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First Annual Highway Traffic Safety Trend Report

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The authors review accident and accident exposure trends in the U.S. from 1950 to 1980. Accident trends assessed include fatalities, fatal accidents injuries, injury accidents, police reported and total vehicular accidents. Exposure trends are vehicle miles of travel (VMT), roadway miles by surface type and roadway class, licensed drivers, registered vehicles population and numbers of households.

The authors present comparisons of changes in these trends for 1950 to 1960, 1960 to 1970, 1970 to 1980 and other selected intervening years. Comparisons are provided in the forms of ratios (e.g., injuries to injury accidents), indicators (e.g., fatalities per billion vehicle miles of travel) and composite indicators (e.g., fatal accident involvement rate by driver's age and sex characteristics adjusted for exposure). In addition, detailed assessment of trends is provided for urban and rural areas, regions (e.g., sunbelt and snowbelt), and for fatal accidents trends between 1975 and 1980 when the effects of vehicle mix shifts, weekly time segments, alcohol involvement and posted speed are included as variables in the assessment.

The authors conclude that fatal and property damage are not growing as rapidly as exposure related variables such as VMT. However, the annual growth rate for injuries exceeds that of VMT. The authors recommend that accident and exposure trends be monitored on a continuing basis and that emphasis be placed on the design of a balanced data base necessary to develop indepth interpretations and projections of these trends.

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PREFACE

A major task in Abt Associates' Accident Trend Monitoring and Exploratory Analysis contract involves the compilation of traffic safety and exposure data. These data are required in order to accomplish one of the long-range objectives of the contract--the design of a comprehensive traffic safety statistical model. During the process of developing such a model it is necessary to obtain historical data on trends in key variables, such as traffic accidents, injuries, and fatalities as well as the number of drivers, vehicles, and travel miles that occur annually on our nation's highways and street systems. The purpose of this report is to present selected results from our comprehensive data base. These results are designed to identify major long-term trends in variables for which data are available, such as traffic fatalities, so that forces underlying changes in these trends can be more easily identified. Once these key trends are isolated, they can be analyzed in greater detail as part of subsequent tasks designed to model mathematically the nature and direction of change. For example, Abt Associates staff are currently utilizing state space forecasting techniques to separate endogenous from exogenous variables (i.e., vehicle miles of travel may be classified as endogenous while numbers of drivers may be classified as exogenous), and to measure the nature of change in trends so that linear secular trends can be distinguished from nonlinear, possibly stochastic, variations in trends. Results of these efforts will be reported in later task reports.

During the process of data compilation, it became apparent that problems associated with incomplete time series data, multiple sources of data and inconsistent definitions of variables in traffic safety characterize the years prior to NHTSA's creation in 1966. This creates difficulties in developing accurate long-term trends from consistent sources. Our approach to dealing with these difficulties is based on the following principles:

- Although we compiled data from all sources, preference for NHTSA and other federal agency data is shown in summary tables, graphs and in use of indicators. This preference is due to our belief that public agency records are more comprehensive and accurate than private organization files. In many cases private organization reports lack documentation of data nor do they adhere to consistent data reporting practices.

- Efforts to develop consistency of definitions were attempted subject to the limitations of resource constraints. For example, 1950 data for Alaska and Hawaii were added to U.S. totals to facilitate comparisons of U.S. change from 1950 to 1960, even though these states were not included in the United States in 1950. Also, the NHTSA definition of traffic fatality was utilized in development of annual estimates of fatalities.

- Ratios and indicators were constructed utilizing concepts derived from exising traffic safety literature. An effort was made to focus on index values to highlight the magnitude and direction of change, although absolute values and percent changes (e.g., annual compound growth rates) were also included. The use of index values also helps overcome data limitations to some extent, since these values may be accurate measures of change even though the absolute values are incomplete.

Also, it became apparent that a substantial amount of accident trend reporting currently exists. Our objective is to supplement the existing set of accident trend reports by concentrating on certain detailed aspects of the traffic safety program area that currently are not included in existing summaries of traffic safety data. Thus, the first annual traffic safety trend report will provide a useful framework for recording past trends concisely. It will also provide the basis for monitoring current trends and presenting results of projects derived from our modeling efforts. These results gradually will improve as consistent data become available from NHTSA's new data sources (e.g., NASS) and as the techniques utilized in developing predictions of change are refined through testing and validation of model parameters and equations.

Abt Associates staff acknowledge with appreciation the role of NHTSA staff members on whose insights and concepts this report is based. Particular thanks are offered to Donald F. Mela, the Contract Technical Monitor, and Dr. Joseph Engel, on whose suggestions and ideas the structure of this report and many of its tables are based. The authors of this report would also welcome suggestions on modifications to existing tables presented in the report or for comments relating to new tables that may be included in revised or future versions of the annnual highway traffic safety report.

1.0 INTRODUCTION

In the United States, traffic accidents are a major national concern. This is true because of the relatively large share of transportation fatalities accounted for by motor vehicle fatalities. According to a recent Transportation Systems Center report, motor vehicle traffic fatalities represented 94 percent of the 1980 transportation fatalities.[1] Although other modes of travel may have higher rates of fatalities than motor vehicle traffic (e.g., general aviation), traffic fatalities and motor vehicle accidents constitute the major share of U.S. transport accidents. Despite the fact that the automotive sector accounts for 73 percent of transportation-related GNP, this sector still accounts for nine-tenths of transportation-related fatalities.[2]

In an effort to guide traffic safety policy and programs, the National Center for Statistics and Analysis of the National Highway Traffic Safety Administration has issued periodic reports on trends in U.S. traffic fatalities and selected types of traffic accidents.[3] Despite the publication of these periodic reports, it is still difficult for decision makers and researchers to have ready and easy access to a standard and uniform set of traffic safety related historical data. Once this standard set of accounts is created, the data collected by various NCSA elements can be assessed comprehensively and disseminated readily.

The purpose of this report is to provide the structure and data necessary to periodically monitor and assess U.S. traffic accident experience. The creation of this "First Annual Highway Safety Traffic Trend

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[1] Transportation Safety Information Report: 1980 Annual Summary, Transportation Systems Center, U.S. Department of Transportation, Cambridge, MA, 1981. See Appendix A for a detailed listing of data sources utilized in the preparation of this report. For definitions of accident types, see Fatal Accident Reporting System Annual Report, National Highway Traffic Safety Administration, 1980, and Manual on Classification of Motor Vehicle Traffic Accidents (Third Edition), National Safety Council, Chicago, 1976.

[2] Transportation Facts and Trends, Transportation Association of America, Washington, D.C., 1980. Transportation has accounted for approximately 20 percent of G.N.P. from 1958 to 1978 (p. 11, also p. 17).

[3] Fact Book: Statistical Information on Highway Safety, National Center for Statistics and Analysis, National Highway Traffic Safety Administration and Federal Highway Administration, Washington, D.C., and "Statistical Dimensions and Recent Trends in Highway Safety," NHTSA memorandum, Washington, D.C., January, 1981.

Report" has provided a basis for evaluating historical trends in U.S. traffic safety experience and for reporting on the results of analysis and projections on an annually updated basis. The structure of the report is oriented toward evaluating how accident trends change over time and how various underlying sources for this change (commonly referred to as "exposure variables") contribute to the explanation of this change. Examples of these sources of change are: shifts to smaller cars, increases in older drivers, and travel shifts related to migration to the "Sunbelt" states.

By improving the capability to monitor trends in accidents and exposure, decision makers are able to discern more accurately the influence of government "actions" (e.g., the 55 mph national speed limit or motorcycle helmet laws). Also, it is possible to utilize these data for preparations of forecasts of future accident, injury, and fatality trends based on assumptions of continued secular trends in exposure variables (e.g., population growth) or assumptions about the likely influence of proposed safety improvements (e.g., passive restraint systems) on future fatality and injury accident levels.[1]

Since decision makers may wish to utilize this information as the basis for calculations about the potential benefits and costs of various government actions, a section on costs of accidents is also included. The report concludes with a review of the influence of urbanization and migration on accident trends by examining these trends at a disaggregate level of regional detail (e.g., urban versus rural areas and sunbelt versus snowbelt states). The remainder of the report includes a review of results of statistical tests applied to key sets of data and an appendix that contains a description of data sources, assumptions and methodology utilized in the development of this report.

The remainder of this chapter of the report introduces aggregate data on U.S. traffic safety experience from 1950 to 1980. Chapter 2.0 is devoted to comparisons of this experience to exposure data, and Chapter 3.0 presents information on the costs of motor vehicle accidents. The next two chapters present regional accident trend information and statistical tests designed to measure the significance of observed differences. Chapter 6 recommends steps needed for future editions of these reports.

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[1] The Office of the Secretary of the U.S. Department of Transportation has recently compiled a set of trends and projections related to automotive and urban transportation: Profiles of the 80's, Assistant Secretary for Policy and International Affairs, Washington, D.C., February, 1980.

1.1 Summary of U.S. Traffic Fatality Experience, 1950 to 1980

Between 1950 and 1980, the number of traffic-related fatalities (i.e., deaths resulting from motor vehicle accidents on public roadways within 30 days of an accident) in the United States increased from 33,186 to 51,077.[1] Corresponding to this increase in fatalities, there was an increase in fatal accidents from 30,450 to 45,271 (see Exhibit 1.1). The percentage change increase for these years in fatalities and fatal accidents was 54 percent and 50 percent, respectively. Although the 1970-1980 decade has experienced an actual decline in fatalities and fatal accidents, the growth between 1960 and 1970 was more than sufficient to offset the decline. From 1979 to 1980, the number of fatalities actually was reduced, but the number of fatal accidents increased slightly.

The ratio of fatalities to fatal accidents did not change substantially from 1950 to 1980. This ratio is a useful way to consider the severity of fatal accidents since it represents the number of fatalities resulting from a particular accident. Despite the long-term stability of this ratio and the decline in fatalities from 1970 to 1980, the absolute magnitude of U.S. traffic fatalities continues to remain a major area of national concern. This is particularly true when the cumulative total of fatalities between 1950 and 1980 is considered--a staggering total of 1.4 million deaths associated with U.S. automotive travel.

1.2 Summary of U.S. Injury Experience, 1950-1980

Although less severe than fatal accidents, a traffic accident which results in injury can result in serious consequences to accident victims (e.g., loss of work through permanent disability).[1] Between 1950 and 1980, the number of injury accidents increased by 246 percent or by 4 percent each year. The number of injuries increased by 240 percent during the same period. As shown in Exhibit 1.2, this also represents a 4 percent annual increase. Obviously, the slow growth rate in fatality experience has not been matched by the fairly rapid increases in injuries and injury accidents. The number of injuries per injury accident declined by 2 percent from 1950 to 1980, so that an increase in frequency of injury accidents seems responsible

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[1] See Appendix B for a discussion of the definitional problems associated with the definitions of injuries and fatalities. For a description of computer programs utilized, see Assessment of U.S. 1980 Traffic Fatality Experience, Appendix Volume, Abt Associates Inc. for National Highway Traffic Safety Administration, Washington, D.C., 1981.

Exhibit 1.1

Traffic Fatalities and Fatal Accidents, 1950-1980

	Actual or Estimated Values					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Fatalities	33,186[a]	36,399[a]	52,627[a]	51,088[b]	51,077[b]	9.7	44.6	-3.1	0.0	1.4
Fatal Accidents	30,450[c]	35,000[c]	45,980[d]	45,218[b]	45,271[b]	14.9	31.4	-1.5	0.1	1.6
Ratio of Fatalities to Fatal Accidents	1.09	1.04	1.14	1.13	1.13	-4.6	9.6	-1.8	0.0	0.1[e]

[a] National Highway Traffic Safety Administration estimates of fatalities (various sources).

[b] Fatal Accident Reporting System, July, 1981.

[c] National Safety Council, various years.

[d] Federal Highway Administration, Fatal and Injury Accident Rates (adjusted).

[e] 1950 to 1980 percent change. Compound annual rates used unless indicated otherwise. See Appendix C for the equations utilized to compute compound annual growth rates.

Exhibit 1.2

Trends in Traffic-Related Injuries and Injury Accidents, 1950-1980

(preliminary)

	Actual or Estimated Values					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Injuries	989,450[a]	1,692,900[a]	2,710,959[b]	3,288,365[c]	3,366,299[d]	71.0	60.1	24.2	2.4	4.2
Injury Accidents	618,406[e]	1,065,000[e]	1,716,983[b]	2,089,030[b]	2,139,326[d]	72.2	61.2	24.6	2.4	4.2
Ratio of Injuries to Injury Accidents	1.60	1.59	1.58	1.57	1.57	-0.6	-0.6	-0.6	-0.0	-0.1

[a] Estimate based on Insurance Information Institute data.

[b] Federal Highway Administration, Fatal and Injury Accident Rates.

[c] National Accident Sampling System (estimated). Data for Federal Highway Administration injury accidents are based on police reported accidents while the data base for NASS accident records includes driver interviews and hospital records.

[d] See Appendix B for description of data utilized and assumptions.

[e] National Safety Council.

for this relatively rapid growth in injuries.[1] Even though the decade of the seventies appears to have experienced the lowest rate of growth in this accident measure--approximately 2 percent annually--the growth in injuries between 1950 and 1970 was 174 percent. This annual increase of 4 percent was reduced to 2 percent from 1970 to 1980. The magnitude of injury accidents is serious, with approximately 1 household in 25 involved in a traffic-related injury.[1]

1.3 Summary of Trends in Overall Traffic Accidents

Although historical trends of certain types of traffic accident frequencies in the U.S. were not compiled by a federal government source until 1979, it is possible to utilize National Accident Sampling System (NASS) estimates of traffic accident frequencies for 1979 to derive estimates of comparable sets of traffic accidents for earlier years.[2] (The rationale for utilizing this approach is discussed in Appendix B.) Based on this approach, figures for 1950, 1960, and 1970 can be developed for both police reported and non-police reported traffic accidents.

Between 1950 and 1980 the number of police reported accidents grew from 3.3 to 7.4 million, or 133 percent (see Exhibit 1.3). This represents a 3 percent annual increase, with the 1960 to 1970 years accounting for the largest share of the overall increase. That is, 56 percent of the annual increase is accounted for by the ten-year period from 1960 to 1970 (i.e., 2.3 million increase from 1960 to 1970 as a share of the 4.1 million increase from 1950 to 1980).

This estimate of police reported accidents (i.e., those officially reported to police authorities) is based on an estimate of both reported and non-reported accidents. Consequently, growth rates for overall motor vehicle accidents are the same as for those involving police reports only.

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[1] Assumes one injured victim per household using 1980 U.S. household and injury data. See Section 2.0 below for additional comparisons of accident rates.

[2] Earlier year data were compiled by the National Safety Council from various state and local government agency reports and published in Accident Facts, the Council's annual compendium of safety-related information.

Exhibit 1.3

Estimated Trends in Motor Vehicle Related Traffic Accidents, 1950-1980
(preliminary)

	Actual or Estimated Values					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Police Reported Accidents	3,345,301[a]	4,214,932[a]	6,482,907[a]	7,333,537[b]	7,449,045[c]	26.0	53.8	14.9	1.6	2.7
Total Accidents	8,280,450[d]	10,433,000[d]	16,046,800[d]	18,145,800[d]	18,409,527[c]	26.0	53.8	14.9	1.6	2.7

[a] Estimated using National Safety Council data and 1979 ratio of NASS accidents and NSC accident estimates (see Appendix B). The ratio of police reported accidents to total reported accidents is assumed constant for estimation purposes.

[b] National Accident Sampling System.

[c] Estimated using 1970 to 1979 growth rates.

[d] National Safety Council.

vehicle accidents are the same as for those involving police reports only. Since the National Safety Council figures imply that non-reported accidents represent 60 percent of the total, it is likely that accident victims are most frequently involved in this type of accident. In fact, based on the estimate of 18 million accidents in 1980, nearly one vehicle in nine was involved in an accident.[1]

1.4 Selected Indicators of U.S. Traffic Safety Trends

As shown in Exhibit 1.4, the ratio of fatalities to injuries has been steadily decreasing, that is the accidents causing fatalities are declining relative to the next most severe class of traffic accident (injuries). This decline is also noted when the indicator is computed on the basis of accident frequencies.[2] Although the decline persists throughout the 1950 to 1980 period, the ratio of fatalities to injuries declined most rapidly from 1950 to 1960.[3] In contrast to the decline in this ratio, the ratio of injury accidents to total motor vehicle related accidents increases by 55 percent between 1950 and 1980. This shift implies that injury accidents increase as a share of total accidents while fatal accidents decrease as a share of total accidents.[4]

An alternative method for viewing the significance of these shifts requires the use of an index rather than a ratio of values. Exhibit 1.5 presents the results of converting the measures displayed in Exhibits 1.1-1.3 to index values. Use of these index values enables the relative shifts from 1950 to 1980 to be magnified and compared with trends in other measures even though the absolute value of trends in those other measures are in different scales of magnitude (e.g., 50,000 or 5 million). Use of these index values facilitates the identification of trends where the greatest

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[1] Assume one accident involvement per vehicle and 1980 U.S. vehicle registration of 164.9 million. See Section 2.0 below for additional comparisons of accident rates. The exact proportion of non-reported accidents is the subject of active research and results of this research effort will be included in future editions of this annual report.

[2] Comparisons of involvement (e.g., fatalities and injuries) relate to persons experiencing accident consequences while accident frequencies are derived exclusive of person involvement characteristics.

[3] The ratio of fatal accidents to injury accidents actually rose slightly during the decade between 1950 and 1960.

[4] This is true regardless of whether police-reported or total accidents are used as the basis of comparison.

Exhibit 1.4

Selected Ratios in U.S. Traffic Accident Trends, 1950-1980

(preliminary)

	Ratios					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Ratio of Fatalities to Injuries	0.034	0.022	0.019	0.016	0.015	-35.3	-24.0	-23.2	-2.2	-2.8
Ratio of Fatal Accidents to Injury Accidents	0.049	0.033	0.027	0.022	0.021	-32.7	-18.2	-22.2	-4.5	-2.9
Ratio of Injury Accidents to Total Police-Reported Accidents	0.185	0.253	0.265	0.285	0.287	36.8	4.7	8.3	0.7	1.5
Ratio of Injury Accidents to Total Accidents	0.075	0.102	0.107	0.115	0.116	36.0	4.9	7.5	0.9	1.5

Exhibit 1.5

Index Values for Selected Traffic Accident Measures, 1950-1980

(1970 = 100)

Measure	1950	1960	1970	1979	1980
Fatalities	63.1	69.2	100.0	97.1	97.1
Fatal Accidents	66.2	76.1	100.0	98.5	98.5
Injuries	36.5	60.1	100.0	121.3	124.2
Injury Accidents	36.0	62.0	100.0	121.7	124.6
Police-Reported Accidents	51.6	65.0	100.0	113.1	114.9

the greatest relative shifts have occurred. In this case, fatalities and fatal accident values for 1980 are actually below the 1970 values (i.e., below 100.0). In contrast, injury accidents and injuries have index values which exceed 100. The relative rise in these two indices implies that injury accidents deserve particular attention.

Similarly, results of the construction of an index for ratios presented in Exhibit 1.6 indicates that the greatest relative increase in the ratios has occurred for the ratio of injury accidents to total accidents. The greatest relative decrease has occurred for the ratio of fatalities to injuries, the 1980 value of which is 79.0 compared with a value of 178.9 for 1950.

Despite the assessment of these index values which provide a cursory overview of accident trends, it is necessary to probe deeper to determine the underlying causes of change in accident trends observed to occur between 1950 and 1980. This requires consideration of changes in variables such as numbers of licensed drivers that impact the size and nature of accident trends. Key questions to be asked are:

- Is the moderation in the trend of fatalities significant?
- Is the rapid rate of growth of injury accidents significant?
- What factors would explain a shift to injury accidents that corresponds to a relatively lower proportion of fatal accidents?

To obtain greater insights into the significance of changes in accident trends and potential underlying factors that explain these changes in trends, it is helpful to consider the potential impact of variations in socioeconomic trends that might produce changes in traffic accident trends.[1] For example:

- From 1950 to 1980 the volume of traffic on our nation's highways increased by 230 percent and the number of registered vehicles increased by 233 percent.

