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16. Abstract

This report synthesized the research findings of Phase I of the Statewide Traffic Safety Study of Louisiana, sponsored by the Louisiana Department of Transportation and Development. The objective of Phase I was to provide a comprehensive review of the state of the art in highway traffic safety, both within the U.S. and abroad, including studies on factors influencing road safety, available databases, safety legislation, safety initiatives and programs, and safety-related funding, at both state and federal levels.

Research on crash-related contributing factors, including human, roadway environment, and vehicle factors were reviewed in depth. The impact of intelligent transportation systems on traffic safety was also reviewed. Traffic safety laws, both at federal and state levels, were investigated to provide an overview of existing legislation. A variety of safety-related programs that have been implemented throughout the states were explored. These programs included aggressive driver programs, automated enforcement programs, cell phone enforcement programs, alcohol and drug impaired driving programs, occupant protection programs, helmet law enforcement programs, and older driver laws. Analytical tools and procedures commonly used in traffic safety analysis were also reviewed. These included statistical methods widely used in current practice and major ongoing initiatives (such as CHSIM, IHSDM, and Highway Safety Manual), new tools (such as SafetyAnalyst, Road Safety Audits, AASHTO Implementation Guides, etc.), and software packages (such as CARE). Louisiana's safety-related funding in recent years was reviewed and the trend examined. Finally, a crash-related database inventory was conducted. This produced a list of federal and Louisiana databases that are of potential importance in the next phase of the study.

The review revealed that road safety is indeed a problem in Louisiana. The crash rate in Louisiana is consistently among the ten highest state rates, alcohol-related accidents are among the highest in the nation, and car insurance rates have grown more rapidly in Louisiana in the last several years than any other state in the union. The review has provided the background from which a research program can be designed. The research program will identify the factors contributing to the high crash rate in Louisiana and recommend countermeasures that will improve the situation.

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STATEWIDE TRAFFIC SAFETY STUDY PHASE I

REVIEW OF CURRENT TRAFFIC SAFETY RESEARCH, PRACTICE, ANALYTICAL PROCEDURES, AND DATABASES

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Louisiana Transportation Research Center

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ABSTRACT

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Research on crash-related contributing factors, including human, roadway environment, and vehicle factors were reviewed in depth. The impact of intelligent transportation systems on traffic safety was also reviewed. Traffic safety laws, both at federal and state levels, were investigated to provide an overview of existing legislation. A variety of safety-related programs that have been implemented throughout the states were explored. These programs included aggressive driver programs, automated enforcement programs, cell phone enforcement programs, alcohol and drug impaired driving programs, occupant protection programs, helmet law enforcement programs, and older driver laws. Analytical tools and procedures commonly used in traffic safety analysis were also reviewed. These included statistical methods widely used in current practice and major ongoing initiatives (such as CHSIM, IHSDM, and Highway Safety Manual), new tools (such as SafetyAnalyst, Road Safety Audits, AASHTO Implementation Guides, etc.), and software packages (such as CARE). Louisiana's safety-related funding in recent years was reviewed and the trend examined. Finally, a crash-related database inventory was conducted. This produced a list of federal and Louisiana databases that are of potential importance in the next phase of the study.

The review revealed that road safety is indeed a problem in Louisiana. The crash rate in Louisiana is consistently among the ten highest state rates, alcohol-related accidents are among the highest in the nation, and car insurance rates have grown more rapidly in Louisiana in the last several years than any other state in the union. The review has provided the background from which a research program can be designed. The research program will identify the factors contributing to the high crash rate in Louisiana and recommend countermeasures that will improve the situation.

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This project was supported by the Louisiana Department of Transportation and Development (DOTD), and the Louisiana Highway Safety Commission, through the Louisiana Transportation Research Center (LTRC Research Project 05-2SS; State Project 737-99-0349). Dr. Eric Kalivoda of the Louisiana Department of Transportation and Development launched this project, and his initiative is gratefully acknowledged.

IMPLEMENTATION STATEMENT

This report provides a comprehensive review of the state of the art in highway traffic safety, both within the U.S. and abroad, including studies on factors influencing road safety, available databases, safety legislation, safety initiatives and programs, and safety-related funding, at both state and federal levels. The deliverables of the Phase I of the Statewide Traffic Safety Study are this report and a separate program of research for Phase II. The program of research will be presented in a formal research proposal to LTRC. The program of research will guide the study in Phase II in accomplishing the following:

- Establishment of a database of Louisiana road safety information,
- Analysis of the data to draw conclusions regarding traffic safety in Louisiana,
- Identification of courses of action that will lead to improved road safety in Louisiana, and
- Preparation of a summary of research findings related to road safety in Louisiana.

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INTRODUCTION

Highway traffic safety is a serious issue. In 2000, 41,821 fatalities, 5.3 million non-fatal injuries, and 28 million damaged vehicles occurred in motor vehicle crashes in the United States. The economic costs of these crashes were estimated at $230.6 billion *[1]*. However, in the past 3 decades, road fatality rates in the United States have decreased; the fatality rate per 100 million vehicle miles traveled declined from 3.35 in 1975 to 1.51 in 2002. What is of concern is that the decline in fatality rate has leveled off in recent years *[2]*. In an effort to maintain a decline in fatality rates, the National Highway Traffic Safety Administration (NHTSA) has set a goal to reduce the fatality rate to 1.0 by 2010.

Highway safety is an enormous problem in Louisiana. Approximately 160,000 crashes occur in the state each year, over 90,000 of which are on the state-maintained highway system. On average, more than 900 people are killed and about 80,000 injured in automobile crashes annually in Louisiana. In the last decade, Louisiana's fatality rate has consistently been within the eight highest in the nation, and in 2001, it tied with Montana and South Carolina as the highest state rate. In that year, Louisiana's fatality rate was 2.3 per 100 million miles traveled, while the national average was 1.5.

Louisiana's high crash rate has significant economic and social costs. Property damage, lost productivity, medical expenses, and inflated motor vehicle insurance rates imposed an estimated $5.3 billion burden on the state in 2002 *[3]*. These costs are not distributed equally; fatality rates among 16-20-year-olds in Louisiana are double that of all other ages *[4]*, *[5]*. This is an intolerable situation and must be changed. While improving road safety is a national objective, the conditions in Louisiana justify an independent study of conditions and opportunities for improvement in the state.

OBJECTIVE

Awareness of the road safety situation in Louisiana among officials of the Louisiana Department of Transportation and Development (DOTD) and the Louisiana Highway Safety Commission (LHSC) has resulted in several road safety initiatives. The study, of which this report is a part, is of one of those initiatives. The objective of this study is to identify and quantify the factors contributing to highway crashes in Louisiana. A secondary objective is to use this information to recommend measures to counter the poor crash record in Louisiana.

SCOPE

The research in this study will be conducted in two phases. The first phase will be aimed at:

- identifying the current state of the art with respect to studies both within the U.S. and abroad on the factors influencing road safety,
- establishing an inventory of crash-related databases, and,
- Preparing a program of research that will permit identification of the main factors influencing road safety in Louisiana.

This report addresses the first two issues listed above, presenting a comprehensive review of the current state of the art in traffic safety and establishing an inventory of existing crash-related databases. The next section provides a literature review of the current state of the art in research on traffic safety both within the U.S. and abroad. Then a review of safety legislation is presented, followed by a review of traffic safety programs that have been implemented in the United States. The next section is a review of analytical tools and procedures used in traffic safety studies, followed by a review of funding sources for improving traffic safety, both at the federal and state levels. Finally a review of crash-related databases is provided, followed by some concluding remarks to this report.

LITERATURE REVIEW

According to the United States General Accounting Office (GAO) *[2]*, many factors combine to produce circumstances that lead to a motor vehicle crash—rarely does a single factor cause such an event. Comprehensive studies that address numerous factors affecting vehicle crashes are reviewed first, followed by reviews on selected causal factors.

Comprehensive Studies

In 2003, the GAO *[2]* published a report to provide information from data, experts, and studies about the factors that contribute to motor vehicle crashes. The GAO found that many factors including human, roadway environment, and vehicles combine to produce circumstances that lead to a motor vehicle crash. "Human factors involve the actions taken by, or the condition of, the driver of the motor vehicle, including speeding and violating traffic laws, being affected by alcohol or drugs, inattention, decision errors, and age. Roadway environment factors include the roadway design, roadside hazards, and roadway conditions. Vehicle factors include any vehicle-related failures that may exist in the automobile or design of the vehicle" *[2]*. Human factors are considered to be the most prevalent factors, followed by roadway environment and then vehicle factors.

Similar conclusions were drawn in the so-called Tri-Level Study conducted in Indiana in the late 1970s *[6]*. This was one of the most significant studies up to that time on the factors that contribute to motor vehicle crashes. It investigated the relative frequency of crash involvement of various human, environmental, and vehicle factors. The research identified human factors as the most frequently implicated factors, and vehicle factors as the least frequently implicated. Both on-scene and in-depth investigations of police reported crashes were conducted. The causal factors were assessed as definite, probable, or possible. As shown in figure 1, the research team found that in the in-depth investigation, human factors were definite causal factors in 71 percent of the crashes; environmental factors in 13 percent; and vehicle factors in 4 percent of the crashes. They also concluded that, human, environmental, and vehicle factors were definite or probable causal factors in 93 percent, 34 percent, and 13 percent of the crashes, respectively.

Among the on-site investigations, the team concluded that human factors were definite causal factors in 64 percent of the crashes; environmental factors in 19 percent; and vehicle factors in 4 percent. And these same three categories were definite or probable causal factors in 90 percent, 35 percent, and 9 percent, respectively.

Each of the three main crash factors were divided and ranked by the study *[6]*. For the human factors, the breakout and the ranking were as follows:

1. Recognition Errors, 41.4 percent
2. Decision Errors, 28.6 percent
3. Performance Errors, 6.9 percent
4. Critical Non-Performance Errors, 1.7 percent

The ranking for the environmental factors were:

1. View Obstruction, 3.8 percent
2. Slick Roads, 3.8 percent
3. Transient Hazards, 1.9 percent
4. Design Problems, 1.9 percent
5. Control Hindrances, 1.2 percent

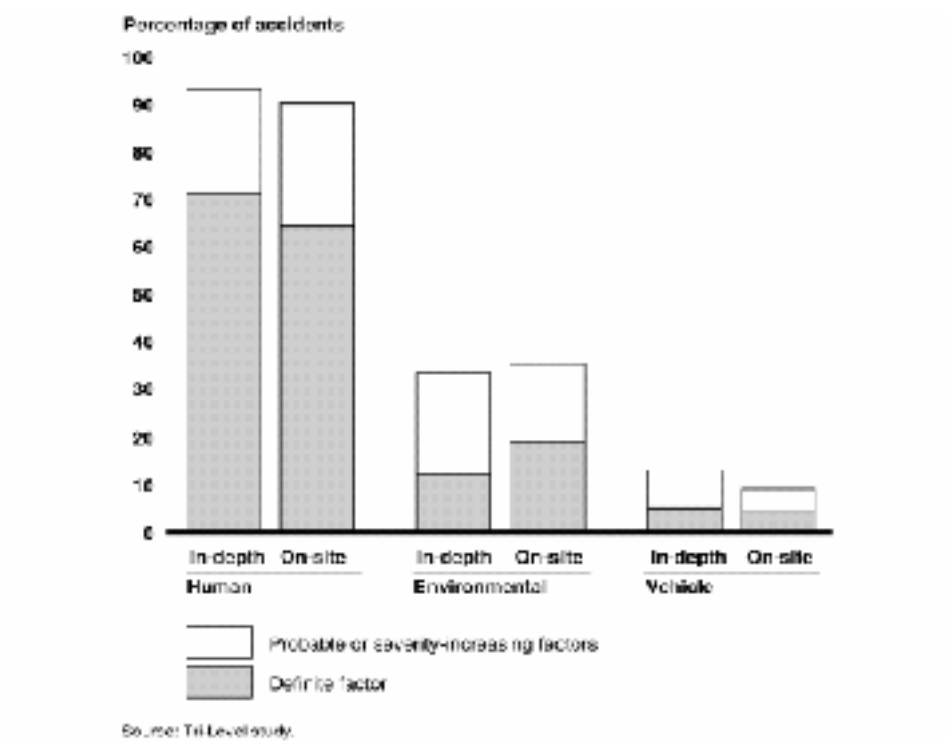


Figure 1
Factor contributing to crashes

The ranking for the vehicular factors were:

1. Braking System, 2.9 percent
2. Tires and Wheels, 0.5 percent

3. Body and Doors, 0.5 percent
4. Communication Systems, 0.2 percent
5. Steering Systems, 0.2 percent

A study to specify driver behavior and unsafe driving acts (UDAs) conducted by Veridian Engineering *[7]* also concluded that human factors were the dominant factors attributing to crashes. In their study, driver behavioral error caused or contributed to 99 percent of the crashes investigated (717 of the 723 crashes). More than half of the drivers involved in the crashes (57 percent) contributed in some way to the cause of their crashes. The six causal factors associated with driver behaviors with relatively high frequencies were:

- Driver Inattention, 22.7 percent
- Vehicle Speed, 18.7 percent
- Alcohol Impairment, 18.2 percent
- Perceptual Errors, 15.1 percent
- Decision Errors, 10.1 percent
- Incapacitation, 6.4 percent

A comparison of human, environment, and vehicle causal factors assigned in the UDA and Tri-level study is shown in figure 2. Due to the more limited research objectives in the UDA, there is a disparity in the assigned levels of environmental and vehicle factors in the two studies. In addition, improvements in vehicle system designs from 1979 to 1999 may lead to the low level of vehicle factors in the UDA study *[7]*. The percentages do not add up to 100 because some crashes were related to more than one primary cause.

The six most frequently assigned human-related causal factors in the two studies are shown in figure 3. Four common causal factor groups in the two studies are driver inattention, excessive speed, perceptual error, and improper lookout. These findings suggest a consistency over time. Together, they were assigned to 67.4 percent of the UDA crashes and 66.8 percent of the Tri-Level crashes.

The alcohol impairment factor was assigned to 18.4 percent of the UDA crashes and only 6.1 percent of the Tri-Level crashes. The Tri-Level study contained a very high incidence rate of property-damage-only (PDO) crashes, but the UDA study had an overrepresentation of serious injury crashes.

Both the Tri-Level Study and UDA study analyzed causal factors for all crash types. Najm *et al. [8]* conducted a study to assign contributing factors to nine target crash types including: (1) rear-end (RE); (2) backing (BK); (3) single vehicle roadway departure (SVRD); (4) lane change/merge (LCM); (5) signalized intersection, straight crossing path (SI/SCP); (6) unsignalized intersection, straight crossing path (UI/SCP)); (7) intersection, left turn across path (LTAP); (8) reduced visibility (RV); and (9) opposite direction (OD). Each of the crash types was investigated to determine causal factors. The distribution of crash causal factors categorized by target crash type is shown in table 1. Human factors were the main contributing factors for all crash types except single vehicle roadway departure crashes, of which the leading causal factor was the bad roadway surface condition (20.2 percent). The main human factors in different types of crashes were driver inattention, which accounted for 56.7 percent of the RE crashes, and drivers who looked but did not see the surrounding vehicles, which was the leading cause of the BK, LCM, and UI/SCP crashes. Drunk driving was the primary cause of OD crashes. Driver inattention was found to be the leading cause in SI/SCP crashes. Drivers who misjudged the gap or the velocity of the entering vehicles resulted in 30 percent of LTAP crashes.

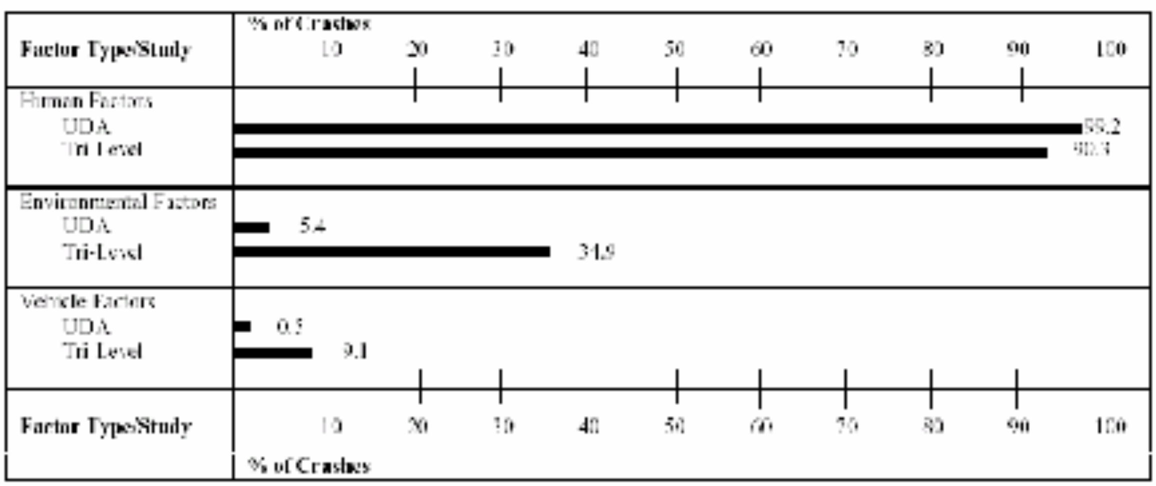


Figure 2
Comparison of UDA/tri-level assignments of human, environment, and vehicle factors *[7]*

Campbell, Smith, and Najm *[9]* analyzed the contributing factors for three types of crashes including single vehicle off-roadway, rear end, and lane change for light vehicles. The results indicated that inattention, alcohol/drugs, and speeding are the top three contributing factors to these types of crashes. The study also found that contributing factors were similar in the majority of crash types regardless of the severity of the crash. In addition, the study showed that the contributing factors were influenced more by the critical event (either control loss or road edge departure), which was the action that made the collision possible, than the vehicle movement prior to the critical event (either traveling straight or negotiating a curve), which was the vehicle's activity prior to the driver's recognition of the impending critical event.

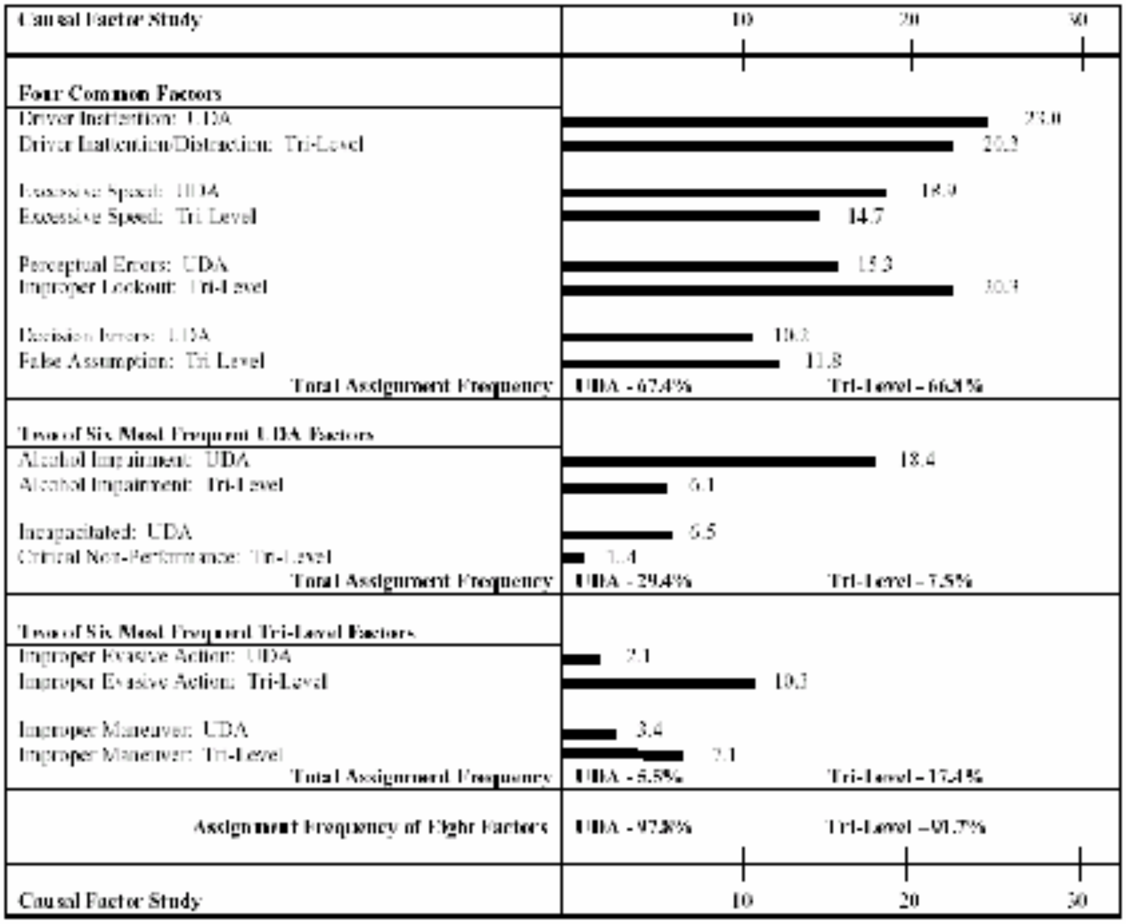


Figure 3
Comparison of six most frequent UDA causal assignments with six most frequent tri-level causal assignments *[7]*

For off-roadway crashes, Najm *et al. [10]* conducted research to analyze the crash causal factors. All types of crashes were analyzed, from single vehicle to multi-vehicle collisions. The variables chosen as crash contributing factors were all human factors including alcohol involvement, a person's physical impairment, driver distraction, speeding, and hit and run. Off-roadway crashes were separated by roadway type (freeway and non-freeway) and then separately analyzed. The distribution of crash casual factors for off-roadway crashes is shown in table 2.

Speeding was found to be the most dominant contributing factor in both freeway and non-freeway off-roadway crashes causing 34.0 percent and 22.6 percent of the crashes, respectively. Alcohol/drugs were the next leading cause in off-roadway crashes. Driver distraction was the primary cause in 4.1 percent of freeway crashes and 6.2 percent of non-freeway collisions.

Table 1

Target crash causes *[8]*

	Rear-End	Backing	Single Vehicle Roadway Departure	Lane Change/ Merge	Signalized Intersection/ Straight Crossing Path	Unsignalized Intersection/ Straight Crossing Path	Left Turn Across Path	Opposite Direction
Inattention	56.7%	0.0%	15.5%	3.8%	35.4%	22.6%	1.4%	17.8%
Looked-Did Not See	0.0%	60.8%	0.0%	61.2%	0.0%	36.7%	23.2%	0.0%
Obstructed Vision	0.0%	0.0%	0.0%	0.0%	4.3%	14.3%	24.4%	0.0%
Tailgating/Unsafe Passing	26.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
Misjudged Gap/Velocity	0.4%	0.0%	0.0%	29.9%	0.0%	12.2%	30.0%	5.9%
Excessive Speed	0.0%	26.6%	17.8%	2.2%	0.0%	0.0%	0.0%	0.0%
Tried to Beat Signal/POV	0.0%	0.0%	0.0%	0.0%	15.2%	0.0%	11.2%	0.0%
Failure to Control Vehicle	0.0%	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Evasive Maneuver	0.0%	0.0%	13.7%	2.6%	0.0%	0.0%	0.0%	18.6%
Violation of Signal/Sign	0.0%	0.0%	0.0%	0.0%	23.2%	3.4%	7.4%	0.0%
Deliberate Unsafe Driving Act	0.0%	0.0%	2.2%	0.0%	0.0%	0.0%	0.0%	0.0%
Miscellaneous	1.1%	0.1%	0.0%	0.0%	5.9%	0.0%	1.7%	1.0%
Drunk	2.1%	3.0%	10.1%	0.0%	12.6%	2.7%	0.4%	31.7%
Asleep	0.0%	1.9%	11.8%	0.0%	0.0%	0.0%	0.0%	0.0%
Ill	9.6%	0.0%	3.5%	0.0%	0.0%	0.0%	0.0%	1.1%
Vehicle Defects	1.2%	5.7%	5.3%	0.3%	1.6%	0.0%	0.0%	4.5%
Bad Roadway Surface Cond.	2.3%	0.0%	20.2%	0.0%	0.0%	7.0%	0.0%	18.3%
Reduced Visibility/Glare	0.1%	0.0%	0.0%	0.0%	0.0%	1.1%	0.1%	0.0%
TOTAL:	100%	100%	100%	100%	100%	100%	100%	100%

Table 2

1998 GES off-roadway priority distribution*[10]*

Causal Factor	FREEWAY	Non-Freeway
ALCOHOL/DRUGS	12.8%	19.7%
DRIVER IMPAIRMENT	8.2%	5.2%
DRIVER DISTRACTION	4.1%	6.2%
SPEEDING	34.0%	22.6%
HIT & RUN	1.0%	8.6%
OTHER	39.8%	37.8%

For fatal rollover crashes, a study by the National Center for Statistics and Analysis (NCSA) examined the characteristics of passenger vehicles (passenger cars and light trucks, including sport utility vehicles, vans, and pickup trucks) and the drivers *[11]*. The findings showed that light trucks, especially Sport Utility Vehicles (SUV), are a rapidly increasing component of the total number of fatal rollover crashes. The findings also showed that human factors were the main causes of the crashes: nearly three-fourths of occupants killed in rollover crashes were not using restraints and about two-thirds of them were ejected from the vehicle; positive and elevated Blood Alcohol Content was associated with fatal rollovers; young male drivers were more likely to be involved in fatal rollover crashes, and most crashes occurred on roads where speed limits were 55 miles per hour or greater. Roadway factors were also noted in the study: rollover crashes occurred more frequently on two-lane roads without dividing barriers. Another important finding was that rollover crash occurrence varied by vehicle type: while the number of fatal passenger car rollover crashes has been decreasing in recent years, the number of fatal light truck rollover crashes is increasing, particularly among SUVs and vans. However, fatality rate per 100,000 registered vehicles showed that while the fatality rates for passenger cars have been dropping since 1995, the fatality rates for light trucks have remained relatively constant.

The contributing factors for the crashes that occurred on the different type of roadways were analyzed in some studies. Tessmer *[12]* compared factors that contributed to fatal crashes in rural and urban areas of the United States. The results showed that 40 percent more deaths occurred on rural roadways than on urban roadways, even though the VMT (vehicle miles traveled) was lower on rural roads. The factors associated with higher numbers of fatalities on rural roads included high speed limits, head-on collisions, alcohol, involvement of both light and large trucks, and longer emergency response times. The factors that contributed to fatalities in urban areas included high speed limits and car, motorcycle, and pedestrian involvement.

Factors contributing to crashes on low-volume rural roads were studied by Stamatiadis et al. *[13]*. The crash data showed that age of the driver was one of the primary contributing factors. Drivers under the age of 25 were more likely to be involved in single-vehicle crashes than any other group of drivers. Young drivers were often involved in single-vehicle crashes occurring at night, under higher-speeds, narrower lanes, sharper curves, and lower-volume roads.

The University of North Carolina Highway Safety Research Center *[14]* conducted a study for the North Carolina Department of Transportation to identify the factors most closely associated with severe crashes in North Carolina. The main conclusions from the study were:

- For the human factor category, alcohol involvement was a significant factor in severe crashes.

