 0.26 gms%) (definite) |

Severity Increasing Factor

- | | |
|---|--|
| 1 | Driver 1 did not or could not release his foot from the accelerator pedal (possible) |
|---|--|

Relevant Condition

- | | |
|---|---|
| 1 | Right front passenger did not know how to drive and could not try to bring the car under control (definite) |
|---|---|

Injury Causation

- | | |
|---|--|
| 5 | Multiple impacts caused car to bend and crush toward occupants (definite) |
| 2 | If used restraints might have prevented some injuries received during the first and possibly second POI's (possible) |

Matrix Element Description (Continued)Matrix Cell No.

(* indicates positive factors)

ExplanationInjury Causation (Continued)

8

Impact with shopping center non-breakaway steel pole resulted in severe injuries (definite)

Post-Crash Factor

9*

Special extrication equipment was available to remove the right front passenger (definite)

Recommendation

1

Accidents such as this may be prevented by equipping vehicles with ignition interlock systems designed to detect the alcohol impaired driver. Further development and implementation of interlock systems should be encouraged.



E-219

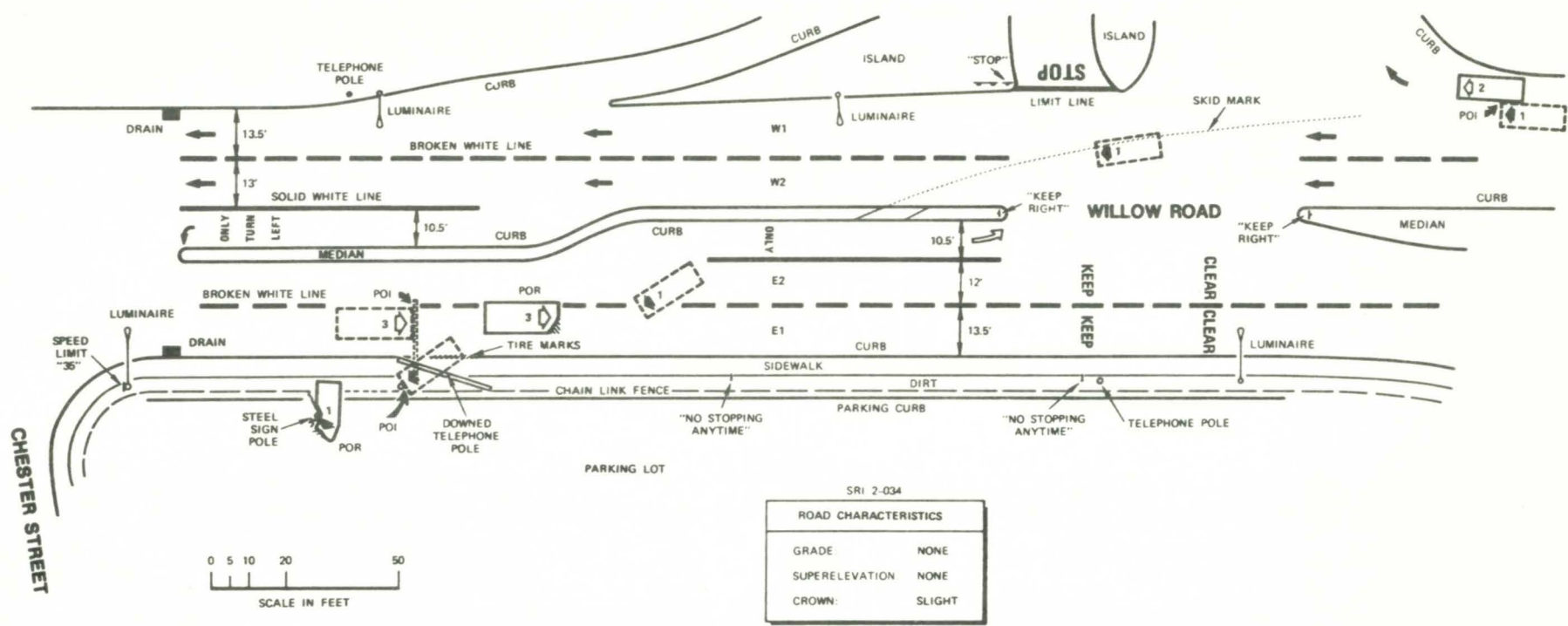


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-035

I CASE SUMMARY

(Car/Car - Headon)

Identification

This accident occurred on Lawrence Expressway, 0.2 miles south of Duane Avenue, Sunnyvale, California, open roadway, light industry and pasture, April 13, 1973, Friday, 1343 hours, 2 cars - headon, fatal AIS* 8. Vehicle 2 crossed the median and collided with Vehicle 1. Figure 1 is a plan view of the accident scene.

Ambience

Day, 62°F, 56% relative humidity, wind from west at 10-14 mph, good visibility, dry pavement.

Highway

Lawrence Expressway is 121' wide, 6 lanes plus southbound right exit only lane, curbs and raised dirt median 17' wide, asphaltic concrete, 8' wide paved shoulders and curbs on west side of southbound lanes and east side of northbound lanes, straight, slight crown, no accesses and 4 poles per 1/4 mile for Vehicle 1 southbound approach, and 1 road, 2 driveways, and 16 poles and trees per 1/4 mile for Vehicle 2 northbound approach. Accident history: 1970, 4; 1972, 3 (1 injury producing). Average daily traffic: 32,740 (1968) both directions.

Traffic Controls

Speed limit 50 mph, lanes separated by broken white lines, southbound right exit lane separated by broken white lines of shorter length than lane lines, solid white lines separate lanes from shoulders, double yellow lines adjacent to median.

Vehicles

Vehicle 1, car, 1973 Ford LTD, 2-door, blue, hardtop, 1,675 miles on odometer, no inspection sticker, power steering and brakes, padded dash, sunvisors, upper torso and lap restraints, head restraints (down on seat top), no defects, no maintenance sticker.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Damage: Front bumper torn off, front end crushed 24 inches, hood buckled, right roof side rail, and right B and C pillars distorted, windshield cracked, battery case broken, right front suspension bent, right front wheel bent. Interior damage: steering wheel rim bent, steering column EA collapsed 0.5 inch. CDC* 11-FDEW-3

Vehicle 2, car, 1965 Ford Mustang, 2-door, blue, hardtop, 63,055 miles on odometer, power steering, padded dash, lap restraint, no known defects, routine maintenance and brake work November 16, 1972, at 56,297 miles.

Damage: Entire front end of car broken off at firewall, severe intrusion of right toepan and right door into passenger compartment, rear axle damaged on right side. CDC 02-RDAW-3

Occupants

Driver 1, female, 33 years old, 65-1/2 inches tall, 120 lbs, married, 2 years of college, living in area 13 years, occupation: manager fashion style firm, pastime camping, trip plan United Parcel Service to home, no ETA, total distance 8-1/2 miles, accident occurred 2 miles from origin, 17 years driving experience, 10,000 miles per year, drives route 2-3 times per week, case vehicle owned two weeks, driven about 800 miles, wears contact lenses, general feeling of well being - happy. Lap restraint worn.

Injuries: Probable cerebral concussion; multiple contusions on left face, left chest, left inside upper arm, right elbow-forearm, right palm of hand, right and left abdomen, right and left knees and front of legs; lacerations left upper and lower orbicularis oris muscle, front teeth loosened. AIS 2.

Center front passenger, Vehicle 1, male, 2-1/2 years old, 38-3/4 inches, 33 lbs., son of Driver 1. Lap restraint worn.

Injuries: blow to frontal area of forehead probably resulting in cerebral concussion; contusions across abdomen; probable intestinal contusions; abrasions on right hand. AIS 2.

Driver 2, female, 49 years old, 66", 242 lbs., married, occupation cook, driving experience unknown but presumed just learning (temporary driver's license), trip plan possibly from driver's home to driving around, driver's home and nearby place of work 2-3/4 miles from accident site, vehicle probably unfamiliar (vehicle registered to passenger), area and road probably unfamiliar, driver education and training unknown, physical and mental condition unknown (partially digested food in stomach indicates recent meal), blood alcohol and other drug tests negative, restraints not used.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

Injuries: multiple rib fractures, lung contusions, bilateral hemothorax, sternal fracture, lacerated liver, 9" scalp laceration, 4" right leg laceration, abrasions and contusions right shoulder area near neck and right upper outer arm, abrasion right upper outer leg and right knee, abrasion near left thumb, swollen right hand. Died 4 hours after accident. AIS 7, fatal.

Vehicle 2, Right Front Passenger, female, 37 years old, 62", 145 lbs., restraints not used.