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[1] This process consists of accident trend identification, correlation of accident trends with socioeconomic trends, and assessment of significant differences between accident and socioeconomic trends.

Exhibit 1.6

Index Values for Selected Traffic Accident Ratios, 1950-1980

(1970 = 100)

Ratio	1950	1960	1970	1979	1980
Fatalities to Fatal Accidents	95.6	91.2	100.0	99.1	98.2
Injuries to Injury Accidents	101.3	100.6	100.0	96.8	96.2
Fatalities to Injuries	178.9	115.8	100.0	84.2	79.0
Injury Accidents to Police-Reported Accidents	69.8	95.5	100.0	107.5	108.3
Injury Accidents to Total Accidents	70.1	95.3	100.0	107.5	108.4

- The number of licensed drivers, however, increased by only 135 percent during the same time frame.

- Also, both roadways and vehicles have improved their safety characteristics during this time period.

In the next chapter of this report, these factors will be evaluated and trends in these factors will be compared with those presented above. These comparisons should provide insights about the degree to which trends in accidents conform to trends that influence the demand or supply for automotive travel. Since accident frequency may, in part, be dependent on the volume of automotive travel, it is logical to assume that the increases in travel generate increases in accidents. Whether or not this occurs or--if it does occur, whether these changes are proportional to increases in travel--remains to be determined.

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[1] The above increases represent an annual increase of 2.9 percent. Compared to the 1.4 percent increase in fatalities and the 2.7 percent increase in accidents, there appears to have been less than a proportional increase in accidents. Injuries have increased by 4.1 percent, however, and this annual increase is greater than the increase in licensed drivers, registered vehicles and vehicle miles of travel.

2.0 SOURCES OF CHANGE IN TRAFFIC ACCIDENT TRENDS

The primary source of change in traffic accident trends is the increase in automotive travel. Factors underlying the demand for travel are population growth and increase in the proportion of the population with drivers licenses. Factors related to the supply of travel are the numbers of registered vehicles and miles of surfaced roads. The intersection of demand and supply factors can be represented by the actual volume of travel or vehicle miles of travel. A wide variety of indirect factors influence the precise volume of travel within specific time periods. For example, fuel prices influence the price of automotive travel, as do fuel economy characteristics of vehicles. Trends in relative incomes and prices influence vehicle miles of travel and also influence vehicle purchase decisions. Thus, an increase in younger drivers may mean a greater sensitivity to rising fuel prices. Since certain vehicles are fuel-efficient, e.g., motorcycles, an increase in motorcycle use is expected. As a result, there is an increase in motorcycle vehicle miles of travel, and exposure of a segment of the population to traffic accident increases. Since motorcycle vehicle miles of travel are associated with higher relative fatality rates, an increase in motorcycle fatalities and injury rates is also likely.

Factors that offset the influences of increased demand for automotive travel and moderate concomitant accident severities are those of restraints (e.g., helmets), speed limit restrictions and vehicle or highway design improvements (e.g., crashproof bumpers and interstate highways). A factor that reinforcesthe likelihood of accidents given a certain level of vehicle miles of travel is alcohol consumption. Factors which influence the number of victims involved in a specific accident (e.g., ratio of fatalities to fatal accidents) are vehicle occupancy rates and population or vehicle density per mile of surfaced roads.

The purpose of this chapter of the First Annual Highway Traffic Safety Trend Report is to identify the nature and direction of major trends in supply- and demand-related factors that influence automotive travel. The chapter, therefore, begins with the assessment of changes in the overall level of vehicle miles of travel and then reviews the influence of key demand and supply related exposure variables (e.g., proportion of

population over 16 with drivers licenses and numbers of registered vehicles). In addition to these key variables, additional review of the impact of other demographic shifts, influence of alcohol consumption and vehicle mix also will be explored. Section 2.1 below reviews the U.S. experience in growth of vehicle miles of travel from 1950 to 1980.

2.1 Vehicle Miles of Travel as a Source of Change In U.S. Traffic Accident Experience

As indicated above, a major yardstick of automotive travel in the U.S. is represented by "vehicle miles of travel." This measure is a sum of annual travel by the nation's entire automotive vehicle fleet on all its public and private roads and highways.[1] Because of the importance of this measure, it has become customary to express automotive related accident experience as a ratio of accidents to vehicle miles of travel. This ratio is defined as the fatality rate, injury rate, or accident rate and is expressed in terms of numbers of victims or incidents per unit of vehicle miles of travel.[2]

Between 1950 and 1980, the level of vehicle travel in the United States increased by more than one trillion vehicle miles of travel, or by 230 percent (see Exhibit 2.1). Although the annual rate of growth for VMT was 4 percent in this time period, the rate of growth for urban area vehicle miles of travel exceeded the overall annual growth rate by an additional 1 percent.[3] The decade which experienced the greatest growth was the 1950 to 1960 period (i.e., about 6 percent annually) and the decade with the least growth was the 1970 to 1980 period.[4] These long-term growth rates exceed the growth rate in fatalities and police reported trends described earlier.

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[1] Off-the-road travel is excluded. A more sensitive measure of automotive travel is the number of person miles of travel. This represents the number of persons traveling rather than the number of vehicles traveling. This was not computed for 1950 and 1960 due to a lack of data on rates per vehicle in those years. This was computed for 1970, 1979 and 1980 and used in comparisons of expected cost of accidents. See Exhibit 3.7 below.

[2] For convenience, this unit of vehicle miles of travel (VMT) is expressed in terms of millions or billions of vehicle miles of travel.

[3] Additional comparisons of differential accident rates for urban and rural areas will be provided in Chapter 4.0 below.

[4] The sixties manifested more rapid growth in urban VMT while the fifties show the greatest relative increase in rural VMT (7 percent annual growth in urban VMT for 1960 to 1970 and 6 percent annual growth in rural VMT for 1950 to 1960).

Exhibit 2.1

Trends in Vehicle Miles of Travel, 1950-1980
(in millions)

	Actual or Estimated Values					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Vehicle Miles of Travel[a]	458,246	718,845	1,114,098	1,529,133	1,515,000	56.9	55.0	36.0	-0.9	4.1
Urban	219,248	331,585	574,595	859,054	844,950	51.2	73.3	47.1	-1.6	4.6
Rural	239,998	387,260	539,503	670,079	670,050	61.4	39.3	24.2	0.0	3.5

[a]Federal Highway Administration, Office of Highway Planning.

Exhibit 2.2 summarizes selected growth rates and compares these to the growth rate for VMT. However, the growth rate in VMT does not exceed the growth rate in injuries. Furthermore, variations in the long-term trend may be surfacing. From 1979 to 1980, vehicle miles of travel decline by 0.9 percent but fatalities remain constant. Also, both injuries and accidents increased by 2.0 and 1.6 percent even though VMT decreased slightly.[1] Should the experience of recent years continue, accident rates may reverse their secular decline.

To focus on this phenomenon more closely, it is necessary to examine these rates for similar time periods. Exhibit 2.3 summarizes the results of comparing the number of fatalities, injuries and police-reported accidents with annual vehicle miles of travel for 1950-1980. The percentage change in the ratio of fatalities to VMT between 1950 and 1980 was negative, indicating a long-term decline in the frequency of traffic fatalities relative to exposure as represented by vehicle miles of travel (i.e., minus 53 percent). Similarly, the percentage change for accidents to vehicle miles of travel declined by 33 percent. The rate for injuries relative to VMT increased only slightly between 1950 and 1980.

Although the injury rate was constant for the 1950-1980 period, this is largely due to 1950 to 1970 growth of 13 percent which is offset by the decline in this rate by 13 percent from 1970 to 1980. Despite the decrease in the injury rate in the 1970's, the rate appears to increase again based on the 1979 to 1980 positive shift of nearly 3 percent. Although this shift is partly due to a one percent decline in VMT in 1980, injuries rose by an estimated 2 percent between 1979 and 1980.[2]

An alternative representation of the shift in these trends is displayed in Exhibit 2.4 and graphically in Figure 2.1. Once again it is possible to utilize index values to facilitate comparisons. In the case of the trends described earlier, these index values show the greatest relative increase for vehicle miles of travel (particularly urban VMT), which shifts from an index value of 41.1 to 136.0 between 1950 and 1980. The next largest shift occurs for the fatality rate, which drops from an

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[1] As discussed earlier, shifts in the ratio of injury accidents to total accidents have occurred which partially explain the growth rate in overall injuries.

[2] Compare Exhibits 1.2 and 2.2.

Exhibit 2.2

Summary of Traffic Accident Growth Rates for Selected Measures and Ratios

	Annual Percent Change	
	1979-1980	1950-1980
Measures		
Fatalities	0.0	1.4
Injuries	2.0	4.2
Accidents	1.6	2.7
Vehicle Miles of Travel	-0.9	4.1
Ratios		
Fatalities to Injuries	0.0	-2.7
Injury Accidents to Total Accidents	0.9	1.5

Exhibit 2.3

Ratio of Accident Trends and Vehicle Miles of Travel, 1950-1980
(in hundreds of millions of VMT)

	Ratios					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Fatalities per VMT	7.246	5.062	4.724	3.341	3.371	-30.1	- 6.7	-28.6	0.9	-2.6
Fatal Accidents per VMT	6.648	4.867	4.127	2.957	2.988	-26.7	-15.2	-28.3	1.0	-2.7
Injuries per VMT	215.921	235.503	243.332	215.048	222.198	5.0	7.3	-11.6	2.9	0.0
Injury Accident per VMT	134.951	148.154	154.114	136.615	141.210	9.8	4.0	- 8.4	3.4	0.2
Police-Reported Accidents per VMT	730.023	586.348	581.897	479.588	491.686	-19.7	- 0.8	-15.5	2.5	-1.3

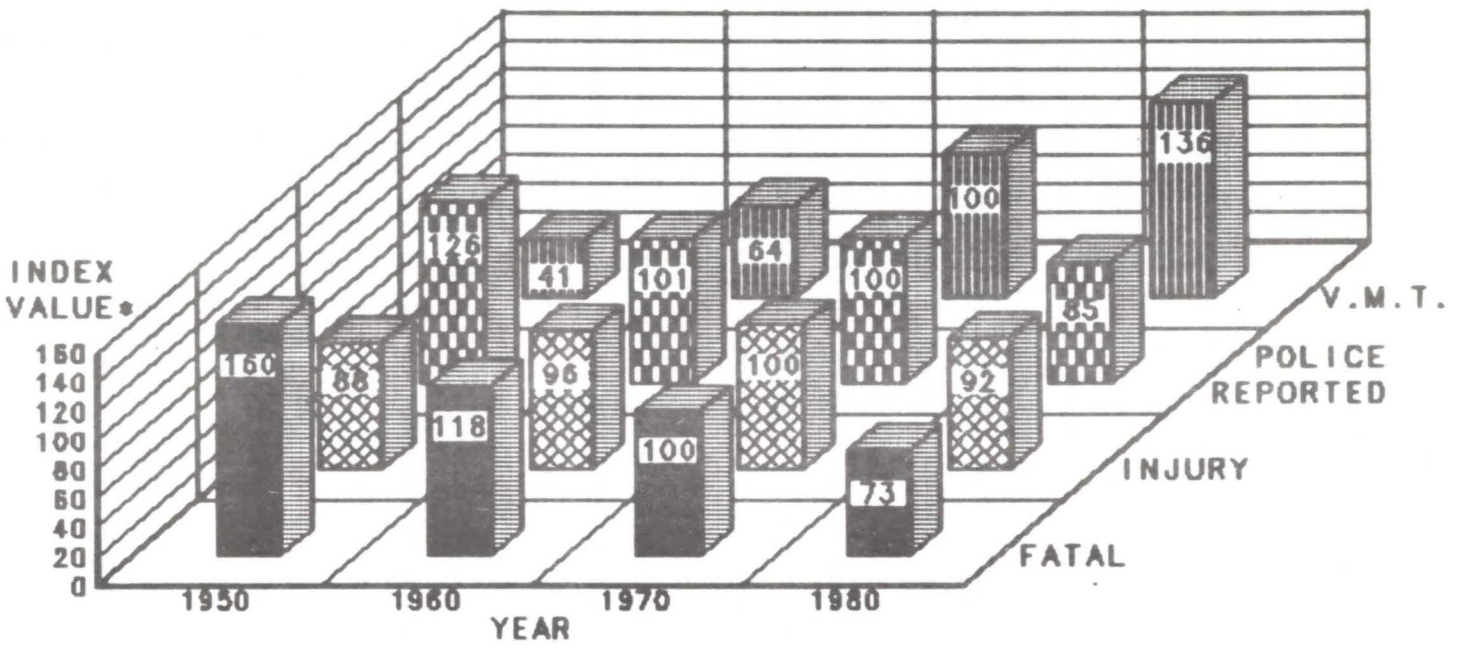
Exhibit 2.4

Index of Accident Trends and Vehicle Miles of Travel, 1950-1980
(1970 = 100)

Ratio	1950	1960	1970	1979	1980
Vehicle Miles of Travel	41.1	64.5	100.0	137.3	136.0
Urban VMT	38.2	57.7	100.0	149.5	147.1
Rural VMT	44.5	71.8	100.0	124.2	124.2
Fatalities per VMT	153.4	107.2	100.0	70.8	71.4
Fatal Injuries VMT	161.0	117.9	100.0	71.7	72.4
Injuries per VMT	105.0	96.8	100.0	88.4	91.3
Injury Accidents per VMT	87.6	96.1	100.0	88.7	91.6
Police-Reported Accidents per VMT	125.5	100.8	100.0	82.4	84.5

FIGURE 2.1

TRENDS IN SELECTED ACCIDENT TYPES RELATIVE TO VEHICLE MILES OF TRAVEL (1950–1980)



*Index values of vehicle miles of travel(V.M.T.), fatal, injury and police reported accidents per billion vehicle miles of travel. (1970=100) In 1970, fatal and injury accidents represented 27 percent of total police reported accidents.

V.M.T. 1970 ABS. VALUE =1,114.1 BILLION
POLICE REPORTED 1970 ABS. VALUE =5,819.0
INJURY ACCIDENTS 1970 ABS. VALUE=1,541,1
FATAL ACCIDENTS 1970 ABS. VALUE = 41.3

ABT ASSOCIATES INC.
TRANSPORTATION RESEARCH GROUP

to 71.4 for the same time period. Similar, but less sharp, declines in the accident and injury rates are observed.

2.2 Trends in Licensed Drivers and Population Age Groups 1950-1980

The long-term increase in annual vehicle miles of travel described above is not equalled by the 1950 to 1980 increase in the number of licensed drivers. While VMT increased by 230 percent, the number of licensed drivers increased by 135 percent (see Exhibit 2.5). In this subsection, we investigate the role of changes in the numbers of licensed drivers and their potential impact on traffic safety trends. In addition, the impact of shifts in the proportion of population with drivers licenses and shifts in the age distribution are assessed by evaluating changes in numbers of persons with drivers licenses by age group and by sex. Also, it is possible to evaluate the shift in fatality rates relative to both population by age group and to numbers of licensed drivers by age group. The latter indicators provide a yardstick for eliminating the effects of changes in the demographic mix of drivers in traffic safety measures. This enables an assessment of changes in the accident involvement rate of population age groups whose numbers are disproportionately increased as a result of purely demographic factors (e.g., "baby boom").[1]

One aspect of the long-term trend which is obvious, is that the proportion of the population over 16 with a drivers license has increased from 57 percent in 1950 to 85 percent in 1980. The annual growth rate of licensed drivers of 3 percent is double the rate observed for persons over 16. As shown in Exhibit 2.6, the bulk of the increase in new licensed drivers occurs for females, whose proportion of drivers license acquisition increased from 65 percent in 1970 to 77 percent in 1980.[2]

Exhibit 2.7 displays the trends in ages of licensed drivers between 1960 and 1970.[3] Although the age group of 25-64 year old drivers grew

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[1] Other factors, such as the variation in exposure of population age-sex groups, are not dealt with in this section due to lack of detailed trend data on the demographic characteristics of travelers.

[2] Data on drivers license status by sex are unavailable for early years. From 1970 to 1980 the age-sex group experiencing the greatest relative shift in number of drivers occurs for females 65 and over. Also, data for licensed drivers may contain some duplication due to possession of multiple drivers licenses by the same individual. This may occur due to varying state laws for drivers license possession.

[3] Data on drivers license status by age are unavailable for 1950.

Exhibit 2.5

Trends in Drivers Licenses and Population Over 16, 1950-1980

	Year					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Drivers Licenses	62,246,666	87,252,563	111,542,787	143,284,000	145,972,000	40.2	27.8	30.9	1.9	2.9
Population Over 16	108,737,000	121,142,000	141,888,000	165,808,000	171,164,000	11.4	17.1	20.6	3.2	1.5
Percent of Population Over 16 with Drivers License	57.2	72.0	78.6	86.4	85.2	25.9	37.4	8.4	1.4	1.3

Exhibit 2.6

Trends in Drivers Licenses and Population Over 16 for Males and Females, 1970-1980

	1970	1979	1980	Annual Percent Change 79-80	Annual Percent Change 70-80
Males with Drivers Licenses	63,302,000	76,531,000	77,677,000	1.5	2.1
Male Population Over 16	67,651,000	79,283,000	81,877,000	3.3	1.9
Percent of Male Population Over 16 with Drivers Licenses	93.6	96.5	94.9	-1.7	0.1
Females with Drivers Licenses	48,241,000	66,753,000	68,295,000	2.3	3.5
Female Population Over 16	74,237,000	86,525,000	89,287,000	3.1	1.9
Percent of Female Population Over 16 with Drivers Licenses	65.0	77.2	76.5	-0.9	1.6

Exhibit 2.7

Trends in Drivers Licenses by Age of Driver, 1960-1980
(preliminary)

Age	Adjusted Counts				Percent Change		Annual Percent Change	
	1960	1970	1979	1980	60-70	70-80	79-80	60-80
15-24	16,045,764[a]	24,618,000	30,849,000	31,384,000	53.4	27.5	2.9	3.4
25-44	38,910,324	43,836,000	57,471,000	58,608,000	12.7	33.7	2.0	2.1
45-64	26,476,820	34,121,000	40,048,000	40,507,000	28.9	18.7	1.1	2.1
65 and over	5,819,753	8,957,000	14,916,000	15,473,000	53.9	72.7	3.7	5.0

[a]Federal Highway Administration data adjusted to conform to the Census and National Safety Council population age group classes.

by 2 percent annually, the 15-24 age group experienced an annual increase of 3 percent. The 65 and over group grew most rapidly with 5 percent average annual growth from 1960 to 1980.[1] Since the older and younger groups of drivers have increased their share of drivers licenses relative to other groups, it is logical to expect that these groups' accident involvement would increase. However, based on the use of data presented in Exhibit 2.8, the death rate for age groups 15-24 declined by 48 percent between 1960 and 1980. Similarly, the death rate for the 65 and over age group declined by 64 percent for the same time period. These declines are greater than the decline in the overall death rate of 16 percent.[2] (Exhibit 2.9 contains a similar display of data utilizing index values.)

In the above example, the use of the term death rate is based on the number of fatalities in an age group compared with the number of licensed drivers for the same age group. It is also desirable to compute a similar ratio for fatalities by age of fatality, that is, based on population in a specific age group. As indicated above, the purpose of constructing this rate is to eliminate purely demographic effects from comparisons of accident trends. Based on data in Exhibits 2.10 and 2.11, it is possible to develop fatality rates for population age groups. These rates indicate that the age-specific fatality rates for the 15-24 year old group and the 65 and over group declined by 1.7 and 2.1 percent, respectively, while the overall death rate increased by 1 percent. The increase of 1 percent from 1950 to 1980 is largely due to increases in the death rate for the 25 to 44 year old group.[3] As shown in Exhibits 2.12 and 2.13 the increase in the death rate for the age groups between 25 and 44 offsets reductions in the death rate for all other age groups.

