

FINAL REPORT  
PROJECT B-617

# MULTIDISCIPLINARY ACCIDENT INVESTIGATIONS PHASE 4

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A Report on Research Performed  
Under Contract With  
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School of Civil Engineering  
GEORGIA INSTITUTE OF TECHNOLOGY  
Atlanta, Georgia





MULTIDISCIPLINARY ACCIDENT INVESTIGATIONS  
PHASE 4

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## ABSTRACT

This report summarizes the results of a comprehensive and systematic study of twenty-five vehicular collisions which occurred in Georgia during a ten month period. One of the crashes, which involved a school bus, occurred in Athens, Georgia. All of the other crashes occurred in metropolitan Atlanta.

The research was a broadbased team effort which involved the participation of a civil engineer, two physicians, an automotive technician, a psychologist, a mechanical engineer, a pathologist, a social worker, and a secretary. The research included an epidemiological study of factors leading to the initiation of accidents as well as a study of the "second collision" to establish the kinematics of the occupants and to identify the agent(s) which caused the injuries and deaths.

This report describes the results of Phase 4 of a continuing research program sponsored by the National Highway Safety Bureau. Previous reports (1, 2, 3)\* describe the research that was accomplished under phases 1, 2, and 3 of this program and include detailed case studies of 45 investigations made under these phases. This report includes case summaries of 25 investigations completed during a 14-month report period ending August 31, 1970. The full case reports for these investigations have been previously mailed to the National Highway Safety Bureau, and upon release by NHTSB, may be purchased from the Clearinghouse for Federal Scientific and Technical Information, 5285 Port Royal Road, Springfield, Virginia, 22151.

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\* Numbers in parentheses designate references at end of report.



## CHAPTER I

### INTRODUCTION

In 1968, the federal government under the auspices of the National Highway Safety Bureau undertook a program to collect a scientifically valid body of information regarding vehicular collisions. The initial phase of this program involved the development of six multidisciplinary medical-engineering research teams located in various cities throughout the United States: Atlanta, Boston, Houston, Los Angeles, New Orleans, and Rochester. Nine additional multidisciplinary teams have since been organized. These teams have been given the objectives of determining causes of traffic accidents and identifying agents which produce injuries and deaths in these accidents. In addition, the research teams have endeavored to evaluate effectiveness of new safety features, to provide early detection of vehicular and roadway design problems, and to determine aging effects in vehicles and the value of periodic motor vehicle inspection.

To date, seventy crash investigations have been completed by the Atlanta research team. Three reports (1, 2, 3) have been previously published by the Atlanta team describing the work that was accomplished under phases 1, 2, and 3 of this program:

<u>Phase</u>	<u>Number of Cases</u>	<u>Date of Report</u>	<u>Number of Pages</u>
1	10	June, 1968	116
2	20	February, 1969	179
3	15	June, 1969	140

These reports include detailed case studies of the 45 investigations made under previous phases of the program.

The present document summarizes the results of twenty-five accident investigations which were completed during the report period July 1, 1969 to August 31, 1970. The full case reports for these investigations have been previously mailed to the National Highway Safety Bureau and, upon release by NHTSB, are being distributed by the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151.

## CHAPTER II

### PROCEDURE

This research employed a multidisciplinary medical-engineering approach. It involved the participation of a neurological surgeon, general surgeon, pathologist, psychologist, civil engineer, mechanical engineer, safety engineer, automotive technician, secretary, and research assistants. The principal role of each participant is given by Table 1.

In each case, the research team was concerned, first of all, with identifying, isolating, and evaluating those human, vehicular, and environmental factors which contributed to the accident initiation. Secondly, the team concerned itself with the kinematics of the vehicle occupants during the post-impact phase, and the identification and description of accident trauma and the agent which caused each injury.

Twenty-five vehicular crash investigations were made during this report period, all but one of which occurred in metropolitan Atlanta, Georgia. A sketch of this study area is given as Figure 1. One of the investigations (Accident Number 58), which involved a school bus, occurred in Athens, Georgia.

#### Selection of Accidents for Investigation.

Thirteen of the cases chosen for investigation were discovered by periodic review of police reports or by conversation with police officers. Members of the research team learned of ten case accidents by monitoring police messages. One investigation was initiated after members witnessed the crash vehicle being towed to a repair shop. The Athens school bus crash was discovered by means of commercial radio.

In selecting accidents for further investigation, an attempt was made to obtain a reasonable distribution of fatal collisions, injury producing collisions, and property damage collisions. In the latter case, an additional selection criterion was used which required that at least one of the vehicles had to be towed from the scene.

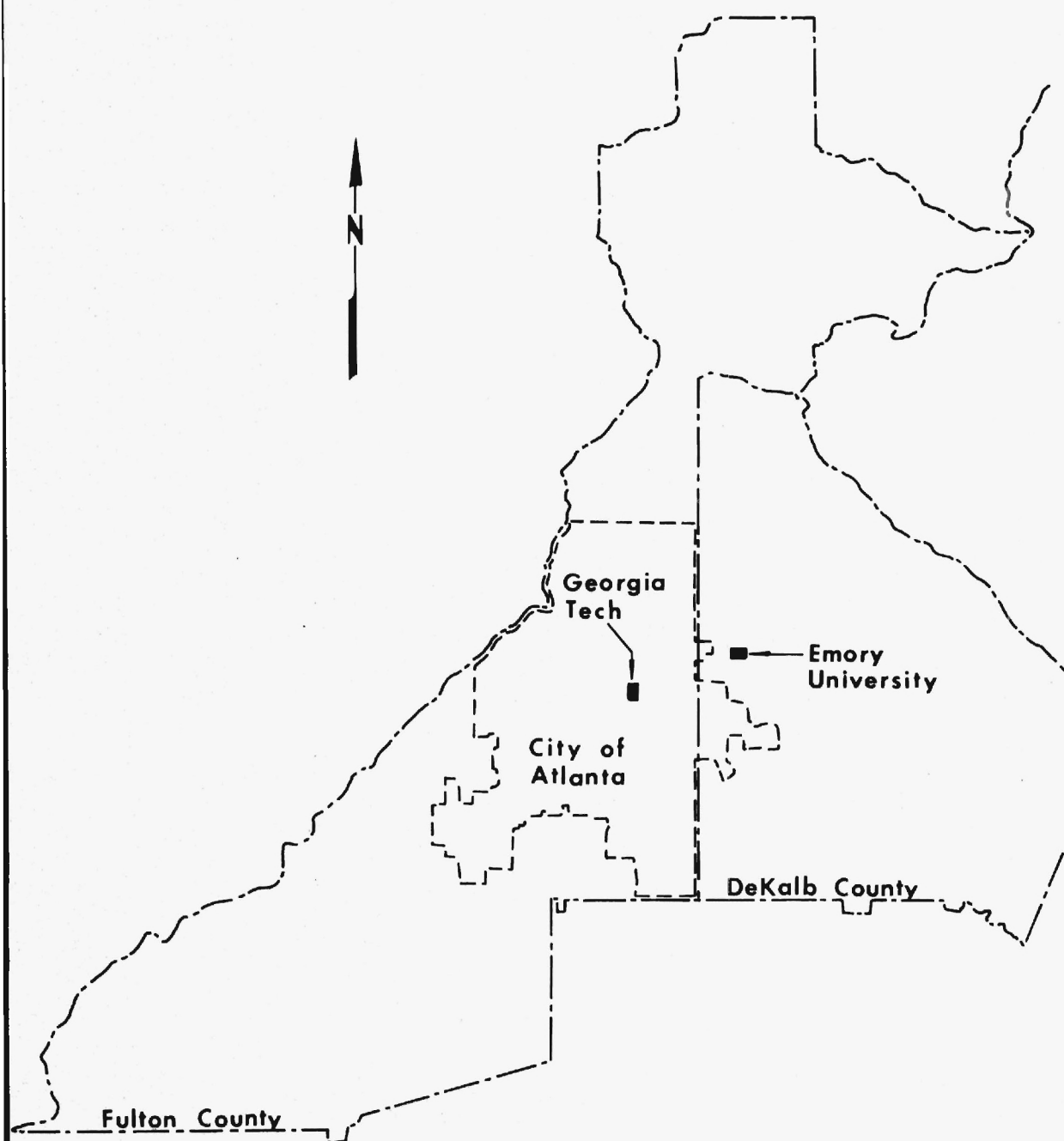


Figure 1. A Sketch of the Study Area.

Table 1. Principal Functions of Various Research Participants.

Participant	Principal Functions
Fleming L. Jolley, M. D. Neurological Surgeon	Identified and described accident trauma; correlated injury patterns with agent(s) which produced injuries.
Norman E. McSwain, Jr., M. D. General Surgeon	
Paul H. Wright, Ph.D. Civil Engineer	Served as Administrative Director of Project; identified and evaluated factors which contributed to accident initiation; authored final report.
Mr. Bruce Ivey Automotive Technician	Directed all mechanical aspects of the study including identification of pre-accident mechanical defects and evaluation of vehicle damage.
W. M. Williams, Ph.D. Mechanical Engineer	Assisted with accident analysis; provided expertise on automotive systems.
Robert R. Stivers, M. D. Pathologist	Served as a consultant to provide autopsy reports.
P. Andrew Springer, B.S., P.E. Safety Engineer	Provided information regarding previous traffic violations of drivers and evaluation of roadway in light of previous accident history.
Michael F. Bearden Student Research Assistant	
E. Jo Baker, Ph.D. Psychologist	Provided psychological studies for certain drivers.
Miss Jo Stallings Social Worker	Assisted Dr. Baker by conducting psychological interviews.
John S. Hassell, Jr., B. S. George W. Black, Jr., B. S. Engineering Assistants	Made on-the-scene investigations; conducted engineering roadway studies and prepared maps.
Bert Arrillaga, B. S., M. S. William R. Griffin, B. S. King-Kuen Mak, B. S. Student Research Assistants	Made photographs; conducted field studies; assisted with writing of report.
Mrs. Betty Jordan Secretary	Typed final report; handled numerous administrative details.

Only crashes involving a late model vehicle (i.e., manufactured since 1967) were chosen for investigation. No pedestrian accidents were investigated.

#### On-The-Scene Investigation.

One of the members of the research team patrolled regularly with a DeKalb County Police Officer during periods of high accident frequency. In addition, radio messages of the Atlanta Police Department were monitored during normal working hours. By these means, team members were able to arrive at the accident scene less than 15 minutes after impact in 10 of the 25 crashes investigated. In these cases, photographs were taken, witnesses were interviewed, and skid marks and other physical evidence were measured and documented. On numerous other occasions, members of the team went to the scene of accidents, but in these cases the accidents failed to meet the criteria for further investigation.

#### Roadway Studies.

Because of the observed tendency for certain physical crash evidence to deteriorate rapidly or disappear, roadway studies were undertaken at each accident scene as soon as practicable after learning of the accident. The roadway studies were conducted by two or three people and consisted of measuring or evaluating the following roadway factors: alignment and curvature, gradient, cross section dimensions, superelevation, sight distance, visibility, traffic control and warning devices, and skid resistance of the pavement.

Estimates of pavement skid resistance were based on tests made with a Tapley decelerometer at a speed of twenty miles per hour.

Attempts were made to locate skid and gouge marks and other physical evidence to assist in determining the movement of the vehicle during the impact event.

Photographs of the roadway were made with a 35 mm. YASHICA TL-Super camera and a 35 mm. NIKON F camera.



### Mechanical Analyses.

In most cases, a preliminary mechanical inspection was performed at the impound lot. It was usually necessary to make a more thorough mechanical inspection after the vehicle was removed to a more suitable location (e.g., the Salvage Disposal lot). One case vehicle was purchased and transported to the research team headquarters where a more thorough mechanical inspection was made.

Results of the mechanical inspections were recorded on Collision Performance and Injury Report Forms (General Motors Report No. GM PG 2070) and the damages and defects of each automobile were documented by means of color photograph slides.

### Medical Reports on the Injured.

The pattern of injuries received by each individual was determined by reviewing the medical records of those hospitalized with the attending physicians. These physicians proved most cooperative.

A number of the injured were examined with the attending physicians to gain additional insight to correlate the injury pattern with contacting agents within the vehicle. Such cooperation has permitted identifying for the attending physician certain additional facts as to symptomatology of injury received by his patient.

Additional valuable information was gained in reviewing x-rays as well as other diagnostic studies performed.

### Autopsies.

The 25 crashes investigated during this report period resulted in nine fatalities. One crash, (accident 50), a head-on collision of a 1968 Dodge Coronet and a tractor-trailer truck, resulted in four fatalities. The team was unable to obtain autopsies for these victims; however, extensive post-mortem examinations were performed.

In another crash (accident 53), one of the victims died two days following the crash. In this case, the injuries were well documented during the victim's hospitalization and an autopsy was not performed.

Autopsies were performed for four victims in accidents 59, 61, and 65 (two fatalities). Dr. Robert R. Stivers served as a consultant pathologist for the research team.



#### Psychologist's Report.

Psychological studies were made under the direction of Dr. E. Jo Baker, Associate Professor, School of Psychology, Georgia Institute of Technology. She was assisted by Miss Jo Stallings, Social Worker, of the Georgia Mental Health Institute, who conducted home interviews of the various drivers.

#### Report of Previous Traffic Violations.

With the cooperation of the Georgia Department of Public Safety, a check was made of each driver's previous traffic violations, and this information was made a part of the respective case reports.

#### Roadway Accident History.

In most cases, particularly those involving hazardous roadways, a study was made of the accident history of the roadway and an evaluation of the roadway from this viewpoint was made a part of the case report.

#### Police Officer's Report.

Periodic visits were made to the Atlanta Police Station and the DeKalb County Police Department to learn of accidents that had occurred. Copies of police reports were obtained for those accidents chosen for investigation to provide personal and biographical data and supplemental information on how the accident occurred.

#### Case Review and Analysis.

Periodic meetings of the research team were held to review and analyze case studies. These meetings were particularly helpful in establishing occupant kinematics and injury causation. After suitable discussion and review, results of the case studies were written and photographs were chosen for publication.

## CHAPTER III

### DISCUSSION OF RESULTS

This research was based on the fundamental and scientifically valid concept that vehicular crashes do not "just happen" but can be attributed to one or more discernible conditions or factors. The 25 crashes which constitute this study were reviewed in the context of the epidemiologic triad -- the roadway environment, the vehicle, and the driver.

In the paragraphs which follow, a summary description is given of environmental, vehicular, and human conditions observed during this study followed by an evaluation of the factors in accident initiation. A discussion of the crash performance of the vehicles is also given as it relates to injury attenuation and prevention.

Case summaries for the 25 crashes are given in the appendix.

#### Environmental Conditions.

The 25 crashes occurred on a variety of roadways. Eight crashes occurred on urban expressways and four on heavily travelled urban arterial streets. There were eight accidents on two-lane collector or local streets, one on a four-lane rural divided highway, and four at intersections.

As shown by Table 2, the most predominant type of accident investigated was "leaving roadway, striking fixed object". In six of these accidents, the vehicle left the roadway at or near a sharp horizontal curve, and five of these crashes were at locations where poles and other fixed objects were located less than two feet from the pavement edge. At two locations, the hazard was compounded by adverse crown or negative superelevation.

Six of the accidents involved vehicles which crossed over an expressway median or roadway centerline and collided with a vehicle travelling in the opposite direction. The seriousness of this type of crash is demonstrated by the fact that these crashes accounted for

seven deaths (out of a total of nine) and one permanent disability. Four of the deaths occurred in a single crash (Accident 50) in which an automobile crossed an expressway median into the path of a tractor-trailer truck. The need for median barriers to lessen the probability of this type of crash has been described in a previous report (2).

Table 2. Classification of Accidents by Type

Type of Accident	Number Investigated
Leaving roadway, striking fixed object	10
Intersection collision with another vehicle	5
Crossing median or center line (collision with another vehicle)	3
Collision with vehicle with subsequent crossing of median or center line resulting in additional collision(s)	3
Rear-end collision on expressway	2
Head-on collision on expressway	1
Leaving roadway, rollover	1
	<hr/> 25

In one investigation (Accident 70), it was noted that the roadway was zoned for a speed limit higher than the design speed. In this case, the vertical curvature (or profile grade) design was determined to be inadequate.

In another case (Accident 46), the consequences of the crash were worsened by a failure of the highway department to utilize a modern sign support of breakaway design. The research team noted with disappointment that the support was not replaced with one of breakaway design.

#### Vehicular Factors.

All but one of the crashes investigated involved a 1968, 1969, or 1970 vehicle. A classification of the vehicles studied according to year of manufacture is given in Table 3. This table should not be interpreted to indicate that late model vehicles are more frequently

involved in accidents than older vehicles. The table simply indicates that the team was able to conform to the requirements of the sponsor that only accidents involving at least one late model vehicle be investigated.

Table 3. Classification of Accident Vehicles by Year of Manufacture

Year of Manufacture	Number of Vehicles
1970	5
1969	13
1968	8
1967	3
1966	1
1965	1
1964	7
1963	3
1961	1
1960	1
1959	1
1956	1
	<hr/> 45

In three of the 25 cases (accidents 47, 58, and 68), defective brakes were blamed for accident initiation. In Accident 58, which involved a school bus, the brake failure was attributed to improper vehicle inspection and lack of adequate preventive maintenance.

Vehicular factors contributed jointly with other factors to accident initiation in two other cases: Accident 62 (improper and worn tires) and Accident 65 (broken bolt in steering mechanism).

#### Human Factors.

The accidents investigated during this report period involved drivers with ages ranging from 16 to 68. The average driver age was 34 and the median age was 29. About 20 percent of the drivers were females.

Previous traffic violations were held by 15 of the 44 drivers,

and one driver had a record of 16 previous traffic violations.

Alcohol was a significant factor in six of the accidents, and diseases contributed to the initiation of two crashes. Fatigue was listed as a probable contributing factor in four cases.

It is alarming that in six of the 25 crashes, the driver was thought to have been either unconscious or asleep when the vehicle went out of control.

#### Factors in Accident Initiation.

In an attempt to describe and evaluate the various factors which contributed to the initiation and consequences of the accidents investigated, the research team defined the following terms:

1. Principal Contributing Factors. This factor, acting alone, was sufficient to explain the occurrence of the accident. Without this single factor, the accident, in the investigators' opinion, would not have occurred.
2. Joint Principal Contributing Factors. These factors are defined as two or more factors acting jointly which were sufficient to explain the occurrence of the accident. Without the combined presence of these factors, the accident, in the investigators' opinion, would not have occurred.
3. Modifying Factors. Absence of these factors would not have prevented the accident from occurring. However, these factors, in the investigators' opinion, compounded the consequences of the crash and increased the magnitude of the damages to property and injuries to those involved in the accident.

A summary of the 25 accidents investigated during this report period is given by Tables 4, 5, and 6. A summary description of each accident is given in the appendix.

#### At-Crash and Post-Crash Factors.

One of the most disappointing aspects relating to the at-crash phase is the failure of drivers and passengers to use seat belts. Despite limited data, it is clear that unsatisfactory public acceptance of lap and shoulder restraints is a major hindrance to efforts to reduce the number of collision deaths and mitigate the injuries. During this



report period, for example, it was observed that in six of the 25 cases the use of lap and shoulder restraints would have lessened or prevented occupant injuries.

Another at-crash factor deserving of special mention is the tendency of hoods to penetrate the windshield as a result of impact. This phenomenon, which has been mentioned in previous reports, has been observed in six crashes (Accidents 04, 09, 19, 41, 53, and 57).

In one case (Accident 63), it was noted that the safety windshield and energy absorbing steering column performed well. The driver, who was not restrained, was uninjured as the vehicle impacted a power pole at a speed of 25-35 miles per hour.

A wide distribution of damaged vehicles were studies during this report period. This is shown by the following list which classifies the 45 vehicles into nine damage categories:

<u>Damage Scale *</u>	<u>Number of Cases</u>
1	3
2	0
3	8
4	7
5	8
6	5
7	7
8	1
9	4

The vehicle year and make and estimated cost of vehicular damages for each accident is listed in Table 7.

In Accident 59, which involved a post-crash fire, it was noted that the first police officer to arrive at the scene was not equipped with a fire extinguisher. As a result of this investigation, the Atlanta research team has recommended that police traffic investigators be furnished with fire extinguishers.

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\* The Damage Scale is the last component of the Vehicle Deformation Index. In this scale, the larger the number, the greater the deformation.



Table 4. Principal Contributing Factors.

Principal Contributing Factors	Matrix	Accident Number
Medical	1	46, 61
Alcohol	1	56, 59
Alcohol and/or amnesia	1	55
Unknown (human factor)	1	48, 57
Improper lane change (reason unknown)	1	50
Operating vehicle wrong way on expressway (attempting to start vehicle)	1	53
Improper parking (to evade provoked driver)	1	64
Inattentiveness & drinking	1	66
Improper vehicle maintenance (brake failure)	4	58
Defective brakes	4	47
Brake failure (due to rupture at front of brake hose)	4	68

Table 5. Joint Principal Contributing Factors.

Joint Principal Contributing Factor(s)	Matrices	Accident Number
Alcohol, excessive speed	1, 1	52
Driver error (failure to remove vehicle from roadway after minor accident), excessive speed	1, 1	60
Excessive speed, violation of red traffic signal	1, 1	63
Fatigue and alcohol	1, 1	69
Driver error (inattentiveness), broken bolt holding steering wheel	1, 4	65
Driver error (over-steering) and muddy roadway	1, 7	49
Excessive speed and poor roadway roadway design	1, 7	51, 70
Driver error and phasing of traffic signal	1, 7	54
Driver error (excessive speed), improper and slick tires, roadway hazard (raised man-hole cover)	1,4,7	62
Excessive speed, wet roadway, poorly designed roadway	1,7,7	67

Table 6. Modifying Factors.

Modifying Factor(s)	Matrix	Accident Number
Failure to provide breakaway support	8	46
Design of drop inlet too high, causing vehicle to be elevated	8	62
Trees too close to edge of road	8	67

Table 7. Estimate of Cost of Damages to Vehicles

Accident Number	Vehicle Year and Make	Estimated Cost of Damages
46	1969 Chevrolet Impala	\$ 2,850
47	1969 Pontiac LeMans	1,800
	1964 Ford Mustang	1,500
48	1969 Mercury Comet	1,800
	1963 Ford Falcon	2,200
49	1964 Pontiac Catalina	1,800
	1968 Chevrolet Impala	2,800
50	1968 Dodge Coronet 440	2,700
	1966 White truck & refrigeration type trailer	40,000
51	1969 Camaro	2,200
52	1969 MGB	2,970
53	1960 Pontiac	350
	1961 Ford Station Wagon	250
	1969 Ford Galaxie 500	3,100
54	1968 Chevrolet one-ton parcel delivery van	4,235
	1969 Ford Maverick	3,000
55	1969 Chevy II Nova	2,700
	1967 Ford Mustang	1,700
56	1969 Pontiac LeMans	2,800
57	1968 Chevelle	3,250
58	1968 Ford Fairlane 500	3,000
	1959 Dodge 66 passenger school bus	4,800
59	1968 Pontiac Catalina Station Wagon	3,800

(Continued)

Table 7 (Continued). Estimate of Cost of Damages to Vehicles

Accident Number	Vehicle Year and Make	Estimated Cost of Damages
60	1970 Volkswagen	\$ 2,200
61	1968 Chevrolet Impala	2,800
62	1967 Mustang	1,600
63	1970 Dodge Super Bee	3,000
	1963 Chrysler New Yorker	1,800
64	1969 Chevrolet Caprice	2,050
	1964 Chevelle Malibu	900
65	1963 Chevrolet Impala	450
	1965 Ford Fairlane 500	1,300
	1969 Ford Torino	3,200
	1964 Chevelle Station Wagon	125
66	1970 Chevrolet Malibu	3,200
	1956 Oldsmobile "98" Holiday	250
67	1970 Plymouth Barracuda	2,500
68	1964 Plymouth Valiant	650
	1968 Fiat 850	850
69	1969 Buick LeSabre	3,500
70	1970 Chevrolet Malibu	<u>3,700</u>
Total		\$ 129,680

Grand Summary of Research Findings.

A total of 70 crashes have been investigated to date involving 108 vehicles. These crashes resulted in 28 deaths and vehicular damage losses amounting to over \$300,000. (See Table 8.)

A grand summary description of the findings from these 70 investigations is given by Tables 9, 10, 11, and 12.

Table 8. Estimate of Cost of Damages to Vehicles.

Phase	Number of Accidents	Number of Vehicles	Vehicular Damage Losses
1	10	15	\$ 23,750
2	20	29	55,815
3	15	23	91,050
4	25	41	<u>129,680</u>
			\$300,295

Table 9. Classification of Accidents by Type-Summary of  
70 Accident Investigations.

Type of Accident	Number Investigated
Leaving roadway, striking fixed object	31
Crossing median or center line (collision with another vehicle)	12
Collision with vehicle with subsequent crossing of median or center line, resulting in additional collision(s)	3
Intersection collision with another vehicle	13
Leaving roadway, rollover	4
Leaving roadway into ditch (bus)	1
Entering median, overturning	1
Rear end	2
Rear end on expressway	3
Head on collision on expressway	1
	<u>71 *</u>

\* Accident 45 involves both rollover and rear end collisions and  
has been considered as two separate cases.

Table 10. Principal Contributing Factors - Summary of 70  
Accident Investigations.

Principal Contributing Factor	Matrix	Number Investigated
Alcohol	1	10
Alcohol and/or amnesia	1	1
Psychological	1	1
Medical (Black out, myocardial infarction)	1	2
Driver error (pressing accelerator instead of brake by mistake)	1	1
Violation of traffic signal	1	1
Violation of stop sign (unfamiliarity with city streets)	1	1
Failure to yield right-of-way	1	3
Excessive speed, driving wrong way on one- way street (panic)	1	1
Operating vehicle wrong way on expressway (attempting to start vehicle)	1	1
Improper passing	1	1
Improper lane changing (reason unknown)	1	1
Improper parking (to evade provoked driver)	1	1
Inattentiveness and drinking	1	1
Excessive speed	1	1
Unknown (human factor)	1	4
Improper vehicle maintenance (defective brakes)	4	3
Defective brakes or brake failure	4	3
Tire failure (hitting the curb)	4	1
Wet roadway	7	<u>1</u>
		39

Table 11. Joint Principal Contributing Factors -  
Summary of 70 Accident Investigations

Joint Principal Contributing Factors	Matrices	Number Investigated
Alcohol, violation of signal	1, 1	1
Alcohol, excessive speed	1, 1	1
Alcohol, fatigue	1, 1	2
Excessive speed, violation of red traffic signal	1, 1	1
Excessive speed, failure to take evasive action	1, 1	1
Driver error (inattentiveness), violation of stop sign	1, 1	1
Driver error (failure to remove vehicle from roadway after minor accident), excessive speed	1, 1	1
Driver unfamiliarity with vehicle, vehicle handling peculiarities	1, 4	1
Driver error (over-reacting), tire failure	1, 4	1
Driver error (inattentiveness), broken bolt holding steering wheel	1, 4	1
Alcohol, hazardous roadway	1, 7	1
Excessive speed, hazardous roadway	1, 7	4
Excessive speed, inadequate traffic control	1, 7	1
Driver errors, hazardous roadway	1, 7	1
Driver error (over-steering), muddy roadway	1, 7	1
Driver error, phasing of traffic signal	1, 7	1
Slick tires, wet roadway	4, 7	3
Alcohol, excessive speed, roadway design	1, 1, 7	1
Alcohol, driver errors, hazardous roadway	1, 1, 7	1
Excessive speed, worn tires, wet roadway	1, 4, 7	2
Driver error (inattentiveness), improper tire pressure, damaged roadway	1, 4, 7	1
Driver error (excessive speed), improper and slick tires, roadway hazard (raised man-hole cover)	1, 4, 7	1
Excessive speed, wet roadway, hazardous roadway	1, 7, 7	1
Excessive speed, fatigue, unfamiliarity with vehicle, hazardous roadway	1, 1, 1, 7	<u>1</u>
		31



Table 12. Modifying Factors - Summary of 70  
Accident Investigations.

Modifying factor(s)	Number Investigated
Worn tires, defective brakes	3
Worn tires	4
Defective brakes	1
Defective brakes and steering	1
Wet roadway	1
Roadway (absence of guardrail or barrier in median)	4
Design of drop inlet too high, causing vehicle to be elevated	1
Trees too close to edge of road	1
Failure to provide breakaway support	1
Vehicle design (brake system)	1
Driver error (failure to take evasive action)	1

## CHAPTER IV

### OBSERVATIONS AND CONCLUSIONS

A review of the 70 investigation reports which have been completed thus far supports the view often stated by other safety researchers that vehicular crashes are caused by a wide variety of human, vehicular, and roadway factors. It is also evident that a substantial percentage of vehicular crashes are complex events which are triggered by two or more factors. For example, forty-four percent of the investigations conducted thus far involved two or more causative factors, and three or more contributing factors were identified in 10 percent of the cases.

The presence of multiple causative factors implies that multiple countermeasures are warranted. There are, in short, many remedial programs that could be instituted to prevent and reduce the destructive effects of vehicular crashes. Furthermore, the establishment of the relative merits of the various traffic safety programs is a complex problem which ideally should include an evaluation of the costs as well as the benefits of the various countermeasures, singly and in combination. Such an evaluation is well beyond the scope of this study, which had as its primary purpose the collection and documentation of valid scientific accident data. During the past two and a half years, however, members of the Atlanta research team have naturally formed impressions and judgments regarding the extent and seriousness of various hazards and the relative merit of countermeasures to reduce or remove these hazards.

The observations listed below may be helpful to public officials in directing attention to areas of concern which are deserving of prompt remedial action. Additional comments and recommendations are given in the individual case summaries included in the Appendix.

1. The results of this study support the findings of other researchers that driving under the influence of intoxicants is a major

factor in accident initiation.

2. The research suggests that improvements in Georgia's driver licensing system are needed including periodic re-examination of drivers and medical supervision of certain aspects of the driver licensing program.

3. Evidence of inadequate vehicle maintenance has been frequently noted in the course of this research. The team is especially concerned that inadequate maintenance of school buses may be a common practice. Inadequate vehicle inspection and preventive maintenance of schoolbuses has been noted in the investigation of three accidents and was the principal contributing factor in two of these cases. (Only one of these accidents occurred in Georgia.)

4. Further improvements in vehicle design are required to prevent the intrusion of foreign objects into passenger compartments. Of particular concern is the rearward displacement of the hood with subsequent penetration of the windshield. It is gratifying that the Department of Transportation has issued an Advance Notice of Proposed Rule Making relating to this hazard. The issuance of an amendment to Federal Motor Vehicle Standard No. 113 to specify performance requirements to lessen the likelihood of this occurrence is strongly recommended.

5. Great hazard is associated with the presence of trees, utility poles, and other fixed objects only one or two feet beyond the curb of heavily traveled streets and highways. This hazard is compounded when these objects exist on the outside of roadway curves which have not been superelevated.

6. State and local highway departments should place guardrails and other barriers in narrow medians which separate high speed traffic lanes. This is a serious problem, and officials should place a high priority on such improvements.

7. In view of the limited public acceptance of lap and shoulder restraints, it appears that a passive restraint system will be required if significant decreases in injuries and deaths are to be achieved.

#### LIST OF REFERENCES

1. "A Study of Severe Vehicular Accidents, Phase 1: Medico-Engineering Training Program", School of Civil Engineering, Georgia Institute of Technology, June, 1968.
2. "A Study of Severe Vehicular Accidents, Phase 2", School of Civil Engineering, Georgia Institute of Technology, February, 1969.
3. "A Study of Severe Vehicular Accidents, Phase 3", School of Civil Engineering, Georgia Institute of Technology, June, 1969.

## APPENDIX



Brief Description of Accident. This accident involved a 1969 Chevrolet, 2-door hardtop, which suddenly left the roadway and struck a highway sign support. The vehicle subsequently rotated and rolled onto its right side. The driver of the vehicle stated that he has had a history of blackout spells and that he lost consciousness just prior to the crash. The speed of impact was 35-45 miles per hour. The collision severity rating was moderate and the estimated cost of damages is \$2,850. The deformation index is 12LYEN4.

Roadway Environment. The crash occurred at 9:30 P.M. along a four-lane controlled access expressway with a 55-foot median. The alignment is straight and the grade is negligible. The Portland cement concrete pavement was dry and visibility was restricted due to darkness.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: medical (matrix no. 1B)
2. Modifying factor: failure to provide a breakaway sign support. (matrix no. 8 )

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
27 M	Driver	None used	Scalp laceration	Hood
			Fractured neck (Moderate)	A-pillar & roof

Comments:

Matrix

1. A breakaway sign support would have greatly lessened the severity of this crash. Sign supports destroyed in crashes such as this should be replaced with a support of breakaway design. 8
2. Attention is directed to the fact that the hood was displaced rearward and penetrated the windshield. This hazardous phenomenon has been observed previously in accidents involving General Motors vehicles and is considered by members of this research team to warrant more detailed evaluation of the design of the hood and the hood hinges. (See Figure 46-5.) 5
3. This crash suggests that there is a need for closer medical supervision of driver licensing. 1A
4. This driver's injuries would have been lessened had he been wearing lap and shoulder belts. 2





Brief Description of Accident. Accident 47 involved a 1969 Pontiac four-door hardtop (vehicle 1) which crossed the roadway center line into the path of a 1964 Ford Mustang (vehicle 2). Defective brakes (vehicle 1) were responsible for the initiation of this crash. The speed of impact for vehicle 1 was 10-20 miles per hour and for vehicle 2, 15-25 miles per hour. The collision severity for vehicle 1 was minor with estimated cost of damages of \$1,800. Vehicle 2 was rated minor with the cost of damages estimated at \$1,500. The primary deformation index was 3RFEW3 for vehicle 1 and 1LFYEW3 for vehicle 2.

Roadway Environment. The crash occurred at 4:50 P.M. along a heavily traveled six-lane, two-way street at its intersection with another city street. The intersection is signalized and the streets are of curb and gutter design with sidewalks. The alignment is straight and there is a negative grade in the direction of travel of vehicle 2 of 3.5 percent. The asphalt pavement was dry at the time of the crash.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: Defective brakes (vehicle 1).  
Matrix no. 4.

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
64 F	Veh. 1 - Driver	None used	Fractured right clavicle and right radius (Moderate)	Right front door
47 M	Veh. 2 - Driver	Lap belt	Laceration upper lip, loss of 2 teeth, abdomen tenderness (Minor)	Steering wheel

Comments.

Matrix

1. The initiation of this crash was due to an imbalance in the braking effort on the rear brakes, as indicated by a differential in wear between the left and right rear brake shoes. It would appear that further study of this problem is justified. 4
2. The injuries of the driver of vehicle 1 would have been lessened had she been wearing lap and shoulder belts. 2



Brief Description of Accident. Accident 48 involved vehicle 1, a 1969 Mercury Comet two-door hardtop, which crossed the roadway centerline and collided practically head-on with a 1963 Falcon two-door hardtop, vehicle 2. The driver of vehicle 1 stated that a steering malfunction caused the vehicle to lose control, but a mechanical analysis of the vehicle failed to reveal a steering defect. The impact speed was 35-45 MPH for vehicle 1 and 30-40 MPH for vehicle 2. The vehicle deformation indices were 12LYMW6 for vehicle 1 and 11LYEW7 for vehicle 2.

Roadway Environment. The accident occurred at 11:25 P.M. along a four-lane undivided, heavily traveled residential street. Curvature and roadway gradient are slight. The asphalt pavement was dry, and the street was illuminated.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: Human, the nature of which is unknown (matrix no. 1). While the circumstances suggest that the driver had fallen asleep, psychological factors may have contributed to the initiation of this crash.

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
16 M	Veh. 1 - Driver	None used	Facial lacerations (minor)	Steering rim
20 M	Veh. 2 - Driver	None	Unconsciousness Left ear laceration (minor)	Front portion of left window frame
16 M	Veh. 2 -Rt. front	None	Fractures, nose & face Massive facial lacerations (moderate)	Hood, vehicle 1

Comments.

Matrix

- |  |   |
|--|---|
| 1. The proper use of lap and shoulder belts would have lessened the injuries to all three victims in this crash.   | 2 |
| 2. It is noted that the Mercury Comet had no padding on the A-pillar. While this fact did not contribute to injury severity in this case, the frequency of passenger contact with the A-pillar makes this a matter of concern. | 5 |



Brief Description of Accident. This crash involved a 1964 Pontiac, two-door hardtop (vehicle 1) which ran over a muddy spot in the roadway, lost control, crossed the roadway center line into the path of a 1968 Chevrolet four-door sedan (vehicle 2). The driver of vehicle 1 evidently over-corrected for an off-the-road skid which caused the vehicle to cross the roadway when it moved onto dry pavement. The impact speed of vehicle 1 was 20-30 miles per hour and for vehicle 2, 15-25 miles per hour. The collision severity for vehicle 1 was moderate, with an estimated cost of damages of \$1,800. Collision severity for vehicle 2 was moderate, with an estimated cost of damages of \$2,800. The deformation index for vehicle 1 was 1FZEW3 and for vehicle 2, 1LFYEW4.

Roadway Environment. The accident occurred at 1:55 P.M. on a two-lane two-way residential arterial street 25 feet in width. The street is of curb and gutter design. Catch basins in the vicinity of the crash were clogged with debris and mud covered the pavement. The crash was initiated near the bottom of a vertical curve and at the end of a  $5\frac{1}{2}^\circ$  curve. Except for the muddy spot the asphaltic pavement was dry.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factors: muddy roadway and driver error (over-steer). Matrix numbers 7 and 1.

Occupant Injury and Injury Causation.

<u>Age</u> & <u>Sex</u>	<u>Vehicle Number &amp;</u> <u>Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury</u> <u>Producing Agent</u>
56 F	Veh. 1 - Driver	Lap belt	Comminuted fracture of the left patella	Steering column
			Abdominal bruise	Seat belt
			Minor abrasion to forehead (Moderate)	Steering rim
68 M	Veh. 2 - Driver	None used	Facial abrasions	Windshield
			Fractures, left knee (Moderate)	Lower face in- strument panel



Brief Description of Accident. Accident 50 was a complex accident involving four vehicles. The major collision involved a 1968 Dodge Coronet four-door sedan (vehicle 1) which evidently was bumped by a 1969 Ford tractor-trailer truck (vehicle 3) causing the Dodge to go out of control across an expressway median into the path of a 1966 White tractor-trailer truck (vehicle 2). Vehicle 3 subsequently struck a 1964 Chevrolet sedan (vehicle 4). The impact of the Dodge with vehicle 2 virtually demolished the Dodge and killed four of its five occupants. Vehicle 2 subsequently overturned and burned. At impact, vehicle 1 was travelling at a speed of 10-20 miles per hour, and vehicle 2 was travelling 50-60 miles per hour. The deformation index for vehicle 1 was 10LPAW9.

Roadway Environment. This accident occurred along a heavily travelled four-lane highway with frequent intersections and cross-overs. The roadway has 12-foot traffic lanes and a 50-foot grassy median. The alignment is straight and the gradient is negligible. The asphaltic pavement was dry.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: improper lane change by driver of vehicle 3 (matrix no. 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
35 M	Driver, veh. 1	None used	Skull fracture Compression of chest Multiple fractures, abrasions, lacerations (fatal)	A-pillar Unknown Unknown
31 F	Center front, veh. 1	None used	Head injury (fatal)	Unknown
34 F	Left rear, veh. 1.	None used	Massive head injury Multiple fractures, abrasions, lacerations (fatal)	Unknown
16 F	Right rear, veh. 1	None used	Massive head injury Multiple fractures, abrasions, lacerations (fatal)	Unknown Unknown
16 F	Right front, veh. 1	None used	Fracture, right femur Laceration to scalp (moderate)	Unknown Rear portion of right window frame



Comments.