Injuries: multiple rib fractures, right lung partial collapse, lung contusion, bilateral hemothorax, lacerated liver, lacerated spleen, ruptured right diaphragm, ruptured pericardium, lacerated inferior vena cava in abdomen near sacrum, lacerations and abrasions on forehead and left face under chin, left neck, front upper teeth fractured, abrasions left shoulder near neck, left chest, abrasions and lacerations right arm dorsal surface, lacerations right elbow and right upper forearm, dorsal right thigh, abrasions right knee and both ankles. AIS 8, fatal.

Standards

The following Motor Vehicle Safety Standard (MVSS) was specifically relevant to this case:

MVSS 208*. Occupant Crash Protection. Occupants in Vehicle 1 were wearing lap restraints which lessened injuries by retaining them in their seats. Use of detachable upper torso restraints would have lessened injuries more.

Description

Pre-Crash

Vehicle 1 was southbound in lane S3 at a driver estimated speed of 50 mph. Vehicle 2 was northbound, possibly in lane N2, speed unknown. For some unknown reason Vehicle 2 crossed the median without leaving skid marks. Driver 1 saw a "flash of blue" (Vehicle 2) but did not take evasive action.

Crash

Vehicle 1 impacted Vehicle 2 right front corner to right front corner, as shown in Figure 1. The impact partially tore the front end of Vehicle 2 off at the firewall. Then Vehicle 1 impacted the firewall and right A-pillar of Vehicle 2 causing severe intrusion into the passenger compartment. Vehicle 1 continued to slide along the right side of Vehicle 2, pushing in the door, rear quarter area, and damaging the right rear wheel and rear axle. The impacts caused Vehicle 1 to rotate counterclockwise and Vehicle 2 to rotate clockwise, as viewed from above. At initial impact, lap restrained Driver 1 hit her left chest on the steering wheel and her left check on the dash. The column collapsed slightly and her knees contacted the dash. Lap restrained center front passenger hit his forehead on the dash cowl.

Driver 2 impacted the steering wheel dash and windshield receiving fatal chest injuries, lacerated liver and scalp laceration. The right front passenger received the blow of the right side intrusion receiving fatal chest and abdominal injuries.

As Vehicle 2 came to rest the right front passenger was partially ejected, her feet remaining in the vehicle.

Post-Crash

A witness traveling behind Vehicle 1 was able to stop within 20 ft of Vehicle 1. Driver 1 remained in her car but called for help. Driver 2 was extricated from Vehicle 2 after rescuers cut the steering column on the engine side of the firewall. Driver 2 was taken in the ambulance with the Vehicle 1 occupants to the hospital where she died 4 hours later of chest injuries. The right front passenger was declared dead at the scene. A dead dog was removed from Vehicle 2 by animal control personnel. Vehicle 1 was towed from the scene. Vehicle 2 was removed in 2 pieces. Fire trucks hosed down the area.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factors)

ExplanationAccident CausationPrimary or Principal Cause

1 Vehicle 2 crossed median into opposing traffic
(definite)

Severity Increasing Factor

1 Driver 1 did not see Vehicle 2 in time to take
avoidance measures (definite)

Relevant Conditions

1 Driver 2 was inexperienced (learning to drive)
(probable)

7 Median design did not prevent vehicle crossover
(definite)

Injury Causation

5 Initial corner-to-corner impact caused Vehicle 2 engine
compartment to separate from body, which allowed
Vehicle 1 to impact Vehicle 2 exposed A-pillar and
adjacent firewall; this caused severe occupant
injury (definite)

2* Occupants of Vehicle 1 were wearing lap restraints
(definite)

2 Driver 1 not wearing available shoulder restraints
(definite)

2 Occupants of Vehicle 2 not wearing available
restraints (definite)

Post-Crash Factors

9* Another driver was able to stop before impacting
Vehicles 1 and 2 (definite)

9* Fire trucks hosed down area (definite)

Matrix Element Description (Continued)Matrix Cell No.

(* indicates positive factor)

ExplanationPost-Crash Factors

- | | |
|---|---|
| 6 | Vehicle 2 body was hoisted up by tow truck and fuel leaked out (definite) |
| 6 | Vehicle 2 steering column was cut at firewall to free trapped driver (definite) |

Recommendation

- | | |
|---|--|
| 5 | This accident suggests that unitized body vehicles should be evaluated for retention of structural integrity and occupant protection in certain accident configurations |
| 5 | The problem of damage inflicted by large, heavy vehicles to smaller, lighter ones in collisions should be studied in light of projections of the automobile populations in the future. |

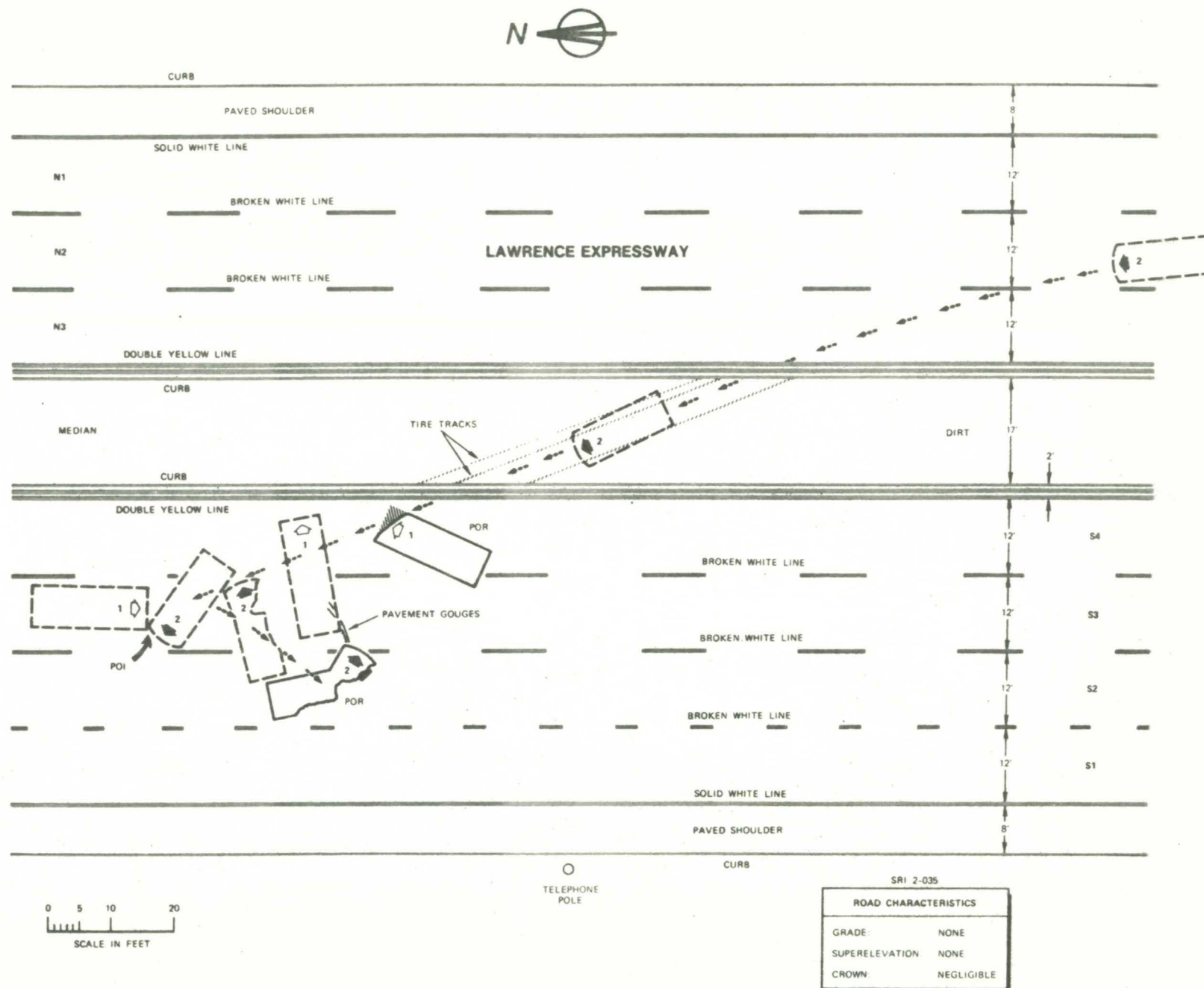


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-036

I CASE SUMMARY

(Car/Car--Rear End)

Identification

This accident occurred on Quarry Road 185' south of the intersection with Arboretum, Palo Alto, California, open roadway, adjacent to shopping and professional area, May 4, 1973, 1154 hrs., Friday, 2 cars--rear end, IP (injury producing) AIS* 1. Driver 1 was thinking about things, realized Vehicle 2 had stopped, applied brakes, but impacted rear of Vehicle 2. Driver 1 complained of pain in chest and abdominal areas. Figure 1 is a plan view of the accident scene.