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[1] The growth rate for licensed drivers overall is 3 percent between 1960 and 1980 (see Exhibit 2.5). Differences in a specific year may relate to lags in drivers license acquisition by the fraction of the population that are eligible (e.g. 16 year olds).

[2] The desirable measure here would be the number of miles each driver actually is exposed to potential accidents. This datum is not available for the years required in this analysis, although current efforts are underway to provide these data for use in future accident trend analysis.

[3] The computation of age-sex specific fatality rates--a more accurate measure--is possible using data available for the Fatal Accident Reporting System. For a discussion of the shifts in this rate for recent years, see "An Assessment of U.S. 1980 Fatality Experience," Abt Associates Inc. for National Highway Traffic Safety Administration, March, 1981. Also, see discussion in subsection 2.5 below.

Exhibit 2.8

Trends in Fatality Rates Based on Licensed Drivers by Age of Fatality, 1960-1980[a]

Age	Death Rate per 100,000 Licensed Drivers					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	60-80[b]
15-24[c]	NA	54.1	64.4	29.8	28.2	-	19.0	-56.2	-5.4	-3.3
25-44	NA	25.0	30.0	33.5	33.3	-	20.0	11.0	-0.6	1.5
45-64	NA	29.9	31.6	33.2	33.3	-	5.7	5.4	3.4	0.5
65 and over	NA	96.5	79.3	36.2	34.9	-	-17.8	-56.0	-3.6	-5.2
Total	53.3	41.7	47.2	35.7	35.0	-21.8	13.2	-25.6	-2.0	-1.4[d]

[a]Data on licensed drivers by age are not available for 1950.

[b]Annual percent change for age detail death rates are computed on the basis of 1960 to 1980 data only.

[c]Rates for age group 0-14 are not computed.

[d]Growth rate for the total is based on 1950 to 1980 trends.

Exhibit 2.9

Trends in Fatality Rates Based on Licensed Drivers by Age of Fatality, 1950-1980

Index Values (1970 = 100)

Age Group	1950	1960	1970	1979	1980
15-24	--	84.0	100.0	46.3	43.8
25-44	--	83.3	100.0	111.7	111.0
45-64	--	94.6	100.0	105.1	105.4
65 and Over	--	121.7	100.0	41.9	44.0
Total	112.9	88.3	100.0	75.6	74.2

Exhibit 2.10

U.S. Traffic Fatalities by Age of Fatality, 1950-1980

(preliminary)

	Actual or Adjusted Values					Percent Change			Annual Percent Change	
Age	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
0-14	3,697[a]	4,473	5,749	3,996[b]	3,786[b]	21.0	28.5	-34.1	- 5.3	0.1
15-24	7,396	8,678	15,858	9,183	8,865	17.3	82.7	-42.2	- 3.5	0.6
25-44	9,861	9,716	13,150	19,229[c]	19,545[c]	- 1.5	35.3	48.6	1.6	2.3
45-64	7,301	7,916	10,767	13,287[c]	13,490[c]	8.4	36.0	25.3	1.5	2.1
65 and Over	4,931	5,616	7,103	5,393	5,393	13.9	26.5	-24.1	0.0	0.3
Total	33,186	36,399	52,627	51,088	51,077	9.7	44.6	- 2.9	0.0	1.4

[a]National Safety Council data adjusted to conform to NHTSA definition of fatality.

[b]Fatal Accident Reporting System, August, 1981.

[c]Preliminary

Exhibit 2.11

Percent Distribution of U.S. Traffic Fatalities by Age of Fatality, 1950-1980
(preliminary)

	Percent of Traffic Fatalities					Percent of Population				
Age	1950	1960	1970	1979	1980	1950	1960	1970	1979	1980
0-14	11.1	12.3	10.9	7.8	7.4	26.9	31.1	28.6	22.8	22.6
15-24	22.3	23.9	30.1	18.0	17.4	14.7	13.6	17.6	18.8	18.8
25-44	29.7	26.7	25.0	37.6	38.2	30.0	26.1	23.7	27.2	27.7
45-64	22.0	21.7	20.5	26.0	26.4	20.3	20.0	20.7	20.0	19.6
65 and Over	14.9	15.4	13.5	10.6	10.6	8.1	9.2	9.4	11.2	11.4
Total	100.0[a]	100.0[a]	100.0[a]	100.0[b]	100.0[b]	100.0[c]	100.0[c]	100.0[c]	100.0[c]	100.0[c]

[a]National Safety Council.

[b]Fatal Accident Reporting System, August, 1981.

[c]U.S. Bureau of the Census, Current Population Reports, Series P-25.

Exhibit 2.12

Trends in Fatality Rates Based on Population
by Age of Fatality, 1950-1980

Age	Death Rate per 100,000 Population					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
0-14	9.0	8.0	9.9	8.0	7.4	-11.1	23.8	-25.3	-7.5	-0.7
15-24	33.1	35.3	44.3	22.2	20.1	6.6	25.5	-54.6	-9.5	-1.7
25-44	21.6	20.6	27.3	32.1	31.2	- 4.6	32.5	14.3	-2.8	1.2
45-64	23.7	21.9	25.7	30.3	30.3	- 7.6	17.4	17.9	0.0	0.8
65 and over	39.8	33.7	37.2	21.9	21.1	-15.3	10.4	-43.3	-3.7	-2.1
Total	21.8	20.1	25.9	23.2	22.6	- 7.8	28.9	-12.7	-2.6	0.1

Exhibit 2.13

Trends in Fatality Rates Based on Population by Age of Fatality, 1950-1980
Index Values (1970 = 100)

Age Group	1950	1960	1970	1979	1980
0-14	90.9	80.8	100.0	80.8	71.4
15-24	74.7	79.7	100.0	50.1	47.4
25-44	79.1	75.5	100.0	117.6	116.1
45-64	92.2	85.2	100.0	117.9	119.1
65 and Over	107.0	90.6	100.0	58.9	57.0
Total	84.2	77.6	100.0	90.0	88.8

Demand for automotive travel between 1950 and 1980 apparently increased as a result of the growth of population and licensed drivers--particularly those in certain age groups. Using rates computed on the basis of age of licensed drivers and population, it is shown that this shift did not contribute markedly to fatal accident trends experienced between these years. Since travel increased and overall fatal accident rates declined, it is possible that other factors may explain this reduction in fatality rates between 1970 and 1980.[1] These factors relate to those involved in the supply of automotive travel (e.g., highway type or vehicle mix) and are discussed below in Subsection 2.3.

2.3 Trends in Supply-Related Factors

The two major supply-related factors that are useful in evaluating traffic accident trends are numbers of vehicles and roadway miles. The American motorists' demand for automotive travel is satisfied when a vehicle is acquired and utilized on the nation's road system. Supply of the vehicle by a manufacturer and supply of the infrastructure necessary to utilize the vehicle (e.g., surfaced roads) influences the degree to which the motorist generates vehicle miles of travel. In this section of the report, we review the 1950-1980 trends in these two key variables and examine their potential relationship to changes in the nature and level of traffic accidents.

As shown in Exhibit 2.14, the number of motor vehicles registered grew at an annual rate of over 4 percent from 1950 to 1980. This rapid growth rate exceeds or equals the rate of growth in vehicle miles of travel, licensed drivers and all accident trends reported in the above sections. Although the most rapid growth in vehicles occurs for motorcycles, the number of automobiles increases by the largest number and accounts for the bulk of the increase in the number of new registered vehicles.

The growth rate in miles of surfaced roads displayed in Exhibit 2.15 is much slower, with the most rapid growth occuring in the 1950-1960 time period. Non-surfaced road mileage actually declined from 1960 to 1980 by 46 percent and growth rates for certain types of roadway appear to vary

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[1] Comparable data for non-fatal accident rates are not available for similar time periods.

Exhibit 2.14

Trends in Vehicle Registration, 1950-1980
(in thousands)
(preliminary)

	Actual or Estimated Number[a]					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Motor Vehicles	49,616[b]	74,432	111,242	159,621	165,394	50.0	49.5	48.7	3.6	4.1
Automobiles	40,339	61,671	89,244	120,248	123,467	52.9	52.8	44.7	2.7	3.8
Motorcycles	454	574	2,824	5,502	5,823	26.4	397.0	106.2	5.8	8.9
Buses	224	272	378	520	542[c]	21.4	39.0	37.6	4.2	3.0
Trucks	8,599	11,914	18,797	33,350	35,562	38.6	57.8	89.2	6.6	4.8

[a]Federal Highway Administration, Highway Statistics Division.

[b]Excludes Alaska and Hawaii.

[c]Estimated using 1970 to 1979 average annual percent change.

Exhibit 2.15

Trends in Road Mileage by Surface Type, 1950-1980
(in thousands)

	Actual or Estimated Number[a]					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Surfaced Roads[a]	1,939[b]	2,557	2,946	3,167	3,193[c]	31.9	15.2	8.4	0.8	1.7
Surface Type I[d]	93	129	115	125[e]	126[c]	38.7	-10.9	9.7	0.8	1.0
Surface Type II[f]	280	430	647	864	889[c]	53.6	50.5	37.4	2.9	3.9
Surface Type III[g]	407	672	897	996	1,005[c]	65.1	33.5	12.0	0.9	3.1
Surface Type IV[h]	1,159	1,327	1,288	1,181	1,173[c]	14.5	11.1	- 8.9	-0.7	0.0
Non-Surfaced Roads	1,374	989	784	751	747[c]	-28.0	-20.1	- 4.7	-0.5	-2.1

[a] Federal Highway Administration, Highway Statistics Division. Totals may not add due to rounding.

[b] Excludes Alaska and Hawaii.

[c] Estimated using average annual percent change and/or adjusted for control total.

[d] Portland cement concrete with or without bituminous wearing surface less than one inch thick in compacted thickness and brick or block.

[e] Excludes brick and block

[f] Mixed bituminous, bituminous penetration having a combined thickness of surface and base 7 inches or more and/or a high loadbearing capacity with or without portland cement concrete base, bituminous concrete and sheet asphalt with or without portland cement concrete base.

[g] Bituminous surface treated, mixed bituminous or bituminous penetration having a combined thickness of surface and base less than 7 inches and/or a high loadbearing capacity with or without portland cement concrete base.

[h] Soil surfaced, slag, gravel, or stone.

considerably from the growth rate for all types of surfaced miles.[1] Growth in the number of surfaced miles facilitates greater levels of vehicle miles of travel despite the relatively slow increase in overall roadway miles from 1950 to 1980 (i.e., total miles increased by only 19 percent).

Another method of assessing these trends requires the use of ratios. These ratios permit comparisons of relative growth in variables such as numbers of vehicles and numbers of surfaced miles. Exhibit 2.16 indicates that the ratio of the number of registered vehicles per mile of hard surfaced roads experienced relatively slow growth from 1950 to 1970 but experienced rapid growth from 1970 to 1980. This implies that the relative density of vehicles on roadways is increasing at a slow but possibly increasing rate.[2] Also included in this exhibit, are changes in the ratio of registered vehicles per licensed driver and registered vehicles per household. Interestingly, the ratio of registered vehicles to households experienced relatively more rapid growth than the ratio of registered vehicles per licensed driver.[3] This indicates that the number of vehicles per household is increasing as well as the number of drivers per household. Despite increases in ratios that imply rising potential demand for less rapidly increasing surfaced miles of roadway, the actual demand for travel has not risen as rapidly.[4] This slackening in the growth of actual demand becomes apparent in the decline of vehicle miles of travel per registered vehicle, the 1980 and 1950 levels of which are nearly identical.

Possibly as a result of the decline in growth of vehicle miles of travel and an increase in the quality of surfaced roads, the rate of growth in fatalities is less than the corresponding rate of growth in vehicle miles

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[1] Shifts to mixed bituminous surface with concrete base of greater than 7 inches (Surface Type II) occur at an annual rate of 4 percent, while use of soil, slag or gravel for road surfacing is constant. This implies an upgrading of surface types that contributes to increased vehicle miles of travel.

[2] The size of the increase in this ratio may be offset by substituting the number of lane miles in the denominator.

[3] The number of licensed drivers per household grew less rapidly than the number of vehicles per household as a result of an increase in "secondary household drivers" who do not own a car.

[4] Potential demand is expressed by numbers of drivers and vehicles, while actual demand in use of roadways is expressed in terms of vehicle miles of travel.

Exhibit 2.16

Trends in Selected Ratios, 1950-1980

	Ratios					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Registered Vehicles per Licensed Driver	0.7971	0.8531	0.9973	1.1140	1.1331	7.0	16.9	13.6	1.7	1.2
Registered Vehicles per Household	1.1392	1.4097	1.7546	2.064	2.0916	23.7	-24.5	19.2	1.3	2.0
Licensed Drivers per Household	1.4292	1.6526	1.7593	1.8529	1.8459	15.6	6.5	4.9	-0.4	0.8
Registered Vehicles per Mile of Hard Surfaced Roads	63.61	60.51	67.09	80.37	81.88	-4.9	10.9	22.0	1.9	0.8
Vehicle Miles of Travel per Registered Vehicle	9,270	9,733	10,276	9,580	9,190	5.0	10.9	-10.6	-4.2	0.0
Vehicle Miles of Travel per Mile of Hard Surfaced Road (in thousands)	236.3	281.1	378.2	482.8	474.5	19.0	34.5	25.5	-1.6	2.4

of travel (i.e., 4 percent in VMT and 1 percent in fatalities between 1950 and 1980). For some roadway classes, however, the rate of growth in fatalities has been greater than for others. Exhibit 2.17 reveals that the growth rate for fatalities on the interstate highway system has been nearly 3 percent a year between 1967 and 1980. Also, injury rates on these highways have grown by over 5 percent a year for the same time period (see Exhibit 2.18).

Unless these numbers of fatalities and injuries are examined relative to vehicle miles of travel by roadway class, the above growth rate could be misleading. This comparison is provided by utilizing the vehicle miles of travel data contained in Exhibit 2.19 to develop fatality and injury rates for specific roadway classes. As indicated in Exhibit 2.20, the growth rate for fatalities and injuries relative to VMT for 1967 to 1980 is actually negative. In fact, using index values based on 1970 data experence shown in Exhibit 2.21, the rates decline for all classes of roadways with one exception. Federal Aid Secondary routes manifest an increase in injury rates from 1967 to 1980 (i.e., index values greater than 100 after 1970). This is true despite a relative decline in the number of roadway miles in this class of roadway. (See Exhibit 2.22.) In the section below, several more detailed comparisons of trends are investigated.

2.4 Recent Trends in Fatal Accidents

As a result of NHTSA's efforts to provide information on accident trends, the Fatal Accident Reporting System was initiated in 1975. The establishment of this data set provides an opportunity to assess more closely recent trends in fatal accidents. The purpose of this subsection is to review a selected set of fatal accidents to identify possible shifts in overall accident trends that deserve particular attention and to evaluate the impact of changes in selected characteristics of fatal accidents. Fatal accidents deserve particular attention due to their severity and due to the result of apparent shifts in the composition of fatal accidents described earlier. Shifts in the composition of fatal accidents can be as important as increases in the absolute level of trends since these shifts may augur future absolute changes in trends. Shifts in the type of fatal accident also may provide insights to government decision makers on the relative priorities of alternative traffic safety programs (e.g., programs related to motorcycle and moped fatalities may be increased in scope to deal with a rising proportion of motorcycle related fatalities).

Exhibit 2.17

Trends in Fatalities by Class of Roadway, 1967-1980
(preliminary)

	Actual or Estimated Numbers					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980	67-70	70-75	75-80	79-80	67-80
Roadway Class										
Interstate	3,175	4,217[a]	3,215[b]	4,431[b]	4,438[b]	32.8	-23.8	38.1	0.2	2.6
Other Federal[c] Aid Primary	19,807	19,201	23,385	27,395	27,139	- 3.1	21.8	16.1	-0.9	2.5
Federal Aid Secondary and Non-Federal Aid	27,792	29,209	17,925	19,282	19,500	5.1	-38.6	8.8	1.1	-2.8
Federal Aid[d] Secondary	12,310	13,848	8,219[d]	8,841[d]	8,941[d]	12.5	--	--	--	--
Non-Federal Aid	15,482	15,361	9,706	10,441	10,559	- 0.8	--	--	--	--
Total	50,777	52,627	44,525	51,108	51,077	3.6	-15.4	14.7	-0.1	0.0

[a] 1967-1970 data from FHWA Fatal and Injury Accident Rates. Adjusted to conform to NHTSA definition of fatalities. Federal aid facilities generally are built to higher design standards and have greater capacity than Non-Federal Aid Facilities. Primary Federal Aid roadways connect major cities while secondary facilities serve as connectors to Primary Federal Aid roadways.

[b] 1975-1980 data from Fatal Accident Reporting System.

[c] Includes portion of interstate traveled way fatalities for 1967 and 1970.

[d] Assumes 1967-1970 split of fatalities between Federal Aid Secondary and Non-Federal Aid roadways.

Exhibit 2.18

Trends in Injuries by Class of Roadway, 1967-1980
(in thousands)
(preliminary)

	Actual or Estimated Numbers					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980	67-70	70-75	75-80	79-80	67-80
Roadway Class										
Interstate	96[a]	141	142	190	189[b]	46.9	0.7	33.1	-0.5	5.3
Other Federal Aid Primary[c]	730	740	673	742	718	1.4	- 9.1	6.7	-3.2	-0.1
Federal Aid Secondary[d]	942	513	998	1,241	1,386	16.1	94.5	38.9	11.7	3.0
Non-Federal Aid[e]	1,242	1,363	995	972	908	9.7	-27.0	- 8.7	-6.6	-2.4
Total[f]	2,510	2,757	2,808	3,145	3,201	9.8	1.9	14.0	1.8	1.9

[a] FHWA Fatal and Injury Accident Rates, 1967-1979.

[b] Estimated using 1970-79 average annual percent change and adjusted to control totals.

[c] Also includes Federal Aid Urban Arterials.

[d] Also Includes Federal Aid Urban Collectors.

[e] Includes arterials, collectors and local roads. Reclassification by functional class of roadway may result in revised estimates for each roadway class.

[f] Total injuries may differ slightly from those presented earlier due to use of different data sources.

Exhibit 2.19

Trends in Vehicle Miles of Travel by Class of Roadway, 1967-1980
(in billions)
(preliminary)

	Year					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980[a]	67-70	70-75	75-80	79-80	67-80
Roadway Class										
Interstate	111	161	230	293	290	45.0	42.9	26.1	--	7.7
Other Federal Aid Primary	326	364	387	449	445	11.7	6.3	15.0	--	2.4
Federal Aid Secondary	191	217	383	468	463	13.6	76.5	20.9	--	7.0
Non-Federal Aid	336	372	329	320	317	10.7	-11.5	- 3.6	-	-0.4
Total	964	1,114	1,329	1,530	1,515	15.4	19.3	14.0	-1.0	3.5

[a]Assumes 1979 share of VMT is constant for each class of roadway.