1. The forces imported to the Dodge by the fast moving tractor-trailer truck were extremely large, resulting in the virtual demolition of the automobile. In crashes such as this, it is apparent that an automobile offers little protection to its passengers. Indeed, it is doubtful that it would be practicable to design a vehicle to protect its passengers in a crash of this severity. A more feasible remedial measure, it would seem, would be to prevent vehicle cross-overs on high-speed, high-volume roadways by the elimination of grade crossings and more extensive use of median barriers (matrix no. 7).

2. This is the second crash investigated by the Atlanta team in which a tractor-trailer truck was destroyed by a fire of unknown origin. Since this crash, it has been learned that drivers of these vehicles commonly use ether to help start the diesel engines. This ether comes in at least two forms: liquid ether encased in gelatin pellets and ether vapor in pressurized spray cans. This material is extremely inflammable and members of the Atlanta team believe this may be a source of fires in tractor-trailer crashes. (matrix 6).



Brief Description of Accident. Accident 51 involved a 1969 Chevrolet Camaro two-door hardtop which left the roadway at a curve on a poorly designed roadway, struck a pole, and then overturned. The vehicle was occupied by the driver and one passenger. The vehicle went out of control at a speed of 45-55 MPH. The primary deformation index is 03TDA07 and the secondary index is 03RBEN1.

Roadway Environment. The crash occurred at about 3:00 A.M. along an old narrow two-lane road which has poor design features. The roadway had sharp curvature ( $D=33^\circ$ ), adverse superelevation, and a negative grade of 8.5 percent. Numerous poles are located along the outside of the curve. The roadway is poorly illuminated, and no warning signs warn drivers of the hazard. The asphalt pavement was dry.

Significant Findings Regarding Accident Initiation.

1. Joint principal contributing factors: poor roadway design (curvature, superelevation, presence of poles, steep grade, poor illumination, and inadequate signing) and driver error (excessive speed). (Matrix cells 7, 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
18 M	Driver	Lap belt	Insignificant	----
18 M	Right front	Lap belt	Insignificant	----

Comments.

Matrix

1. There is a need for local governments to periodically review the design features of old roadways and upgrade them to meet increasing traffic demands.

7

2. The lack of significant injury in this case is attributed to the wearing of lap belts and the fact that the doors remained closed during the impact event.

1, 5\*





Brief Description of Accident. Accident 52 involved a 1969 MGB two-door convertible, which left the roadway on a curve and struck two utility poles. An interview with the driver revealed that he had been drinking. The impact speed was 50-60 MPH and the vehicle deformation index was 12LFEN6.

Roadway Environment. The accident occurred at 11:15 P.M. along a two-lane, arterial street. At the site there was a 16 degree curve and a gradient of plus 5.5 percent northbound. The asphalt pavement was dry, and the street was illuminated.

Significant Findings Regarding Accident Initiation.

1. Joint principal contributing factors: alcohol (matrix no. 1) and excessive speed of 70-80 MPH (matrix no. 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
33 M	Driver	Lap and shoulder belt	Lacerations on neck and shoulder	Shoulder belt
			Sprained right ankle (Minor)	Toe pan
25 F	Rt. front	Lap belt	Lacerations on right side of nose and below lower lip	Padded instru- ment panel
			Bruises on left hip and abdomen	Lap belt
			Bruises on knee cap (Minor)	Bottom of in- strument panel

Comments.

Matrix

- |   |   |
|---|---|
| 1. The driver's unfamiliarity with the vehicle may have contributed to the initiation and severity of this crash. | 1 |
| 2. The fact that the steering column did not collapse is a matter of concern.                                     | 5 |



Brief Description of Accident. Accident 53 was a complex event involving three crashes and four vehicles: a 1960 Pontiac four-door sedan (vehicle 1), a 1967 Oldsmobile two-door hardtop (vehicle 2), a 1961 Ford station wagon (vehicle 3), and a 1969 Ford two-door hardtop (vehicle 4). The crash was initiated when the occupants of vehicle 1 turned it around and pushed it down-grade the wrong way on an expressway. It was struck by vehicles 2 and 3. Vehicle 3 went out of control and crossed the median into the path of vehicle 4. This latter crash was the most severe, involving an impact speed of 10-20 MPH for vehicle 3 and 50-60 MPH for vehicle 4. For the latter impact the deformation index was 3RYAW7 for vehicle 3 and 12FZHW7 for vehicle 4.

Roadway Environment. The crash occurred at 8:47 P.M. along a four-lane expressway with a 34-foot median. The roadway is straight and has a gradient of 2.3 percent. The Portland cement concrete pavement was dry. The street is not illuminated. There is no median barrier.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: driver error, attempting to operate vehicle wrong-way on an expressway, (matrix 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
41 M	Driver, veh. 3	None	Massive head trauma	Windshield, A-pillar and/or upper face of instrument panel
			Massive chest trauma (Fatal)	Instrument panel
49 F	Driver, veh. 4	None used	Facial lacerations	Steering wheel
			Bruised chest	Steering wheel
			Laceration, right knee (Moderate)	Instrument panel
50 M	Right front, veh. 4	None used	Head (cerebral contusion and cerebral edema)	Hood
			Fracture, both arms (Critical)	Instrument panel
7 F	Center front, veh. 4	None used	Laceration, right arm	Instrument panel
			Abrasion, right knee (Minor)	Instrument panel

See next page

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
14 M	Right rear, veh. 4	None used	Fractured cheek bone Fractured pelvis (Minor)	Unknown Other occupants
15 M	Left rear, veh. 4	None used	Broken nose Fractured wrist (Minor)	Head restraint Front seat back
12 M	Left center rear, veh. 4	None used	Fracture left tibia Laceration of forehead (Minor)	Front seat back Front seat back
14 M	Right center rear, veh. 4	None used	Fracture, right arm Facial cuts (Minor)	Seat back Seat back

Comments.Matrix

1. The Atlanta research team believes that evidence is clear that the rearward displacement of the hood into and through the windshield constitutes a serious hazard. This phenomenon has been observed in five previous accidents. (See reports 04, 09, 19, 41, 53). It is strongly recommended that improvement in the design of the hood and hood hinge be made to correct this hazard.

5

2. Two of the vehicles involved in this crash were in unacceptably poor mechanical condition, and the poor mechanical condition of one vehicle was an indirect contribution to the initiation of the crash. This points up the need for the enactment and enforcement of a strong motor vehicle inspection law.

4

3. The seat backs of vehicle 4 provided little crash protection to the rear occupants. There is practically no padding on the rear of these seats, and on impact the seat covers tore, exposing various pieces of metal, impact with which resulted in injuries to the rear seat occupants.

5

4. Although there was no evidence that alcohol contributed to this crash, it is noted that the driver of vehicle 3 had sixteen previous traffic violations, eleven of which related to intoxication. His drivers' license had been permanently revoked about six months before this crash. Perhaps a stronger driver licensing law and more frequent driver license checks would help remedy this situation.

1



Brief Description of Accident. This accident involved a 1968 Chevrolet mail truck which struck a 1970 Ford Maverick, two-door hard-top on the area of the left fender and door. The impact caused the Maverick to change its direction of travel, striking the sidewalk curb which served as a ramp, causing it to elevate itself and strike a vehicle which was parked in a parking lot. After striking the Maverick, the mail truck rotated counterclockwise and turned on its side. Prior to the crash the mail truck was traveling at a speed of 15-25 miles per hour and the Maverick at a speed of 25-35 miles per hour. The vehicle deformation index rating for the mail truck is 03FZEW<sup>4</sup> and for the Maverick 09LDAW8.

Roadway Environment. The crash occurred at 2:30 P.M. at the intersection of two major streets in the north fringe of the central business district of Atlanta. The Maverick was traveling west on a six-lane, two-way street and the mail truck north on a four-lane one-way street. The intersection is signalized and illuminated. The grades are negligible.

Significant Findings Regarding Accident Initiation.

1. Joint principal contributing factors: phasing of traffic signal (matrix no. 7) and driver error (matrix no. 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
54 M	Veh. 1 -Driver	None used	Scalp laceration Swollen left hand (Minor)	Unknown Turn signal
22 M	Veh. 2 -Driver	None used	Cerebral concussion Basilar skull fracture Blood accumulation near tympanic membrane Two broken front teeth Pneumothorax (Severe)	Header, near left A-pillar   Upper rim of steering wheel Left door

Comments.

Matrix

1. It is believed that the amber clearance interval of three seconds is too short for this intersection considering vehicle speeds and street widths.

7



Comments.Matrix

2. This accident points out the need for coordinated community planning for the handling of emergency medical services. After the crash, the driver of vehicle 2 was carried 10 miles to the Army Hospital at Fort McPherson. Three hours later he was transferred to Grady Hospital, which is two miles from the scene of the crash. Five days after admission to Grady Hospital he was transferred to the Naval Hospital in Charleston, S. C.

3

The transfer from the Fort McPherson Hospital to Grady Hospital was justified by the fact that he received potential life-endangering injuries, the care and treatment of which could be properly administered at the Army Hospital. However, the additional unnecessary movements are examples of the needless transfer of the seriously injured, frequently practiced in this city.



Brief Description of Accident. Accident 55 involved a 1967 Mustang two-door hardtop (vehicle 1) which, while travelling on the wrong side of an expressway, collided head-on with a 1969 Chevrolet Nova two-door sedan (vehicle 2). The Mustang was driven by a 19 year old male who had been drinking. The Chevrolet was occupied by the driver and one passenger. Estimated speed of impact was 45-55 miles per hour for each vehicle. The deformation index rating for each vehicle was 12FDAW5.

Roadway Environment. The accident occurred at 1:45 A.M. on a four-lane expressway with a 48-foot grassy median. The roadway is straight and the gradient is plus three percent eastbound. The roadway has a night time speed limit of 65 miles per hour. It is not illuminated. The Portland cement concrete pavement was dry.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: alcohol and/or amnesia (matrix 1).
2. Probable predisposing factors: physical fatigue and emotional stress (matrix 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
19 M	Driver, veh. 1	None used	Laceration, forehead (Moderate)	Sun visor
21 M	Driver, veh. 2	None used	Cerebral concussion Facial lacerations Fracture, left femur (Moderate)	Windshield Windshield Steering rim
19 F	Rt. front, veh. 2	None used	Scalp laceration Laceration, right eyebrow & cheek Cervical sprain Fracture, right mandible Fracture, right femur & lacerations of both knees (Moderate)	Rear view mirror Windshield Windshield Upper face, instrument panel Unknown

Comments.

Matrix

1. This accident points up the need for the enactment and enforcement of a strong implied consent law. 1
2. The proper use of lap and shoulder belts would have lessened the injuries to all the victims of this crash. 1





Brief Description of Accident. Accident 56 involved a 1969 Pontiac LeMans, two-door hardtop, which left the roadway, side-swiped two trees and then collided head-on with a third tree. This latter impact occurred at a speed of 45-55 miles per hour. The vehicle was occupied by four teen-aged males who had been drinking. The deformation index for the latter impact was 12FCEN6.

Roadway Environment. The crash occurred at 10:20 P.M. on a two-lane residential collector street. The street is 27 feet in width and has turf shoulders approximately 10 feet in width. The vehicle left the roadway near the bottom of a vertical curve and along a 9.5 degree horizontal curve. The street is not illuminated. The asphaltic pavement was dry.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: alcohol, (matrix no. 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
16 M	Driver	None used	Brain injury Laceration, left eye Laceration, chin Contusions, chest, lung, heart Contusion, left thigh Laceration, left knee Lacerations, left foreleg Fracture, left humerus (Life Threatening)	Floorboard Instrument panel Console Shift lever Steering column Steering column Unknown Unknown
16 M	Right front	None used	Contusions, both eyes Fracture, nose Fracture, cheekbone Laceration, finger and left foot (Dangerous, serious)	Instrument panel Instrument panel Instrument panel Unknown
17 M	Right rear	None used	Contusion, forehead Sprained ankle (Minor)	Head restraint Front seat
17 M	Left rear	None used	Sprained ankle Shoulder soreness (Minor)	Front seat Front seat back

Comments.Matrix

- |   |   |
|---|---|
| 1. This crash demonstrates once again the hazard of driving while under the influence of alcohol. The fact that the victims were minors (who cannot legally purchase alcoholic beverages) raises complex questions of public policy regarding how to cope with this problem. The imposition of strict enforcement penalties including long term revocation of the driver's license appears to be warranted in cases such as this. | 1 |
| 2. The driver's lack of driving experience could have contributed to the initiation of this crash or worsened its consequences.   | 1 |
| 3. Based on this and previous investigations there appears to be inherent hazards with the placement of the gear shift lever and console between the two front passenger seats. It is believed that this matter warrants additional research.   | 5 |
| 4. It is the opinion of the research team that the proper use of three-point seat belts would have lessened the injuries to all four victims in this crash.   | 2 |



Brief Description of Accident. Accident 57 involved a 1968 Chevelle, two-door hardtop, which left the roadway and struck a metallic power pole at an estimated speed of 35-45 miles per hour. The deformation index for this impact is 12FZEW4.

Roadway Environment. The crash occurred at 8:00 A.M. on a two-lane arterial street of curb and gutter design. The street is 30 feet in width. The vehicle left the roadway at the beginning of a horizontal curve ( $D = 8^{\circ} 45'$ ) where the grade is plus 0.5 percent northbound and the superelevation is 7.5 percent.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: unknown. This crash was probably caused by driver inattention (matrix 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
30 F	Driver	Lap belt	Through and through laceration of lower lip	Upper surface of instrument panel
			Bruises of left knee and ankle	Instrument panel
			Laceration, lower right forearm (Minor)	Broken windshield

Comments.

Matrix

1. This accident illustrates the hazard of placing fixed objects such as utility poles adjacent to the edge of traffic lanes.

8

2. It is noted that the hood was displaced rearward and penetrated the windshield, a hazard referred to in previous reports.

5



Brief Description of Accident. Accident 58 involved a 1968 Ford, two-door hardtop (vehicle 1) and a 1959 Dodge school bus (vehicle 2). The crash was initiated when the driver of the school bus which was traveling on an exit ramp toward an intersection attempted to brake the vehicle without success. Upon realizing that the brakes had failed, the driver of vehicle 2 proceeded to the intersection where it was struck by vehicle 1 on the right front side. Upon impact vehicle 2 struck a triangular island and overturned, resting on its side. After the primary impact, vehicle 1 had a second collision with the bus, the left rear of vehicle 1 striking the right side of the bus. Vehicle 1 continued to move clockwise to approximately 135 degrees, resting on the edge of the pavement facing in an easterly direction. The impact speed of vehicle 1 was 25-35 miles per hour and that of vehicle 2 was 10-20 miles per hour. The vehicle deformation index for vehicle 1 was 12FDEW5 and that for vehicle 2 was 03RYLW4 for the initial impact and 03DH01 for the rollover.

Roadway Environment. The crash occurred at 7:45 A.M. at the intersection of a moderately traveled two-lane, arterial road and a one-lane exit ramp. The arterial road is straight and has a gradient of 4.0 percent, southbound. The ramp is also straight, with a varying grade of about 2.0 percent near the intersection and 5.0 percent some 150 feet west of the intersection. Traffic is regulated at the ramp by a stop sign.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: brake failure caused by improper vehicle inspection and preventive maintenance (matrix 4).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
25 M	Driver, Veh. 1	None used	Bruised leg Bruised chest Bruised forehead (Minor)	Instrument panel Steering wheel Windshield
38 M	Rt. Front, Veh. 1	None used	Fractures of 1st, 2nd, 3rd, and 4th ribs (left) and contusion of the anterior chest wall Strained cervical muscles (severe)	Gear shift lever & steering rim Sun visor and header
21 F	Driver, veh. 2	None	Contusion of the right parietal region Anterior laceration of right leg	Door opening lever Gear shift lever

Occupant Injury and Injury Causation. (Cont'd.)

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
			Superficial lacerations of the 2nd & 3rd fingers on the left hand (Moderate)	Unknown
12 F	Passenger (seated in the 8th row from the front on the left side center position), veh. 2	None	Mild compression fractures of the anterosuperior borders of the 11th and 12th dorsal vertebra (Moderate)	9th window from the front

Comments.Matrix No.

1. The principal contributing factor in this accident was a brake failure. By removing the right rear wheels and drums it was found that the drum was badly heat checked and scored. The brake lining on the top shoe was worn through and the shoe was contacting the drum. The shoe had expanded beyond its normal limits and the wheel cylinder piston was protruding out of the cylinder approximately  $1\frac{1}{2}$  inches. This allowed brake fluid to pass from the system resulting in a brake failure.

The condition of this brake system is mainly attributed to inadequate inspection and preventive vehicle maintenance. This inadequacy was noted in previous bus crash investigations performed by the Georgia Tech research team (see Report 07 and Special Report 3).





Brief Description of Accident. Accident 59 involved a single vehicle, a 1968 Pontiac Station Wagon, which left the roadway and traveled approximately 200 feet where the right rear of the vehicle struck an 18-inch pine tree causing minor damages. The right front of the vehicle then impacted a nine-inch ash tree at an estimated speed of 50-60 miles per hour. The primary vehicle deformation index was 12FZEY5. The driver was fatally injured and the vehicle was practically destroyed by fire.

Roadway Environment. The crash occurred at 2:25 A. M. along a two-lane urban arterial at the beginning of a  $7\frac{1}{2}$  degree curve. The roadway, 23 feet in width, is paved with asphaltic concrete. At the accident scene, the roadway is not illuminated.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: alcohol, (matrix 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
31 M	Driver	Unknown	Fracture of the 3rd, 4th, and 5th ribs (right) and 3rd, 4th, 6th, and 7th ribs (left)	Right side of steering wheel or face of the instrument panel
			Multiple fractures of skull	Fire
			3rd degree burns over entire body	Fire
			Burned trachea and lungs (Fatal)	Fire

Comments.

Matrix

1. The interior of this vehicle was completely destroyed by a fire which evidently started within the engine compartment. Consideration should be given to using fire resistant materials for the upholstery in vehicle interiors.

6

2. The first police officer to arrive at the scene was not equipped with a fire extinguisher, and most of the fire damage reportedly occurred after his arrival. While the death of the driver could not be attributed to the fire, the furnishing

6



Comments (Cont'd.)Matrix

of police traffic investigators with fire extinguishers is recommended.

3. The crash demonstrates once again the severity of the alcohol problem and the difficulties relating to its control.

1



Brief Description of Accident. Accident 60 involved a 1970 Volkswagen two-door sedan (vehicle 1) which struck a 1964 Ford four-door hardtop (vehicle 2) in the right rear. Vehicle 2 was unoccupied and parked in an expressway lane at the time, having previously been involved in an earlier very minor accident with a third vehicle (vehicle 3) which was blocking another expressway lane. Speed of impact was 35-45 miles per hour and the vehicle deformation index for vehicle 1 was 11LYAW3 and for vehicle 2, 06BRMW1.

Roadway Environment. The crash occurred at 3:15 P. M. on a six-lane expressway with a sixteen foot raised earth median with a guard rail barrier. The roadway is practically straight and has a positive grade of 3.5 percent in the direction of travel. The lanes are paved with Portland cement concrete which was dry at the time of the crash.

Significant Findings Regarding Accident Initiation.

1. Joint principal contributing factors: failure to remove vehicles from roadway following minor accident (drivers, vehicles 2 and 3) and excessive speed (vehicle 1), (matrix 3 and 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
18 M	Veh. 1 - Driver		Facial lacerations Bruised knees Bruised right upper arm (Minor)	Windshield Instrument panel  Unknown
48 M	Veh. 2 - Driver not in vehicle at time of crash - uninjured.			

Comment.

1. The Georgia Motor Vehicle Code does not properly stress the need to remove damaged but drivable vehicle from high speed traffic lanes following a crash. The law states that the driver in an accident involving damage to his vehicle shall stop the vehicle at the scene and that "every such stop shall be made without obstructing traffic more than is necessary." It is not surprising that law officers make few efforts to enforce this vague provision. (Matrix 3, 6 and 9).



Brief Description of Accident. This crash involved a 1968 Chevrolet Impala hardtop which left the roadway and struck a bridge column at an estimated speed of 55-65 miles per hour. The accident was initiated when the driver, the only occupant, suffered a heart attack. The vehicle deformation index was 12FCAW9, and the estimated cost of replacement is \$2,800.

Roadway Environment. The crash occurred at approximately 7:30 P. M. under a grade separation structure along a heavily-travelled high-speed four-lane expressway. The roadway has paved shoulders and a forty-foot turf median. The 31-inch by 36-inch bridge support which was struck is located six feet from the outer pavement edge. The road is paved with bituminous concrete which was dry at the time of the crash. The alignment is straight and the gradient is negligible. The roadway is not illuminated and visibility was restricted due to darkness. No skid marks were found.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: medical. (Driver had myocardial infarction.)

Occupant Injury and Injury Causation.

<u>Age</u> & <u>Sex</u>	<u>Vehicle Number &amp;</u> <u>Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury</u> <u>Producing Agent</u>
68 M	Driver	None used	Fractured skull	Hood
			Multiple facial fractures	Hood
			Flail chest	Steering wheel
			Bilateral hemothorax	Steering wheel
			Contusion of aorta	Steering wheel
			Contusion of heart	Steering wheel
			(Fatal*)	

\* Death probably resulted from myocardial infarction.

Comments.

Matrix

1. Bridge columns located only six feet from heavily-travelled high-speed lanes constitute a serious roadway hazard. When it is necessary to locate such objects this close to expressway lanes, a guard rail should be provided to direct vehicles away from the hazard. Alternatively, energy absorbing devices should be constructed around or in front of the supporting structure to lessen impact forces.

8

2. This crash emphasizes the need for closer medical supervision of driver licensing

1



Brief Description of Accident. Accident 62 involved a 1967 Mustang convertible which, after being delayed by some power company workers, was accelerated to approximately 45 to 55 MPH as it entered a 19 degree curve. Due to the excessive speed, the vehicle encroached into the left lane. As the vehicle emerged from the curve the driver steered to the right to avoid a raised metal plate covering a manhole. The vehicle skidded sideways and struck a drop inlet drainage structure at an impact speed of 30 to 40 MPH in the area of the front wheel and A-frame. The vehicle subsequently overturned and rotated 360 degrees. The vehicle rested on its top some 50 feet from the point of impact oriented in the same original direction of travel. The vehicle deformation index rating is 03TDHO-7.

Roadway Environment. The crash occurred at 12:30 P. M. along a two-lane moderately travelled residential collector road. At the time of the accident the roadway was being repaved with an asphalt concrete layer which terminated approximately 30 feet from the point of impact. The accident occurred approximately 57 feet from a 19 degree curve with a 4.0 percent superelevation and 2% grade. In the immediate area of the accident the roadway has a negligible superelevation, a 0.5 percent gradient and a 5 percent crown.

Significant Findings Regarding Accident Initiation.

1. Joint principal contributing factors: driver error, excessive speed (matrix 1), improper right rear tire and slick front tire (matrix 4), and roadway hazard, raised manhole cover (matrix 7).

2. Modifying factor: design of drop inlet structure too high, causing vehicle to be elevated (matrix 7).

Occupant Injury and Injury Causation

Age & Sex	Vehicle Number & Seating Position	Restraint	Injury & Severity	Injury Producing Agent
16 M	Driver	None	Insignificant	----

Comments.

1. The driver of the vehicle, a healthy muscular 16 year old male, stated that when he saw that a crash was going to occur, he held his head down and clung to the steering wheel. This action and his excellent physical condition partly explain his lack of significant injuries (matrix 2\*).

2. There was a surprising lack of deformation of the roof of this vehicle, attributable principally to the strength of the A-pillars (matrix 5).





Brief Description of Accident. Accident 63 involved a 1970 Dodge Super Bee, two-door hardtop (vehicle 1) which, while racing with an unidentified vehicle and travelling at a speed of 55-65 miles per hour, drove through a red signal striking a 1963 Chrysler four-door sedan (vehicle 2) on the right front side. After impact, vehicle 1 moved to the right striking a power pole at an impact speed of 25-35 miles per hour. Vehicle 2 swerved out of control to the left, crossed the westbound lane of Memorial Drive, climbed the north curb, and came to a stop after it collided with the front of a store.

Roadway Environment. The accident occurred at 2:30 P. M. along a three-lane two-way urban arterial street. Each lane is 11 feet wide, and the pavement is asphaltic concrete. It is of curb and gutter design and has paved sidewalks. In the area of the accident two streets intersect the urban arterial and the intersection is signalized.

Significant Findings Regarding Accident Initiation.

1. Joint principal contributing factors: excessive speed and violation of red traffic signal by driver of vehicle 1 (matrix no. 1B).

Occupant Injury and Injury Causation

Age & Sex	Vehicle Number & Seating Position	Restraint	Injury & Severity	Injury Producing Agent
18 M	Driver, veh. 1	None used	Insignificant	---
58 F	Driver, veh. 2	None	Insignificant	---

Comments.

Matrix

1. This accident illustrates the hazard of placing fixed objects such as utility poles adjacent to the edge of traffic lanes. 8
2. Considering the high speed of impact it is remarkable that the driver of vehicle 1 escaped significant injury. His lack of injury is attributed principally to the safety windshield and energy absorbing steering wheel, both of which performed well. 5
3. A special need exists to educate young drivers that automobiles are not race cars and that the public streets and highways are not race tracks. The Atlanta research team has noted with disappointment the practice of automobile manufacturers to link their products to the race tracks through their advertisements. These advertisements, which are lacking in subtlety, are particularly directed to the young, inexperienced, and unsophisticated drivers. The automobile manufacturers should declare a moratorium on the type of advertising which encourages young drivers to race private automobiles on public streets and highways. 1





Brief Description of Accident. Accident 64 involved a 1969 Chevrolet, two-door hardtop (vehicle 1) and a 1964 Chevrolet, two-door hardtop (vehicle 2). The crash was initiated when the driver of vehicle 2 parked his vehicle on the median, encroaching into the travelled lane in order to evade a driver of an unidentified vehicle who had become provoked with him. The driver of the unidentified vehicle drove away, and the driver of vehicle 2 started walking back toward his vehicle when vehicle 1, travelling at a speed of 50-60 miles per hour, struck the rear of vehicle 2 with its right side at an impact speed of 30-40 miles per hour. After impact vehicle 2 rotated about 80 degrees clockwise, coming to rest partially on the shoulder and partially in the right northbound lane. After the initial impact, vehicle 2 struck the driver of vehicle 2. The vehicle deformation index rating is 06BDEW-4.

Roadway Environment. The crash occurred at 11:00 P. M. along a four-lane divided expressway consisting of two 12-foot lanes in each direction separated by a 40-foot turf median. At the accident location, the roadway is straight and has a grade of -1.5 percent northbound. The roadway is paved with an asphaltic concrete pavement, and there is no illumination.

Significant Findings Regarding Accident Initiation.

1. Principal contributing factor: driver error, parking vehicle 1 in a manner that it became a roadway hazard, (matrix 1B and 4).

Occupant Injury and Injury Causation

<u>Age</u> <u>&amp; Sex</u>	<u>Vehicle Number &amp;</u> <u>Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury</u> <u>Producing Agent</u>
36 M	Driver, veh. 1	None	Lacerations of the lateral aspect of the lower leg	Lower mid-face of instrument panel right of glove compartment door
			Mild cerebral concussion	Windshield
			Abrasion on right rear temple & ear	Windshield
			Abrasion of right anterior flank of abdomen (Minor)	Instrument panel
27 M	Driver, veh. 2 (Pedestrian at time of accident)		Abrasion and concussion over the right gluteus muscle area and right hip area	Exterior, veh. 2
			Tenderness in the lumbar region (Minor)	Exterior, veh. 2

Comments.Matrix

- |  |   |
|--|---|
| 1. This crash could have been avoided if the driver of vehicle 1 would have taken other evasive corrective action, namely to drive into the traversable turf median. | 1 |
| 2. The front brakes of vehicle 2 were found to have defects not detectable by the present Georgia motor vehicle safety inspection system.                            | 4 |



Brief Description of Accident. Accident 65 was a complex accident involving four vehicles: a 1963 Chevrolet two-door sedan (vehicle 1), a 1965 Ford Fairlane two-door sedan (vehicle 2), a 1969 Ford Torino four-door sedan (vehicle 3), and a 1964 Chevelle station wagon (vehicle 4). The crash was initiated as vehicle 4 attempted to make a left turn. As vehicles 1 and 2 approached the turning vehicle and slowed, vehicle 1 struck vehicle 2 in the right rear, causing it to cross the center line and collide with vehicle 3 which was travelling in the opposite direction. In the latter impact, the most serious of four collisions which occurred, vehicle 2 was travelling at a speed of 20-30 miles per hour and vehicle 3 at 35-45 miles per hour. The case vehicle (number 3) had a primary deformation index of 11FDEW-5 and a secondary deformation index of 09LBLW-1.

Roadway Environment. The accident occurred at 1:05 P. M. on a four-lane, two-way, 48-foot arterial road at its intersection with a 26-foot local residential street. The arterial street is straight and has a gradient of 4.5 percent. The roadway is curbed and has an asphaltic concrete pavement which was dry at the time of the accident.

Significant Findings Regarding Accident Initiation.

1. Probable joint principal contributing factors: driver inattention (vehicle 1) and broken bolt holding steering arm (vehicle 1). Laboratory examination of the broken bolt holding the left steering arm indicated that it had been partially sheared for a considerable period prior to the accident. It is believed that the failure of this bolt significantly contributed to the initiation of this crash. (matrix 1, 4)

Occupant Injury and Injury Causation

Age & Sex	Vehicle Number & Seating Position	Restraint	Injury & Severity	Injury Producing Agent
19 M	Driver, veh. 1	None	Facial bruises Shoulder soreness (Minor)	Left A-pillar Left door
50 F	Driver, veh. 2	Lap belt, loosely secured	Abrasion, forehead Tenderness, sternum Fracture, rt. femur & lacerations, legs Multiple vertebrae fractures (Fatal)	Steering rim Steering rim Add-on air conditioner General twisting & bending

Preliminary judgement as to cause of death: pulmonary embolus

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
54 F	Rt. front, veh. 2	None used	Fracture, rt. tibia  Multiple contusions face & head Chest pain (Serious)	Leg twisted beneath her as legs struck heater duct A-pillar and/or rt. front window Instrument panel
55 F	Driver, veh. 3	None used	Head & scalp lacerations Fracture, left femur  Compound fracture, right ankle Laceration below right knee (Serious)	Windshield  Lower steering rim Foot jammed under brake pedal Sharp object under instrument panel
59 M	Rt. front, veh. 3	None used	Cerebral contusion & subarachnoid hemorrhage Rib fractures & pneumothorax Fracture, left hip joint Fracture, rt. tibia & fibula (Fatal)	Windshield  Instrument panel Knee struck instrument panel Restraint of lower instrument panel

Cause of death: blood loss within pleural cavities.

45 F	Driver, veh. 4	Unknown	None	---
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Comments.

Matrix

1. A mechanical examination of vehicle 1 indicated considerable wear of the bolts in the steering mechanism, indicating that play in the steering linkage pre-existed this crash.

4

2. Previous medical disabilities contributed significantly to the ultimate deaths of the two victims in this accident.

1

3. The final autopsy reports for the victims of this crash will be made available at a later date.





Brief Description of Accident. Accident 66 was a cross-the-median crash involving three vehicles: A 1970 Malibu Chevrolet, two-door sports coupe, (vehicle 1), which encroached into the median at an angle of 15 degrees and was vaulted a horizontal distance of 50-60 feet over the guardrail and median at a vertical angle of 9-11 degrees. Along its path the vehicle scraped the guardrail and struck a 1964 Plymouth Sedan (vehicle 3), causing negligible damage. Vehicle 1, moving into the middle lane, struck with its right front the left front area of a 1956 Oldsmobile (vehicle 2) at an impact speed of 30-40 miles per hour. The impact speed of vehicle 2 was 45-55 MPH. Upon impact vehicle 1 rotated counterclockwise, and its right rear made secondary contact with the left rear of vehicle 2. Vehicle 1 came to rest in the middle lane heading in the opposite direction of travel, while vehicle 2 stopped in the right lane a few feet south of the point of impact. The vehicle deformation index is 01FZEW5 for the primary impact of the Malibu and 03RBMW1 for the secondary impact. For the Oldsmobile the vehicle deformation index is 11LFEW6.

Roadway Environment. The crash occurred at 3:00 P. M. along a six lane expressway with a 14-foot turf median. There is a two foot high guardrail in the center of the median. At the immediate accident location the road is straight and has a negligible grade and a superelevation of 1.8 percent. The Portland cement concrete has a skid resistance of 0.70. Approximately 200 feet south of the point of impact, where vehicle 1 originally went out of control, the roadway has a curvature of seven degrees.

Significant Findings Regarding Accident Initiation.

1. Probable principal contributing factor: driver inattention due to drinking beer and eating potato chips, (matrix no. 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
41 M	Driver, veh. 1	None used	Contusion of chest	Right face of instrument panel
			Contusion of lower left jaw (Moderate)	Right A-pillar
23 M	Driver, veh. 2	None used	Contusion of right & left knee caps	Steering column & right lower face instrument panel
			Laceration, left forearm (Moderate)	Left window and window frame - near the vent window



<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
23 M	Right front, vehicle 2	None used	No injury	----
17 M	Right rear, vehicle 2	None	Contusion of shoulder girdle & abdomen (Moderate)	Back of front seat back

Comment.Matrix

1. A two-foot high guardrail placed atop a narrow 18-inch high earth median does not effectively serve its primary purpose: to prevent vehicles from encroaching into opposing lanes. This type of barrier is particularly ineffective when the angle of encroachment is large (15 degrees or more). Observations of other Atlanta expressway crashes have indicated that vehicles which strike this type of median barrier frequently bounce off the guardrail and overturn.

8



Brief Description of Accident. Accident 67 involved a 1970 Plymouth Barracuda which left the roadway at a sharp curve and struck a mailbox and tree. The impact speed was 25 to 35 miles per hour. The driver claimed that the steering mechanism locked up causing the vehicle to leave the road; however, a mechanical inspection of the vehicle failed to show any evidence that there had been a steering malfunction. The deformation index was 12FCEW5, and the cost of damages was \$2,500.

Roadway Environment. The accident occurred at a twenty degree curve along a residential street which is not designed for high speeds. Along the curve, the roadway has a negative superelevation due to an adverse crown. Numerous trees located two feet from the curb are a definite hazard to any car leaving the road. It was raining at the time of the crash.

#### Significant Findings Regarding Accident Initiation.

1. Joint principal contributing factors: excessive speed (matrix 1), wet roadway (matrix 7), and poorly designed roadway (matrix 7).
2. Modifying factor: trees close to edge of road (matrix 7).

#### Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
28 M	Driver	None used	Contusion of mouth area Lacerations to left knee (Minor)	Steering wheel rim Undetermined object below instrument panel
25 F	Right front	None used	Lacerations of upper lip, two teeth knocked out Laceration, right foreleg (Moderate)	Instrument panel Heater duct
25 M	Right rear	None used	Laceration, lower lip Laceration, right hand & wrist Abrasions, both legs Contusion, left forearm Contusions, left leg and foot (Moderate)	Seat back Control cables Seat back Face of instrument panel Underside of right front seat.

Comments.Matrix

1. There was an unsecured spare tire and wheel in 5  
the luggage compartment which pushed the rear seat back forward  
about eight inches and penetrated the passenger compartment.  
The luggage compartment partition should be sufficiently strong  
to prevent the intrusion of such loose objects into the rear  
passenger compartment.



Brief Description of Accident. Accident 68 involved a 1964 Plymouth Valiant two-door sedan (vehicle 1) which evidently violated a STOP sign at a "T"-intersection and collided with a 1968 Fiat two-door convertible (vehicle 2). The speed of impact was 20-30 MPH for vehicle 1 and 35-45 MPH for vehicle 2. At impact, the Fiat was wedged under the Plymouth, causing the Plymouth to rotate 180 degrees clockwise and overturn. It came to rest on its top on the shoulder of the road approximately 25 feet from the point of impact. The primary deformation index rating is 11FYIW3 and the secondary deformation index rating is 11TDG03. After impact, the Fiat rotated approximately 90 degrees counterclockwise, went down a 10-foot embankment, coming to rest right side up about 60 feet from the point of impact. The vehicle deformation index rating for vehicle 2 is 02FZEW7.

Roadway Environment. The crash occurred at 4:00 P. M. at the intersection of two heavily traveled two-lane state routes. The roadway on which vehicle 1 was traveling intersects the other state route at a 30 degree angle to form a channelized "T"-intersection. This approach is regulated by "STOP" and "KEEP RIGHT" signs. The roadway on which vehicle 2 was traveling is straight and has a slight grade. The weather was clear and the asphaltic concrete pavement was dry.

Significant Findings Regarding Accident Initiation.

1. Probable principal contributing factor: brake failure (vehicle 1) due to ruptured left front brake hose (matrix 4).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
23 F	Driver, veh. 1	None	Bruise and slight cut of the left side of the head	Upper portion of window frame
			Bruised left shoulder and hip	Left door arm rest
			Bruises to legs (Minor)	Roof interior
23 F	Driver, veh. 2	None used	Blunt trauma to the orbit & eyeball	Windshield
			Multiple facial lacerations	Windshield
			Fracture, left upper arm	Steering wheel
			(Dangerous, serious)	

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
27 M	Right front, vehicle 2	None used	Cerebral concussion Laceration, right frontal scalp & right eyelid Abrasions & contusions, both hands and arms (Non-dangerous, severe)	Right A-pillar Windshield Instrument panel & windshield

Comments.

Matrix

1. The fact that vehicle 1 displayed a state vehicle inspection sticker which was less than one month old reflects inadequacies in Georgia vehicle inspection procedures.

4

2. The driver of vehicle 1 gave contradictory statements regarding the crash, and the occupants of vehicle 2 had no memory of the event. There were no witnesses. In cases of this sort, one must often rely on scientific analysis of the crash in order to determine accident causation. Even with in-depth scientific study, it is not always possible to establish accident causation with certainty.

1, 4,  
& 7





Brief Description of Accident. Accident 69 involved a 1969 Buick LeSabre convertible which went out of control when the driver went to sleep. The vehicle entered an expressway median and struck a steel guardrail and a bridge abutment as the driver attempted to re-enter the roadway. The vehicle subsequently rolled down an embankment between two grade separation structures. The driver was ejected from the car. The speed of impact with the guardrail and bridge was 30-50 miles per hour. The deformation index was 11FYAW9. The car was a total loss with estimated cost of replacement of \$3,500.

Roadway Environment. The crash was initiated while the vehicle was approaching a grade separation structure on I-285, a four-lane, divided, controlled access interstate highway. The roadway is slightly curved and the grade is 1.0 percent. The Portland cement concrete pavement surface was dry. Visibility was restricted due to darkness.

Significant Findings Regarding Accident Initiation.

1. Joint principal contributing factors: fatigue (matrix 1) and alcohol (matrix 1).

Occupant Injury and Injury Causation.