- For the roadway and environmental factor category, curves, low shoulders, trees, and darkness were the factors that contributed most to high crash occurrence.
- For the vehicle factor category, crashes involving motorcycle and bicycles were more severe compared to other type of crashes.

Ward and Lancaster *[15]* conducted an international literature review of human factors contributing to driving behavior. In the review, 102 references were cited, covering the following 16 areas: age, gender, ethnicity, education, personality, risk perception, social deviance, previous accident-involvement, experience, stress, life events, fatigue and physiology. A summary of the main findings are as follows:

Age

Younger drivers:

- High crash involvement
- The highest driving violation rates
- Speeding
- High alcohol and/or drug involvement
- Low seatbelt usage
- Lack of driving skill

Older drivers:

- Visual impairments
- Drowsy driving

Gender

Men:

- High crash rates
- High violation rates
- Drunk driving
- Low seatbelt usage
- Aggressive driving

Women:

- Perceptual or judgmental errors
- Less driving confidence

Education

- Use of seatbelts increased with increasing education

Personality

- Risky driving behavior was associated with sensation-seeking, impulsiveness, hostility/aggression, and emotional instability.

Aggression

- Minor-crash involvement was associated with more aggression and tension.
- Drunk driving could cause aggression.
- Aggressive drivers were often poorly educated.

Thoroughness in Decision-Making

- Hasty decision-making and faster driving tended to be associated with high crash involvement.

Driving Confidence

- A higher level of driving confidence was associated with increased tendency for driving violations, while a lower degree of self-confidence was associated with an increased crash-risk.

Attitudes

- Those drivers who regularly commit traffic violations tended to take to the associated driving behavior.

Risk Perception

- Alcohol affects the level of risk perception.
- Driving experience was associated with an increased level of risk perception.

Social Deviance

- There was a strong relationship between social deviance and traffic violations, crash involvement, drunk driving and aggression.

Experience and Previous Motor-Vehicle Accidents

- Driving experience was related to "at-fault" crash rate.

Stress

- High job-stress predicted future crashes.
- Financial stress increased the likelihood of more serious crashes.

Life Events/Factors

- Lower life-satisfaction scores were associated with poorer driving behavior scores.
- Most negative life-events were associated with drunk driving.

Fatigues

- Increased experience was related to a reduction in frequency of drowsy driving.
- Alcohol consumption was suggested to be the single greatest cause of driver fatigue.

Physiology

- Certain visual impairments predicted crash involvement.

- Specific medical conditions increased crash risk.
- Habitual alcohol-consumption increased crash risk.

Ethnicity

- Young white Americans (<45 years old) experienced higher rates of crash involvement, while non-white Americans experienced higher crash rates for ages 45 and above.
- Black Americans' crash involvement rate was not high, but their crashes tended to be more severe. Native Americans had a high crash-fatality rate.

In 1998, The American Association of State Highway Officials (AASHTO) *[16]* approved its Strategic Highway Safety Plan, which was developed by the AASHTO Standing Committee for Highway Traffic Safety with the assistance of the Federal Highway Administration (FHWA), the NHTSA, and the Transportation Research Board Committee on Transportation Safety Management. The plan included strategies in 6 elements and 22 key emphasis areas that affect highway safety *[17]*. Each of the emphasis areas included strategies and an outline of what was needed to implement each strategy. The 6 elements and the goal of the 22 key emphasis areas are:

Drivers:

- Goal 1: Instituting Graduated Licensing for Young Drivers
- Goal 2: Ensuring Drivers are Fully Licensed and Competent
- Goal 3: Sustaining Proficiency in Older Drivers
- Goal 4: Curbing Aggressive Driving
- Goal 5: Reducing Impaired Driving
- Goal 6: Keeping Drivers Alert
- Goal 7: Increasing Driver Safety Awareness
- Goal 8: Increasing Seatbelt Usage and Improving Airbag Awareness

Special Users:

- Goal 9: Making Walking and Street Crossing Safer
- Goal 10: Ensuring Safer Bicycle Travel

Vehicles:

- Goal 11: Improving Motorcycle Safety and Increasing Motorcycle Awareness
- Goal 12: Making Truck Travel Safer
- Goal 13: Increasing Safety Enhancements in Vehicles

Highways:

- Goal 14: Reducing Vehicle-Train Crashes
- Goal 15: Keeping Vehicles on the Roadway
- Goal 16: Minimizing the Consequences of Leaving the Road
- Goal 17: Improving the Design and Operation of Highway Intersections
- Goal 18: Reducing Head-on and Across-median Crashes
- Goal 19: Designing Safer Work Zones

Emergency Medical Services:

- Goal 20: Enhancing Emergency Medical Capabilities to Increase Survivability

Management:

- Goal 21: Improving Information and Decision Support Systems
- Goal 22: Creating More Effective Processes and Safety Management Systems

NCHRP Project 17-18(3) *[18]* is currently developing a series of guides to assist state and local agencies in reducing injuries and fatalities in targeted emphasis areas. Each guide includes a brief introduction, a general description of the problem, the strategies/countermeasures to address the problem, and a model implementation process. Thirteen guides have been published to date as part of NCHRP Report 500, which documents the results of NCHRP Project 17-18(3).

There are many research projects underway and planned that address aspects of crash causes. The NHTSA is currently conducting the "100-Car Naturalistic Driving Study" to help develop better crash-avoidance warning systems. This driving research study involved collecting data from 100 vehicles equipped with various sensors and cameras. The NHTSA has partnered with the FHWA, University of Virginia, and the Virginia Polytechnic Institute and State University (VATECH) to fund the study. Virginia Tech is responsible for conducting the study *[2]*.

The NHTSA is also funding the "Drive Atlanta Study" which involves installing data recorders in 1,100 vehicles to develop information on situations and circumstances where excessive speed contributed to crashes. Data for the study will be provided by the Atlanta Traffic Management Center on prevailing traffic conditions, the National Oceanic and Atmospheric Administration on weather, and the Georgia Department of Transportation on roadway characteristics. This combination of data will help to analyze when and where the driving occurred, what the posted speed limits were, what the roads' characteristics were, etc. The researchers plan to create speed profiles to examine exactly how speed is involved in crashes *[2]*.

In addition, to improve highway safety, the Future Strategic Highway Research Program (F-SHRP) included three major areas for improvement:

1. Methodology development using existing data,
2. Large-scale research studies of multiple factors related to the risk of collisions and casualties for high priority roadway safety issues, and
3. Analysis of the field data for countermeasure implications.

In 2001, the Federal Motor Carrier Safety Administration (FMCSA) and NHTSA implemented a Large Truck Crash Causation Study. The goal was to develop a greater understanding of the factors leading to large truck crashes to develop cost-effective countermeasures *[2]*.

Traffic safety, among many other factors, also impacts the cost of vehicle insurance *[19]*. According to the "2004 Auto Insurance Pricing Report" *[20]*, in 2004, the average U.S. household is paying $2,343 for auto insurance a year, which is a six percent increase over last year. Louisiana is the 9th most expensive state for auto insurance. Based on the information collected from over 100,000 auto insurance quotes, Louisiana consumers experienced the largest percentage increase (22 percent) in the nation, while those in New Hampshire enjoyed a 14 percent decrease during the same time period. Table 3 gives the top ten states with the largest percentage increase and table 4 gives the complete breakdown by state, from the same source. Louisiana is highlighted in red.

Table 3

Top ten states with the largest percentage increase in insurance costs

State	2003	2004	% Difference	Dollar Change
LA	$2,677.71	$3,256.29	21.6%	$578.58
SC	$1,659.34	$1,930.81	16.4%	$271.47
AR	$1,928.25	$2,188.55	13.5%	$260.30
NV	$2,275.38	$2,577.66	13.3%	$302.28
MT	$1,627.92	$1,834.27	12.7%	$206.36
WY	$1,868.74	$2,096.09	12.2%	$227.35
FL	$2,238.79	$2,477.01	10.6%	$238.21
CT	$2,331.37	$2,578.42	10.6%	$247.04
VA	$1,637.48	$1,801.15	10.0%	$163.67
MD	$2,539.79	$2,757.83	8.6%	$218.04

According to the "Safety Management System News" *[21]*, Louisiana vehicle owners pay $150 more than the national average in insurance costs. This increased cost is attributed to four causes: 1) bad roads, 2) drunk drivers, 3) low seat belt use, and 4) high insurance claim frequency. Each of the above causes are somewhat related to highway safety.

Table 4
2003 and 2004 auto insurance for each state

State	2003	2004	% Difference	Dollar Change
AL	$1,772.48	$1,908.74	7.7%	$136.26
AR	$1,928.25	$2,188.55	13.5%	$260.30
AZ	$2,410.17	$2,473.20	2.6%	$63.03
CA	$2,122.00	$2,243.08	5.7%	$121.07
CO	$2,447.62	$2,365.93	-3.3%	$(81.69)
CT	$2,331.37	$2,578.42	10.6%	$247.04
DC	$2,290.17	$2,366.66	3.3%	$76.49
DE	$1,994.38	$2,073.66	4.0%	$79.28
FL	$2,238.79	$2,477.01	10.6%	$238.21
GA	$2,010.22	$2,131.47	6.0%	$121.25
IA	$1,492.17	$1,536.80	3.0%	$44.63
ID	$1,553.92	$1,678.68	8.0%	$124.76
IL	$2,177.62	$2,093.56	-3.9%	$(84.06)
IN	$2,041.12	$1,915.77	-6.1%	$(125.35)
KS	$2,158.71	$2,027.15	-6.1%	$(131.56)
KY	$2,389.38	$2,483.06	3.9%	$93.68
LA	$2,677.71	$3,256.29	21.6%	$578.58
MD	$2,539.79	$2,757.83	8.6%	$218.04
ME	$1,447.75	$1,433.81	-1.0%	$(13.94)
MI	$2,556.89	$2,562.48	0.2%	$5.59
MN	$2,223.01	$2,326.08	4.6%	$103.07
MO	$2,173.64	$2,081.56	-4.2%	$(92.07)
MS	$2,088.66	$2,230.17	6.8%	$141.51
MT	$1,627.92	$1,834.27	12.7%	$206.36
NC	$1,349.66	$1,222.22	-9.4%	$(127.43)
ND	$1,684.24	$1,783.28	5.9%	$99.04
NE	$1,680.72	$1,745.47	3.9%	$64.75
NH	$2,589.63	$2,228.85	-13.9%	$(360.78)
NM	$1,999.47	$2,138.48	7.0%	$139.01
NV	$2,275.38	$2,577.66	13.3%	$302.28
NY	$3,286.70	$3,292.11	0.2%	$5.41
OH	$1,925.45	$1,884.41	-2.1%	$(41.03)

OK	$2,063.77	$2,202.70	6.7%	$138.94
OR	$1,738.63	$1,807.54	4.0%	$68.91
PA	$2,607.86	$2,760.26	5.8%	$152.41
RI	$3,036.70	$2,810.74	-7.4%	$(225.97)
SC	$1,659.34	$1,930.81	16.4%	$271.47
SD	$1,737.15	$1,742.11	0.3%	$4.95
TN	$1,811.24	$1,869.48	3.2%	$58.23
TX	$2,569.54	$2,625.37	2.2%	$55.82
UT	$1,709.98	$1,811.16	5.9%	$101.18
VA	$1,637.48	$1,801.15	10.0%	$163.67
VT	$1,492.60	$1,608.75	7.8%	$116.15
WA	$2,121.07	$2,179.79	2.8%	$58.72
WI	$1,815.58	$1,806.67	-0.5%	$(8.91)
WV	$2,456.90	$2,574.39	4.8%	$117.50
WY	$1,868.74	$2,096.09	12.2%	$227.35

Human Factors

Human factors have been identified as the most prevalent factors by data, experts, and studies in traffic crashes *[2]*. Speeding and violating traffic laws, alcohol or drugs, inattention, decision errors, and age were the main human factors considered in the GAO study. Two more categories, aggressive driving and occupant protection, were identified in other studies and have been added to the review of individual factors below.

Age

GAO *[2]* found a strong relationship between a driver's age and the likelihood of being involved in a crash. Although age itself was not the direct cause of the crash, the characteristics displayed by different age groups led to different probabilities of being involved in traffic crashes. An analysis of NHTSA's databases by GAO indicated that younger and older drivers became involved in a greater number of crashes, especially fatal crashes, than did other age groups. Figure 4 shows that drivers ages 16 through 20 and those ages 75 or older had a greater chance of being involved in fatal crashes per vehicle mile traveled (VMT) than did other age groups.

According to the Insurance Institute for Highway Safety, teenagers' crash rates were disproportionately high mainly because of the drivers' youth combined with driving inexperience. Their study showed that the age factor reflected in a more risky driving style among adolescents *[22]*. The study found that the increased crash risk came immediately on licensure and dropped very rapidly in the first few months. When compared with older drivers, young people were more likely to drive at excessive speeds, follow too closely, violate traffic signs and signals, overtake other vehicles in a risky manner, allow too little time to merge, and fail to yield to pedestrians. Risky driving led young people into hazardous situations, and inexperience made it more difficult to cope with such situations. Driving at night was also found to be associated with an increased risk of serious crashes for young drivers. Further more, fatigue and alcohol were more likely to contribute to younger drivers' crashes during nighttime hours.

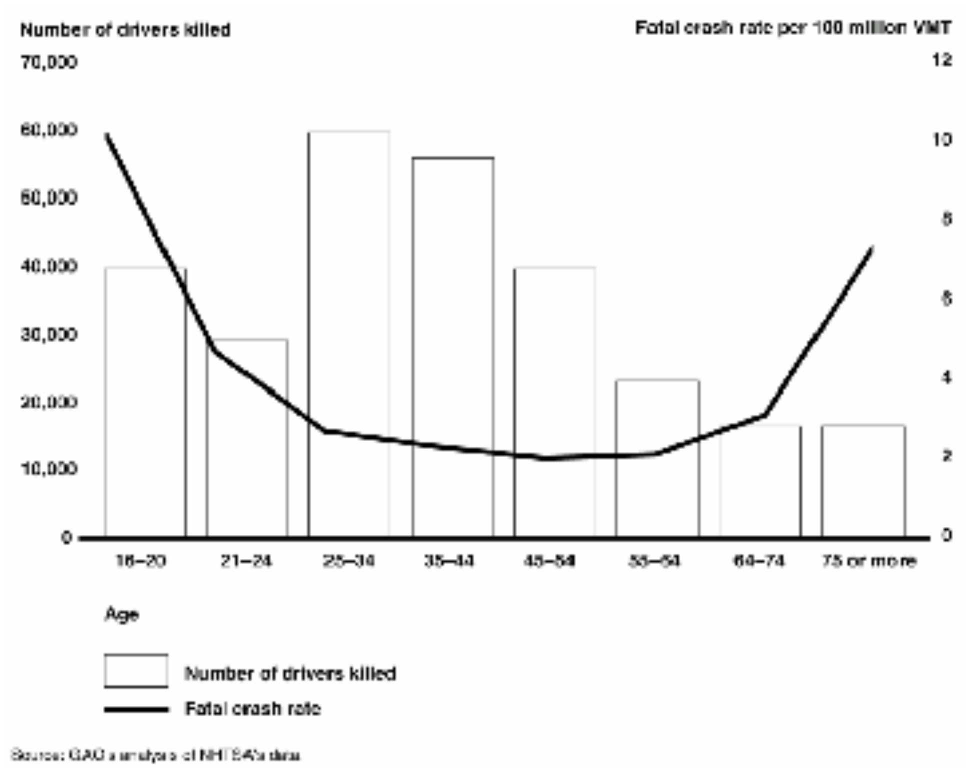


Figure 4
Number and rate of driver involvement in fatal crashes by age, 1997– 2001

George Mason University's Center for the Advancement of Public Health conducted a young driver study *[23]*. In their study, a thorough literature review was conducted. They found that crashes involving young drivers were most often single-vehicle crashes, primarily run-off-the road crashes that involved driver error and/or speeding *[24]*. Most of the novice drivers' increased risk was found to be related to inappropriate driving behavior, such as deliberately taking risky actions, thrill seeking, driving at high-speeds, and driving while impaired. Two main causes of crashes among young beginning drivers were their limited ability to perceive hazards and judge risks, and a lack of motivation to avoid risks. On the contrary, young drivers may be motivated to seek risks *[25]*.

The research conducted by Clarke *et al*. *[26]* found that young drivers, especially young males, had relatively more crashes than other drivers. Young driver crashes also had somewhat different characteristics. In particular, they included single vehicle crashes involving loss of control, excess speed for conditions, crashes during the hours of darkness, crashes on all-purpose single carriageway (i.e., undivided carriageway in United States) rural roads, and crashes while making right turns. The study indicated that a large percentage of young driver's crashes were purely the result of two or three "failures of attitude", rather than skill deficits per se. Those who drove "performance" cars, denoting cars of above average performance, could even be considered as above average in driving skills, but simultaneously had a higher crash involvement due to attitudinal faults.

Older drivers are also at increased risk. According to a recent study by the Insurance Institute for Highway Safety *[27]*, this is mainly resulted from increased physical and mental impairment. A literature review conducted by the University of Michigan Transportation Research Institute *[28]* found that older drivers are more likely to suffer from medical disabilities and may use medications. Both of these could affect their driving. The study also found that with increasing age, most drivers experience some loss of visual perception and decreased cognitive and psychomotor functions *[2]*.

A study sponsored by the American Automobile Association's (AAA) Foundation for Traffic Safety *[29]* analyzed 25 years of police-level crash data from nearly 4 million injury crashes in the State of Texas to determine the relationship between driver age and four factors: fragility, illness, perceptual lapses, and left turns. Three different age thresholds were used in defining this group: 65 and older, 75 and older, and 85 and older. Drivers aged 55 to 64 constituted the comparison group in the analyses. The results showed that drivers in the three older age categories, compared with drivers aged 55–64, were found to be more likely to die in injury crashes. The people in the older age group were more likely to (1) have been ill or suffering some other physical defect at the time of their crashes, (2) have suffered perceptual lapses that contributed to their crashes, and (3) have been involved in left-turn crashes.

The United Kingdom Department for Transport conducted a thorough literature review to examine a wide range of research pertinent to older drivers *[30]*. The research indicated several very important points:

- Older people's crashes were different from the crashes experienced by other age groups, resulting from differences in decision-making style and abilities.
- Older driver crashes at junctions tended to have fewer contributing causes. That is, junctions are dangerous for older drivers without any added risk factors.

- Older people attempted to avoid driving in situations perceived to be risky, such as poor weather, and a greater control of driving is exerted while driving under these situations.

In Louisiana, age has been found to be an important factor in crashes *[31]*. The crash reports provided by LHSC indicated that both the fatal crash rate and the injury crash rate for young drivers are higher compared to other age groups. In 2002, the fatal crash rates per 100,000 licensed drivers were 105, 115, and 102 for male drivers in age group 15-17, 18-20, and 21-24, respectively, which were higher than the average of 67 for all male drivers. The female driver in these three age groups also had higher fatal crash rates of 50, 34, and 28 compared to the average of 22.

Alcohol and Other Drugs

The GAO's analysis *[2]* showed that from 1997 through 2001, approximately 76,000 alcohol-related fatal crashes (41 percent of all fatal crashes), 980,000 alcohol-related injury crashes (10 percent of all injury crashes), and 2.3 million property damage only (PDO) alcohol-related crashes (7 percent of all crashes) occurred in the United States. Eight-six percent of these fatalities occurred in crashes where the recorded blood alcohol content (BAC) was .08 percent or above. The GAO also found that male drivers were more likely to be involved in alcohol-related fatal crashes than female drivers (figure 5).

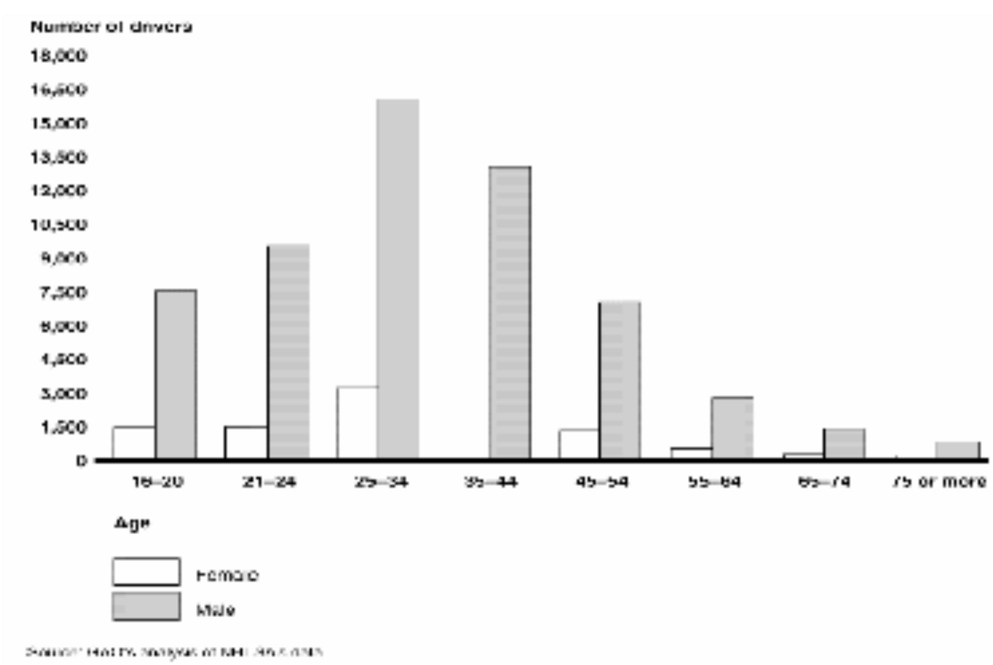


Figure 5
Drivers in alcohol-related fatal crashes, by age and gender, 1997–2001 *[2]*

Recent research by the Southern California Research Institute *[32]* showed that not only do high blood alcohol levels impair people's driving, but lower alcohol levels also affect driving performance. In the study, 168 test subjects were tested at different BAC levels. The resulting report showed that alcohol impaired driving-related skills from BAC levels of 0.02 percent through 0.10 percent BAC, the highest level tested.

According to a study conducted by US DOT *[33]*, young drivers were more often involved in alcohol-related crashes than any other age group. A large proportion of the alcohol-crash problem involves young white males. In 1998, 84 percent of fatal-crash involving drivers with BACs of .10 or more were male, and more than 70 percent were white. However, certain racial/ethnic subgroups had higher involvement rates than other subgroups. Of these, American Indians had the highest rate, and Asian/Pacific Islanders the lowest. The study found that drivers who were unemployed were much more likely to be alcohol-positive than those who were employed; drivers in the mid-income range had the highest prevalence of alcohol use, and drivers in the high-income range and the low-income range had the lowest; drivers with the least formal education had the highest occurrence of alcohol use, and drivers with the most formal education had the lowest.

Zador *et al. [34]* conducted a study to examine alcohol-related relative risk of driver involvement in fatal crashes by age and sex as a function of BAC. The results have revealed that, in general, the relative risk of involvement in a fatal passenger vehicle crash increased steadily with increasing driver BAC in every age/sex group among both fatally injured and surviving drivers. Older drivers had a lower risk of being fatally injured in a single vehicle crash than younger drivers; the same was true for females when compared to males in the same age range. The results clearly showed that drivers with BACs somewhat below 0.10 percent pose highly elevated risk both to themselves and to other road users.

Since 1991, NHTSA has been conducting a nationally representative telephone survey every two years to measure the current status of attitudes, knowledge, and behavior of the general driving-age public regarding drinking and driving. The Gallup Organization *[35]* conducted interviews with a national sample of 6,002 persons age 16 or older in the United States between November 3 and December 23, 2001. Nearly 77 percent of respondents said that drinking and driving by others is a major threat to their personal safety. This is a significant decline since 1999 (80 percent). In 1995, 20 percent of drivers reported driving within two hours of drinking in the past year. This proportion rose to 23 percent in 1999 and remained the same in 2001.

In 2000, police in Louisiana reported 11,061 crashes involving a driver or pedestrian with a BAC of .01 or more. An estimated total of 47,500 crashes in Louisiana involved alcohol *[36]*. These crashes killed 447 and injured an estimated 21,100 people. Alcohol was a factor in 32 percent of Louisiana's crash costs. Alcohol-related crashes in Louisiana cost the public an estimated $2.9 billion in 2000, including $1.2 billion in monetary costs and almost $1.7 billion in quality of life losses. Louisiana already has many important impaired driving laws such as Administrative License Revocation, zero tolerance law, and .08 BAC law.

Aggressive Driving

According to the New York State Governor's Traffic Safety Committee *[37]*, aggressive driving is defined as the operation of a motor vehicle in an unsafe and hostile manner without regard for others. Aggressive driving behavior may include: making frequent or unsafe lane changes, failing to signal or yield the right of way, tailgating, and disregarding traffic controls.

NHTSA estimates *[38]* that about one-third of traffic crashes and about two-thirds of the resulting fatalities can be attributed to driving behavior commonly associated with aggressive driving.

Tasca *[39]* conducted a literature review on aggressive driving research. He concluded that the available research can be divided into two main categories: 1) surveys of the driving public and 2) small-scale field experiments involving small samples of drivers.

In January 1999, the NHTSA published a telephone survey of 6,000 drivers from age 16 and older, who shared their attitudes and experiences about speeding and unsafe driving, including aggressive driving. More than 60 percent of those interviewed perceived unsafe driving by others, including speeding, as a major personal threat to themselves and their families. Three out of four drivers believed that doing something about unsafe driving was "very important." And more than half of the 6,000 respondents admitted to driving recklessly on occasion.

Age and gender *[39]* have been identified as factors associated with aggressive driving behavior. Parry *[40]* conducted a study that consisted of a survey of the attitudes and behaviors of 279 British motorists. The analysis indicated that male drivers ages 17 to 35 were associated with the highest scores for aggression on the road. The lowest scores were observed for the oldest age groups. A Dutch study *[41]* reported negligible gender effects, but substantial age-related differences. Hauber observed 966 drivers approaching pedestrian crossings and conducted a follow-up survey to measure drivers' perceptions of aggression. The results showed that twenty-five percent of drivers displayed aggressive behavior.

Gender differences were negligible. However, age difference was obvious (31 percent of young aggressive drivers compared to 20.7 percent of older drivers). It was also determined that commercial vehicle drivers were more likely to drive aggressively (37.6 percent) than other drivers (24 percent). Parker *et al*. *[42]* also strengthened this point in his reports: driver age was a significant predictor of aggressive driving, but gender was found to be a poor predictor.

Several other factors including anonymity, social factors, personality, life style, driver attitudes, and environmental factors have also been cited as causal factors to the aggressive driving behavior *[39]*.

Driver Inattention

Driver inattention is a major contributor to highway crashes. The NHTSA estimates that at least 25 percent of police-reported crashes involve some form of driver inattention. Two categories of driver inattention are distraction and drowsiness. Driver distraction is a factor in over half of inattention crashes. Distraction occurs due to driver delay in the recognition of information needed to safely accomplish the driving task because some event, activity, object, or person within or outside the vehicle compels or induces the drivers to shift attention away from the driving task *[43]*. The NHTSA defines four categories of distraction: visual distraction, auditory distraction, biomechanical distraction, and cognitive distraction. Many distracting activities in which drivers can engage involve more than one of these components *[2]*.