Ambience

Day, 60°F, wind 6-10 mph gusty SSW, scattered clouds, bright and clear, dry pavement.

Highway

Quarry Road is a local road, 43' wide, three lanes in area of accident, asphalt, 3' concrete gutter and concrete curb both sides, straight, about 6 accesses and 30 poles and trees per 1/4 mile before accident site. Accident history of location: 1969, 2; 1970, 2; 1971, 0; 1972, 3; total 1969-72, 7.

Traffic Controls

Speed limit 25 mph, north- and southbound lanes separated by double yellow line and amber reflectors, two northbound lanes separated by white paint spots, intersection with Arboretum 185' north of accident site.

Vehicles

Vehicle 1, car, 1972 Ford Pinto 2-door, white with green vinyl roof and green trim, coupe, 11,673 miles on odometer, no inspection sticker, no power components, padded sunvisors, upper and partial lower dash, padded arm rests and horn button, lap and upper torso restraints equipped, integral head restraints, no defects noted, routine maintenance at 6,131 miles on January 13, 1973.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Damage: Front from right of left headlight across to vehicle right, pushed in 6", top right of radiator pushed back 4" from vertical, right headlight broken, induced buckle on right front fender above right front wheel. CDC* 12-FZEW-1.

Vehicle 2, car, 1968 Plymouth Custom Suburban, 4-door, white, station wagon, 76,830 miles on odometer, no inspection sticker, power brakes and power steering, padded dash and sunvisors, lap and upper torso restraints, no head restraints, no defects noted, routine maintenance at 71,063 miles on September 26, 1972.

Damage: 1/4" depression in tailgate and center of bumper pushed in 1/2" sufficient to jam tailgate so that it would not open. CDC 06-BYEW-1.

Occupants

Driver 1, 20-year-old female, 64", 140 lbs., occupation student nurse and nursing assistant, 3 years driving experience at 12,000 miles per year, trip plan working in hospital nursing (nursing class) to home, a total of 19 miles, ETD 1140, ETA 1210, collision occurred 3/8 miles from hospital, owned and driven vehicle 9 months, drives accident route twice per week (Wednesday and Friday) attending class, driver education in high school including use of simulator at age 16 (sophomore year), physical and mental condition good, lap restraint worn snugly (doesn't know how to "work" the upper torso restraint).

Injuries: sore chest, bruise at left ovary from seat belt (according to doctor). AIS 1.

Driver 2, 29-year-old female, 68", 140 lbs., married with 2 children, 20 yrs schooling, occupation anesthesiologist, hobbies camping, gymnastics, tennis, photography; trip plan work to home via baby sitter, ETD 1140 hrs, no ETA, driver education from driver education instructor (father), accident occurred 2 blocks from origin, 3 miles from destination, 13 yrs driving experience, familiar with area and route, drives route 3 times/week, could not estimate annual mileage, owned case vehicle 4-1/2 yrs, no physiological or psychological problems, lap restraint worn snugly.

Injuries: none

Standards

The following Motor Vehicle Program Standard was specifically relevant to this case:

MVSS 208. Occupant Crash Protection. Driver 1 did not know how to use upper torso restraint. Driver 2 complained of poor design of upper torso restraint. Standard does not encourage use of upper torso restraint.

*

Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

DescriptionPre-Crash

Driver 1 had left hospital en route home at calculated speed of 21 mph and was thinking about what she was going to do when she arrived. Driver 2 had left work and was on her way to baby sitter. She stopped behind several cars at intersection. She had her foot on the brake. Driver 1 was going to turn right at the intersection and noted that Driver 2 ahead had stopped. Driver 1 applied her brakes locking the right rear wheel which left 15' of skid marks; the front wheels locked leaving 12' LF and 8' RF skid marks. Driver 1 put up her right hand to keep her head from hitting.

Crash

Vehicle 1 from the front at the right side of vehicle to right of the left headlight impacted rear of Vehicle 2 to right of its center at calculated 9 mph. Vehicle 1 front was pushed in 6" damaging the radiator. Vehicle 1's bumper underrode Vehicle 2's bumper. Damage to Vehicle 2 was extremely minor, but sufficient to jam the tailgate. Lap belted Driver 2 moved forward upon impact hitting her chest on the steering wheel but did not collapse the column. She received a contusion in the area of the left ovary from the lap belt, according to her doctor.

Post-Crash

Driver 1 immediately backed up her car and parked at the curb to get out of traffic. Driver 1 exited and went up to the other car to see if Driver 2 was all right. Driver 2 noticed Driver 1 holding her abdomen, so she told Driver 1 to sit down and then she went across the street to call the police. Police arrived and took statements. Tow truck removed Vehicle 1 and Driver 2 drove Vehicle 2 home. Driver 2 telephoned a friend to pick her up.

Causal Factors and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationPrimary or Principal Cause

1 Driver 1 was inattentive and did not notice
Vehicle 2 stopped (definite)

Severity Increasing Factors

1* Driver 1 braked attempting to slow vehicle
when she saw accident was imminent (definite)

Relevant Conditions

1 Driver 1 was preoccupied with thoughts (definite)

5 Vehicle 1 front bumper underrode Vehicle 2
rear bumper causing damage to Vehicle 1 cooling
system (definite)

Injury Causation

2 Driver 1 used lap restraint only allowing
chest to hit steering wheel; she claimed she
did not know how to use upper torso restraint
(definite)

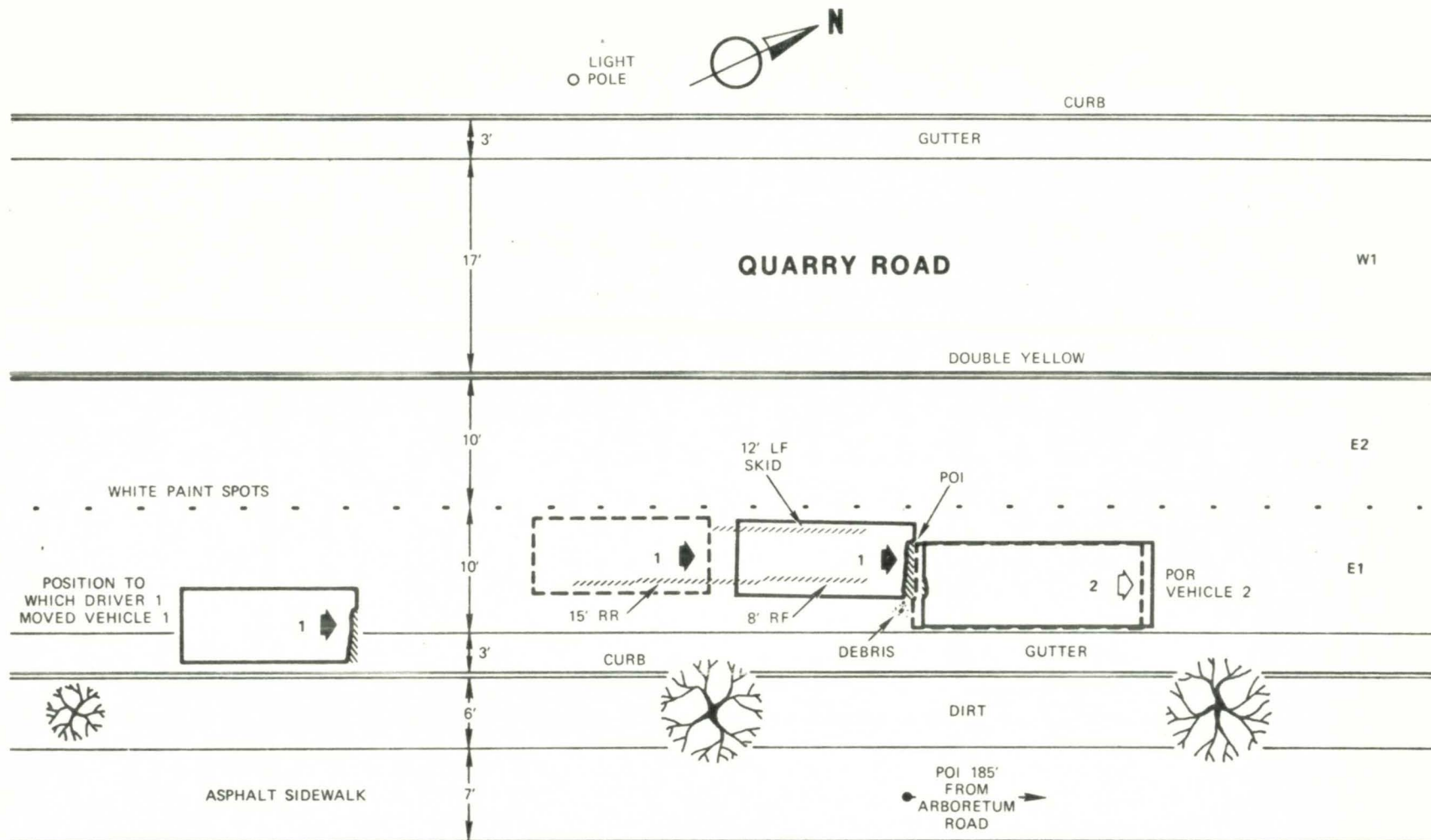
Recommendations

4 Integral, nondetachable, comfortable upper torso
restraints should be designed for vehicles

2 Drivers should be shown how to use upper torso
restraints when vehicle is purchased.

1 Problem of driver inattention should be studied

E-233



0 5 10
SCALE IN FEET

SRI 2-036

ROAD CHARACTERISTICS

Grade	None
Crown	Slight
Superelevation	None

FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-037/38

I CASE SUMMARY

(Six Cars - Loss of Control/Rear End)