<u>Age &amp; Sex</u>	<u>Vehicle Number &amp; Seating Position</u>	<u>Restraint</u>	<u>Injury &amp; Severity</u>	<u>Injury Producing Agent</u>
32 M	Driver	None used	Cerebral concussion	Roof frame
			Facial contusions	Roof frame
			Head laceration	Roof frame
			Contusion of pelvic girdle (left)	Left door
			Contusion, left leg	Ground
			Fracture, right foot (Moderate)	Unknown

Comment.

1. An energy attenuating barrier should be provided in the medians of expressways at overpasses to prevent vehicles from falling into the intersecting roadway. While differences of opinion exist as to what constitutes the best installation at these locations, practically any of the barriers proposed by highway engineers would have lessened the damages to the vehicle in this crash. In this case, the guardrails, which were mounted parallel to the pavement edge to prevent vehicles from leaving the roadway, prevented the out-of-control vehicle from re-entering the roadway (matrix 8).



Brief Description of Accident. Accident 70 involved a 1970 Chevrolet Malibu, two-door sports coupe which was driven over a hill at a speed of 70-80 MPH. Near the crest, the vehicle struck a traffic channelization device (button). The driver lost control and the vehicle left the roadway where it impacted several small trees before it rolled onto its left side and the windshield and left A-pillar struck an eight-inch pine tree at a speed of 50-60 MPH. The vehicle subsequently impacted an earth bank, causing massive damage to the left front portion of the car. The vehicle deformation index of the two impacts are 11FDEW5 and 10LFAW7.

Roadway Environment. The crash occurred at 1:20 A. M. along a 30-foot two-way residential collector street. This road is hilly with steep grades and short vertical curves. The accident was initiated at a crest where a plus 9.0 percent grade intersects a minus 11.0 percent grade. The roadway has an asphaltic concrete pavement which was dry at the time of the crash. The street has curbs and is illuminated.

#### Significant Findings Regarding Accident Initiation.

1. Joint principal contributing factors: speed and roadway (vertical curvature and traffic delineators) (matrix 1 and 7).

#### Occupant Injury and Injury Causation

Age & Sex	Vehicle Number & Seating Position	Restraint	Injury & Severity	Injury Producing Agent
18 M	Driver	None used	Fracture, left upper leg & tear of femoral artery Mild concussion Laceration & abrasion cornea Fracture, left 7th rib Multiple abrasions (Dangerous & serious, not critical)	Lower compartment interior Left A-pillar Left A-pillar Left door Unknown - driver ejected
18 M	Right front	None used	Multiple lacerations, face Hematoma, neck Pneumothorax, both lungs Fracture, left 5th rib Occipital scalp laceration Laceration, left thigh Fracture, 2nd & 3rd metatarsals (Dangerous & serious, not critical)	Windshield Tree Instrument panel Steering wheel Head restraint Shattered windshield Unknown

Comments.Matrix

1. The roadway at the accident location has a design speed of 25 MPH. It is zoned for a speed limit of 35 MPH. 7

2. The use of traffic buttons and other channelization devices at the crest of a hill is a questionable traffic engineering practice. 7

E-20-606

FINAL REPORT  
PROJECT E-20-606



# MULTIDISCIPLINARY ACCIDENT INVESTIGATIONS PHASE 5

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MULTIDISCIPLINARY ACCIDENT INVESTIGATIONS  
PHASE 5

Prepared for the  
U. S. Department of Transportation  
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The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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16. Abstract  <p>This report summarizes the results of a comprehensive and systematic study of thirty vehicular accidents all but one of which occurred in the metropolitan Atlanta, Georgia, area. One of the accidents, which involved a truck fire, occurred in Roberta, Georgia.</p> <p>The research was a broadbased team effort which involved the participation of civil engineers, physicians, an automotive technician, a psychologist, a mechanical engineer, a pathologist, a social worker, and a secretary. The research included an in-depth study of factors leading to the initiation of accidents as well as a study of the "second collision" to establish the kinematics of the occupants and to identify the agent(s) which caused the injuries and deaths.</p> <p>This report describes the results of Phase 5 of a continuing research program sponsored by the National Highway Traffic Safety Administration. A grand summary of the findings from 100 collision investigations is included in the report.</p>			
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## ABSTRACT

This report summarizes the results of a comprehensive and systematic study of thirty vehicular accidents which occurred in Georgia during the period April, 1970, to July, 1971. One of the accidents, which involved a truck fire, occurred in Roberta, Georgia. All of the other crashes occurred in metropolitan Atlanta.

The research was a broadbased team effort which involved the participation of civil engineers, physicians, an automotive technician, a psychologist, a mechanical engineer, a pathologist, a social worker, and a secretary. The research included an in-depth study of the "second collision" to establish the kinematics of the occupants and to identify the agent(s) which caused the injuries and deaths.

This report describes the results of Phase 5 of a continuing research program sponsored by the National Highway Traffic Safety Administration. Previous reports (1, 2, 3, 4)\* describe the research that was accomplished under earlier phases of this program. The first three reports included detailed case studies of 45 investigations made under these phases. This report includes case summaries of 30 investigations completed during a 13-month report period ending September 30, 1971. The full case reports for these investigations have been previously mailed to the sponsor, and are available for public inspection at the National Highway Traffic Safety Administration, 400 Seventh Street, S. W., Washington, D. C., 20591.

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\* Numbers in parentheses designate references at end of report.

# CHAPTER I

## INTRODUCTION

In 1968, the federal government under the auspices of the National Highway Safety Bureau undertook a program to collect a scientifically valid body of information regarding vehicular collisions. The initial phase of this program involved the development of multidisciplinary medical-engineering research teams located in six U. S. cities: Atlanta, Boston, Houston, Rochester, Los Angeles, and New Orleans. Additional multidisciplinary teams have since been organized, and sixteen research teams are currently active. These teams have been given the following objectives:

1. to determine causes of traffic accidents,
2. to identify agents which produce injuries and deaths in these accidents,
3. to evaluate effectiveness of new safety features,
4. to provide early detection of vehicular and roadway design problems, and
5. to evaluate Federal Motor Vehicle Safety Standards and Federal Highway Safety Program Standards.

To date, one hundred crash investigations have been completed by the Atlanta research team. Four final reports (1,2,3,4) have been previously published by the Atlanta team describing the work that was accomplished under earlier phases of this program:

<u>Phase</u>	<u>Number of Cases</u>	<u>Date of Report</u>	<u>Number of Pages</u>
1	10	June, 1968	116
2	20	February, 1969	179
3	15	June, 1969	140
4	25	August, 1970	59

The first three reports included detailed case studies of the 45 investigations made under these phases of the program. Since July, 1969, when Phase 4 of the research program was initiated, case reports have been submitted to the sponsor singularly and immediately upon completion.

The present document summarizes the results of thirty accident investigations which were completed during the report period September 1, 1970, to September 30, 1971. The full case reports for these investigations have been previously mailed to the Accident Investigation Division, National Highway Traffic Safety Administration and are available for public inspection at 400 Seventh Street, S. W., Washington, D. C., 20591.

## CHAPTER II

### PROCEDURE

This research employed a multidisciplinary approach involving the participation of civil engineers, physicians, an automotive technician, a psychologist, a mechanical engineer, a pathologist, a social worker, a secretary, and research assistants. The principal role of each participant is given by Table 1.

In each case, the research team was concerned, first of all, with identifying, isolating, and evaluating those human, vehicular, and environmental factors which contributed to the accident initiation. Secondly, the team concerned itself with the kinematics of the vehicle occupants during the at-crash phase, and the identification and description of accident trauma and the agent which caused each injury.

Thirty vehicular crash investigations were made during this report period, all but one of which occurred in metropolitan Atlanta, Georgia. A sketch of this study area is given as Figure 1. One of the investigations (Accident Number 92), which involved a truck fire, occurred in Roberta, Georgia.

#### Selection of Accidents for Investigation.

Selection of accidents for investigation was based on criteria stipulated by the sponsor:

1. That each investigation involve at least one vehicle manufactured since 1968.
2. That the studies consist of a reasonable and balanced distribution of fatal, injury-producing, and property damage collisions with the stipulation that in the latter case at least one vehicle had to be towed from the accident scene.

Twenty-two of the 30 cases chosen for investigation were discovered by monitoring police radios and going to the scene of accidents to which an ambulance had been dispatched. Team members discovered two cases by happenstance, and two were reported by a DeKalb County policeman serving the team as a consultant. One case was



Table 1. Principal Functions of Various Research Participants.

Participant	Principal Functions
Fleming L. Jolley, M. D. Neurological Surgeon and Norman E. McSwain, Jr., M. D. General Surgeon	Identified and described accident trauma; correlated injury patterns with agent(s) which produce injuries.
Paul H. Wright, Ph.D. Civil Engineer	Served as Administrative Director of Project; identified and evaluated factors which contribute to accident initiation; authored reports.
Mr. Bruce Ivey Automotive Technician	Directed all mechanical aspects of the study including identification of pre-accident mechanical defects and evaluation of vehicle damage.
W. M. Williams, Ph.D. Mechanical Engineer	Assisted with accident analysis; provided expertise on automotive systems.
Robert R. Stivers, M. D. Pathologist	Served as a consultant to provide autopsy reports.
E. Jo Baker, Ph.D. Psychologist	Directed psychological studies for certain drivers.
Miss Jo Stallings, A.C.S.W. Social Worker	Assisted Dr. Baker by conducting psychological interviews.
King-Kuen Mak, B.S., M.S.C.E. and Jonathan Horner, B.S., B.S.C.E. Engineering Assistants	Made on-the-scene investigations; conducted engineering roadway studies and prepared maps; made photographs; conducted field studies; assisted with writing of reports.
Mrs. Betty Jordan Mrs. Laura Mack Secretaries	Typed reports; handled numerous administrative details.

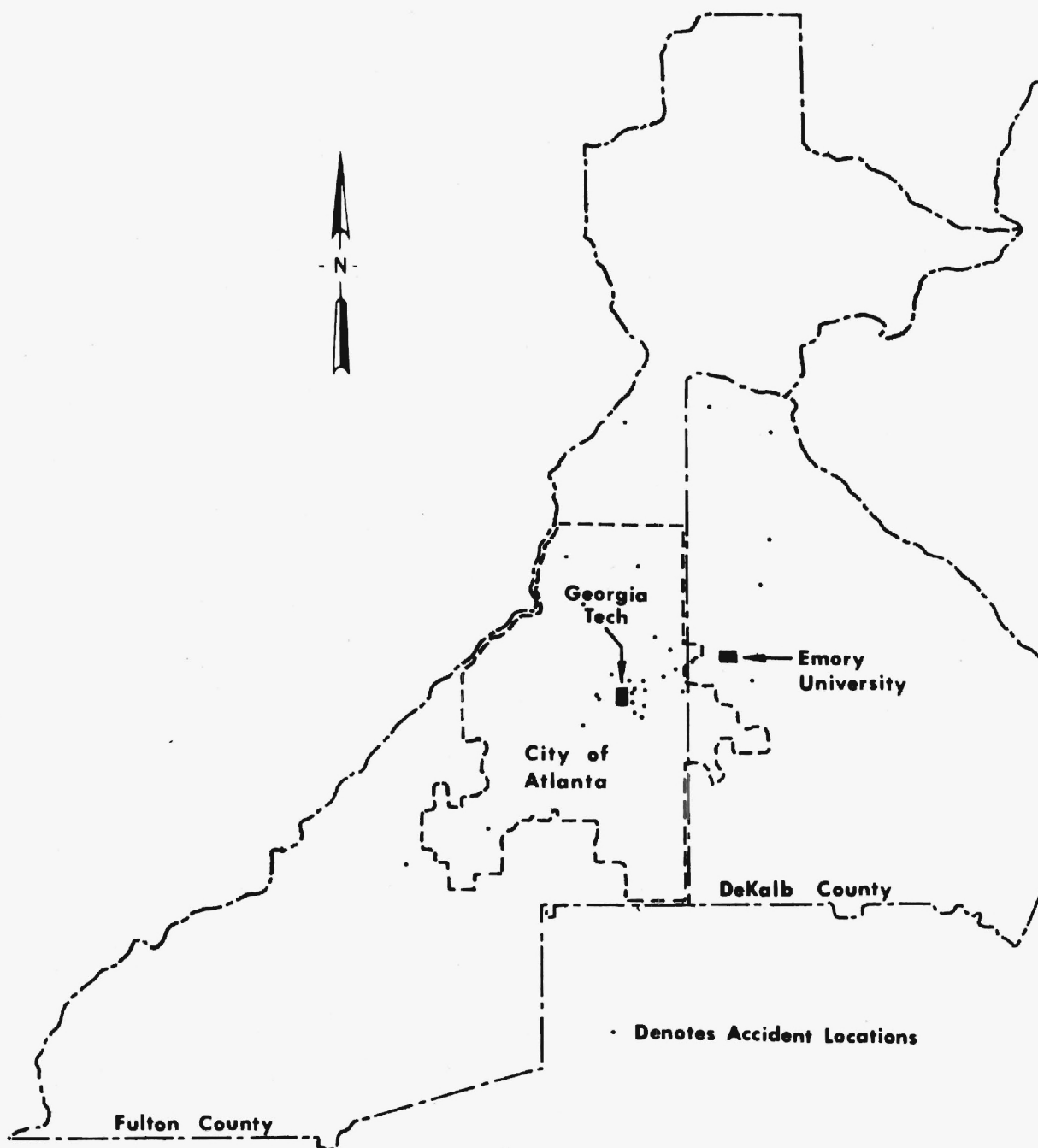


Figure 1. A Sketch of the Study Area.

reported by one of the team physicians, and another was discovered by periodic review of police reports. Finally, two investigations involving vehicular design problems were initiated after the cases were reported to the team by an employee of an insurance claims department.

#### On-Scene Investigation.

In 26 of the 30 cases, members of the research team were able to arrive at the accident scene before the vehicles had been moved, and often team members arrived before the ambulance. In these cases, photographs were taken, witnesses were interviewed, and skid marks and other physical evidence were measured and documented. On numerous other occasions, members of the team went to the scene of accidents which failed to meet the criteria for further investigation.

#### Roadway Studies.

Because of the observed tendency for certain physical crash evidence to deteriorate rapidly or disappear, roadway studies were undertaken at each accident scene as soon as practicable after learning of the accident. The roadway studies were conducted by two or three people and consisted of measuring or evaluating the following roadway factors: alignment and curvature, gradient, cross section dimensions, superelevation, sight distance, visibility, traffic control and warning devices, traffic volume at the time and day of week of the accident, and skid resistance of the pavement.

Estimates of pavement skid resistance were based on tests made with a Tapley decelerometer at a speed of twenty miles per hour.

Attempts were made to locate skid and gouge marks and other physical evidence to assist in determining the movement of the vehicle during the impact event.

Photographs of the roadway were made with a 35 mm. YASHICA TL-Super camera and a 35 mm. NIKON F camera.

#### Mechanical Analyses.

While it was sometimes possible to detect certain readily visible vehicular defects at the accident scene, it was necessary in each case to conduct an in-depth mechanical analysis after the vehicle

had been removed to a more suitable location. The mechanical inspections were made at impound lots, salvage disposal lots, garages, vehicle owners' homes--in short, wherever the inspection could be conveniently performed. Generally, whenever a mechanical defect was suspected, the component was removed from the vehicle and transported to the team office or laboratory for further analyses. In one case, a consultant metallurgist was employed to make a study of the nature of a ball joint failure.

Results of the mechanical inspections were recorded on Collision Performance and Injury Report Forms (General Motors Report No. GM PG 2070) and Vehicle Inspection Data forms. The damages and defects of each automobile were documented by means of color photograph slides and black and white photographs.

In order to make the results of the mechanical analysis more amenable to computer analysis, an alphanumeric vehicular deformation index (5) was used to describe vehicle damages. This index contains vectorial representation of impact direction, impact magnitude and a detailed description of vehicle impact location. The deformation index is composed of four components:

1. Direction of principal force at point of impact.
2. Vehicle deformation location.
3. General type of collision.
4. Damage scale.

A detailed description of the vehicle deformation index system is given by Figure 2.

#### Medical Reports on the Injured.

The pattern of injuries received by each accident victim was generally determined by reviewing the medical records of those injured, and/or by conversation with the attending physicians.

A number of the injured were examined with the attending physicians to gain additional insight to correlate the injury pattern with contacting agents within the vehicle. Such cooperation has permitted identifying for the attending physician certain additional facts as to symptomatology of injury received by his patient.

Additional valuable information was gained in reviewing x-rays as well as other diagnostic studies performed.

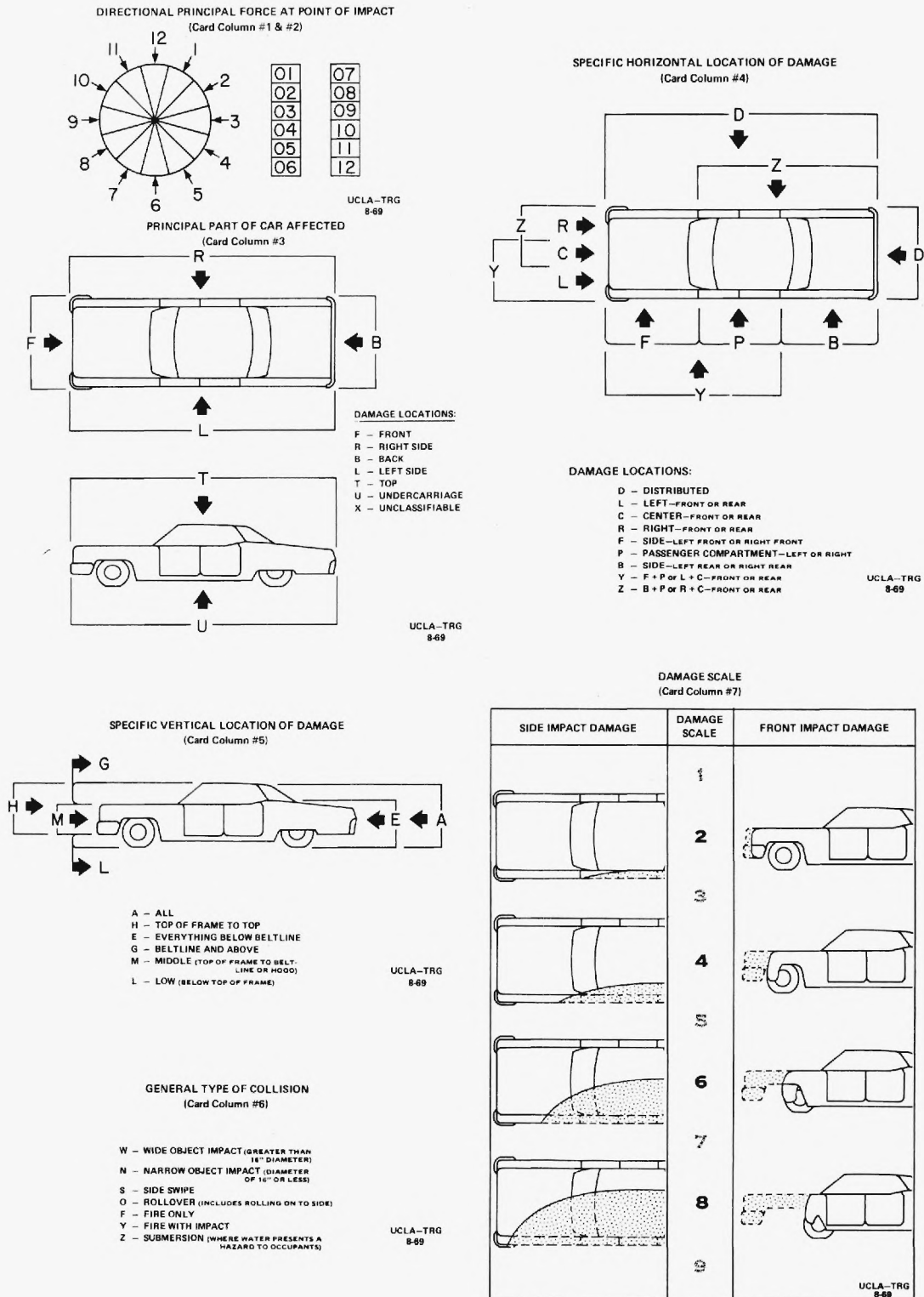


Figure 2. Vehicle Deformation Index System.



#### Autopsies.

Four of the 30 cases resulted in fatalities, and autopsies were performed in three of these cases. The Medico-Legal Autopsy Report form developed by the Registry of Accident Pathology, Armed Forces Institute of Pathology was used for reporting the results of these autopsies.

#### Post-Crash Interviews.

Drivers involved in case accidents were usually interviewed by staff personnel either on-scene or in the driver's home. In those cases in which there was suspicion of involvement of psychological factors, in-depth home interviews of drivers were conducted by a social worker under the direction of a psychologist. Interviews of passengers and witnesses were generally conducted by telephone.

#### Report of Previous Traffic Violations.

With the cooperation of the Georgia Department of Public Safety, a check was made of each driver's previous traffic violations, and this information was made a part of the respective case reports. In five cases involving out-of-state drivers, traffic violation information was obtained from the drivers' respective state Department of Public Safety. In four of these cases, the information was requested by another multidisciplinary team.

#### Roadway Accident History.

In each case, a study was made of the accident history of the roadway and an evaluation of the roadway from this viewpoint was made a part of the case report.

#### Police Officer's Report.

Periodic visits were made to the Atlanta Police Station and the DeKalb County Police Department to learn of accidents that had occurred. Copies of police reports were obtained for those accidents chosen for investigation to provide personal and biographical data and supplemental information on how the accident occurred.

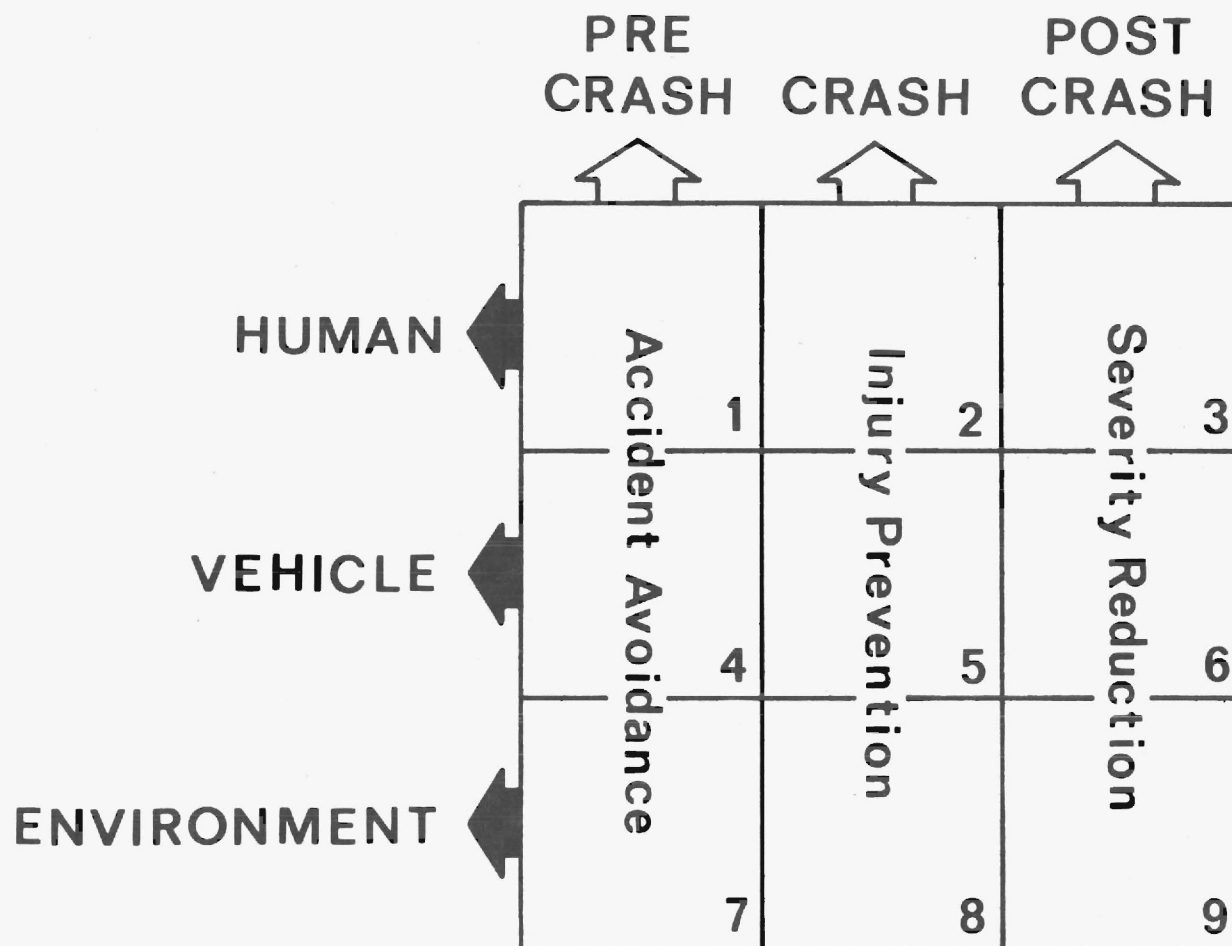


Figure 3. Program Matrix for Highway Safety Research.

### Case Review and Analysis.

Each case was analyzed within the framework of a nine-cell matrix (6) recommended by the sponsor. This matrix is employed in order to: 1) conveniently categorize causal factors, findings, conclusions, and recommendations of researchers; 2) to facilitate the location of findings relating to the specific interests of users; and, 3) to permit tallying frequencies of occurrence of significant factors in common cells, thus providing a gross indication of where the problem areas and trends are emerging.

The matrix, shown by Figure 3, is comprised of three groups of factors: human, vehicular, and environmental; and three phases of the accident event: pre-crash, at-crash, and post-crash. The pre-crash phase is concerned with accident avoidance, the at-crash with injury prevention, and the post-crash phase with the reduction of the severity of the accident.

In an attempt to describe and evaluate the various factors which contributed to the initiation and consequences of the accidents investigated, the research team defined the following terms:

1. Principal Contributing Factors. This factor, acting alone, was sufficient to explain the occurrence of the accident. Without this single factor, the accident, in the investigators' opinion, would not have occurred.
2. Joint Principal Contributing Factors. These factors are defined as two or more factors acting jointly which were sufficient to explain the occurrence of the accident. Without the combined presence of these factors, the accident, in the investigators' opinion, would not have occurred.
3. Modifying Factors. Absence of these factors would not have prevented the accident from occurring. However, these factors, in the investigators' opinion, compounded the consequences of the crash and increased the magnitude of the damages to property and injuries to those involved in the accident.

### Preparation of Case Reports.

After the various source reports and studies were assembled, a rough draft of the narrative of the case report was made and distributed to members of the research team. Periodic meetings of the research team were held to review case studies. After suitable discussion and review, the case reports were revised and prepared for mailing to the sponsor.

A typical case report was 50 to 60 pages in length, and it included a one-to-three page summary, a narrative description of the investigation, a roadway sketch, black and white photographs, a police report, a color slide index, the GM Collision Performance and Injury Report Form, vehicle inspection data, and, in fatal cases, the Medico-Legal Autopsy Report. A selection of 35 mm. color photographic slides were submitted with the written report.

### CHAPTER III

#### DISCUSSION OF RESULTS -- PHASE 5

In the paragraphs which follow, a brief account is given of the sampled accident population, describing in a general way the characteristics of the drivers, vehicles, and roadway locations studied during this report period.

A subsequent section of this chapter will describe the various human, vehicular, and environmental factors which contributed to the initiation of the 30 crashes. Finally, a discussion will be given of the various factors which tended to modify the crash consequences as well as an evaluation of the effectiveness of safety countermeasures.

Case summaries for the 30 crashes are given in the appendix.

#### The Accident Population.

The accidents investigated during this report period involved 49 drivers with ages ranging from 13 to 66. A breakdown of the drivers into age groups and sex is given in Figure 4. The average driver age was 35 and the median age was 36. About 20 percent of the drivers were females.

Previous traffic violations were held by 27 of the drivers. One driver had a record of 14 previous traffic violations including five violations of D.U.I. while another driver had 7 violations with five D.U.I. Eleven of the drivers revealed that they had driver's education.

Four fatalities were investigated during this phase. However, over 75 percent of people involved in the accidents received either minor injuries or no injuries. Figure 5 shows the distribution of injury severity involved in this phase.

A wide distribution of damaged vehicles were studied during this report period. This is shown by Table 2 which classifies the 52 vehicles according to the damage scale of the vehicular deformation index.



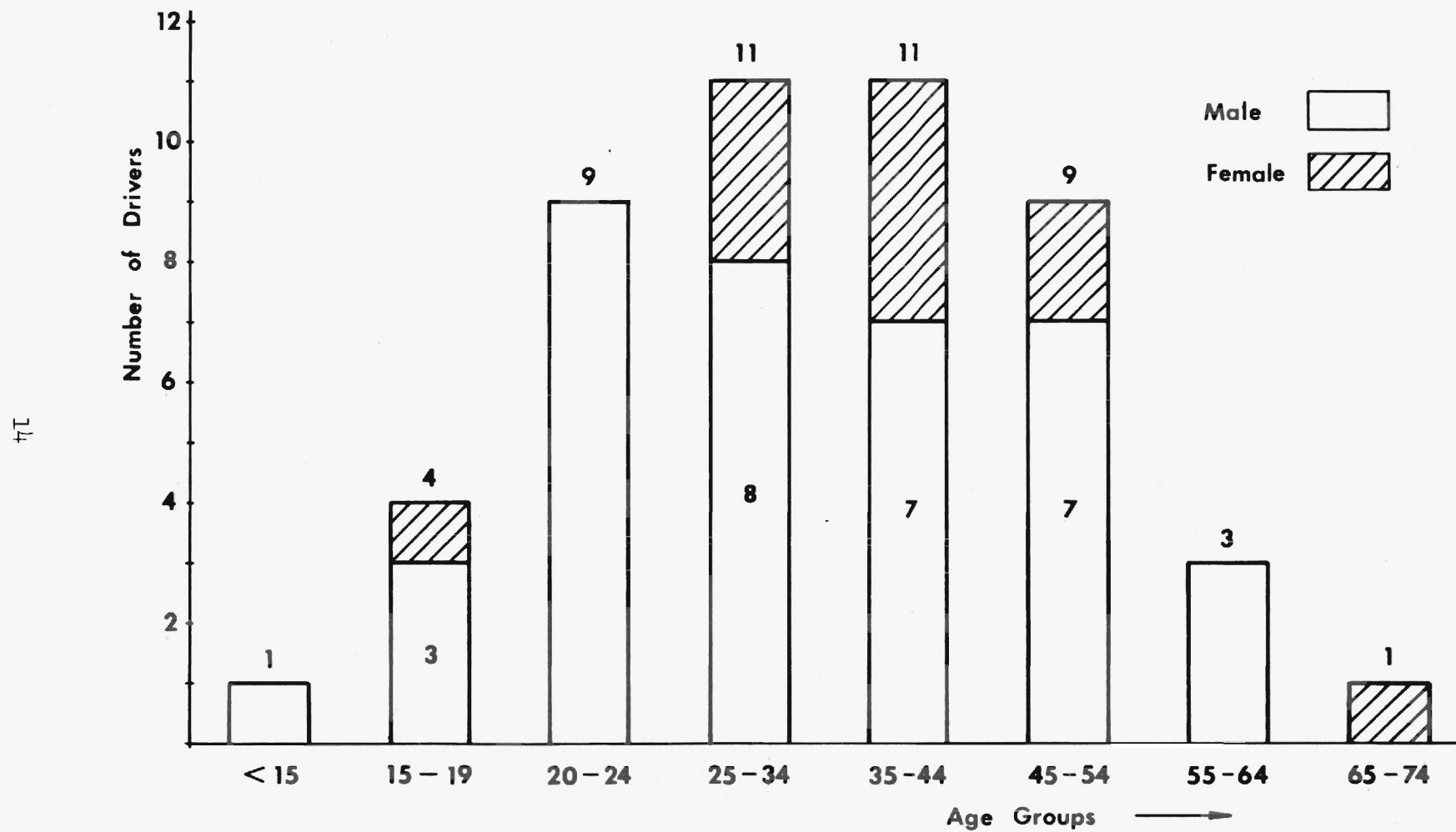


Figure 4. Research Sample Population Distribution by Age Groups and Sex of Drivers, Phase 5.

# INJURY SEVERITY CODE

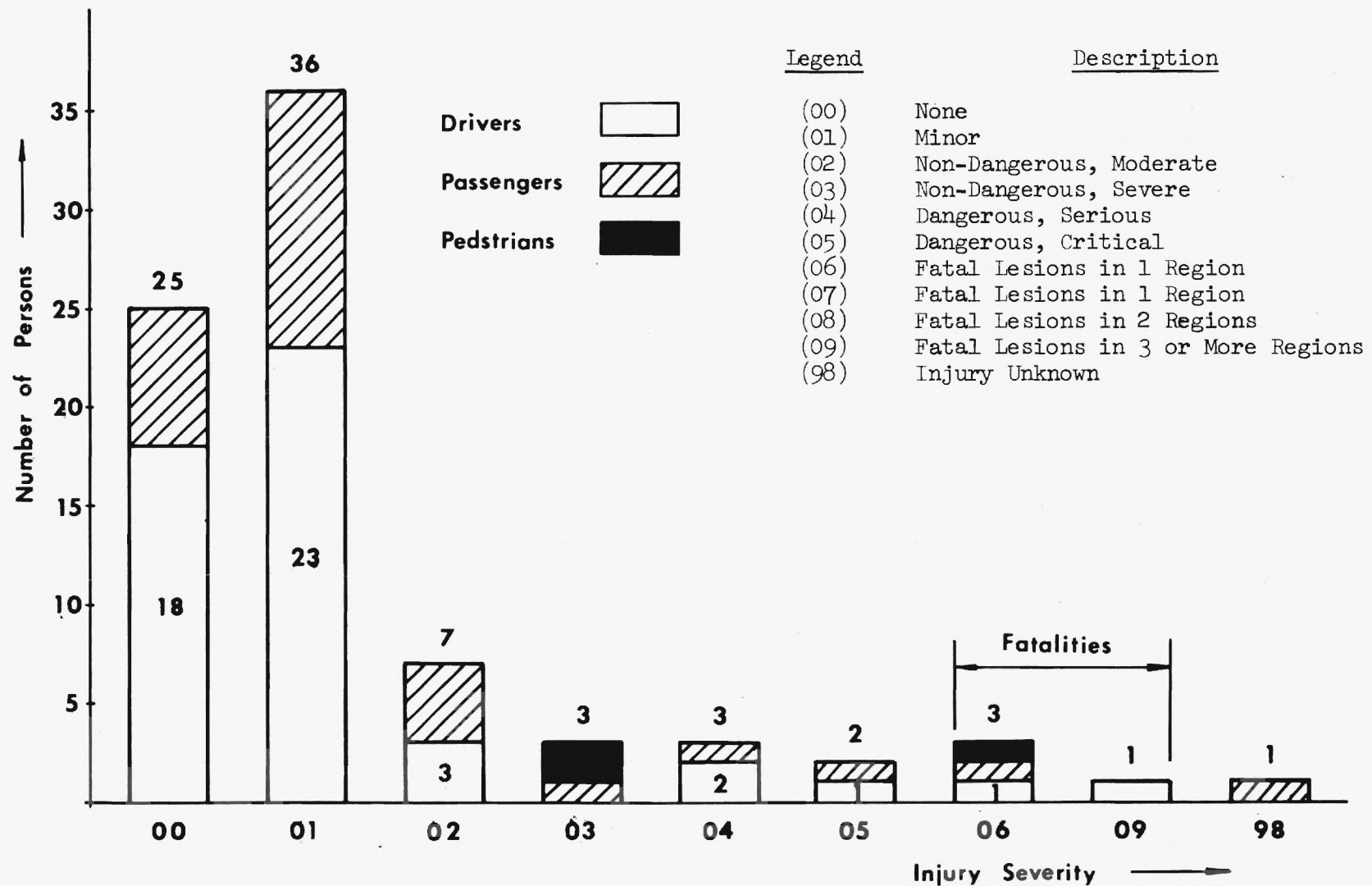


Figure 5. Injury Severity Distribution of Research Samples, Phase 5.

Table 2. Distribution of Research Sample Vehicle  
Damage Scales, Phase 5.

Damage Scales	Number of Vehicles
1	11
2	7
3	18
4	7
5	3
6	2
7	1
8	0
9	1
No Damages (Pedestrian Accident)	1
Not Applicable (Truck Fire)	1
Total	52

Table 3 shows the vehicle year and make and estimated property damages for each accident. It is noted that the 30 crashes resulted in property damage amounting to a total of \$86,756.

The 30 crashes investigated in this phase involved a total of 52 vehicles including nine trucks, six foreign and 37 domestic automobiles. All of the crashes involved at least one 1968, 1969, 1970, or 1971 vehicle. A classification of the vehicles studied according to year of manufacture is given by Table 4. This table should not be interpreted to indicate that late model vehicles are more frequently involved in accidents than older vehicles. The table simply indicates that the team was able to conform to the requirement of the sponsor that only accidents involving at least one late model vehicle be investigated.

As shown by Table 5, the most predominant type of accident investigated during this report period was "intersection collision". These collisions comprised one-third of all the cases investigated. Nine of the 30 cases studied involved a vehicle which left the roadway and struck a fixed object, emphasizing the need to provide a safe roadway environment.

All but one of the crashes occurred in metropolitan Atlanta, Georgia, a regional center of finance and commerce of 1.4 million population. Twenty-one of the accidents occurred within the City of Atlanta, three in other areas of Fulton County, five in DeKalb County, and one near Roberta, Georgia. Five of the accidents studied occurred on urban expressways, eleven on urban arterials, ten on collector streets, two on local streets, one on a rural highway, and one in a parking area. Twenty-six of the 30 accidents occurred during daylight hours and four during hours of darkness. The roadway was dry when 23 of the accidents occurred, and wet when the remaining seven occurred.

#### Contributing Factors.

Tables 6 and 7 list the factors which were judged to have contributed to the initiation of the various crashes. The most striking characteristic of these lists is the wide variety of factors which caused the crashes. It is also interesting that 22 of the 30 cases

Table 3. Cost of Vehicle Repairs, Phase 5.

Accident Number	Vehicle Year & Make	Estimated Cost of Damages
71	1970 Dodge Dart Custom	\$ 2,900.
72	1970 Chevrolet Impala	3,500
	1968 Dodge C-700 truck with 5-yard dump body	606
73	1970 Plymouth Road Runner	850
74	1970 Oldsmobile Cutlass Supreme	1,000
	1964 International Harvester Metro Van	850
75	1968 Oldsmobile Cutlass	2,500
	1967 Rambler	76
76	1970 Chevrolet Nova	900
77	1970 Oldsmobile 88 Delta Custom	1,200
	1969 Volkswagen	1,900
	1970 Buick Skylark	250
	1970 Pontiac GTO	350
78	1969 Chevrolet C-30 2 $\frac{1}{2}$ -ton truck	No Damages
79	1970 Oldsmobile Ninety-Eight	1,500
	1960 Volkswagen	350
80	1970 American Motors Rebel SST	2,800
81	1969 Volkswagen Stationwagon	2,200
82	1969 Chevrolet Impala	2,800
	1961 Chevrolet Biscayne	200
83	1969 Volkswagen 1500	850
	1959 Jaguar XK	1,700
84	1970 Dodge Challenger	1,500
	1969 Ford Econoline 300 Van Truck	1,800
85	1969 Pontiac Ventura	3,000
86	1970 Chevrolet Bel Air	650
87	1969 Plymouth Fury III	1,585
	1968 Lincoln Continental	3,500



Table 3 (Continued). Cost of Vehicle Repairs, Phase 5.