Exhibit 2.20

Trends in Fatality and Injury Rates by Class of Roadway, 1967-1980
(in billions of VMT)
(preliminary)

	Rates					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980	67-70	70-75	75-80	79-80	67-80
Fatalities										
Interstate	28.6	26.2	14.0	15.1	15.3	- 8.4	-51.1	9.3	1.3	-4.9
Other Federal Aid Primary	60.8	52.8	37.5	37.6	37.4	-13.2	-29.0	- 0.3	-0.3	-3.8
Federal Aid Secondary	64.4	63.8	40.4	35.8	37.6	- 1.0	-36.7	- 6.9	-0.7	-4.2
Non-Federal Aid	46.1	41.3	34.3	40.8	40.5	-10.4	-17.0	18.1	0.7	-1.0
Injuries										
Interstate	864.9	875.8	617.4	648.5	651.7	1.2	-29.5	5.6	0.5	-2.2
Other Federal Aid Primary	2,239.3	2,033.0	1,739.0	1,652.6	1,613.5	- 9.2	-14.5	-7.2	-2.4	-2.6
Federal Aid Secondary	2,314.1	2,364.1	2,605.7	2,651.7	2,993.5	2.1	10.2	14.9	12.9	2.0
Non-Federal Aid	3,696.4	3,664.0	3,024.3	3,037.5	2,864.4	-0.9	-17.5	- 5.3	-5.7	-2.0

Exhibit 2.21

Index of Accident Trends and Vehicle Miles of Travel by Class of Roadway, 1967-1980

Indicators	Index Values (1970 = 100) 1967	1970	1975	1979	1980
Fatalities per Billion VMT					
Interstate	109.2	100.0	53.4	57.6	58.4
Other Federal Aid Primary	115.2	100.0	71.0	71.2	70.8
Other Federal Aid Secondary	100.9	100.0	63.3	56.1	58.9
Non-Federal Aid	111.6	100.0	83.1	98.8	98.1
Injuries per Billion VMT					
Interstate	98.8	100.0	70.5	74.1	74.4
Other Federal Aid Primary	110.2	100.0	85.5	81.3	79.4
Other Federal Aid Secondary	97.9	100.0	110.2	112.2	126.6
Non-Federal Aid	100.8	100.0	82.5	82.9	78.2

Exhibit 2.22

Trends in Miles of Roadway by Class of Roadway, 1967-1980

Roadway Class	Miles of Roadway					Percent Change			Annual Percent Change	
	1967	1970	1975	1979[a]	1980[b]	67-70	70-75	75-80	79-80	67-80
Interstate	23,650	29,996	36,715	40,448	42,058	26.8	22.4	14.6	4.0	4.5
Other Federal Aid Primary	216,751	217,410	218,123	259,870	265,570	0.3	0.3	21.8	2.2	1.6
Federal Aid Secondary	647,943	645,396	692,420	524,963	558,891	-0.4	7.3	-19.3	6.5	-1.1
Non-Federal Aid	2,815,739	2,824,216	2,867,241	3,070,098	3,101,667	0.3	1.8	8.2	1.0	0.7
Total[c]	3,704,083	3,717,018	3,814,499	3,895,379	3,968,186	0.3	2.6	10.4	1.9	0.5

[a]Federal Highway Administration, Fatal and Injury Accident Rates; 1967-1979.

[b]Estimated using sum of urban and rural miles estimate for 1980.

[c]Trends in lane miles would be a more accurate measure for changes in highway supply. However, these data are not available. If numbers of lane miles by highway type are assumed to be 6, 4, and 2 for interstate, primary and other road classes, the 1967 to 1980 annual percent change in road miles is 0.6 percent.

Exhibits 2.23 and 2.24 show how many new motorcycle fatalities occurred as a proportion of total fatalities. According to these tables, the number of motorcycle related fatalities has increased annually by 10 percent from 1975 to 1980, compared to a 3 percent increase in occupant fatalities (i.e., fatalities involving vehicle occupants). The number of non-occupant fatalities (e.g., pedestrians and pedalcyclists) increased by only one percent during the same time period, although this subgroup is a smaller share of the total number of fatalities.

Even more important is the obvious shift in the number of minicompact and subcompact fatalities where annual percent changes are 15 and 19 percent, respectively.[1] Similar growth rates for non-occupants struck by these same vehicle types imply that there are important changes in the composition of fatal accident characteristics despite relative constancy in the overall level of fatalities between 1975 and 1980. (See Exhibit 2.25.)

Aggregation of these trends for both occupant and non-occupant fatalities produces this set of findings:

- Passenger car related fatalities increased by less than 1 percent but major increases in all but intermediate and full-size passenger car fatalities occur between 1975 and 1980 (see Exhibit 2.26).
- Motorcycle, moped, and "other truck" related fatalities showed relative growth and deserve continued attention despite their small share of the absolute total number of fatalities accounted for by these subgroups (see Exhibit 2.26).
- The shift in composition of passenger car fatalities, by size of car, has resulted in an increase in the share of subcompact-related fatalities from 9 to 20 percent and an increase from 24 to 39 percent for compact size vehicles. Full-size vehicles manifested a reduction in the share of total fatalities from 47 to 12 percent (see Exhibit 2.27).

Although shifts in vehicle mix may have accounted for these changes, other factors such as improved highways and alcohol involvement also may have contributed to changes in the composition of traffic fatalities.[2]

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[1] Obviously, a shift in the numbers of vehicles in these sizes classes has also occurred from 1975 to 1980. Data on the numbers of vehicles by size class are being prepared for NHTSA as part of ongoing research and will be utilized in subsequent editions of this report to adjust these trends.

[2] The imposition of the national 55 mile an hour speed limit has partially accounted for a reduction in the severity of accidents. A detailed assessment of this change is currently underway and will be documented in a subsequent task report.

Exhibit 2.23

Trends in Fatalities by Occupant Status, 1975-1980
(preliminary)

	Number of Fatalities			Percent Change		Annual Percent Change
	1975	1979	1980	75-80	79-80	75-80
Occupant	35,925	41,926	41,913	16.7	0.0	3.1
Non-Occupant	8,600	9,162	9,164	6.6	0.0	1.3
Total	44,525	51,088	51,077	14.7	0.0	2.8

Exhibit 2.24

Trends in Occupant Fatalities by Vehicle Type, 1975-1980

Vehicle Type	Number of Fatalities			Percent Change		Annual Percent Change
	1975	1979	1980	75-80	79-80	75-80
Passenger Cars[a]	25,928	27,795	27,433	5.8	- 1.3	1.1
Minicompact (≤2100 lbs)	1,851	3,078	3,737	101.9	21.4	15.1
Subcompact (2101-2700 lbs)	2,275	3,840	5,520	142.6	43.8	19.4
Compact (2701-3600 lbs)	6,304	8,406	10,612	68.4	26.2	11.0
Intermediate (3601-4100 lbs)	3,242	3,894	4,311	33.0	10.7	5.9
Full Size (>4100 lbs)	12,226	8,577	3,253	-73.4	-62.2	-30.3
Pick-up Trucks and Vans	4,332	6,452	6,563	51.5	1.7	8.7
Other Trucks	1,145	1,488	1,287	12.4	-13.5	2.4
Motorcycles	3,114	4,712	4,960	59.3	5.3	9.9
Mopeds and Minibikes	44	150	162	268.2	8.0	29.9
Other	1,362	1,329	1,508	10.7	13.5	2.1
Total	35,925	41,926	41,913	16.7	0.0	3.1

[a]Fatal Accident Reporting System. Cases with unknown passenger car sizes have been allocated on the basis of the distribution of passenger cars of known sizes.

Exhibit 2.25

Trends in Non-Occupant Fatalities by Type of Vehicle Involved, 1975-1980

Type of Vehicle Involved	Number of Fatalities			Percent Change		Annual Percent Change
	1975	1979	1980	75-80	79-80	75-80
Passenger Cars[a]	5,959	5,582	5,532	- 7.2	- 0.9	- 1.5
Minicompact[b]	224	313	388	73.2	24.0	11.5
Subcompact	341	470	770	125.8	63.8	17.7
Compact	1,433	1,666	2,038	42.2	22.3	7.3
Intermediate	1,077	1,142	1,229	14.1	7.6	2.7
Full Size	2,954	1,991	1,107	-62.5	-44.4	-21.7
Pick-up Trucks and Vans	1,191	1,646	1,680	41.1	2.1	7.1
Other Trucks	470	646	613	30.4	- 5.1	5.5
Motorcycles	83	92	125	50.6	35.9	8.5
Mopeds and Minibikes	1	0	3	--[d]	--[d]	--[d]
Other	324	303	319	- 1.5	5.3	- 0.3
Unknown[c]	572	893	892	55.9	0.0	9.3
Total	8,600	9,162	9,164	6.6	0.0	1.3

[a] Fatal Accident Reporting System. Cases with unknown passenger car sizes have been allocated on the basis of the distribution of passenger cars of known sizes.

[b] Size Classes based on vehicle weight.

[c] Cases where vehicle type is unknown are primarily cases where hit and run fatalities are involved and the vehicle was not identified.

[d] Percent change not computed.

Exhibit 2.26

Trends in Fatalities by Vehicle Type, 1975-1980

Vehicle Type	Number of Fatalities			Percent Change		Annual Percent Change
	1975	1979	1980	75-80	79-80	75-80
Passenger Cars[a]	31,887	33,377	32,965	3.4	- 1.2	0.7
Minicompact[b]	2,075	3,391	9,269	346.7	173.3	34.9
Subcompact	2,616	4,310	5,908	125.8	37.1	17.7
Compact	4,675	10,072	12,650	170.6	25.6	22.0
Intermediate	4,319	5,036	5,540	28.3	10.0	5.1
Full Size	15,180	10,568	4,360	-71.3	-58.7	-28.3
Pick-up Trucks and Vans	5,523	8,098	8,243	49.3	1.8	8.3
Other Trucks	1,615	2,134	1,900	17.6	-11.0	3.3
Motorcycles	3,197	4,804	5,085	59.1	5.8	9.7
Mopeds and Minibikes	45	150	165	266.7	10.0	29.7
Other	1,686	1,632	1,827	8.4	11.9	1.6
Unknown[c]	572	893	892	55.9	0.0	9.3
Total	44,525	51,088	51,077	14.7	0.0	2.8

[a] Fatal Accident Reporting System. Cases with unknown passenger car sizes have been allocated on the basis of the distribution of passenger cars of known sizes.

[b] Size Classes based on vehicle weight.

[c] Cases where vehicle type is unknown are primarily cases where hit and run fatalities are involved and the vehicle was not identified.

Exhibit 2.27

Percent Distribution of Passenger Car Traffic Fatalities by Vehicle Type, 1975 and 1980

Passenger Car Size	1975	1980
Minicompact	7.1	13.6
Subcompact	8.8	20.1
Compact	24.3	38.7
Intermediate	12.5	15.7
Full Size	47.2	11.9
Total	100.0	100.0

For example, differences in the distribution of fatalities by posted speed limit (highway or road speed limits) indicate that the number of fatalities occurring on roads with posted speeds between 30 and 50 miles an hour increase by 35 percent from 1975 to 1980 and that the number of fatalities occurring on roads with lower speeds increase by only 10 percent for the same time period (see Exhibit 2.28).

Also, the numbers of fatalities where drivers consume alcohol appear to be increasing, with a 1977 to 1980 change of 28 percent (see Exhibit 2.29). Once again, variation in this shift can be observed by driver characteristics. A marked increase in female drivers reported drinking (particularly those between 25 and 44) is observed between 1977 and 1980. For female drivers of all age groups a 13 percent annual increase is noted, compared with a 17 percent increase for female drivers, 25 to 44, and a 9 percent rise in the number of male drivers reported drinking. Consequently, it may be worthwhile to identify problems associated with female drinking drivers even though this subgroup represents a smaller share of the total number of drivers in this category. (The proportion of female to male drivers increased from 11 percent in 1977 to 12 percent in 1980.)

Another factor related to shifts in the composition of traffic fatalities relates to the spatial and temporal characteristics of fatal accidents. Should drivers change their driving habits due to rising fuel prices or variations in carpooling, the number of fatalities occurring within a given time period could change. Exhibit 2.30 summarizes the changes in fatal accidents by weekly time segment from 1970 to 1980 to help monitor the impact of change in the proportion of fatal accidents that occur in a given time segment (e.g., weekends). According to data obtained from the Fatal Accident Reporting System and the National Safety Council, a decline in daytime fatal accidents has been offset by an increase in nighttime fatal accidents. Alternatively, the percent distribution of daytime accidents has declined from 48 to 40 percent while the proportion of nighttime accidents has increased from 52 to 60 percent (see Exhibit 2.31). Commuting accidents decline but non-commuting accidents decline more rapidly. Weekend-nighttime accidents continue to increase as a share of the number of nighttime accidents despite the fact that there are more hours of nighttime

Exhibit 2.28

Trends in Fatalities by Posted Speed Limits, 1975-1980

Posted Speed[a]	Number of Fatalities 1975	1979	1980	Percent Change 75-80	Annual Percent Change 79-80	75-80
All Fatalities						
0-25 mph	3,484	3,527	3,422	- 1.8	- 3.0	- 0.3
30-50 mph	17,430	20,809	21,177	21.5	1.8	3.6
55 mph and over	23,611	26,752	26,478	12.1	- 1.0	2.0
Occupant Fatalities						
0-25 mph	2,039	2,279	2,219	8.8	- 2.6	1.5
30-50 mph	12,917	15,787	16,125	24.8	- 4.2	4.1
55 mph and over	20,969	23,860	23,569	12.4	1.2	2.1
Non-Occupant Fatalities						
0-25 mph	1,445	1,248	1,203	-16.7	- 3.6	- 2.8
30-50 mph	4,513	5,022	5,052	11.9	0.6	2.0
55 mph and over	2,642	2,892	2,909	10.1	5.9	1.7

[a]Fatal Accident Reporting System. Cases with unknown speed have been allocated based on a distribution of speed limits for known cases.

Exhibit 2.29

Trends in Numbers of Drivers Reported Drinking Involved in Fatal Accidents, 1977-1980
(preliminary)

Age and Sex of Driver	Number of Drivers			Percent Change	Annual Percent Change	
	1977	1979	1980	77-80	79-80	77-80
Total	15,182	18,577	19,380	27.7	4.3	8.5
Male	13,643	16,658	17,144	25.7	2.9	7.9
Under 16	49	49	49	0.0	0.0	0.0
16-24	6,329	7,590	7,694	21.6	1.4	6.7
25-44[b]	5,022	6,391	6,717	33.8	5.1	10.2
45-64[b]	1,958	2,264	2,328	18.9	2.8	5.9
65 and Over	285	364	356	24.9	- 2.2	7.7
Female	1,539	1,919	2,236	45.3	16.5	13.3
Under 16	10	13	19	--[c]	--[c]	--[c]
16-24	689	880	965	40.1	9.7	11.9
25-44[b]	540	681	855	58.3	25.6	16.6
45-64[b]	268	305	349	30.2	14.4	9.2
65 and Over	32	40	48	50.0	20.0	14.5

[a]Fatal Accident Reporting System. Drivers whose age is unknown have been allocated to age groups where age is known.

[b]Preliminary estimates.

[c]Percent change not reported.

Exhibit 2.30

Trends in Fatal Traffic Accidents by Weekly Time Segments, 1970-1980

Weekly Time Segment	Actual or Estimated Accidents				Percent Change			Annual Percent Change	
	1970[a]	1975[b]	1979	1980	70-75	75-80	70-80	79-80	70-80
Day[c]	22,039	17,583	18,992	18,798	-20.2	6.9	-14.7	- 1.0	- 1.6
Commuting	7,421	6,242	6,920	6,601	-15.9	5.8	-11.0	- 4.6	- 1.2
Non-commuting	7,891	6,435	6,908	6,692	-18.5	4.0	-15.2	- 3.1	- 1.7
Weekend	6,727	4,906	5,164	5,055	-27.1	3.0	-24.9	- 2.1	- 2.9
Night[d]	23,941	21,578	26,226	26,923	- 9.9	24.8	12.4	2.7	1.2
Weeknight	9,792	8,886	10,658	11,106	- 9.3	25.0	13.4	4.2	1.3
Weekend	14,149	12,692	15,568	15,817	-10.3	24.6	11.8	1.6	1.1
Total	45,980	39,161	45,218	45,271	-14.8	15.6	- 1.5	0.1	- 0.2

[a]Estimated using National Safety Council 1970 distribution of fatal accidents and adjusted to the FHWA number of fatal accidents.

[b]Fatal Accident Reporting System, Accidents with unknown time have been allocated based on distribution of accidents with known times.

[c]Daytime segments are: Commuting hours--Monday to Friday between 7 and 9 am and between 4 and 7 pm. Non-commuting hours are Monday to Friday 9:01 am to 3:59 am. Weekend day hours are Saturday and Sunday from 6:00 am to 6:00 pm.

[d]Nighttime segments are: Weeknight--Monday through Thursday 7:01 pm to 6:59 am. Weekend--remaining hours.

Exhibit 2.31

Percentage Distribution of Fatal Traffic Accidents by Weekly Time Segments, 1970-1980

Weekly Time Segment	1970	1975	1979	1980
Day	47.9	44.9	42.0	40.5
Commuting	16.1	16.0	15.3	14.6
Non-commuting	17.2	16.4	15.3	14.8
Weekend	14.6	12.5	11.4	11.1
Night	52.1	55.1	58.0	59.5
Weeknight	21.3	22.7	23.6	24.5
Weekend	30.8	32.4	34.4	35.0
Total	100.0	100.0	100.0	100.0

during the week.[1] Further discussion about the spatial characteristics of accident trends (e.g., regional or urban and rural differences) in accident rates is provided in Section 4.0 below.

2.5 Composite Trends in Fatalities Adjusted for Exposure

Figure 2.2 shows graphically the data in Exhibit 2.12 of the death rate per 100,000 population for five different age groups over four different decade intervals.[2] Figure 2.2 shows that the highest automotive death rate in 1980 was for the 25 to 44 year old population segment. Proportionately more 25 to 44 year olds in 1980 died in traffic fatalities (i.e., 31.2 per 100,000 population) than any other age group. This was dramatically different from the 1970 death rates where the 15 to 24 year age group had the highest death rate (i.e., 44.3 per 100,000 population). In 1960, the 15 to 24 year old age group also had the highest death rate while in 1950, it was the 65 and over age group who had the highest death rate (i.e., 39.8 deaths per 100,000 population). It can be seen from this graph that the death rate has dropped dramatically for both 15 to 24 and 65 and over age groups--previously the high death rate groups. We know, however, that not all members of an age group are drivers, so a decrease in death rate might simply reflect proportionately fewer drivers in these age groups.

Figure 2.3, based on the data in Exhibit 2.8 (see Section 2.2), shows graphically the death rate corrected for the proportion of the age groups with drivers licenses. Here again, we can see that the death rate dropped dramatically for 15 to 24 year olds from 1970 to 1980 while the death rate was relatively constant over time for the 25 to 44 and the 45 to 64 year age groups. The death rate also dropped dramatically from 1960 to 1980 for the 65 and over age group. The changes in death rate may reflect differential amounts of travel. We have available data on the amount of annual travel for

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[1] Adjustments of weekly time segment fatality experience by VMT proportions occuring in equivalent weekly time segments is another adjustment that may clarify the significance of these percentage shifts over time. Data on shifts in VMT by hour are not available for these time periods.

[2] Death rates reflect the proportion of individuals in an age group who are killed. The individuals may have been drivers, pedestrians, or passengers.