The GAO's analysis of 1997 through 2001 data from the NHTSA found that, overall, about 2.5 million drivers of passenger vehicles that were towed away from crashes were identified as inattentive. Of these, about 1.3 million were distracted, about 871,000 "looked but did not see" and about 348,000 were sleepy or asleep. In addition, about 7.6 million drivers were identified as "attentive" at the time of the crash. The GAO also conducted a more detailed analysis of inattentive drivers. As figure 6 shows, overall, more drivers between ages 16 and 44 were involved in inattentive-type crashes than drivers aged 45 and above. More drivers aged 16 to 20 were inattentive than any other age group.

The analysis by the GAO indicated that some outside person, object, or event was identified as a contributing factor to 27 percent of the distractions. Other common sources of distractions included another occupant in the vehicle, followed by adjusting a radio, cassette, or CD. Drowsiness and fatigue are also aspects of inattention and can contribute to crashes.

In the study of examination and analysis of nine major target vehicular crashes, Najm *et al.* *[44]* concluded:

- 19.4 percent of rear-end collisions resulted from a combination of tailgating (following too closely) and driver inattention.
- Driver inattention caused subject vehicles to drift out of the travel lane and result in 3.8 percent of lane change/merge crashes, 6.8 percent of single vehicle roadway departure crashes, and 17.8 percent of opposite direction crashes.
- 7.0 percent of single vehicle roadway departure crashes caused by driver inattention resulted from an evasive action to avoid a rear-end crash with a lead vehicle.
- Of the cases included in the "opposite direction" crash sample, a number of cases identified as "driver inattention" could not be specifically determined (distraction, daydreaming, or other), thus driver drowsiness many have been a factor *[45]*.

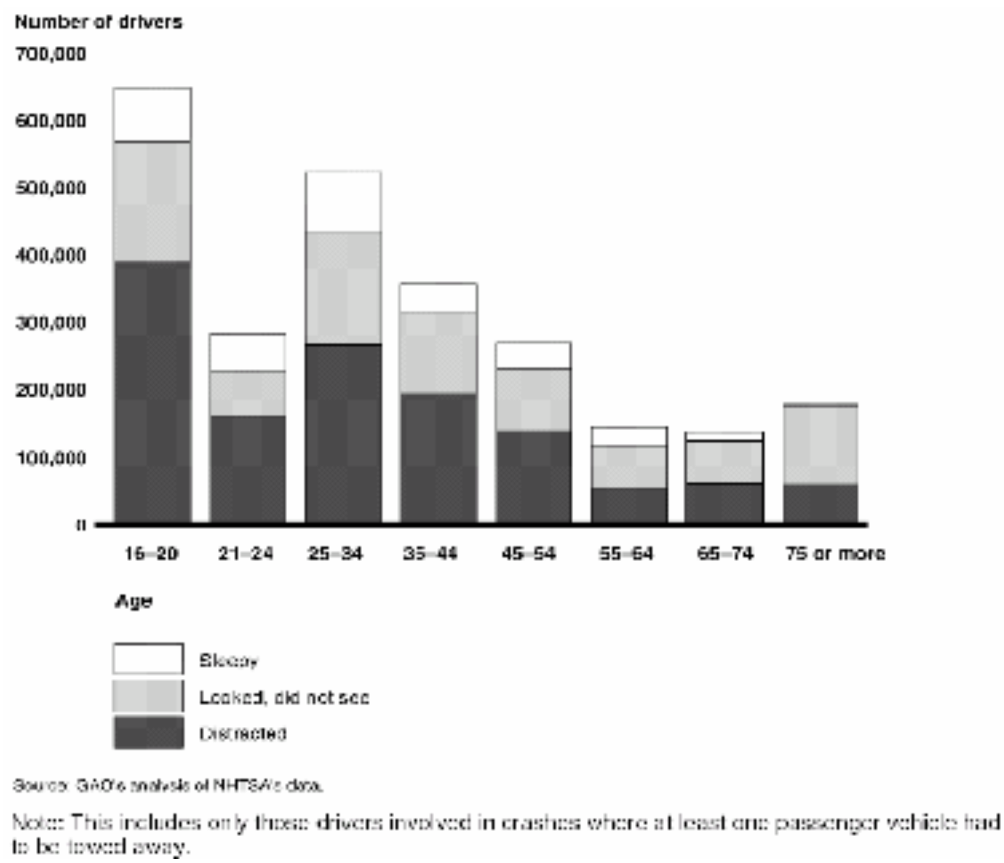


Figure 6
Inattentive drivers involved in crashes by age, 1997–2001

Anderson *et al. [45]* identified driver inattention as one of several unsafe driving acts in their study. Driver inattention was found to contribute in 22.7 percent of cases, which is the leading factor in the six causal factors identified by the study. According to the study, "Inattention was determined to be the sole causal factor for 16.7 percent of the drivers who contributed to crash causation, and was noted as the primary causal factor in combination with other contributing factors for another 5.2 percent of the drivers, and as a contributing factor in combination with other primary factors for another 0.8 percent of drivers contributing to crash causation." *[45]*.

In 1999, the Response Insurance Group conducted 1,016 telephone interviews with adults 16 years or older across the country, asking respondents to self-report distractions they had encountered or engaged in while driving and whether each distraction led to a crash or a near crash situation. The research indicated that 76 percent of all drivers self-reported having been distracted by at least one of the following activities while driving, which in many cases caused an "accident" or a "near accident" (table 5) *[45]*.

Table 5

Self-report distractions *[45]*

Activity	**Percentage Distracted**	**Accident/Near Accident**
Tuning in a radio station	62%	
Eating	57%	
Turning head around to speak	56%	18%
Reaching for something	44%	21%
Reading	32%	
Writing	32%	
Using glove compartment	32%	
Talking on a cell phone	29%	13%
Cleaning the windshield	23%	
Rubbernecking	22%	
Steering without hands	20%	
Combing hair	17%	5%
Picking nose	17%	
Fighting with a passenger	16%	16%
Spilling coffee	14%	26%
Breaking up fight between kids	12%	26%
Wiping off cigarette ashes	12%	12%
Racing with another car	12%	21%
Dog jumping around in car	11%	16%
Putting on makeup	10%	9%
Putting in eye drops/contacts	3%	9%
Have child on lap while driving	3%	
Using a computer	1%	21%

The University of North Carolina Highway Safety Research Center conducted research on the role of driver distraction in traffic crashes *[44]*. Phase I of the study was to identify the major sources of distraction to drivers and the relative importance of the distractions as potential causes of crashes. From the overall 1995-1999 Crashworthiness Data System (CDS) data, 48.6 percent of the drivers were identified as attentive at the time of their crash; 8.3 percent were identified as distracted, 5.4 percent as "looked but did not see," and 1.8 percent as sleepy or asleep. The specific sources of distraction among distracted drivers are listed in table 6.

Table 6
Specific source of distractions *[44]*

Specific Distraction	**% of Drivers**
Outside person, object or event	29.4
Adjusting radio, cassette, CD	11.4
Other occupant in vehicle	10.9
Moving object in vehicle	4.3
Other device/object brought into vehicle	2.9
Adjusting vehicle/climate controls	2.8
Eating or drinking	1.7
Using/dialing cell phone	1.5
Smoking related	0.9
Other distraction	25.6
Unknown distraction	8.6

The study found that young drivers (under 20 years of age) were the most likely to be involved in distraction-related crashes. In addition, certain types of distractions were more prominent in certain age groups, for example, adjusting the radio, cassette, or CD among the under 20-year-olds; and outside objects and events among those age 65 and older. Variations by driver sex were less pronounced, although males were slightly more likely than females to be categorized as distracted at the time of their crash.

Phase II of the North Carolina study *[46]* was intended to provide insight into how often drivers engage in various distracting or potentially distracting behaviors, whether there are age and sex differences in drivers' exposure to various distractions, whether driving conditions alter the frequency and duration of distractions, and the consequences of distractions on selected measures of driving performance. The results have shown that:

- Distractions are a common component of everyday driving.
- Age differences in the likelihood of engaging in a particular distraction were generally small.
- Drivers were engaged in some form of potentially distracting activity up to 16.1 percent of the total driving time. Followed by eating and drinking at 4.6 percent, internal distractions at 3.8 percent, and external distractions and smoking each at 1.6 percent. The rest of the components of distracting behaviors are manipulating audio controls (1.4 percent), using a cell phone (1.3 percent), other occupant distractions (0.9 percent), reading or writing (0.7 percent), and grooming (0.3 percent).

Drowsiness and fatigue are also aspects of inattention and can contribute to crashes. Drowsiness is a basic physiological state, brought about by the restriction or interruption of sleep. It also results from natural changes in the body's level of alertness during each 24-hour sleep-wake cycle *[2]*.

Driving is affected by numerous factors that lead to fatigue, changes in performance, and an increased potential for a crash. Although most drivers have experienced fatigue while driving, it is typically thought of as a commercial driver problem *[2]*.

An Australian study on fatigue-related crashes *[47]* revealed that they are often more severe than other crashes as drivers' reaction times are often delayed or drivers have not employed any crash avoidance maneuvers. The study also reported that the age of the fatigued driver/rider and the type of fatigue-related crash (single vehicle or head-on) appeared to be related. Single vehicle crashes involved a higher proportion of fatigued drivers/riders under 29 years of age compared with head-on crashes. However, fatigued drivers/riders over 50 years of age were involved in more head-on crashes. This relationship may be linked to the time of the crash. That is, single vehicle crashes are more likely to occur in the early morning and early morning crashes are more likely to involve fatigued drivers/riders under 29 years of age. A similar argument could explain the relationship between older fatigued drivers/riders and head-on crashes.

Occupant Protection

Safety belt use saves lives and prevents injuries. Each percentage point increase in use saves about 270 additional lives across the nation. It is estimated that safety belts save the lives of more than 14,000 motorists each year and save about $50 billion in medical care, lost productivity, and other injury-related costs nationwide *[48]*.

The National Safety Council *[49]* developed the nationwide report on driver and passenger safety. It stated that despite advances made by the United States in traffic safety, traffic fatalities are still the leading cause of death for teenagers. Overall, 32,061 drivers and passengers died as occupants in vehicle crashes on the nation's roadways in 1999, which was 77 percent of the 41,611 traffic fatalities reported for the year—a much greater number of fatalities per capita when compared to many other developed countries. An estimated 9,553 of those 32,061 people would have been alive today if all vehicle occupants over the age of four had been properly restrained. By comparison, Canada has 92 percent seatbelt use rate and a much lower fatality rate: about 9 out of 100,000 people die in crashes, versus 15 people per 100,000 in the United States.

The report graded (table 7) 50 states and the District of Columbia with the following results: 19 states received Ds and Fs, and eight states received a less-than-acceptable C-. Louisiana received C-. California was the only state to receive an A; two states received an A- and another 11 states received Bs. The report indicated that the 50 states and the District of Columbia as a whole deserve a mediocre to failing grade. In comparison to most developed nations, the U.S. ranks near the bottom of the list in seatbelt use *[49]* (figure 7).

Canada has achieved seatbelt use rate of 92 percent, which is among the best in the world. Canadian seatbelt laws are primary laws that permit law enforcement officers to stop and ticket a driver for not wearing a seatbelt as the only offense. Secondary laws, which are unique to the United States, only allow police to issue a citation for not wearing a seatbelt if the motorist is pulled over for another infraction such as an expired license tag. Comprehensive programs of periodic intensive enforcement of the belt laws in Canada have been adopted. This has lead to seatbelt usage in Canada in excess of 90 percent since 1994 *[49]* (figure 8).

Some of the key findings from the National Safety Council's report *[49]* were:

- The top-ten rated states all have primary seatbelt laws. States that have upgraded to primary seatbelt laws have generally experienced a 10 to 15 percentage point increase in seatbelt use, according to the NHTSA's National Occupant Protection Usage Survey (NOPUS) *[50]*.
- The top-rated states also share a commitment to highly visible enforcement of seatbelt laws.
- Every state that received an F either has a secondary seatbelt law or has no seatbelt law.
- States that have secondary seatbelt laws can significantly raise seatbelt use by engaging in periodic "high visibility" enforcement.

Table 7

States seatbelt usage grading *[49]*

Grading The Nation

State	Overall	Belt Use	State Law	Fatalities 0-12	Fatalities 13-19	Fatalities 20	Law Enforcement	Total
California	A	A	A	B -	A	B -	B +	3.87
New Mexico	A -	A	A +	B-	D -	D-	B	3.52
D.C.	A -	B	A +	A +	A	A	A	3.50
Oregon	B +	B +	A	B	B +	B -	B -	3.38
Michigan	B +	B +	A -	B +	B	C	B	3.30
Maryland	B +	B +	B	A	B	B	A	3.23
Hawaii	B +	B	A	C +	B	A	A -	3.20
New York	B +	B -	A	A	A -	B +	A -	3.17
Connecticut	B	B-	A	A-	B +	B	B	3.05
North Carolina	B	B	B +	C -	C -	C -	A -	3.00
Washington	B -	B	C	C	B-	B-	A	2.77
Texas	B -	B -	A -	C -	C	C -	C	2.70
Iowa	B -	B -	C	C -	C +	C -	A -	2.50
New Jersey	B -	C +	C +	A	A	B	C -	2.50
Nevada	C +	B	C	C	C	D	A -	2.47
Georgia	C +	C +	B	D	D +	D	A -	2.32
Utah	C +	B-	D-	B	D +	D	B +	2.17
Minnesota	C	C +	D	A -	B -	C	C +	2.13
Arizona	C	B-	F	C-	C-	D	A	2.02
Alabama	C	C	B -	D	F	F	A -	2.00
Montana	C	B -	D	C	F	F	C -	1.89
Illinois	C	C	D-	B	B	B-	C	1.87
South Carolina	C	C +	D	F	F	D -	A -	1.85
Florida	C	C-	C	C	D +	D	A +	1.84
Virginia	C	C	D	C +	C +	C	A	1.74
Louisiana	C -	C-	C	C	D+	D	C	1.70
Nebraska	C -	C	D	C+	D	D	C-	1.70
Pennsylvania	C	C	F	B	C+	C	C	1.65
Colorado	C -	C-	D-	C	C-	C-	B	1.63
Alaska	C -	D	C	C -	A +	C	B	1.55
Oklahoma	C -	C	C	B	D	D	C	1.54
Delaware	C -	C-	D	C	F	D	B+	1.52
Rhode Island	D +	D	D +	B +	A	B	C +	1.48
Ohio	D +	C	F	B	C	C	C	1.45
Indiana	D +	D	C +	B	D +	C	C	1.45
Wisconsin	D +	C-	F	B	C	C	C-	1.44
Maine	D +	D	C	A	D +	B	C	1.40
Kentucky	D +	D	C-	C	D +	D -	A -	1.35
Missouri	D +	C -	F	C	D -	D	C -	1.27
Wyoming	D +	C-	F	F	F	F	A	1.20
Kansas	D	D	D -	C -	D	D	C -	1.15
Vermont	D	D	F	C +	D	C-	B	1.00
Massachusetts	D -	F	D	A	B	B +	B	0.80
New Hampshire	F	F	F	A -	B-	B-	C -	0.59
Arkansas	F	F	C-	C	F	D -	C	0.48
West Virginia	F	F	D	D	D	D	B	0.47
Tennessee	F	F	F	C	F	D	A -	0.33
North Dakota	F	F	F	D	D +	D -	B -	0.28
South Dakota	F	F	F	D	D	D -	C	0.23
Mississippi	F	F	F	F	F	F	A -	0.22
Idaho	F	F	F	F	D -	D -	C +	0.18

*States shown in bold have standard enforcement seat belt laws, also known as primary enforcement, which allow officers to stop and ticket drivers for being unbuckled.

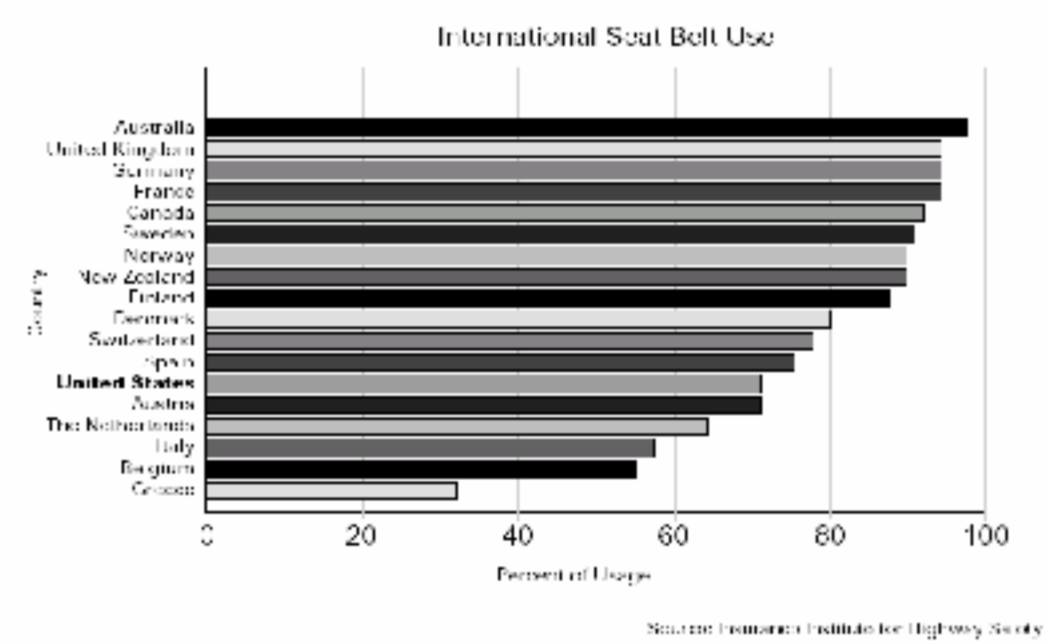


Figure 7
International seatbelt use *[49]*

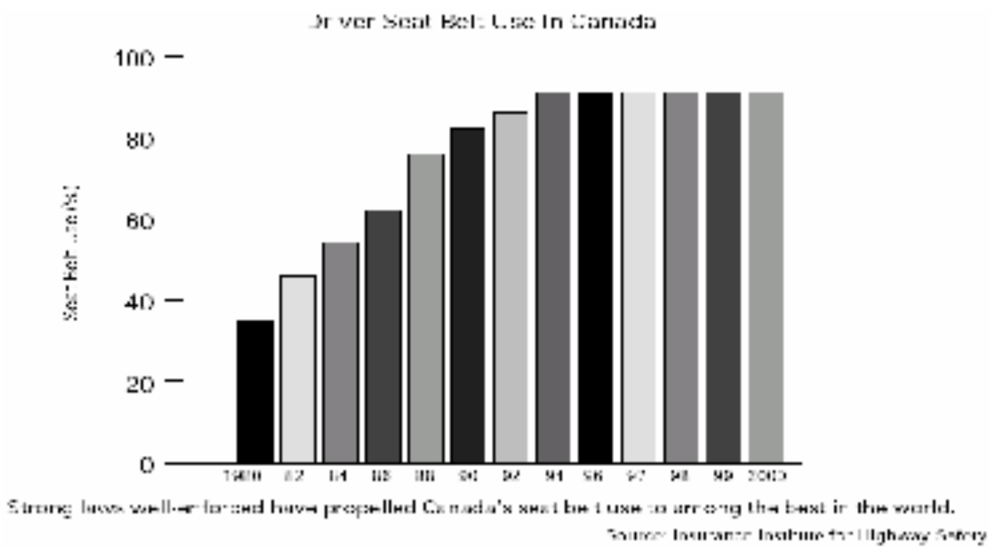


Figure 8
Driver seatbelt use in Canada *[49]*

The research on safety belt usage by commercial motor vehicle drivers *[51]* shows that approximately 5,000 people are killed annually in crashes involving large trucks. The truck occupant is often killed in situations that may be preventable. In single-vehicle crashes, many drivers die because they fail to wear a safety belt. A total of 3,909 trucks were observed in the study, and the overall safety belt usage rate was 48 percent. Class 7 trucks, those with at least six tires, but fewer than 10, had a safety belt usage rate of 54 percent. Class 8 trucks, those with more than 10 tires, had a usage rate of 47 percent. This number is very low compared to a 79 percent usage rate for all passenger vehicles.

A study was conducted for the NHTSA *[52]* to obtain a measure of the current level of misuse of child restraint systems among the general public. The project focused specifically on forms of misuse that can be expected to raise the risk of injury. Over 4,100 vehicles and over 5,500 children weighing less than the driver-estimated weight of 80 lb, from 6 States (Arizona, Florida, Mississippi, Missouri, Pennsylvania, and Washington), were observed in the study. Results showed that 62.3 percent of these children were restrained in child restraint systems; 25.9 percent were restrained in a safety belt; and 11.8 percent were unrestrained. Overall, critical child restraint systems misuse was 72.6 percent. The most common critical misuses were loose harness straps securing the child to the child restraint systems and loose vehicle safety belt attachment around the child restraint systems. A positive relationship was found between drivers using safety belts and children being restrained—91.7 percent of the children who were transported by belted drivers were restrained in either a child restraint system or a safety belt, compared to 62.3 percent of the children transported by unbelted drivers.

In Louisiana, the seatbelt usage rate has increased from 54 percent in 1995 to 70 percent in 2002. The seatbelt project conducted by LHSC has shown that increased enforcement and a public awareness campaign in seatbelt use can achieve the goal of reducing injuries and fatalities in crashes *[53]*.

Speeding

Driving either faster than the posted speed limit or faster than what conditions would safely dictate can contribute to traffic crashes. Speeding reduces a driver's ability to steer safely around curves or objects in the roadway, extends the distance necessary to stop a vehicle, and increases the distance a vehicle travels while the driver reacts to a dangerous situation *[2]*.

According to the GAO's analysis of the NHTSA's databases, from 1997 through 2001, speeding has been identified as a contributing factor in about 15 percent of all crashes and about 30 percent of all fatal crashes. As shown in figure 9, for every age category of drivers involved in fatal crashes, males were more likely than females to be involved in a fatal speed-related crash. In addition, younger drivers, regardless of sex, are the most likely to be involved in a speed-related fatality. From 1997 through 2001, among 16- to 20-year-olds, 36 percent of male drivers and 24 percent of female drivers 16 to 20 years old who were involved in fatal crashes were speeding at the time of the crash. The percentage of speeding-related fatal crashes decreases with increasing driver age.

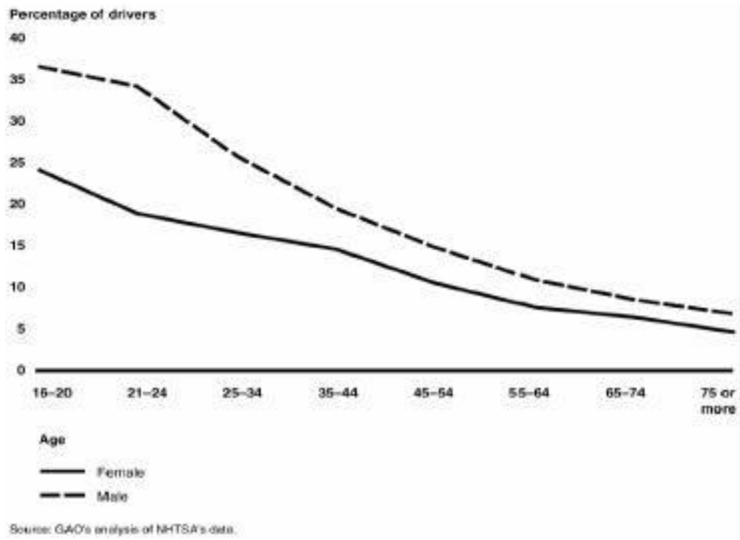


Figure 9

Speeding drivers in fatal crashes by age and gender, 1997–2001 *[2]*

On certain types of roads, speeding has more severe consequences than on others *[54]*.

- Almost half of all speeding fatalities occur on local and collector roads, which are low speed roads found in residential and business areas.
- Local and collector roads in America have a speeding fatality rate almost triple that of the Interstates.
- Rural roads are especially hazardous for speeders and those who share the road with them. Almost 65 percent of all speeding-related fatalities take place on rural roads.
- Rural local roads are especially dangerous: their speeding-related fatality rate is four times higher than their urban counterparts.

Some studies have confirmed a direct relationship between speed and crash severity. In addition, speed variance is also a factor. When vehicles on a particular roadway are traveling at very different speeds, the probability of a crash increases. The relative crash involvement rate increases for vehicles that are traveling above or below the average speed of traffic *[2]*.

A study done in the United States 30 years ago attempted to quantify the relationship between speed and crash involvement *[55]*. The study was conducted on rural roads. It reported that the relationship was U-shaped, with the crash risk being elevated at both relatively low and relatively high speeds. However, it has been suggested that these studies do not reliably quantify the relationship between speed and crash involvement at the lower end of the speed distribution.

Solomon found that “the daytime involvement rates took the form of a U-shaped curve, being greatest for vehicles with speeds of 22 mph or less, decreasing to a low at about 65 mph, then increasing somewhat for speeds above this; the night-time rates took the same form but were higher, especially for speeds in excess of 60 mph” *[55]*. These results are indicated in figure 10.

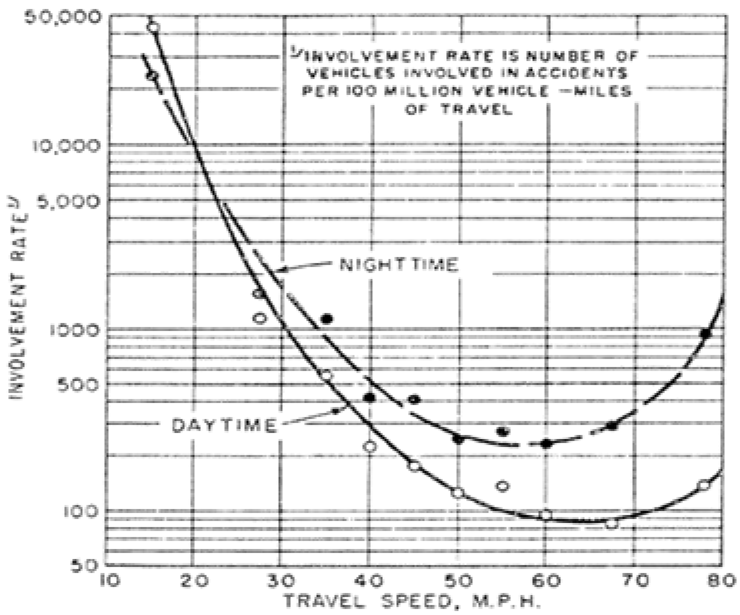


Figure 10

Accident involvement rate by travel speed, day and night *[55]*

A study conducted by the NHTSA and the FHWA indicated that fatal crashes have increased in states that raised speed limits *[56]*. “The study found that states with increased speed limits in 1996 experienced approximately 350 more Interstate fatalities than would have been expected based on historical trends—about 9 percent above expectations. Concurrently, the Interstate fatalities experienced in states that did not increase speed limits in 1996 were consistent with pre-1996 trends” *[2]*.

In Louisiana, the statutory speed limit on interstates was raised from 65 mph to 70 mph in 1997. An analysis of crashes one year later showed that raising speed limits had a significant effect on the number of fatal crashes on rural interstates *[57]*. Elevated parts of the interstates, in particular, showed a dramatic percentage increase in fatal crashes.