Identification

This accident occurred on Stevens Creek Boulevard just before the intersection with Portal Avenue, Cupertino, California, business fringe area, May 4, 1973, 1355 hrs, Friday, 6 cars--loss of control/rear end, IP (injury producing) AIS* 2. Driver 1 blacked out allowing Vehicle 1 to impact Vehicle 2, then moved to adjacent lane and impacted Vehicle 5; Vehicles 2 and 5 impacted Vehicles 3 and 6; Vehicle 3 impacted Vehicle 4. Figure 1 is a plan view of the accident scene.

Ambience

Day, 65°F, wind from west at 5-10 mph, roadway dry.

Highway

Stevens Creek Boulevard is an arterial, approximately 100' wide, 6 lanes with left turn only lane eastbound, 4' wide raised median with rocks, asphaltic concrete road surface, concrete barrier curbs, 2' wide concrete gutter adjacent to curbs, 2' wide packed dirt strip on south side of street adjacent to curb, straight, 9 driveways, 1 street, and 15 poles/trees on south side of street 1/4 mile before accident site. Accident history: 1971, 3; 1972, 7 (1 IP); Jan-April 1973, 2 (1 IP). Average daily traffic 28,600 vehicles, both directions.

Portal Avenue is a 32' wide two lane road. No other data gathered because accident occurred before the intersection.

Traffic Controls

Speed limit on Stevens Creek 45 mph, lanes delineated by broken white lines, eastbound through lanes separated from left turn lane by solid white line, word "ONLY" and arrow indicating left turn painted in lane, solid white limit line at intersection,

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Signals are semi-traffic actuated returning to Stevens Creek: on Stevens Creek, initial green 15 sec., vehicle interval 5 sec., maximum green 40 sec., yellow 3.5 sec; Portal Avenue, initial green 6 sec., vehicle interval 4 sec., maximum green 30 sec., yellow 3 sec.; Stevens Creek left turn phase, initial 4 sec., vehicle extension 4 sec., maximum green 30 sec., yellow 3 sec.; Portal pedestrian crossing, initial WALK 6 sec., flashing DON'T WALK 22 sec.

Vehicles

. Vehicle 1, car, 1973 Plymouth Duster, 2-door, gold, hardtop, 2,064 miles on the odometer, manufactured 2-73, no inspection sticker, no power accessories, padded dash and sunvisors, lap and upper torso restraints, head restraints, no known defects, no routine maintenance (new car).

Damage: front end pushed in approximately 4 in., right front bumper pushed back 7-1/4 in., right front fender pushed in and buckled, windshield cracked, dashboard dented. CDC* 12-FDEW-1.

Vehicle 2, car, 1970 Austin America, 2-door, green, sedan, 24,759 miles on odometer, manufactured 11-69, no inspection sticker, no power accessories, padded sunvisors, dash, lap and upper torso restraints for front seats removed prior to accident, head restraints in place, no known defects, routine maintenance (oil change, etc.) performed by friend two months prior to accident.

Damage: Front end pushed in 7 inches, rear end pushed in 6 inches, windshield cracked, steering wheel bent. CDC 12-FDEW-2 (primary), 06-BYEW-1 (secondary).

Vehicle 3, car, 1968 Chevrolet Impala Custom, 2-door, light blue over dark blue, hardtop, 59,491 miles on odometer, no inspection sticker, power steering, padded dash and sunvisors, lap restraints, no known defects, routine maintenance at 57,672 miles (date unknown).

Damage: rear end pushed in 6 in., one taillight lens broken, front end pushed in 8 in. CDC 06-BDEW-1 (primary), 12-FDEW-1 (secondary).

Vehicle 4, car, 1972 Ford LTD Country Squire, 5-door, blue and simulated wood, station wagon, 23,936 miles on odometer, no inspection sticker, power steering and brakes, padded dash and sunvisors, lap and upper torso restraints, head restraints, no known defects, routine maintenance at 8,152 miles on September 28, 1972 and 18,000 mile checkup around February (no sticker noted).

Damage: 3 in. dent in rear tailgate/door causing door and power window to jam; 2 in. dent in tailgate 3 ft. to left of other dent. CDC 06-BYEW-1.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

Vehicle 5, car, 1968 Buick GS California, 2-door, black vinyl over white, coupe 41,007 miles on odometer, no inspection sticker, power steering, padded dash and sunvisors, lap and upper torso restraints, no head restraints, no known defects, routine maintenance at 27,384 miles on November 23, 1972.

Damage: rear end pushed in 16 in., front corner of right front fender pushed back, point of center hood pushed back, right front fender pushed back jamming right door. CDC 06-BDEW-2 (primary), 12-FZEW-1 (secondary).

Vehicle 6, car, 1970 Plymouth Roadrunner 383, 2-door, green, hardtop, 54,967 miles on odometer, inspection sticker (expires June 30, 1973), power accessories unknown, head restraints, lap and upper torso restraints, no known defects, maintenance unknown.

Damage: small dent in rear trunk above license plate, some white paint transfer on left end of rear bumper. CDC 06-BCEW-1.

Occupants

Driver 1, 70-year-old male, 69", weight estimated at 185 lbs., 58 years driving experience now averaging 6,000 miles per year, trip plan home to insurance claims agent to have recently damaged vehicle appraised, distance of 5-1/4 miles, ETD and ETA unknown, collision occurred 2-1/2 miles from home, purchased Vehicle 1 new February 25, 1973, 2 months prior to the accident, had driven most of its 2,064 miles, drives accident route about two times per week, learned to drive "out at the farm" in Canada at age 12, physical condition unknown (one blackout episode two months prior, cause unknown), mental condition somewhat unhappy (wife died two years prior and still not well adjusted) and possibly affected by old age, appeared very confused and told conflicting stories earlier in the day to persons who spoke with him, possible physical and mental blackout just prior to accident, restraints not used (lap restraints hooked behind seat to prevent buzzer from working).

Injuries: superficial laceration in left forehead, blow to jaw in middle (hematoma), soreness and contusions in abdomen, concussion (unconscious). AIS 2.

Driver 2, 25-year-old female, 61", 110 lbs., 3 years driving experience at unknown annual mileage (estimated by investigator at 9,000 miles per year from mileage on vehicle), trip plan old house to new house moving household goods, a distance of 3-1/2 miles, accident occurred 1-1/2 miles from destination, purchased Vehicle 2 new on September 17, 1970, 2-2/3 yrs. prior to accident, driven for 24,759 miles, drives accident route daily around date of accident, high school driver education at age 17 including use of simulator, physical condition good but low blood sugar problem, mental condition good, restraints not used (had been removed from vehicle prior to accident).

Injuries: head sore at hairline in center, sore chest, contusion on anterior upper right arm, contusions on anterior upper right thigh, contusion anterior lower left leg, contusion medial left foot at arch, sore small toe left foot. AIS 1.

Right Front Passenger, Vehicle 2, 4-year-old male, height and weight unknown, restraints not used (removed from vehicle prior to accident).

Injuries: lacerations on head, cheek and mouth, contusions arms and legs. AIS 1.

Driver 3, 36-year-old male, 72", 200 lbs., married, 10th grade education, occupation - machinist, hobbies - fishing and guitar playing, trip plan: origin - friend's home, destination - home, purpose - visit friends, however they were not at home, no ETA, trip distance 6-7 miles, accident occurred 3-4 blocks from origin, has driven 18 yrs at an average of 10,000-15,000 miles/year, drives route 5-6 times a year, driven case vehicle 3 years and about 30,000 miles, no driver education, no physiological problems, restraint system not in use.