Accident Number	Vehicle Year & Make	Estimated Cost of Damages
88	1971 Dodge Charger	\$ 989
	1966 Buick Special	750
89	1970 Chevrolet Monte Carlo	1,550
	1966 Chevrolet Impala	800
90	1970 Mercury Marquis Convertible	750
	1970 Pontiac Tempest	3,800
91	1971 Plymouth Fury III	3,800
92	1970 Ford LN-700 truck with an enclosed body	8,750
93	1962 American Motors Rambler	300
	1969 Buick Electra 225	3,000
94	1971 Dodge Challenger Convertible	4,200
95	1968 Plymouth Fury III	1,000
96	1966 Chevrolet El Camino Pick-up truck	950
	1971 Oldsmobile Cutlass "S"	4,300
97	1964 Ford N-600 truck	250
	1971 Oldsmobile Ninety-Eight	6,000
98	1969 Jaguar E Type, 4.2 liters	350
	1964 Chevrolet Series 10 truck	600
99	1966 Ford F-100 truck	600
	1968 Ford Falcon	950
	1968 Ford LTD	200
	1967 Chevrolet C-10 truck	100
100	1970 Plymouth GTX	1,200
	1963 Chevrolet Impala	250
Total		\$86,756

Table 4. Distribution of Vehicles by Year  
of Manufacture, Phase 5.

Year of Manufacture	Number of Vehicles
1971	5
70	17
69	10
68	6
67	2
66	4
64	3
63	1
62	1
61	1
60	1
59	1
Total	52

Table 5. Summary of Accidents by Type, Phase 5.

Type of Accident	Case Numbers	No. of Accidents
Intersection collision	72,74,83,84,87,88,89, 90,97,100	10
Leaving roadway, striking fixed object	71,73,76,80,81,85,86, 91,94	9
Leaving roadway--expressway rollover	75,95	2
Head-on collision	79,93	2
Pedestrian	77,78	2
Intersection collision, rollover	96	1
Intersection collision-- leaving roadway, expressway collision	99	1
Expressway collision	82	1
Sideswipe--leaving roadway, striking fixed object	98	1
Fire accident	92	1

Table 6. List of Principal Contributing Factors,  
Phase 5.

Principal Contributing Factors	Case Numbers	Matrix
Alcohol	77	1
Alcohol	85	1
Driver error (failure to exercise due caution when emerging from parking lot)	84	1
Driver error (failure to maintain forma- tion in funeral procession)	88	1
Driver error (failure to observe approach- ing vehicle)	96	1
Suicidal intent	81	1
Mechanical failure (right lower ball joint)	73	4
Mechanical failure (brakes)	80	4

Table 7. List of Joint Principal Contributing Factors,  
Phase 5.

Joint Principal Contributing Factors	Case Numbers	Matrix
Violation of red light, anticipation of green signal	74	1,1
Violation of red signal, failure to exercise due caution	99	1,1
Human factors (emotional stress, lack of sleep, medication, weakness resulting from a hangover and/or influenza)	86	1,1
Inattentiveness of driver, not wearing required eye glasses	87	1,1
Excessive speed, overloaded vehicle	72	1,4
Excessive speed, poorly designed roadway	71	1,7
Simultaneous lane changing by at least 3 drivers triggered by traffic back-up	75	1,7
Failure to yield right-of-way, restricted visibility	76	1,7
Preoccupation of driver, missing "STOP" sign	83	1,7
Driver error (failure to exercise due caution), sight distance restriction due to turning vehicle	90	1,7
Violation of red signal due to inattentiveness of driver, sight distance restriction	97	1,7
Alcohol, excessive speed, unfamiliarity with roadway	91	1,1,1
Alcohol, excessive speed, poor judgment (driver or passenger shifted vehicle into reverse)	94	1,1,1
Violation of red signal, failure to exercise due caution, excessive speed	100	1,1,1

Table 7 (Continued). List of Joint Principal Contributing Factors, Phase 5.

Joint Principal Contributing Factors	Case Numbers	Matrix
Alcohol, inattentiveness of driver, no street illumination	82	1,1,7
Unfamiliarity with vehicle, poor roadway design, improper traffic control	79	1,7,7
Driver error (oversteering), driver error (too close to centerline), unfamiliarity with roadway, poor roadway design	93	1,1,1,7
Alcohol, alcohol, improperly aimed head- light, street not illuminated	78	1,1,4,7
Driver error (improper reaction), speed excessive for conditions, worn tires, wet and slippery roadway	95	1,1,4,7
Ruptured muffler, design defect (location of muffler too close to fuel tank and orientation of muffler seam)	92	4,4
Color of vehicle, glare, background	89	4,7,7
Driver unfamiliarity with vehicle, speed too fast for conditions, slick tire, curved roadway, wet and slippery road- way	98	1,1,4,7,7



involved two or more causative factors and, in 10 cases, three or more factors were listed.

In the following paragraphs, the significant human, vehicular, and roadway contributing factors will be briefly discussed.

Human Factors. About 63 percent of the contributing factors identified during this phase were human factors. The large majority of the human factors were driver errors, and the driver errors identified varied widely, ranging from simple inattention to suicidal intent. Alcohol was a factor in five of the 30 cases. Two of the intoxicated drivers were considered to be problem drinkers and one was a 17-year-old high school student. One of the drivers was a 13-year-old who was described as "uncontrollable" by juvenile authorities. Excessive speed was noted in six of the investigations, and unfamiliarity with the roadway and with the vehicle was discovered in two cases each.

Vehicular Factors. In three cases, design or manufacturing related mechanical defects were listed as principal contributing factors. In two of the crashes, a single vehicular factor was judged to have explained the occurrence of the crash. One involved the failure of a right lower ball joint, and the other crash was caused by failure of the bonding between the brake lining and the shoe. In the third case, a ruptured muffler and its proximity to the fuel tank was judged to have caused a truck fire.

Vehicular factors were listed to have jointly contributed to the initiation of five of the other crashes. These factors were: worn tires (two cases), overloaded vehicle, improperly aimed headlights, and vehicle color.

Fourteen additional vehicular deficiencies or conditions were discovered, but these problems were judged not to have contributed to accident initiation. Thus, 23 vehicular related problems were found in the 52 vehicles inspected during this report period.

Environmental Factors. Although environmental factors were identified in 13 of the 30 cases, none of the accidents was attributed solely to the environment. Of the 13 environmental factors identified, six involved poor roadway design, two were matters of traffic control, two were wet roadways, and inadequate illumination

was a factor in two crashes. In one accident, visibility was restricted due to a turning vehicle.

Modifying Factors.

In six of the 30 investigations, modifying factors were identified. These factors did not contribute to accident initiation but were judged to have worsened the consequences of the crash. A list of the modifying factors reported during this phase is given as Table 8.

Table 8. List of Modifying Factors, Phase 5.

Modifying Factors	Case Number	Matrix
Excessive speed	73	1
Excessive speed	80	1
Wet and slippery roadway	76	7
Wet and slippery roadway	79	7
Over-reaction of driver and poor median design	75	1,8
Location of pole	98	8

## CHAPTER IV

### DISCUSSION OF RESULTS -- SUMMARY OF 100 CASES

Since the inception of the research program in February, 1968, a total of 100 in-depth multidisciplinary accident investigations have been performed. The purpose of this chapter will be to summarize the results of all of these investigations. After the human, vehicular, and environmental characteristics of the accident population have been described, a grand summary of the contributing factors and the modifying factors will be given.

#### The Accident Population.

The 100 accidents selected for investigation have been well distributed over time. This is shown by Figure 6 which compares the time of occurrence distribution of those cases investigated with all accidents occurring in Atlanta during a five-month period ending May 31, 1971.

The drivers involved in these crashes appear to be similar to the accident population in general in terms of age and sex. Figure 7 gives a distribution of accident-involved drivers, comparing those sampled by the research team with the overall experience of the City of Atlanta. Twenty-two percent of the drivers involved in the 100 cases studied were females, compared to 25 percent of the total accident population.

At least 40 percent of the drivers were found to have been charged with previous traffic violations. This percentage may be lower than experienced by the accident population in general because some difficulty was experienced in obtaining driver violation records, particularly in the earlier phases. One of the drivers had a record of 26 traffic violations and four others had 12 or more violations. Another driver had been charged with seven violations including five charges of driving under the influence and his license had been suspended or revoked seven times.

It was found that only about 13 percent of the occupants of vehicles equipped with lap belts were wearing them at the time of

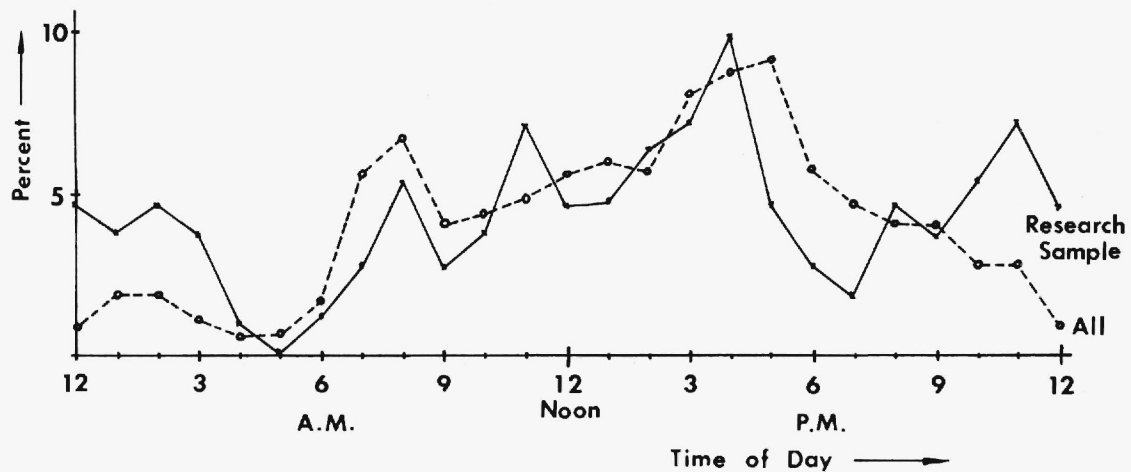
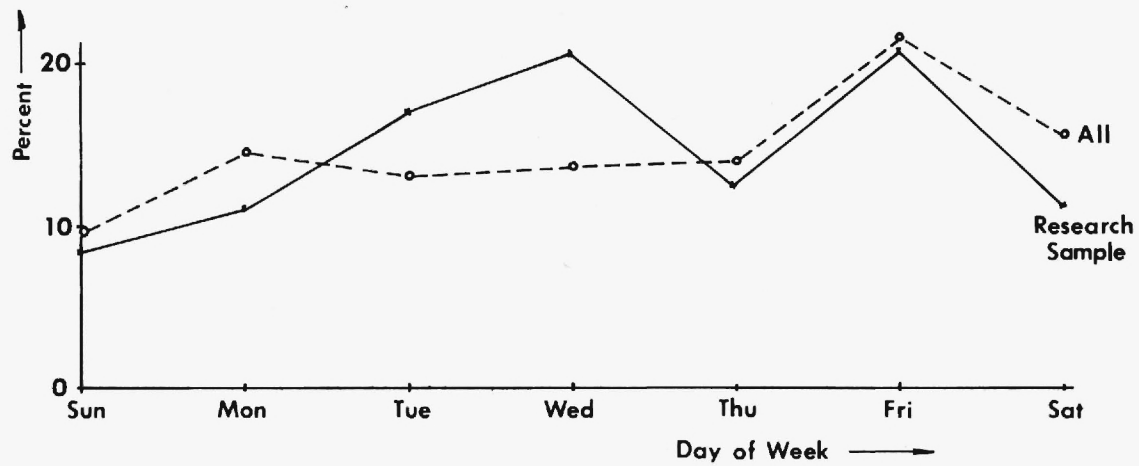


Figure 6. Comparison of City of Atlanta Accident Population and Research Sample by Day of Week and Time of Day.

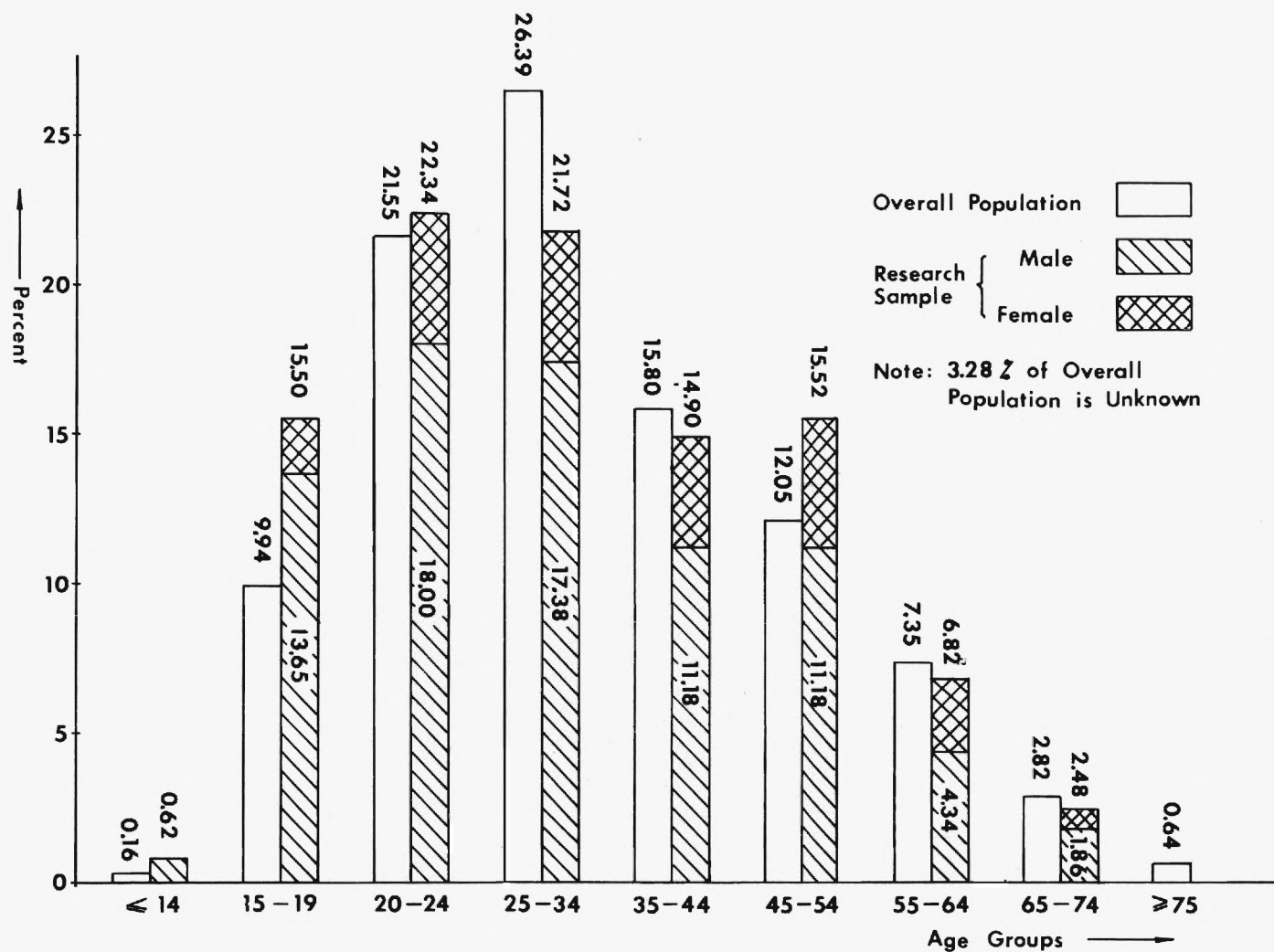


Figure 7. Comparison of City of Atlanta Accident Population and Research Sample by Age Group and Sex of Drivers.



the accident. A seat belt survey by Nobles (7) of 645 drivers and passengers in the Atlanta driving population indicated that about 36 percent of the occupants of vehicles equipped with lap belts were wearing them. (See Table 9.) A Chi-Square test (5 percent level of significance) comparing these data required rejection of the null hypothesis that the two sets of data were drawn from the same population. This difference is probably due to the police radio monitoring and accident selection procedures of the Atlanta team, which responded predominantly to accidents involving personal injuries\*. Similarly, less than two percent of the occupants in the case studies were wearing available shoulder belts as compared to about seven percent in the driving population.

Tables 10 and 11 are presented to show the level of injury sustained by the victims of the various crashes. These tables reflect the efforts of the team during the earlier phases to concentrate on fatal and severe injury producing crashes, and in phases 4 and 5 to sample "a reasonable and balanced distribution of fatal, injury producing, and property damage collisions" to conform with the data requirements of the sponsor.

Tables 12 and 13, which list the vehicles according to damage severity, also reflect the efforts of the team to obtain a better balanced sample from the accident population.

A total of 165 vehicles were involved in the 100 crashes, and there were vehicular damage losses in the amount of \$387,051.

As shown by Table 14, the most common type of accidents were "leaving roadway, striking fixed object", "intersection collision" and "crossing median or centerline". It is therefore not surprising that the vehicles inspected were subjected to forces predominantly from the front and the sides. This is illustrated by Figure 8, which shows that a total of 58 percent of the vehicles were subjected to forces from the 11:00, 12:00 or 1:00 o'clock directions and 24 percent received forces from the 3:00 or 9:00 o'clock direction.

Thirty-four of the 100 accidents studied occurred on urban arterial streets, 29 on local and residential streets, 23 on urban

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\* These data seem to indicate that either people who wear seat belts are less likely to be involved in crashes or are less likely to be injured in a crash. The latter conclusion appears to be more plausible.

Table 9. Results of Seat Belt Study.

	Accident Population*	Driving Population**
Vehicles Equipped with Lap Belts	103 (80%)	509 (85%)
Vehicles Not Equipped with Lap Belts	26 (20%)	91 (15%)
Drivers Using Lap Belts	12 (12%)	200 (39%)
Drivers Not Using Lap Belts	91 (88%)	309 (61%)
Occupants Using Lap Belts	22 (13%)	230 (36%)
Occupants Not Using Lap Belts	142 (87%)	415 (64%)
Vehicles Equipped with Shoulder Belts	45 (35%)	228 (38%)
Vehicles Not Equipped with Shoulder Belts	84 (65%)	372 (62%)
Drivers Using Shoulder Belts	1 ( 2%)	17 ( 7%)
Drivers Not Using Shoulder Belts	44 (98%)	211 (93%)
Occupants Using Shoulder Belts	1 ( 1%)	20 ( 7%)
Occupants Not Using Shoulder Belts	68 (99%)	271 (93%)

\* Data includes all of vehicles inspected under Phases 1, 2, 3 and 4, and a portion of those inspected under Phase 5.

\*\* Driving population data taken from a seat belt survey of 600 Atlanta vehicles by Nobles (7).

Table 10. Number of Cases in Phases 1, 2, and 3  
with Maximum Injury Severity Shown.

Maximum Injury Severity	No. of Investigations
None	3
Minor	12
Moderate	13
Severe	3
Dangerous	1
Fatal	13
Total	45

Table 11. Number of Injured Persons in Phases 4 and 5  
with Occupant Injury Code Shown.

Injury Severity Code	Number of Injured Persons
(00) None	36
(01) Minor	56
(02) Non-Dangerous, Moderate	24
(03) Non-Dangerous, Severe	9
(04) Dangerous, Serious	11
(05) Dangerous, Critical	3
(06) Fatal Lesions in 1 Region, plus injuries of other regions of Severity Code 3 or less	4
(07) Fatal Lesions in 1 Region, plus injuries of other regions of Severity Code 4 or 5	3
(08) Fatal Lesions in 2 Regions	2
(09) Fatal Lesions in 3 or More Regions	4
(98) Unknown	3
	155

Table 12. Vehicle Damage Severity Ratings for all Vehicles Inspected in Phases 1, 2, and 3.

Rating	No. of Vehicles
Minor	12
Moderate	20
Severe	19
Critical	17
Total	68

Table 13. Damage Scale of the Vehicular Deformation Index for all Vehicles in Phases 4 and 5.

Damage Scale	No. of Vehicles
1	14
2	7
3	26
4	14
5	11
6	7
7	8
8	1
9	5
No Damages	1
Unknown	2
Not Applicable	1
Total	97

Table 14. Classification of Accidents by Type-Summary  
of 100 Accident Investigations.

Type of Accident	Number Investigated
Leaving roadway, striking fixed object	40
Leaving roadway, rollover	6
Leaving roadway into ditch (bus)	1
Intersection collision with another vehicle	23
Intersection collision, rollover	1
Intersection collision, leaving roadway, striking fixed object	1
Crossing median or centerline (collision with another vehicle)	12
Collision with vehicle with subsequent crossing of median or centerline, resulting in addi- tional collision(s)	3
Entering median, overturning	1
Rear end	2
Rear end on expressway	3
Head-on collision	2
Head-on collision on expressway	1
Expressway collision	1
Sideswipe, leaving roadway, striking fixed object	1
Fire accident	1
Pedestrian	2
Total	101*

\* Accident 45 involves both rollover and rear end collisions and  
has been considered as two separate cases.

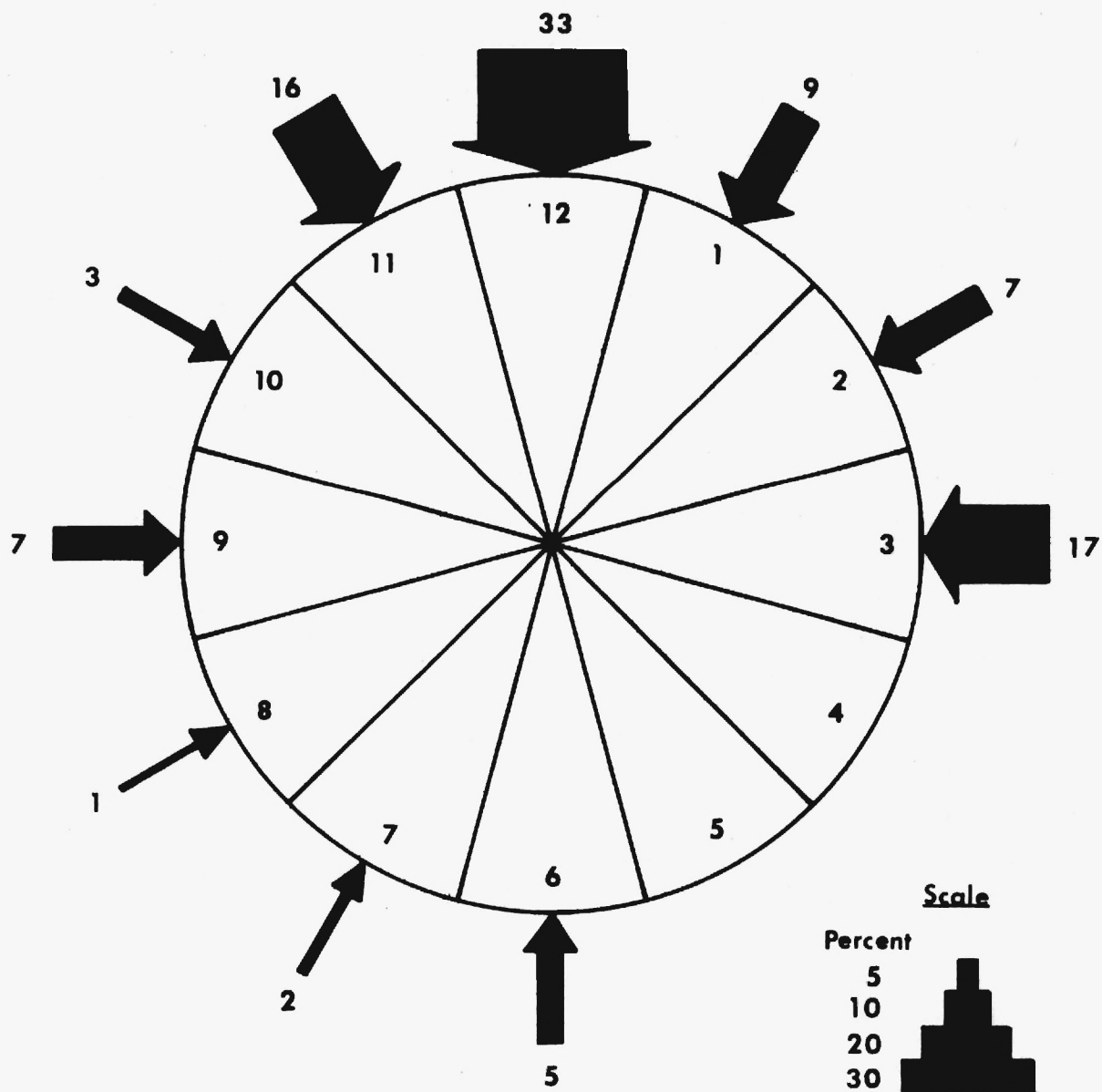


Figure 8. A Distribution of Force Directions for the Vehicles Involved in 100 Crashes.



expressways, five on two-lane rural highways, four on four-lane divided highways, three in parking areas, and two on downtown Atlanta commercial streets.

Sixty of the one hundred accidents occurred in the City of Atlanta, eight in other areas of Fulton County, 25 in DeKalb County and three in Clayton County. Studies were also completed on one accident each in Macon, Athens, and Roberta, Georgia, and Decatur, Alabama.

Sixty-two of the collisions occurred during the day, and 38 occurred during hours of darkness. In comparison, in the City of Atlanta during the period 1968 through 1970, approximately 70 percent of all accidents reported occurred during daylight hours and 30 percent occurred at night (including dawn and dusk).

Twenty-one percent of the crashes studied by the research team occurred on a wet or snowy roadway and the roadway was dry when 79 percent of the accidents occurred. Comparable data for the City of Atlanta during 1968-1970 show that 23 percent of accidents occur on wet or snowy roadways and 77 percent on dry roadways.

In summary, the 100 crashes investigated involved predominantly late model vehicles and a wide variety of drivers. The crashes were well distributed over time and occurred in an urban environment. Very few pedestrian crashes were studied, and the very minor "fender bender" crashes were excluded from the investigation.

#### Contributing Factors.

A total of 180 contributing factors were identified for the 100 crashes. Fifty-five percent of the investigations conducted thus far involved two or more causative factors, and three or more contributing factors were identified in 18 percent of the cases.

<u>No. of Factors Identified</u>	<u>No. of Cases</u>
1	45
2	37
3	12
4	5
5	1

In 45 of the cases, a single factor was sufficient to explain the occurrence of the crash. These principal contributing factors, listed in Table 15, consisted of one environmental, nine vehicular, and 35 human factors.

Table 16 lists the joint principal contributing factors which were identified for 55 of the investigations. It is evident from this and the preceding table that the accidents investigated were caused by a wide variety of human, vehicular, and environmental factors which often interacted in a complex way to trigger the initiation of the event.

Human Factors. About 65 percent of the 180 factors identified were human factors, 14 percent were vehicular, and 21 percent were related to the roadway environment. Alcohol was identified as a contributing factor in 25 percent of the cases studied. In comparison, researchers have consistently shown that alcohol contributes to about half of all fatal crashes (8)\*. It should be remembered that this research program was concerned with the investigation of a reasonable and balanced distribution of fatal, injury producing, and property damage collisions. It has been estimated (8) that alcohol contributes to about six percent of run-of-the-mill crashes (including "fender benders" which were excluded from this investigation).

Vehicular Factors. Vehicular factors were judged to have contributed to 25 percent of the crashes, and vehicles with one or more defects were found in 45 percent of the cases investigated. Several of the vehicular deficiencies did not contribute to accident initiation but modified the accident severity; others did not alter the accident in any way. The most common vehicular deficiency, found in 23 vehicles, was badly worn tires. Inadequate brakes was the next most prevalent deficiency, found in 24 vehicles. Other vehicular problems noted included steering and suspension inadequacies, mismatched wheels and tires, and misaligned headlights. Eleven of the 160 vehicles were not inspected because of uncooperative attorneys, insurance companies or vehicle owners.

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\* An eight-month study in 1971 by the Fulton County Medical Examiner indicated that 46 percent of the fatally injured drivers tested had a blood alcohol level greater than 0.10 percent.

Table 15. Principal Contributing Factors - Summary of 100  
Accident Investigations.

Principal Contributing Factor	Matrix	Number Investigated
Alcohol	1	12
Alcohol and/or amnesia	1	1
Psychological	1	1
Medical (black out, myocardial infarction)	1	2
Driver error (pressing accelerator instead of brake by mistake)	1	1
Driver error (failure of driver to exercise due caution when emerging from parking lot)	1	1
Driver error (failure to maintain formation in funeral procession)	1	1
Driver error (failure to observe approaching vehicle)	1	1
Violation of traffic signal	1	1
Violation of stop sign (unfamiliarity with city streets)	1	1
Failure to yield right-of-way	1	3
Operating vehicle wrong way on expressway (attempting to start vehicle)	1	1
Improper passing	1	1
Improper lane changing (reason unknown)	1	1
Improper parking (to evade provoked driver)	1	1
Excessive speed	1	1
Suicidal intent	1	1
Unknown (human factor)	1	4
Improper vehicle maintenance (defective brakes)	4	3
Defective brakes or brake failure	4	4
Mechanical failure (right lower ball joint)	4	1
Tire failure (hitting the curb)	4	1
Wet roadway	7	1
		<hr/> 45

Table 16. Joint Principal Contributing Factors -  
Summary of 100 Accident Investigations.

Joint Principal Contributing Factors	Matrices	Number Investigated
Alcohol, violation of signal	1,1	1
Alcohol, excessive speed	1,1	1
Alcohol, fatigue	1,1	2
Alcohol, inattentiveness	1,1	1
Excessive speed, violation of red traffic signal	1,1	1
Excessive speed, failure to take evasive action	1,1	1
Excessive speed, driving wrong way on one-way street	1,1	1
Driver error (inattentiveness), violation of stop sign	1,1	1
Driver error (failure to remove vehicle from roadway after minor accident), excessive speed	1,1	1
Violation of red light, anticipation of green signal	1,1	1
Violation of red signal, failure to exercise due caution	1,1	1
Human factors (emotional stress, lack of sleep, or medication, or weakness resulting from a hangover and/or influenza)	1,1	1
Inattentiveness of driver, not wearing required eye glasses	1,1	1
Driver unfamiliarity with vehicle, vehicle handling peculiarities	1,4	1
Driver error (over-reacting), tire failure	1,4	1
Driver error (inattentiveness), broken bolt holding steering wheel	1,4	1
Excessive speed, overloaded vehicle	1,4	1
Alcohol, hazardous roadway	1,7	1
Excessive speed, hazardous roadway	1,7	5
Excessive speed, inadequate traffic control	1,7	1

Table 16 (Continued). Joint Principal Contributing Factors -  
Summary of 100 Accident Investigations.

Joint Principal Contributing Factors	Matrices	Number Investigated
Failure to yield right-of-way, hazardous roadway	1,7	1
Driver error (oversteering), muddy roadway	1,7	1
Violation of signal, phasing of traffic signal	1,7	1
Simultaneous lane changing by at least 3 drivers triggered by traffic back-up	1,7	1
Failure to yield right-of-way, restricted visibility due to turning vehicle	1,7	2
Preoccupation of driver, missing "STOP" sign	1,7	1
Violation of red signal due to inattentiveness of driver, sight distance obstruction	1,7	1
Ruptured muffler, design defect (location of muffler too close to fuel tank and orientation of muffler seam)	4,4	1
Slick tires, wet roadway	4,7	3
Alcohol, excessive speed, unfamiliarity with roadway	1,1,1	1
Alcohol, excessive speed, poor judgment (driver or passenger shifted vehicle into reverse)	1,1,1	1
Violation of red signal, failure to exercise due caution, excessive speed	1,1,1	1
Alcohol, excessive speed, roadway design	1,1,7	1
Alcohol, inattentiveness of driver, no street illumination	1,1,7	1
Excessive speed, worn tires, wet roadway	1,4,7	2
Driver error (inattentiveness), improper tire pressure, damaged roadway	1,4,7	1
Driver error (excessive speed), improper and slick tires, roadway hazard (raised man-hole cover)	1,4,7	1
Excessive speed, wet roadway, hazardous roadway	1,7,7	1

Table 16 (Continued). Joint Principal Contributing Factors -  
Summary of 100 Accident Investigations.

Joint Principal Contributing Factors	Matrices	Number Investigated
Unfamiliarity with vehicle, poor roadway design, improper traffic control	1,7,7	1
Color of vehicle, glare, background	4,7,7	1
Alcohol, failure to yield right-of-way, excessive speed, poor roadway maintenance	1,1,1,7	1
Driver error (oversteering), driver error (too close to centerline), unfamiliarity with roadway, poor roadway design	1,1,1,7	1
Excessive speed, fatigue, unfamiliarity with vehicle, hazardous roadway	1,1,1,7	1
Alcohol, alcohol, improperly aimed headlight, street not illuminated	1,1,4,7	1
Driver error (improper reaction), speed excessive for conditions, worn tires, wet and slippery roadway	1,1,4,7	1
Driver unfamiliarity with vehicle, speed too fast for conditions, slick tire, curved roadway, wet and slippery roadway	1,1,4,7,7	1



Environmental Factors. Environmental factors appeared in 31 of the 100 investigations, and as a joint principal contributing factor in 30 of these cases. These factors included such problems as wet roadway, missing or improper traffic control devices, and in a few cases, incredibly poor geometric design.

Summary. To summarize, the findings of this research program support the view expressed by other researchers that vehicular accidents are caused by a wide variety of human, vehicular, and environmental factors. It is also evident that a substantial percentage of vehicular crashes are complex events which are triggered by two or more factors.

It is also apparent that human factors constitute the most prevalent type of contributing factors, as at least one human factor was identified in 85 of the 100 cases. It is significant, however, that only 52 of these cases were attributed to human factors alone. That is to say, in 48 of the cases the accident could have been prevented by removing a vehicular or environmental factor.

This research supports the findings of other researchers that driving under the influence of alcohol is a major factor in accident initiation. Alcohol, in fact, was the most common single human factor identified, appearing in 25 percent of the total cases.

This research suggests that factors relating to the vehicle contribute to approximately one-fourth of traffic accidents, although about one-half of the vehicles involved in crashes may have vehicular deficiencies.

Finally, based on the findings of this project, environmental factors are thought to contribute to the initiation of about 30 percent of vehicular accidents. Almost without exception, environmental factors contribute jointly with human and/or vehicular factors to initiate crashes.

#### Modifying Factors.

Modifying factors were identified in 25 of the 100 cases. These factors did not contribute to accident initiation, but in the investigators' judgment worsened the consequences of the crash. A total of 30 modifying factors were noted, of which 14 related to the vehicle, 12 were environmental, and four were human factors. A list of the modifying factors are given by Table 17.

Table 17. Modifying Factors - Summary of 100  
Accident Investigations.

Modifying Factor(s)	Matrices	Number Investigated
Driver error (failure to take evasive action)	1	1
Excessive speed	1	2
Worn tires	4	4
Defective brakes	4	1
Vehicle design (brake system)	4	1
Wet roadway	7	3
Roadway (absence of guardrail or barrier in median)	8	4
Roadway (location of pole)	8	1
Design of drop inlet too high, causing vehicle to be elevated	8	1
Trees too close to edge of road	8	1
Failure to provide breakaway support	8	1
Over-reaction of driver, poor median design	1,8	1
Worn tires, defective brakes	4,4	3
Defective brakes and steering	4,4	1

## CHAPTER V

### COUNTERMEASURES -- STATUS AND NEED

It was stated in Chapter IV that traffic accidents are caused by a wide variety of human, vehicular, and environmental factors. As Tarrants (9) has pointed out, the presence of multiple causative factors implies that multiple countermeasures are warranted. There are, in short, many remedial programs that could be instituted to prevent and reduce the destructive effects of vehicular crashes. Furthermore, the establishment of the relative merits of the various traffic safety programs is a complex problem which ideally should include an evaluation of the costs and the benefits of the various countermeasures, as well as an attempt to determine the best combination or mix of countermeasures to achieve the greatest reduction of crash loss for the least expense. Such an evaluation is well beyond the scope of this study, which had as its primary purpose the collection and documentation of valid scientific accident data. During the past three and a half years, however, members of the Atlanta research team have naturally formed impressions and judgments regarding the extent and seriousness of various hazards and the relative merit of countermeasures to reduce or remove these hazards. The evaluations and recommendations given in this chapter are based on the overall experiences of the research team throughout the project period, as well as a review of the work of other researchers active in the traffic safety field.

The observations listed below may be helpful to public officials in directing attention to areas of concern which are deserving of prompt remedial action. The list, admittedly, is not an exhaustive one. Additional comments and recommendations are given in the individual case summaries included in the Appendix.

#### Human Countermeasures.

Despite the fact that human factors have been shown to be the most prevalent contributor to crashes, it would appear that the

various remedial programs aimed at improving or controlling driver behavior may be the least desirable methods of reducing the losses from vehicular crashes. This conclusion arises not only from the high cost of these programs but also from lack of evidence that certain of these human countermeasures have been successful (10). Nevertheless, the magnitude of the problem dictates that it be attacked on the broadest possible front including efforts designed to control or change driver behavior. However, in the words of Klein and Waller (10):

"... such efforts must be based in sound research and must be implemented not on a happenstance basis, as they currently are, but systematically, tentatively, and under careful professional scrutiny -- in the manner of other public health countermeasures."

An evaluation of human remedial programs relative to their application to Atlanta and the State of Georgia is given below.

Driver Re-examination. Under the current driver licensing law, there are four classes of licenses: Learner, Operator, Chauffeur, and Veteran. The learner's license may be issued to 15-year-old drivers and is valid for a period of one year. Operators and chauffeurs licenses are renewable every two or five years, and unless the license has expired, the applicant is not re-examined either for visual acuity or knowledge of traffic laws. Veterans are issued a permanent license under the present law.

House Bill 58, which was introduced in the 1971 General Assembly, would have required a visual acuity test every five years but no examination for knowledge of traffic laws. The bill was postponed and will probably be considered by the Assembly in 1972.

Passage of the bill in its present form would be an improvement over the present law and a step towards greater compliance with Highway Safety Standard Number 5. The passage of this or a similar law requiring periodic re-examination of drivers (including veterans) is recommended.

License Classification. Under the current driver licensing law, a licensee may drive any class of motor vehicle from motorcycles to tractor-trailer trucks. A chauffeur's license is required for those drivers operating vehicles for hire.



House Bill 59, which was favorably reported by the House Motor Vehicle Committee in 1971, is expected to be up for vote during the 1972 session of the General Assembly. The bill would create five classes of driver licenses on the basis of vehicle type and would establish separate examinations for driving motorcycles, automobiles, buses, and two classes of trucks. This bill would strengthen the state's driver licensing law and would again be a move toward greater compliance with Highway Safety Standard Number 5. The passage of this or a similar bill is recommended.

Point System. In 1969, a bill was passed which established in Georgia a point system to provide more uniform procedures for driver license suspensions. Prior to the passage of this law, the Department of Public Safety had discretionary authority to suspend drivers' licenses and it was the policy of the Department to suspend licenses for a period of 30 days for those drivers convicted of two moving traffic violations during a six-month period. The current point system requires the Department of Public Safety to suspend the license of drivers who accumulate 15 traffic violation points during an 18-month period. Experience has shown that a driver who habitually commits traffic violations is less likely to have his license suspended under the current point system than under the previous discretionary law.