Red Light Running and Other Traffic Control Violations

Red Light Running (RLR) crashes have become an increasing concern for the traffic safety community. According to Retting, Williams, and Greene *[58]* approximately 750 fatalities and 260,000 crashes annually in the United States are related to RLR. Another study *[59]* found that occupant injuries occurred in 45 percent of RLR crashes, compared to 30 percent for other urban crash types *[60]*.

A study performed by the Insurance Institute for Highway Safety and the Preusser Research Group *[61]* identified characteristics of RLR crashes and the drivers involved. It found that drivers' noncompliance with traffic control devices, such as traffic signals and stop signs, is a major cause of motor vehicle crashes. The study examined the prevalence of RLR crashes on a national basis to identify the characteristics of such crashes and the drivers involved. The study estimated that, of the 260,000 RLR crashes that occurred in 1996, 809 resulted in fatalities. It was also found that, as a group, red light runners involved in crashes were more likely than other drivers to be younger than age 30, to be male, to have prior moving violations and convictions for driving while intoxicated, to have invalid driver's licenses, and to be reported by police as having consumed alcohol prior to the crash *[2]*.

A number of intersection factors and human factors influence red light running. These factors vary from intersection to intersection. Some factors are intersection-related and others are driver-related *[62]*. RLR crashes are more likely to occur in urban areas. Fatal RLR crashes are more likely to occur during daylight hours and more likely to involve male drivers than female drivers. Younger drivers tend to be more involved in RLR situations that include night crashes, alcohol consumption, and/or suspended or revoked driver licenses

Research conducted by Mohamedshah and Chen *[60]* examined selected geometric characteristics of intersections and their impact on RLR crash rates and to establish a relationship between them. The results showed that the traffic volume on both the entering and crossing streets, the type of signal in operation at the intersection, and the width of the cross-street at the intersection are the major variables affecting RLR crashes.

The Virginia Tech Transportation Institute (VTTI) conducted a 30-month study *[63]* for the NHTSA to develop performance specifications and supporting objective tests for a field test of vehicle-based countermeasures to intersection crashes. The study targeted intersection crashes associated with violations of stop signs and traffic signals. Table 8 summarizes the contributing factors across all crash types and injury levels and figure 11 presents the information in a pie chart. The following points were noted in interpreting the results:

- For human factors, driver distraction and inattention was the largest primary contributing factor at 37 percent, followed by obscured driver vision at about 10 percent. Speeding was a greater factor for straight pre-crash maneuvers than for turning pre-crash maneuvers.

- For environmental and roadway factors, weather was the largest at 13 percent, followed by road surface at 4 percent.

Table 8
Primary contributing factors for all crossing-path (CP) crash types and known crash severities for light vehicles cited with violations, 2000 GES data *[63]*

Primary Contributing Factor	Frequency	Percent
Alcohol or Drugs	8,000	2%
Driver's Vision Obscured	38,000	10%
Driver Impairment (including drowsiness)	3,000	1%
Driver Distraction or Inattention	143,000	37%
Speeding	8,000	2%
Total Primary Contributing Factors	**200,000**	**52%**
Environmental or Roadway Factors	**Frequency**	**Percent**
Weather (not clear)	51,000	13%
Road Surface (not dry)	15,000	4%
Roadway Alignment (not straight)	6,000	2%
Total Environmental or Roadway Factors	**71,000**	**19%**
Total Contributing Factors	**271,000**	**71%**
Total Crashes from Table 34	**387,000**	**100%**

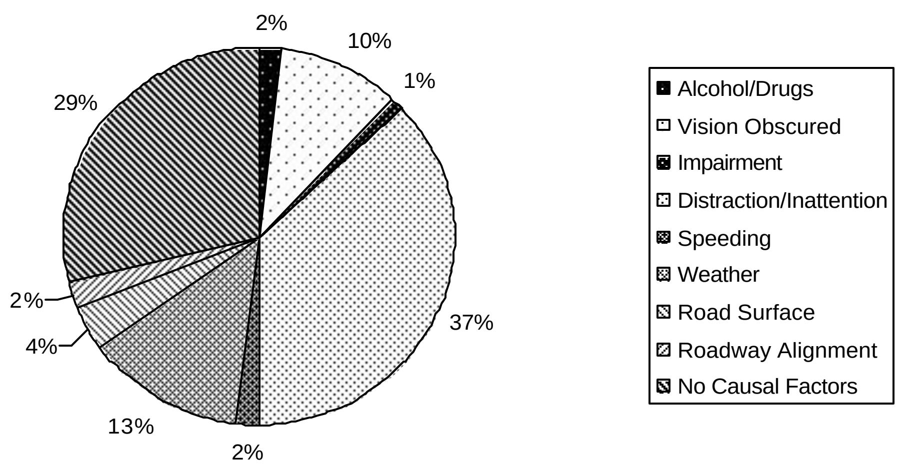


Figure 11
Percentage of primary contributing factors for all CP crash types and known crash severities for light vehicles cited with violations, 2000 GES data (all pie chart legends are presented clockwise starting at the top of the chart) *[63]*

Driver Decision Error

Driver decision errors involve misjudgments including improperly judging stopping distances, improperly judging distances of cars, and other misjudgments. The behavior such as traveling the wrong way on a one-way street is also considered as misjudgment. The UDA study *[7]* showed that, in 99 percent of the crashes analyzed, a driver behavior error caused or contributed to the crash.

Roadway Environment Factors

According to a GAO *[2]* report, the roadway environment is generally cited as the second most prevalent factor contributing to crashes. Roadway environment factors that contribute to crashes include the design of the roadway, roadside hazards, and roadway conditions. The same categorization has been adopted in our review.

Roadway Design

In this section, some important roadway design features are reviewed, including cross section, alignment, intersection, and work zones. A new design concept from several European countries is also discussed.

A. Cross Section

Lane Width. Many studies have shown that an adequate pavement width is necessary for safe driving, and that crash rates decrease with an increase in the width of the traffic lane. Zegeer *et al. [64]* conducted a study on lane width involving about 17,000 accidents in Kentucky. It focused on run-off-the-road and opposite-direction accidents. The results showed that increased lane width is associated with substantive accident reductions. The study showed that run-off-the-road and opposite-direction accidents increased by a factor of 1.12 and 1.21 per foot decrease in pavement width, respectively.

A later study conducted by Zegeer *et al. [65]* set out to quantify the safety benefits of lane widening, shoulder widening, sideslope flattening, etc. The results of the study showed that for two-lane rural roadways, 1 foot of lane widening can be expected to reduce accidents such as run-off-the-road, head-on, and opposite- and same-direction sideswipes by 12 percent, and 4 feet of widening could reduce these accident types by 40 percent.

Zegeer *et al. [66]* also examined the effect of lane width, shoulder width, and shoulder type on low volume roads (less than 2000 ADT). That study indicated that single-vehicle (i.e., fixed-object and rollover) and opposite direction (i.e., head-on and opposite-direction sideswipe) accidents were two types of accidents that were highly related to the lane width. A linear regression model was developed to estimate expected accident effects of variable roadway widths. After controlling for other traffic and roadway variables, lane widths of 11 feet or greater were shown to have significantly lower accident rates than 10 feet lane widths as shown in figure 12. Also, the study indicated that accidents on low-volume roads are affected primarily by roadway width, roadside hazards, roadway terrain, and the number of driveways per mile. The presence of a shoulder is associated with a significant accident reduction for lane widths of 10 feet or wider. For 10 feet lanes, a shoulder of 5 feet or greater affects accident rates significantly, while for 11 and 12 feet lane widths, shoulders 3 feet or wider are needed. For 13 feet lanes, shoulders 5 feet or wider could reduce the accident rate by half.

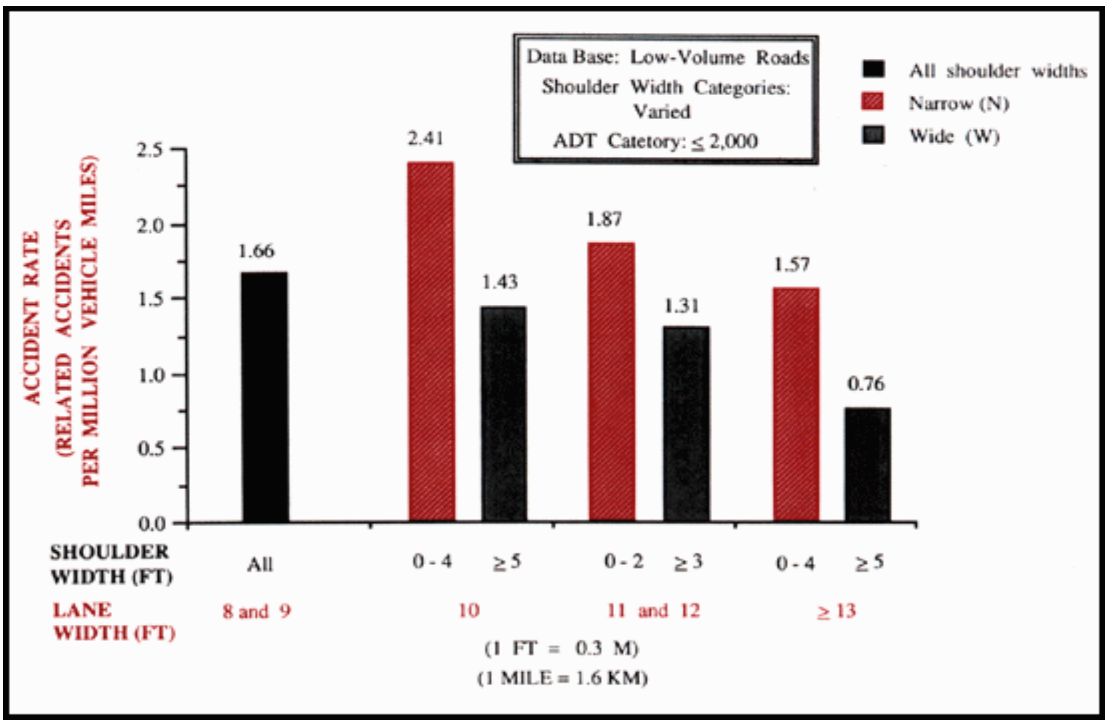


Figure 12

Rates of related accidents by lane width from the low-volume roads database *[66]*

However, much of the earlier evidence indicated that the benefit of lane widening decreases as lanes get wider and may be detrimental to safety at some point. Zegeer *et al.* *[62]* concluded that widening a lane beyond 11 feet is not cost effective. Hauer *[67]* pointed out that the wider lanes have both positive and negative impact on safety. Although wider lanes enlarge the average separation between vehicles moving in adjacent lanes and therefore could absorb the small random deviations of vehicles from their intended path, they tend to induce speeding and tailgating.

Median. The relationship between median width and safety is affected by several design decisions, including whether or not to provide a median, and if a median is needed, what shape and width it should have *[67]*. Harwood *[68]* considered design alternatives for improving suburban highways. Two-lane highways were converted to three-lane divided with two-way left-turn lanes (TWLTL), four-lane undivided, four-lane divided, and five-lane with TWLTL. The safety evaluation of the alternatives was based on the data for 469 miles of suburban highways in California and Michigan. After controlling for other factors, such as the effect of differences in ADT, percentage of trucks, left-turn demand, lane width, shoulder width, etc., the study found that the safety benefits of providing a median seemed to be small.

Long and Gan *[69]* used accident data from 1991 to 1998 in Florida to compare accident rates (accidents per million vehicle miles) for divided and undivided roads. The results showed that for four-lane urban arterials, undivided roads have a higher accident rate than divided roads for all accident severities. The study also pointed out that the difference in accident rate might also be caused by the differences between the various road attributes including roadside development, traffic, geometry, and surrounding area, etc.

Seamons and Smith *[70]* used California data from 1984 to 1988 from 2,464 miles of freeways without barriers to study the safety impact of median width. Observed accident frequencies were calculated for five categories of median width (45-55 feet, 55-65 feet, 65-75 feet, 75-85 feet, >85 feet) and different ADT classes. The results indicated that for each ADT category, the cross-median accident frequency declines with median width.

Knuiman et al. *[71]* examined accident data on the road including four-lane rural and urban Interstate, freeway and major highway road sections in Utah and Illinois. The accident rates were found to be associated with various median widths as showed in table 9.

The accident rate decreased with the increase of the median width. However, roads that have wider medians generally have higher ADTs and better design and maintenance standards which may help to reduce the accident rate. To further explain the contributing factors, the study developed a multivariate statistical model to account for influences of functional classification, speed limit, right-shoulder width, access control, ADT, and section length. It turned out that roads with wider medians still tended to have lower accident rates. However, the differences are much less significant.

Table 9

Accident rates associated with various median widths *[71]*

	Median width [ft]	Average Accidents/MVM	Relative Accident Rate
UTAH	0	6.50	1.00
	1-10	6.18	.95
	11-29	4.62	.71
	30-54	1.59	.24
	55-84	1.37	.21
	85-110	1.11	.17
ILLINOIS	0	6.92	1.00
	1-24	6.47	.93
	25-34	2.92	.42
	35-44	1.29	.19
	45-54	1.27	.18
	55-64	.45	.07
	65-84	.59	.09
	85-110	.53	.08

Shoulders. Zegeer, Deen, and Mayes *[64]* reviewed studies focusing on shoulder width and safety. They indicated that there was considerable variation in findings concerning correlations of shoulder width with accident occurrence. Some of these studies reported decreased accident rates with increased shoulder widths for specific annual average daily traffic (AADT) rates only. Others have found a definite benefit from wide shoulders.

Miaou *[72]* used data on 596 two-lane rural road sections in Alabama, Michigan, and Washington to model the relationship between 4,632 single vehicle accidents in 1980-84 and various geometric and traffic characters. He found that increasing shoulder width by one foot decreases the number of single vehicle run-of-the-road accidents by 8.81 percent.

As mentioned earlier, a study by Zegeer et al. *[64]* using a large database from Kentucky showed that increasing shoulder width is associated with a decrease in opposite-direction and run-off-the-road accident rates when lane widths are 9 and 10 feet. For wider lanes, the decline in accident rate was modest.

A before-and-after study conducted in Australia *[73], [74]* showed that there was a 44 percent reduction in injury accidents after paving a 0.6-0.8 m gravel shoulder.

Rumble Strips. Rumble strips are used to provide a vibrotactile or audible warning to motorists. They are intended to reduce crashes caused by motorists leaving the roadway or entering oncoming lanes.

In 1996, Colorado installed 17 miles of centerline rumble strips on a winding, two-lane mountain highway to evaluate the safety benefit *[75]*. Comparison of traffic records for 44-month periods before and after the installation showed that head-on accidents decreased from 18 to 14, and sideswipe accidents from opposing directions decreased from 24 to 18.

In 1990, special rumble strips, equipped with a Sonic Nap Alert Pattern (SNAP) that produces a distinct warning sound and vibration that alert drivers whose vehicles are drifting off the roadway were installed on all 506 miles of the Pennsylvania Turnpike *[75]*. The results showed that drift-off-the-road crashes decreased by 65 percent per month. After 1991, SNAP strips and recessed reflective payment markers were routinely installed in new roadway segments on the Turnpike. Six years later, it was shown that the crash rate had been reduced by 2.3 crashes per 100 million vehicle miles.

Alignment - Horizontal Curves. Accidents on horizontal curves have been recognized as a considerable safety problem for many years. Accident studies indicate that curves experience a higher accident rate than tangents *[76]*.

Haywood *[77]* conducted a literature review on the relationship between roadway geometric design and safety. He pointed out that increasing degrees of curvature caused more accidents, as shown in figure 13. Single, sharp curves in a highway system can create hazardous situations. In addition, some studies indicate that sharp horizontal curves at infrequent intervals are much more dangerous than frequent applications of the same class of curves. The horizontal curvature has the highest correlation with accident rates on two-lane rural roads.

McLean *[78]* conducted a study to examine driver speed behavior and rural road alignment design. The study indicated that curves with radii less than 400 m (1,300 ft) have a particularly high accident rate, and road curvature has the greatest influence on driver speed behavior comparing to other alignment properties.

Zegeer et al. *[76]* conducted a study to determine the effect that horizontal curve features have on the safety of two-lane rural roads and to evaluate geometric improvements for safety upgrading. An analysis of 104 fatal and 104 non-fatal accidents on rural curves in North Carolina showed that in 77 percent of the fatal accidents and 64 percent of the non-fatal accidents, the first maneuver was toward the outside of the curve. Further, an analysis on 10,900 horizontal curves in the State of Washington with corresponding accident, geometric, traffic, and roadway data variables showed that the percentage of severe non-fatal injuries and fatalities were greater on curves than on tangents.

Although many studies reported a relationship between horizontal curvature and the total percentage of accidents by geometric design feature on the highways, inadequate driving performance such as deficient skills in negotiating curves, and traffic violations such as exceeding the design speed on the curve, also play a role *[79]*.

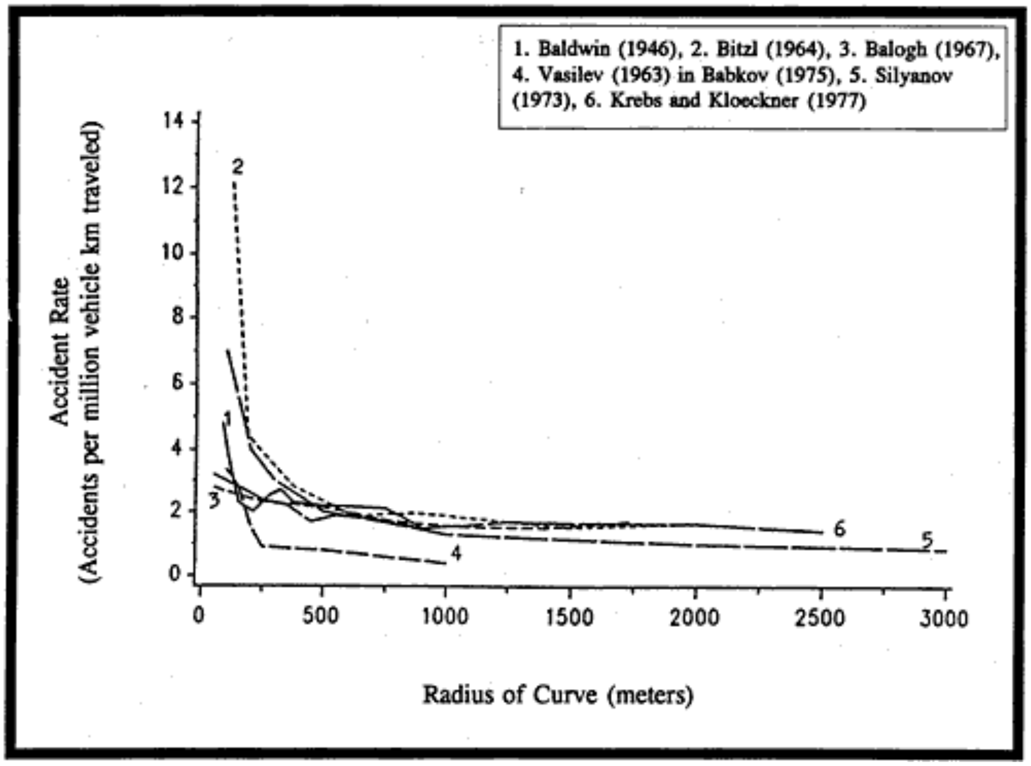


Figure 13

Related studies on the relationship between accident rate and radius of curvature *[79]*

Vertical Curvature. Highway vertical alignment comprises tangent grades and parabolic vertical curves. Sight distance is the main consideration in controlling vertical curvature. Farber *[80]* performed sensitivity analyses of the effects of change in eye height, object height, friction, and speed on stopping sight distance on crest vertical curves. He found that stopping sight distance was relatively insensitive to a reasonable range of changes in driver eye height, but that it was very sensitive to speed, friction, and reaction time.

B. Intersections

Left-Turn Lanes. Many studies have shown that installing left-turn lanes at intersections has been very effective in increasing safety. Foody and Richardson *[81]* found that accident rates decreased by 38 percent with the addition of a left-turn lane at signalized intersections and by 76 percent at unsignalized intersections.

Hauer *[82]* reported that the provision of left-turn lanes at unsignalized intersections, when combined with other treatment such as installation of curbs or raised medians, reduced accidents by 70, 65, and 60 percent in urban, suburban, and rural areas, respectively. Similarly, Lacy *[83]* found that a left-turn lane, when coupled with several other safety improvements, reduced accident frequency by 35 percent and accident severity by 80 percent.

A recent FHWA report indicated "added left-turn lanes are effective in improving safety at signalized and unsignalized intersections in both rural and urban areas" *[84]*. Installation of a single left-turn lane on a major-road approach could be expected to reduce total intersection accidents at rural unsignalized intersections by 28 percent for four-leg intersections and by 44 percent for three-leg intersections. At urban unsignalized intersections, installation of a left-turn lane on one approach could be expected to reduce accidents by 27 percent for four-leg intersections and by 33 percent for three-leg intersections. At four-leg urban signalized intersections, installation of a left-turn lane on one approach could be expected to reduce accidents by 10 percent.

Not all studies, however, have shown that left-turn lanes reduce accidents. McCoy and Malone *[85]* reported that there was a significant increase in right-angle accidents at unsignalized intersections with the introduction of left-turn lanes.

Right-Turn Lanes. Bauer and Harwood *[86]* indicated that right-turn channelization resulted in a decrease in both total multiple-vehicle accidents and fatal and injury multiple-vehicle accidents. However, Vogt and Bared *[87]* modeled accidents for three-leg unsignalized intersections along rural two-lane highways, and based upon the prediction model, the presence of a right-turn lane increases intersection-related accidents by 27 percent.

According to the previously quoted FHWA report *[84]*, "added right-turn lanes are effective in improving safety at signalized and unsignalized intersections in both rural and urban areas. Installation of a single right-turn lane on a major-road approach would be expected to reduce total intersection accidents at rural unsignalized intersections by 14 percent, and accidents at urban signalized intersections by 4 percent."

Roundabouts. Roundabouts are a new form of at-grade intersection design and can be considered both an intersection geometric design feature and a form of intersection traffic control *[88]*. They have been popular in Europe and Australia for many years as an alternative to two-way stop control and signalized intersections.

The geometric configuration of roundabouts, as compared to two-way stop control and signalized intersections, promotes the reduction of severe accidents such as right angle, head-on, and left-turn head-on. A decision point is defined as a point or place in the intersection at which a driver is required to make a decision about their travel path. The number of decision points for drivers is reduced at roundabouts. Finally, the reduced speed increases driver reaction time and reduces the severity of accidents.

The use of roundabouts in Australia is extensive in both rural and urban areas. A study conducted in Victoria, Australia, on 73 roundabouts *[89]* indicated a 74 percent reduction in the casualty accident rate after roundabouts were installed. Also, there was a 32 percent reduction in property damage accidents.

Another accident study was conducted in 1994 on 12,000 roundabouts located throughout France *[90]*. Of the 12,000 roundabouts studied, only 1,339 accidents occurred during the one-year study period. That equates to a frequency of only 11 accidents per year per 100 roundabouts. Of the accidents reported, less than 25 percent of the accidents involved serious injury or fatalities. Comparisons were also made between the safety performance of "traditionally controlled" rural intersections and roundabouts. Guichet *[90]* reported that roundabouts averaged fatal or serious type injuries 38 times for every 100 accidents, while "traditionally controlled" intersections in rural areas reported 55 injury or fatal accidents for every 100 accidents. Roundabouts were also found to be safer than signalized intersections in urban areas. The authors reported that signalized intersections had accident frequencies four times higher than roundabouts.

Sight Distance. Sight distance of an intersection is the distance ahead or along an intersecting roadway that a driver can see from any locations on the roadway system, ahead or along an intersecting roadway *[84]*. Provision of adequate sight distance is fundamental to the design of roadways and intersections for safe operations. Three types of sight distance are particularly critical to the safe operation of at-grade intersections: intersection sight distance, stopping sight distance, and sight distance to traffic control devices.

Three studies have addressed the safety effects of intersection sight distance. David and Norman *[91]* found that, within specific ADT levels, the reduction in accident experience from a sight distance improvement was, in most cases, highest for the intersection approaches with the lowest initial sight distances. Hanna et al. *[92]* found that intersections with "poor" sight distance had an observed accident rate of 1.33 accidents per million entering vehicles, while intersections as a whole had an accident rate of 1.13 accidents per million entering vehicles. Mitchell *[93]* found that total intersection accidents were reduced by 67 percent when intersection sight obstructions were removed. Unfortunately, none of these studies were specific concerning the magnitude of the sight distance improvements made.

Fambro et al. *[94]* found that accident rates were high for intersections located on crest vertical curves with limited sight distance. The results of another recent study by Fambro et al. *[95]* are consistent with that finding.

C. Work Zone

Work zones in the United States have approximately 700 traffic-related fatalities, 24,000 injury crashes, and 52,000 non-injury crashes every year *[96]*. Work zone crashes account for 2 to 3 percent of all police-reported crashes *[97]*.

With respect to crash severity in work zones, Rouphail et al. *[98]* reported a 20 percent decrease in fatal and injury crash proportions and close to a 50 percent proportional increase in rear-end crashes during long-term construction projects. Ha and Nemeth *[99]* found that work zone crashes were slightly less severe than crashes in non-work zones. According to Wang et al. *[97]*, rear-end collisions accounted for a large percentage of work zone crashes, and this percentage was lower in non-work zones. Furthermore, the percentage of sideswipe collisions in work zones was higher than the percentage of sideswipe collisions elsewhere.

Garber and Tzong-Shiou (1991) *[100]* studied the effects of traffic control devices on multi-lane and two-lane highway work zones. They reported that an increase in crash rate depended on the type of traffic control devices used at the site. Ha and Nemeth *[99]* mention case studies where better traffic control could prevent many crashes.

In summary, the majority of the crashes in work zones involve no injury. The injury crashes in work zones seem less severe than injury crashes in non-work zones. Rear-end and sideswipe collisions occur more frequently in work zones than in non-work zones, and traffic controls in work zones influence the crash rates *[96]*.

D. "2+1" Roadway

Several European countries use a design concept identified as a "2+1" design to improve the safety and operational efficiency of selected two-lane highways *[101]*. This concept involves providing a continuous three-lane cross section and striping the roadway in such a manner as to provide for passing lanes in alternating directions throughout the section, as illustrated in figure 14. Some countries provide a barrier between the travel lanes in opposing directions; Sweden, for example, uses a cable barrier on its 2+1 facilities.

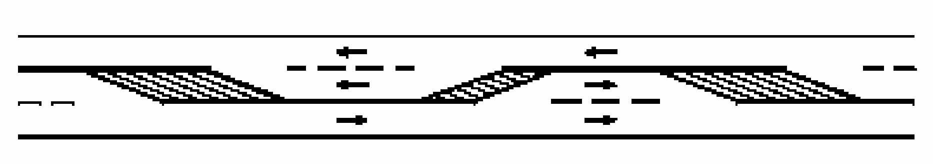


Figure 14
Schematic of 2+1 roadway *[101]*

In Germany, accident analyses have concluded the following:

- Conventional two-lane highways with shoulders and two-lane highways with wide lanes have lower safety performances than the 2+1 cross section does. The 2+1 cross section enables passing maneuvers within designated passing lanes without involving the opposing traffic.
- Four-lane undivided highways have a considerably lower safety performance than 2+1 roadways do.