Injuries: contusions on both knees, stiff neck. AIS 1.

Right Front Passenger, Vehicle 3, female, 36 years old, 59", 105 lbs, wife of Driver 3, no restraints used.

Injuries: probable cerebral concussion, wrenched back, left leg twisted causing knee to become sore and black and blue. AIS 1.

Driver 4, 40-year-old male, 69", 205 lbs., married with 3 children, 12th grade education, occupation - postal clerk, also has newspaper dealership, hobby - collecting foreign coins, trip plan origin work, destination bank, ETD 1:45 pm, ETA 1:52 pm, accident occurred about 1 mile from origin, 24 yrs driving experience at 29,000-30,000 miles/yr., drives route once per week, no driver education, owned case vehicle 11-1/2 mos., driven case vehicle 23,000 miles, no permanent or transient physiological problems, "feeling fine" day of accident. Restraint system not in use.

Injuries: "sprained neck" resulting in headaches and backaches. AIS 1.

Driver 5, 31-year-old female, 64", 130 lbs., married with 2 children, 12th grade plus 1 yr cosmetology, occupation housewife, hobbies crocheting and swimming, trip plan origin hospital to visit relatives, destination home, ETD 1330 hrs., ETA 1500 hrs., total distance 24-1/2 miles, accident occurred 6 miles from origin, 16 yrs driving experience, SCAT estimated she drives 7,000 miles/year, high school driver education at age 16, drives route 1-2 times per month, owned case vehicle 5 years, driven case vehicle about 23,000 miles, no permanent or transient physiological problems, no psychological problems, restraints not worn.

Injuries: sore neck. AIS 1.

Driver 6, 46-year-old male, 71", 170 lbs., occupation detective sergeant Sheriff's Office, 30 years driving experience at 15,000 miles per year (driver uncertain of mileage; much is done during working hours due to occupation), trip plan from one investigation to another a total of 3-3/4 miles, accident occurred 1 mile from destination, vehicle is assigned to driver since 1970, has put 46,000 miles on it, drives accident route about 3 times per week, learned to drive through trial and error, physical and mental condition good, restraints not used (never uses them).

Injuries: none

Standards

The following Highway Safety Program Standards (HSPS) and Motor Vehicle Program Standards (MVPS) were specifically relevant to this case:

HSPS 5, Driver Licensing. Driver 1 apparently was driving with no license in possession and no record of a license could be found through the Division of Driver's License automated records system. When appearing before judge for violation, he produced a temporary license.

MVPS 207, Anchorage of Seats. Vehicle 2 front seat latches to floor had been removed prior to accident allowing both front seats to pivot forward upon Vehicle 2 impact with Vehicle 3 pushing Driver 2 and Right Front Passenger into dash and windshield.

MVPS 208, Occupant Crash Protection. Vehicle 2 lap and upper torso restraints had been removed prior to accident. Driver 2 said they were very uncomfortable and she was going to have them replaced with better belts. Vehicle 1 lap restraints were hooked behind the seat to deactivate buzzer system; Driver 1 said his grandson hooked them that way. Vehicle 4 lap restraints were belted tightly across the seat cushion to deactivate buzzer system.

MVPS 301, Fuel Tanks, Fuel Tank Filler Pipes, and Fuel Tank Connections. Vehicle 5 fuel tank filler pipe was slightly moved at tank neck allowing slight leakage of fuel.

Description

Pre-Crash

Driver 1 caused a sideswipe accident earlier in the day, damaging his vehicle. His story to that driver was that he had been to the dentist and received anesthesia prior to dental work. In the early afternoon he was en route to his insurance claims agent to report this accident when he blacked out. Driver 1 was probably travelling at 30 mph, calculated from rear end impact, in Lane E1. Driver 2 was travelling at approximately 30 mph in Lane E1, and slowing down for a yellow light and vehicles at an intersection. Vehicles 3, 4, 5 and 6 were stopped at the light.

Crash

Vehicle 1 impacted Vehicle 2 in the rear causing 6" crush to the rear of Vehicle 2. Unrestrained Driver 1 impacted the windshield. Driver 2 felt the impact, looked up and saw another vehicle ahead of her; she put out her right arm to keep the right front passenger from going forward. Vehicle 2 impacted Vehicle 3 in the rear at approximately 25 mph causing 6" crush to the rear of Vehicle 3 and 7" crush to the front of Vehicle 2. Upon impact with Vehicle 3, the unlatched front seats of Vehicle 2 pivoted forward and both unrestrained occupants impacted the dashboard and windshield. Vehicle 3 impacted Vehicle 4 at approximately 9 mph causing 3" crush to the rear of Vehicle 4 and 8" crush to the front of Vehicle 3. The right front passenger of Vehicle 3 impacted the windshield. Vehicle 4 was moved forward approximately 20'. Driver 4 received a sprained neck.

In the meantime, Vehicle 1 had veered from Lane E1 to Lane E2 and impacted Vehicle 5 at approximately 25 mph causing 16" crush to the rear of Vehicle 5 and additional crush to the right front area of Vehicle 1. Driver 5's head went back causing a sore neck. Vehicle 5 was pushed forward into Vehicle 6 causing only a very minor dent in the rear trunk lid of Vehicle 6 and about 5" crush to the right front fender of Vehicle 5. Driver 5 came forward, her left knee hitting the steering column. Driver 6 barely felt the impact. He had noticed the collision between Vehicles 1 and 5 in his rearview mirror.

Post-Crash

Driver 6, a detective sergeant, radioed in the accident and requested an ambulance. He left his car in place, got out, passed Driver 5 and told her not to move, walked back to Vehicle 1 and saw Driver 1 passed out. An ambulance arrived and two sheriff's units. Driver 6 helped three other persons remove Driver 1 from right door and place him in ambulance. Flares were placed at the scene. Driver 2 remained in the vehicle keeping the right front passenger calm. People helped them out the right door and put them into an ambulance. Driver 3 pulled his right front passenger from the floor to the seat and then got out and checked Driver 1. He went over to Vehicle 2 and saw that Driver 2 was all right and then returned to his car. Driver 4 got out of his car to see what had happened, got back in and moved his car across the intersection to the side of the road. He walked back and asked if Driver 3 were all right. He then assisted putting Driver 1 into the ambulance. Driver 3 backed his car next to the curb. Driver 5 exited through left door to check the damage. She talked to a deputy who called communications to have Driver 3's husband notified of the accident. She drove her car to the curb. Vehicles 6, 3, and 4 were driven from the scene. Vehicles 1, 2, and 5 were towed. Debris was swept up. During this time traffic was routed around Lanes E1 and E2.

Causal Factors, Conclusions and RecommendationsMatrix Element Diagram

The following diagram defines the numbering system used in the following matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factor)

ExplanationAccident CausationPrimary or Principal Causes

- 1 Driver 1 blacked out and lost control of his car. (definite)

Severity Increasing Factor

- 7 Four vehicles were waiting at and one approaching a stop light and were rear ended (definite)

Relevant Conditions

- 1 Driver 1 may have had some type of drug (perhaps at dentist's office) which affected his driving about 4 hours prior to accident (possible), which led to an accident about 1000 hrs. on morning of case accident (definite)
- 1 Driver 1 had had one blackout episode two months prior to accident (probable)

Matrix Element Description (Continued)Matrix Cell No.

(* indicates positive factor)

ExplanationInjury Causation

- | | |
|---|---|
| 2 | Driver 1 was not wearing restraints (they were belted behind the seat to deactivate buzzer system) (definite). No vehicle occupants were wearing restraints; use of restraints in Vehicles 1, 2, and 3 would have prevented the minor resulting injuries (definite) |
| 5 | Vehicle 2 restraints had been removed prior to accident (definite) |
| 5 | Vehicle 2 seat latches were missing allowing front bus-type seats with occupants to pivot forward (definite) |

Recommendations

- | | |
|---|---|
| 1 | Drivers receiving medication (such as at dentist's office) should be warned of effect on driving. |
| 1 | Old age drivers should be evaluated for medical problems and driving ability periodically. |
| 4 | Some form of convenient transit system for persons unable to drive should be available. |