Senate Bill 113, defeated in the 1971 General Assembly, would have changed the point system law to provide for license suspension with the accumulation of 11 points in a 24-month period. A general strengthening of the point system law is needed, and the passage of S.B. 113 or a similar law is recommended.

Another weakness of the present point system law is the failure of certain courts to fully report information on the disposition of traffic offenses. Legislation is needed to insure more thorough and uniform reporting of traffic violation information to the Department of Public Safety by judges and court clerks. This matter is the subject of a current study sponsored by the Office of the Coordinator of Traffic Safety, and the passage of remedial legislation should await the completion of that study.

Medical Advisory Board. House Bill 57, which was considered but not passed by the 1971 General Assembly, would have created a

16-member Medical Advisory Board to assist the Department of Public Safety on issuance or suspension of drivers' licenses when medical questions are involved. The Georgia Tech research team has previously stated the need for medical supervision of certain aspects of the driver licensing program (4). Passage of this or a similar bill would bring the state into greater compliance with Highway Safety Standard Number 5, and such passage is recommended.

Habitual Offender Law. The State of Virginia has enacted legislation which identifies and denies the privilege to drive to persons who "by their conduct, attitude and record have demonstrated their disrespect for the laws of the Commonwealth, the orders of her courts and the statutorily required Acts of her Administrative Agencies" (11). The law provides for a license revocation of 10 years for those persons identified by court action as habitual offenders and mandatory confinement in the state penitentiary for a period of one to five years for those persons who continue to drive without licenses.

Although there is a danger of looking upon an habitual offender law as a "silver bullet" solution (9), such a law is nevertheless attractive and worthy of serious consideration.

Alcohol Countermeasures. Under Georgia law, a driver charged with driving under the influence of alcohol may plead nolo contendere, the effect of which is to subject the defendant to conviction without admitting guilt to the charges. The nolo contendere plea has been used by drivers charged with driving under the influence in order to avoid the mandatory revocation of the driver's license required for drivers convicted of D.U.I. In 1971, two laws were passed by the General Assembly relating to nolo contendere pleas to D.U.I. charges:

1. House Bill 398 calls for a 30-day mandatory suspension of license and other such punishments as the judge deems appropriate for those persons twice entering pleas of nolo contendere to charges of driving under the influence.

2. House Bill 399, which is directed to the Department of Public Safety, provides for a one-year suspension of license if the vehicle operator enters a plea of nolo contendere to D.U.I. charges for the second or subsequent times.



While these laws should be effective in preventing abuses relating to the habitual use of the nolo contendere plea, it is difficult to justify the use of the plea for the first D.U.I. charge. Modification of these laws in order to make them applicable to all nolo contendere pleas to D.U.I. charges is therefore recommended.

Georgia has an implied consent law under which a driver suspected of driving under the influence is required to submit to a chemical test of his blood or breath in order to measure the blood alcohol content. According to the law, a blood alcohol concentration of 0.10 percent is presumptive evidence of the driver's impaired ability to drive. If the driver fails to submit to a chemical test of his blood or breath, his driver's license is suspended for a period of six months. Certain violators have found that it is possible to circumvent the implied consent law by pretending to be unable to fill the intoximeter cylinder. A provision of Senate Bill 116 would classify as refusal to take the test the failure of a person to fill the intoximeter cylinder. The enactment of this provision is recommended. The Georgia Tech team further recommends that the law be amended to provide that a blood alcohol level of 0.05 percent be presumptive evidence that the defendant was under the influence of intoxicating liquor.

While better legislation and enforcement aimed at identifying and punishing those who drink and drive may be of some benefit, it is believed that the long term solution to this problem is more likely to lie in the development of a device that will prevent an intoxicated driver from driving his vehicle. For example, such a device, called a Phystester Ignition Interlock System, has been developed by General Motors Delco Electronics Division (12).

According to the developers, the Phystester is designed to work like this:

When the driver turns on the ignition key in his car, a random number with a fixed number of digits (five), is displayed for a few seconds on a miniature scoreboard. Then the number turns off, and the keys on the keyboard below the scoreboard light up. The keyboard is similar to that on a pushbutton telephone.

The driver then has a short time in which to punch into the keyboard the exact number he has just seen displayed on the scoreboard. If he does this successfully in the time allowed, the car will start. If he fails the test, the driver has two more chances to start the vehicle, although a different number would be displayed for each separate try. If he failed two more times, the vehicle is inhibited from starting for an extended period of time.

It should be emphasized that the research team does not endorse this particular device or any other specific device.

#### Vehicle Countermeasures.

There are three areas of concern relating to vehicle countermeasures that are worthy of special mention: motor vehicle inspection, restraint systems, and general vehicle design. Specific comments relating to other vehicle countermeasures have been given in case reports.

Motor Vehicle Inspection. The current motor vehicle inspection program in Georgia is an expensive countermeasure which apparently is not effective either in providing timely detection of relatively minor mechanical problems which develop over a short period of time or of identifying serious component degradation which occurs with vehicle aging. The current annual inspections are too infrequent to deter owners from operating vehicles with defects which occur precipitously or which develop over a short period of time (e.g., broken windshields, burned out lamps, and badly worn tires). On the other hand, the general shallowness of the inspection now performed make it unlikely that vehicular deficiencies relating to component degradation will be identified. Since deficiencies of this type occur predominantly in older vehicles, and in view of the high costs of motor vehicle inspection, it is recommended that all vehicles less than three years old be exempted from the requirement for an annual inspection. (It is estimated that about one-third of the vehicles would thus be excluded.)

It is suggested that a three-year ten-dollar inspection certificate be sold to the owners of new vehicles and that the funds from the sale of these certificates be used to employ a team of state patrolmen charged with the responsibility of enforcing the motor

vehicle inspection law. These patrolmen would make periodic unannounced road block inspections of vehicles checking for easily recognized vehicular defects. Operation of a vehicle with certain obvious defects (e.g., burned out lamps, slick tires, inoperable windshield wipers) would be construed as a violation of the motor vehicle inspection law and make the vehicle owner subject to a fine. These on-the-road inspections would have the added benefits of identifying intoxicated and otherwise impaired drivers and discourage drivers from operating without a license. This team of patrolmen could also be given the responsibility of evaluating and licensing inspection stations throughout the state.

The current motor vehicle inspections are given by Article XVI of the Uniform Act Regulating Traffic on Highways of the State of Georgia and the Georgia Official Motor Vehicle Inspection Manual. The following changes to the motor vehicle inspection procedures are recommended:

1. Brake inspections should preferably be made by means of a mechanical brake testing machine (dynamic analyzer). If such a device is not used, all of the wheels should be removed and an in-depth inspection and analysis of the brake system should be made. The brakes should be road tested with the aid of a decelerometer.
2. The inspection should include an examination of the operability of the windshield washer system.
3. All cooling system hoses and all fan and power equipment belts should be inspected.
4. The condition of the ignition system and the antipollution system should be tested by means of a dynamometer.

In view of the cost of the equipment required to properly perform the recommended motor vehicle inspections and in order to offset public cynicism about inspection results, it is believed that the inspections could best be performed by state-owned and state-operated stations.

Restraint Systems. One of the most discouraging aspects of the traffic safety picture is the indifference of the travelling public to the use of seat belts. As was reported in Chapter 4, an Atlanta survey indicated that only about one-third of the drivers were using



lap belts. During the seat belt survey, it was observed that the shoulder belts being used were predominantly the three-point type where the lap and shoulder belt could not be used separately.

Although the Atlanta team has not attempted to learn why vehicle occupants do not wear seat belts, it would seem that a major deterrent to their use is one of design. Use of seat belts in most vehicles today requires deliberate and often difficult and time-consuming efforts on the part of the user.

In the long run, it appears that a passive restraint system may be required to significantly reduce the injuries and the number of deaths in moderate and high speed crashes. In the meantime, until the suitability of air bags or other passive restraint systems have been proven, seat belt systems should be designed so as to facilitate their use. A further improvement would be to design the seat belt system so that the occupant would be required to take deliberate, overriding action when the belt is not used. A proposed system of this type which requires that seat belts be connected before the engine may be started is worthy of consideration.

It is further observed that responsible drivers now using lap and shoulder belts could be strongly offended by the imposition of any passive restraint systems which presents additional dangers or which would replace the current system without providing equal protection in all situations. It would be unfortunate to disenchant these drivers who are now most receptive to traffic safety by requiring them to give up the current system for a potentially less adequate one.

General Vehicle Design. There is increasing evidence that design improvements incorporated in vehicles manufactured since 1968 are resulting in significant reductions in injuries and the number of deaths in crashes. The research team has been particularly well impressed with the crash performance of windshields in late model automobiles. The team has conducted one investigation in which the proper performance of the energy absorbing steering column was credited with saving the life of the driver, and there have been other cases in which the level of injury has been reduced. Injury reductions due to improved design of the vehicle interior were noted in several other cases.

Further improvements are needed in interior vehicle design to better protect unrestrained occupants in head-on type impacts. More attention needs to be given to designing the lower edge of the instrument panel and the area beneath the instrument panel to decrease the number and level of injuries to lower limbs. Knee and ankle injuries caused by entanglement with brake pedal or accelerator would indicate the need of a redesign in these two basic features of the anterior compartment. Digit laceration with tendon and/or nerve injury has been an interesting and frequently observed injury. This is usually caused by a ring on the finger contacting a restricting point on the steering wheel. Altered design of the steering wheel could possibly reduce the injuries. Such injuries can be quite handicapping in a number of occupations.

During this research program, it has become evident that current automobiles subjected to center side impacts provide inadequate protection to the driver and passengers. This is generally true even in those instances where seat belts have been used. Excessive lateral compartment intrusion has been noted even in cases involving low to moderate impact speeds. It seems unlikely that restraint systems can be devised to adequately protect the individual on the impacted side in a lateral penetration collision. In this type of crash, critical and fatal injuries have been observed including: (1) skull fractures with irreparable brain damage; (2) closed thoracic injuries of rib fractures, lacerated lungs and pneumothorax and/or hemothorax. Fractured lower ribs often penetrate and cause injuries to spleen, kidney, intestines and major arteries and veins resulting in lengthy morbidity or death. It is therefore recommended that a high priority be assigned to the strengthening of side structures of automobiles to provide better protection to occupants in side impact crashes.

#### Environmental Countermeasures.

The need for remedial programs to improve the roadway environment is shown by the fact that environmental deficiencies were reported in 62 of the 100 cases investigated\*. Fifty-one (82 percent)

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\* Thirty-one of the 100 cases involved environmental factors which contributed to accident initiation, and twelve involved environmental factors which modified the consequences of the crash. At least one environmental deficiency was reported in 19 other cases.

of these cases occurred on expressways, arterials, or collector streets. This seems to indicate that these heavily-travelled and relatively high speed roadways have numerous characteristics which are hostile to the driving population, and that roadway improvements have not kept pace with traffic growth and increases in vehicle speeds. Yet, roadway safety improvements are being made, particularly on streets and highways in the Federal-aid system. During the past four years, over \$16 million dollars has been spent by the Federal Government and the Georgia State Highway Department for specific safety improvements of state Federal-aid roads. Significant safety improvements have been made to the expressway system in metropolitan Atlanta including installation of median barriers, clearance of roadside areas, and the installation of breakaway sign supports.

In contrast to Federal-aid roadways, it appears that few safety improvements are being made on local streets and highways. It has been observed that there are numerous safety hazards on local streets and highways resulting from easily identifiable design deficiencies. It is believed that the benefits to be gained from correcting these deficiencies would far exceed the costs of the improvements. A Federally-assisted Program for the Improvement of Local Roads for Safety ( with the acronym PILRS ) similar to the TOPICS program is recommended to correct these hazards.

Finally, it should be noted that the problem of unsafe roadways relates more to inadequate finance and insufficient concern on the part of public officials than to a lack of technology. The techniques of providing suitable roadway geometric design features have been well understood by street and highway designers for several decades. There has been a substantial amount of research and development work relating to highway safety design and operating practices and this work has been well documented (13). These design improvements include the provision of clear roadside areas and the utilization of breakaway sign supports, protective guardrail, energy absorbing barriers, and improved drainage structures.

A comprehensive and thorough program to improve all the safety features of the driving environment is obviously an extremely expensive undertaking, and cannot be quickly accomplished. Nevertheless,



it is apparent that continuing remedial programs with established priorities are needed to bring about a safer driving environment in spite of the limited amount of funding.

#### Medically Related Countermeasures.

During this study certain progress in injury severity reduction has been noted, not only in the packaging of the passenger but also in the transportation and care of the injured. Unfortunately, many of the same problems exist and the degree of progress in emergency care management is not satisfactory.

Ambulance Service. With matching funds through grant projects of the Department of Transportation and the Office of Highway Safety Coordinator, the number of ambulances in the Atlanta area have been significantly increased during the study period. Direct communication between the emergency rooms of Grady Hospital and the ambulance have provided more direct medical attention to the injured.

A major problem still exists in the routing of the injured. Custom prevails that the ambulance carry the injured to the hospital of choice if the injured so requests. Since certain of the hospitals do not have full time physicians nor the expertise in trauma management, delay of definitive care does exist. Further delay is caused by walk-in non-emergency patients at these clinics, and on occasions overloading of the emergency facilities with true emergencies causes undesirable delays. The lack of centralized overall management of emergency care units remains, and correction of this need does not seem likely in the immediate future.

This study, except for special assignments, has related to urban area collisions. Theoretically, emergency care is superior to that of non-urban collisions. Major problems exist in receiving prompt notification of the occurrence and location of crashes and the provision of immediate treatment of the injured. The following comments and recommendations relate to this problem:

1. Telemetry with two-way communication between ambulance and the medical staff at the hospital has proven its effectiveness in the Atlanta urban area, and an extension of its use is recommended.

2. During this study, the value of a knowledge of first aid or medical self-help training in reducing morbidity and perhaps

preventing mortality has been demonstrated.

3. The wearing of an identifying medical handicap bracelet or necklace could possibly have prevented at least one fatality in this study, and more extensive use of this aid is recommended.

4. Delays in obtaining medical help in certain instances in this study could have been avoided by some type of crash-actuated signalling device. Consideration should be given to the development and employment of such a device.

Medical Care of the Injured. With regard to the medical care of the injured, it appears that better training of physicians in total care of the injured is necessary. Certain hospitals are equipped and staffed to care for the critically as well as the not so critically injured. The design and function of other hospitals is not such that duplication of all services should be available. Proper routing of emergency injuries would correct this particular problem.

Delay in obtaining physician services did not appear to be a dilemma in this urban survey. This is not true in rural areas. Trained mobile surgical trauma teams including paramedical staff and equipment to provide better medical service in rural areas could reduce morbidity and mortality. Rapid transportation of the injured is essential, requiring both air and surface vehicles.

## LIST OF REFERENCES

1. "A Study of Severe Vehicular Accidents, Phase 1: Medico-Engineering Training Program", School of Civil Engineering, Georgia Institute of Technology, June, 1968.
2. "A Study of Severe Vehicular Accidents, Phase 2", School of Civil Engineering, Georgia Institute of Technology, February, 1969.
3. "A Study of Severe Vehicular Accidents, Phase 3", School of Civil Engineering, Georgia Institute of Technology, June, 1969.
4. "Multidisciplinary Accident Investigations, Phase 4", School of Civil Engineering, Georgia Institute of Technology, August, 1970.
5. Siegel, Arnold W., "The Vehicle Deformation Index: A Report of the International Ad Hoc Committee for Collision Deformation and Trauma Indices", Trauma Research Group, University of California at Los Angeles.
6. "Program Matrix for Highway Safety Research", Report No. HS-820 094, U. S. Department of Transportation, National Highway Traffic Safety Administration, December, 1970.
7. Nobles, Charles S., "Seat Belt Survey", unpublished report, Georgia Institute of Technology, June, 1971.
8. "1968 Alcohol and Highway Safety Report", submitted to Committee on Public Works by U. S. Department of Transportation, August, 1968.
9. Tarrants, William E., "Myths and Misconceptions in Traffic Safety", Highway Research News No. 31, Spring, 1968.

10. Klein, David and Waller, Julian A., Causation, Culpability and Deterrence in Highway Crashes, prepared for U. S. Department of Transportation, July, 1970.
11. Code of Virginia, Chapter 5, Title 46.1, Article No. 7.
12. General Motors Corporation, News Release, "Facts About General Motors' Phystester<sup>(TM)</sup> Ignition Interlock System", March, 1971.
13. Handbook of Highway Safety Design and Operating Practices, U. S. Department of Transportation, Federal Highway Administration, May, 1968, with Supplement No. 1, November, 1968.

## APPENDIX



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 71

Identification. This accident involved a stolen vehicle which was being driven by a 13-year-old male. The vehicle left the road at a sharp curve and struck a utility pole. The accident occurred on East Rock Springs Road in north Atlanta, Georgia, at about 11:50 A.M. on a Wednesday in April, 1970. Maximum occupant injury severity: minor (01).

Ambience. The weather was warm and clear and the roadway surface was dry.

Roadway. East Rock Springs Road is a two-lane, two-way urban residential collector street. The vehicle went out of control in a sharp curve ( $D=26^\circ$ ) and near the crest of a vertical curve. There is an adverse crown of 4.0 percent. Numerous utility poles are located along the roadway about one foot beyond the edge of the curb. The roadway has a poor accident history.

Traffic Controls. The street is marked with a center line stripe and is zoned for a 35 MPH speed limit. On the approach to the curve, there is a bent arrow warning sign along with a 20 MPH advisory speed sign.

Vehicle. A 1970 6-cylinder Dodge Dart two-door sedan, white with black vinyl top; no mechanical defects. Right center side of vehicle struck utility pole causing maximum penetration of 14 inches. Deformation index is 02-RZEN-4. Vehicle is a total loss, cost of replacement, \$2,900.

Driver. A 13-year-old male who had been charged with five offenses including two counts of larceny and one of burglary; a diabetic since the age of six; former patient in a state hospital, where he was characterized as "adjustment reaction to childhood"; described as "uncontrollable" by juvenile authorities. Not restrained. Not significantly injured.

Right Front Passenger. A 17-year-old female; ninth grade drop-out; user of drugs; described as "uncontrollable" by her mother. Not significantly injured. Use of seat belts unknown.

Left Rear Passenger. A 14-year-old male; height approximately 4'11"; weight about 85 pounds. Not restrained. Received minor laceration, contusion, and abrasion of lip; moderate contusion anterior chest wall; large laceration right arm. Injury severity index: minor (01).

Right Rear Passenger. A 12-year-old female; height 5'1"; weight about 90 pounds. Not restrained. Received multiple contusions and complained of neck pain. Injury severity index: minor (01).

Pre-Crash Events. About five minutes before initiation of Accident 71, the case vehicle was involved in minor collision with another vehicle two miles northwest of second accident scene. The driver and occupants of the case vehicle were fleeing the scene of first accident when second crash occurred. Vehicle was entering curve at a speed of 50-60 MPH when it went out of control. No braking skid marks were found.



At-Crash Events. The vehicle impacted the utility pole at a speed of 40-50 MPH, and subsequently rotated 120 degrees clockwise, coming to rest about 20 feet east of the pole.

Post-Crash Events. The driver of the vehicle fled the scene of the crash and was later apprehended by the police. The 17-year-old passenger drove the vehicle into a nearby driveway and comforted the injured until the ambulance arrived. The police removed two pistols from the vehicle, but no evidence of drugs was found.

Causal Factors, Comments, Recommendations.

Matrix

- |  |      |
|--|------|
| 1. Joint principal contributing factors: poorly designed roadway and excessive speed.  | 7, 1 |
| 2. Predisposing psychological factors were noted in this investigation. The driver demonstrated a lack of prudent judgment as well as a general absence of regard for the welfare of self or others. | 1    |
| 3. This crash illustrates the hazard of the joint presence of sharp horizontal and vertical curves. The hazard was compounded by the placement of poles along the outside edge of the curb.          | 7    |



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 72

Identification. This accident involved a dump truck hauling hot asphalt paving mix (vehicle 1) which struck and subsequently overturned on a 1970 Chevrolet four-door sedan (vehicle 2). The accident occurred at the intersection of an expressway off-ramp and a two-lane, two-way arterial street in Fulton County, Georgia, at 10:40 A.M. on a Monday in May, 1970. Maximum occupant injury severity: dangerous, serious (04).

Ambience. The weather was partly cloudy and the ambient air temperature was 77 degrees. The pavement surface was dry.

Roadway. The accident occurred at the intersection of the westbound exit ramp of Route I-285 and North Peachtree Road. The ramp is straight and intersects North Peachtree Road at an angle of 71 degrees. The one-way ramp has two lanes and a grade of minus 4.0 percent about 125 feet from the intersection. The ramp grade is negligible in the vicinity of the intersection.

Traffic Controls. The intersection is regulated by four-way stop signs and a four-way red flashing signal. There is a 35 MPH advisory speed limit sign near the entrance to the ramp.

Vehicle 1. A 1968 Dodge C700 dump truck; 5 yard capacity; rated gross weight 25,500 pounds. Vehicle deformation index for first crash is 12-FLMW-1. Deformation index for the overturning is 12-TPGW-3. Cost of repair: \$606.

Vehicle 2. A 1970 Chevrolet Impala four-door sedan. Vehicle deformation index for first crash is 12-RFEW-3 and for the overturning crash, 00-TDGW-7. Cost of replacement: \$3,500.

Driver, Vehicle 1. A 50-year-old male with 34 years' driving experience, not restrained. Received bruise of left shoulder and left hip from contact with left upper roof and left door. Injury severity index: minor (01).

Driver, Vehicle 2. A 46-year-old female with 30 years' driving experience; new resident in city. Not restrained. Received internal derangement of left knee as she moved laterally to right; moderate facial laceration from fractured windshield; extensive burn wounds on both arms and legs caused by hot asphalt paving mix which came through the right front window. Injury severity index: dangerous, serious (04).

Pre-Crash Events. The dump truck was being used to haul a load of hot asphalt paving mix (300-350° F.) to a construction site. It had a gross weight of 32,600 pounds, being loaded nearly 50 percent in excess of the rated capacity. The truck exited the expressway at a speed of 50-55 MPH and proceeded downgrade to the intersection. The driver of the truck applied brakes, but was unable to stop.

At-Crash Events. The truck proceeded into the intersection and struck vehicle 2, which was making a left turn. The truck shoved the automobile about 55 feet and overturned, its contents spilling onto and into the car.

Post-Crash Events. The ambulance, stationed only about a mile from the accident location, arrived approximately 5-7 minutes following the crash. At the hospital, difficulty was experienced removing the asphaltic substance from the wounds.

<u>Causal Factors, Comments, Recommendations.</u>	<u>Matrix</u>
1. Joint principal contributing factors: overloaded vehicle and excessive speed.	4, 1
2. Modifying factor: deficient brakes were judged to have worsened the consequences of this crash.	4
3. It is unlikely that the driver of vehicle 2 would have been injured had she been wearing lap and shoulder belts.	1
4. This accident demonstrates the hazard that is associated with the hauling of hot paving mix in open dump trucks. Consideration should be given to requiring that trucks hauling hot materials such as this display signs indicating "HAZARDOUS MATERIAL". Since the haul distances for these trucks are typically short, this is a matter which addresses itself to the various states.	4
5. Despite the fact that the dump truck involved in this crash was carrying a load nearly 50 percent in excess of its rated capacity, it evidently was not in violation of state law. Title 68, Section 68-405, of the Georgia Code permits a maximum wheel load of 10,170 pounds and a maximum axle load of 20,340 pounds. This law is primarily intended to prevent overload and damage to pavement systems rather than to promote highway safety. Interestingly, according to the law, the State Highway Department shares the responsibility of enforcing the law with the Department of Public Safety, and as a matter of practice, enforcement is left principally to the State Highway Department. Consideration should be given to amending Title 68, Georgia Code, so as to require that trucks display appropriate markings indicating gross allowable weight based on maximum rated capacity as recommended by the vehicle manufacturer. It would appear that the Department of Public Safety should be given the responsibility for enforcing a provision prohibiting vehicles to transport loads so as to exceed the vehicle's gross allowable weight.	4



Identification. This accident involved a 1970 Plymouth Road Runner which was being driven by a 20-year-old male. The vehicle went out of control and left the roadway due to failure of the right lower ball joint. The accident occurred on Butner Road in southwest Fulton County, Georgia, at about 6:15 P.M. on a Thursday in May, 1970. There was no occupant injury.

Ambience. The weather was warm and clear with ambient air temperature 87°. Wind was from the south at 5 MPH and the road surface was dry.

Roadway. Butner Road is a two-lane, two-way rural residential collector street. The vehicle went out of control near the crest of a vertical curve with a  $5\frac{1}{2}$  percent change of grade. The roadway is paved with asphaltic concrete and has unpaved shoulders on both sides. The roadway surface was in good condition.

Traffic Controls. The street is marked with double yellow stripes in the center and is zoned for a speed limit of 45 MPH.

Vehicle. A 1970 Plymouth Road Runner, curb weight 3,900 pounds, damaged on right front fender, right rear fender, and rear bumper. Vehicle deformation indices, respectively, 01-FRMN-1, 04-RBMW-1 and 06-BIMN-1. Minor damage to exterior, front seat backs slightly distorted rearward. Estimated cost of repair is \$850.00. Right lower ball joint evidently failed prior to impact. Otherwise mechanically sound. There was no evidence that the vehicle had been involved in a prior accident.

Driver. A 20-year-old male; four years of driving experience; familiar with both vehicle and route; not restrained; not injured.

Right Front Passenger. A 20-year-old male. Wearing lap belt. Not injured.

Pre-Crash Events. The driver and the passenger in the case vehicle were on their way to a college travelling eastward at 60-70 MPH. The driver saw a farm tractor in front of him stopping for a left turn, and applied the brakes. He found the wheels to be locked and so released the brakes. The vehicle then went out of control and started rotating counterclockwise.

At-Crash Events. The vehicle crossed and left the roadway and struck an earth bank and a small tree at an estimated speed of 10-20 MPH. The damage to the vehicle was very minor and neither of the occupants was injured.

Post-Crash Events. The vehicle was towed to a dealer for repairs by a wrecker.

Causal Factors, Comments, Recommendations.

Matrix

- |  |   |
|--|---|
| 1. Principal contributing factor: failure of right lower ball joint. | 4 |
| 2. Modifying factor: excessive speed.                                | 1 |



Causal Factors, Comments, Recommendations. (cont'd.)

Matrix

3. The ball joint evidently failed suddenly after the driver locked his brakes. With a distance from the braking point to the danger point (the farm tractor) of 320 feet, panic braking was not warranted.

1

4. Considering the minor rear end damage to this vehicle, there was an unacceptably large amount of rearward yielding of the right front seat back. Interestingly, the damaged and weakened seat backs were not repaired.

5

5. The possibility of catastrophic failure of a vehicle's ball joint must be regarded with serious concern. The conclusion of the metallurgist (which was inconsistent with other available facts) that the fracture likely was initiated in a previous heavy impact does not lessen the seriousness of the problem. If such a fracture can be initiated in a vehicle without causing perceptible damage, how is its driver (or another driver or a new owner) to become aware of the hazard?

4

The Georgia Tech research team knows of two other cases involving Chrysler Corporation automobiles in which a similar failure of the ball joint was noted. The Boston University Multidisciplinary Research Team has reported one such case (B.U. Case No. 70-20) involving a 1967 New Yorker, and another failure was reported to the team by an insurance agent. The latter case involved a 1969 Plymouth. At least one other similar failed Chrysler Corporation ball joint has been observed by the team's automotive specialist, but details on this case are not available.

Further study to determine the scope and seriousness of this problem appears to be warranted and such study is recommended.



# GEORGIA INSTITUTE OF TECHNOLOGY

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Vehicular Collision Research Team

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SUMMARY AND COMMENTS

REPORT NO. 74

Identification. This accident involved an International Metro van truck (vehicle 1) which ran a red light and collided with an Oldsmobile Cutlass (vehicle 2). The accident occurred at the intersection of West Peachtree Street and Third Street near downtown Atlanta, Georgia, at approximately 3:35 P.M. on a Wednesday in June, 1970. Maximum occupant injury severity: minor (01).

Ambience. The weather was warm with partly cloudy skies and an ambient air temperature 87°. The wind was from the southwest at 4 MPH and the roadway surface was dry.

Roadway. At the accident site, West Peachtree Street, a heavily travelled arterial, is a six-lane, two-way undivided highway, while Third Street, a local commercial street, is a two-lane, one-way roadway. Both streets are paved with asphaltic concrete and are of curb and gutter design. Third Street has a plus 6.5 percent eastbound while the grade on West Peachtree Street is negligible.

Traffic Controls. Both streets are marked with broken white stripes and crosswalk markings are provided on all four approaches. West Peachtree Street is zoned for a speed limit of 30 MPH, while Third Street has no posted speed limit. The intersection is controlled by a semi-actuated traffic signal.

Vehicle 1. A 1964 International Metro van truck (G.V.W. 4,000 pounds); no mechanical defects. Equipped with sliding side doors, both of which were open at the time of the crash. Not equipped with seat belts. Vehicle was a total loss with deformation index of 03-RFAO-5. Cost of replacement: \$850.

Vehicle 2. A 1970 Oldsmobile Cutlass two-door hardtop; no mechanical defects. Vehicle deformation index is 12-FYEW-3. Cost of repairs: \$1,000.

Driver, Vehicle 1. A 20-year-old male; working as a summer employee while a full-time student during rest of year. Not restrained. Ejected from vehicle and pinned under it, but only received contusions on the back and scratches on left ankle, leg and hip. Injury severity index: minor (01).

Driver, Vehicle 2. A 48-year-old male; Southeastern Regional Manager for a drug manufacturing company. Was on his way making routine daily calls. Wearing lap belts. Not significantly injured.

Pre-Crash Events. The truck was transporting a load of laundry to a laundry station. The driver of the truck was occupied with changing of lanes and entered the intersection on a red light at about 30 MPH. The driver of the Oldsmobile was most likely anticipating for the green light on his approach and proceeded into the intersection at approximately 20 MPH.



At-Crash Events. The truck and the Oldsmobile collided with no evidence that either vehicle had attempted to brake. The truck rotated clockwise and overturned, while the driver was ejected and pinned under the overturned vehicle.

Post-Crash Events. People from a nearby garage freed the driver of the truck from under the overturned vehicle by lifting up the truck with portable hydraulic jacks. He was then taken to Grady Memorial Hospital and was released after treatment.

<u>Causal Factors, Comments, Recommendations.</u>	<u>Matrix</u>
1. Joint principal contributing factors: violation of red traffic signal after changing lanes (driver, vehicle 1) and anticipation of green signal (driver, vehicle 2).	1, 1
2. There is hazard associated with the operation of van trucks with the doors open. State laws should require that the doors of a vehicle be closed while the vehicle is in motion.	2
3. Drivers who execute lane changes in the vicinity of an intersection are faced with a more complex driving task which results in an increased perception-reaction time. It follows that such maneuvers increase the potential of accident occurrence. The hazard of making such maneuvers should be emphasized in driver education courses (matrix 1B).	1B
4. Drivers frequently anticipate a green signal and proceed into an intersection at the approach speed. This practice has the effect of negating the amber phase on the opposing two approaches. The hazard of anticipating green lights should be emphasized in driver education courses.	1B
5. The use of lap belts by the driver of vehicle 2 probably accounts for the fact that he was not significantly injured.	2



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

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SUMMARY AND COMMENTS

REPORT NO. 75

Identification. This accident involved a 1968 Oldsmobile Cutlass two-door hardtop (vehicle 1) which after making light contact with a 1967 Rambler four-door sedan (vehicle 2) mounted a raised earth expressway median, struck a guardrail, and overturned. The accident occurred on Atlanta's North Expressway just north of 10th Street at 8:50 A.M. on a Monday in July, 1970. Maximum occupant injury severity: minor (01).

Ambience. The weather was clear, the road surface was dry and the air temperature was 78 degrees.

Roadway. At the location of the accident, the North Expressway has three 12-foot traffic lanes separated by a raised earth median. A two-foot high guard rail is in the center of the median. The alignment is straight and the grade is negligible. The roadway is paved with portland cement concrete and has mountable curbs.

Traffic Controls. The expressway is zoned for a speed of 50 MPH. Lane markings and raised pavement delineators are provided.

Vehicle 1. A 1968 Oldsmobile Cutlass two-door hardtop. Principal damage was to the left front corner of the roof. Vehicle deformation index: 03-TDGW-3. Broken windshield and left door glass. Scratches and minor sheet metal damage to the left front fender, right front fender and door. Cost of damages: \$2,500. Vehicle in good mechanical condition.

Vehicle 2. A 1967 Rambler four-door sedan. Minor damage to left rear door. Vehicular deformation index: 08-LPMW-1. Cost of repairs: \$76.

Vehicle 3. A 1969 Chevelle, which was not damaged.

Vehicle 4. An unidentified (phantom) vehicle, which was not damaged.

Driver, Vehicle 1. A 19-year-old female college student; declined to cooperate with investigators. Complained of headaches and a sore back. Received various minor lacerations from shattered window and/or windshield. Injury severity index: minor (01).

Driver, Vehicle 2. A 32-year-old unmarried male. He was not injured.

Driver, Vehicle 3. A 55-year-old night watchman, who admitted he was sleepy at the time the accident was initiated. He was not injured.

Pre-Crash Events. Crash was initiated as three and possibly four drivers attempted near-simultaneous lane changes. A traffic back-up is the most likely explanation for these lane changes. Driver of vehicle 3 changed from lane 1 to lane 2, blaming a phantom driver ahead of him for the need to change lanes. Driver of vehicle 2 was in lane 2, was forced to change to lane 3. Driver of vehicle 1 was attempting to change from lane 3 to lane 2.

At-Crash Events. Vehicles 1 and 2 made slight contact. Driver of vehicle 1 swerved to the left onto the raised median after moving into lane 2. Vehicle 1 struck the guard rail and overturned.

Post-Crash Events. Vehicle 1 was removed to an impound lot and its driver was taken to Grady Memorial Hospital for examination and subsequent release.

Causal Factors, Comments, and Recommendations.

Matrix

- |  |      |
|--|------|
| 1. Joint principal contributing factors (1st crash):<br>near-simultaneous lane changes by at least three drivers,<br>probably triggered by a traffic back-up.  | 1, 7 |
| 2. Modifying factors (cause of overturning crash): over<br>reaction of driver of vehicle 1 and poor median design.   | 1, 7 |
| 3. Possible contributing factor to first crash: driver<br>of vehicle 3 was sleepy.   | 1    |
| 4. It has been previously observed that vehicles which<br>mount a raised earth median barrier and strike the guard rail<br>frequently overturn (see accident no. 66). The hazard of this<br>design has been pointed out to the Georgia Highway Department,<br>and improvements in median barrier design have recently been<br>made on Atlanta's Northeast Expressway where the hazardous<br>design had previously been employed. | 7    |
| 5. It is noted that the glove compartment door of vehi-<br>cle 1 did not remain closed during the overturning crash<br>(reference: Federal Motor Vehicle Safety Standard No. 201).   | 5    |



Identification. This accident involved a 1970 Chevrolet Nova (vehicle 1) which, in an attempt to avoid a collision with a left turning Mercedes Benz (vehicle 2), left the roadway and struck a utility pole. The accident occurred at the intersection of Spring Street and Fifth Street near downtown Atlanta, Georgia, at about 2:45 P.M. on a Tuesday in July, 1970. Maximum occupant injury severity: minor (01).

Ambience. The weather was cloudy with showers and the ambient air temperature was 75°. Wind was from the southeast at 6 MPH. It was raining at the time of the accident and the roadway surface was wet.

Roadway. Spring Street, a major arterial, is a four-lane two-way roadway with no parking on either side. Fifth Street is also a four-lane two-way roadway, but with parking on both sides. The streets intersect at right angles and are of curb and gutter design. Both streets have straight alignments. Spring Street has a negative 3 percent grade from the intersection in both directions of travel.

Traffic Controls. Both streets are marked with white stripes and crosswalk markings are provided on all four approaches. A speed limit of 30 MPH is posted on both streets. The intersection is controlled by a fixed-time traffic signal.

Vehicle 1. A 1970 Chevy Nova 2-door sedan weighing 3,000 pounds, was struck on the center front end. Crash deformation index is 01-FCEN-3. Interior damages - light switch knob broken. After market radio, under-dash mounted, could cause serious damages to occupants.

Driver, Vehicle 1. A 31-year-old male; an employee of UPI and was on the way to work; familiar with both the route and the vehicle. He had two previous accidents and three previous traffic violations. Not restrained. Received minor contusions on left forehead as he moved forward and impacted the windshield; also received lacerations on the right knuckle; impact on the underdash and hang-on radio resulted in lacerations and contusions on the right knee and contusions to the left knee.

Driver, Vehicle 2. A 32-year-old male; no injury as there was no actual contact between the two vehicles. He has a Venezuela license, and not a Georgia one, but had four previous traffic violations. He was arrested and charged for failing to yield right-of-way and causing the accident. He pleaded not guilty, but was fined \$40.00.

Pre-Crash Events. Vehicle 1 was travelling southerly on Spring Street in the curb lane (lane 1) at about 30 MPH while vehicle 2 was making a left turn from Spring Street to Fifth Street. Southbound vehicles in the center lane (lane 2) had already yielded the right-of-way to vehicle 2. However, the driver of vehicle 1 did not notice vehicle 2 until vehicle 2 was partially in the curb lane and it was too late to stop to avoid the collision.



At-Crash Events. Vehicle 1, in an attempt to avoid collision with vehicle 2, veered to the right and struck a utility pole at an estimated speed of 20-30 MPH.

Post-Crash Events. The driver of vehicle 1 was given emergency care at a nearby garage before the arrival of the ambulance. He was then taken to a hospital where he was treated and released.

The driver of vehicle 2 returned to the accident scene and admitted that he caused the accident. He was then arrested and charged.

Causal Factors, Comments, Recommendations.

Matrix

- |   |      |
|---|------|
| 1. Joint principal contributing factors: failure to yield right-of-way (driver, vehicle 2) and restricted visibility due to the roadway profile and the presence of stopped left turning vehicles.  | 1, 7 |
| 2. Modifying factor: a slippery pavement due to rain was judged to have worsened the consequences of this crash.  | 7    |
| 3. The driver of vehicle 1 swerved to the right and applied his brakes and skidded out of control into the utility pole. It is likely that he could have regained control of his vehicle had he not locked his brakes. It should be emphasized in driver education courses that locking brakes results in virtual loss of steering control. | 1    |
| 4. This accident suggests that it is desirable to provide a braking system that will not lock under panic conditions. See comment 3.  | 4    |
| 5. Members of the Atlanta Research Team have observed in this case and others that the central plastic layer of the windshield on compact cars tends to be punctured in low to moderate impacts. Further research is recommended to determine if a different windshield design is required for compact and subcompact cars.                 | 5    |
| 6. This accident again demonstrates the hazard of placing utility poles adjacent to the edge of heavily travelled traffic lanes.  | 7    |
| 7. Radios and other add-on accessories should be designed so as to minimize injuries from occupant contact.   | 5    |
| 8. The use of lap and shoulder belts would probably have prevented the injuries to the driver of vehicle 1.   | 1    |



Identification. This accident occurred in the temporary storage area of an automobile dealer, located at Peachtree Road in northeast Fulton County, Georgia, at about 11:00 A.M. on a Tuesday in August, 1970. It involved a 1970 Oldsmobile Delta 88 Custom which, in backing out from the service department of the automobile dealer, struck two pedestrians and damaged three other vehicles. Maximum occupant injury severity: non-dangerous, severe (03).