The safety performance of the two existing 2+1 roadways in Finland has not been consistent. On one roadway, the safety performance has been good; the other roadway has experienced a number of accidents in the winter.

The Finnish Road Administration has estimated that traffic safety on 2+1 sections without median barriers is not much better than on ordinary two-lane roads. The passing lanes have improved traffic flow, but have not provided a substantial safety improvement. Since about half of the fatal accidents are head-on crashes, Finland is planning to incorporate cable barriers into its 2+1 design for future construction. They believe that a median barrier would reduce head-on accidents by 80 percent.

The Swedes expected that 2+1 roadways with cable barriers would reduce accidents involving severe injuries or fatalities by up to 50 percent from ordinary 13-m (43-ft) roadways. So far, the safety performance of these roads has been even better than expected.

Table 10 compares the overall Accident Reduction Effectiveness of 2+1 Roads, expressed as a percentage reduction in accident frequency, with a conventional two-lane roadway for Germany, Finland, Sweden, and the United States.

Based on the safety benefits of 2+1 roadways in Europe, their use in the United States has been recommended. 2+1 roads may be a suitable treatment for roadways with traffic volumes higher than what can be served by isolated passing lanes, but not high enough to justify a four-lane roadway. They are also potentially applicable where a four-lane roadway would be desirable, but sufficient funds are not available to construct a four-lane facility. 2+1 roadways are most appropriate for use on level or rolling terrain. Rather than have 2+1 roadways, in mountainous terrain and on isolated steep grades, it is normally more appropriate to have truck climbing lanes on upgrades and, where needed, passing lanes on downgrades. It is also recommended that 2+1 roadways be considered in the United States for highways with traffic flow rates up to 1,200 vehicles/hour in a single direction.

Table 10

Comparison of U.S. and international safety performance for two-lane highways with passing lanes and 2+1 roads *[101]*

			Estimated percent reduction in accident frequency compared with a conventional two-lane highway			
Country	Design alternative	Median barrier used?	Fatal accidents	Injury accidents	Fatal plus injury accidents	All severity levels combined
Germany	2+1 road	No	—	—	36	26
Finland	2+1 road[1]	No	0	13	11	—
	2+1 road[2]	Yes	46	22	25	[2]
Sweden	2+1 road on semi-motorway	Yes	50–70	—	40–55[3]	[2]
	Conventional 2+1 road	Yes	45–55	—	30–50	[2]
	Conventional 2+1 road	No	—	—	5–10	[2]
U.S.	Minimal passing lane frequency[1]	No	7	7	7	7
	Intermediate passing lane frequency[1]	No	14	14	14	14
	Continuous alternating (2+1)[1]	No	24	24	24	24

[1] Based on estimates from limited data.
[2] No data are available for property damage only (PDO) accidents; however, PDO accidents may have increased because of the presence of the cable barrier.
[3] Includes fatal and serious injury accidents only.

Roadside Hazard

Roadside hazards are physical features that a vehicle can crash into if it leaves the roadway *[2]*. About a third of all motor vehicle deaths involve vehicles leaving the roadway and hitting fixed objects such as trees, utility poles, embankments, guardrails, ditches, curbs, culverts, sign or light posts, bridge supports, and mailboxes alongside the road *[102]*. Roadside hazard crashes occur in both urban and rural areas but are mostly a problem on rural roads. They are most likely to occur on curves and/or downhill road sections. More than a third involve a vehicle that rolls over, and about a third involves occupant ejection. Trees are by far the most common objects struck in roadside hazard crashes. Figure 15 gives a graphic presentation.

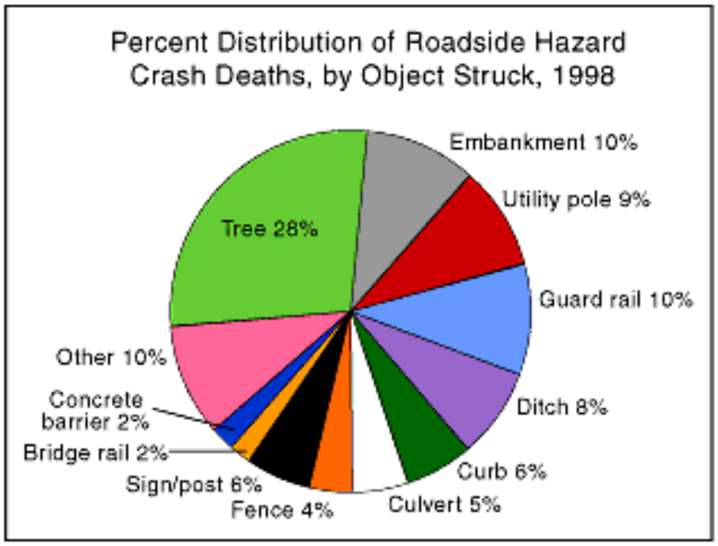


Figure 15
Roadside hazard percent distribution *[102]*

The following facts are based on analysis of data from the U.S. Department of Transportation's Fatality Analysis Reporting System (FARS) *[102]*. Unless otherwise specified, the data are for year 1998.

- 11,809 people died in roadside hazard crashes in 1998, essentially unchanged from 1997 and about 8 percent more than in 1975.
- The proportion of motor vehicle deaths involving roadside hazards has remained between 28 and 30 percent since 1979.
- Forty-five percent of drivers killed in roadside hazard crashes had blood alcohol concentrations at or above 0.10 percent.
- Drivers of 43 percent of the vehicles in fatal roadside hazard crashes were men younger than 35

Crash Types

- Ninety-seven percent of roadside hazard crash deaths occurred in single-vehicle crashes.
- Forty percent of deaths in roadside hazard crashes involved vehicles rolling over.
- Thirty-two percent of deaths in roadside hazard crashes involved occupant ejections.
- Two-thirds of deaths in roadside hazard crashes occurred in frontal impacts.

Object Struck

- Trees are the most common hazard. Twenty-eight percent of deaths in roadside hazard crashes involved a vehicle striking a tree.
- Embankments and guard rails are the next most common hazards. Each accounted for about 10 percent of deaths in roadside hazard crashes.

Road Type

- Forty-eight percent of deaths in roadside hazard crashes occurred on major roads, 34 percent occurred on minor roads, and 18 percent occurred on freeways, including interstates.
- Sixty-six percent of deaths in roadside hazard crashes occurred on rural roads.
- Forty-three percent of deaths in roadside hazard crashes occurred on curves.
- Seventeen percent of deaths in roadside hazard crashes occurred on wet or slippery roads.
- Fifty-five percent of deaths in roadside hazard crashes occurred on roads with speed limits 55 mph or faster *[102]*.

Roadway Conditions

Roadway conditions can contribute to crashes through both road surface conditions and reduced visibility *[2]*. Surface conditions can impair a driver's ability to control the vehicle. Episodic decline in road surface conditions results from loss of friction due to rain, snow, and ice, or reduction in visibility during nighttime hours or due to fog, rain, or snow *[2]*. More permanent conditions include deterioration of the pavement surface in the form of pavement edge drop-offs, potholes, and reductions in surface friction due to age and wear.

The Roadway Safety Foundation conducted an extensive review of the technical literature of the past 12 years to identify major safety issues associated with the roadway *[103]*. Safety issues identified in this effort included crashes resulting from: roadway departure hazards, roadway design limitations, road surface conditions, and the following six potential hazardous roadway conditions:

- **Narrow roadways and bridges**: Collisions with bridge ends are relatively infrequent, but they are often severe.
- **Railroad crossings:** According to the Federal Railroad Administration, nearly every 100 minutes someone in America is hit by a train, and people are 30 times more likely to die when involved in a collision with a train than with another car, bus, or truck.
- **Work zones:** Work zones and utility areas, create conditions that can be hazardous to drivers and highway workers. Some 700 people are killed and 37,000 are injured in work zones every year. Sometimes work zones are poorly marked, and warning signs are hard to see, especially at night. Warning signs and traffic control devices may not be related to actual work in progress or accurately portray real work zone hazards.
- **Intersections:** The dangerous intersections are ones with confusing turn lanes, blind spots, or lack of appropriate or inadequate signage or traffic signals. Obstructions, including vegetation, can block a driver's view of signs, signals, and other traffic control devices.
- **Roadway access problems:** Roadway access conditions that can cause driver confusion/frustration, such as driveways, roadways into new developments/businesses, and blind entrances.
- **Pedestrian and bicycle traffic:** There were 5,220 pedestrian deaths and 69,000 injuries during 1998, and these numbers are expected to increase as our population ages. Pedestrians over 70 constitute approximately 9 percent of the population, but they account for 17 percent of the fatalities. In 1998, 761 bicyclists were killed and an additional 53,000 were injured in traffic crashes.

Vehicle Factors

Light Vehicles

According to the GAO's analysis, as shown in figure 16, vans were the least likely to be involved in a crash, while passenger cars were the most likely to be involved in a crash. The figure also shows that both vans and SUVs had the lowest fatal crash rate *[2]*. Rollover crashes are particularly serious because they are more likely to result in fatalities. Figure 17 shows the percentage of rollover occurrence by vehicle type in 2001. Passenger cars were the vehicle type least likely to roll over in a crash. In comparison, SUVs were over three times more likely to roll over in a crash than were passenger cars. The proportion of SUVs that rolled over in fatal crashes was over twice as high when compared with passenger cars. In 2001, 35 percent of the fatal crashes in SUVs involved rollovers.

The study by the Insurance Institute for Highway Safety *[104]* examined single vehicle rollover crashes. The study concluded that the combined rollover crash rate for pickup trucks and SUVs was more than twice the rate for passenger cars. The higher rollover rate for pickup trucks and SUVs was present even when considering a variety of crash circumstances, including location, roadway alignment, and the driver's age. The study concluded that both pickup trucks and SUVs were more prone to rollover crashes than are passenger cars.

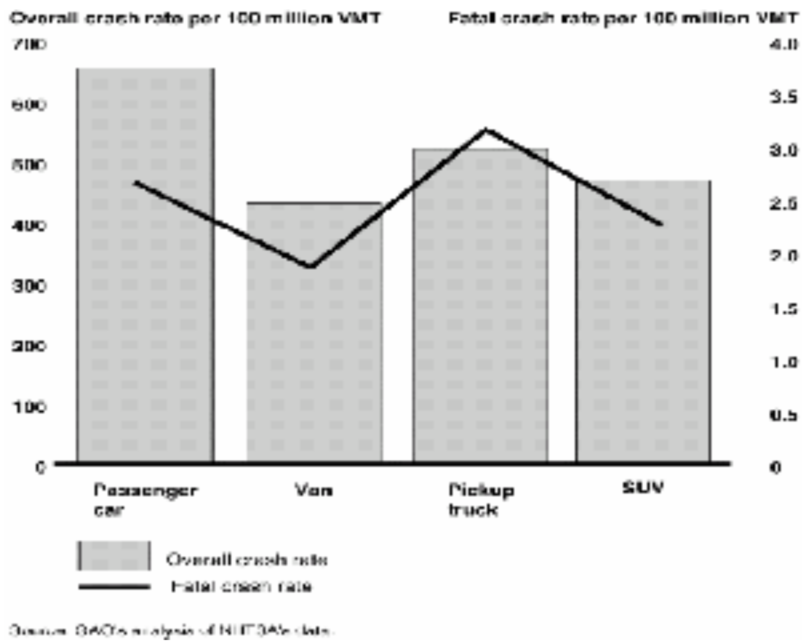


Figure 16
Vehicle crash rates, 2001

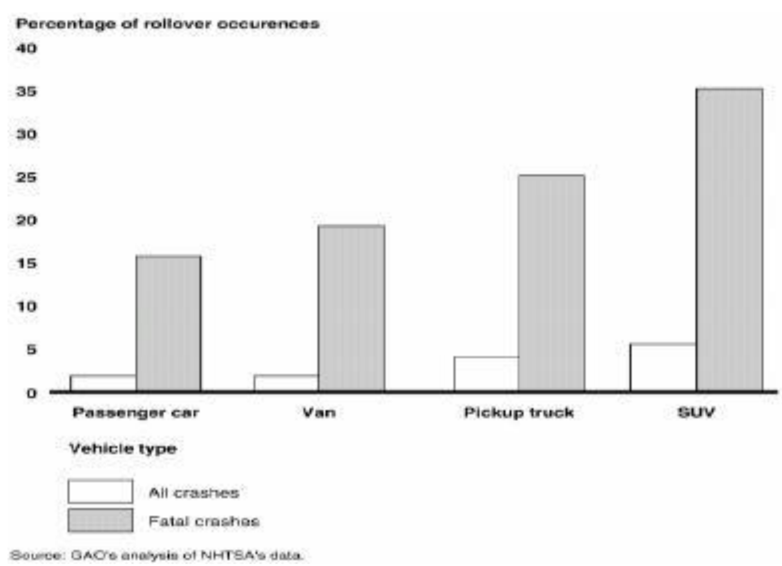


Figure 17
Passenger vehicle rollovers, 2001

A recent NHTSA study addressed rollovers from 1991 through 2000 *[11]*. One of its findings was that of all vehicle types considered in the study, SUVs were the only type in which the number of occupant fatalities in rollover crashes exceeds the number of occupant fatalities in nonrollover crashes; in 2000, nearly two-thirds of SUV occupant fatalities occurred in rollover crashes. One of the report's conclusions was that, despite declines in passenger car occupant fatalities, the increasing influence of light truck fatal crashes in general, and rollover crashes in particular, was instrumental in maintaining the level of crash fatalities.

In February 2003, the Alliance of Automobile Manufacturers, a trade group that represents the three major U.S. automobile manufacturers and a number of foreign manufacturers, published analyses examining occupant fatality rates by vehicle type. One analysis used registered vehicles as a method to compare fatality rates between vehicle types. Its results indicate that in 2001, SUVs had a slightly higher occupant fatality rate than had passenger cars—16.25 and 15.70 per 100,000 registered vehicles, respectively. The alliance points out that 72 percent of people killed in SUV rollover crashes were not wearing safety belts. They further stated that in 2000, 35 percent of SUV single-vehicle rollover fatalities were alcohol-related *[2]*.

Heavy Vehicles

Large trucks, including tractor-trailers, single-unit trucks, and certain heavy cargo vans with gross weights of more than 10,000 pounds account for a disproportionate share of traffic deaths based on miles traveled. In 2002, 4,897 people were killed in crashes involving large trucks, representing 11 percent of all traffic fatalities despite the fact that large trucks make up just 4 percent of all registered vehicles and 7 percent of all vehicle miles traveled *[105]*.

The fatal crash rate for large trucks was 2.4 deaths per 100 million vehicle miles traveled, which is more than 50 percent greater than the rate for all vehicles on the roads. People in passenger vehicles are more vulnerable in collisions with large trucks because of the great difference in weight between cars and large tucks. In two-vehicle crashes involving passenger vehicles and large trucks, 98 percent of the fatalities were occupants of the passenger vehicle *[105]*.

Overweight trucks are even more dangerous than trucks that stay within the current federal weight limits. Overweight trucks not only take longer to brake and are more prone to roll over in crashes, but they also damage roads and bridges at rapidly increasing rates even when slightly overloaded *[105]*.

Poor driver performance, including fatigue, is a major contributing factor, as is an inadequate level of awareness of trucks by other drivers on the road. The unsafe condition of many trucks, particularly their braking and steering systems and tires, is also a concern *[105]*.

University of Michigan Transportation Research Institute conducted a study for the AAA Foundation for Traffic Safety *[106]* to explain the unsafe driver actions and conditions that are more likely in fatal crashes between cars and large trucks than in fatal crashes between cars. This study's examination of the FARS records for two-vehicle fatal crashes from 1995 to 1998 showed that driver factors related to unsafe driver actions were much more likely to be recorded for car drivers than for truck drivers. Most of these driver factors were as likely to be recorded for car-car crashes as for car-truck crashes. Four driver factors were found to be more likely in car-truck crashes than in car-car crashes:

- Drowsy, sleepy, asleep, fatigued
- Following improperly
- Vision obscured by rain, snow, fog, smoke, sand, or dust
- Improper or erratic lane change

The second stage of the research involved closely examining a random sample of 529 crashes for the main factors differentiating fatal car-car and fatal car-truck crashes. The results of the analyses indicated that more than half of the fatal car-truck crashes in which a driver fell asleep were head-on crashes, and more than one-quarter of these occurred between 3 and 6 a.m. The results point to the use of alcohol or drugs and speeding as unsafe behaviors among younger drivers for both cars and trucks involved in fatal car-truck crashes. The following conclusions were also obtained from the study:

- Drowsy or fatigued driving and following improperly were more likely to be reported for male than female car drivers.
- Car drivers whose vision was obstructed tended to be older than the other drivers.
- Car drivers who were drowsy/fatigued were likely to be younger than other drivers.
- Younger truck drivers were more likely than older truck drivers to follow improperly, speed, and use alcohol or drugs.

Motorcycle Crashes

In 2002, 3,244 motorcyclists were killed and an additional 65,000 were injured in traffic crashes in the United States — 1 percent more than the 3,197 motorcyclist fatalities and 7 percent more than the 60,000 motorcyclist injuries reported in 2001 *[48]*. In 1997, 1 in 20 U.S. road fatalities was a motorcycle rider; in 2001, it was 1 in 13 *[107]*. The NHTSA cites many possible causes, such as the fact that riders tend to be older: the average age of motorcyclists killed in crashes increased from 29.3 in 1990 to 36.3 in 2001. Another contributing factor is the increase in motorcycle engine sizes—from an average of 769 cubic centimeters in 1990 to 959 cubic centimeters in 2001.

More than 38,000 motorcyclists died in single vehicle motorcycle crashes between 1975 and 1999. Motorcyclist fatalities in single vehicle crashes decreased each year from 1990 to 1996, reaching a low of 937 in 1996 and again in 1997. However, the fatalities in single vehicle motorcycle crashes increased to 1,042 (11.2 percent) in 1998 and to 1,140 (9.4 percent) in 1999. The overall increase in motorcyclist fatalities from single vehicle crashes from 1997 to 1999 was 203 (21.7 percent) *[107]*.

Findings from FARS data provide insight into possible reasons for motorcyclist fatalities in single vehicle motorcycle crashes *[108]*.

- More riders age 40 and over are getting killed;
- More motorcyclist fatalities are occurring on rural roads;
- High BAC levels are a major problem among motorcycle operators;
- Half of the fatalities are related to negotiating a curve prior to the crash;
- Over 80 percent of the fatalities occur off roadway;
- Undivided roadways account for a majority of the fatalities;
- Almost two-thirds of the fatalities were associated with speeding as an operator contributing factor in the crash;
- Almost 60 percent of motorcyclist fatalities occur at night;
- Collision with a fixed object is a significant factor in over half of the fatalities;
- Braking and steering maneuvers possibly contribute to almost 25 percent of the fatalities;
- Helmet use among fatally injured motorcyclists below 50 percent; and,
- Almost one-third of the fatally injured operators did not have a proper license *[108]*.

Motorcycle fatalities in Louisiana increased by 170 percent from 1997 to 2002. Injuries increased by 58 percent in the same time period. It is clear that a decline in helmet use is the most important factor contributing to death and severe injury in motorcycle crashes. Other factors are an increase in alcohol use, specifically on weekends, and an increase in “pleasure” riders on weekends, specifically in the evening hours. These riders often do not have motorcycle endorsements that authorize the operation of motorcycles and, thus, may have less experience in driving a motorcycle than riders who use their motorcycle regularly to drive to work *[107]*.

Equipment Failure

Among the three major categories of contributing factors, vehicle-related factors are the least significant. The tri-level study concluded that vehicle factors are definite causal factors in only 4 percent of all crashes *[6]*. The UDA study found even smaller percentage than the tri-level study *[7]*. Smart Motorist *[109]* pointed out that the most cited types of equipment failure are the loss of brakes, tire blowouts or tread separation, and steering/suspension failure. Combined totals for all reported equipment failure accounts for less than 5 percent of all motor vehicle crashes.

ITS and Highway Safety

Advanced Traffic Management Systems

Congestion Reduction. Multiple vehicles crashes are more likely to occur under congested conditions. User services such as ramp metering, incident management systems, and coordinated traffic signal systems can improve traffic flow and reduce congestion, and therefore reduce crashes as well as secondary crashes *[110]*.

The TransGuide system implemented in San Antonio, Texas, uses changeable message signs, video cameras, and loop detectors to detect incidents *[111]*. After the execution of the system, incident response time improved by about 20 percent, crashes decreased by 35 percent, and secondary crashes decreased by 30 percent.

Ramp Metering. A ramp meter evaluation study conducted by Minnesota DOT *[112]* in Twin Cities metropolitan area indicated that ramp metering system produced an annual reduction of 2.6 million hours of unexpected delay. In addition, ramp metering resulted in annual savings of 1,041 crashes, or approximately four crashes per day.

An 18-month evaluation on a pilot ramp-metering project in Denver, Colorado, in 1981 revealed that the peak driving speed increased 57 percent. Rear-end and sideswipe crashes decreased 5 percent because stop-and-go conditions were eliminated *[113]*.

Traffic Management System. A computer simulation study estimated the impact of a freeway management system on incident-related congestion in Fargo, North Dakota *[114]*. The results revealed an 8 percent decrease in network travel times and an 8 percent increase in speeds with the installation of dynamic message signs to notify travelers of alternative routes around incidents. The study also investigated the integration of the freeway management system with an adaptive signal control system on adjacent arterial roadways to accommodate diverted traffic, which resulted in an 18 percent reduction in travel times.

COMPASS, a traffic management system for Highway 401 in Metropolitan Toronto, was developed to provide safe and efficient travel on 42 km of the highway *[115]*. It consists of loop detectors and closed circuit television (CCTV) cameras. Incident conditions and delays are monitored, and information is sent then to dynamic message signs, the media, and radio stations for delivery to travelers. The system reduced incident duration from an average 86 minutes to 30 minutes, prevented 200 crashes per year, and improved average travel speed.

Advanced Traveler Information Systems

Advanced traveler information system is a high-tech system used to announce traffic conditions to motorists and travelers. A number of tools monitoring traffic flow and then automatically inform motorists about traffic problems. The messages are delivered to motorists by dynamic message signs, radio stations, pagers, the internet, etc. One example is an in-vehicle navigation system known as TravTek installed in a vehicle to display a visual map and voice directions *[116]*. Although no reduction in crashes or near crashes have been observed with this system, researchers have estimated a potential reduction in crash risk to be as much as 4 percent based on simulation results.

The Advanced Regional Traffic Interactive Management and Information System (ARTIMIS) is a regional traffic management system *[117]* that serves the Northern Kentucky and Cincinnati metropolitan areas. It contains an advanced transportation management system and an advanced traveler information system. In June 1995, a telephone information service began providing real-time traffic and travel condition information by specific route or route segment. Sources of up-to-date traffic information include video cameras, radar detectors, inductive loops, aircraft, service patrols, and drivers acting as probes. In a survey conducted in February and March 1999 *[118]*, ARTIMIS users rated the service very high in accuracy and ease of use. More than 99 percent of those surveyed said they benefited by avoiding traffic problems, saving time, reducing frustration, and arriving at destinations on time.

Commercial Vehicle Operations

The risk of fatality in collisions involving a large truck is great. Mitretek Systems *[119]* reported a potential reduction of 14 percent to 32 percent in fatal crashes involving commercial vehicles based on hypothetical usage of ITS commercial vehicle operations (ITS-CVO) and the implementation of changes in inspection practices.

Garber and Black *[120]* noted that sideswipe, angle, and rear-end crashes accounted for more than 75 percent of large truck crashes on secondary roads in Virginia. Their study recommended that a vehicle on-board radar (VORAD) vehicle detection and driver alert system could be deployed to reduce these types of crashes.

One of the ITS user services for commercial vehicle operations is electronic screening. With its implementation, fewer lane changes and passing operations around commercial vehicles slowing to enter a weigh station are required. The safety benefits could be gained from decreased risk of accidents from traffic queues at weigh stations *[121]*.

Advanced Vehicle Control and Safety Systems

Fancher et al. *[122]* estimated the potential of crash avoidance technologies to enhance safety. They indicated that Advanced Vehicle Control and Safety Systems could greatly reduce various types of crashes. The components of the system include headway control systems to reduce rear-end crashes, lane-edge detection systems, and lane-keeping systems to reduce run-off-road crashes, etc. It has also reported that Lateral lane-edge detection and warning systems have been predicted to reduce all crash costs by 10.6 percent. Such a warning system would reduce the severity of the crash by automatically braking to slow the vehicle, even if the driver is unable to take an action to avoid a crash.

Mitretek Systems *[119]* also reported that an advanced collision-warning device has provided evidence of enhanced safety for commercial vehicles including trucks and buses. They indicated that crashes were reduced by 33 percent after such a device was installed in the entire fleet for Transport Besner Trucking Company.

Summary of Literature Review

The literature review revealed that the common factors contributing to vehicle crashes can be classified into the following groups:

1. Human Factors
2. Roadway Factors
3. Vehicle Factors

These three categories comprise many factors. Those that are considered to be the most significant in each category in Louisiana are listed below.

Among human factors, the following four factors are suggested as being particularly significant in Louisiana, based purely on the study team's subjective assessment at this stage of the project's progress and based on the review documented in this report. Phase II of the project will investigate and prove, or disprove, these suggestions:

1. Alcohol and Drugs.
2. Occupant Protection – seatbelt usage.
3. Aggressive Driving, Driver Distraction and Traffic Violations such as speeding, tailgating, cell phone use while driving, and red light running.
4. Age – with particular concern to the age group 16-20, graduated driver licensing systems, and older driver safety.

Among the roadway factors, the following are suggested as being significant contributors to road safety in Louisiana:

1. Roadway design factors such as cross-section, alignment, and intersection design.
2. Roadside hazards such as trees, embankments, signposts, etc.
3. Railroad crossings and work zones.

The following have been identified in vehicle factors:

1. Motorcycle crashes.
2. Truck crashes.
3. Light vehicle rollovers.

SAFETY LEGISLATION

To reduce injuries and deaths caused by motor vehicle crashes, all states impose laws to increase traffic safety. Every year, state legislatures contemplate new methods to improve implementation of the safety aspects of the Transportation Equity Act for the 21st Century (TEA-21), enforcement of seatbelt laws, strengthen child passenger protection laws, restrict licenses for unsafe younger and older drivers, deter driving under the influence, and enhance overall traffic safety policies *[123]*. Legislation and enforcement play an important role in reducing the traffic fatalities in each state.

TEA-21 expired in October 2004. The proposed new transportation reauthorization bill is titled "Safe, Accountable, Flexible, and Efficient Transportation Equity Act of 2003" (SAFETEA). The newly proposed bill places a central focus on transportation safety, and the creation of a new core funding category dedicated to safety within the Federal-aid highway program is also proposed *[124]*.