FIGURE 2.2

MOTOR VEHICLE DEATHS PER 100,000 POPULATION
(1950-1980)

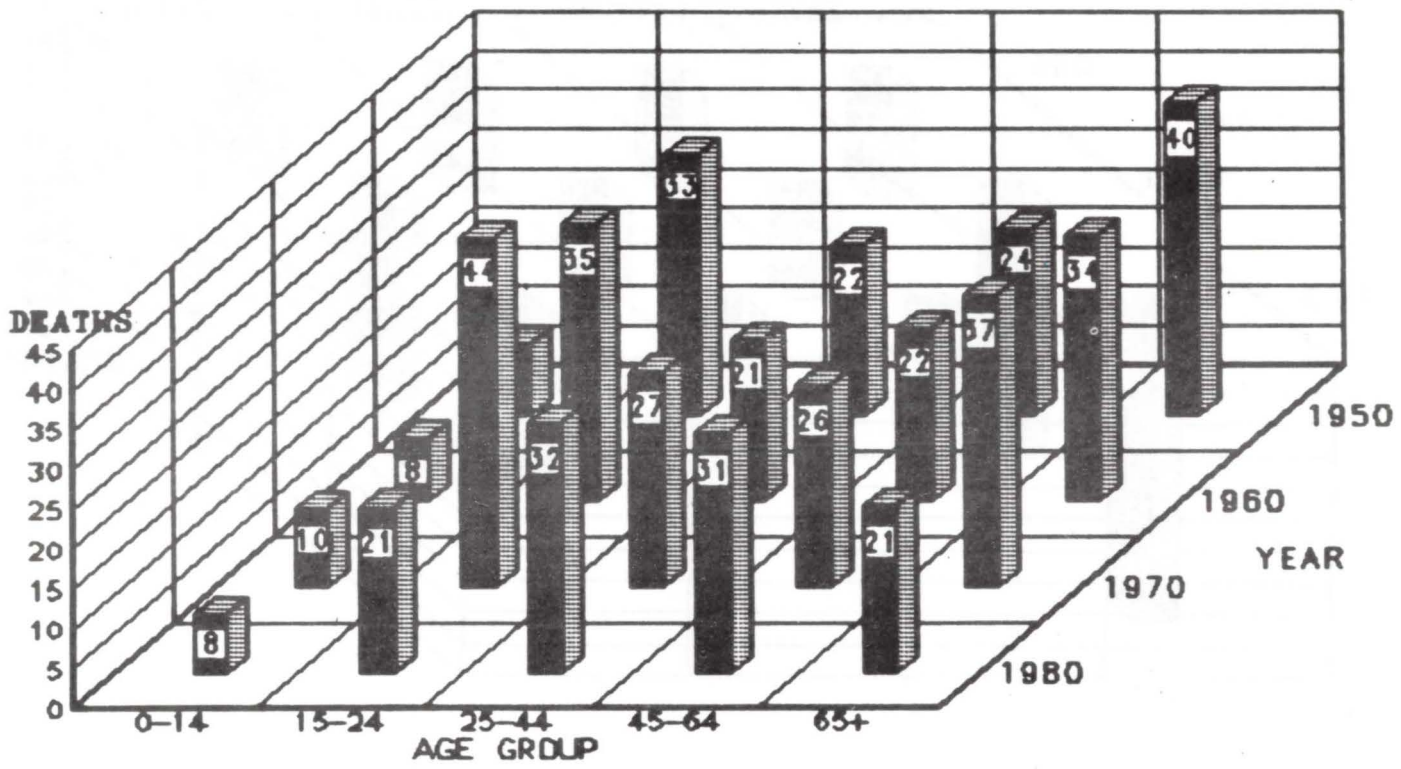

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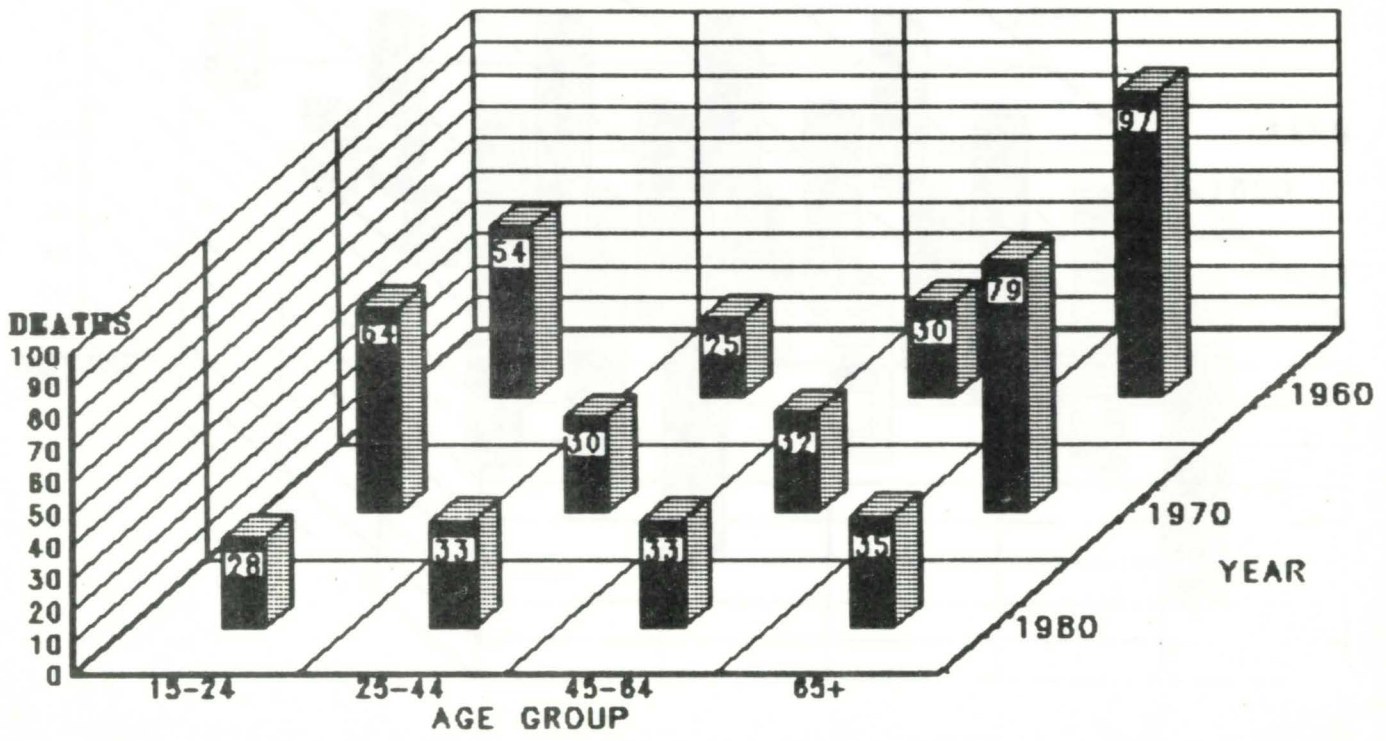
FIGURE 2.3

MOTOR VEHICLE DEATHS PER 100,000 LICENSED DRIVERS (1960-1980)



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the average driver in each of the age groups for 1969 and 1977 from the Nationwide Personal Transportation Study. Using these data (see Exhibit 2.32), we adjusted the death rate per 100,000 licensed drivers to reflect the death rate per billion miles of travel. These results are displayed graphically in Figure 2.4 and in tabular form in Exhibit 2.33. Inspection of Figure 2.4 shows that the death rate per billion miles of travel sharply drops from 1970 to 1980 for both the 15-24 year age group and the 65 and over age group, with the elderly individual 3.6 times more likely to be killed than the younger individual per mile of travel.

One of the recurring questions in traffic statistics analyses concerns responsibility for accidents. This question can be approached through a comparison of death rates and fatal accident involvements. In fatal accident involvements, the characteristics of the driver(s) involved in a crash are related to the presence or absence of a fatality. A driver involved in a crash where someone dies, may or may not kill himself. Driver involvements in fatal crashes are shown graphically in Figure 2.5 and in tabular form in Exhibit 2.34. These data were calculated using 1980 FARS data and corrected for the number of drivers, based on FHWA data and adjusted for the average annual mileage for each age and sex group using the 1977 Nationwide Personal Transportation Study data. Unfortunately, fatal accident involvements are not available for the year 1970, so the change in the fatal accident involvement rate over time for different age groups cannot be examined. However, we can compare the 1980 death rate per billion miles of travel (Figure 2.4) and the 1979 fatal accident involvement rate per billion miles of travel (Figure 2.5). The information in Figure 2.5 give a fatal involvement rate per billion miles of travel for both males and females. Figure 2.5 shows that 16-24 and 65 and over males have the highest fatal involvements compared with all other age and sex combinations. The low death rate for 15-24 year olds per billion miles of travel (Figure 2.4) contrasts sharply with the high fatal involvements of the same age group--especially the males. It appears that young male drivers are involved in fatal accidents, where others are dying disproportionately more frequently than the young male drivers.

Section 3.0 below contains a review of variations in accident trends associated with rural and urban areas, as well as the assessment of regional differences in these trends.

Exhibit 2.32

Average Annual Mileage for
Drivers By Age of Driver, 1969-1977

Age Group	1969[a]	1977[b]	Percent Change
15-24	6,790	8,492	25.1
25-44	10,074	11,752	16.7
45-64	9,241	9,815	6.2
65 and over	5,210	5,451	4.6
Total	8,685	10,006	15.2

[a]Data from 1969 Nationwide Personal Transportation Study
[b]Data from 1977 Nationwide Personal Transportation Study

FIGURE 2.4

MOTOR VEHICLE DEATHS PER BILLION VEHICLE MILES OF TRAVEL (1950-1980)

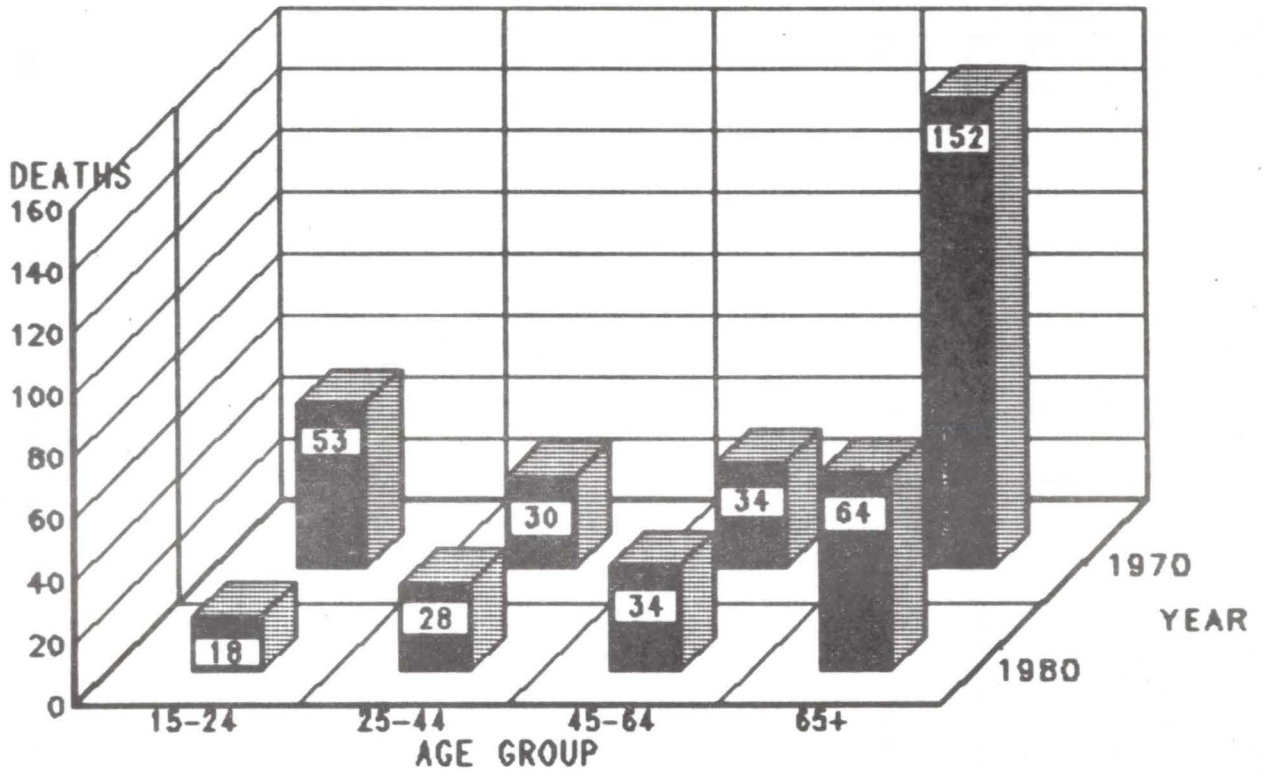

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Exhibit 2.33

Death Rates Per Billion

Miles of Travel by Age Group, 1970-1980

Age Group	1970[a]	1980[b]
15-24	53.3	17.8
25-44	29.8	28.3
45-64	34.2	33.9
65 and over	152.2	64.0
Total	54.3	35.0

[a]Vehicle Miles of Travel from 1969 Nationwide Personal Transportation Study

[b]Vehicle Miles of Travel from 1977 Nationwide Personal Transportation Study

Exhibit 2.34

Fatal Accident Involvement Rates for Male and Female Drivers by Age of Driver, 1980 (preliminary)

Age Group	Percent Distribution of Licensed Drivers[a]	Percent Distribution of Fatal Accident Involvements[b]	Average Miles Driven Per Year[c]	Estimated Fatal Accident Involvement Per Billion Vehicle Miles of Travel[d]
Males				
15-24	11.4	31.5	12,042	100
25-44	21.6	31.0	17,545	36
45-64	14.3	14.6	14,598	31
65 and over	6.0	4.7	6,260	54
Subtotal	53.4	81.8	14,311	47
Females				
15-24	10.0	6.4	5,934	48
25-44	19.8	6.7	7,042	21
45-64	12.4	3.7	5,546	24
65 and over	4.4	1.4	3,414	41
Subtotal	46.6	18.2	6,058	28
Total	100.0	100.0	10,400	42

[a] Federal Highway Administration, Highway Statistics (1979) N=143,284,000

[b] Fatal Accident Reporting System, September, 1981 N=62,939

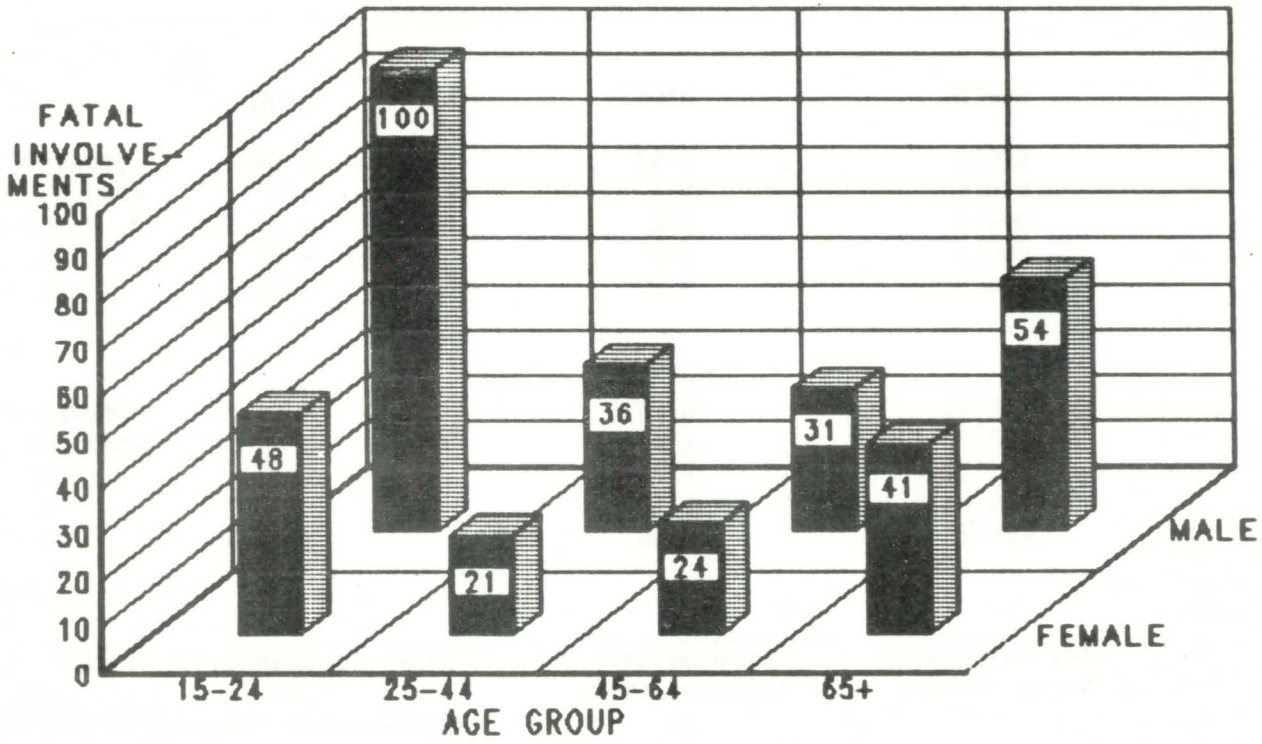
[c] Nationwide Personal Transportation Study, 1969 and 1977 (estimated trend).

[d] Assume average number of miles driven per driver per year multiplied by number of licensed drivers in that age group yields exposure in billions of miles of VMT.

FIGURE 2.5

FATAL ACCIDENT INVOLVEMENTS FOR MALE AND FEMALE DRIVERS

(PER BILLION VEHICLE MILES OF TRAVEL)
(1980)



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3.0 REGIONAL VARIATIONS IN ACCIDENT TRENDS

In this section, we examine the trend in accidents for urban and rural areas as well as for variations in trends for sunbelt and snowbelt states. The objective of this more detailed inspection of accident trends is to determine if substantial differences exist when the data are subdivided by geographic characteristics. This further refinement of the data is based on the suspicion that urban areas, due to their dense populations, may have a greater likelihood of accident involvement. It is also based on the concept that regions such as the "sunbelt" region may have different lifestyles or have experienced disproportionate increases in population of certain age groups which might affect accident rates.

Subsection 3.1 below examines the differences in accident trends for urban and rural areas and subsection 3.2 deals specifically with differences between sunbelt and snowbelt regions of the U.S.

3.1 Urban and Rural Differences in Accident Trends

The difference in urban and rural environments gives rise to the hypothesis that traffic accidents are also likely to differ. For example, pedestrian traffic is greater in urban areas than in rural areas. Not only are there likely to be differences in the types of traffic accidents, there are also likely to be variations in the number of accidents occurring in urban areas due to the relative concentration of traffic in these areas. Also, this relative concentration might result in a relative as well as absolute difference in accidents for urban areas.

This subsection is further subdivided into three units, each focusing on a specific aspect of the differences between urban and rural accident trends. Subsection 3.1.1 addresses the differences in accident types (e.g., type of fatal accident and injury accident), and subsection 3.1.2 compares the relative differences in fatal and injury accidents for urban and rural areas. Subsection 3.1.3 examines these latter differences in depth and considers the trends in fatal and injury accident rates after adjusting for changes in vehicle miles of travel.

3.1.1 Differences in Rural and Urban Accident Types

Rural areas have typically been associated with fatal accidents despite the fact that urban areas generally experience the majority of injury accidents. This is true because vehicles are able to travel at

greater speeds on rural roads, possibly along roads where traffic is not segregated by direction. As shown in Exhibit 3.1, this difference has become smaller. From 1950 to 1980, the split of fatal accidents in urban and rural areas shifted from 71 percent rural to 56 percent rural. Also, urban areas experienced rapid growth in their share of injury accidents (from 54 percent in 1950 to 68 percent in 1980.)

Fatal accidents involving collisions in urban areas increased disproportionately from 86 percent to 95 percent. (See Exhibit 3.2.) The bulk of this increase is accounted for by two motor vehicle and other collisions since the number of pedestrian fatal accidents decreased to 25 percent from 54 percent. In contrast, rural areas experienced a decrease in the proportion of two motor vehicle accidents although the greatest reduction occurs for noncollision accidents, as shown in Exhibit 3.3.

Injury accidents in urban areas for pedestrians declined from 26 percent in 1950 to 7 percent in 1980, and noncollision injuries also dropped from 12 to 7 percent for the same time period (as shown in Exhibit 3.4.) Even though these categories of accidents declined in their relative proportions, the overall totals of urban injury accidents increased from 650 thousand to over one million--primarily as a result of increases in "two or more motor vehicle" collisions. (This accident type accounted for an increase of 520 thousand accidents from 1950 to 1980.)

Rural area injury accidents also increased but at a slower rate. As shown in Exhibit 3.5, the increase in accidents for rural areas is a result of increases in noncollision accidents (more than 100 thousand of the total increase of 290 thousand from 1950 to 1980) and an increase in the number of "two or more motor vehicle" collision accidents. Pedestrian accidents remained at a constant level while "all other collisions" increased their share of the total slightly from 3 percent in 1950 to 5 percent in 1980.