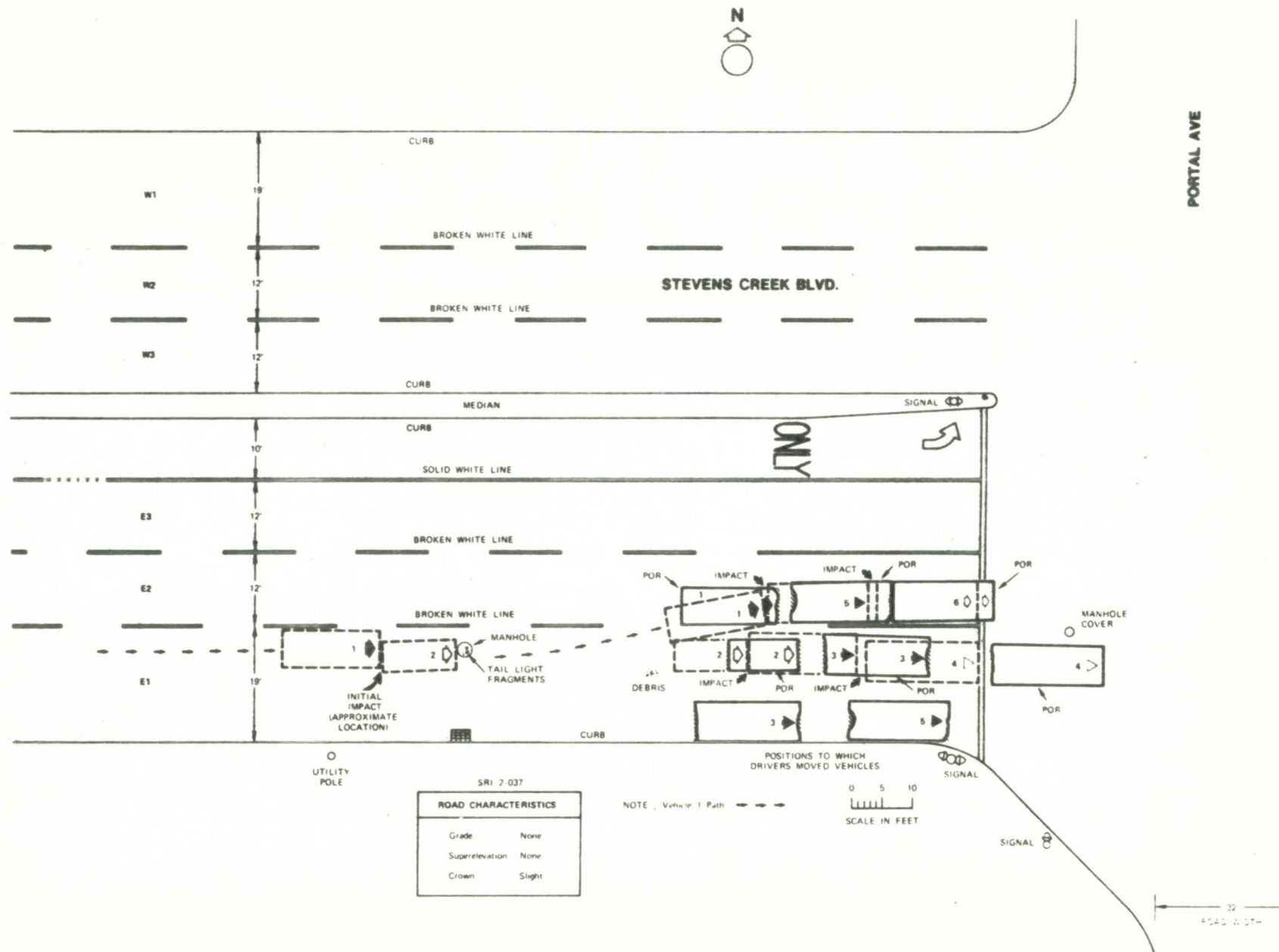


FIGURE 1 COLLISION DIAGRAM

Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-039

I CASE SUMMARY

(Car/Car - Lateral)

Identification

This accident occurred at the intersection of Allerton St. and Alden St., Redwood City, California, intersection, residential, May 31, 1973, 1330 hrs., Thursday 2 cars - lateral, IP (injury producing) AIS* 1. Vehicle 1 was westbound and Vehicle 2 northbound, both approaching the uncontrolled intersection. Vehicle 1 impacted Vehicle 2. Figure 1 is a plan view of the accident scene.

Ambience

Day, 82° F, 48% relative humidity, winds from the east at 4-7 mph, pavement dry.

Highway

Alden St. is 40' wide east of the intersection and 55' wide west of the intersection, two lanes of travel, unmarked, asphaltic concrete, concrete gutter and sidewalk curb on both sides, straight, 14 poles and trees and 11 accesses on both sides of the street in the last 1/10 mile traveled by Vehicle 1.

Allerton St. is 56' wide south of the intersection and 40' wide north of the intersection, two lanes of travel unmarked, concrete curbs and gutter and sidewalks on both sides, rain drainage dip in roadway north of intersection across width of street, straight, 25 poles and trees and 8 accesses in the last 1/10 mile traveled by Vehicle 2.

The accident history of the intersection shows one accident in the last three years (according to city traffic engineer). Average daily traffic is less than 600 vehicles per day.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Traffic Controls

The speed limit is unmarked and assumed 25 mph due to residential area, the opposing traffic lanes are not delineated, yellow XING before intersection and solid yellow lines delineating crosswalks both east of intersection and single solid yellow line west of intersection. There are no other traffic control devices at the intersection.

Vehicles

Vehicle 1, car, 1962 Chevrolet Chevy II 300, 4-door, beige, sedan, 134,000 miles on the odometer, partially removed inspection sticker from State of Kentucky, date unknown, no power accessories, no padded components, no restraints, front tires bald on inside with 2/32 in. tread on rest of tire, unrepaired body damage from previous accidents, no gas cap, left sunvisor missing, extreme deterioration of vehicle interior (upholstery, etc.), no lubrication sticker but driver claimed engine work done by self two months prior to accident.

Damage: Front end, bumper and grille pushed in, maximum crush 14 inches at left end of front bumper, radiator pushed back, dents in dashboard, parking brake handle broken, front seat tracks damaged. CDC* 11-FDEW-2

Vehicle 2, car, 1973 Ford Gran Torino, 4-door, green, sedan, 354 miles on the odometer, no inspection sticker, power steering, padded dash, sunvisors, arm rests, lap and upper torso restraints, head restraints, no known defects, no routine maintenance (new car).

Damage: Small dent in right front door, greater damage to right rear door and right C-pillar, maximum crush 11 inches, no interior damage due to occupant contact. CDC 02-RZEW-3

Occupants

Driver 1, 23-year-old male, 73", 165 lbs., married, unemployed (formerly mechanical assembler, janitor and utility man), approximately 2 years driving experience at 10,000 to 12,000 annually, trip plan unknown (driver would not say on lawyer's advice), driven vehicle 6 months, mileage unknown, drives route about once per year, driver education in junior high school in Kentucky, physical and mental condition unknown, restraints not used.

Injuries: left side forehead received contusions. AIS 1

Vehicle 1, front center passenger, 5-year-old female, height and weight unknown, restraints not used.

Injuries: lacerations over left eye and on nose. AIS 1.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a.

Vehicle 1, right front passenger, adult male, height and weight unknown, restraints not used.

Injuries: lacerations on head. AIS 1.

Vehicle 1, rear seat passengers, adult male, adult female and child of unknown sex, heights and weights unknown, restraints not used.

Injuries: none.

Vehicle 2, driver, male, 54 years old, 70", 175 lbs., married, MBA degree, occupation - branch manager of national advertising firm, hobby "collecting certain items," trip plan: origin car dealer to pick up license plates, destination work, ETD about 1245 hours, no ETA, trip distance 1.7 miles, accident occurred 1.0 miles from origin, no driver education, driving 36 years, averages 20,000 miles/year, driven case vehicle 11 days and 354 miles, drives route 2 times/year, no previous accidents, 2 traffic citations, ingested 1 Singoserp in early morning for high blood pressure, wears glasses, had just finished eating lunch. Lap restraint worn.

Injuries: none

Standards

The following Highway Safety Program Standard (HSPS) was specifically relevant to this case:

HSPS 13, Traffic Engineering Services. Consideration of some traffic control for this uncontrolled intersection should be made.

Description

Pre-Crash

Vehicle 1 was westbound at an estimated speed of 30 mph. Vehicle 2 was northbound at an estimated speed of 20 mph. As Driver 1 approached the intersection he noticed Vehicle 2 to his left and applied his brakes leaving 17' of skid marks. Driver 2 saw Vehicle 1 out of the corner of his eye but took no evasive action.

Crash

Vehicle 1 impacted Vehicle 2 in the right rear door causing 14" crush to the front of Vehicle 1 and 11" crush to the right rear of Vehicle 2. Upon impact, occupants in Vehicle 1 came forward, Driver 1 hitting his left forehead; the center front passenger hitting her head on the dashboard. The right front passenger received lacerations on his head. The rear seat passengers came forward and pushed forward the front seat back on the right side. The rear seat cushion came loose. Driver 2 received no injuries.