Federal Incentive Programs and Penalty Programs through TEA-21

TEA-21 was signed into law in June 1998. This federal law restructured many programs and reauthorized highway safety grant programs. TEA-21 also established seven safety incentive programs and two penalty provisions. The incentive programs set out in TEA-21 are to reward states for improving highway safety. A total of $936 million was set aside for these seven incentive programs. According to the Section 405 incentive grant program for which 68 million dollars have been set aside, states become eligible to participate in the program by meeting at least four of the following six criteria:

- Pass laws that require seatbelt use by front seat passengers in passenger vehicles.
- Enact primary enforcement legislation.
- Assess minimum fines and penalty points for violations of seatbelt and child seatbelt use laws.
- Establish a statewide publicity program that emphasizes high visibility enforcement for occupant protection.
- Create a statewide education program about child passenger protection that includes proper seating positions for children in vehicles with air bags, as well as instruction on how to reduce the improper use of child restraint systems.
- Implement a child passenger protection law that requires minors to be secured in a child safety seat or other appropriate restraint system.

The Section 157 Safety Innovative Incentive Program has $500 million in grants to be dispersed over five years to states demonstrating an increase in seatbelt use. To qualify for the incentives, a state must show a seatbelt use rate higher than the national average for the two preceding calendar years or show a seatbelt use rate higher than the state's "base seatbelt rate," which is the State's highest seatbelt use rate for any calendar year from 1996 through the calendar year preceding the previous calendar year.

In October 2001, U.S. Secretary of Transportation Norman Mineta announced that 36 states plus the District of Columbia had qualified for incentive grants for increasing seatbelt use. The amount given to each state was based on savings in medical costs to the federal government and ranged from $6,000 to $14 million. The grants could be used to fund highway safety programs, enforcement programs, and highway construction. The NHTSA estimated that by increasing seatbelt use, more than 11,000 lives are saved in America each year.

TEA-21 also created incentive programs to combat drunk driving. Under the act, states receive additional funding for adopting illegal per se laws with a .08 blood alcohol content (BAC), or laws dealing with repeat offenders, open containers, and other driving under the influence (DUI) countermeasures. In some cases, states that comply with TEA-21 provisions will be able to keep funds designated for highway construction instead of having these funds transferred to highway safety *[125]*.

The National Association of Governors' Highway Safety Representatives (NAGHSR) released a report evaluating TEA-21 programs in the summer of 2001. According to the report, many states have had difficulty with the administrative side of the incentive and sanction programs outlined in TEA-21. The report also pointed out that TEA-21 emphasized occupant protection and impaired driving programs but neglected to provide funding to address other pressing transportation safety problems.

State Traffic Safety Laws

Generally state laws are based on issues specific to each state. The Governors Highway Safety Association has classified the state laws into 15 main categories:

- Aggressive Driving Laws
- Automated Enforcement Laws
- Cell Phone Laws
- Checkpoint Laws
- Child Passenger Safety Laws

- Drug Impaired Driving Laws
- Graduated Licensing Laws
- Helmet Laws
- Impaired Driving Laws
- Low Speed Vehicle Laws
- Older Driver Laws
- Safety Belt Laws
- Sanctions for School and Construction Zones
- Segway Laws
- State Speed Limit Laws

Aggressive Driving Laws

Aggressive driving covers a broad range of unsafe driver behavior such as speeding, tailgating, passing on the right, weaving in and out of traffic, failure to yield right-of-way, running red lights, cutting drivers off, or any combination of these types of behaviors. Hand gestures, yelling, flashing high beams and honking horns also fall within the definition *[126]*. Another issue is the distinction between aggressive driving and road rage. Aggressive driving acts are traffic offenses, while road rage involves a criminal act.

In the past five years, more and more states have introduced legislation on the topic of aggressive driving *[125]*. Most states have enacted laws aimed at "reckless driving" that include a broad range of behaviors. However, some states are now beginning to recognize that certain behaviors are better defined as "aggressive." States are addressing this risky driver behavior in various ways. One way is through increased enforcement efforts *[126]*. In 1998, Arizona was the first state to pass a law creating a specific aggressive driving offense. Nevada, Delaware and Rhode Island followed and established an aggressive driving offense. In addition, Utah amended its reckless driving law to provide for an offense similar to ones enacted in the other three states. Twelve states introduced a total of 32 bills in 2001 that addressed various aspects of aggressive driving *[125]*.

More than 26 states and local governments have established law enforcement programs to target aggressive drivers. At least 24 states have established the "Smooth Operator" law enforcement program developed by the NHTSA, which specifically targets aggressive driving *[126]*. To date, nine states have either enacted aggressive driving legislation or have modified existing reckless driving statutes to include aggressive driving (table 11). Aggressive driving laws typically stipulate that a driver must be observed demonstrating more than one action included a series of driver actions that are defined as aggressive. The nine states are Arizona, Delaware, Florida, Georgia, Maryland, Nevada, Rhode Island, Utah, and Virginia *[126]*. The State of Louisiana has not enacted any law pertaining to aggressive driving until now.

The Ohio State Highway Patrol's Operation TRIAD (Targeting Reckless, Intimidating and Aggressive Drivers) uses aircraft, highway patrol officers, and local police officers to look for aggressive driving at congested locations, complaint areas, school bus routes, and dangerous rail crossings. The patrol combines enforcement with extensive media coverage to increase public awareness about aggressive driving and encourage safer driving habits. Many programs in other states share similar characteristics *[125]*. Another method of addressing the problem utilizes locally-based citizens' initiatives and coalitions to implement public information/education campaigns aimed at improving driver courtesy. Other methods of addressing the problem involved technological advances such as photo radar.

Table 11

Aggressive Driver Laws *[126]*

State	"Aggressive" Driver Actions
Arizona	Speed plus at least two of the following: failure to obey traffic control device, passing on the right out of regular lanes of traffic, unsafe lane change, following too closely, or failure to yield right-of-way.
Delaware	At least 3 of the following: failure to obey traffic control device, passing on the right, driving outside of regular lanes of traffic, following too closely, failure to yield right-of-way, failure to use turn signal, speeding, passing a stopped school bus.
Florida	At least two of the following: speeding, unsafe or improper lane change, following too closely, failing to yield right-of-way, improper passing, failure to obey traffic control device.
Georgia	Operations with the intent to annoy, harass, molest, intimidate, injure or obstruct another person.
Maryland	At least three of the following: failure to obey traffic control device, passing on the right, driving outside of regular lanes of traffic, following too closely, failure to yield right-of-way, speeding.
Nevada	Within 1 mile, speeds, creates a hazard for other drivers, and at least two of the following: fails to obey traffic control device, passing on the right off of paved roadway, following too closely, failure to yield right-of-way.
Rhode Island	At least two of the following: failure to obey traffic control device, passing on the right, driving outside the lanes of traffic, following too closely, failure to yield right-of-way, failure to use turn signals, use of emergency lane for travel.
Utah	Yes. Amended reckless driving law to include aggressive driver actions
Virginia	Is a hazard to others with the intent to harass, intimidate, injure or obstruct another person and commits at least one of the following: failure to drive on the right side of highway, failure to drive in lanes marked for traffic, following too closely, failure to yield right-of-way, failure to follow traffic control device, passing on right, speed, stopping on a highway.

Automated Enforcement Laws

Automated enforcement refers to technology to enforce traffic safety laws. Most automated enforcement laws apply to red light violations; however, some laws authorize enforcement for speed, and a few authorize enforcement for any offense for which it is suitable. Automated enforcement laws vary significantly from state to state; some authorize enforcement statewide, whereas others permit it only in specified communities.

Running red lights causes more than 250,000 crashes each year and is responsible for approximately 750 fatalities nationwide. The use of red light cameras can help communities enforce traffic safety laws by automatically photographing the vehicles of drivers who run red lights. Typically, two photographs are taken, one when the vehicle crosses the stop line and a second when the vehicle is in the intersection. Red light cameras usually only photograph the license tag of the vehicle and include the date, time and place, vehicle speed, and elapsed time from the light turning red to the time the photograph was taken. Over the last 10 years, the use of photo radar has increased dramatically *[125]*. Five years ago, only one city was using this technology. Today, more than 60 U.S. communities are using cameras to enforce traffic laws including red light running and speeding. Twenty-four states considered 68 bills during the 2001 legislative sessions regarding automated enforcement.

A few states treat automated enforcement citations just like parking tickets in that the registered owner is liable. California, Colorado, Delaware, the District of Columbia, Georgia, Maryland, and Utah have enforced this law statewide while Arizona, Illinois, Nevada, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Islands, Tennessee, Texas, Virginia, Washington, and Wisconsin have enforced this law in specific parts of the state such as municipalities, jurisdictions, and big cities, depending on their population and form of local government. Louisiana has not enacted any automated enforcement laws.

Cell Phone Laws

Although many activities can make driving perilous, cell phone use while driving has rapidly become one of the hot issues in traffic safety. Much is still not known about the safety impact of using cell phones in cars in comparison to eating, applying make-up, tuning the radio, or talking with passengers. Studies conducted in the United States, Great Britain, and Japan have concluded that people who use mobile phones while driving pose a greater risk of crashing. One widely quoted report published in the *New England Journal of Medicine [127]* concluded that the distraction caused by phone use in motor vehicles quadrupled the risk of a collision during the brief period of a call, a rate equivalent to the impairment caused by legal intoxication.

The NHTSA has studied the traffic safety implications of mobile telecommunications technology in motor vehicles since cell phones became popular *[128]*. A survey published by NHTSA in July 2001 indicated that, at any given time during daylight hours, about 3 percent of drivers of passenger cars, vans, SUVs and pickups—or approximately 500,000 drivers—were using a hand-held cell phone. The report also estimated that 54 percent of drivers "usually" had some type of wireless phone in their vehicle with them. Fifty-five percent of these drivers report that their phone was on during all or most of their trips, and 73 percent reported using their phone while driving. The study was based on street corner observations and did not include data on highway use or hands-free models.

Various states are conducting studies to analyze the correlation between cell phone use while driving and crashes where driver distraction is a causal factor *[126]*. A few states regulate the use of wireless phones, except in specific situations. In 2001, New York became the first state to prohibit drivers from talking on hand-held cell phones while operating a motor vehicle. California requires that rental cars with cellular telephone equipment must include written operating instructions for the safe use of the cell phone. Florida and Illinois allow cellular telephone use in the car as long as the device does not impair sound to both ears of the driver. Arizona and Massachusetts prohibit school bus drivers from using cell phones while operating a school bus. Massachusetts also requires that all drivers have at least one hand on the steering wheel at all times while using a cell phone.

In addition to these laws, many states are working to improve their knowledge about the potential risks associated with cell phones. Two years ago, only Minnesota and Oklahoma tracked mobile phone involvement in motor vehicle collisions *[125]*. Now, at least 15 states collect information about cell phones and driver distractions on crash report forms. Additionally, legislators in Louisiana, New Jersey, New Mexico, Pennsylvania, and Virginia approved cell phone and driving studies although no law as such has been enacted. Current bans on the use of cell phones in vehicle are summarized in figure 18.

Checkpoint Laws

Sobriety checkpoints are a valuable component of a comprehensive enforcement strategy aimed at deterring alcohol-impaired driving. Sobriety checkpoints involve stopping every vehicle, or a specific sequence of vehicles, at a predetermined, fixed location to detect impaired drivers. Sobriety checkpoints allow officers to stop vehicles without any suspicion of wrongdoing. Research shows that the key to effective deterrence is the public's perception of the likelihood of being caught in violation of the law. The public identifies checkpoint activity with increased risk of apprehension. However, because of constitutional issues and legal rulings, not all states conduct sobriety checkpoints. Currently, 38 states and the District of Columbia conduct sobriety checkpoints *[126]*. The Louisiana Supreme Court recently ruled in favor of law enforcement use of checkpoints if conducted under specific guidelines. This allows the state to begin using checkpoints to reduce their alcohol-related fatality rates and improve safety belt use rate *[129]*.

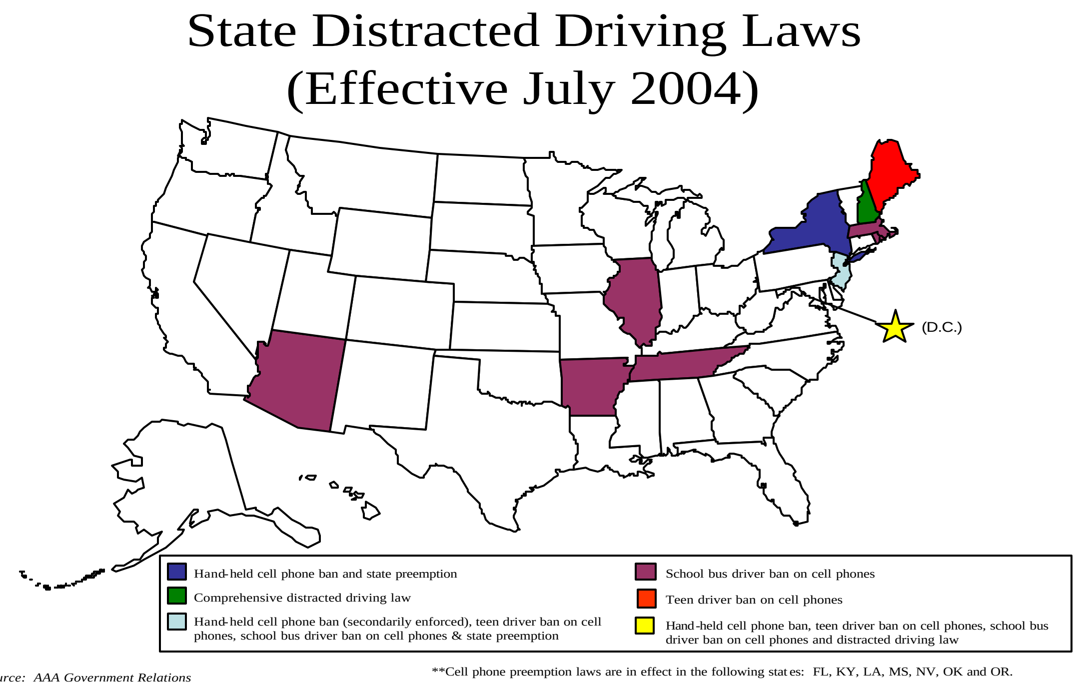


Figure 18
Distracted driving laws *[126]*

State Child Passenger Safety Laws
More than 274,000 children are injured each year in motor vehicle crashes. Fatal injuries resulting from car crashes are the leading cause of death for children age 5 through 12 claiming the lives of 2,108 children in 1999. Kids are put at greatest risk by riding unrestrained. In 1999 more than 50 percent of all children ages 5 to 9 who were killed were completely unbuckled *[125]*.

All states and the District of Columbia have child safety seat laws with standard enforcement, allowing law enforcement officers to issue a citation when they see a violation of that law. However, many states have gaps in their child passenger restraint laws that leave children of certain ages or children in certain seating positions, uncovered by legislation, thus diminishing the protection that children need in motor vehicles. Only 22 states and the District of Columbia have comprehensive child occupant protection laws, requiring all children through age 16 to be restrained in every seating position *[130]*. A strong child passenger law covers all occupants up to age 16 in all seating positions and the adult belt law applies to all other occupants *[131]*. Adult safety belt use is the best predictor of child occupant restraint use. When Louisiana upgraded its safety belt law from secondary to primary enforcement, child restraint use jumped from 45 to 82 percent even though there was no change in the state's child passenger safety law.

One problem facing many parents of small children is correctly installing the child safety seat. In fact, they are installed incorrectly approximately 80 percent of the time, according to the National Highway Traffic Safety Administration. Fire departments and other organizations across the country have established programs to help parents learn how to install the seats. The state child passenger safety laws existing in Louisiana can be summarized in table 12.

Table 12
Louisiana child passenger safety laws *[126]*

Age/Size	**Restraint Use**
Birth to at least 1 year **and** less than 20 pounds	**Ride rear-facing in an infant or convertible child safety seat**
At least 1 year **and** at least 20 pounds to 40 pounds	Ride **forward facing in convertible or combination child safety seat** (used with the internal harness)
At least 40 pounds to 60 pounds or at least 4 years old to 6 years old	Ride in a **belt positioning booster seat** (backless or high backed)
At least 6 years old or at least 60 pounds	Ride using the **vehicle lap-shoulder belt** or **belt positioning booster seat**

State Drug Impaired Driving Laws

Drug impaired driving is a growing problem in this country, although it has not received the same attention as driving under the influence of alcohol. While all states have laws related to drinking and driving, and national standards against which to measure alcohol impairment, few states have enacted laws to address drug impairment. Only eight states have per se laws that prohibit any presence of a prohibited substance or drug in the driver's body while in control of the vehicle. These states are Arizona, Georgia, Illinois, Indiana, Iowa, Minnesota, Rhode Island and Utah. An effective tool employed by many states is the Drug Evaluation Classification (DEC) program, which provides specialized training for law enforcement personnel to become certified as a Drug Recognition Expert (DRE). Certified DRE officers become proficient in basic drug terminology, pharmacology and drug classification, and in identifying indicators of impairment. This level of specialized training not only assists law enforcement agencies in their efforts to identify and remove drug impaired drivers from the roadways, it also enables officers to better present evidence of drug impairment that is acceptable to the judicial system. Thirty-six states have officially sanctioned Drug Evaluation Classification programs to train DRE personnel though they do not have a strict drug law *[126]*. Louisiana does not have a strict drug law, but it is one of the 36 states that have the DEC program.

Graduated Licensing Laws

Graduated licensing is a system designed to implement full licensure in stages under controlled conditions, offering beginning drivers the opportunity to become more experienced under lower risk conditions *[126]*. Graduated licensing requires young drivers to demonstrate responsible driving behavior through three phases of licensing—learner's permit, intermediate or provisional license, and full license. Safety is the big concern that has led to these restrictions. The leading cause of death for 15- to 20-year-olds is traffic crashes; more than 4,900 died in 2000 in the United States. Drivers between the ages of 15 and 20 make up 6.8 percent of the driving population but were involved in 14 percent of all fatal crashes. Their lack of experience and tendency to take risks contribute to this high fatality rate. Driver error accounts for a majority of fatal crashes for 16-year-olds *[125]*. According to the Insurance Institute for Highway Safety and the Traffic Injury Research Foundation, in an optimal system, the minimum age for a learner's permit is 16; the learner stage lasts at least 6 months, during which parents must certify at least 30-50 hours of supervised driving; and the intermediate stage lasts until at least age 18 and includes both a night driving restriction starting at 9 or 10 p.m. and a strict teenage passenger restriction allowing no teenage passengers, or no more than one teenage passenger. The nighttime driving restriction is a key element according to safety advocates. It is not a curfew, but a requirement for supervised nighttime driving. Night driving is difficult for all drivers; more fatal crashes occur at night *[126]*. The risk for teen drivers at night is even higher. Forty-one percent of teenage motor vehicle deaths in 1999 occurred between 9 p.m. and 6 a.m. Thirty-three states and the District of Columbia impose nighttime driving restrictions.

The majority of states and the District of Columbia have all three stages, although the laws and systems vary from state to state. In Louisiana, the minimum age to get a learner's permit is 15 years. During the learner's period the driver can drive only under supervision at all times. To get the second stage of intermediate licensure, the driver must be at least 16 years of age and should have been holding the learner's license for a period of at least 6 months. During the intermediate stage, the driver is not allowed to drive between 11 p.m. and 5 a.m. unless supervised. The minimum age to attain a full license is 17.

State Helmet Laws

Thirty million motorcyclists drive on the roads and highways of the United States. A motorcyclist is approximately 15 times more likely to die in a crash than an occupant in a car. In 2000, motorcycle crashes killed more than 2,862 riders and injured over 58,000. Head injury is the leading cause of death and an unhelmeted motorcyclist is 40 percent more likely to die of a head injury, according to NHTSA. In addition, NHTSA estimates that in a crash, helmets reduce the likelihood of a fatality by 29 percent *[125]*. Motorcycle helmets provide the best protection from head injury for motorcyclists involved in traffic crashes. The passage of helmet use laws governing all motorcycle riders is the most effective method of increasing helmet use. As of 2001, 20 States, the District of Columbia, and Puerto Rico required helmet use for all motorcycle operators and passengers. Since 1997, six States (Arkansas, Texas, Kentucky, Louisiana, Florida, and Pennsylvania) had weakened universal helmet laws to limit coverage to those under the age of 21. These six States were the first since 1983 to repeal or weaken a universal helmet law. Following the repeal of the law, the fatalities in each of these states increased drastically. A comparison of Louisiana crash data *[107]* showed:

- The average death rate (motorcycle occupants killed for every 100 crashes) was 44 percent higher for the three years (2000-2002) after the repeal when compared with the three years prior to the repeal (1996-1998) (2.8 percent versus 4.1 percent).
- The death rate for motorcycle occupants killed for every 100 crashes was 4.4 percent in 2003.
- The death rate for motorcycle drivers without helmets was 65 percent higher than for motorcyclists with helmets (3.7 percent versus 6.1 percent).
- It is estimated that the repeal of the helmet law caused at least 74 additional deaths of motorcycle drivers in the past five years (1999-2003) and an additional 73 severe injuries.
- The repeal of the helmet law has cost the citizens of Louisiana at least $134 million in direct costs over the past five years.
- The repeal of the helmet law has cost the citizens of Louisiana at least $390 million in direct and indirect costs over the past five years for pain and suffering and loss of quality of life.
- The motorcycle crashes over the past four years contributed significantly to the healthcare cost of the state. It is estimated that the total direct cost for motorcycle crashes in Louisiana over the past five years was $1.1 billion. If loss of quality of life is included, this amount increases to a staggering $2.6 billion.

Following all this, Louisiana now has a motorcycle helmet law effective from August 15, 2004, which covers all motorcycle riders, regardless of age.

Bicycle helmets also prevent injuries, but no state has a universal bicycle helmet law *[130]*. Only 19 states and the District of Columbia have statewide bicycle helmet laws, and they apply only to young riders. Local ordinances in a few states require bicycle helmets for some or all riders *[126]*. In Louisiana, bicycle riders younger than 12 are covered by the law.

Impaired Driving Laws

Alcohol involvement still remains the leading factor in motor vehicle deaths. States continue to explore ways to reduce drunken driving deaths and to respond to the funding incentives and penalties imposed by the federal government through TEA-21, passed in 1998, and the Transportation Appropriations Bill (H.R. 4475) passed in 2000. During the 2001 session, nearly 900 drunken driving related bills were introduced in state legislatures. Among the key issues considered was the adoption of .08 BAC illegal per se laws, high-BAC initiatives, drunk driving-related child endangerment, and stronger penalties for implied consent refusals *[125]*.

In Louisiana, driving under the influence of alcohol remains a top safety issue. Alcohol-related crashes accounted for an estimated 18 percent of Louisiana's auto insurance payments. Louisiana already has many important impaired driving laws *[132]*. They are saving money and lives. Louisiana's impaired driving laws are described below:

> *0.08 Per Se Law* - Makes it illegal to operate a motor vehicle at or above 0.08 Blood Alcohol Concentration. During the 2001 legislative session, 10 states lowered the legal limit for drunk driving from .10 to .08 BAC. The states were Alaska, Arizona, Arkansas, Georgia, Indiana, Louisiana, Maryland, Missouri, Nebraska, and Oklahoma.

> *Administrative License Revocation* - Administrative license revocation (ALR) is the removal of a DUI/DWI offender's driver's license at the time of an arrest upon the failure or refusal of a chemical test. This distinction is important – administrative revocations are immediate in nature and, because of this, ALR is one of the most effective ways to deter people from driving under the influence of alcohol.

> *Child Endangerment* - Law that creates a separate offense or enhances existing DUI/DWI penalties for an offender who drives under the influence of alcohol with a minor in the vehicle.

Fake ID - A statute that creates an offense for an underage person to use a fraudulent ID and provides for a driver's license suspension for attempting to purchase alcohol using a false ID.

Felony DUI - Law that makes DUI/DWI a felony offense based on the number of prior convictions.

Graduated Drivers Licensing - A three-tiered licensing system under which novice drivers are given full driving privileges gradually, after an extended period of education and supervised driving with nighttime restrictions along with a citation- and alcohol-free driving record.

Habitual Traffic Offender - Habitual Traffic Offender Laws provide for special punishment to persons who have shown a disregard for the traffic laws. Persons are subjected to either special or increased sanctions if their driving record indicates that they have committed numerous traffic law violations for either serious or minor traffic law offenses or a combination of them.

Ignition Interlock - A device installed in an offender’s vehicle that prevents it from starting if the driver’s BAC is above a specified set limit.

Keg Registration - A requirement for beer kegs and other large beer containers to be tagged with identification tags and recording the purchaser’s name, address and location where the keg is to be used in order to track the source, if minors are served.

Mandatory BAC Testing for Drivers who are Killed - Statutes that create mandatory testing for all drivers killed in vehicle crashes.

Mandatory BAC Testing for Drivers who Survive - Mandatory blood alcohol testing of all drivers involved in serious injury crashes who survive.

Mandatory Jail 2nd Offense - A statute that mandates an individual who has been convicted of a second offense of DUI/DWI receive a jail term as part of the sanctions he/she receives.

Penalties for Test Refusal Greater than Test Failure - Statutes that provide for increased penalties for refusing to take a breath test, stricter than those penalties for an individual who takes and fails a breath test.

Primary Belt Law - Law allowing police to stop and ticket a driver for non-use of safety belt without requiring that the driver commit or be cited for another offense.

Selling Alcohol to Youth - Usually enforced by the state's alcohol beverage commission (ABC), these laws empower the ABC to rescind the license of any business that knowingly sells alcohol to an underage individual.

Sobriety Checkpoints - An enforcement program that allows officers to stop all or predetermined vehicles to check for sobriety of the drivers.

Vehicle Confiscation - Seizure of the vehicle operated by an offender at the time the alcohol-related offense was committed.

Vehicular Homicide - Statutes which allow a homicide charge to be brought against an individual who kills another person through the operation of a motor vehicle, either intentionally or negligently.

Youth Consumption of Alcohol - A law making it an offense for individuals under 21 to consume alcohol or to have any amount of alcohol in their bodies.

Youth Purchase - Laws that make it an offense for an individual 21 years or younger to purchase alcohol and provide for significant penalties including driver's license suspension.

Zero Tolerance - Law that makes it illegal for drivers under the age of 21 to operate a motor vehicle with a blood alcohol level of .02 or more *[132]*.

Of the number of impaired driving laws that exist, Louisiana has enforced just some of them. Many impaired driving laws are effective in reducing the alcohol-related fatalities but have not been enforced by the state *[132]*. Some of those laws include:

Anti-Plea Bargaining - A statute, case law, or policy that prohibits plea bargaining or reducing an alcohol-related offense to a non-alcohol related offense.

Dram Shop - A term referring to liability of establishments arising out of the sale of alcohol to obviously intoxicated persons or minor who subsequently cause death or injury to third-parties as a result of alcohol-related crashes.

Hospital BAC Reporting - A statute which requires or authorizes hospital personnel to report blood alcohol test results of drivers involved in crashes to local law enforcement where the results are available as a result of treatment.

Lower BAC for Repeat Offender - These laws pertain to offenders who have had one or more prior DUI/DWI convictions. Laws affecting the repeat intoxicated offender include: Licensing Sanctions, Vehicle Sanctions, Addressing Alcohol Abuse, and Mandatory Sentencing.

Mandatory Alcohol Assessment/Treatment - Law that mandates that convicted DUI/DWI offenders undergo an assessment of alcohol abuse problems and participate in required treatment program.

Mandatory Alcohol Education - A law which mandates that convicted DUI/DWI offenders complete an alcohol education program before driving privileges can be reinstated.