3.1.2 Trends in Fatal and Injury Accidents for Rural and Urban Areas

Rural areas accounted for 50 percent of the vehicle miles traveled and 66 percent of traffic fatalities in 1967. But by 1980, these percentages declined to 43 percent and 60 percent, respectively. Even though overall levels of traffic in rural areas of increased from 1967 to 1980,

Exhibit 3.1

Number and Percent of Accidents in Rural and Urban Areas, 1950-1980
(preliminary)

Fatal	1950 Number	1950 Percent	1960[a] Number	1960[a] Percent	1970[b] Number	1970[b] Percent	1975[c] Number	1975[c] Percent	1979 Number	1979 Percent	1980 Number	1980 Percent
Rural	21,589	70.9	25,375	72.5	29,465	68.3	24,708	55.8	25,317	56.0	25,315	55.9
Urban	8,861	29.1	9,625	27.5	16,575	32.7	14,453	44.2	19,901	44.0	19,956	44.1
Total[d]	30,450	100.0	35,000	100.0	45,980	100.0	39,161	100.0	45,218	100.0	45,271	100.0
Injury[e] (thousands)												
Rural	283	45.8	457	42.9	611	35.6	628	32.6	677	32.4	684	32.0
Urban	335	54.2	608	57.1	1,106	64.4	1,300	67.4	1,412	67.6	1,455	68.0
Total	618	100.0	1,065	100.0	1,717	100.0	1,928	100.0	2,089	100.0	2,139	100.0[f]

[a] National Safety Council, Accident Facts, 1950-1960

[b] Federal Highway Administration, Fatal and Injury Accident Rates, 1970 (revised), 1975 - 1979 injuries only.

[c] Fatal Accident Reporting System, 1975-1980, September 1981

[d] Due to estimating procedures utilized, national totals presented earlier and sum of rural and urban totals may differ.

[e] Estimated based on distribution of urban and rural injuries.

[f] Estimated using 1970 to 1979 average annual change.

Exhibit 3.2

Number and Percent of Distribution of Fatal Accidents for Urban Areas by Type of Accident, 1950-1980 (preliminary)

Type of Accident	1950 Number	1950 Percent	1960 Number	1960 Percent	1970[a] Number	1970[a] Percent	1975[b] Number	1975[b] Percent	1979 Number	1979 Percent	1980 Number	1980 Percent
Pedestrian	4,785	54.0	4,235	44.0	6,441	39.0	4,180	28.9	5,002	25.1	4,972	24.9
Two or More Motor Vehicles	2,215	25.0	2,984	31.0	5,318	32.2	4,213	29.2	6,218	31.3	6,129	30.7
All Other Collisions	656	7.4	962	10.0	2,279	13.8	5,345	37.0	7,560	38.0	7,773	39.0
Collisions (Subtotal)	7,656	86.4	8,181	85.0	14,038	85.9	13,738	95.1	18,780	94.4	18,874	94.6
Non Collision	1,205	13.6	1,444	15.0	2,477	14.1	715	4.9	1,121	5.6	1,082	5.4
Total	8,661	100.0	9,625	100.0	16,515	100.0	14,453	100.0	19,901	100.0	19,956	100.0

[a] National Safety Council, Accident Facts, 1950-1970

[b] Fatal Accident Reporting System, 1975-1980, September, 1981

Exhibit 3.3

Number and Percent Distribution of Fatal Accidents for Rural Areas by Type of Accident, 1950-1980 (preliminary)

Type of Accident	1950 Number	1950 Percent	1960 Number	1960 Percent	1970[a] Number	1970[a] Percent	1975[b] Number	1975[b] Percent	1979 Number	1979 Percent	1980 Number	1980 Percent
Pedestrian	3,022	14.0	3,553	14.0	3,477	11.8	2,908	11.8	2,491	9.8	2,527	10.0
Two or More Motor Vehicles	1,204	38.0	10,404	41.0	12,405	42.1	8,439	34.2	8,857	35.0	8,386	33.1
All Other Collisions	2,396	11.1	2,537	10.0	3,713	12.6	9,762	39.5	10,366	40.9	10,472	41.4
Collisions (Subtotal)	13,622	63.1	16,494	65.0	19,595	66.5	21,105	85.5	21,714	85.5	21,385	84.5
Non Collision[c]	7,967	36.9	8,881	35.0	9,870	33.5	3,599	14.5	3,603	14.2	3,930	15.5
Total	21,589	100.0	25,375	100.0	29,465	100.0	24,708	100.0	25,317	100.0	25,315	100.0

[a]National Safety Council, Accident Facts, 1950-1970

[b]Fatal Accident Reporting System, 1975-1980, September, 1981

[c]Includes "rollover" types of accidents.

Exhibit 3.4

Number and Percent Distribution of Injury Accidents for Urban Areas by Type of Accident, 1950-1979
(in thousands)
(preliminary)

Type of Accident	1950		1960		1970		1975[a,b]		1979[c]		1980[d]	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Pedestrian	88	26.2	91	15.0	122	11.0	114	8.8	100	7.1	99	6.8
Two or More Motor Vehicles	186	55.4	426	70.0	810	73.2	1,023	78.7	1,072	75.9	1,109	76.2
All Other Collisions	23	6.9	38	6.3	85	7.7	103	7.9	141	10.0	150	10.3
Collisions (Subtotal)	297	88.5	555	91.3	1,017	91.9	1,240	95.4	1,313	93.0	1,358	93.3
Non Collision	38	11.5	53	8.7	89	8.1	60	4.6	99	7.0	97	6.7
Total	335	100.0	608	100.0	1,106	100.0	1,300	100.0	1,412	100.0	1,455	100.0

[a] National Safety Council, Accident Facts, 1950-1976.

[b] Estimated based on distribution of injuries by accident type.

[c] National Accident Sampling System, September, 1981

[d] Estimated using 1970 to 1979 average annual change.

Exhibit 3.5

Number and Percent Distribution of Injury Accidents for Rural Areas by Type of Accident, 1950-1979
(in thousands)
(preliminary)

Type of Accident	1950		1960		1970		1975[a,b]		1979[c]		1980[d]	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Pedestrian	5	1.8	8	1.7	20	3.3	13	2.1	12	1.8	12	1.7
Two or More Motor Vehicles	201	70.9	289	63a.3	381	62.3	401	63.9	435	64.3	441	64.5
All Other Collisions	8	2.7	15	3.3	51	8.4	40	6.3	36	5.3	35	5.1
Collisions (Subtotal)	214	75.4	312	68.3	452	74.0	454	72.3	483	71.4	488	71.3
Non Collision	69	24.6	145	31.7	159	26.0	174	27.7	194	28.6	196	28.7
Total	283	100.0	457	100.0	611	100.0	628	100.0	677	100.0	684	100.0

[a] National Safety Council, Accident Facts, 1950-1976.

[b] Estimated based on distribution of injuries by accident type.

[c] National Accident Sampling System, September, 1981

[d] Estimated using 1970 to 1979 average annual change.

the relative share of fatalities and injuries for rural areas decreased. Absolute levels and relative shares of vehicle miles of travel, fatalities and injuries have increased for urban areas, on the other hand. Exhibit 3.6 displays the results of comparing the absolute levels and relative shares of vehicle miles of travel, roadway miles, fatalities, and injuries. As indicated in this exhibit, the share of injuries in urban areas increased only slightly from 64 to 67 percent between 1967 to 1980. During this same time period, travel in urban areas increased from 50 to 57 percent, and the share of fatalities rose from 34 to 40 percent.

When the proportions of fatalities and injuries in urban and rural areas are further subdivided by roadway classes, some additional insights are possible. Exhibit 3.7 shows that for rural areas, the greatest increase in the share of fatalities occurred on non-federal-aid routes. For these roadways, the relative share of fatalities increased from 20 to 27 percent. Similarly, injury rates increased from 30 to 35 percent, even though the vehicle miles traveled on non-federal-aid routes remained constant. For Interstate highways, vehicle miles of travel increased from 11 to 20 percent while the share of fatalities increased from 6 to 8 percent, and the share of injuries increased from 5 to 7 percent. Federal aid secondary routes experienced a decline of VMT from 29 to 20 percent, with a somewhat smaller reduction in their share of fatalities and injuries (30 percent to 25 percent).

In comparison, the share of urban VMT increased on federal aid secondary routes--from 11 to 39 percent (see Exhibit 3.8). These routes also experienced increases in roadway miles--from 5 to 27 percent. This suggests that the process of urbanization may be responsible for these shifts. That is, formerly rural areas have become developed and have come to be included in the boundaries of urban areas. Consequently, these routes have increased their relative share of total fatalities and injuries. For example, the share of fatalities in these routes in 1967 was 13 percent of the total number of urban fatalities. By 1980, this share increased to 44 percent. The bulk of the increase in fatalities occurred between 1970 and 1975 when the number of fatalities on urban federal aid secondary routes increased by 219 percent (see Exhibit 3.9) Although the number of fatalities on urban Interstate highways increased annually by 4 percent between 1967 and 1980, the total number of traffic fatalities in urban areas increased by only one percent. In the absence of these increases, urban area

Exhibit 3.6

Number and Percent Distribution of Selected Variables for Urban and Rural Areas, 1967-1980
(preliminary)

Area	Vehicle Miles Traveled (in billions)		Roadway Miles (in thousands)		Fatalities		Injuries (in thousands)	
	1967	1980	1967	1980	1967	1980	1967	1980
Urban	484	851	510	414	17,187	20,630	1,615	2,177
Percent	50.2	56.9	13.8	15.8	33.8	40.4	64.4	66.8
Rural	481	644	3,194	3,279	33,590	30,447	894	1,082
Percent	49.8	43.1	86.2	84.2	66.2	59.6	35.6	33.2
Total	965	1,495	3,704	3,895[a]	50,777	51,077	2,509	3,259

[a]1979 Roadway Miles

Exhibit 3.7

Percent Distribution of Selected Variables for Rural Areas by Class of Roadway, 1967-1980

Roadway Class	Vehicle Miles Traveled		Roadway Miles		Fatalities		Injuries	
	1967	1980	1967	1980	1967	1980	1967	1980
Interstate	11.4	20.0	0.6	1.0	6.0	7.8	4.6	5.8
Other Federal Aid Primary	40.5	40.1	6.0	7.2	44.4	40.2	36.1	34.0
Federal Aid Secondary	28.5	19.9	19.5	11.5	30.1	25.4	29.8	25.2
Non Federal Aid	19.5	20.0	73.9	80.3	19.5	26.6	29.5	35.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Exhibit 3.8

Percent Distribution of Selected Variables for Urban Areas by Class of Roadway, 1967-1980

Roadway Class	Vehicle Miles Travelled		Roadway Miles		Fatalities		Injuries	
	1967	1980	1967	1980	1967	1980	1967	1980
Interstate	11.6	18.6	0.9	1.5	6.9	9.9	3.4	6.1
Other Federal Aid Primary	27.3	20.9	4.6	4.2	28.4	22.5	25.3	18.6
Federal Aid Secondary	11.1	39.0	5.0	26.9	12.6	43.7	10.8	46.3
Non Federal Aid	50.0	21.5	89.5	67.4	52.1	23.9	60.5	29.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Exhibit 3.9

Trends in Fatalities by Class of Roadway for Urban Areas, 1967-1980 (preliminary)

Roadway Class	Estimated Fatalities					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980	67-70	70-75	75-80	79-80	67-80
Interstate	1,175	1,556	1,721	2,041	2,041	32.4	10.6	18.6	0.0	4.3
Other Federal Aid Primary	4,883	4,706	3,918	4,647	4,648	-3.6	-16.7	18.6	0.0	-0.4
Federal Aid Secondary	2,170	2,385	7,600	9,012	9,014	9.9	218.7	18.6	0.0	11.6
Non-Federal Aid	8,959	9,030	4,160	4,934	4,935	0.8	-53.9	18.6	0.0	-4.7
Total	17,187	17,677	17,399	20,634	20,630	2.9	-1.6	18.6	0.0	1.4

fatality experience from 1967 to 1970 would have shown an absolute and relative decrease (i.e., the change in fatality counts for the remaining routes was negative).

Some of the increase in fatalities in urban federal-aid secondary routes is accounted for by reductions in the number of fatalities in these routes in rural areas. For rural areas, the number of fatalities declined by 1 percent annually and by an absolute number that represents 48 percent of the increase on these routes in urban areas. This partial offset helps explain about half the increase in fatalities in urban areas but does not explain the entire increase (Compare Exhibit 3.10 with Exhibit 3.9).

In contrast to urban areas, rural area non-federal aid routes experienced an increase in the number of fatalities of about 2 percent annually. This increase was more than offset by a 5 percent annual decrease in the number of urban fatalities experienced on these routes.

The experience for injuries on urban roadways is somewhat equivalent to that of traffic fatalities. Exhibits 3.11 and 3.12 contain similar displays for these trends. Although urban fatality growth was partially offset by rural fatality decline on certain roadways (e.g., federal aid secondary routes), urban injury rates increased for both urban and rural areas. In fact, the annual increase for the number of injuries was greatest for federal aid secondary routes and Interstate highways in both rural and urban areas. Urban non-federal-aid roadway injuries declined by 3.5 percent and rural injuries for these roadways increased by 2.8 percent.[1]

Since there are differences in the trends and relative shares of fatalities and injuries for urban and rural areas that are not easily explained, it may be helpful to consider the impact of changes in these trends after adjusting for differences in the number of roadway miles and vehicle miles of travel for these areas. By separating out the influence of changes in the variables, it is possible to measure the relative changes in traffic safety for these areas more accurately.[2] One method to measure

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[1]Despite an apparent balance in relative growth, there is actually a net reduction in injuries for these roadway types of 2 percent. Compare Exhibit 3.1 and 3.12 and refer to Exhibit 2.18, above.

[2]Even though frequencies or shares of accidents change, decision makers may not consider shifts in traffic due to rural-urban migration as a variable that can be controlled. Shifts in accident trends after discounting for changes in travel or roadway miles can help identify problem areas more directly within the influence of traffic safety program objectives.

Exhibit 3.10

Trends in Fatalities by Class of Roadway for Rural Areas, 1967-1980 (preliminary)

Roadway Class	Estimated Fatalities					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980	67-70	70-75	75-80	79-80	67-80
Interstate	1,999	2,691	1,807	2,396	2,380	34.6	-32.9	31.7	-0.7	1.4
Other Federal Aid Primary	14,914	14,308	10,443	12,296	12,243	-4.1	-27.0	17.3	-0.4	-1.5
Federal Aid Secondary	10,114	11,527	9,302	7,803	7,719	14.0	-19.3	-17.0	-1.1	-2.1
Non-Federal Aid	6,563	6,424	5,574	8,161	8,105	-2.1	-13.2	45.4	-0.7	1.6
Total	33,590	34,950	27,126	30,656	30,447	4.0	-22.4	12.2	-0.7	-0.8

Exhibit 3.11

Trends in Injuries by Class of Roadway
for Urban Areas, 1967-1980
(in thousands)
(preliminary)

Roadway Class	Estimated Injuries					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980	67-70	70-75	95-80	79-80	67-80
Interstate	55	88	94	131	133	60.0	6.8	41.5	1.5	7.0
Other Federal Aid Primary	409	403	386	396	403	-1.4	-4.2	4.4	1.8	-0.1
Federal Aid Secondary	174	207	686	984	1,002	18.9	231.4	46.1	1.8	14.4
Non-Federal Aid	977	1,105	727	616	627	13.1	-34.2	-13.8	1.8	-3.5
Total	1,615	1,803	1,893	2,127	2,165	11.6	5.0	14.4	1.8	2.3

Exhibit 3.12

Trends in Injuries by Class of Roadway for Rural Areas, 1967-1980
(in thousands)
(preliminary)

Roadway Class	Estimated Injuries					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980	67-70	70-75	75-80	79-80	67-80
Interstate	41	53	48	59	62	29.3	-9.4	29.2	5.1	3.2
Other Federal Aid Primary	323	338	287	346	365	4.6	-15.1	27.2	5.5	0.9
Federal Aid Secondary	266	306	313	257	271	15.0	2.3	-13.4	5.4	0.1
Non-Federal Aid	264	258	268	356	376	-2.3	3.9	40.3	5.6	2.8
Total	894	955	916	1,018	1,074	6.8	-4.1	17.2	5.5	1.4

this change precisely is by evaluating shifts in roadway miles for each roadway class for rural and urban areas. Exhibits 3.13 and 3.14 provide a summary of trends in roadway miles by class of roadway. This confirms the earlier finding that the number of roadway miles in the federal aid secondary system in urban areas increased disproportionately (e.g., by 16 percent annually from 1967 to 1980.) However, it is not possible to determine if this unusual rate of growth in the number of roadway miles could explain the absolute and relative increases in accident frequencies observed for these roadways. To evaluate this, it will be necessary to consider changes in vehicle miles traveled for each class of roadway. This additional factor is considered in subsection 3.1.3 below.

3.1.3 Trends in Fatalities and Injuries Adjusted for Changes in Vehicle Miles of Travel, 1967-1980

Vehicle miles of travel grew most rapidly on federal-aid secondary roads in urban areas. As shown in Exhibit 3.15, VMT increased at an annual rate of 15 percent for these roadways--slightly less than the increase in roadway miles observed earlier. Exhibit 3.16 contains a similar display for rural areas which shows that VMT for these roadways declined slightly for the same time period. To include the consideration of changes in vehicle miles of travel, it is necessary to construct fatality and injury rates that are ratios of accident levels and vehicle miles of travel. Exhibits 3.17 and 3.18 show reduction in these rates for all roadway classes in urban areas between 1967 and 1980. Despite the long term reductions in fatality and injury rates, an increase is noted for the fatality rate in federal aid primary routes between 1970 and 1975 that indicates that some short term fluctuations occur.[1] Although rural area fatality rates declined from 1967 to 1980, injury rates in federal aid secondary routes increased slightly.

As in earlier sections, it is possible to convert these rates into a set of index values. These index values show that these rates declined for all roadway classes and for all areas when 1970 is used as the basis

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[1] Similar increases occurred for Interstate and non federal-aid highway injury rates between 1967 and 1970 and between 1975 and 1980.

Exhibit 3.13

Trends in Miles of Roadway by Class
for Rural Areas, 1967-1980
(preliminary)

Roadway Class	Actual and Estimated Miles of Roadway					Percent Change			Annual Percent Change	
	1967	1970	1975	1979[a]	1980[b]	67-70	70-75	75-80	79-80	67-80
Interstate	19,208	24,244	28,935	31,334	32,352	26.2	19.3	11.8	3.2	4.1
Other Federal Aid Primary	193,046	191,210	188,004	232,095	237,609	-1.0	-1.7	26.4	2.4	1.6
Federal Aid Secondary	622,680	616,711	610,069	396,489	380,758	-1.0	-2.0	-37.6	-4.0	-3.9
Non-Federal Aid	2,358,806	2,333,358	2,337,542	2,619,126	2,654,767	-1.0	0.9	13.6	1.4	0.9
Total	3,193,740	3,165,523	3,164,550	3,279,044	3,305,486	-0.9	0.0	4.5	0.8	0.3

[a]Federal Highway Administration, Fatal and Injury Accident Rates

[b]Estimated using average annual 1970 to 1979 rate of growth.

Exhibit 3.14

Trends in Miles of Roadway by Class of Roadway
for Urban Areas, 1967-1980
(preliminary)

Roadway Class	Actual and Estimated Miles of Roadway					Percent Change			Annual Percent Change	
	1967	1970	1975	1979[a]	1980[b]	67-70	70-75	75-80	79-80	67-80
Interstate	4,442	5,752	7,780	9,114	9,706	29.5	35.3	24.8	6.5	6.2
Other Federal Aid Primary	23,705	26,200	30,119	27,775	27,961	10.5	15.0	-7.2	0.7	1.3
Federal Aid Secondary	25,263	28,685	82,351	128,474	178,133	13.5	187.1	116.3	38.7	16.2
Non-Federal Aid	456,933	490,958	529,699	450,972	446,900	7.4	7.9	-15.6	-0.9	-0.2
Total	510,343	551,495	649,949	616,335	662,700	8.1	17.9	2.0	7.5	2.0

[a] Federal Highway Administration, Fatal and Injury Accident Rates

[b] Estimated using 1970 to 1979 average annual percent change.

Exhibit 3.15

Trends in Vehicle Miles of Travel of Roadway by Class of Roadway for Urban Areas, 1967-1980
(in billions)
(preliminary)

Roadway Class	Vehicle Miles of Travel					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980[a]	67-70	70-75	75-80	79-80	67-80
Interstate	56	82	118	159	158	46.4	43.9	33.9	-0.6	8.3
Other Federal Aid Primary	132	154	166	180	178	16.7	7.8	8.4	-1.1	2.3
Federal Aid Secondary	54	66	220	335	332	22.2	233.3	50.9	-0.9	15.0
Non-Federal Aid	242	273	226	185	183	12.8	-17.2	-19.0	-1.1	-2.2
Total	484	575	730	859	851	18.8	27.0	16.6	-0.9	4.4

[a]Assumes 1979 share of VMT is constant for each class of roadway.