Vehicle 1 pushed Vehicle 2 laterally causing it to swing in an arc with the frame forward of the left rear wheel gouging the pavement and the left front wheel gouging the pavement. It continued to turn a total of 200°, slowed, and then rolled forward 15' and came to a stop. Vehicle 1 rotated 90° and came to a stop.

Post-Crash

Driver 2 turned off the ignition and looked towards Vehicle 1. He saw several people exit from Vehicle 2. A California Highway Patrol unit came to the scene after hearing the crash, and talked to occupants of Vehicle 1 and then to Driver 2. He radioed for an ambulance and the Redwood City police who had jurisdiction. The police and the ambulance arrived. Driver 1 and the center front passenger were taken to the hospital. Both vehicles were towed from the scene.

The investigating officer recommended that a complaint be filed against Driver 1 for failure to yield right of way, unsafe speed and open container (beer) in vehicle. As of three weeks after the accident, the complaint had not been filed because of a month backlog of work at the police department.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element DescriptionMatrix Cell No.

(* indicates positive factors)

ExplanationAccident CausationPrimary or Principal Cause

1 Neither driver saw the other vehicle until too late. (definite)

Severity Increasing Factors

7 Residential intersection had no traffic control devices. (definite)

1* Driver 1 applied brakes but was unable to stop in time. (definite)

Relevant Condition

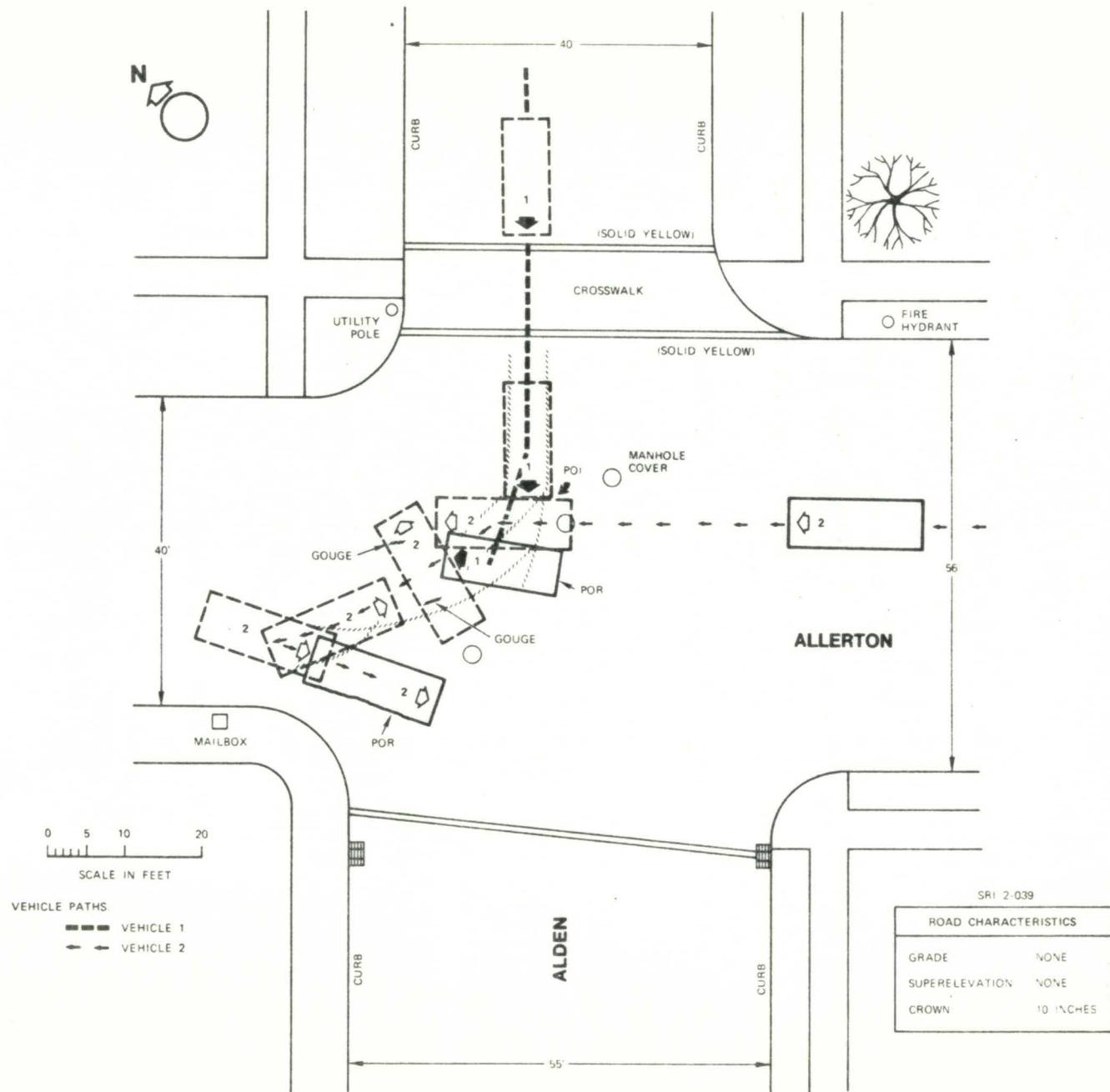
1 Driver 2 made no avoidance maneuvers (definite)

Injury Causation

2 Vehicle 1 had no restraints. (definite)

Recommendations

7 Intersection should be considered for some type of control, e.g., yield sign on one road, etc.



Stanford Research Institute Multidisciplinary
Accident Investigation Team Case SRI 2-040

I CASE SUMMARY

(Car/Car - Oblique Sideswipe)

Identification

This accident occurred on Embarcadero Road at the intersection (but not intersection related) with Bryant Street, Palo Alto, California, intersection, residential, June 13, 1973, 1125 hrs., Wednesday, 2 cars - oblique sideswipe, IP (injury producing) AIS* 1. Eastbound Vehicle 1 swerved left to avoid a car in adjacent lane and continued into oncoming lane; westbound Vehicle 2 braked but was unable to avoid collision. Figure 1 is a plan view of the accident scene.

Ambience

Day, estimated 67°F and 48% humidity, dry pavement.

Highway

Embarcadero Road is a major arterial, 46' wide at accident site, four lanes, no median, asphaltic concrete surface, approximately 3' wide concrete, gutter and concrete curbs on each edge, straight, construction on southside (4 ft wide portion of extreme right side of road torn up just before intersection with Bryant), 19 poles and trees, 8 driveways and 3 streets on both sides of street in last 1/4 mile traveled by Vehicle 1 and 42 poles and trees, 13 driveways and 2 streets in last 1/4 mile traveled by Vehicle 2. Average daily traffic 20,000 vehicles both directions. Accident history: 1969, 8 (3 IP); 1970, 13 (0 IP); 1971, 8 (2 IP). (A third street intersected Embarcadero and Bryant before being blocked off in mid-1973; figures for all three included here.)

Traffic Controls

Speed limit 25 mph, opposing lanes separated by double yellow line, other lanes separated by broken white lines, solid green lines cross Bryant from curb to curb. delineating bicycle lanes (bicycles allowed on sidewalks only), solid white limit lines on Bryant at stop signs, sawhorse construction barriers before southwest corner and northeast corner of intersections protecting broken pavement.

* States, J.P., "The Abbreviated and Comprehensive Injury Scales," Proceedings of the Thirteenth Stapp Car Crash Conference, Society of Automotive Engineers, Inc.

Vehicles

Vehicle 1, car, 1972 Oldsmobile Delta 88, 2-door, tan vinyl over brown, hardtop, 16,667 miles on the odometer, California Highway Patrol inspection sticker expired 12-31-72, power steering and brakes, padded dash, sunvisors and arm rests, lap and upper torso and head restraints equipped, no known defects, routine maintenance performed on May 14, 1973, at 15,508 miles.

Damage: Moderate sideswipe damage from right front wheel to right rear wheel. Right door does not open fully. CDC* 01-RYES-1.

Vehicle 2, car, 1967 Volkswagen 2-door, red, sedan, 89,779 miles on odometer, State of Indiana inspection sticker issued January 11, 1972 at 68,374 miles, no power accessories, padded sunvisors, lap restraints, no known defects, routine maintenance on March 21, 1973 at 86,711 miles.

Damage: Front bumper and bumper guard bent, right front fender torn off, right front wheel bent, front suspension bent, windshield cracked by occupant contact, dents in lower dash. CDC 12-FREE-2.