Ambience. The weather was warm and partly cloudy. Wind was from southwest at 7 MPH. The roadway surface was dry.

Roadway. The storage area is irregular in shape and is about 60 feet by 90 feet in size. The service department is on the north side of the storage area with a negative  $3\frac{1}{2}$  percent grade coming out from the service department. The storage area is paved with asphaltic concrete and is in good condition. There is no sight distance restriction problem and no previous accident record is noted.

Traffic Controls. There is no traffic control in the storage area as it is on private property.

Vehicle 1, a 1970 Oldsmobile 88 Delta Custom, was damaged on the rear bumper, both rear fenders, right rear door and right front fender. Vehicle deformation index is 06-BDMW-2. Estimated cost of repair is \$1,200.

Vehicle 2. Damage to this vehicle was to the right quarter panel, and door sill. Impact with a parked vehicle caused damage to the left rear fender and left rear suspension. The vehicle deformation index of the first impact is 02-RPAW-5, and the second impact is 06-BLEW-3. This vehicle is a total loss, cost of replacement is approximately \$1,900. Vehicle 2 was a 1969 Volkswagen.

Vehicles 3 and 4. The damages to these vehicles were minor and confined to the rear bumpers and trunk lid. The deformation index of vehicle 3 is 06-BBLW-1, and vehicle 4 is 06-BDEW-1.

Driver, Vehicle 1. A 46-year-old female with no previous traffic violation record. She was evidently drunk at the time of the accident, with a blood alcohol content of 0.21. It is suspected that she may either have a nervous disorder or be an alcoholic. She was charged with driving under the influence of alcohol on private property. She pleaded guilty and was fined \$150 and received a suspended sentence of nine months in jail. Not restrained; not injured.

Pedestrian 1. A 23-year-old female, just moved to Atlanta with husband and 3-year-old son (pedestrian 2). She and her son were pinned between the Oldsmobile and their own car - a Volkswagen. She received severe fractures and dislocations of both ankles, with lacerations on both legs. She stayed in the hospital for a period of about 50 days. Injury severity index: non-dangerous, severe (03).



Pedestrian 2. A 3-year-old male who received lacerations on both legs and both femurs were broken. He remained in the hospital for about 40 days. Injury severity index: non-dangerous, severe (03).

Pre-Crash Events. The two pedestrians who were subsequently injured - the woman and her son - were standing by their parked vehicle talking with her husband and a friend of theirs who works at the automobile dealer. In the meantime, the driver of the Oldsmobile drove into the service department requesting for service on her vehicle. However, the service department manager told her that the service department was occupied for the day and gave her an appointment for the next morning. She then backed out of the service department at a high rate of acceleration.

At-Crash Events. The two men saw the oncoming vehicle and jumped out of the way, but the mother and the boy were pinned between the Oldsmobile and the Volkswagen and were seriously injured. The two vehicles mounted a curb and damaged two other parked vehicles before coming to rest. Estimated speed of impact was 20-30 MPH.

Post-Crash Events. The two injured pedestrians were given first aid at the accident site before taken to Piedmont Hospital for emergency treatment. The driver of the Oldsmobile was taken to Grady Memorial Hospital for a blood alcohol content test and was later arrested under the charge of driving under the influence of alcohol.

Causal Factors, Comments, Recommendations.

Matrix

1. Principal contributing factor: alcohol.

1

2. In view of the severity of the offense in this case, the sentence imposed by the traffic court judge was remarkably light. The driver of vehicle 1, a middle to upper income caucasian female who was represented by an attorney, pleaded guilty to driving under the influence. Because of her traffic violation, two persons received severe injuries and narrowly escaped death. The driver received a sentence of nine months in jail (suspended) and a \$150.00 fine. During the same session of traffic court, an apparently low-income, black male who was not represented by an attorney, was charged with driving under the influence. He had been involved in a crash which did not cause any personal injuries. He was sentenced to twelve months in jail (not suspended) and his driver's license was permanently revoked. The Atlanta research team believes it would be useful to make a study of traffic courts to determine if sentences imposed are related to education, economic status, race, age, and sex of the offender, and the availability of counsel.

1

This comment may relate to Highway Safety Program Standard 7.



Identification. This accident involved a 1969 Chevrolet C-30 2½-ton truck which evidently struck and fatally injured a pedestrian. The accident occurred on Robinson Avenue, near Booker Street, in Scottdale, DeKalb County, Georgia, at about 8:50 P.M. on a Friday in October, 1970. Maximum occupant injury severity: fatal (06).

Ambience. The weather was clear and fair with an ambient air temperature of 59 degrees. Wind was from northwest at 8 MPH. The roadway surface was dry.

Roadway. Robinson Avenue is a two-lane, two-way 25-foot wide local residential street. Not illuminated; curb and gutter design; no sidewalks. At the location of the accident Robinson Avenue has a straight alignment with a plus four percent grade going eastbound.

Booker Street, also a local residential street, is a 20-foot wide gravel road intersecting Robinson Avenue at a right angle near the location of the accident.

Traffic Controls. No posted speed limits or any other traffic controls; lanes unmarked. Parking is allowed on both sides of the street.

Vehicle. A 1969 Chevrolet C-30 2½-ton truck in good mechanical condition except that its headlights were improperly aligned too low and slightly too far to the right. The brakes were in good condition and there was no evidence of brake malfunction. No damage to the vehicle was noted.

Driver. A 6'1", 190-pound, 58-year-old Negro male; truck driver for several years; described by his supervisor and fellow employees as honest, reliable and responsible. Over 40 years of driving experience; one previous traffic violation; familiar with vehicle and route. Apparently under the influence of alcohol at time of accident; unable to blow into bag for alcolyzer test. Not restrained, not injured.

Pedestrian. A 6'1", 200-pound, 27-year-old Negro male construction worker who had become a problem drinker after being hospitalized for tuberculosis about ten years ago. Blood alcohol level of 0.25% at time of accident. Received cervical vertebrae fracture and subluxation, with high cervical spinal cord contusion and compression; also multiple lacerations and brush burns on face and both legs. Injury severity index: fatal (06).

Pre-Crash Events. The driver was returning to his home after completing a work trip to southern Georgia. The pedestrian reportedly had been involved in a fight with two other males earlier in the evening. It is probable that he was either crawling or lying prone in the roadway when the truck approached at a speed of about 20 MPH.

At-Crash Events. The victim's body evidently became wedged under the truck's left rear wheels causing these wheels to skid approximately 40 feet as the other wheels rolled free.

Post-Crash Events. The driver of the vehicle is believed to have backed the truck up about 20 feet and summoned the police.

Causal Factors, Comments, Recommendations.

Matrix

- |   |         |
|---|---------|
| 1. Joint principal contributing factors: alcohol (driver), alcohol (pedestrian), improperly aimed headlights, and street not illuminated.   | 1,1,4,7 |
| 2. The vertical alignment of the headlights did not conform to the requirements of the State Motor Vehicle Inspection law. Although the horizontal alignment of the left beam conformed with state requirements, this accident suggests that the standards allow a vehicle's left beam to be oriented too far to the right side of the roadway. | 4       |
| 3. The victim was clothed in dark apparel.  | 1       |





# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 79

Identification. This accident involved a 1960 Volkswagen sedan (vehicle 1) which went out of control and struck a 1970 Oldsmobile Ninety-eight four-door sedan (vehicle 2). The vehicles finally came to rest after slightly damaging two other parked vehicles (vehicles 3 and 4). The accident occurred on Fifteenth Street near downtown Atlanta, Georgia, at approximately 1:10 P.M. on a Wednesday in October, 1970. Maximum occupant injury severity: minor (01).

Ambience. The weather was cloudy and foggy, with light drizzle. The ambient air temperature was 58°, with wind from the east at 11 MPH. The road surface was wet and slippery.

Roadway. At the location of the accident, Fifteenth Street, a lightly travelled local commercial collector, is a two-lane, two-way, 32-foot wide roadway. The street is illuminated and is of curb and gutter design. Vehicle 1 went out of control at a fairly sharp curve ( $D=18^\circ$ ) for which there is no superelevation, but instead an adverse crown of  $8\frac{1}{2}$  percent. There is also a negative four percent grade going westbound.

Traffic Controls. There is no posted speed limit nor lane markings on the roadway. Parking is allowed on both sides of the roadway.

Vehicle 1. A 1960 green Volkswagen two-door sedan, curb weight 1,600 pounds, no power, no restraints, condition good, principal area of damage, center front and left front. Vehicle deformation index is 12-FYEW-3. This vehicle was equipped with an after-market steering wheel that was of a smaller diameter than the original equipment wheel. This difference in size would significantly change the steering characteristics of this vehicle. The three spokes of this wheel were manufactured in such a manner that the edges were rough and sharp and should be considered a possible injury producing agent. Vehicle total loss, cost of replacement \$350.00.

Vehicle 2. 1970 Oldsmobile 98, four-door sedan, full power equipment, front disc brakes, curb weight 4,400 pounds. Damage left front, maximum crush 13 inches. Vehicle deformation index 11-FYMW-3. Cost of repair, \$1,500.00.

Driver, Vehicle 1. A 19-year-old male, employed as a sales clerk at a local paint company. One year's driving experience, three previous traffic violations. Familiar with route, but not with vehicle as he only obtained the vehicle from his brother one week before the accident; he formerly drove a Ford Mustang Mach 1. No restraint system equipped on vehicle; his head impacted the windshield, resulting in minor bruises; also received a deep laceration on his left chin and abrasions and contusions on both knees. Injury severity index: minor (01).

Driver, Vehicle 2. A 53-year-old male; self-employed. Thirty-seven years of driving experience; a long history of previous traffic violations; familiar with both route and vehicle. Not restrained; received contusion on his left elbow; also complained of neck soreness. Injury severity index: minor (01).

Passengers, Vehicle 2. Three passengers; all restrained. Right front seat passenger, a 52-year-old male, received minor abrasions on left knee; no treatment required. Injury severity index: minor (01).

The two rear seat passengers were not injured.

Pre-Crash Events. The driver of the Volkswagen (vehicle 1) was on his way back to work after having lunch with his friend. He was travelling westerly on Fifteenth Street at an estimated speed of 25-35 MPH along the central portion of the roadway. He saw the Oldsmobile (vehicle 2) coming in the opposite direction and realized that he had to slow down and move back to the right side of the roadway, in order to avoid colliding with the oncoming vehicle 2. He applied the brakes sharply, causing the wheels to be locked; then tried to steer to the right, but in vain due to locked wheels. Vehicle 1 then skidded and lost control.

Meanwhile, the driver of vehicle 2, who was going to a local supermarket for business purposes, was travelling easterly on Fifteenth Street at an estimated speed of 10-15 MPH. He saw the oncoming vehicle 1 and applied the brakes. Vehicle 2 was practically stopped when impacted by vehicle 1, due to its low initial speed.

At-Crash Events. Vehicle 1 impacted the left front end of vehicle 2 head-on at estimated speeds of 15-25 MPH and 2-10 MPH, respectively. Due to the large difference in weight between the two vehicles, vehicle 1 rebounded back upon impact and struck the left side of a parked Ford Thunderbird (vehicle 4) with its right rear fender. Vehicle 2, on the other hand, swayed to the right and struck the right rear fender of a parked 1965 Dodge Polara (vehicle 3).

Post-Crash Events. The driver of vehicle 1 was slightly injured, but he refused to go to Grady Memorial Hospital for emergency treatment. He later went to Crawford Long Hospital, where he was treated and released. He was charged with failing to have his vehicle under control and causing an accident. Due to a technicality, his case in traffic court was dismissed.

Causal Factors, Comments, Recommendations.

Matrix

- |   |       |
|---|-------|
| 1. Joint principal contributing factors: poor roadway design (road narrowed), improper traffic control (parking should be prohibited), and unfamiliarity with vehicle.  | 7,7,1 |
| 2. Modifying factor: wet roadway.   | 7     |
| 3. As one approaches the accident location from the east, the road suddenly narrows from 44 foot width to 32 foot width. Since parking is permitted on both sides along the wide and narrow sections, the effective roadway width is 32 feet and 18 feet, respectively. Parking should be prohibited along the westbound side of the roadway. | 7     |
| 4. The roadway had excessive crown.   | 7     |

<u>Causal Factors, Comments, Recommendations. (Cont'd.)</u>	<u>Matrix</u>
5. No center line marking was provided for the narrow section of the roadway.	7
6. After-market steering wheels should be of the same diameter as the original equipment steering wheel.	4
7. Manufacturers of after-market steering wheels should be required to comply with safety standards comparable to those applying to original equipment.	4





# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 80

Identification. This accident involved a 1970 American Motors Rebel SST which had defective brakes on the left rear wheel causing the vehicle to lose control. The vehicle left the roadway and struck a utility pole. The accident occurred on Fourteenth Street near downtown Atlanta, Georgia, at approximately 10:20 A.M. on a Monday in November, 1970. Maximum occupant injury severity: minor (01).

Ambience. The weather was fair with partly cloudy skies. The ambient air temperature was 63° with wind from southwest at 9 MPH. The road surface was dry.

Roadway. At the location of the accident, Fourteenth Street, a heavily-travelled commercial collector, is a four-lane, one-way, 40-foot wide roadway. The street is paved with asphaltic concrete and is of curb and gutter design. The alignment of the street is straight with a plus 3 percent grade going westbound. Various poles and signs are located along the roadway close to the edges of the pavement on both sides.

Traffic Controls. Fourteenth Street is zoned for a speed limit of 35 MPH. No parking is allowed on either side of the street. Lane markings and cross-walk markings are provided.

Vehicle. A white 1970 American Motors Rebel SST two-door hardtop, automatic transmission, weighing 3,200 pounds. Defective left rear brake. Collision damage to left front and right center side. Failure of A- and C-pillars. Occupant contact with right side of windshield causing bullseye and right inner door panel. Vehicle total loss, cost of replacement \$2,800. Deformation indices: 03-RZAW-5 and 12-FLMN-2.

Driver. A 17-year-old male; employed on his present job for about two months; familiar with both route and vehicle. One year's driving experience; no previous traffic violations. Not restrained; received abrasions on his right shoulder and lacerations on his left knuckles. He was knocked unconscious when his head impacted the windshield, but managed to get out of the wreck on his own. Injury severity index: minor (01).

Pre-Crash Events. The driver was on his way back to the office after making a call. He was travelling on the left curb lane (lane 4) at an estimated speed of 50-60 MPH. The secondary brake lining on the left rear wheel became unbonded and caused the wheel to be locked. The vehicle started rotating counterclockwise and went out of control.

At-Crash Events. The vehicle first knocked down a "No Parking" sign which set it rotating further in the counterclockwise direction. The vehicle finally impacted a utility pole broadside with its left side. This caused the vehicle to rotate clockwise for approximately 150 degrees before it finally came to rest.

Post-Crash Events. The driver of the vehicle left the wreck on his own effort, in spite of the fact that he was knocked unconscious for a short while. He was then taken to Grady Memorial Hospital and was released after treatment.

<u>Causal Factors, Comments, Recommendations.</u>	<u>Matrix</u>
1. Principal contributing factor: defective brakes (failure of bonding between brake lining and shoe).	4
2. Modifying factor: excessive speed.	5
3. This crash demonstrates the hazard of placing utility poles and signs adjacent to the edge of heavily travelled traffic lanes.	7
4. In the judgment of members of the research team, the 35 MPH speed limit for this street is unrealistically low.	7
5. This crash indicates that the Rebel SST two-door hardtop has inherent structural weaknesses causing it to perform unsatisfactorily in crashes involving center side impacts with poles. This crash, which occurred at an estimated impact speed of 35-45 MPH, resulted in a penetration of about 30 inches and structural failure of the A-pillar and C-pillar on the left side. A right rear passenger would probably have been killed in this crash.	5
6. The possibility of sudden failure of the bonding between the brake lining and shoe should be regarded with serious concern. Without additional study, it is not possible to state whether this accident constitutes an isolated event or whether it is symptomatic of a serious and potentially dangerous condition involving a large group of vehicles. Further research should be undertaken without delay to determine the seriousness and scope of this problem.	4
7. It is interesting to note that the cause of this accident would not have become known had an in-depth investigation not been undertaken. Without a mechanical inspection, investigators would have concluded that the automobile had been struck or forced off the roadway by a passing truck, based on the statement of an eyewitness. These facts demonstrate the value of conducting in-depth investigations and the unreliability of eyewitness accounts.	



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 81

Identification. This accident involved a 1969 Volkswagen station wagon which left the roadway and struck a grade separator on the median, fatally injuring the driver. The accident occurred on Interstate 85 at Shallowford Road Interchange in DeKalb County, Georgia, at about 7:15 A.M. on a Tuesday in November, 1970. Maximum occupant injury severity: fatal (09).

Ambience. The weather was clear and cold with ambient air temperature 27 degrees. Wind was from the northwest at 6 MPH. The roadway surface was dry.

Roadway. Interstate 85 is a four-lane expressway with limited access. It consists of two 12-foot lanes in each direction, separated by a 40-foot turf median. Not illuminated; no guardrails or other median barrier provided. The roadway alignment is straight with a minus one percent grade northbound.

Traffic Controls. The expressway is zoned for a speed limit of 70 MPH during day time and 65 MPH at night. Lanes are marked with white broken stripes.

Vehicle. The vehicle, a 1970 Volkswagen 2-door green station wagon weighing 2,700 pounds was struck on the front end. Vehicle deformation index is 12-FDAW-9. Maximum penetration 85 inches. Severe damage to all parts except rear deck lid. Brake calipers, pads and disc were inspected and in good condition. Cost of replacement is \$2,200.00.

Driver. A 5'5", 140-pound, 28-year-old male; only occupant of vehicle; a graduate student at a local university. Twelve years of driving experience; familiar with vehicle, but probably not with route; three previous traffic violations and several minor accidents. Emotionally upset before accident. Not restrained; killed; cause of death: generalized trauma. Injury severity index: fatal (09).

Pre-Crash Events. The driver had been emotionally upset for some time before the accident. On the night preceding the accident, he was despondent and restless. Then in the morning he left home, telling his wife that he wanted to think. He travelled on Interstate 85 northbound at an estimated speed of 75-85 MPH. At about 200 feet before the grade separator, he left the roadway onto the turf median and continued on toward the bridge support with no apparent attempt of braking or change in direction.

At-Crash Events. The vehicle struck the grade separator head-on with the left front end at about 75-85 MPH resulting in extensive damages to the vehicle.

Post-Crash Events. The driver was pinned inside the wrecked vehicle and a rescue unit from the fire department was summoned to the scene to remove the body from the vehicle. The driver was probably killed almost instantaneously upon impact.

<u>Causal Factors, Comments, Recommendations.</u>	<u>Matrix</u>
1. Principal contributing factor: probable suicidal intent.	1
2. The driver was fatigued, not sleeping the night prior to the crash.	1
3. The conditions involved in this fatal crash dramatize a major mental health problem of how to provide an adequate response to such an apparent "cry for help" on the part of despondent individuals. While evidence to date suggests that suicides constitute a relatively small percentage of traffic deaths, a troublesome traffic safety problem nevertheless exists relating to how to prevent the mis-use of the automobile by emotionally wrought up individuals to "work off" their feelings of anger, frustration, or despondency. Totally satisfactory solutions to this problem, which are to be most likely found in the realms of enforcement and driver licensing, are not readily apparent.	1
4. This crash illustrates the need to place guardrails or other barriers in front of or around supports for grade separating structures on heavily-travelled high-speed lanes to direct vehicles away from the hazard. Alternatively, energy absorbing devices should be constructed to lessen impact forces.	7





# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 82

Identification. This accident involved a 1969 Chevrolet Impala two-door hardtop (vehicle 2) which went out of control, entered an expressway median, and then swung back onto the roadway into the path of a 1961 Chevrolet Biscayne four-door sedan (vehicle 1). The right front passenger of vehicle 2 was fatally injured. The accident occurred on Interstate 85 near Clairmont Road Interchange in DeKalb County, Georgia, at approximately 11:10 P.M. on a Friday in November, 1970. Maximum occupant injury severity: fatal (06).

Ambience. The weather was clear and cool with ambient air temperature 44 degrees. Wind was from the west at 5 MPH. The roadway surface was dry.

Roadway. Interstate 85 is a four-lane expressway with limited access. It consists of two 12-foot lanes in each direction, separated by a 40-foot turf median. Not illuminated; guardrails are provided on both sides of the roadway, nine feet from the pavement edges. The roadway at the location of the accident is level with straight alignment.

Traffic Controls. The expressway is zoned for a speed limit of 70 MPH during day time and 65 MPH at night. Lane markings are provided, and there are various signs along the roadway.

Vehicle 1. A black 1961 Chevrolet Biscayne four-door sedan; weight 3,500 pounds; no power options, no seat belts. Vehicle owner revealed bright light on left did not work prior to crash; left window was also inoperable; maximum crush 22 inches on right front; right wheel base reduced in length by 16 inches; steering wheel severely bent with mast jacket torn from instrument panel. Vehicle deformation index: 12-FDEW-4. Vehicle is a total loss; cost of replacement is \$200.00.

Vehicle 2. A 1969 Chevrolet Impala two-door hardtop, red with black vinyl top. Automatic transmission; power steering; standard drum brakes; air conditioned. Tires - Uniroyal recaps - improperly inflated. Most severe damage on right center side; maximum penetration 29 inches; left and right front body mounts separated. Severe damage to right front interior because of penetration by striking vehicle. Vehicle deformation index is 02-RYAW-6. Total loss; estimated cost of replacement is \$2,800.00.

Driver, Vehicle 1. A 22-year-old male construction worker; 6'2" tall, 200 pounds; admitted to having one drink prior to crash; received broken nose from contact with steering rim; contusion of left chest from steering wheel; laceration of forehead above left eyebrow which required 11 sutures; and a contused left knee. Injury severity index: moderate, non-dangerous (02).

Center Front Passenger, Vehicle 1. A 23-year-old female; 4'11" tall, 110 pounds; impacted instrument panel; received 20 cm. hematoma and 10 cm. laceration of scalp; laceration right knee; laceration and fracture of three fingers of right hand. Injury severity index: moderate, non-dangerous (02).



Driver, Vehicle 2. A 53-year-old male who refused to cooperate with team members because of impending litigation; had blood alcohol level of 0.17 percent. Received contusions of right chest wall and fractures of four ribs from instrument panel. His head struck the windshield and possibly the edge of the hood, causing laceration requiring 24 sutures. Injury severity index: moderate, non-dangerous (02).

Right Front Passenger, Vehicle 2. A 35-year-old male who evidently impacted the right A-pillar and door. Received a depressed skull fracture and 4-inch laceration of head; a fracture of right humerus and numerous small facial lacerations. Injury severity index: fatal (06).

Right Rear Passenger, Vehicle 2. A 31-year-old male who claimed to be sleeping. Received a fracture of left distal radius and contusion of left wrist and ankle. Injury severity index: moderate, non-dangerous (02).

Pre-Crash Events. Occupants of vehicle 1 were en route to local night club, while the men in vehicle 2 had been hunting in Monroe, Georgia. Vehicle 2, travelling southerly towards downtown Atlanta left the expressway, went into the median and was directed back onto the pavement as it rotated about 120 degrees clockwise. It came to rest in the left southbound lane. The driver of vehicle 1 saw vehicle 2 in time to skid 81 feet prior to impact.

At-Crash Events. Vehicle 2, also travelling southerly struck vehicle 1 from the 2:00 o'clock position at an estimated impact speed of 35-45 MPH, causing the major damage to the right front of vehicle 1.

Post-Crash Events. After impact vehicle 1 was shoved about 60 feet southward and was rotated about 45 degrees counterclockwise. Vehicle 1 veered rightward and continued southward about 100 feet where it struck and partially mounted a guardrail. The passenger of vehicle 1 was either ejected or subsequently fell out of the car after this latter impact. The occupants were transported to DeKalb General Hospital by ambulance.

#### Causal Factors, Comments, Recommendations.

#### Matrix

1. Because of the refusal of the driver of vehicle 2 to cooperate and the unwillingness of a witness to talk, there is some uncertainty attached to the selection of factors which contributed to this accident. However, it is the consensus of the research team that the probable joint principal contributing factors were: alcohol (driver, vehicle 2), no street illumination, inattentiveness of driver of vehicle 1 who was probably distracted by female companion. Other possible contributing factors are listed below.

1,7,1

2. The driver of vehicle 1 admitted to having consumed one alcoholic drink prior to leaving for his destination.

1

3. The driver of vehicle 1 has had vision difficulties and has worn eyeglasses but stated that he does not need them now.

1

Causal Factors, Comments, Recommendations. (Cont'd.)Matrix

4. Vehicle 2 was deep red in color which would have made it difficult to see.

4

5. The lights on vehicle 1 were inadequate, as the bright light on the left was not working prior to the crash; however, the inadequacy of the lights are not believed to have been a principal contributing factor to the crash. The evidence suggests that the driver perceived vehicle 2 at a point at least 125 feet north of the impact point, probably obtaining his cue by means of the illumination of passing vehicles or from the lights on vehicle 1.

4



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 83

Identification. This accident involved a 1969 Volkswagen (vehicle 2) which proceeded through a STOP-signed intersection and was struck by a 1959 Jaguar (vehicle 1). The accident occurred at the intersection of Myrtle and 5th Streets near downtown Atlanta, Georgia, at approximately 8:30 A.M. on a Saturday in December, 1970. Maximum occupant injury severity: fatal (06).

Ambience. The weather was clear with an ambient air temperature of 36 degrees. The wind was from the northwest at 4 MPH. The roadway surface was dry.

Roadway. Myrtle Street is a 40-foot wide two-lane, two-way street with parking permitted on both sides. Fifth Street is 33 feet wide with two-lane, two-way operation. Parking is permitted on both sides of the approach in which vehicle 1 was travelling but one side only in the opposite approach. Streets are of curb and gutter design; paved with asphalt. Lined with trees and poles. Sidewalks provided. Grades not excessive.

Traffic Controls. Myrtle Street has a speed limit of 25 MPH. Speed limit signs have not been provided along 5th Street. Intersection is controlled by stop signs along Myrtle Street; however, the "STOP" sign on the right side of the north approach of Myrtle Street (which the driver of vehicle 2 violated) had been knocked down in a previous accident.

Vehicle 1. A 1959 Jaguar XK150, curb weight 2,856 pounds, color red, impact distributed across front end. Vehicle deformation index 12-FDMW-3. No interior damage. Cost of repair approximately \$1,700. This vehicle was in good mechanical condition.

Vehicle 2. A 1969 Volkswagen 1500 2-door sedan, curb weight 1,808 pounds, was struck on the left rear side adjacent to the lower B-pillar. Vehicle deformation index is 09-LZEW-3. Left door latch failed and allowed door to open. Cost of repair \$850.

Driver, Vehicle 1. A 5'7", 140-pound, 21-year-old male engineering student; familiar with both route and vehicle. No previous accidents. Had completed high school driver education course. Restrained by lap belt. Not injured.

Driver, Vehicle 2. A 5'10", 145-pound, 28-year-old single male architect. Familiar with vehicle but he may have been slightly unfamiliar with the intersection. Described by acquaintances as quiet, intelligent, cautious--a "good guy." He was ejected, his head striking the sidewalk causing multiple depressed fractures of the left side of the skull and an explosion-type fracture of the right side. Injury severity index: fatal (06).

Pre-Crash Events. The driver of vehicle 1 was en route to school, while the driver of vehicle 2 was on his way to Columbus, Georgia, to visit his girl friend. Vehicle 2, travelling southerly on Myrtle Street at a speed of 20-30 MPH, proceeded into the intersection, and was struck by vehicle 1 travelling westerly on 5th Street at a speed of 25-35 MPH.

At-Crash Events. The left door of vehicle 2 opened as the vehicle rotated 210 degrees counterclockwise. Its wheels then struck the curb at which time it is believed its driver was ejected. The vehicle rotated an additional 135 degrees and came to rest on the sidewalk. After impact, vehicle 1 rotated about 45 degrees counterclockwise, skidded about 35 feet, and struck a power pole at a speed of 5-10 MPH.

Post-Crash Events. The victim's body was removed to the Fulton County Morgue by a Grady Hospital ambulance. A fire truck was dispatched to the scene to wash the blood from the sidewalk and pavement.

Causal Factors, Comments, Recommendations.

Matrix

- |   |      |
|---|------|
| 1. Joint principal contributing factors: missing "STOP" sign and preoccupation of driver of vehicle 2 (probable).   | 7, 1 |
| 2. This accident forcefully illustrates the importance of wearing seat belts. It is unlikely that the driver of vehicle 2 would have been killed had he been wearing a seat belt.   | 1    |
| 3. This accident suggests that further design improvements are required for the Volkswagen to prevent the door from opening in a center side impact crash.  | 5    |
| 4. It is vitally important that "STOP" signs be replaced as soon as possible when destroyed by accidents or other causes. The procedure used by the City of Atlanta whereby written reports of missing "STOP" signs are made to the Traffic Engineering Department is too slow. It is recommended that such reports be made via the radio communications system. Patrolling employees of the Traffic Engineering Department should be frequently reminded of the importance of spotting and replacing damaged "STOP" signs. | 7    |





Identification. This accident involved a 1969 Ford Econoline 300 van truck which emerged from a parking lot into the path of a 1970 Dodge Challenger two-door hardtop. The accident occurred on Simpson Street near downtown Atlanta, Georgia, at approximately 10:30 A.M. on a Monday in December, 1970. Maximum occupant injury severity: minor (01).

Ambience. The weather was cloudy, ambient air temperature 56 degrees, with wind from the southwest at 7 MPH. The road surface was dry.

Roadway. At the location of the accident, Simpson Street, a heavily-travelled arterial, is a two-way 31-foot wide roadway with lane markings for two lanes of traffic westbound and one lane eastbound. The street is paved with asphaltic concrete, and is of curb and gutter design. The alignment of the street is straight, with a negative 3.5 percent grade westbound. Various poles and signs are located along the roadway close to the edges of the pavement on both sides.

Traffic Controls. Simpson Street is zoned for a speed limit of 35 MPH with no parking on either side of the street. Crosswalk markings are provided.

Vehicle 1. A 1970 Dodge Challenger, two-door green hardtop, curb weight 3,200 pounds. Impact damage to left front. Vehicle deformation index is 12-FLEW-4. Cost of repair approximately \$1,500. This vehicle was in good mechanical condition.

Vehicle 2. A 1969 Ford Econoline 300 van truck, curb weight 3,845 pounds, color green, was struck on the center left side resulting in a maximum penetration of 15 inches. Vehicle deformation index is 10-LDEW-4. Interior damage was limited to extensive paint spillage and sheet metal crumpling from the impact. Cost of repair approximately \$1,800. The vehicle was in good mechanical condition.

Driver, Vehicle 1. A 30-year-old Negro female who after consulting with her lawyer refused to cooperate with the research team. Had one previous traffic violation.

Driver, Vehicle 2. A 27-year-old Negro male. Employed on his present job for about two years, described by his employer as reliable and a good worker. No previous traffic violations; one previous accident. Eleven years driving experience, no formal driver's education. Was wearing lap belt at time of accident. Received minor laceration on top of head from contact with top of truck, and some generalized soreness. Injury severity index: minor (01).

Pre-Crash Events. The driver of vehicle 2 was delivering paint to an address he had by-passed. He turned around in a nearby parking lot, and was preparing to return to make his delivery. The driver of a truck waiting to enter the same driveway occupied by vehicle 2 motioned vehicle 2 to move into the street.



At-Crash Events. Vehicle 2, the Ford van truck, entered the street into the path of oncoming vehicle 1, whose speed at impact was approximately 20-30 MPH. The impact caused both vehicles to rotate counterclockwise, coming to rest on the opposite side of the roadway.

Post-Crash Events. Both drivers left their vehicles on their own effort. Driver, vehicle 1, was transported to Grady Hospital by ambulance. Driver, vehicle 2, cleaned up spilled paint in his vehicle, later went to Grady Hospital for examination.

<u>Causal Factors, Comments, Recommendations.</u>	<u>Matrix</u>
1. Principal contributing factor: driver error. (Driver of vehicle 2 failed to exercise caution when emerging from a parking lot and crossing two travelled lanes.)	1
2. This accident demonstrates the desirability of standardizing the size and location of street numbers so that addresses may be easily identified by drivers.	7
3. In driver education classes, students should be cautioned never to depend solely on signs or motions from other drivers in taking right-of-way.	1
4. The proper collapse of the steering wheel in vehicle 1 is thought to have lessened the injuries to its driver.	5*
5. The injury severity of driver of vehicle 1 would have been lessened had she been wearing both lap and shoulder belts.	2



Identification. This accident involved a 1969 Pontiac Ventura four-door hardtop, which left the roadway and struck a traffic detector support pole. The accident occurred on the southbound lanes of Interstate 85, south of the Monroe Drive Interchange in Northeast Atlanta, Georgia, at approximately 1:05 A.M. on a Wednesday in December, 1970. Maximum occupant injury severity: dangerous, critical (05).

Ambience. The weather was cloudy with scattered showers and the ambient air temperature was 65 degrees. Wind was from the southwest at 15 MPH. It was raining prior to the accident and the roadway surface was wet and slippery.

Roadway. Interstate 85 is a four-lane limited access expressway; consists of two 12-foot lanes in each direction separated by a 14-foot wide raised concrete median with guard rail median barriers; paved shoulders 8 feet in width are provided on both sides of roadway. The roadway is paved with asphaltic concrete which is in good condition; illuminated. Straight alignment; minus 2.75 percent grade going southbound.

Traffic Controls. The expressway is zoned for a speed limit of 60 MPH. Lanes are marked with broken white strips and raised traffic delineators, solid white lines mark the pavement edges and the median.

Vehicle. The single vehicle involved in this crash was a 1969 green Pontiac Ventura; curb weight 4,144 pounds; automatic transmission; power steering; power drum brakes. Point of maximum penetration center front with a maximum crush of 40 inches. The steering column was disengaged from the instrument panel and the column collapsed 5.6 inches. Vehicle deformation index is 12-FCEN-7. Vehicle is a total loss; estimated cost of replacement is \$3,000.

Driver. A 5'6", 120-pound, 43-year-old female widow. Twenty-five years of driving experience; no driver's education; familiar with both vehicle and route; one previous traffic violation of illegal left turn, no previous accidents. Not restrained; received a flail chest, broken left collar bone, fractured pelvic girdle due to impact with the steering wheel and assembly; both wrists fractured as she held on to the steering wheel; lacerations, contusion and a broken nose as her face impacted the instrument panel; also received fractured right ankle; hospitalized for approximately five weeks and at the verge of death several times. Injury severity index: dangerous, critical (05).

Right Front Passenger. A 5'10", 187-pound, 44-year-old divorced male; industrial engineer; worked with driver's husband for approximately 15 years prior to his death; had met with the driver for 5 to 6 times. He could not recall what happened prior to and at the crash. Use of seat belts unknown; received three fractured anterior ribs, fractured right pelvic girdle; severe contusion and hemorrhage on abdomen; laceration and contusions on face and possible head injury. Hospitalized for 14 days. Injury severity index: dangerous, serious (04).

Pre-Crash Events. The occupants of the vehicle were en route from the driver's home to take the passenger to his vehicle, following a social evening; undetermined amount of drinking involved. Neither occupant can recall events immediately prior to crash. Evidence indicated that the driver made no attempt to avoid the collision, not until the very last moment before the crash and she turned the wheels to the left. Tobacco stains on steering wheel suggested she was smoking a cigarette.

At-Crash Events. The vehicle struck a traffic detector support pole at an angle nearly parallel to the roadway, with no evidence of significant rotation after initial impact. Impact was at the front center at an estimated speed of 55 MPH.

Post-Crash Events. Both occupants were taken to Grady Memorial Hospital. The passenger was later transferred to Cobb General Hospital after receiving emergency treatment. The vehicle was towed to the impound lot and later salvaged.

Causal Factors, Comments, Recommendations.

Matrix

- |   |      |
|---|------|
| 1. Principal contributing factor (probable): Alcohol  | 1    |
| Additional contributing factors (possible): Weather conditions (wet roadway) and slick tires.   | 7, 4 |
| 2. In the opinion of the driver's attending physician, the proper functioning of the collapsible steering column accounts for saving her life.  | 5*   |
| 3. It is the opinion of the research team that the proper use of the lap and shoulder belt would have lessened the injury severity of both occupants.   | 1    |
| 4. The roadway at the location of the accident is hazardous: the shoulder is too narrow (8 feet); the pole is too close to the roadway (13 feet) and hardly identifiable (bright reflective color paint on the pole would help motorists to notice its presence). | 7    |
| 5. In the opinion of the research team, this pole should be removed or be of breakaway design.  | 7    |



Identification. This accident involved a 1970 Chevrolet four-door sedan which left the roadway and struck a large tree. The accident occurred at the intersection of North Virginia Avenue and Virginia Avenue, a T-intersection in Northeast Atlanta, Georgia, at about 10:20 A.M. on a Friday in January, 1971. Maximum occupant injury severity: minor (01).

Ambience. The skies were cloudy and it was raining. The air temperature was 35 degrees.

Roadway. The intersecting roadways are two-lane, two-way, local residential streets. North Virginia Avenue is 26 feet in width and Virginia Avenue is 30 feet in width. Both streets are of curb and gutter design and are paved with asphalt. The roadway gradient slopes downward in the direction of travel 5.5 percent. A 32-foot diameter circular island separates the traffic turning onto North Virginia Avenue.

Traffic Controls. Vehicles turning left from Virginia Avenue are required to stop by a STOP sign.

Vehicle. A 1970 Chevrolet Bel Air four-door sedan; curb weight 3,900 pounds; automatic transmission; power steering. Maximum penetration is 20 inches. Vehicle repaired at a cost of \$650. Deformation index: 12-FCEW-3.

Driver. A 55-year-old male gardener with evidence of a drinking problem; frequently absent from his work; recently treated for flu-like ailment. His license had been suspended or revoked seven times previously but at the time of the accident he held a valid license. Received abrasion of right knee from contact with lower instrument panel, and a bloody nose probably from contact with the steering wheel. He also received a minor contusion on the back of the head. Injury severity index: minor (01).

Pre-Crash Events. The driver had been absent from work for three weeks prior to the crash. On the night preceding the crash he telephoned his employer and during the course of the conversation was told his employment had been terminated. At the time of the phone call, the driver was thought to have been drinking. It is unlikely that he slept well that night, if at all. The next day, while proceeding easterly toward the intersection, the driver passed out, passed the STOP sign, and ran off the road.

At-Crash Events. The vehicle struck a 30-inch diameter tree at an estimated speed of 20 MPH and came to rest without significant rotation.

Post-Crash Events. The vehicle was removed to an impound lot and the victim was taken to the V. A. Hospital.

Causal Factors, Comments, Recommendations.

Matrix

1. Joint principal contributing factors: a combination of two or more human factors (emotional stress, lack of sleep, medication, weakness resulting from a hangover and/or influenza).	1, 1
---	------



Causal Factors, Comments, Recommendations. (Cont'd.)

Matrix

2. The fact that the driver has had an alcohol problem suggests that alcohol was a principal contributing factor to this crash, although no evidence was discovered to prove the existence of the alcohol factor. No blood alcohol test or breathalyzer test was made.

1

3. In view of the driver's traffic violations record, the research team is of the opinion that he should not be licensed to drive.