Exhibit 3.16

Trends in Vehicle Miles of Travel by Class of Roadway
for Rural Areas, 1967-1980
(in billions)
(preliminary)

Roadway Class	Vehicle Miles of Travel					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980[a]	67-70	70-75	75-80	79-80	67-80
Interstate	55	80	112	134	133	45.4	40.0	8.8	-0.7	7.0
Other Federal Aid Primary	195	210	221	269	266	7.7	5.2	20.4	-1.1	2.4
Federal Aid Secondary	137	150	163	133	132	9.4	8.7	-19.0	-0.8	-0.3
Non-Federal Aid	94	100	103	134	133	6.4	3.0	29.1	-0.7	2.7
Total	481	540	599	670	664	12.3	10.9	10.9	-0.9	2.5

[a]Assumes 1979 share of VMT is constant for each class of roadway.

Exhibit 3.17

Trends in Fatality and Injury Rates by Class of Roadway for Urban Areas, 1967-1980
(per billions of VMT)
(preliminary)

	Rates					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980	67-70	70-75	75-80	79-80	67-80
Fatalities										
Interstate	21.0	19.0	14.6	12.8	12.9	-9.5	-23.2	-11.6	0.8	-3.8
Other Federal Aid Primary	37.0	30.6	23.6	25.8	26.1	-17.3	-22.9	10.6	1.2	-2.7
Federal Aid Secondary	40.2	36.8	29.1	26.9	27.2	-8.4	-20.9	-6.5	1.1	-3.1
Non Federal Aid	37.0	33.1	18.4	26.7	27.0	-10.5	-44.4	45.1	1.0	-2.5
Injuries										
Interstate	982.1	1,073.1	796.6	823.9	841.8	9.3	-25.8	5.7	2.2	-1.2
Other Federal Aid Primary	3,098.4	2,616.9	2,325.3	2,200.0	2,264.0	-15.5	-11.1	-2.6	2.9	-2.4
Federal Aid Secondary	3,222.2	3,136.4	3,118.2	2,937.3	3,018.1	-2.7	-0.6	-3.2	2.8	-0.5
Non Federal Aid	4,037.2	4,047.6	3,216.8	3,329.7	3,426.2	0.3	-20.5	6.5	2.9	-1.3

Exhibit 3.18

Trends in Fatality and Injury Rates by Class of Roadway for Rural Areas, 1967-1980
(per billions of VMT)
(preliminary)

	Rates					Percent Change			Annual Percent Change	
	1967	1970	1975	1979	1980	67-70	70-75	75-80	79-80	67-80
Fatalities										
Interstate	36.3	33.6	16.1	17.9	18.0	-7.4	-52.1	11.8	0.5	-5.5
Other Federal Aid Primary	76.4	68.1	47.3	45.7	46.0	-10.9	-30.5	2.7	0.7	-4.0
Federal Aid Secondary	73.8	76.8	57.1	58.7	58.4	4.1	-25.7	2.3	-0.5	-1.8
Non Federal Aid	69.8	64.2	54.1	60.9	60.9	-8.0	-22.5	12.6	0.0	-1.1
Injuries										
Interstate	754.4	662.5	428.6	440.3	466.2	-11.1	-35.3	8.8	5.9	-3.8
Other Federal Aid Primary	1,656.4	1,609.5	1,298.6	1,286.2	1,372.2	-2.8	-19.3	5.7	6.7	-1.5
Federal Aid Secondary	1,941.6	2,040.0	1,920.2	1,932.3	2,053.3	5.1	-5.9	6.9	6.2	0.4
Non Federal Aid	2,808.5	2,580.0	2,601.9	2,656.7	2,827.1	-8.1	8.5	8.7	4.9	0.1

of comparison. The greatest relative reduction, shown for fatality rates in Exhibit 3.19, is for rural Interstates, and the lowest relative reduction occurred for rural non-federal aid routes. Relative reductions in injury rates are not experienced for all roadways since values over 100 in 1975 and 1980 are computed for rural non federal-aid roadways and for 1980 for rural federal aid roadways. The greatest relative decline in injury rates is shown for rural Interstate highways.

Aggregating these rates for all roadway classes and taking the ratio of urban and rural rate relative to the national rate is an alternative method for assessing the trends in these accident types. Exhibit 3.21 and Figure 3.1 present the results of this comparison in ratios and in index values. Urban area fatality ratios on the whole increased relatively, although fatality rates in urban areas were about half the rate for rural areas. In contrast, injury rates in urban areas exceeded those of rural areas, and these rates show evidence of relative decline from 1970 to 1980. Rural area injury ratios of 1975 and 1980 exceeded those of 1967 and 1970.

In an attempt to determine a more precise explanation for variations in trends, it is helpful to consider differences at even finer levels of detail (e.g., regions or states). In the next subsection, the possible effect of changes in regional environment will be added to the evaluation in an effort to develop even greater insights about differences in accident trends.

Exhibit 3.19

Index of Fatality Rates by Class of Roadway
for Urban and Rural Areas, 1967-1980

	Index Values (1970 = 100)				
Urban Areas	1967	1970	1975	1979	1980
Interstate	110.5	100.0	76.8	67.4	67.8
Other Federal Aid Primary	120.9	100.0	77.1	84.3	85.3
Federal Aid Secondary	109.2	100.0	79.1	73.1	73.9
Non Federal Aid	111.8	100.0	55.6	80.7	81.6
Rural Areas					
Interstate	108.0	100.0	47.9	53.3	53.6
Other Federal Aid Primary	112.2	100.0	69.5	67.1	67.5
Federal Aid Secondary	96.1	100.0	74.3	76.4	76.0
Non Federal Aid	108.7	100.0	84.3	94.9	94.9

Exhibit 3.20

Index of Injury Rates by Class of Roadway for Urban and Rural Areas, 1967-1980

	Index Values (1970 = 100)				
Urban Areas	1967	1970	1975	1979	1980
Interstate	91.5	100.0	74.2	76.8	78.4
Other Federal Aid Primary	118.4	100.0	88.9	84.1	86.5
Federal Aid Secondary	102.7	100.0	99.4	93.7	96.2
Non Federal Aid	99.7	100.0	79.4	82.3	84.6
Rural Areas					
Interstate	112.5	100.0	64.7	66.5	70.4
Other Federal Aid Primary	102.9	100.0	80.7	79.9	85.3
Federal Aid Secondary	95.2	100.0	94.3	94.7	100.6
Non Federal Aid	108.9	100.0	100.8	103.0	109.6

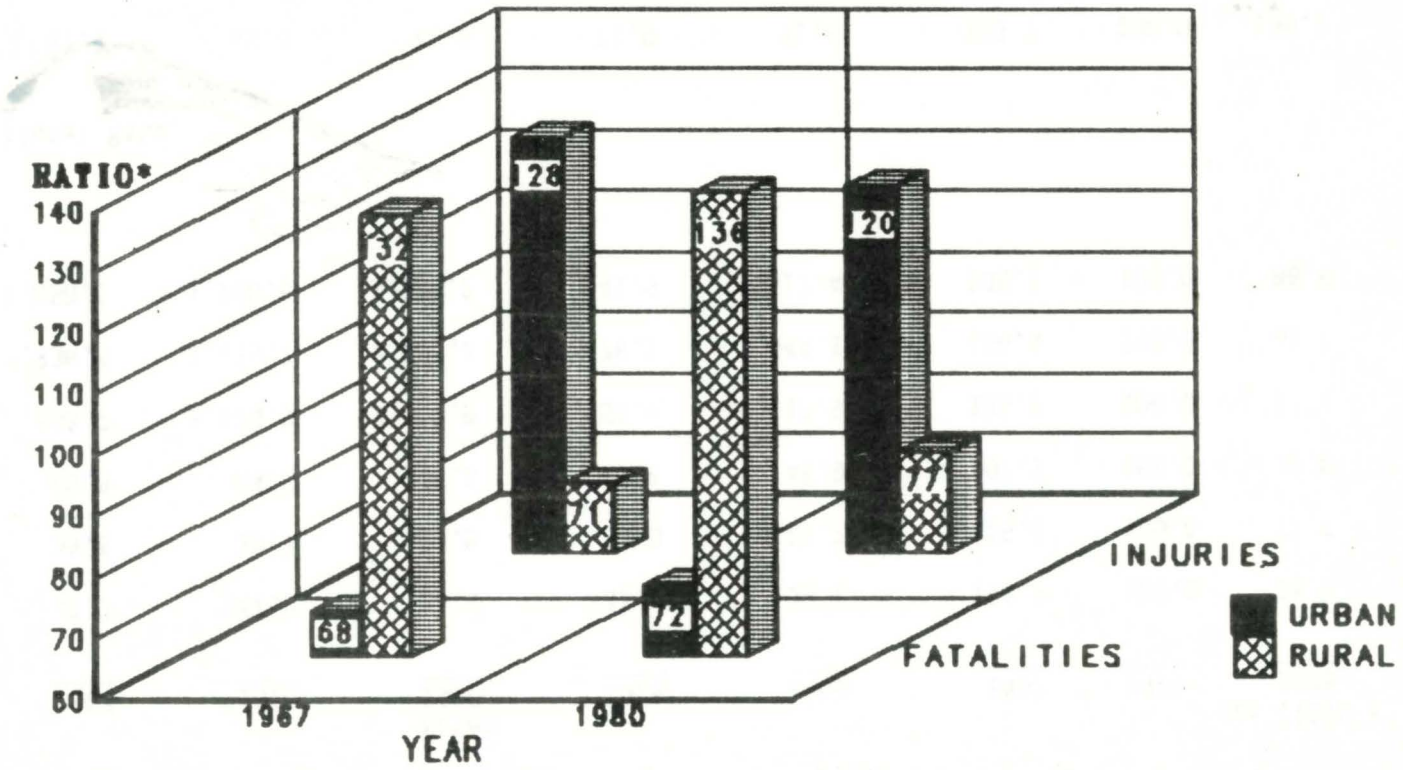
Exhibit 3.21

Trends in Fatalities and Injury Rates for Urban and Rural Areas, 1967-1980
(in billions of VMT)
(preliminary)

	Rates					Index (1970 = 100)				
	1967	1970	1975	1979	1980	1967	1970	1975	1979	1980
Fatalities	52.7	47.2	33.5	33.4	33.7	111.7	100.0	71.0	70.8	71.4
Urban	35.5	30.7	23.8	24.0	24.2	115.6	100.0	77.5	78.2	78.8
Rural	69.8	64.7	45.3	45.8	45.9	107.9	100.0	70.0	70.8	70.9
Injuries	2,603.7	2,474.9	2,112.9	2,055.6	2,112.9	105.2	100.0	85.4	83.1	85.4
Urban	3,336.8	3,135.7	2,593.2	2,476.1	2,544.1	106.4	100.0	82.7	79.0	81.1
Rural	1,858.6	1,768.5	1,529.2	1,641.9	1,617.4	105.1	100.0	86.5	92.8	91.5
Ratio of National Rate										
Fatalities										
Urban	67.4	65.0	71.0	71.9	71.8	103.7	100.0	109.2	110.6	110.4
Rural	132.4	137.1	135.2	137.1	136.2	96.5	100.0	98.6	100.0	99.3
Injuries										
Urban	128.2	126.7	122.7	120.5	120.4	101.2	100.0	96.9	95.1	95.0
Rural	71.4	71.5	72.4	79.9	76.5	99.9	100.0	101.3	111.7	106.7

FIGURE 3.1

TRENDS IN URBAN AND RURAL FATALITY AND INJURY RATES (1967-1980)



*Ratio of urban and rural accidents per billion vehicle miles of travel to total accidents per billion vehicle miles of travel.

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3.2 Regional Variations in Selected Accident Trends

As a result of the growing recognition that portions of the U.S. experienced relatively greater inmigration, accident trend data have been analyzed at the state level of detail.[1] Yet state trend data are often cumbersome to analyze and may be awkward to display. Furthermore, aggregation of state level data into sets of states with somewhat typical driving environments and lifestyles offers the potential to provide insights about the impact of the most recently observed migration trend, that of "snowbelt" to "sunbelt" migration. (See Figure 3.2 for the definition of states included in those regions.) As shown in Exhibit 3.22, the share of U.S. population in sunbelt states has increased from 31 percent in 1950 to 38 percent in 1980. During this time period, the proportion of population in snowbelt states declined from 63 to 55 percent.

Possibly as a result of this shift in population, the traffic accident experience for these regions has not been consistent. Exhibit 3.23 summarizes the results of comparing 1975 to 1980 traffic fatality experience for these regions. Sunbelt regions, for example, experienced a 10 percent increase in "pedalcyclist-related" fatalities while snowbelt states registered an 18 percent decline. Possibly as a result of increased traffic in these regions stemming from new population, sunbelt regions experienced a 22 percent increase in motor vehicle collisions while snowbelt regions experienced only a 2 percent increase. Similar disparities existed for "other collision types" of accidents (e.g., fixed objects). For railroad train collisions, the snowbelt experienced a slower rate of decline than sunbelt regions with the result that the snowbelt accounts for a larger proportion of railroad-related fatalities. In the snowbelt region, the ratio of railroad fatalities increased from 92 to 111 between 1975 and 1980 (see Exhibit 3.24).

Exhibit 3.25 contains a review of regional experience in non-collision as well as pedestrian fatalities for these same regions. Although the number of pedacyclists fatalities increased in sunbelt regions, the share of pedestrian fatalities in sunbelt regions declined slightly. (Compare Exhibits 3.23 and 3.24.)

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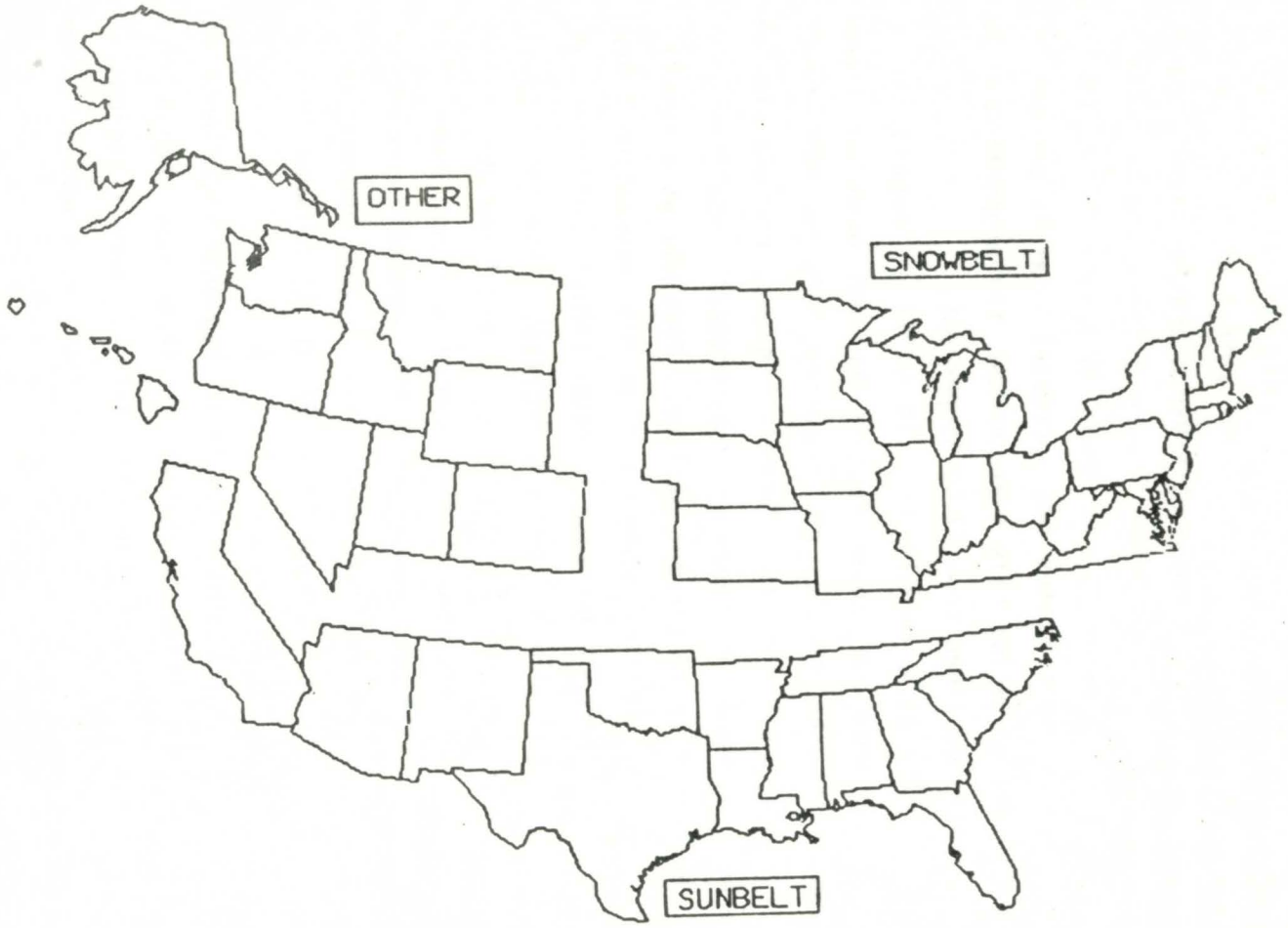
[1] Analysis of Fatality Data by State, James O'Day and R. J. Kaplan, Highway Safety Research Institute, University of Michigan, Ann Arbor, Michigan, 1976.

FIGURE 3.2

DEFINITION OF THE SUNBELT AND SNOWBELT REGIONAL GROUPING OF STATES



[1]Alaska and Hawaii are included in the "Other" category.

Exhibit 3.22

Trends in Population Change by Region, 1950-1980
(in thousands)
(preliminary)

	Percent Distribution					Percent Change			Annual Percent Change	
	1950	1960	1970	1979	1980	50-60	60-70	70-80	79-80	50-80
Regions										
Sunbelt	31.4	33.4	34.8	37.2	38.3	26.6	18.1	22.7	6.2	0.7
Snowbelt	63.2	61.0	59.2	56.1	54.8	14.7	10.0	3.1	0.9	-0.5
Other	5.4	5.6	6.0	6.7	6.9	24.0	19.6	28.5	5.6	0.1
Total (in millions)	151.3	180.0	203.8	220.1	227.1	18.9	13.2	11.4	3.2	1.4

Exhibit 3.23

Traffic Fatalities by Type of Collision and Region, 1975-1980

Collision Type	Number of Fatalities[a] 1975	1979	1980	Percent Change 70-75	79-80	Annual Percent Change 1975-1980
Between Motor Vehicles	17,359	20,248	19,553	12.6	-2.0	2.4
Sunbelt	7,636	9,369	9,310	21.9	0.6	4.0
Snowbelt	8,525	9,294	8,717	2.3	-6.2	0.4
Other	1,198	1,585	1,526	27.4	-3.7	5.0
With Fixed Objects	12,044	14,307	15,227	26.4	6.4	4.8
Sunbelt	4,792	6,029	6,376	33.1	5.8	5.9
Snowbelt	6,450	7,173	7,798	20.9	8.7	3.9
Other	802	1,105	1,053	31.3	-4.7	5.6
With Railroad Train	851	777	723	-15.0	-6.9	-3.3
Sunbelt	388	338	305	-21.4	-9.8	-4.9
Snowbelt	394	388	371	-5.8	-4.4	-1.2
Other	69	51	47	-31.9	-7.8	-8.0
With Pedalcyclist[b]	1,005	904	952	-5.3	0.7	-1.1
Sunbelt	403	453	442	9.7	-2.4	1.8
Snowbelt	549	401	450	-18.0	-0.7	-4.1
Other	53	50	60	13.2	20.0	2.5
Other Collisions	1,378	2,099	1,651	19.8	-21.3	3.7
Sunbelt	608	1,103	856	40.8	-22.4	7.1
Snowbelt	682	846	653	-4.3	-22.8	-0.9
Other	88	150	142	61.4	-5.3	7.5
Total	32,637	38,335	38,106	13.3	0.8	3.1
Sunbelt	13,827	17,292	17,289	25.0	0.0	4.6
Snowbelt	16,600	18,102	17,989	8.4	-0.6	1.6
Other	2,210	2,941	2,828	28.0	3.8	5.1

[a]Fatal Accident Reporting System, September, 1981.