Occupants

Driver 1, 62-year-old male, 69-1/2", 170 lbs., retired insurance claims adjuster, married, 51 years driving experience at 10,000 miles per year, trip plan wife's office at Stanford University to home (was visiting wife), total of 3 miles, departed 1115, no ETA, accident occurred 1-7/8 miles from origin, owned and driven vehicle 18 months, driven 16,667 miles, drives accident route daily, no driver education, physical condition "brittle diabetic" (takes insulin daily, no problems day of accident) and old back injury, mental condition "very relaxed," lap restraint used.

Injuries: old back injury aggravated. AIS 0.

Driver 2, 45-year-old female, 66", 125 lbs., dance teacher, divorced, 29 years driving experience at 12,000 miles per year, trip plan home to an office building to pick up books, total of 18-20 miles, departed 1100, ETA 1130, accident occurred 2 miles from destination, owned and driven vehicle 5 years, driven 78,000 miles, drives accident route once a month, no driver education, physical condition wears glasses, mental condition good (friend visiting for vacation), restraint not used.

Injuries: bump left side of forehead, left arm sore, right thumb sprained, right knee bruises. AIS 1.

Vehicle 2, right front passenger, 33-year-old female, 64", 110 lbs., restraint not used.

Injuries: lacerations left forehead, right arm sore, left knee bruised. AIS 1.

* Collision Deformation Classification, Society of Automotive Engineers Technical Report J224a

Standards

The following Highway Safety Program Standard (HSPS) was specifically relevant to this case:

HSPS 12. Highway Design, Construction and Maintenance: construction site was protected by sawhorse barrier but warning traffic cones should have been placed in road before site to warn motorists who do not look far enough down roadway.

Description

Pre-Crash

Vehicle 1 was eastbound in the fast lane at driver-estimated speed of 30 mph. Driver 1 noticed a vehicle to his right begin to come into his lane to avoid a sawhorse construction barrier. Driver 1 swerved to the left to avoid impact with the adjacent vehicle and lost control, braked leaving 38' of skids and continued into the opposing lanes.

Vehicle 2 was westbound in the fast lane at driver estimated speed 25 mph. She saw Vehicle 1 swerve and applied her brakes leaving 32' of skid.

Crash

The right front fender of Vehicle 1 contacted the right side of Vehicle 1, causing sideswipe type damage. The fender of Vehicle 1 was torn off.

Upon impact, occupants of Vehicle 2 moved toward the right. Driver 2 hit her forehead on the mirror, her right knee on the underside of the dashboard, and probably her right thumb on the windshield. Her left arm was sore, probably from holding the steering wheel. The right front passenger hit her left forehead on the windshield receiving a laceration, and her left knee on the underside of the dashboard. Her right arm was sore, probably from bracing.

Driver 1 does not recall hitting the interior of his vehicle.

Speeds at impact were estimated to be 12 mph for Vehicle 2 and 18 mph for Vehicle 1.

Post-Crash

A third vehicle westbound in the slow lane braked leaving 18' of skids and stopped before impacting Vehicle 1 after the collision. Vehicle 2 occupants checked themselves and the dog in the rear seat but wanted to remain in the car for a while. Driver 1 released his lap restraint, checked the dog in his back seat and went over

to check Vehicle 2 occupants. Police were called. People living on corner invited Vehicle 2 occupants inside. Ambulance and then police arrived. Ambulance was dismissed, tow vehicle moved Vehicle 2 out of roadway. Driver 1 drove his vehicle away and people on corner took Vehicle 2 occupants to their destination and then to tow company where they rented a car and drove home.

Causal Factors and Recommendations

Matrix Element Diagram

The following diagram defines the numbering system used in the matrix element description.

	Pre-Crash	Crash	Post-Crash
Human	1	2	3
Vehicle	4	5	6
Environmental	7	8	9
	Accident Avoidance	Injury Prevention	Restoration and Cleanup

Matrix Element Description

Matrix Cell No.

(* indicates positive factor)

Explanation

Accident Causation

Primary or Principal Cause

- | | |
|---|---|
| 1 | Driver 1 swerved left to avoid vehicle cutting into his lane (definite) |
| 7 | A phantom vehicle cut partly into Vehicle 1's fast lane to avoid barricade (definite) |

Severity Increasing Factor

- | | |
|---|--|
| 1 | Driver 1 overreacted to phantom vehicle's actions and lost control of his car (definite) |
|---|--|

Relevant Condition

- | | |
|---|---|
| 7 | Sawhorse barricade 4' into street at construction site with no traffic cone warnings (definite) |
|---|---|

Matrix Element Description (Continued)Matrix Cell No.

(* indicates positive factor)

ExplanationInjury Causation

2

Vehicle 2 occupants not wearing restraints (definite)

Post-Crash Factor

*9

Driver of another vehicle was able to stop before impacting Vehicle 1 after initial impact.

Recommendations

7

Construction site barricades should have warning cones placed down the road from them

1

Drivers should be taught to look ahead on the road for hazards far enough in advance to take appropriate measures

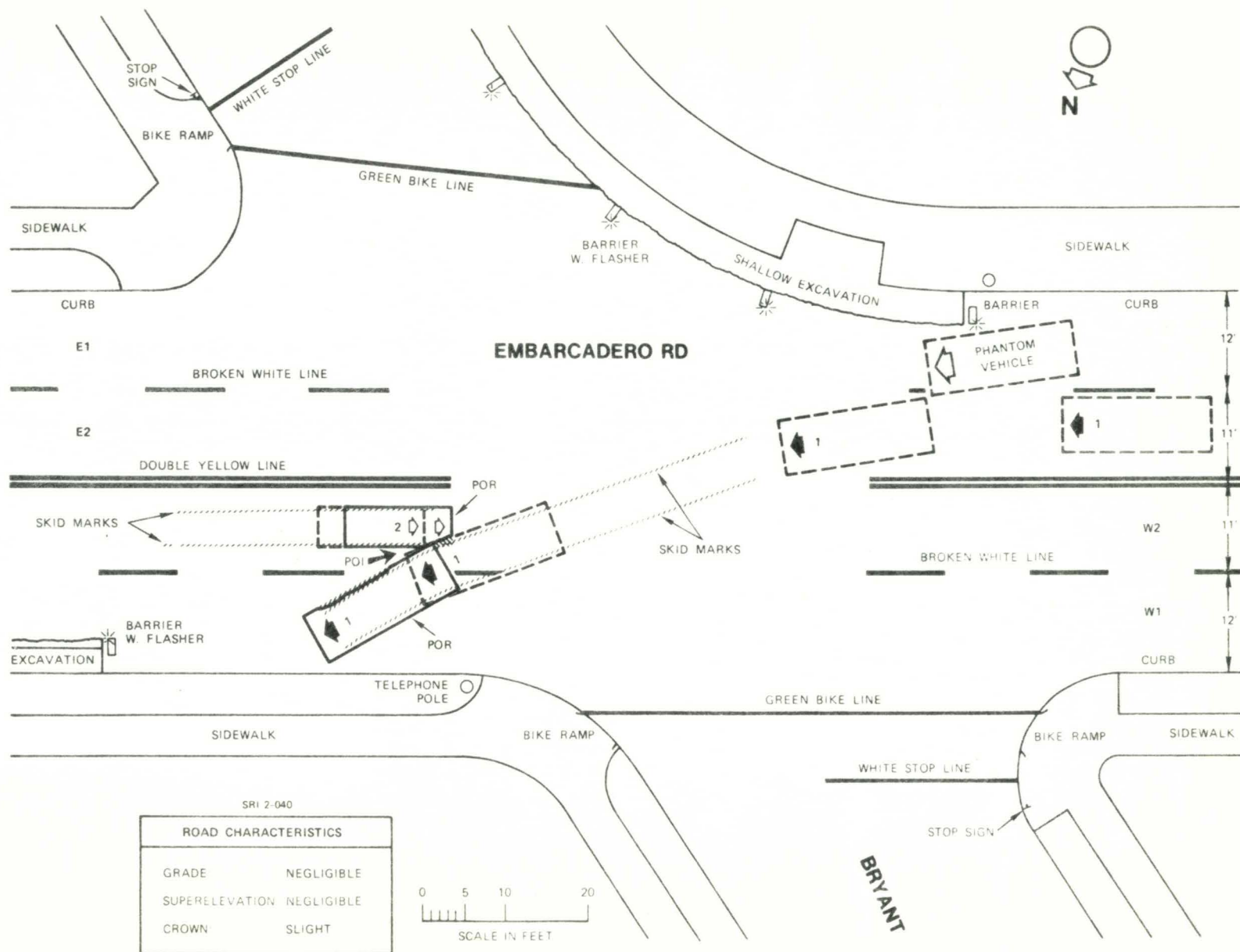


FIGURE 1 COLLISION DIAGRAM