1





# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 87

Identification. This accident involved two vehicles, a 1968 Lincoln Continental four-door sedan (vehicle 1) which struck a 1969 Plymouth Fury III four-door sedan (vehicle 2). The accident occurred in the intersection of North Avenue and Juniper Street near downtown Atlanta, Georgia, at about 10:25 A.M. on a Thursday in January, 1971. Maximum occupant injury severity: minor (01).

Ambience. The weather was clear, winds westerly at 15 MPH, and the air temperature was 31 degrees.

Roadway. North Avenue is an urban arterial; hourly volume 1,104 both directions; three 10-foot lanes in each direction east of the intersection. West of the intersection there are two 11-foot westbound lanes and three 10-foot eastbound lanes. North Avenue has a positive 4.5 percent gradient westbound and 4.25 percent crown entering the intersection, and has straight alignment.

Juniper Street is a one-way arterial; hourly volume 1,164; five 10-foot lanes on each side of the intersection. The street enters the intersection with a negative 6 percent gradient southbound and 4.5 percent crown and has a negative 1.5 percent gradient and 4 percent crown upon leaving the intersection. Juniper Street changes directions approximately 20 degrees at the intersection.

Both streets are of curb and gutter design and are paved with asphaltic concrete. Skid resistance is estimated to be 0.70. Accident history: thirty-one accidents in 1970.

Traffic Controls. This intersection is controlled by a fixed-time traffic signal. Lane markings are present on both streets, and each is zoned for a speed limit of 30 MPH.

Vehicle 1. This vehicle, a 1968 Lincoln Continental four-door sedan, weighing 5,200 pounds, was slightly damaged on the front end. The vehicle deformation index is 12-FZEW-2. Maximum penetration was 5 inches. Both front fenders, hood, grill and bumper were damaged. The front section of the frame was swayed and shortened 2 inches. The vehicle was in good mechanical condition prior to the crash. Cost of repair is \$1,585.

Vehicle 2. This vehicle, a 1969 Plymouth Fury III four-door sedan, weighing 3,805 pounds, was struck on the center left side. The vehicle deformation index is 09-LPEW-3. Maximum penetration was 16 inches located 32 inches to the rear of the front axle. The two left doors and left front fender were damaged, and the left front wheel base dimension was shortened 5.5 inches. The vehicle was in good mechanical condition prior to the crash. Cost of replacement is \$3,500.

Driver, Vehicle 1. A 6'0", 170-pound, 28-year-old male, who was proceeding to work. He is nearsighted, but was not wearing his glasses at the

Driver, Vehicle 1 (Continued).

time of the accident. He was admittedly mentally preoccupied with business matters and in a hurry to return to work when the accident occurred. Injury severity index: none (00).

Driver, Vehicle 2. A 6'0", 185-pound, 45-year-old male. Thirty years' driving experience with one traffic violation recorded (stop sign violation). This driver keeps an extremely busy schedule, and could well have been tired or mentally preoccupied at the time of the accident. Injury severity index: minor (01).

Passenger, Vehicle 2. A 5'5", 120-pound, 45-year-old female, seated in right front position. Received abrasion of right knee and contusions of left rib cage and shoulder. Injury severity index: minor (01).

Pre-Crash Events. The driver of vehicle 1 was in a hurry to return to work, having left an inexperienced man in charge of the eating establishment which the driver managed. The driver's glasses had been broken some time previous to the accident, thus he was not wearing glasses.

The driver and passenger of vehicle 2 were returning to their office after having taped a radio program.

At-Crash Events. The driver of vehicle 2 observed the traffic signal at the intersection change to green and proceeded at a constant speed. Driver 1 contends that he observed a green light for his direction of travel. Witnesses stated that he passed vehicles stopped for the red light, entered the intersection, and struck vehicle 2 at an estimated impact speed of 25 MPH.

Post-Crash Events. The driver and passenger of vehicle 2 were taken to a hospital for treatment and released. Both were later treated by a physician. The driver of vehicle 1 was found guilty in court of violation of traffic signal light ordinance.

Causal Factors, Comments, Recommendations.

Matrix

- |  |      |
|--|------|
| 1. Joint principal contributing factors: inattention and not wearing required eye glasses (driver of vehicle 1).   | 1, 1 |
| 2. With an estimated impact speed of only 25 MPH, there was a maximum deformation of 16 inches to the left side of vehicle 2. In the opinion of members of the research team, this relatively slow speed side impact resulted in an unacceptably large distortion of the passenger compartment interior. (See Figure 87-7.)  | 5    |
| 3. It is noted that the arm rest for vehicle 2 is only 2-1/4 inches in width. Although the driver of vehicle 2 received only minor injuries in this low speed crash, it is believed that the narrow arm rest could produce more serious injuries in higher speed side impact crashes. Arm rests should be designed so as to distribute passenger loadings over a wide flat area. | 5    |



Identification. This accident involved a 1971 Dodge Charger two-door hardtop (vehicle 1) which struck a 1966 Buick Special four-door sedan (vehicle 2) at a signalized intersection. The accident occurred about one mile northwest of the Georgia Tech campus in Atlanta, Georgia, on a Saturday in January, 1971, at about 11:50 A.M. Maximum occupant injury severity: minor (01).

Ambience. The weather was cloudy and warm with ambient air temperature 61 degrees. Wind was from the west-southwest at 14 MPH. The roadway surface was dry.

Roadway. The accident occurred at the intersection of Northside Drive, a six-lane, two-way arterial with a narrow concrete median, and 10th Street, a one-way arterial 40 feet in width. The streets intersect at a right angle with straight alignment. Grades are not excessive. Both streets are paved with asphaltic concrete and of curb and gutter design. Visibility is restricted by a 40-inch high concrete fence.

Traffic Controls. The intersection is controlled by a fixed time traffic signal. The speed limit is 35 MPH for both streets. Parking is permitted along the south side of 10th Street and otherwise prohibited.

Vehicle 1. 1971 Dodge Charger two-door hardtop; 8 cylinder; automatic transmission; power steering; manual drum brakes. Moderate damage to the front of vehicle with vehicle deformation index of 12-FDEW-3. Cost of repairs: \$989.

Vehicle 2. 1966 Buick Special four-door sedan; 8 cylinder; automatic transmission; power drum brakes. Damaged along right center side. Vehicle deformation index: 03-RYMW-2. Cost of repairs: \$750.

Driver, Vehicle 1. A 39-year-old male auto mechanic. Not restrained. Received bruised clavicle and a sore neck. Injury severity index: minor (01).

Driver, Vehicle 2. A 52-year-old civilian clerk for U. S. Army. Not restrained. Not significantly injured.

Right Front Passenger, Vehicle 2. A 48-year-old female; unrestrained. Complained of pain in her right hip. X-rays negative.

Left Rear Passenger, Vehicle 2. A 10-year-old female; unrestrained. Received minor laceration of right upper lip from contact with front seat back. Injury severity index: minor (01).

Right Rear Passenger, Vehicle 2. A 68-year-old female; unrestrained. Complained of pain in lower back and right hip. Impacted right rear door interior. Injury severity index: minor (01).



Pre-Crash Events. Driver of vehicle 1 was en route to his home from work approaching Northside Drive from the west on 10th Street at a speed of about 30 MPH. Occupants of vehicle 2 had attended a funeral for a friend and were en route to a cemetery. A witness stated that vehicle 2 had not maintained a close formation in the funeral procession and that at least three unidentified vehicles were driving in front of vehicle 2 between it and other cars in the cortege. Vehicle 2 approached the intersection on Northside Drive in the middle southbound lane at a speed of about 35 MPH.

At-Crash Events. Vehicle 1 impacted vehicle 2 at a speed of about 20 MPH after skidding 21 feet. Vehicle 1 rotated about 45 degrees clockwise and came to rest near the point of impact.

Post-Crash Events. The passengers of vehicle 2 were transported to Crawford Long Hospital where they were examined and released. Each of the drivers has filed suit against the other for damages.

Causal Factors, Comments, Recommendations.

Matrix

- |  |   |
|--|---|
| 1. Principal contributing factor: driver of vehicle 2 failed to maintain formation in a funeral procession.  | 1 |
| 2. The driver of vehicle 2 was not driving in the right lane as required by the traffic code.  | 1 |
| 3. The identifying windshield sticker carrying the word "FUNERAL" was placed near the central portion of the right side of the windshield. It is believed to have obstructed the driver's vision in this case. | 4 |



Identification. This accident occurred at the intersection of Peachtree-Dunwoody Road and Abernathy Road in north Fulton County, Georgia, at approximately 8:20 A.M. on a Thursday in February, 1971. This accident involved a 1966 Chevrolet Impala four-door sedan (vehicle 2) which, while crossing the intersection, went into the path of and was struck by a 1970 Chevrolet Monte Carlo two-door hardtop (vehicle 1). Maximum occupant injury: minor (01).

Ambience. The weather was cool with partly cloudy skies and an ambient air temperature of 42 degrees. The wind was calm and the roadway surface was dry.

Roadway. Abernathy Road is a newly-completed four-lane, two-way divided highway. At the intersection where the accident occurred, left turning lanes are provided. Peachtree-Dunwoody Road, a moderately-travelled residential collector, is a two-lane, two-way roadway intersecting Abernathy Road at a right angle. Both streets are of curb and gutter design and are paved with asphaltic concrete which is in good condition. Abernathy Road has a negative 3.5 percent grade going westbound while the grade on Peachtree-Dunwoody Road is plus 2.0 percent going southbound.

Traffic Controls. Clear lane markings are provided on all four approaches. This intersection is controlled by "STOP" signs with "STOP" bar markings on both approaches of Peachtree-Dunwoody Road. Abernathy Road is zoned for a speed limit of 45 MPH while the speed limit on Peachtree-Dunwoody Road is 35 MPH. Parking is prohibited on both streets.

Vehicle 1. A 1970 gray Chevrolet Monte Carlo two-door hardtop; black vinyl top; curb weight 3,600 pounds. Good mechanical condition. Main damage on right front; sheet metal damages included right front fender, grill, bumper and hood; minor frame damage. Vehicle deformation index: 12-FZEW-3. Cost of repairs: \$1,550.

Vehicle 2. A 1966 white Chevrolet Impala four-door sedan; curb weight 3,670 pounds. No mechanical defects. Struck on the left front side; maximum penetration 17 inches. Vehicle deformation index: 09-LFEW-3. Secondary damage on left rear fender; secondary vehicle deformation index: 09-LBMW-1. Vehicle replacement cost: \$800.

Driver, Vehicle 1. A 5'6 $\frac{1}{2}$ ", 125-pound, 28-year-old female. Twelve years of driving experience; had driver's education; one previous accident; no records of previous traffic violations. Familiar with both vehicle and route. Not restrained. Received bruised right temple and eye from contact with rear view mirror and sun visor fitting; also received minor contusions and abrasions on both legs due to impact with lower instrument panel and brake release control. Injury severity index: minor (01).

Driver, Vehicle 2. A 5'3", 140-pound, 66-year-old female. More than 40 years of driving experience; no driver's education; no records of previous traffic violations. Familiar with vehicle and had been driving on that route



Driver, Vehicle 2. (Cont'd.)

for one week. Was on her way to Northside Hospital to visit her mother. Was not restrained. Received a broken rib and contusion of left chest from impact with the steering wheel; contusions on the left shoulder by striking the left front door; contusions on left leg and knee due to impact with the underdash and brake release control. Also complained of pain on both sides of head as a result of striking the B-pillar on the left and impacting with the right front passenger on the right. Injury severity index: minor (01).

Right Front Passenger, Vehicle 2. A 5'5", 160-pound, 76-year-old female; aunt of the driver of vehicle 2. Not restrained. Received a broken left collar bone probably due to contact with the steering wheel or the transmission selector lever; received contusion on left side of her head as she impacted with the driver; also received multiple bruises. Injury severity index: minor (01).

Pre-Crash Events. Vehicle 2 was travelling south on Peachtree-Dunwoody Road and stopped at the stop sign at the intersection. The driver of vehicle 2, due to the combination of glare and the blending of the color of vehicle 1 (gray with black vinyl top) into the background (tall pine trees), was not able to perceive vehicle 1 which was travelling westward on Abernathy Road in the center lane (lane 2) at an estimated speed of 45 MPH. Vehicle 2 then proceeded into the intersection and into the path of vehicle 1.

At-Crash Events. Vehicle 1 struck vehicle 2 on the left front side at an estimated speed of 25 MPH after skidding 12 feet. Upon impact, vehicle 2 rotated clockwise and struck the right rear bumper of vehicle 1 in a second collision. Vehicle 1 then continued on and came to rest after climbing the raised median and damaging two signs on the median. The accelerator lever of vehicle 2 stuck and vehicle 2 continued west on Abernathy Road, crossed the median and eastbound lanes and finally came to rest on the raised turf shoulder approximately 160 feet west of the initial impacting point.

Post-Crash Events. The driver of vehicle 1 did not require medical treatment. Vehicle 1 was towed to a nearby Chevrolet dealer for repair. The driver and passenger of vehicle 2 were taken by ambulance to Northside Hospital where they were treated and released. Vehicle 2 was impounded.

Causal Factors, Comments, Recommendations.

Matrix

1. Joint principal contributing factors: glare, color of vehicle 1 (gray with black vinyl top), background (tall pine trees).

7, 4, 7

2. Because of an earth bank, there is a restriction to sight distance to southbound drivers crossing Abernathy Road. The sight distance is marginally adequate if the 45 MPH speed limit on Abernathy Road is observed; however, since the 85th percentile speed is commonly used as a guide in establishing speed limits, this may render the intersection to be a potential hazard.

7

Causal Factors, Comments, Recommendations. (Cont'd.)Matrix

3. The "STOP" sign and "STOP" line are not at the same position and are too far recessed from the curb line of Abernathy Road. At this location, it is recommended that the "STOP" line be parallel to and about four feet from the near edge of the intersecting roadway.

7

4. More research is required to develop windshields and windows that will minimize glare without unduly restricting vision.

4

5. The use of lap and shoulder belts would probably have lessened the injury severity of the driver and passenger of vehicle 2.

2



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 90

Identification. This accident occurred at the intersection of Cheshire Bridge Road and Manchester Road in northeast Atlanta, Georgia, at approximately 2:05 P.M. on a Friday in March, 1971. Two vehicles were involved in this accident: a 1970 Mercury Marquis convertible (vehicle 2) which, while making a left turn from Manchester Road to Cheshire Bridge Road, went into the path of and was struck by a 1970 Pontiac Tempest four-door sedan (vehicle 1). Maximum occupant injury: moderate (02).

Ambience. The weather was cloudy and drizzling with ambient air temperature 55 degrees; calm wind. The roadway surface was wet and slippery.

Roadway. Cheshire Bridge Road, a heavily-travelled commercial minor arterial, is a four-lane, two-way, 40-foot wide undivided roadway. Manchester Road, which ends at this intersection, is a two-lane, two-way, 25-foot wide local commercial street. The two roadways intersect at an angle of about 65 degrees. Both streets are of curb and gutter design; illuminated; paved with asphaltic concrete which has a measured skid resistance of 0.81. Cheshire Bridge Road has a crown of 2.5 percent and a gradient of plus 2.5 percent going westbound; Manchester Road has a crown of 5 percent and a 4.5 percent grade going southbound; both streets are of straight alignment.

Traffic Controls. This intersection is controlled by a "STOP" sign at Manchester Road. Cheshire Bridge Road is zoned for a speed limit of 35 MPH; lanes are marked with white broken stripes and centerline marked with double yellow lines; no parking allowed on both sides of roadway. Manchester Road has no posted speed limit; no lane markings; no parking allowed close to the intersection.

Vehicle 1. A 1970 tan Pontiac Tempest 350, four-door sedan, weight 3,622 pounds; odometer reading 22,980; automatic transmission; power steering; manual drum brakes. Good mechanical condition prior to crash. Made initial contact on the right front with maximum crush of 30 inches. Occupant contact and damages on right A-pillar and glove compartment area of instrument panel. Vehicle deformation index is 12-FZEW-3. Total loss; cost of replacement: \$3,800.00.

Vehicle 2. A 1970 blue Mercury Marquis convertible; weight 4,312 pounds; 429 cu. in. engine; odometer reading 24,271; automatic transmission; power options; front disc brakes. Vehicle in good condition prior to crash; had safety inspection day before accident. Struck on the left side in front of the left front wheel; minor sheet metal damages. Rear view mirror and lower instrument panel damaged by occupant contact. Vehicle deformation index is 09-LFEW-1. Cost of repair: \$750.00.

Driver, Vehicle 1. A 6'2", 220-pound, 23-year-old male auditor. Familiar with both vehicle and route; wearing corrective lenses. 7 years of driving experience; completed the National Safety Council defensive driving course; no records of previous traffic violations. Restrained with lap belt; not significantly injured; not treated. But later complained of pain in left side of neck, left shoulder region and right side of chest; treated by private physician. Injury severity index: minor (01).



Right Front Passenger, Vehicle 1. A 26-year-old male, working in the same office as the driver of vehicle 1. Had spine fusion for scoliosis in 1959. Complained of pain in the neck, upper part of back; taken by ambulance to Georgia Baptist Hospital where he was examined and released. Continued treatment by private physician who described the injury as "Sprain, cervical and upper dorsal spine," and might require another operation on the spine fusion should the pain persist. Physical evidences indicated that he impacted the right A-pillar and the glove compartment area of the instrument panel. Injury severity index: moderate (02).

Driver, Vehicle 2. A 5'2", 115-pound, 25-year-old female, bookkeeper in a local wig company. Familiar with route but had vehicle for only two weeks. 9 years of driving experience; no driver's education; no previous accident; no records of previous traffic violations. Not restrained; not injured; not treated; complained of general soreness and headache. Injury severity index: none (00).

Right Front Passenger, Vehicle 2. A 5'6", 120-pound, 36-year-old female sales clerk, working in the same company as driver of vehicle 2. Restrained with lap belt; received abrasion on left knee due to impact with lower instrument panel; also complained of headache and a pinched nerve in neck. Injury severity index: minor (01).

Pre-Crash Events. The driver and passenger of vehicle 2 were on their way back to work after lunch. Vehicle 2 was stopped at the "STOP" sign at Manchester Road, and seeing that a Cadillac was stopping at the curb lane (lane 1) of westbound traffic on Cheshire Bridge Road to make a right turn and also that the other lanes were free of traffic, proceeded into the intersection and into the path of vehicle 1 which was travelling westerly on Cheshire Bridge Road at an estimated speed of 30 MPH.

At-Crash Events. The right front of vehicle 1 then struck the left front side of vehicle 2 at an estimated impact speed of 25 MPH. After impact, vehicle 1 rotated counterclockwise for about 30 degrees while vehicle 2 rotated clockwise for 30 degrees and came to rest about 10 feet from point of impact.

Post-Crash Events. Vehicle 2 was towed to a Lincoln-Mercury dealer for repair while vehicle 1 was towed to the impound lot and later salvaged. Passenger of vehicle 1 was taken by ambulance to Georgia Baptist Hospital where he was treated and released; ambulance arrived about 35 minutes after accident. Driver of vehicle 2 charged with failure to yield right-of-way, causing accident, but later dismissed.

Causal Factors, Comments, and Recommendations.

Matrix

- |  |      |
|--|------|
| 1. Joint principal contributing factors: sight distance restriction because of turning vehicle, driver error (driver of vehicle 2 failed to exercise due caution). | 7, 1 |
| 2. The research team suspects that the driver of vehicle 1 might have changed lanes just prior to impact; however, such lane change was denied by the driver.      | 1    |

<u>Causal Factors, Comments, and Recommendations. (Cont'd.)</u>	<u>Matrix</u>
3. Modifying factor: wet and slippery pavement.	8
4. Better padding of A-pillars is recommended.	5
5. Vehicle 1 had 30 inches of front end deformation resulting in the upward movement and rearward displacement of the hood to the windshield. Considering the low impact speeds (25 MPH for vehicle 1, 10 MPH for vehicle 2), the extent of front end deformation was judged to be excessive. This large deformation is attributed in part to the use of fiberglass for the construction of the front portion of the body.	5





# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 91

Identification. This accident involved a 1971 Plymouth four-door hardtop which left the roadway and struck a tree and a utility pole. The crash occurred on Monroe Drive near its intersection with Hillpine Drive at a location about 3.5 miles north-northeast of the central business district of Atlanta, Georgia, at about 12:30 A.M. on a Saturday in April, 1971. Maximum occupant injury severity: minor (01).

Ambience. The weather was clear and the ambient air temperature was 63 degrees. The wind was calm. The roadway surface was dry.

Roadway. Monroe Drive, a minor residential arterial street, is a four-lane, two-way road with parking prohibited on both sides of the street. The road is of curb and gutter design and has a straight alignment at the point where the vehicle crashed; however, there is a 10 degree curve in the road located about 300 feet south of the point of impact. The curve is not superelevated. It has an adverse crown of about 3.0 percent and a critical speed of about 76 MPH. The vehicle evidently began to go out of control while in this curve. The street is illuminated and has sidewalks on both sides. There are numerous poles and trees located between the sidewalks and the curb.

Traffic Controls. All four lanes have white lane striping and the road has a posted speed limit of 35 MPH. Parking is prohibited.

Vehicle 1. A 1971 brown Plymouth Fury III four-door hardtop; weighing 3,820 pounds; automatic transmission; power steering; power front disc brakes. Made initial contact with pole on right front side; right front fender and hood were torn off from vehicle; minor frame damage and right frame horn broken; additional sheet metal damage included left front fender, grill and bumper. Vehicle deformation index for primary damage: 02-RFEN-6. Second collision with tree on right rear side in the vicinity of the C-pillar; sheet metal damages included right rear fender, right rear door and the roof. Vehicle deformation index for secondary damage: 03-RZAW-3. Interior damages mainly confined to right rear portion from secondary collision. Right rear window glass and backlight were broken due to secondary impact force. Total loss; cost of replacement: \$3,800.

Driver, Vehicle 1. A 30-year-old male; a marketing-sales executive for a Winston-Salem, North Carolina, tobacco company who was on his way to downtown Atlanta to view a competitor's billboard advertisement; unfamiliar with the automobile, a rented vehicle, and a degree of unfamiliarity with the route. He had one previous accident and one previous traffic violation. Not restrained. Received slight bump on right temple but received no medical treatment. The driver was intoxicated with a blood alcohol level of 0.14 percent.

Pre-Crash Events. The driver was travelling northerly on Monroe Drive. He entered the 10-degree curve at a speed of about 75 miles per hour, and is thought to have struck the curb on the outside of the curve. The vehicle began to "fishtail", skidded sideways across the street, rotating counterclockwise.

At-Crash Events. After rotating about 135 degrees, the vehicle struck a pole, rotated an additional 45 degrees and struck a "NO PARKING" sign and a large tree. The vehicle then rotated another 360 degrees counterclockwise and came to rest heading south in the southbound lane.

Post-Crash Events. The driver got out of the vehicle and went to a nearby house and summoned police. The driver pleaded nolo contendere to a charge of being drunk on the street and was fined \$50 in municipal traffic court.

Causal Factors, Comments, Recommendations.

Matrix

- |  |         |
|--|---------|
| 1. Joint principal contributing factors: alcohol, excessive speed, and unfamiliarity with the roadway.   | 1, 1, 1 |
| 2. The sentence imposed by the traffic court was remarkably light, considering the severity of the offense. The Georgia Tech research team questions the advisability of permitting intoxicated drivers to plead nolo contendere to the lesser charge of being drunk on the street and thus avoid the D.U.I. charge. | 3       |
| 3. There is a degree of driver unfamiliarity with the vehicle when rental cars are used.   | 1       |



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 92

Identification. This accident involved a 1970 Ford LN-700 truck which was destroyed by fire caused by a ruptured muffler. The accident occurred on U. S. Highway 341, approximately 5 miles north of Roberta, Georgia, at approximately 1:00 P.M. on a Monday in January, 1971. Maximum occupant injury: none (00).

Ambience. The weather was partly cloudy and fair with an ambient air temperature of 68 degrees. The roadway surface was dry.

Roadway. U. S. Highway 341, a rural primary highway, is a two-lane, two-way, 24-foot wide roadway. The accident site is located in a 15- to 20-foot cut-section; 15-foot wide turf shoulders and 5-foot wide drainage ditches. It has a 1.75 percent crown and a plus 3.25 percent grade going southbound. The roadway is paved with asphaltic concrete with an estimated skid resistance of 0.70.

Traffic Controls. The roadway is zoned for a speed limit of 60 MPH. Lane markings include: white stripes on edges of pavement, broken white stripe and yellow restriction line for southbound traffic for centerline markings.

Vehicle. The accident vehicle, a 1970 LN-700 Ford truck outfitted with an enclosed body; odometer reading 20,206. No power accessories, no padded components, no restraint system. Muffler blown some two weeks prior to accident. No other analysis could be performed because of extensive fire damage. No crash involved. Deformation index rating: 00-XDAF-0. Cost of replacement: \$8,750. Routine maintenance had been performed by the rental company.

Driver. A 5'11", 260-pound, 40-year-old male truck driver; only occupant of vehicle. Familiar with route and also with this type of truck although he drove a different truck every time. Last time he drove this truck was 1-1/2 weeks prior to the accident. 22 years of driving experience; had previous accidents and traffic violations but none related to truck driving. No injuries; he was away from the vehicle when it exploded. Injury severity index: none (00).

Pre-Crash Events. The driver was on his way to a brewing company in Perry, Georgia, and was travelling down the highway at about 60-65 MPH. He heard a "hissing" noise that sounded like a hot radiator. He stated that he slowed down and stopped the vehicle on the shoulder of the highway; set the brakes and turned off the engine. He then stepped out of the cab and proceeded to open the hood to examine the radiator. He first unlatched the left hood latch and as he was about to unlatch the right hood latch, he noticed flames in the vicinity of the right fuel tank.

At-Crash Events. The immediate reaction of the driver was to run away from the truck. He then heard an explosion and as he turned back, the whole vehicle was completely engulfed in fire.

Post-Crash Events. The driver summoned police and the fire department. However, there was little that could be done on the truck which was already completely engulfed in fire.

Causal Factors, Comments and Recommendations.

Matrix

1. Joint principal contributing factors: ruptured muffler, design defect (location of muffler too close to fuel tank and orientation of muffler seam). 4, 4
2. This investigation indicates that there is hazard associated with the location of a truck muffler within about two inches of the gasoline tank, especially when the muffler seam is oriented towards the tank. Greater separation of the muffler and gasoline tank and reorientation of the muffler seam is strongly recommended. 4
3. The truck was not equipped with a fire extinguisher. 6





# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 93

Identification. This accident involved a 1962 American Motors Rambler two-door sedan (vehicle 1) which went out of control after its right wheels dropped off the edge of the pavement. The vehicle crossed the centerline and struck a 1969 Buick Electra 225 four-door sedan (vehicle 2) on the left front resulting in minor injuries to drivers of both vehicles. The accident occurred on Snapfinger Road in DeKalb County, Georgia, at approximately 7:50 A.M. on a Tuesday in April, 1971. Maximum occupant injury severity: minor (01).

Ambience. The weather was clear and fair with ambient air temperature 60 degrees. Wind was from northwest at 12 MPH. The roadway surface was dry.

Roadway. Snapfinger Road is a moderately-travelled two-lane, two-way, 20-foot wide residential collector with 6-foot wide unpaved shoulders. Parts of the road have been upgraded to a 29-foot wide roadway with curb and gutter design. Such a transition is located about 200 feet east of the site of the accident. Vehicles running off the roadway have caused a drop of  $5\frac{1}{2}$  inches off the edge of the pavement on the narrower part of the roadway. Not illuminated; straight alignment; a 2 percent crown with a plus 1.5 percent grade going westbound. Paved with asphaltic concrete which is in good condition with a skid resistance of 1.00.

Traffic Controls. The roadway is zoned for a speed limit of 45 MPH. Center marking consists of white broken stripes; no pavement edge marking; no warning sign for narrowing of roadway.

Vehicle 1. A white 1962 American Motors Rambler two-door sedan; weight 2,492 pounds; automatic transmission; no power options; no safety features including seat belts. Made initial contact on left front; left front fender torn off; maximum penetration 30 inches on left front. Left wheel base shortened by 12.5 inches. Additional sheet metal damage included the grill, bumper and hood. Interior damages mainly on the firewall and floorpan on left front; the steering column telescoped 2.5 inches into the passenger compartment. Vehicle deformation index: 11-FYEW-4. Vehicle is a total loss; cost of replacement is \$300.

Vehicle 2. A brown 1969 Buick Electra 225 four-door sedan; weight 4,500 pounds; 440 cu. in. V-8 engine; power steering; power brake drums; power seat adjusters; tilt feature on steering column. Initially struck on left front; sheet metal damages consisted of grill, front bumper, left front fender, both left front and rear doors. Left wheel base shortened by 11 inches; windshield broken by the torn off fender from vehicle 1 and impact force. Minor interior damages; steering column energy absorbing device collapsed  $2\frac{1}{8}$  inches. Vehicle deformation index: 12-LYEW-3. Vehicle is a total loss; estimated cost of replacement \$3,000.

Driver, Vehicle 1. A 6'0", 170-pound, 35-year-old male; only occupant of vehicle; assistant manager at a local department store. 13 years of driving experience; had  $8\frac{1}{2}$  hours of driving lessons at an independent driving



school; one previous accident and two previous traffic violations. Familiar with vehicle but not with route as he had travelled it only three times. Moved to Atlanta from California only five days prior to crash. Had polio in left arm at 9 years of age. Not restrained; received fractured ankle from contact with deformed firewall or brake pedal, abrasion on forehead from contact with left A-pillar, contusions and lacerations on both knees from underdash. Injury severity index: minor (01).

Driver, Vehicle 2. A 5'5", 120-pound, 35-year-old female secretary; only occupant. Driving since 16 years old; no formal driver's education; no previous traffic violations. Familiar with both route and vehicle. Not restrained; received laceration on left elbow, bruises on both knees from underdash and underside of right forearm from steering rim, bruise and pinched nerve in left hand. Injury severity index: minor (01).

Pre-Crash Events. Driver of vehicle 1 was en route to work and was travelling southwesterly on Snappfinger Road at approximately 35 MPH. The driver stated that he saw oncoming vehicle 2 travelling close to the centerline, so he kept his vehicle to the right side of the pavement. Due to narrowing of the pavement width, vehicle 1 went off the edge of the pavement which has a drop of  $5\frac{1}{2}$  inches. The driver of vehicle 1, in an effort to bring the vehicle back onto the pavement, steered sharply to the left and then to the right, possibly with hard braking. Vehicle 1 then started skidding sideways. Meanwhile, driver of vehicle 2 was en route to her home and was travelling northwesterly at an estimated speed of 45 MPH.

At-Crash Events. Vehicle 1 crossed the centerline and collided with the left front of vehicle 2 at an estimated speed of 25 MPH, at an angle of approximately 10 degrees relative to the centerline. After impact, vehicle 2 rotated approximately 45 degrees counterclockwise and came to rest about 110 feet from the point of impact, while vehicle 1 rotated approximately 30 degrees clockwise and came to rest approximately 30 feet from the impacting point.

Post-Crash Events. Drivers of both vehicles were taken to DeKalb General Hospital where they were treated and released. Both vehicles were towed by wreckers to an impound lot and later salvaged. Driver of vehicle 1 was charged with and found guilty of travelling on wrong side of road and failure to maintain control, causing accident.

Causal Factors, Comments, Recommendations.

Matrix

1. Joint principal contributing factors: poor roadway design (drop on edge of pavement, narrowing of width of pavement); driver error (over-steering) on vehicle 1; possible driver error (too close to centerline) on vehicle 2; unfamiliarity with roadway (driver of vehicle 1).

7,1,1,1

2. From a safety viewpoint, the policy of widening and curbing short interspersed sections of a roadway is unsound. At locations where it is necessary for a roadway to transition from a relatively wide curbed section to a narrow uncurbed section, appropriate warning signs should be provided.

7

Causal Factors, Comments, Recommendations. (Cont'd.)Matrix

3. This accident illustrates the hazard associated with poorly maintained shoulders.

7

4. Proper collapse of the energy absorbing steering column probably lessened the injuries of the driver of vehicle 2.

5\*



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 94

Identification. This accident involved a 1971 Dodge Challenger convertible which went out of control at an expressway overpass structure and struck a bridge railing. The crash occurred on Mt. Vernon Highway at its intersection with Interstate Route I-285 in north Fulton County, Georgia, at about 2:05 P.M. on a Thursday in April, 1971. Maximum occupant injury severity: dangerous, critical (05).

Ambience. The weather was clear and the ambient air temperature was 77 degrees. The wind was from the northwest at 17 MPH. The roadway surface was dry.

Roadway. Mt. Vernon Highway, a residential collector, is a two-lane, two-way, 24-foot wide street of curb and gutter design. The accident occurred on a concrete grade separation structure which has two 14-foot lanes with a 10-inch high curb and five-foot sidewalks. The alignment is straight and the grade practically flat.

Traffic Controls. The roadway is zoned for a speed limit of 35 MPH. There are double yellow pavement stripes in the center of the roadway.

Vehicle. The crash vehicle is a 1971 gray Dodge Challenger convertible, equipped with power steering, power disc front brakes, A.C. tape player, automatic transmission on console. Primary damage to left front with secondary damage to the right rear side with vehicle deformation indices, respectively, 01-FDEW-3 and 03-RBEW-2. Vehicle is a total loss, with a cost of replacement approximately \$4,200. The transmission was disassembled and inspected. There was evidence that the vehicle had been placed in reverse at a high rate of speed.

Driver. A 17-year-old male high school student; one previous traffic violation (speeding); no previous accidents. Unfamiliar with vehicle and not too familiar with the route. Had consumed nine beers during the thirty minute period immediately preceding the crash. Not restrained. Complained of pain in his upper back. Examined at Grady Memorial Hospital and released to jail. Injury severity index: minor (01).

Right Front Passenger. A 17-year-old male high school student. Intoxicated. Not restrained. Ejected from vehicle. Was propelled over the bridge railing landing on earth slope 25 feet below. He received a cerebral contusion, fractures of right wrist, right forearm, left wrist, and cervical vertebrae C2 and C3. Injury severity index: non-dangerous, severe (03).

Left Rear Passenger. A 17-year-old male high school student. Intoxicated. Not restrained. Ejected onto bridge pavement. He received multiple abrasions, contusions of both arms and shoulders, and avulsions of both heels. Injury severity index: minor (01).

Right Rear Passenger. A 17-year-old male high school student. Intoxicated. Not restrained. Ejected from the vehicle over the bridge railing. Propelled 75 feet beyond and 12 feet below major impact point. Received

fracture of right kidney requiring removal, hematoma of the colon and mesocolon, a fracture dislocation of the left wrist, and a contusion of the right flank. Injury severity index: dangerous, critical (05).

Pre-Crash Events. The occupants "borrowed" the vehicle without the owner's permission. They had been driving around drinking beer, taking turns driving. The vehicle was travelling northeasterly approaching the overpass at a speed of about 70 MPH. The driver or one of the passengers is thought to have shifted the gear into reverse in a playful, deliberate act. After skidding 44 feet, the vehicle went out of control to the right rubbing up against the right bridge curb. It then swerved across the centerline to the left.

At-Crash Events. The vehicle climbed the curb and struck the bridge railing at an estimated speed of 55 MPH. The vehicle rotated 135 degrees counterclockwise and made secondary contact with the bridge railing, then rotated an additional 160 degrees and came to rest.

Post-Crash Events. After a delay of about 30 minutes, ambulances arrived and transported three of the victims to the hospital. One victim was transported to the hospital by a policeman. The driver was charged with D.U.I. and speeding and spent three days in jail. He pleaded nolo contendere and was fined a total of \$175 and placed on 11 months' probation.

<u>Causal Factors, Comments, Recommendations.</u>	<u>Matrix</u>
1. Joint principal contributing factors: alcohol, excessive speed, and poor judgment (the driver or one of the passengers shifted the vehicle into reverse).	1, 1, 1
2. The driver was unfamiliar with the vehicle.	1
3. The driver was somewhat unfamiliar with the route.	1
4. If the occupants had been travelling in a vehicle with a hard top instead of a convertible, it is unlikely that anyone would have been ejected.	2
5. The use of lap belts would have prevented the ejection of the three passengers and lessened their injuries.	2
6. Riding on the rear deck of a convertible is an apparent violation of the city code which states that no person shall ride on any vehicle or any portion of a vehicle not intended for use by passengers.	1
7. Unacceptable delays were experienced in getting ambulances to the scene of this crash, suggesting that improved emergency medical services may be required for this section of the city.	3
8. Under Georgia law, it is possible for a driver charged with D.U.I. to plead nolo contendere and avoid the automatic one-year suspension of his driver's license. Legislation was passed in 1971 which limits the drunk driver to one plea of nolo contendere (with a chance to keep his license). After that, a nolo contendere plea is treated in the same manner as a plea of guilty, and the driver's license is suspended.	1





# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 95

Identification. This accident involved a 1968 Plymouth Fury III four-door hardtop which went out of control, left the roadway and overturned. The crash occurred on the southbound lanes of the Northwest Expressway, Interstate Route I-75, approximately one-half mile south of Mt. Paran Road in northwest Fulton County, Georgia, at about 2:50 P.M. on a Friday in May, 1971. Maximum occupant injury severity: none (00).

Ambience. The weather was cloudy with slight rainfall and an ambient air temperature of 75 degrees. The wind was from the south at 15 MPH. It was raining at the time of the accident and the roadway surface was wet and slippery.

Roadway. Interstate Route I-75, a four-lane expressway with limited access, consists of two 12-foot lanes in each direction separated by a 56-foot turf median; 10-foot paved asphaltic shoulders; 1½-foot deep drainage ditches 9 feet from the shoulder; illuminated; no median barriers or guardrails. At location of accident, the roadway is in a cut-section with 2.5:1 slope banks; there is also a tapered acceleration lane for traffic from Mt. Paran Road to merge into southbound expressway traffic. The roadway alignment is straight with a 0.8 percent crown and a negative 3.5 percent grade going southbound. The roadway is paved with Portland cement concrete with a measured skid resistance of 0.76 under dry conditions at 20 MPH. Under wet conditions and a speed of 60 MPH, the estimated skid resistance is 0.60.

Traffic Controls. The roadway is zoned for a speed limit of 70 MPH during day time and 65 MPH at night. Lane markings are provided. Various signs and light poles are located along the roadway.

Vehicle. A 1968 brown and white Plymouth Fury III four-door hardtop; odometer reading 51,175; automatic transmission; power steering; manual brakes. Vehicle in good mechanical condition prior to accident; heavy wear on tires showing signs of overinflation. Exterior sheet metal damages consisted of the top, rear bumper and left side of the grill. The top was depressed approximately 10 inches. Broken backlight glass; fractured windshield. No interior damages; signs of occupant contact on roof interior, sun visor and rearview mirror. Vehicle deformation index: 03-TDHO-2; total loss; cost of replacement: \$1,000.00.

Driver. A 5'9", 180-pound, 35-year-old female schoolteacher; only occupant of vehicle; 5 months pregnant; good physical health; wears glasses but had her eyes checked in September, 1970. Familiar with both route and vehicle. 18 years of driving experience; had driver's education in college; no previous accidents; no previous traffic violations. Not restrained; received no injuries. Injury severity index: none (00).

Pre-Crash Events. The driver was on the way to her home from school and she had an appointment with her obstetrician. She was travelling southerly on I-75 at about 60 MPH. She passed another vehicle and was moving back to the right lane (lane 1) when she started to lose control of the vehicle. The vehicle left the roadway, rotating counterclockwise.