[b]Excludes pedestrians

Exhibit 3.24

Distribution of Traffic Fatalities by Type of Collision and Region, 1975-1980

	Percent Distribution			Ratios of Regional Share to National Share[a] (times 100)		
Collision Type	1975	1979	1980	1975	1979	1980
Between Motor Vehicles	53.2	52.8	51.3	100.0	100.0	100.0
Sunbelt	55.2	54.2	53.8	103.8	102.7	104.9
Snowbelt	51.4	47.2	48.4	96.7	89.4	94.3
Other	54.2	53.9	54.0	101.9	102.1	105.3
With Fixed Object	36.9	37.3	40.0	100.0	100.0	100.0
Sunbelt	34.7	34.9	36.9	94.0	93.6	92.3
Snowbelt	38.9	39.6	43.3	105.4	106.2	108.3
Other	36.3	37.6	37.2	98.4	100.8	93.0
With Railroad Train	2.6	2.0	1.9	100.0	100.0	100.0
Sunbelt	2.8	2.0	1.8	107.7	100.0	94.7
Snowbelt	2.4	2.1	2.1	92.3	105.0	110.6
Other	2.4	1.7	1.7	92.3	85.0	89.5
With Pedalcyclist	3.1	2.4	2.5	100.0	100.0	100.0
Sunbelt	2.9	2.6	2.6	93.5	108.3	104.0
Snowbelt	3.3	2.2	2.5	106.5	91.7	100.0
Other	3.1	1.7	2.1	100.0	70.8	84.0
Other Collisions	4.2	5.5	4.3	100.0	100.0	100.0
Sunbelt	4.4	6.4	5.0	104.8	116.4	116.3
Snowbelt	4.1	4.7	3.6	97.6	85.5	83.7
Other	4.0	5.1	5.0	95.2	92.7	116.3

[a]Ratio of 1.0 indicates that region and national shares are identical, multiplied by 100.

Exhibit 3.25

Traffic Fatalities by Types of Accident and Region, 1975-1980

	Percent of Total Fatalities		
	1975	1979	1980
Collision			
Sunbelt	72.0	73.9	73.0
Snowbelt	75.8	77.4	77.4
Other States	64.4	69.0	67.7
Noncollision in Roadway			
Sunbelt	11.7	10.7	11.3
Snowbelt	7.5	7.2	7.6
Other States	23.2	19.3	20.9
Pedestrian			
Sunbelt	16.3	15.4	15.7
Snowbelt	16.7	15.4	15.0
Other States	12.4	11.7	11.4

In the next section of this report, the results of applying statistical tests to these differences are described. These tests help pinpoint those differences that are significant given the differences in sizes of the different categories of accidents. Also, similar results are presented after regional and trend variations in vehicle miles of travel are excluded.

4.0 STATISTICAL SIGNIFICANCE OF OBSERVED DIFFERENCES

The data presented in the previous chapters suggest that many changes have occurred since 1950. All types of accidents, including fatal accidents, have increased; however, VMT and other measures of exposure have increased as well. It is important to determine whether this increase in fatal accident frequencies is statistically significant, and how this significance or implied direction of changes varies when one considers it relative to all accidents or to VMT.

The following paragraphs present three statistical tests which examine:

- absolute differences in fatal accidents frequencies,
- changes in fatal accidents relative to non-fatal police reported accidents, and
- changes in fatal accident rates (based on VMT).

Test #1: Test for Changes in Frequency Counts

The first test simply examines changes in the frequency of fatal accidents over the 1950 to 1980 period.

Assumptions: Assume that the number of fatal accidents in year t, denoted by f_1, follows a Poisson distribution[1] with mean F_1. Similarly, the number of fatal accidents in year t + 10, denoted f_2, follows a Poisson distribution with mean F_2.

Test: A two-tailed test of the null hypothesis of no change can be performed using a one-degree-of-freedom chi-squared test. The null hypothesis is $F_1 = F_2$.

Test Statistic: Either of two chi-squared statistics is typically used. The first is Pearson's goodness-of-fit chi-squared denoted by:

$$\chi^2_G = \sum_{i=1}^{2} (f_i - F)^2 / F$$

$$= 2 \sum_{i=1}^{2} (f_i^2/n) - n$$

Where $n = f_1 + f_2$ and $F = n/2$

---

[1]The chi-squared statistics presented here are appropriate for the Poisson distribution as well as other discrete distribution such as the binomial and multinomial. See R.L. Plackett, The Analysis of Categorical Data, New York: Hafner Press, Division of MacMillan Publishing Co., Inc., 1974, pp. 8-12.

The second is the likelihood-ratio chi-squared, denoted by χ^2_L :

$$\chi^2_L = 2 \sum_{i=1}^{2} f_i \log(f_i/F_i)$$

The results of the χ^2 tests show (Exhibit 4.1) that there was a significant increase in fatal accidents between 1950 and 1960 and between 1960 and 1970, but there was a significant decrease over the 1970 to 1980 period.[1] There was little change between 1979 and 1980. However, it is difficult and sometimes misleading to interpret changes in fatal accident frequencies in a vacuum. An alternative comparison examines changes in fatal accidents as compared with all police reported accidents. A still better test looks at fatal accidents relative to VMT. Each is discussed below utilizing similar distributional assumptions.

Test #2: Test for Relative Changes in Frequency Counts

In this case, the problem is to test for a significant difference between the change in the number of fatal accidents and the change for all police reported accidents over the 30-year period.

Test: Define

f_{1j} = number of fatal accidents in year j = 1 to 5, representing 1950, 1960, 1970, 1979, 1980

f_{2j} = number of other police reported accidents in year j

$n_j = f_{1j} + f_{2j}$

= total number of police reported accidents in year j

F_{ij} = expected value (mean) for f_{ij}

A separate two-tailed test of the null hypothesis that the percent change for fatal accidents equals the percent change for all other police reported accidents can be performed using a one-degree-of-freedom chi-squared test. For example, the null hypothesis of no change between years 1950 and 1960 is:

$$\frac{F_{12}}{F_{11}} = \frac{F_{22}}{F_{21}} = \frac{n_2}{n_1}$$

---

[1] Note that this test is not very powerful when applied to a 10-year period. It is presented for completeness.

Exhibit 4.1

Statistical Significance of Fatal Accident Trends, 1950-1980

Fatal Accidents

1950	1960	1970	1979	1980
30,450	35,000	45,980	45,218	45,271

Percent Change

1950-1960	1960-1970	1970-1980	1979-1980
14.9*	31.4*	-1.3*	0.1

*Significant at the 0.05 level.

Test Statistic: Either χ^2_G or χ^2_L for testing independence in a 2x2 table can be used.

As shown in Exhibit 4.2, fatal accidents increased by a significantly smaller amount than did other types of accidents for all time periods considered. That is, the percentage of total accidents that result in a fatality significantly decreased between 1950 and 1980.

Test #1 can be viewed as a test of the null hypothesis that the absolute number of fatalities remains constant over time. Test #2 can be viewed as a test of the null hypothesis that the percentage of accidents that result in a fatal injury does not change over time. In some cases, it is desired to test whether a certain rate is constant over time, a rate being defined as the ratio of a frequency count to some continuous base such as vehicle miles traveled over a given period. For these applications, Test #3 is appropriate.

Test #3: Test for Change in Rates

Can the changes in fatal accidents over the 1950 to 1980 period be explained by taking into account the increase VMT? That is, has the fatality rate (relative to VMT) changed significantly over the past 30 years?

Assumptions: The observed number of fatalities is a random variable following a Poisson distribution, and VMT is assumed to be fixed at its observed values.

Test: A two-tailed test of the null hypothesis of no change in the fatality rate can be performed using a one-degree-of-freedom chi-squared test. The null hypothesis is:

$$\frac{F_1}{VMT_1} = \frac{F_2}{VMT_2}$$

Test Statistic: Either χ^2_G or χ^2_L can be used to test for a significant difference between the observed fatality counts f_i and the estimated counts expected under the null hypothesis. The test statistic used here is:

$$\chi^2_G = (f_1 - F_1)^2/F_1 + (f_2 - F_2)^2/F_2$$

where $F_i = (f_1 + f_2) \times (VMT_i)/(VMT_1 + VMT_2)$

Exhibit 4.2

Statistical Significance of Changes in Fatal Accident Trends Relative to All Accidents, 1950-1980

	Accidents				
	1950	1960	1970	1979	1980
Fatal	30,450	35,000	45,980	45,218	45,271
Non-fatal	3,314,851	4,179,932	6,436,927	7,288,319	7,403,774
Total Police Reported	3,345,301	4,214,932	6,482,907	7,333,537	7,449,045
Ratio of Fatal to Total Police Reported	0.0091	0.0083	0.0071	0.0062	0.0061

	Percent Change			
	1950-1960	1960-1970	1970-1980	1979-1980
Fatal	14.9	31.4	-1.3	0.1
Non-fatal	26.1	54.0	15.0	1.6
Total Police Reported	26.0	53.8	14.9	1.6
Ratio of Fatal to Total Police Reported	-8.8*	-14.6*	-14.3*	-1.6

*Significant at the 0.05 level based on Test #2.

Exhibit 4.3 shows fatal accidents per billion VMT. The χ^2 statistics suggest that fatal accident rates based on VMT have significantly declined during each of the last three decades. Hence, while fatal accidents have been increasing in absolute terms, they have decreased relative to other types of accidents. Despite the relative ease of computation, the results of applying statistical tests of difference to accident trends may be inappropriate since long-term trend differences are significant in a generic sense regardless of the relative magnitude of statistical significance. Future issues of this First Annual Highway Traffic Safety Trend Report will discuss other techniques that may be more appropriate for evaluating and projecting these trends.[1] The next section of this report provides recommendations for the design and scope of these future reports.

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[1] Methodology for analyzing these trends and for projecting future trends is described in Fatality Trend Modeling, Abt Associates Inc. for the National Center for Statistics and Analysis, National Highway Traffic Safety Administration, Washington, D.C., 1982.

Exhibit 4.3

Statistical Significance of Fatal Accident Rates, 1950-1980

Fatal Accidents per Billion VMT

1950	1960	1970	1979	1980
66.45	48.69	41.27	29.57	29.88

Percent Change

1950-1960	1960-1970	1970-1980	1979-1980
-26.7*	-15.2*	-28.3*	1.0

*Significant at the 0.05 level.

5.0 RECOMMENDATIONS

The detailed assessment of traffic safety performance is an essential ingredient of national traffic safety policy and program formulation. Conversion of information on safety performance into projections of future levels of accidents will enable decision makers to target scarce resources to address program areas where traffic safety improvements have the greatest potential return.[1]

Three basic components of the information required to monitor, assess and project trends are:

- accident trends - This includes information on accident characteristics at national and regional levels of detail by type of accident.
- exposure trends - This includes information on the numbers of licensed drivers, vehicles by type and roadway characteristics necessary to interpret relative changes in accident trends.
- accident costs - This information is needed to address questions of traffic safety performance and evaluate the relative cost-effectiveness of traffic safety programs. Detailed information on traffic accidents by type of accident as well as national aggregate level data are required.

The objective of this report has been to design a standardized and uniform approach to traffic safety trend monitoring. If this function is to continue it will be necessary to adopt consistent definitions for use in accident data base information systems. These definitions should also be consistent with exposure and cost information systems so that accurate comparisons of trends in accidents and exposure or costs can be performed on a continuing basis. The preparation of this report has contributed to the formulation of the structure of these data sets and to the integration of what has heretofore been a diverse array of traffic safety information. Future editions of the trend report will aim to improve the depth of analysis provided between data sets and to extend the trends into horizon years.

Information sources, assumptions, and analytical techniques utilized in this trend report are described in the appendices below.

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[1] Although this report has dealt primarily with historical trends, the Second Annual Highway Traffic Safety Report will include projections. This report will be completed during 1982.

APPENDIX A: DATA SOURCES

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Insurance Facts, Insurance Information Institute, 1968 through 1980, New York. National Highway Traffic Safety Administration and Federal Highway Administration, Fact Book: Statistical Information on Highway Safety, National Center for Statistics and Analysis, Washington, D.C.

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APPENDIX B: ASSUMPTIONS

Accidents

Historical motor vehicle traffic acident data are available from several sources. Unfortunately, all of the trend information required for this study was not available from a single source. Moreover, these data sources were not consistent among each other (and, in some cases, were not internally consistent.) The data sources examined for this study are summarized in Exhibit B.1.

There were no accurate published data for injury accidents prior to 1967. In order to estimate those values, it was assumed that:

- The ratio of police-reported injuries (from FIAR) to total injuries (as reported in Insurance Facts) remained constant at its 1967 to 1979 average of 0.55 for 1950 through 1966.
- The number of injuries per injury accident followed its 1967 to 1979 trend (as reported by FIAR) in earlier years.

The number of police reported property damage only accidents were assumed to be a residual. They were estimated as total police reported accidentsobtained from the National Safety Council, less fatal accidents, and estimated injury accidents. Results of the estimating are contained in Exhibit B.2.

Exhibit B.1

Major Sources of Motor Vehicle Accident Trend Data and Selected Definitional Characteristics[1]

Organization/Agency	Data Base/Publication	Years Covered	Contents	Definitions
National Highway Traffic Safety Administration (NHTSA)	Fatal Accident Reporting System (FARS)	1975-1980	Fatalities, Fatal Accidents	30-Day Fatality Definition
	National Accident Sampling System (NASS)	1979	Police Reported Accidents	30-Day Fatality Definition
	Fact Book (Various Issues) (NCSA)	1950-1974	Fatalities	National Center of Health Statistics data adjusted to 30-day fatality definition
Federal Highway Administration (FHWA)	Fatal Injury and Accident Rates (FIAR)	1966-1979	Police Reported Injuries, Injury Accidents; Fatalities, Fatal Accidents	One-year fatality definition until 1979; 30-day definition in 1979.
National Safety Council (NSC)	Accident Facts	1950-1980	Police Reported Fatalities, Fatal Accidents; Injuries, Injury Accidents; Property Damage Only Accidents	One-year fatality definition "Injuries" refer to "disabling" injuries. Injuries and injury accidents estimates involve the use of rounded numbers and may result in small rounding errors.
Insurance Information Institute (III)	Insurance Facts	1950-1979	Total Injuries, Fatalities, Accidents	One-year fatality definition.

[1]This exhibit is a concise synopsis of selected definitional problems encountered in the development of this report. Further documentation of these problems will be provided in the Second Annual Highway Traffic Safety Trend Report to be completed in 1982.

Exhibit B.2

U.S. Traffic Accident Summary, 1950-1980

	1950	1960	1970	1979	1980
Fatalities (estimates)	33,186[a]	36,399[a]	52,627[a]	51,088[b]	51,077[b]
Fatal accidents	30,450[c]	35,000[c]	45,980[d]	45,218[b]	45,271[b]
Injuries	858,478[c]	1,468,881[c]	2,710,959[d]	3,288,365[f]	3,366,288[g]
Injury accidents (estimates)	618,406[e]	1,065,000[e]	1,716,983[d]	2,089,030[d]	2,139,326[g]
Police Reported Accidents	3,345,301[h]	4,214,932[h]	6,482,907[h]	7,333,537[f]	7,449,045[g]
Property Damage Only (estimates)	7,631,594[i]	9,333,000[i]	14,283,837[i]	16,011,552[i]	16,224,930[i]
Total Accidents	8,280,450[k]	10,433,000[k]	16,046,800[k]	18,145,800[k]	18,409,527[g]

[a] Sources for 1950 and 1960 data are National Center for Statistics and Analysis estimates.

[b] Fatal Accident Reporting System (as of July 1981).

[c] NSC adjusted estimates. In 1960, NSC revised the definition of injury accident from non-fatal injury to disabling injury.

[d] FHWA, Fatal and Injury Accident Rates (FAIR).

[e] Estimated by extrapolating 1967 to 1979 average annual change in injuries/injury accident from FAIR.

[f] NASS estimates (adjusted).

[g] Estimated using 1970 to 1979 annual percent change.

[h] Estimated using National Safety Council data using standard conversion factor (0.404).

[i] Estimated as a residual, i.e., total accident minus fatal and injury accidents.

[k] National Safety Council.

APPENDIX C: COMPOUND GROWTH RATES

The tables presented in Chapters 1 through 4 of the report include percent changes in various motor vehicle traffic accident variables. These changes are measured over ten year periods and as annual (compound) percent change over the 1950 to 1980 period. This appendix documents the method used to calculate the annual changes and discusses briefly the advantage over the use of average annual changes.

There are several methods of computing average annual percent changes over a multi-year period. One of the more common involves simply dividing the total change over the period by the number of intervals in the period, i.e.,

$$\text{Average Annual Change (AAC)} = \left[\frac{X_{t1} - X_{t0}}{X_{t0}} \Big/ (t_1 - t_0) \right] \times 100$$

where:

X_{t0} = Number of accidents in the base year t_0

X_{t1} = Number of accidents in some later year t_1

The percent resulting from this computation is often interpreted as a uniform annual percent change over the period in question; however, this is misleading. This method implies constant (uniform) absolute changes and decreasing (increasing) percent changes as the base grows (shrinks).

Consider the following example:

X_{t0} = 39,161 fatal accidents in 1975

X_{t1} = 45,271 fatal accidents in 1980

$$\text{AAC} = \left[\frac{45{,}271 - 39{,}161}{39{,}161} \Big/ 5 \right] \times 100 = 3.12\%$$

This suggests that the average annual percent change is 3.12 percent. But, as shown in Exhibit C.1, this reflects accurately the 1975 to 1976 percent change only. The actual annual percent change falls monotonically over the period, reaching a low of 2.7 percent for the 1979 to 1980 change. If one were to apply the 3.12 percent increase in a compound manner, the result would be 45,633 fatal accidents in 1980, an overestimate of about 4 percent.

This suggests a geometric pattern with equal percent changes over time, but increasing (decreasing) absolute changes as the base increases (decreases). (See Exhibit C.1.) These compound percent changes may be calculated using a standard growth formula, i.e.,

$$X_{t1} = X_{t0} e^{r(t_1-t_0)}$$

or

$$r = \left[\ln \frac{X_{t1}}{X_{t0}}\right] / (t_1-t_0)$$

where: X_{t0}, X_{t1} are as before
r = continuous compound rate of change.

This can be converted to a discrete rate of change, i, by noting that:[1]

$$(1+i) = e^{r}$$

or

$$i = e^{r}-1$$

This discrete rate of change has been used in Chapters 1 through 4 because we are evaluating the change from the end of one year to the end of another year. Since these represent uniform annual percent changes, they may be compared appropriately with the 1979 to 1980 percent changes to determine whether the rate of change is rising or falling.

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[1] Note that this is equivalent to $X_{t1} = X_{t0}(1+i)^{(t_1-t_0)}$. A more detailed discussion is found in Alpha C. Chiang, Fundamental Methods of Mathematical Economics, New York: McGraw-Hill, 1967, pp. 273-280.

Exhibit C.1

Comparison of Average Annual and Compound Percentage Change for Traffic Fatalities, 1975-1980

	Average Annual Percent Change			Compound Annual Percent Change		
	Number	Absolute Change	Percent Change	Number	Absolute Change	Percent Change
1975	39,161	--	--	39,161	--	--
1976	40,383	1,222	3.12	40,313	1,152	2.94
1977	41,605	1,222	2.94	41,499	1,186	2.94
1978	42,827	1,222	2.85	42,720	1,221	2.94
1979	44,049	1,222	2.77	43,977	1,257	2.94
1980	45,271	1,222	2.70	45,271	1,294	2.94