Open Container Law that is TEA-21 Compliant- Open container laws prohibit the possession of any open alcoholic beverage container and the consumption of any alcoholic beverage in the passenger area of a motor vehicle. Since every state has laws to prevent and punish impaired driving, open container laws can serve as an important tool in the fight against impaired driving.

Plate Sanctions - A law allowing license plates to be impounded and destroyed. In some cases, special license plates may be made to allow a confiscated vehicle to be driven by family members.

Preliminary Breath Tester - Portable breath testing device used to determine BAC of suspected DUI/DWI offenders.

Repeat Offender Law that is TEA-21 Compliant - Repeat offenders are those offenders who have two or more drunk driving offenses. In order to comply with TEA-21, the statute must include the following four penalties:

1. A minimum one-year hard license suspension.
2. Impoundment, immobilization, or the installation of an ignition interlock device on all vehicles owned by the offender.
3. All offenders must undergo an assessment of their degree of alcohol abuse and the law must authorize the imposition of treatment as appropriate.
4. There must be a mandatory minimum sentence.

Social Host - Statute or case law that imposes potential liability on social hosts as a result of their serving alcohol to obviously intoxicated persons or minors who subsequently are involved in crashes causing death or injury to third-parties.

Vehicle Impound - Seizure and impoundment of the vehicle operated by a DUI/DWI offender for a predetermined period of time

Vehicle Sanctions While Suspended - Seizure and sale of the vehicle operated by an offender at the time the alcohol-related offense was committed.

Youth Attempt at Purchase - A statute which makes it illegal for a person age 21 years or younger to attempt to purchase alcohol *[132]*.

Low-Speed Vehicles on Public Roads

Low-speed vehicles (LSVs), also known as neighborhood electric vehicles or NEVs, are defined by the National Highway Traffic Safety Administration as a vehicle having top speeds of 20 to 25 mph. Low-speed vehicles are exempt from almost all safety standards applying to cars. The only safety requirements for the vehicles are a windshield, mirrors, headlights, signal lights, tail and brake lights, reflectors, safety belts, and a parking brake. Low-speed vehicles do not have to have doors or bumpers, and they are not required to meet any crashworthiness tests. Nineteen states (Arizona, California, Colorado, Florida, Georgia, Hawaii, Indiana, Iowa, Michigan, Nevada, New York, North Carolina, North Dakota, Oklahoma, Oregon, Tennessee, Utah, Virginia, and Washington) have laws allowing low-speed vehicles on public streets with speed limits of up to 35 mph. Kansas allows low-speed vehicles on streets with speed limits up to 40 mph. Twenty-seven states, including Louisiana, have not enacted any specific laws on low-speed vehicles, but their current laws allow the vehicles to be driven on public streets. Six states (Connecticut, Idaho, Maine, Minnesota, Washington, and Wisconsin) have not enacted any specific prohibition to the vehicles, but their current laws prohibit the vehicles from driving on public streets *[126]*.

Older Driver Laws

By 2020, the number of drivers over 65 will increase tremendously. More than 50 million people over the age of 65 will be living in the United States compared with 35 million in 2000. The mobility and independence of this age group is something many states and organizations are researching. Even today, the number of licensed older drivers is increasing. Although they have fewer crashes per drivers compared to younger drivers, they do have higher fatal accident rates.

Because of the aging process, some older drivers discover their eyesight deteriorating, their reflexes slowing, and their hearing weakening. Some older drivers place self-imposed restrictions on their driving. For example, some will choose to limit their driving to daylight hours only, avoid rush hour, or choose not to drive on highways. Other older drivers may be unaware of their deficiencies or are unwilling to restrict their driving. Most families are concerned but are uncertain about what they can do or are unwilling to act *[133]*. Some states have tried to make this process easier through laws designed to make sure older individuals are able to safely operate a car. These laws range from driving restrictions to shortening time between renewals and requiring regular vision and driving tests. The restrictions usually prohibit nighttime driving or require the person to stay on familiar roads or within a limited area *[124]*. Some older drivers feel compelled to continue to drive even after they recognize their declining skills because no alternative transportation exists. Some states and cities are addressing this issue by developing transportation alternatives.

Renewal procedures for older drivers include accelerated renewal cycles that provide for shorter renewal intervals for drivers older than a specified age, typically 65 or 70; a requirement that they renew their licenses in person rather than electronically or by mail where remote renewal is permitted; and testing that is not routinely required of younger drivers such as vision and road tests *[126]*. Some states require a road test if the driver accumulates a certain number of points on their license *[125]*. Illinois law requires everyone over 75 to take a road test. By shortening the length of time a driver's license is valid, state departments of motor vehicles are able to check up on the individual during the renewal process to detect any impairments or problems that would limit the person's ability to drive.

These special renewal procedures for older drivers apply in addition to the license renewal procedures that exist in all states for dealing with licensed drivers of any age who no longer meet the standards for licensure because of physical or mental infirmities *[126]*. The length of the renewal period varies from state to state and some states have included special provisions for older drivers. Louisiana has a renewal period of four years and does not allow mail renewal to people 70 years or older or whose prior renewal was by mail.

Safety Belt Laws

Forty-nine states (all except New Hampshire) and the District of Columbia have mandatory safety belt laws. New Hampshire requires only children under 18 to buckle up. State efforts have improved seatbelt use in the nation as a whole—from only 11 percent in 1980 to 49 percent in 1990 to 73 percent in 2001. This growth is due to a combination of legislation, law enforcement efforts, and public awareness campaigns *[125]*. In most states, these laws cover front-seat occupants only, although belt laws in 18 states (Alaska, California, Delaware, District of Columbia, Idaho, Kentucky, Maine, Massachusetts, Montana, Nevada, New Mexico, New York, Oregon, Rhode Island, Utah, Vermont, Washington, and Wyoming) cover all rear seat occupants, too. People in passenger cars, pickups, SUVs, and vans are required to comply with belt laws in most states, but in a few states occupants of some kinds of vehicles (usually pickups) are exempt. In only 21 states, belt use laws are primary, meaning police may stop vehicles solely for belt law violations. Police authority to enforce belt laws in other states is limited. Officers must have some other reason to stop a vehicle before citing an occupant for failing to buckle up *[131]*. Louisiana has a primary seatbelt law which covers occupants of 13 years or older in the front seat and imposes a maximum fine of $25 for the first offense. National seatbelt laws, and the penalties for transgression, are shown in table 13.

Sanctions for Exceeding the Speed Limit in Either a Construction or School Zone
Thirty-four states have sanctions for exceeding the speed limit in construction zones and 19 states have sanctions for exceeding the speed limit in a school zones. Louisiana is not included in either list *[126]*.

Segway Vehicles on Public Roads
A new method of personal transportation was recently introduced by Segway, LLC. Popularly known as the "Segway," these electronic personal assistive mobility devices (EPAMDs) are electrically propelled two-wheeled devices designed to transport one person with a maximum speed of less than 20 mph. Currently 41 States and the District of Columbia have enacted various laws pertaining to their use.

- Thirty-five have laws specifically allowing EPAMDs on public streets (Alabama, Alaska, Arizona, California, Delaware, Florida, Georgia, Illinois, Indiana, Kansas, Louisiana, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Virginia, Washington, West Virginia, and Wisconsin).
- Three states (Connecticut, Iowa and Vermont) have specifically prohibited EPAMDs from riding on streets.
- Three states (Idaho, Nevada, and South Dakota) and the District of Columbia allow EPAMDs on sidewalks and/or bicycle paths *[126]*.

Of the jurisdictions that have enacted legislation, 13 states have minimum age requirements for operators. Nine jurisdictions require helmets for certain age groups, and one (New Jersey) requires helmet use for all ages.

In most states, EPAMDs must follow the rules pertaining to pedestrians while on roads and sidewalks. For example, in some states, a pedestrian, when on the road, is required to travel on the left side of the road facing traffic. However, on roads and sidewalks, pedestrians, not EPAMDs, always have the right of way.

Table 13
National seatbelt laws *[126]*

State	Who is Covered? In What Seat?	Max. Fine First Offense
Alabama	6+ yrs. in front seat	$25
California	16+ yrs. in all seats	$20
Connecticut	4+ yrs. in front seat	$15
Delaware	16+ in all seats	$25
D.C.	16+ yrs. in all seats	$50
Georgia	6-17 yrs. in all seats; 18+ yrs. in front seat	$15
Hawaii	4-17 yrs. in all seats; 18+ yrs. in front seat	$45
Illinois	6+ yrs. in front seat; all in all seats if driver is younger than 18 yrs.	$25
Indiana	16+ yrs. in front seat	$25
Iowa	11+ yrs. in front seat	$10
Louisiana	13+ in front seat	$25
Maryland	16+ yrs. in front seat	$25
Michigan	4-15 yrs. in all seats; 4+ yrs. in front seat	$25
New Jersey	7 yrs. and younger and 80+ lbs.; 8-17 yrs. in all seats; 18+ yrs. in front seat	$20
New Mexico	18+ yrs. in all seats	$25
New York	16 + yrs. in all seats	$50
North Carolina	16+ yrs. in front seat	$25
Oklahoma	All in front seat	$20
Oregon	16+ in all seats	$75
Tennessee	4+ yrs. in front seats	$10
Texas	4-16 yrs. in all seats; 17+ yrs. in front seat	$200
Washington	All in all seats	$101
American Samoa	All in all seats	$25
Guam	All in front seat	$50-$70
Mariana Islands	All in all seats	$25
Puerto Rico	All in all seats	$10
Virgin Islands	All in front seat	$25

Currently, no states require the operator of an EMPAD to be licensed. EPAMDs are exempted from registration requirements. Because EPAMDs are new on the market, they have not been classified as either a motor vehicle or a consumer product *[124]*. Louisiana has not enacted laws regarding EMPAD.

State Speed Limit Laws

Speeding-related crashes are estimated to cost society $28 billion per year. Speeding is a contributing factor in about 30 percent of all crashes, costing approximately 12,000 people their lives each year. State legislatures have an important policy role in ensuring public safety by setting speed limits *[125]*. Different states have different speed limits for different types of roads. The speed limit for rural interstates, urban interstates, and other limited access roads in Louisiana IS 70 mph, while the speed limit on other roads is 65 mph *[126]*. The speed limits permitted in each state are summarized in table 14 below:

Table 14

National speed limit laws *[126]*

State	Limited Access Rural Interstates		Limited Access Urban Interstates	Other Limited Access Roads	Effective Dates of Limits on Rural Interstates
	Cars	Trucks			
Alabama	70	70	65	65	5/9/1996
Alaska	65	65	55	65	1/15/1988
Arizona	75	75	55	55	12/8/1995
Arkansas	70	65	55	60	8/19/1996
California	70	55	65	70	1/7/1996
Colorado	75	75	65	65	6/24/1996
Connecticut	65	65	55	65	10/1/1998
Delaware	65	65	55	65	1/17/1996
District of Columbia	N/A	N/A	55	N/A	1974
Florida	70	70	65	70	4/8/1996
Georgia	70	70	65	65	7/1/1996
Hawaii	60	60	50	45	1974
Idaho	75	65	75	65	5/1/1996
Illinois	65	55	55	65	4/27/1987
Indiana	65	60	55	55	6/1/1987
Iowa	65	65	55	65	5/12/1987
Kansas	70	70	70	70	3/7/1996
Kentucky	65	65	65	65	6/8/1987
Louisiana	70	70	70	70	8/15/1997
Maine	65	65	65	65	6/12/1987
Maryland	65	65	65	65	7/1/1995

Massachusetts	65	65	65	65	1/5/1992
Michigan	70	55	65	70	8/1/1996
Minnesota	70	70	65	65	7/1/1997
Mississippi	70	70	70	70	2/29/1996
Missouri	70	70	60	70	3/13/1996
Montana	75	65	65	day 70; night 65	5/28/1999
Nebraska	75	75	65	65	6/1/1996
Nevada	75	75	65	70 v	12/8/1995
New Hampshire	65	65	65	55	4/16/1987
New Jersey	65	65	55	65	1/19/1998
New Mexico	75	75	75	65	5/15/1996
New York	65	65	65	65	8/1/1995
North Carolina	70	70	70	70	8/5/1996
North Dakota	75	75	75	70	6/10/1996
Ohio	65	55	65	55	7/15/1987
Oklahoma	75	75	70	70	8/29/1996
Oregon	65	55	55	55	6/27/1987
Pennsylvania	65	65	55	65	7/13/1995
Rhode Island	65	65	55	55	5/12/1996
South Carolina	70	70	70	60	4/30/1999
South Dakota	75	75	75	65	4/1/1996
Tennessee	70	70	70	70	3/25/1998
Texas	day 75; night 65	65	day 70; night 65	day 75; night 65; trucks 65	12/8/1995
Utah	75	75	65	65	5/1/1996
Vermont	65	65	55	50	4/21/1987
Virginia	65	65	65	65	7/1/1988
Washington	70	60	60	60	3/15/1996
West Virginia	70	70	55	65	8/25/1997
Wisconsin	65	65	65	65	6/17/1987
Wyoming	75	75	60	65	12/8/1995

Summary of Safety Legislation in Louisiana

The traffic safety legislations that exist in the state of Louisiana is summarized in table 15.

Table 15

Louisiana traffic safety legislations *[126]*

Impaired Driving Laws			
Illegal Per Se	**Open Container or Repeat Offender**	**Vehicle Sanction?**	**Admin. License Suspension 1st Offense**
0.08	Neither	Vehicle Confiscation, Discretionary Ignition Interlock	90 days

Speed Limit Laws				
Limited Access Rural Interstates		**Limited Access Urban Interstates**	**Other Limited Access Roads**	**Effective Dates of Limits on Rural Interstates**
Cars	Trucks			
70	70	70	70	8/5/97

Helmet Use Laws	
Motorcycle Riders Covered by Helmet Law	**Bicycle Riders Covered by Helmet Law**
All riders	Riders younger than 12

Safety Belt Laws		
Type of Law	**Who is Covered? In What Seat?**	**Maximum Fine First Offense**
Primary	13+ yrs. in front seat	$25

Child Passenger Safety Laws		
Child Restraint Required	**Adult Safety Belt Permissible**	**Maximum Fine First Offense**
Younger than 1 yr. or less than 20 lbs. in a child safety seat; 1-3 yrs. Or 20-39 lbs. in a forward facing child safety seat; 4-5 yrs. Or 40-60 lbs. in a child booster seat	6-12 yrs. Or greater than 60 lbs.	$50

SAFETY PROGRAMS

This section provides information on road safety programs that have been implemented in the past. The purpose of the review is to identify how effective these programs have been in improving road safety.

Aggressive Driver Enforcement Programs

Aggressive driving is a serious problem affecting all road users and is a major concern of highway users including pedestrians, motorcyclists, and bicyclists. According to a 1999 NHTSA telephone survey of 6,000 drivers, more than 60 percent of those interviewed perceived unsafe driving by others as a major personal threat to themselves and their families. Roadway congestion is considered as a factor that tends to intensify aggressive driving behaviors *[134]*. A number of law enforcement agencies across the country have launched a variety of operations to target enforcement of traffic laws commonly associated with aggressive driving, such as speeding, following too closely, unsafe lane changes, and failure to obey traffic control devices. Along with the enforcement, media campaigns are also being conducted in order to increase awareness and educate the motoring public about aggressive driving and basic traffic laws. Increased use of automated enforcement technology such as red light running cameras and photo speed measuring devices can have a significant impact as well *[134]*. This is particularly true in areas where congestion, lack of shoulders or other barriers inhibit law enforcement from making a traffic stop. Because of the danger caused by the aggressive driver, it has become necessary for law enforcement agencies to develop new, aggressive, enforcement methods. By focusing enforcement efforts and media attention on violations commonly associated with aggressive driving and encouraging voluntary compliance with traffic laws in general, the number of crashes and injuries each year can be reduced.

The following law enforcement programs have been developed in various states to target aggressive drivers.

Arizona

Arizona was the first state to enact aggressive driving legislation, which went into effect in May 1998. The program targets drivers who are speeding, following too closely, and making erratic or unsafe lane changes, as well as all other criminal and traffic violations. A Traffic Complaint Hotline was established for reporting traffic complaints by citizens, including aggressive driving. Traffic complaints have increased 76 percent, of which 75 percent are speed-related complaints. Arizona added aggressive driving statute 28-695 to the Reckless Driving Section and amended the name of the statute to Reckless and Aggressive Driving.

Arizona originally enacted the Reckless and Aggressive Driving law, 28-695, in July 1998. The penalty assessed was six points against the driver's license. The legislature amended and changed the law to assess eight points on the driving record and increased the elements necessary to prove aggressive driving. The Arizona statute defines aggressive driving as a situation in which a person commits a violation of speeding and at least two other traffic violations (i.e., failure to obey traffic control devices, improper passing, driving off the pavement or traveled portion of the highway, following too closely, failure to yield right-of-way, or driving in a way that is an immediate hazard to another person or vehicle).

The Arizona Department of Public Safety's (DPS) *Aggressive Driver Detail* focuses both on enforcement and a strong media campaign. Unmarked cars, motorcycles, and marked patrol cars are used. Officers are always in uniform while working the Aggressive Driving Detail. Rural areas are currently being tested with marked cars. Several aggressive driver details are scheduled each week throughout the State. There is a zero tolerance policy for aggressive driver violations.

Another aggressive driver program, *Operation Chill*, is the longest running in the country. "Operation Chill" uses aircraft, motorcycles, unmarked patrol vehicles, and marked patrol vehicles. Arizona's public service announcement about aggressive driving, *"30 Seconds, Is It Worth It?,"* recently won first place in a highway safety public service announcement campaign. An *Aggressive Driver Interdiction Program* was developed and implemented. Motor officers and supervisors work saturation-type patrols in pre-designated locations where aggressive driving behaviors have or are likely to adversely impact traffic. There is a "zero-tolerance" approach to the enforcement of all violators. The Arizona Department of Public Safety currently conducts six aggressive driver enforcement programs per week. The program is staffed with up to 10 officers and/or sergeants, utilizing marked police motorcycles, two unmarked patrol vehicles, and aircraft *[135]*. Problem areas are identified and saturated up to three times a week. It is not known to what extent the program has been effective in reducing aggressive driving in Arizona.

California

California initiated the *Smooth Operator Campaign* which proved to be the longest running aggressive driving media program in the country. The program used enforcement patrols that identified six primary driving behaviors contributing to traffic congestion. The program was started in 1988 to deal with increasing traffic congestion in the major metropolitan areas. The first enforcement wave occurred in April-May, 1997, and the second wave started in June, 1997. During the first wave, 11,835 vehicles were stopped and 11,927 summons were issued.

Smooth Operator's second wave of occurred from June 16-22, 1997. Almost 16,000 vehicles were stopped with 15,134 summons issued, resulting in 285 criminal arrests.

The California Highway Patrol initiated the *Aggressive Driving Public Awareness and Enforcement Campaign* project during fiscal year 1999. The project funds personnel overtime, in-state travel, printing, promotional material, and video public service announcements associated with the public information and education campaign, and a focus group. The main goal of the project is to conduct a public awareness campaign addressing the benefits of reducing aggressive driving behaviors and how to avoid confronting an aggressive driver. Overtime hours were distributed for officers in four divisions. A pre-campaign survey was conducted to establish and evaluate public perceptions of aggressive driving and road rage. A market research focus group was conducted for developing campaign images and messages. Public Affairs Officers have scheduled and delivered traffic safety presentations focused on the aggressive driving message. Six English and six Spanish language radio public service announcements are being developed. Campaign materials were developed through information obtained from the aggressive driver survey. Law enforcement efforts in California have met with positive support from the public. Although it is difficult to measure the success of the law enforcement programs, proponents believe they have been successful.

Colorado

The Colorado State Patrol began a program with Vision TEK Incorporated and Colorado wireless phone companies in June 1998, which allows motorists to *"Be a STAR"* and *"Start Taking an Active Role"* to fight "aggressive driving and road rage" by calling STAR CSP (*277). The Colorado State Patrol accepts calls from motorists dialing *CSP on their cell phones to report acts of aggressive driving. The STAR CSP Program automatically records and compiles calls into a database. CSP Communications Officers are able to obtain vital information in two to three seconds. The system prints out a complete report of the calls, which is delivered to a CSP Dispatcher and automatically issues warning letters to the owner of the vehicle. The callers are also allowed to vent their frustrations regarding other motorists. When they receive a call at the communications center, the dispatcher determines if the call is an urgent circumstance or if it is someone venting their frustrations. If it is an emergency, the dispatcher handles the call and sends the required assistance. All other phone calls are forwarded to the computer system that logs the complaint. The computer system can track the license plate numbers of the vehicles with the aggressive driving behavior. Once the computer database logs three complaints on the same license plate number, a letter is sent to the registered owner, advising that person regarding the complaint. The CSP would eventually send troopers to the homes of the registered owners of the vehicles and issue citations based upon the complaints.

The Colorado State Patrol uses an extensive media campaign along with enforcement in their aggressive driving program known as *ADAPT (Aggressive Drivers are Public Threats)*. Unmarked patrol vehicles, motorcycles and aircraft are used for enforcement. *Two Seconds for Safety* is the leading component of the media campaign. The campaign urges motorists to use the two-finger "peace" or "victory" sign with several different messages: "Thank you," for a courteous act of kindness, or "I'm sorry" or "Excuse me," for an inadvertent driving behavior that another motorist may view as aggressive. The two-finger "peace" or "victory sign" can also mean, always keep a two-second interval between you and the vehicle in front of you *[136]*.

CSP has also produced several television Public Service Announcements (PSAs) with the use of volunteer drivers, donated vehicles, and a television helicopter. These PSAs have received three national awards of excellence from the safety and film industries. These PSAs depict aggressive driving behavior sequences and give a message about safe driving. CSP has made excellent use of media involvement, PSAs, newspaper stories, pamphlets, and brochures to educate the public about aggressive driving. In addition, using a computer to handle the extra phone calls and track the license plate numbers has been a cooperative agreement with CSP and the developer of the computer. In 1997, injuries and fatal crashes decreased by 1.3 percent, but the actual number of fatalities went up from 612 to 624 from 1996. In 1997, CSP investigated 9,303 non-speed, aggressive driving behavior crashes and 6,989 excessive speed crashes. In 1998, CSP investigated 10,137 non-speed aggressive driving behavior crashes and 5,415 excessive speed crashes. Each year, the CSP publishes a two-page annual report that lists the numbers of crashes, fatalities, DUI arrests, and the safety messages used in their many different media campaigns. The annual report can be mailed or given to motorists during a traffic stop.

Connecticut

The Connecticut State Police's aggressive driving program started in 1997 *[135]*. Traffic units continue to be the cornerstone of the program. Traffic personnel use both marked and unmarked patrol vehicles. Also, they use non traditional police vehicles, aircraft, and, weather permitting, motorcycles to conduct their operations. Unmarked units identify aggressive drivers and marked units make the stop. Aircraft are sometimes used and work in tandem with ground units to minimize the hazards of high speed pursuits. The program has been funded by federal grants and other state funds. Statistics are collected for different enforcement projects and periods. The department has been involved in project BIG ORANGE since 1995. Troopers use orange DOT trucks as a platform for conducting enforcement operations in construction and maintenance zones. Connecticut is also involved in short-term projects. The media remains involved in the aggressive driving efforts through press releases on current and new programs. The media is allowed to participate in a "Ride with a Trooper" program. The holiday advisories are provided to the public through the media.

Florida

In Florida, the St. Petersburg Police Department (SPPD) developed the program *Where's Jockers?* St. Petersburg had high incidences of drivers running red lights, crashes with fatalities, and aggressive driving. Marked patrol vehicles were not effective in stopping the aggressive driving behavior, so Officer Mike Jockers developed an innovative approach to address these issues. An officer, known as "Officer Jockers," dresses in clothes appropriate for the vehicle he is sitting in and observes traffic. Officer Jockers, equipped with a radar gun and hand-held radio, sits in all types of non-traditional city vehicles to observe traffic and call ahead to marked patrol vehicles to take enforcement action. Officer Jockers has used lawn mowers, bus benches, road construction vehicles, and power truck buckets to observe red light violations. By using the non-traditional vehicles, the public can not be sure where the law enforcement officers are located. The public does not know if the police department is doing a special *Where's Jockers?* enforcement effort or if the officers are doing their regular job. The media in the St. Petersburg area has given extensive coverage to the *Where's Jockers?* program. By working with the media, the SPPD has taken the aggressive driving issue to far more people than just those being stopped. The SPPD uses hand-held radios and portable radar units that allow their officers greater mobility to observe traffic.

St. Petersburg is in the process of changing the name of their aggressive driving program from *Where's Jocker's?* to *Where's Alf?* and *Where's Willie*. Every Friday, an officer from these two programs coordinates a city wide traffic operation with both patrol and community police officers. Recently, the Sheriff's Department and Florida Highway Patrol became involved in the program. The department has used the media extensively in their enforcement efforts announcing their work areas. They have also done public education and training to make the citizens of St. Petersburg more aware of hazardous driving behaviors. A video is available from St. Petersburg Police Department showing the department in several different enforcement settings. St Petersburg Police Department is incorporating their new *Where's Alf?* program into a bigger program called 3-E's, which stand for Enforcement, Education, and Engineering *[135]*. They want to use a broad based effort to educate the public, to look at roadway design and signing as possible problems as well as enforcement to deal with the aggressive driving problem. Before the program began, the SPPD met with the city prosecutors and judges to make them aware of the enforcement strategy and the use of the non-traditional vehicles so that the judicial system understood these issues before defendants came to court. They also became aware of how large St. Petersburg's aggressive driving problem was when a large number of cases began to come to the court.

Clearwater Police Department launched their aggressive *Driving Detection and Suppression* program on July 27, 1999. The Traffic Enforcement Squad is looking for motorists who commit multiple hazardous moving violations. The local mental health officials assisted in developing anger management tip cards for road rage suspects. Road rage reports are entered into a database, which supports follow up mailings to suspects. In addition, criminal histories of suspects are checked and the database is shared with CID for future investigations. A traffic hotline reports aggressive drivers who receive follow up mailing. This program is run on a monthly basis with the locations advertised on the department's television station *[136]*. The operation is staffed with both traffic teams and community policing teams.

Indiana

The Indiana State Police began targeting flagrant traffic violators in 1988. This vigorous traffic enforcement program targeted the same drivers as other aggressive driving programs, but it did not have an official name. They use unmarked, nontraditional law enforcement vehicles and aircraft to detect the aggressive driver. They also use vehicles that appear to belong to the Department of Transportation for enforcement purposes in construction zones. The Indianapolis Police Department received a grant for an aggressive driving enforcement and public information and education campaign. There six other agencies participating are the Marion County Sheriff's Department, Indiana State Police, Lawrence Police Department, Speedway Police Department, Beech Grove Police Department, and Cumberland Police Department. The partnerships utilize various tactics for enforcement. The *Single Officer Tactic* uses marked patrol vehicles. The *Centipede Tactic* consists of placing four to six marked and unmarked police cars from the seven law enforcement agencies approximately two miles apart. The *Ghost Vehicle Tactic* utilizes two officers with a marked and unmarked car. The unmarked car locates the aggressive driver and the marked car apprehends the violator *[135]*. The *Over-pass Tactic* places an officer on foot on an overpass and radios a marked car to apprehend the violator. The *Work Zone Tactic* utilizes an officer to patrol a work zone where aggressive drivers often appear.