At-Crash Events. The vehicle knocked down a reflector post and continued on for a total distance of approximately 130 feet and overturned.

Post-Crash Events. The driver unlocked the door of the vehicle and left the vehicle on her own effort. She was then taken to her obstetrician at Emory University by a passer-by in a private vehicle. She was examined by her obstetrician and released as she received no injuries. The vehicle was impounded and later salvaged.

Causal Factors, Comments and Recommendations.

Matrix

- |  |         |
|--|---------|
| 1. Joint principal contributing factors: wet and slippery roadway; worn tires; speed excessive for conditions; driver error (improper reaction).   | 7,4,1,1 |
| 2. Remarkably, the driver was not injured despite the fact that she was not wearing a seat belt. Being pregnant, it seems likely that she would have been injured had she been wearing her lap belt.   | 2       |
| 3. Additional research is recommended for the development of a reliable seat belt system for pregnant women. In the meantime, driver education courses should point out the potential hazard in the wearing of seat belts by pregnant women. | 4,1     |
| 4. The driver of the vehicle was late for her appointment with her obstetrician.   | 1       |



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 96

Identification. This accident occurred at the intersection of 14th Street and Techwood Drive, about one mile north of the central business district of Atlanta, Georgia, at about 3:45 P.M. on a Friday in May, 1971. The collision involved a 1966 Chevrolet El Camino pick-up truck (vehicle 1) whose driver failed to observe the oncoming traffic, entered the intersection and struck a 1971 Oldsmobile Cutlass (vehicle 2). Maximum occupant injury severity: minor (01).

Ambience. The weather was clear and the ambient air temperature was 72 degrees. The wind was from the northwest at 6 MPH. The roadway surface was dry.

Roadway. Techwood Drive, a lightly-travelled local commercial street (hourly volume: 161 both directions), is a two-lane, two-way, 40-foot wide roadway north of the intersection and is a four-lane, two-way, 40-foot wide roadway south of the intersection. It has a positive 1.5 percent gradient entering the intersection southbound, and a negative 3 percent gradient departing the intersection. Fourteenth Street is a heavily-travelled commercial collector street with one-way operation; hourly volume: 1,520. It has four ten-foot lanes east of the intersection and two ten-foot lanes and one twenty-foot lane west of the intersection. Fourteenth Street has a negative 6 percent gradient westbound in the intersection. The streets meet at a 90 degree angle.

Both streets have straight alignment; curb and gutter design; and are illuminated. The intersection is paved with concrete with an estimated skid resistance of 0.65. Accident history: 32 accidents in 1970 and 16 accidents in 1971.

Traffic Controls. The traffic at this intersection is controlled by stop signs on Techwood Drive. Techwood Drive has a posted speed limit of 35 MPH. Fourteenth Street is zoned for a speed limit of 30 MPH, changing to 35 MPH just west of the intersection. Standard lane and pedestrians crosswalk markings. No parking allowed in the proximity of the intersection. One-way operation was instituted in May, 1969.

Vehicle 1, a 1966 brown Chevrolet El Camino truck, 6 cylinder 230 cu. in. engine, automatic transmission, manual steering, manual brakes (drum), lap belts. Equipped with after-market truck bed enclosure. Exterior damages: hood, grill, bumper, two front fenders; damage distributed across front of vehicle; maximum penetration 7 inches at corner of left front fender; hood elevated and moved forward, did not contact windshield; slight frame horn damage; wheel base not shortened. Interior damage: left door panel by occupant contact. Primary damage 12-FDEW-2. Vehicle repairable, estimated cost \$950.00. Valid inspection sticker, good mechanical condition.

Vehicle 2. A 1971 dark green Oldsmobile Cutlass "S", two-door hardtop, green vinyl top, curb weight 3,458 pounds, equipped with 350 cu. in. 4 barrel carburetion, automatic transmission, power steering, power brakes (drum), padded instrument panel, lap and shoulder belts front and lap belts in rear,

Vehicle 2. (Cont'd.)

no special equipment. Exterior damages: top, both right fenders, door, hood, left rear fender, upper C-pillar. Wheel rim damage left rear, lateral extent of damage distributed over entire right side and right front of top. Frame was damaged, wheel base shortened left side 1 inch, lengthened right side 1 inch. Windshield cracked, plastic inner layer torn, bond separation 10 percent, both right side windows broken. Interior damages to instrument panel. Intrusion of top into passenger compartment, 6 inches above right window sill, maximum penetration located 61 inches to rear of right front axle and resulted from rollover. Primary damage 03-RPMW-3, secondary damage 03-TPGO-3. Total loss, cost of replacement \$4,300.00. Valid inspection sticker, new owner of vehicle uncooperative but original owner stated that vehicle was in good mechanical condition.

Driver, Vehicle 1. The driver of this vehicle was a 63-year-old married male employee of an international security agency. His trip origin was a tire dealership on the northwest corner of the intersection where the accident occurred, evidently to pick up the passenger in his vehicle. The Georgia State Highway Patrol records show four previous traffic violations for this driver: 2 in 1943, 1 in 1945 and 1 in 1953. He received a visible minor contusion on his forehead probably from impacting left upper window frame. This driver would not cooperate with the research team, thus further pertinent information is not available. Injury severity index: minor (01).

Right Front Passenger, Vehicle 1. The only passenger in this vehicle has had a series of heart attacks, beginning 3 days after the accident, and has been under intensive care since that time. He was a 56-year-old male co-worker with the driver, and was evidently receiving a ride from the driver. He sustained no apparent injury in the crash. Other pertinent information is not available because of the lack of an interview. Injury severity index: none (00).

Driver, Vehicle 2. The driver and sole occupant of this vehicle is a 5'8", 155-pound, 20-year-old single male student at a local university, and part-time employee of a local utility plant. Trip purpose: en route to work from school. Had obtained car from his mother's place of employment. Familiar with route. Had driven vehicle (family car) 5 weeks. Five years' driving experience, including a learning permit for one year and a high school driver's training course. One recorded traffic violation, traffic signal ordinance, received more than a year prior to this accident. Unrestrained. Received lacerations on left knee (source unknown) and left forearm (source unknown). Injury severity index: minor (01).

Pre-Crash Events. The driver of vehicle 1 was proceeding southbound on Techwood Drive, origin of trip a tire dealership on the northwest corner of the intersection where the accident occurred. He was evidently giving his passenger a ride. The driver stated that he stopped, looked up 14th Street, saw no traffic approaching, and proceeded to cross the intersection.

The driver of vehicle 2 stated that he stopped at a traffic signal, located 150 feet from the intersection where the accident occurred. (This is considered highly unlikely.) He then continued to proceed west on 14th Street. He saw vehicle 1 entering the intersection at about the time he arrived at the intersection. He tried to swerve left to avoid vehicle 1.



At-Crash Events. The front of vehicle 1, with an estimated speed of 15 MPH, struck vehicle 2 in the right front side. Vehicle 2 was travelling at an estimated speed of 50 MPH at the time of impact. Vehicle 1 rotated about 50 degrees clockwise and came to rest facing the curb on the southwest corner of the intersection, having travelled a distance of approximately 25 feet from the point of impact.

Vehicle 2 rotated clockwise approximately 50 degrees, sliding sideways on the concrete pavement about 20 feet before the left rear wheel mounted the curb, causing the tire to blow out. The vehicle continued to slide sideways and the left rear wheel rim dug into the turf strip, causing the vehicle to overturn. The vehicle then slid on its top for another 25 feet, knocking down a speed zone sign before coming to rest about 65 feet from the point of impact, having rotated a total of approximately 90 degrees.

Post-Crash Events. The three persons involved in the accident were able to get out of their vehicles without assistance. The ambulance arrived about 10 minutes after the crash and transported the driver of vehicle 2 to Grady Memorial Hospital where he was treated and released. The occupants of vehicle 1 did not submit to treatment at that time. The roadways were cleared about 30 minutes after the crash. The driver of vehicle 1 was charged with, and later fined \$17 for failure to yield right-of-way.

Causal Factors, Comments and Recommendations.

Matrix

- |  |   |
|--|---|
| 1. Principal contributing factor: the driver of vehicle 1 failed to observe vehicle 2 approaching (reason unknown). By field study and observation, the research team determined that vehicles reappear from a sag vertical curve approximately 400 feet from the intersection where the accident occurred. Insufficient sight distance is therefore not considered a factor in this case. | 1 |
| 2. Modifying factor: excessive speed of vehicle 2.   | 1 |
| 3. The fact that the roof structure failed under static load of the overturned vehicle with little dynamic load suggests that two-door hardtop vehicles of this type have an inherent weakness in the roof support structure.  | 5 |



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 97

Identification. This accident involved a 1964 Ford N600 truck (vehicle 1) which ran a red light and struck a 1971 Oldsmobile Ninety-Eight four-door hard-top (vehicle 2). The accident occurred at the intersection of Northside Drive and 8th Street in northwest Atlanta, approximately one-half mile northwest of the Georgia Tech campus, on a Tuesday in June, 1971, at approximately 4:00 P.M. Maximum occupant injury severity: dangerous, serious (04).

Ambience. The weather was cloudy and warm with an ambient air temperature of 84 degrees. Wind was from the west at 5 MPH. The roadway surface was dry.

Roadway. Northside Drive is a heavily-travelled urban arterial (ADT: 15,457) consisting of three lanes in each direction divided by a 4-foot wide median. In each direction, lanes 1 and 3 are 11 feet in width while the center lane (lane 2) is 10 feet wide. At the intersection with 8th Street, Northside Drive is straight in alignment and level with a 3 percent crown.

Eighth Street is a two-lane, two-way, lightly-travelled local street; intersecting Northside Drive at a right angle; ADT: 167; 18 feet in total width; 5-foot wide elevated sidewalks. The roadway is straight in alignment; has a negative 8.5 percent grade going westbound; no crown.

Both streets are of curb and gutter design; illuminated; paved with asphaltic concrete with a measured skid resistance of 0.74 under dry conditions. Accident history: 7 accidents from January to June, 1971, and 13 accidents in 1970.

Traffic Controls. The intersection is controlled by a fully-actuated traffic signal. Because of narrowness of 8th Street, a "STOP" bar, recessed 30 feet from curb line of Northside Drive, is provided on 8th Street for westbound traffic so as to accommodate right-turning vehicles from Northside Drive. The location of the "STOP" bar, coupled with an earth bank and vegetation at the corner of the intersection, greatly restricts the sight distance from 8th Street toward Northside Drive (curb lane) to approximately 30 feet and that from Northside Drive (curb lane) to 8th Street to practically zero. Posted speed limits are: 35 MPH on Northside Drive and 25 MPH on 8th Street. No parking allowed on both streets.

Vehicle 1. A green and white Ford N600 truck; equipped with 8 cylinder engine, 4 speed manual transmission, manual steering, power brakes, no padding; lap belts only. Exterior sheet metal damage: left front fender, bumper and grill; damage was distributed over entire front end; maximum penetration was 2 inches located on the left headlight area. Radiator was pushed back into fan requiring vehicle to be towed from scene. There was no interior damage nor physical evidences of occupant contact. Vehicle deformation index: 12-FDMW-1. Estimated cost of repair: \$250. Inspection sticker expired April 30, 1971, 2 months prior to accident. Mechanical defects: slick tire on right rear inner dual. Unable to check tire pressure because of recessed valve cores. Otherwise, vehicle in good mechanical condition prior to crash.



## SUMMARY AND COMMENTS

Vehicle 2. Vehicle 2, a 1971 dark green Oldsmobile Ninety-Eight four-door hardtop equipped with a 455 cu. in. V-8 engine, 4 barrel carburetion; automatic transmission; power steering; power brakes (disc front); padded instrument panel; lap and shoulder belts in front and lap belts in rear. Special equipment: automatic speed control, tilt and telescoping wheel. Exterior damages: left front and rear doors with broken glasses, left front fender. Lateral extent of damage 113". Maximum penetration 24" in line with left B-pillar. Frame was not damaged. Interior damages: deformed steering wheel rim, left instrument panel, tilt wheel control, automatic speed regulating control. No physical evidence of occupant contact. The steering column energy absorbing device was not compressed. Intrusion to the passenger compartment was 20" in the area of the left B-pillar and left front door, resulting from contact with vehicle 1. Primary damage 09-LYHW-4. Total loss, cost of replacement \$6,000. Vehicle in good mechanical condition prior to crash.

Driver, Vehicle 1. A 6'2", 230-pound, 23-year-old male truck driver. Familiar with route and vehicle. He had his driver's license for 5 years but had been driving since he was a young boy; had National Safety Council Defensive Driving Course; one previous minor accident; three previous traffic violations. Not restrained; received negligible injuries consisting of minor general soreness and a jammed left index finger. Not treated. Injury severity index: minor (01).

Driver, Vehicle 2. A 6'0", 175-pound, 41-year-old male salesman. Familiar with route, but only had vehicle for two weeks. 26 years of driving experience; no driver's education; no previous traffic violations. Not restrained; received a ruptured spleen which required removal; multiple rib fractures on left side (numbers 6 through 11); contusion of the left kidney with hematuria and a left hemathorax. No physical evidences of occupant contact but injuries almost certainly resulted from impact with left front door. Taken by ambulance to Georgia Baptist Hospital where he was hospitalized for 10 days. Injury severity index: dangerous, serious (04).

Right Front Passenger, Vehicle 2. A 6'2", 170-pound, 42-year-old male; sales manager of the company the driver of vehicle 2 works in. Not restrained; received contusion of left scapula from probable impact with the steering rim; fractured 5th and 6th ribs on left side with pleuritic-type pain, likely resulting from impact with gear shift lever; contusion on right knee from striking air conditioner vent and contusion in the left temporal area, probably caused by impact with instrument panel. Taken by ambulance to Georgia Baptist Hospital; treated and released but later examined and treated by an orthopedic surgeon. Injury severity index: moderate, non-dangerous (02).

Pre-Crash Events. The driver of vehicle 1 was on his way to a delivery about 2 blocks north of the accident scene. He was travelling northerly on the curb lane (lane 1) of Northside Drive at a speed of approximately 35 MPH. He stated: "As I approached the intersection, I saw the light changing." He then saw vehicle 2 emerging from 8th Street, he applied brakes and tried to steer to the right.

The occupants of vehicle 2 were returning from a business appointment to their plant. Both driver and passenger stated they were travelling west

on 8th Street; stopped at the "STOP" bar for the red signal light; first car in queue; talking about their business appointment. Then proceeded into intersection as traffic light changed to green.

Upon analysis and reconstruction of the accident, as shown in Figures 97-6 and 97-7, members of the research team concluded that vehicle 1 did run the red light; however, it is unlikely that vehicle 2 came to a dead stop at the "STOP" bar for the red light, but instead approached the intersection at an average speed of 15 MPH as the light changed from red to green.

At-Crash Events. Vehicle 1 skidded approximately 43 feet and struck vehicle 2 on the left side in the passenger compartment area at an estimated speed of 20 MPH. The Oldsmobile was estimated to be moving at about 15 MPH at the point of impact. Both vehicles rotated counterclockwise and came to rest about 15 feet from the point of impact.

Post-Crash Events. An ambulance arrived 15 minutes after the accident and transported the driver and passenger of vehicle 2 to Georgia Baptist Hospital for emergency treatment. Vehicle 1 was towed back to the delivery company and later repaired. Vehicle 2 was impounded and later salvaged.

Both drivers were charged with violating the red light ordinance (causing accident). Trial was postponed to late August, 1971, because of the physical condition of the driver of vehicle 2.

Causal Factors, Comments, Recommendations.

Matrix

- |  |      |
|--|------|
| 1. Joint principal contributing factors: violation of red signal (driver of vehicle 1) due to inattentiveness, and obstruction to sight distance due to earth bank and vegetation.   | 1, 7 |
| 2. It is unlikely that vehicle 2 came to a complete stop at the "STOP" bar as testified by its occupants.  | 1    |
| 3. The obstruction to sight distance caused by the vegetation and earth bank constitutes a safety hazard which should be corrected. There are several ways this condition could be improved. The most effective improvement would be to widen the 8th Street approach and move the "STOP" bar to the crosswalk. Another possible improvement would be to make 8th Street one-way eastbound. Marginal improvement could be realized by moving the earth bank eastward and removing vegetation growth. | 7    |
| 4. The driver of vehicle 2 was talking with the passenger and was probably inattentive to his driving task.  | 1    |
| 5. Vehicle 1 had an expired vehicle inspection sticker. A worn right rear inner tire was in violation of the motor vehicle inspection law.   | 4    |
| 6. The truck rode over the frame of the automobile resulting in about 24 inches of side penetration. In crashes of this type, the side penetration could be reduced by providing roll bar type structural members in the automobile and/or by providing a lower bumper height for the striking vehicle.  | 5    |
| 7. It is noted that certain General Motors automobiles have a chrome molding strip along the rear edge of the hood. This is a possible violation of Federal Motor Vehicle Safety Standard 107.   | 4    |



# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 98

Identification. This accident occurred on Moores Mill Road, about 100 feet southwest of the Interstate Route 75 interchange. This location is approximately 5.5 miles northwest of the central business district in Atlanta, Georgia. The accident occurred on a Wednesday in June, 1971, at about 3:30 P.M. It involved a 1969 Jaguar (vehicle 1) which slid across the centerline and sideswiped a 1964 Chevrolet pick-up truck (vehicle 2), causing vehicle 2 to leave the roadway and collide with a utility pole. Maximum occupant injury severity: non-dangerous, moderate (02).

Ambience. Light rain had fallen and the roadway surface was wet. Ambient air temperature 85 degrees. Wind from southwest at 8 MPH.

Roadway. Moores Mill Road is a moderately-travelled (hourly volume at time of accident: 822 vehicles, sum of both directions) two-lane, two-way residential collector street. Width 30 feet; curb and gutter design; illuminated; paved with asphaltic concrete; estimated skid resistance 0.65 under wet conditions.

The accident site is located at an irregular horizontal curve with a maximum curvature of 15.5 degrees; gradient positive 1.2 percent westbound. Numerous signs, utility poles and trees line the roadway. No accidents reported at this location during 1970 or 1971.

Traffic Controls. The posted speed limit is 35 MPH. Standard centerline and yellow stripes to prohibit passing in either direction are provided. The horizontal curve is identified from each direction by large arrows on yellow diamond-shaped signs (the Manual on Uniform Traffic Control Devices requires rectangular-shaped signs). Parking not allowed.

Vehicle 1. A 1969 red Jaguar E Type, 4.2 liters, 6 cylinder engine, unladen weight 2,464 pounds, 4-speed manual transmission, manual steering, power disc brakes, padded instrument panel and door panel. Exterior damages: left front fender; lateral extent of damages 34 inches; maximum penetration 5 inches located 22 inches from front of vehicle. No frame damage. No interior damage. No sign of occupant contact. Vehicle deformation index: 11-FLMW-1. Estimated cost of repairs \$350. Slick left rear tire, degraded windshield wiper blades. Valid state inspection sticker.

Vehicle 2. A 1964 blue Chevrolet Series 10 pick-up truck, 6 cylinder engine, no power equipment, no lap belts. Exterior damages: contact with vehicle 1--left front fender, left door; contact with pole--hood, grill, right front fender. Maximum penetration 15 inches located right front corner. Hood latch disengaged, front elevated. Interior damages with evidences of occupant contact: lower instrument panel, steering wheel and windshield. Vehicle deformation index: primary-- 11-LYEW-1; secondary-- 12-FREN-2. Repair cost estimate \$600. Inspection sticker valid. Mechanical condition poor; tail pipe missing allowing exhaust to be discharged underneath passenger compartment. Very weak shock absorbers, windshield wiper blades poor, engine throwing oil and emitting oil fumes.



Driver, Vehicle 1. The driver and only occupant of the 1969 Jaguar was a 5'11", 170-pound, 25-year-old male; occupation given as "promoter of concerts"; familiar with route but not with vehicle having driven it only once or twice before; possessed New Jersey driver's license; three previous known traffic violations within the past 2 years. Unrestrained; uninjured. Injury severity index: none (00).

Driver, Vehicle 2. A 5'11", 210-pound, 50-year-old male painter; familiar with vehicle and route; was driving with license in revocation; fourteen previous traffic violations including five convictions for driving while intoxicated. Fined \$150 following this accident. Unrestrained; uninjured. Injury severity index: none (00).

Center Front Passenger, Vehicle 2. A 13-year-old male, stepson of driver. Unrestrained; received abrasion to left knee from instrument panel. Later complained of double vision and continuous headaches but examination by osteopath revealed no impairments. Injury severity index: minor (01).

Right Front Passenger, Vehicle 2. A 16-year-old stepson of the driver. Sustained spiral fracture of right tibia, as a result of having right foot wedged between heater and floor pan. Injury severity index: non-dangerous, moderate (02).

Pre-Crash Events. Vehicle 1 was proceeding west, stated purpose of trip from shopping to home; lost control in curve at an estimated speed of 35 MPH, slid across centerline. Vehicle 2 was proceeding east at an estimated speed of 30 MPH, stated purpose of trip from work to home.

At-Crash Events. The left front of vehicle 1, with an estimated impact speed of 20 MPH, struck vehicle 2 immediately behind the left front wheel. Estimated impact speed of vehicle 2 was 30 MPH. Vehicle 1 rotated clockwise about 80 degrees, coming to rest on the right side of the roadway, having travelled a distance of approximately 30 feet from the point of impact.

After initial impact, vehicle 2 continued forward in a nearly straight line, colliding with a 12-inch diameter utility pole located about 1.5 feet from the pavement edge. Estimated speed at this impact: 20 MPH. No noticeable rotation or further movement following this crash.

Post-Crash Events. Atlanta policemen and a police rescue unit were dispatched to the scene. An ambulance carried the injured right front passenger of vehicle 2 to Grady Memorial Hospital. Vehicle 1 was driven to the home of its owner. A wrecker towed vehicle 2 to the driver's home.

The driver of vehicle 1 was later fined \$25.00 for violation of lane ordinance. The driver of vehicle 2 was fined \$150.00 for driving with driver's license in revocation.

#### Causal Factors, Comments and Recommendations.

#### Matrix

1. Joint principal contributing factors: driver unfamiliarity with vehicle (vehicle 1), excessive speed for conditions (vehicle 1), slick tire (vehicle 1), wet roadway, curved road.

1,1,4,7,7

<u>Causal Factors, Comments and Recommendations. (Cont'd.)</u>	<u>Matrix</u>
2. Modifying factor: location of utility pole.	8
3. Both vehicles were in poor mechanical condition prior to the crash.	4,4
4. Driver of vehicle 1 did not have a Georgia driver's license as required by law. The Municipal Court record failed to make note of this violation. It is apparent that this law, requiring non-residents to obtain a Georgia driver's license after 30 days in the state, is extremely difficult to enforce.	1
5. Driver of vehicle 2 was driving with his license in revocation. This was the fifth time he was convicted of this violation.	1
6. Investigating officers failed to notice the tire with cord exposed on vehicle 1.	1
7. The only significant injury sustained in this accident (fractured tibia, right front passenger, vehicle 2) again indicates a need for improving the safety features of pick-up truck interiors.	4





# GEORGIA INSTITUTE OF TECHNOLOGY

School of Civil Engineering

Vehicular Collision Research Team

Atlanta, Georgia 30332

SUMMARY AND COMMENTS

REPORT NO. 99

Identification. This accident involved four vehicles: a 1966 Ford pick-up truck (vehicle 1) which collided with a 1968 Ford Falcon two-door sedan (vehicle 2), a 1968 Ford four-door sedan (vehicle 3), and a 1967 Chevrolet pick-up truck (vehicle 4). The accident occurred near the north fringe of Atlanta's central business district on a Friday in July, 1971, at an expressway interchange, North Expressway at 10th Street. Maximum occupant injury severity: moderate, non-dangerous (02).

Ambience. Skies overcast but not raining; road surface dry. Temperature 77 degrees; wind from northwest at 5 knots.

Roadway. Diamond interchange in which 10th Street overpasses North Expressway. Tenth Street is 48 feet wide; four traffic lanes one-way eastbound; curbs and sidewalks provided. Straight alignment; plus 6.0 percent gradient eastbound. Asphaltic pavement with 0.72 skid resistance. North Expressway is a controlled-access six-lane expressway with 14-foot wide median. Straight alignment, insignificant grade. Worn concrete pavement, estimated skid resistance 0.65. At accident location, exit ramp merges with frontage street which has three 11-foot lanes, one way; straight alignment; plus 4.5 percent grade northbound. Tenth Street has about 1,650 vehicles per hour during accident hour; expressway has 125,000 ADT. During 1970, there were 10 accidents along 10th Street in vicinity of crash.

Traffic Controls. Both ramps are controlled by semi-actuated controller interconnected with other nearby signals on 10th Street. Speed limit 50 MPH on expressway; 30 MPH on 10th Street; frontage street not zoned. Standard lane markings are provided.

Vehicle 1. A 1966 blue and white Ford F100 truck, 6 cylinder engine, all systems manual, padded upper instrument panel, 2 lap belts. Exterior damage: 1st impact--bumper, grill, both front fenders, hood; 2nd impact--right side of truck bed sustained minor damage in line with right rear axle; 3rd impact--in same area as first impact causing right front wheel to turn and bend tie rod and drag link; 4th impact--with vehicle 4 on left side truck bed. Lateral extent of damages from primary impact 30 inches and maximum penetration of 24 inches; 2nd impact, maximum penetration 3 inches; 4th impact, maximum penetration 5 inches. Interior damage: steering wheel caused by occupant contact. Inferior workmanship in replacing the vehicle top resulted in windshield being ejected from its mounting. Vehicle deformation index ratings as a result of collision of vehicle 1 with vehicle 2, primary-- 12-FZEW-3, secondary-- 03-RBMW-1. Vehicle deformation index of collision of vehicle 1 with vehicle 3, 12-FRIW-0. Vehicle deformation index of collision of vehicle 1 with vehicle 4, 04-LBMW-1. Vehicle in good mechanical condition, except for slick tires. Cost to repair vehicle \$600.

Vehicle 2. A 1968 red Falcon 2-door sedan, curb weight 2,680 pounds, 6 cylinder engine, all manual systems, padded instrument panel, load distributing steering wheel, 2 lap belts front seat and 3 lap belts rear seat.

Vehicle 2. (Cont'd.)

Exterior damages: left front fender, hood, left door, left rear fender, left front wheel. Lateral extent of front side damages 70 inches, maximum penetration 8 inches; maximum penetration at rear fender 2 inches. Frame not damaged, wheel base lengthened 1.1 inches right side, shortened left side .4 inch. Windshield cracked, plastic inner layer torn and a bond separation of 5% was noted. The left vent glass post was forced out of place exposing a sharp, jagged edge. Interior damages: lower instrument panel, ashtray, steering wheel, left door panel, armrest, and rear view mirror, all caused by occupant contact. Steering energy absorbing device not compressed, shear capsule separation .25 inch. Breakaway rear view mirror mount disengaged by occupant contact. Vehicle deformation index: primary damage, 09-LYEW-3; secondary damage, 09-LBEW-1. Vehicle was in good mechanical condition prior to crash. Vehicle is total loss, cost of replacement \$950.00.

Vehicle 3. A 1968 burgundy Ford LTD four-door hardtop was struck on the right rear causing damage to the right rear fender and bumper. Vehicle deformation index: 03-RBMW-1. Due to the fact that this vehicle was in transit, further investigation was not possible.

Vehicle 4. A 1967 red and white Chevrolet Series 10 truck, gross vehicle weight 5,000 pounds, 6 cylinder engine, manual transmission, manual steering, manual drum brakes, 2 lap belts front seat. Minor damage to right front fender, maximum penetration 5 inches, lateral extent of damage 8 inches. Vehicle driven from scene by owner. No interior damages, no indication of occupant contact. Vehicle defects: slick tires. Vehicle deformation index: 01-FRMW-1. Cost of repairs \$100.00.

Driver, Vehicle 1. A 40-year-old female motel desk clerk; 5'2", 155 pounds. Not restrained. Received bloody nose from contact with steering rim; contusion of left knee from impact with steering column; contusions of left humerus and left sacroiliac area from impacting vehicle interior below instrument panel. Injury severity index: non-dangerous, moderate (02).

Driver, Vehicle 2. A 5'9", 181-pound, 42-year-old male. One previous traffic violation. Unrestrained. Received flexion-extension injury of neck as head went through left open window; minor laceration of left ear from contact with left vent window post. Injury severity index: minor (01).

Right Front Passenger, Vehicle 2. A 49-year-old, 5'4", 142-pound male. Received abrasion of left leg from impacting instrument panel and soreness of left temple caused by striking rear view mirror. Injury severity index: minor (01).

Occupants, Vehicle 3. Five out-of-state persons were in vehicle 3: driver, a 39-year-old male; right front, a 38-year-old female; left rear, a 13-year-old male; center rear, a 10-year-old female; and right rear, an 18-year-old female who received minor bruise to left cheek. Injury severity index: minor (01).

Driver, Vehicle 4. A 36-year-old male sheet metal worker; one previous traffic violation. Not injured.

Pre-Crash Events. Proceeding easterly on 10th Street in lane 3 at a speed of 20-30 MPH, the driver of vehicle 1 reportedly violated a red signal. Finding an empty queue and a signal just changing to green, the driver of vehicle 2 entered the intersection in the left curb lane at a speed of 10-20 MPH.

At-Crash Events. Vehicle 1 struck vehicle 2 in the area of the left front wheel causing it to rotate about 70 degrees. Vehicle 2 came to rest after skidding 26 feet. The driver of vehicle 1 was thrown to the right side of the vehicle into a prone position in the truck floor. The driverless vehicle rotated in a counterclockwise arc, mounted the west on-ramp curb and proceeded down a 3:1 earth embankment. Vehicle 1 entered the curb lane and then struck vehicle 3 in the right rear fender area, after which it rotated clockwise into vehicle 4 which had stopped in the middle north-bound lane.

Post-Crash Events. The driver of vehicle 4 went to the aid of the driver of vehicle 1 who lapsed into unconsciousness shortly after the vehicle came to rest. The crash caused a massive traffic jam. Wreckers towed away vehicle 1 and 2. The other vehicles were driven away by the owners. Two ambulances transported the injured to Grady Memorial Hospital.

Causal Factors, Comments, Recommendations.

Matrix

- |  |      |
|--|------|
| 1. Joint principal contributing factors: violation of red signal by driver of vehicle 1 and failure to exercise due caution by driver of vehicle 2 (probable). See comment 2.  | 1, 1 |
| 2. Members of the research team have observed that it is not uncommon for Atlanta drivers to violate red traffic signals by continuing through the intersection just after the signal changes to red. Interestingly, this does not generally pose a problem so long as traffic is heavy and there is a waiting line at the STOP bar on the opposing approaches. The time required for a stopped vehicle to accelerate and move into the intersection is usually adequate to make it possible for the violating driver's car to clear the intersection area. Such a violation presents a high risk of collision, however, when a driver of a vehicle on an opposing approach finds an empty queue and a signal just changing to green and enters the intersection without slowing down and exercising caution. The need to exercise caution under these circumstances should be emphasized in driver education classes. (Highway Safety Program Standard No. 4) | 1    |
| 3. It has been observed that pick-up trucks are being extensively used for commuting, social, recreational and other personal transportation purposes. It is recommended that Federal Motor Vehicle Safety Standards 201, 203, and 204 be extended to apply to pick-up trucks as soon as these changes can reasonably be effected.   | 5    |





Identification. This accident occurred at the intersection of 12th Street and Juniper Street in Northeast Atlanta, Georgia, at approximately 5:45 P.M. on a Friday in July, 1971. Two vehicles were involved in this accident: a 1963 Chevrolet Impala four-door hardtop (vehicle 2) which ran a red light and was struck by a 1970 Plymouth GTX two-door hardtop (vehicle 1). Maximum occupant injury: minor (01).

Ambience. The weather at the time of this accident was cloudy and warm. Ambient air temperature was 79 degrees; wind north-northwest at 5 knots; the roadway surface was dry.

Roadway. Juniper Street is a moderately-travelled (hourly traffic volume: 838) residential collector street going one-way southbound with three through lanes and a left-turn-only lane which ends at the intersection. To the north of 12th Street, Juniper Street is offset 6 feet east of the alignment of the street south of the intersection. The street also narrows from 42 feet to 32 feet at the intersection. Twelfth Street is a lightly-travelled (hourly traffic volume: 396 both directions), two-lane, two-way residential street which narrows from 32 feet to 21 feet at the intersection when proceeding west.

The two roadways intersect at a right angle. Both streets are of curb and gutter design, illuminated and paved with asphaltic concrete with a measured skid resistance of 0.65. Accident history: one accident in 1971.

Juniper Street has a negative 5 percent gradient approaching, and a negative 4 percent gradient departing the intersection southbound. Twelfth Street has a positive 6.5 percent gradient approaching, and a positive 8 percent gradient departing the intersection westbound. The intersection is crowned in the direction of 12th Street with a 2-inch crown on the east side and a 6-inch crown on the west side of the intersection.

Traffic Controls. The intersection is controlled by a fixed-time traffic signal with a one-minute cycle. Juniper Street originates two blocks north of 12th Street; no posted speed limit for the roadway north of the intersection. Twelfth Street is zoned for a speed limit of 30 MPH. Both streets have standard lane markings, and no parking is allowed in the proximity of the intersection.

Vehicle 1. A 1970 blue Plymouth GTX, curb weight 3,675 pounds, eight cylinder 400 cu. in., 390 HP, automatic transmission, manual steering, manual drum brakes, padded A-pillar, padded instrument panel, load distributing steering wheel, lap and shoulder belts on front bucket seats and three lap belts on rear seat. No special equipment. Exterior damages--bumper, hood, grill, and both front fenders. Secondary damage to left door outer panel; damage to left rear fender caused by wrecker. Lateral extent of damage 38 inches, maximum penetration 10 inches, located 31 inches front center from left side of vehicle, right front corner of hood elevated, hood latch jammed, left door glass broken. Frame was not damaged, wheel base 1 inch longer than original dimension on right side. No interior damage, no sign of occupant contact. Primary damage 12-FDEW-2, secondary damage 09-LPMW-1. Repair cost estimate: \$1,200.

Vehicle 2. A 1963 dark blue Chevrolet Impala four-door hardtop, 8 cylinder 283 cu. in. engine, curb weight 3,475 pounds, automatic transmission, power steering, power drum brakes, padded instrument panel, power seats and air conditioner, lap belts. Exterior damages--primary impact: right front fender and both right doors, lateral extent of damage 64 inches, maximum penetration 22 inches; secondary impact: bumper, grill, hood and left front fender, lateral extent of damage 34 inches, maximum penetration 20 inches. The right wheel base was shortened 5 inches and the left wheel base was lengthened 2 inches. Interior damages--vertical rotation of instrument panel, seat track separated at adjuster, movement of seat forced disengagement of left front door latch. Primary damage 03-RYEW-4; secondary damage 11-FYEW-2. Vehicle is a total loss, cost of replacement \$350. Mechanical condition good, however, the four coil springs had collapsed.

Driver, Vehicle 1. A 5'11", 160-pound, 23-year-old married male employee of a local exterminating firm. Sole occupant of vehicle, familiar with both route and vehicle. 7 years' driving experience, no formal driver's training. Two recorded traffic violations, speeding and improper lane change, both in 1969. Unrestrained; not significantly injured, not treated. Injury severity index: none (00).

Driver, Vehicle 2. A 5'6", 140-pound, 20-year-old single male employee of a local building materials firm. Sole occupant of vehicle; had travelled route a very limited number of times; familiar with vehicle. 3 years' driving experience, completed two quarters' high school drivers' training course. Had had impaired vision in right eye since 9 years of age from being struck by automobile, and according to his father also suffered some brain damage. Has suppressed use of right eye to eliminate double vision, has normal monocular vision in left eye, has no depth perception due to lack of image fusion. Was charged and fined \$22 for violation of traffic signal ordinance in this accident; two previous convictions within past year involving accidents: Failure to yield right-of-way (turned left in front of oncoming vehicle) and following too close. Unrestrained; was dazed by impact and received 2-inch laceration in the right lateral cervical region near shoulder and contusion of the left lateral thigh. Injury severity index: minor (01).

Pre-Crash Events. The driver of vehicle 1 stated in an interview that he was upset about getting away from work late, and in a hurry to get home to leave on a holiday weekend. He was travelling south on Juniper Street in lane 2, and estimated that he was travelling 55-60 MPH approaching the 12th Street intersection. He believes the traffic signal was green when he was about a block from the intersection which agrees with the testimony of two witnesses. He observed a pick-up truck come to a sudden stop in the left-turn-only lane to his left and forward of him, and heard a horn blowing, but did not comprehend the significance of these events. The driver of the pick-up truck had shifted into second gear preparing to turn left, and observed vehicle 2 proceeding west on 12th Street toward the intersection with considerable speed (obviously not preparing to stop). He blew his horn to warn the driver of vehicle 1.

The driver of vehicle 2 stated in an interview that he was en route to an evening job, janitorial work at a local broadcasting station, from his regular daytime employment. This trip plan could not be substantiated by the driver's evening employer therefore his true trip plan is unknown. Vehicle 2 approached the intersection at an estimated speed of about 45 MPH, also its speed of impact.



At-Crash Events. The driver of vehicle 1 stated that he "only saw a blur, or flash" (referring to vehicle 2) and did not have time to use his brakes. His only action was to hang on to the steering wheel. At impact, the driver of vehicle 1 moved to his left against the door. A four-foot post-impact skid mark was left by vehicle 1, as it rotated approximately 45 degrees in a clockwise direction. The impact speed of vehicle 1 is estimated to be 45 MPH.

The driver of vehicle 2 was thrown to his right, contacting some sharp object and sustaining a laceration of the right lateral cervical region. He also sustained a contusion of the left lateral thigh from contact with some blunt object, possibly the steering column, steering wheel or lower face of the instrument panel. The front seat of vehicle 2 was pushed into the left door, forcing it open.

After being struck by vehicle 1, vehicle 2 rotated approximately 45 degrees counterclockwise leaving an 8-foot post-impact skid mark. Vehicle 2 then struck a two-foot stone retaining wall bordering the sidewalks on the southwest corner of the intersection. The estimated speed of this secondary crash was 25 MPH having travelled approximately 36 feet following initial impact. Vehicle 1 came to rest alongside and nearly parallel to vehicle 2.

Post-Crash Events. The driver of vehicle 2 was able to get out of his car but then laid down on the ground beside the car and remained there until he was removed by ambulance attendants. The ambulance arrived approximately 20 minutes after the accident occurred. Police were in the area and arrived momentarily after the accident.

The driver of vehicle 2 was treated at a local hospital and released. He was cited for traffic signal ordinance violation and fined \$22 in court.

<u>Causal Factors, Comments, Recommendations.</u>	<u>Matrix</u>
1. Joint principal contributing factors: violation of traffic signal (driver, vehicle 2), failure to exercise due caution when entering intersection and excessive speed (driver, vehicle 1).	1, 1, 1
2. The statements of two witnesses indicate that vehicle 2 entered the intersection some time after the traffic signal was red in its direction of travel.	1
3. The driver of vehicle 2 has no depth perception and limited vision to his right side.	1
4. Young drivers with handicaps which may affect their driving ability should be trained to realize that they must exercise a much greater degree of caution than the non-handicapped driver.	1
5. Rough treatment by towing services of crashed vehicles is frequently observed. This increases the total damage costs of crashed vehicles.	6