Maryland

Maryland State Police participate in the *Smooth Operator* program conducted in the Washington, D.C. metropolitan area. The *A.D.V.A.N.C.E. (Aggressive Driving Video and Non-Contact Enforcement)* Vehicle was developed to assist the MSP in identifying aggressive drivers on the Capital Beltway. The vehicle uses lasers to determine the range and speed of vehicles on the highway and a computer system to record video images of the front, side, and rear of a vehicle when the measured speed of the vehicle exceeds a predetermined threshold. The information is quickly assembled into a violation report that is sent to the violator. A manual override allows the operator to trigger the acquisition of video data in order to capture other aggressive driving patterns such as following too closely and erratic lane changes.

The operator can view live video from any camera by selecting the appropriate switch on the front of the video monitor. The system can also record traffic statistical information as speed distributions (histograms) of vehicles in the flow of traffic. These data allow the operator to estimate the average speed of traffic. Data is saved on a removable disk and subsequently used to generate violation reports that can be analyzed or mailed to the owner of the vehicle *[135]*. The operator can review any and all data on the computer monitor.

Project *A.D.V.A.N.C.E.* uses a vehicle equipped with technology that has not traditionally been used in traffic enforcement. The LIDAR speed-measuring device, coupled with a new device called Autosense, measures the speed of the vehicle. The Autosense device triggers the side and rear cameras to take pictures of the vehicle, the registration plate, and the operator *[136]*. The *A.D.V.A.N.C.E.* system establishes a database of violations that includes pictures of the vehicle that can be mailed to the vehicle's owner. A traffic violation in Maryland currently assesses points to the driving record. Since points are assessed, the driver has to be contacted and identified immediately.

Massachusetts

The Massachusetts State Police *3D Program (Dangerous, Drunk, and Drugged Driving)* began on September 12, 1997, with a large media campaign. The program uses a sergeant and three troopers assigned full time to the unit. The team uses marked and unmarked patrol vehicles, as well as unmarked or non-traditional vehicles, typically seized from drug or criminal interdiction cases. They have equipped the vehicles with in-car video cameras, radar units, and emergency lights. A uniformed officer assigned to the unmarked vehicle works in coordination with two or more marked patrol vehicles. The unmarked or non-traditional patrol vehicles work in areas that have been identified as aggressive driving problem areas, such as areas with high incidences of crashes, congestion, or fatalities. When observing violation, the officer in the unmarked or non-traditional vehicle positions the patrol vehicle so that the driving behavior can be video taped and provides the marked patrol vehicles with the violator's location. The unmarked vehicle maintains contact with the violator until the marked unit is behind the violator and a stop is initiated. However, if the violator's driving behavior is egregious, the officer in the unmarked vehicle, who is in uniform, will initiate the traffic stop to eliminate the hazardous driving behavior. By maintaining this process, Massachusetts State Police have not had any pursuits. The unmarked patrol units' rear deck lights are activated when the vehicle is following an aggressive driver and trying to initiate a traffic stop. The motorist behind the patrol vehicle will have ample time to slow and avoid a collision.

Troopers work four- to five-hour shifts on the road. Then report to the Troop Headquarters. The trooper runs a computer check on the driver history for the drivers that they cited that day *[136]*. If the driver's license history shows more than three aggressive driving behaviors within the last three years, they refer the driver to the Registry of Motor Vehicles and file a report to "Request for Immediate Threat of Suspension or Revocation" hearing. If the Registry of Motor Vehicle suspends or revokes a driver's license, the driver is required to attend either remedial driver training or anger management.

The Massachusetts State Police have held more than 300 "Request for Immediate Threat of Suspension or Revocation" hearings. The arresting officers have not lost one ruling. Every case referred to the Registry of Motor Vehicles has resulted in the driver's license being suspended or revoked. By using the "Immediate Threat Report Form," the Massachusetts State Police use a law that is underutilized but already in place. And, since not one ruling has gone against the charging law enforcement officer, this is a good indicator that their method of addressing the repeat aggressive driver is effective *[136]*.

Michigan

Michigan State Police Operation *BAD (Bust Aggressive Drivers)*, uses an old car to avoid attention from potential aggressive drivers. The Oak Park Post uses an old gray car with a rusty roof and peeling paint, commonly called their stealth vehicle, to observe aggressive drivers. A uniformed trooper rides in the old car, while troopers in marked patrol vehicles drive in the area *[135]*. When the driver of the stealth vehicle observes aggressive driving behavior, the trooper calls to a marked unit to initiate the traffic stop.

Minnesota

The Minnesota State Patrol has equipped its helicopters with cameras that produce clear pictures of license plate numbers up to 500 feet. The pictures are downloaded via satellite to the traffic control center *[135]*. A portable receiver allows the video to be seen in a squad car and is used to stop aggressive and drunk drivers and take appropriate action.

New Hampshire

In November 1999 the New Hampshire State Police formed an aggressive driving unit. The unit consists of four uniformed troopers and one sergeant. Each unit member is issued an unmarked vehicle (Chevy Tahoe, Luminas, Mustang, and Crown Vic) that is fully equipped with lights and sirens. The unit works in day light hours and usually during rush hours. They saturate a selected high complaint area and look for two or more moving violations by a single violator. Television media and local newspaper reporters have reported on the program *[135]*. In the first five months, the unit totaled 700 violator contacts and issued close to 1,100 summonses to aggressive drivers. Less than 10 percent have contested the summonses. The unit has had a 100 percent conviction rate.

New Mexico

In 1997, the Albuquerque Police Department started the *Safe Streets Program* to use intensive traffic enforcement to reduce violent felony crimes and aggressive driving. Since then, the number of crash fatalities and violent criminal events has decreased dramatically. The main strategy was to saturate one of four high-crash areas with law enforcement officers. The saturation patrols consisted of 12 motorcycle officers, a Driving Under the Influence (DUI) enforcement team, and officers drawn from the local command. The primary tactic was to position officers at the gateways to the four target areas. They stopped and cited motorists for all traffic infractions. Saturation patrols continued in the same area for one month and then moved to another area. Twice during the second month, officers returned to the first area to give the public perception that the saturation patrol was occurring in both areas. During the third month of the enforcement effort, the saturation patrol team went back to the first area once during the month and twice to the second area. That pattern continued, until all four areas received maximum patrol efforts.

The Albuquerque Police Department also formed freeway enforcement teams. These teams use unmarked patrol vehicles and a "cherry picker" truck that placed an officer in the bucket with a radar gun and hand-held radio to report speeding and aggressive drivers to officers in marked patrol vehicles *[136]*. During one five-day period for two hours per day, they issued 1,400 citations, primarily for speeding. ANACAPA Sciences, Inc. performed case study of the Albuquerque Police Department's *Safe Streets* program for NHTSA. During the five years before *Safe Streets* began in 1997, traffic collisions had increased by 46 percent in Albuquerque. An increase in aggressive driving and road rage incidents accompanied a 12 percent increase in all collisions from 1995 to 1996, which resulted in the special enforcement effort. From 1996 to 1997, property damage only crashes decreased by 9 percent, injury crashes declined by 18 percent, DUI crashes declined by 20 percent, and fatal crashes declined by 34 percent. These results are shown in table 16.

New York

The New York State Police (NYSP) use low profile vehicles with unconventional emergency lighting systems and front and rear mounted video cameras. A toggle switch allows the troopers to change cameras without taking their eyes off the road. The department also uses passenger vans equipped with two video cameras. These vans are used in conjunction with marked patrol vehicles to initiate the traffic stop. The height of the vans allows a better vantage point for videotaping and, because it is a nontraditional police vehicle, unsuspecting motorists are videotaped before they realize it. NYSP has identified 20 target zones for aggressive driving problems and concentrated enforcement efforts in those zones at least once a month. NYSP has produced several different pieces, such as magnets, pictures, pamphlets, pens, etc., to use in their media campaign to educate the public.

The Suffolk County Police Department developed a program called *Returning Courtesy To Our Highways* and received a grant from The New York State Governor's Traffic Safety Board. Officers work overtime for a two-hour period following either the midnight tour or day tour. Officers use an unmarked vehicle and are instructed to specifically enforce violations commonly associated with aggressive driving *[135]*.

Table 16
Crashes by type in Albuquerque between 1992-1997 showing the effects of *Safe Streets* program *[126]*

	1992	1993	1994	1995	1996	1997
Injury	5075	5528	5960	6211	6134	5004
PDO	10184	13065	14711	14375	17006	15464
DWI	1344	1400	1184	982	1055	843
Fatal	53	43	43	50	50	33
Total	16656	20036	21898	21600	24245	21344
Change	n/a	20%	9%	-1%	12%	-12%

Ohio

The Ohio State Highway Patrol's (OSHP) aggressive driving program *Operation TRIAD*—Targeting Reckless, Intimidating, and Aggressive Drivers—kicked off on July 4, 1997. District and local highway patrol posts are responsible for researching and recommending *Operation TRIAD* sites, providing manpower for the enforcement details, and coordinating local law enforcement and media coverage. *Operation TRIAD* uses a large, fixed-wing aviation division and local highway patrol officers, combined with local law enforcement officers, to deter aggressive or dangerous driving acts.

Aggressive driving enforcement is used in peak traffic volume and density locations, complaint areas, high DUI areas, school bus routes, and high crash railroad crossings. The *Operation TRIAD* master plan uses the following driving behaviors as guidelines for targeting enforcement:

- Following too closely
- Passing off the travel portion of the highway
- Lane change violations
- Speeding beyond the traffic flow
- Merging into traffic from on-ramp through safety or gore area
- Failure to yield at ramps or intersections
- Railroad crossing violations
- Displaying or using a weapon

Extensive media coverage of *Operation TRIAD* has increased public awareness about the enforcement details and encouraged a safe driving environment for all motorists.

The OSHP aviation section works closely with the local judges to train them about traffic safety, specifically aggressive driving. The section pilot offers newly elected judges, and offers a ride-along in the plane to observe traffic from the air. The judges can see the traffic problems from the air and observe how the pilot can follow a vehicle for two to five miles and develop a driving pattern over an extended distance *[136]*. The judges can also see how easy it is to maintain visual contact, make positive identification from the air, and communicate this information to the ground.

Oklahoma

In October of 1997, the U.S. Department of Justice awarded the Oklahoma City Police Department (OCPD) a Local Law Enforcement Block Grant to start an aggressive driving program. *R.A.A.I.D (Reduction of Accidents and Aggressive and Inconsiderate Drivers)* became operational in September 1998. The goal of *R.A.A.I.D.* is to reduce crashes, particularly fatal crashes.

The grant was used to purchase automobiles, radar units, speed surveys, computer tracking equipment; train the officers to use the equipment; and provide overtime funds for personnel. All law enforcement officers who work the overtime *R.A.A.I.D.* shifts must attend an eight-hour training session. These sessions train the officers about the background and history of the *R.A.A.I.D.* program, the aggressive driving issues, radar operation, identification of problem traffic areas, and what is expected of the officer working the *R.A.A.I.D.* program.

Media coverage on the aggressive driving program is extensive, with live broadcasts during enforcement efforts and guest appearances by public information, education officers, and *R.A.A.I.D.* trained officers. OCPD continually monitors crash data and identifies ten high-crash areas. They assign the *R.A.A.I.D.* officers to those high crash areas and, if a new high-crash area surfaces, they adjust the teams' work locations. The program uses unmarked patrol vehicles. Compared to the year before the *R.A.A.I.D.* program began, statistics show a decrease in the following categories.

- Total crashes: decrease 3.9 percent
- Injury crashes: decrease 11.2 percent
- DUI injury: decrease 17.3 percent
- Fatality crashes: decrease 23.1 percent

The Municipal Courts have set up special *R.A.A.I.D.* codes, which will help in tracking most of the citations issued during the program's enforcement efforts. Other things that they track include total number of citations for a specific offense, final dispositions, conviction rates, and revenue generated because of the *R.A.A.I.D.* enforcement program.

During the February 1999 legislative session, a bill was filed making it illegal for law enforcement officers in Oklahoma to use unmarked patrol vehicles. This bill would have greatly affected the *R.A.A.I.D.* law enforcement strategy. Through the legislative process, standards were set on when and how they could deploy unmarked patrol vehicles. A major issue in Oklahoma with unmarked patrol vehicles is persons imitating law enforcement officers *[136]*. The Oklahoma legislature addressed that issue by increasing the penalty for persons impersonating a law enforcement officer.

Pennsylvania

Pennsylvania State Police use two different programs to address aggressive driving enforcement *Operation Centipede* and *TAG-D (Ticket the Aggressive Driver)*. The *Operation Centipede* program uses 8-10 officers, who are positioned one- to two-miles apart throughout the target area. The officers are in both marked and unmarked vehicles, some with radar equipment. The officers are advised to strictly enforce all posted speed limits and cite any aggressive driving behaviors. As the motoring public passes the first trooper, they may assume no other troopers will be present for several miles. When motorists pass another trooper within two miles and then another trooper within another two miles, they may believe that troopers will be found all along the route.

The *TAG-D* program also uses a combination of marked and unmarked law enforcement vehicles, a vehicle that appears disabled, radar, fixed wing aircraft, and pursuit vehicles. On the day of the saturation patrol effort, officers are advised what driving behaviors they are targeting for enforcement.

Pennsylvania saw a five percent decrease in crashes with fatalities or injuries in areas targeted as part of the *Operation Centipede* and *TAG-D* highway safety enforcement programs. The number of crashes with fatalities or injuries decreased from 4,045 to 3,838. The total number of crashes with or without injuries decreased from 6,076 to 5,656, a drop of six percent *[136]*. Since the Pennsylvania State Police started the *Operation Centipede* and *TAG-D* programs in 1997, crashes with deaths or injuries requiring transportation for treatment of injuries dropped by nearly 24 percent in the areas targeted by the enforcement programs.

South Carolina

The South Carolina Highway Patrol has an Aggressive Driving Program called *Operation State Trooper On Patrol (STOP). Operation STOP* uses unmarked vehicles that look like taxis and other used vehicles. Seven districts each has an aggressive driving team that consists of a supervisor and four troopers. The supervisor identifies the violator, and the trooper makes the stop. Each team focuses on high speed and a combination of other violations. During various times of the year, three teams focus on a particular interstate. An aircraft is used along with two motorcycles per team and the media is involved. From June 1999 to June 2000, traffic fatalities increased by 64. Traffic fatalities dropped within three months since the Aggressive Driving Program actively working in teams. There were 11 fewer fatalities compared to the same time in 1999. The South Carolina Highway Patrol provides a two-hour aggressive training session to all of their officers. The training familiarizes the officers with the problem posed by the aggressive driver and provides the necessary information for identifying the interdiction of the aggressive driver.

In early 1997, the Greer Police Department began an extensive education program for both the citizens of the community and the officers, which is known as *Targeting the Aggressive Driver*. Its primary purpose is to make everyone aware of the importance of obeying traffic laws and reducing crashes. In addition, an enforcement program was implemented to supplement the education portion *[135]*. The overall result has been a 22 percent decrease in crashes in the first seven months of the campaign compared to the same period in 1996.

Texas

Richardson, Texas, has several major intersections with an eight-lane, divided expressway intersecting with three- and four-lane frontage roads where, when traffic is heavy, vehicles consistently run red lights. Thus, enforcement is very difficult and dangerous. To apprehend violators, officers usually go through the intersection after the light has turned red, putting law enforcement officers and citizens in a dangerous situation. Besides the width of the intersection, multiple lighting patterns and two to three second clearance times allow late-comers to safely clear the intersection, thus creating longer lines and more congestion. During the city's quarterly traffic meetings, representatives from the police department, traffic engineers, and the traffic superintendent discussed the high number of intersection crashes and the perceived lack of enforcement at intersections. Collaboration between the police department, the engineering department, and the traffic engineer enabled them to develop an innovative, cost-effective solution to the traffic problem. Through a coordinated effort, they developed a "downstream" light system to help the Richardson Police Department take enforcement action. The "downstream" light did not require any change of laws and it could be done at a fraction of the cost of a photo red light system. A white light was wired on the back of the signal heads or on the cross beam of the light assembly. The white light was activated when the red light received power. Officers could sit across the intersection, or "downstream" from the traffic light, know when the light turned red and wait for the violating vehicles to approach their location. The officer could either flag the motorist over or fall behind the vehicle and safely make the traffic stop *[136]*. This light system cost the city of Richardson approximately $500 per intersection. The "downstream" light system requires a 35-watt white light bulb, powered when the red light at an intersection is activated.

During a two-day enforcement period officers issued more than 300 citations for red light running. More than 70 percent of the citations written were the result of the use of the "downstream" lights. Without the "downstream" lights, those citations probably would not have been written.

Washington

The Washington State Patrol started its aggressive driving program on Memorial Day weekend, 1998. Two unmarked vehicles and motorcycles were assigned to target flagrant violators. Currently, there are 10 *Aggressive Driving Apprehension Team (ADAT)* vehicles throughout the state. There are also two vehicles that look like taxi cabs. The trooper calls ahead to a marked patrol vehicle, that initiates the stop. Video cameras are mounted in each vehicle. Most of the funding for equipment and vehicles has been paid for by Washington State Traffic Safety grants.

Each district has the option of teaming up with other agencies, but most of the *ADAT* vehicles work the interstate system. Troopers are assigned to the *ADAT* vehicle, working during rush hour or high traffic areas on a three-month rotating basis. There have not been any incidents with violators failing to stop for the unmarked vehicles. Marked vehicles and motorcycle officers participate in the Aggressive Driving Program. Training on aggressive driving is provided to cadets and troopers *[135]*. A media blitz advised the public about the program when it first began.

Greater Washington, D.C., Metropolitan Area

The *Smooth Operator Program* is a multi-agency enforcement and education effort in the Washington, D.C. metropolitan area. There are currently 21 law enforcement agencies from Maryland, Virginia, and Washington, D.C., involved in the combined effort. The program uses coordinated enforcement waves, four times a year, to deter aggressive driving and reduce crashes. Marked and unmarked patrol vehicles, as well as non-traditional vehicles are used. Each of the agencies targets aggressive drivers in their own area of jurisdiction during each of the enforcement waves.

According to the Texas Transportation Institute's Urban Roadway Congestion Report 1982-1993, the Washington, D.C., metropolitan area is the second most congested traffic area in the country. Programs like *Smooth Operator*, which educate the public about aggressive driving and also give the perception that law enforcement enforces traffic laws, have been successful *[136]*. During one six-month period, over 60,000 citations and warnings were written for aggressive driving with the *Smooth Operator program*. The enforcement waves that this program conducts reinforce the media campaign about aggressive driving.

Wisconsin

The Milwaukee Police Department (MPD) was awarded a grant by NHTSA to demonstrate and evaluate innovative enforcement and public information and education programs to reduce aggressive driving. This 18-month project began in October 1998. Milwaukee's plan outlines eight separate, three-week enforcement efforts focusing on aggressive driving behavior. The plan features some innovative enforcement waves such as an *angel patrol* for drivers who drive faster than their guardian angel can fly, the *flasher patrol* for drivers who do not use their turn signals when turning or switching lanes, and the *basket patrol* for drivers who like to weave in and out of traffic. A strong media campaign announced the enforcement efforts and advised the public about safe driving habits. They produced an aggressive driving logo that was used on all publications and media events. Milwaukee paid particular attention to recording driving behavior before, during and after the demonstration project, to identify any change in driver behavior *[136]*. They changed the citation forms to allow the officer to denote that the incident was aggressive driving and to track the number of incidences and citations. The Milwaukee Police Department evaluated new technology that measured the distance between vehicles. Speed display boards were placed on designated routes to advise the public of their speed.

The goals of the Milwaukee project were

- Develop an innovative enforcement strategy to reduce aggressive driving
- Develop and evaluate the effectiveness of public information and education programs to discourage aggressive driving
- Document the involvement of drugs and alcohol
- Identify legislative, prosecutorial, and judicial needs to address the problem
- Reduce the area's per capita congestion costs, fuel waste, and lost person hours because of congestion

National Strategies for Addressing Aggressive Driver Behavior
In 1999, the U.S. Department of Transportation (DOT) brought together a collection of public safety, legal, judicial, and community representatives to discuss ways to answer the persistent problem of aggressive driving. The symposium, *Aggressive Driving and the Law: A Symposium*, featured participation by transportation officials, district and State attorneys, district court judges, law enforcement administrators, emergency personnel, criminal defense attorneys, safety advocates and activists, researchers, and government policy makers. The symposium participants identified six topic areas that they believed would be useful for categorizing aggressive driving countermeasures. The six areas were (1) Statutory Strategies, (2) Enforcement Strategies, (3) Applied Technology, (4) Charging Decisions, (5) Sentencing Strategies, and (6) Community Leadership *[135]*. The Aggressive Driving Implementation Team selected from symposium participants was formed to devise strategies to carry out these recommendations, and organize them into a *National Aggressive Driving Action Guide (Action Guide)* intended for use by State and local officials, legislative bodies, criminal justice practitioners, highway safety advocates and related organizations, and the community.

The intent of the Implementation Team was to create a dynamic and easy-to-update planning guide for the States. Recognizing that the problem of aggressive driving does not lend itself to a "one size fits all" solution, the Implementation Team recommended strategies that States can customize to create potential "best solutions."

The Implementation Team's aggressive driving recommendations, collected under the six topic areas, make up the body of the Action Guide. The Action Guide aims to mitigate the problem of aggressive driving through stronger laws, enhanced law enforcement, increased follow-up by prosecutors and judges, and heightened awareness among the general public *[137]*. Recommendations in each of the six areas are briefly summarized below.

Statutory Strategies. The Implementation Team members recommended strengthening the existing statutes to convey the message that aggressive driving is a serious offense that is potentially unlawful and chargeable as a crime. They also recommended that State and Federal governments should provide assistance to law enforcement agencies to help pay the costs of and provide support for retraining on new reckless or aggressive driving statutes.

Enforcement Strategies. The primary recommendation in this category was that all involved parties, from law enforcement, prosecutors, and the judiciary, to transportation officials, automobile manufacturers, and motorists, should establish aggressive driving as a national priority requiring attention. Innovative funding was recommended for aggressive driving programs and related equipment and training to help arrest and prosecute violators who otherwise go undetected. Equipping law enforcement officers with pioneering technologies to better detect and apprehend aggressive drivers, and establishing guidelines for citizens to report unsafe driving were the other major recommendations, requiring the cooperation of other sectors, including government officials and the cellular telephone industry.

Applied Technology. There are various recommendations in this category to promote wider use of enforcement-related technologies, such as in-car video cameras, automated speed and photo red-light enforcement cameras, laser speed-measuring equipment, and unstaffed radar speed display devices. Also recommended is facilitating better communications among different disciplines, including establishing data links from officers' reports and citation-writing functions to the prosecutor's office, and to court systems when appropriate. Other technology recommendations include increasing the use of computer technology in patrol cars to give officers access to license histories and previous stops, exploring the use of variable speed limit signs, and promoting Intelligent Transportation Systems (ITS) technology, particularly for its congestion relief benefits.

Charging Decisions. The main recommendation in this category was the criminalization of aggressive driving behavior through reckless driving statutes. Law enforcement, the judiciary, and legislators were instructed that when multiple violations occur together or in rapid succession, they should be charged as a criminal offense, with possible penalties of probation and imprisonment. The Implementation Team has suggested the development of written guidelines and training for prosecutors and law enforcement personnel to guide them in making appropriate charging decisions.

Sentencing Strategies. The primary recommendation in this category is for State legislatures to enact a broad range of criminal sanctions to provide judges with more sentencing flexibility. Another major recommendation was to make varying degrees of severity a part of penalty provisions in aggressive driving statutes, depending on the nature of the offenses and any aggravating circumstances. Criminal sanction statutes include license suspension or revocation, and judges making use of probationary conditions.

Community Leadership. The Implementation Team believes strongly in the power of business leaders, community organizations, and government officials to raise awareness about aggressive driving among their constituents. Public education and awareness help to turn the public against aggressive driving and to classify it as socially unacceptable *[137]*. The adoption of a zero tolerance stance is advocated with public awareness campaigns and community outreach by law enforcement, business, and community leaders for creating a powerful means for transforming attitudes towards the tolerance for aggressive driving.

Automated Enforcement

Automated enforcement can be defined as the use of image capture technology to observe and enforce traffic control laws, regulations, or restrictions. At places where the enabling legislation authorizes the use of automated enforcement, the image capture technology eliminates the need for a police officer to directly witness a traffic offense *[138]*. Automated enforcement systems use a camera with a trigger mechanism that takes a picture of the vehicle's license plate, when the driver of a vehicle commits a certain traffic violation. The alleged violator's license plate is then checked against a vehicle registration database. If state legislation allows, the vehicle owner may then be sent a warning letter or ticket in the mail. Different automatic triggers can detect RLR, speeding—both on freeways and residential streets—and railroad crossing gate running *[139]*.

Though many jurisdictions using automated enforcement are in states that have laws authorizing its use, all states where automated enforcement is in use do not have such laws, and they are not always necessary. Though most of the automated enforcement programs and laws are for red light violations, its use for speeding is also increasing, and a few jurisdictions are using automated enforcement for other violations such as failing to pay a toll and disobeying a railroad crossing signal *[131]*.

Red Light Camera Systems

Red light camera systems are triggered when a vehicle enters an intersection after the light has been red for a predetermined time. Such enforcement is needed because red light running is a leading cause of urban crashes. The Insurance Institute of Highway Safety research shows cameras can reduce red light running at intersections where the cameras are deployed and even at nearby intersections where they’re not in use. The Insurance Institute of Highway Safety’s recent review of red light camera studies around the world concluded that cameras reduce red light violations by 40-50 percent and reduce injury crashes by 25-30 percent. One study found a reduction of 68 percent in front-to-side impact injury crashes, the kind of crashes most related to red-light running *[131]*.

Use of red light cameras is becoming more common in the United States as a countermeasure to the million-plus motor vehicle crashes that occur each year at traffic signals. Red light cameras have been used for many years in Australia, Europe, and Asia. A red light camera system is connected to the traffic signal system and to sensors buried in the pavement at the crosswalk or stop line. The system continuously monitors the traffic signal, and the camera is triggered by any vehicle passing over the sensors traveling faster than a preset speed and a specified elapsed time after the signal has turned red. A second picture is taken of the red light violator in the intersection. The camera records the date, time of day, time elapsed since the start of the red signal, and the vehicle's speed *[140]*. Photographs are reviewed by public officials who issue tickets by mail to either the offending vehicle owner or the driver at the time of the offense, depending on state law.

Many states and local jurisdictions have undertaken studies and enacted programs in reaction to this major transportation safety concern. Red light cameras are in use in more than 100 U.S. communities, including the ones listed in table 17 by Insurance Institute of Highway Safety:

Tips and best practices from successful red light camera programs are given below:

Arizona. Citation recipients in Mesa, Arizona wishing to appeal their camera-issued ticket do so in a civil traffic court presided over by a judge familiar with the red light camera system. As part of the state's evidence, the defendant, the police representative testifying for the state, and the judge all have a packet of five exhibits that includes photographs of the offending vehicle running the light and a diagram of the site and the intersection. The police also have available an equipment inspection log certifying that the cameras were operational before and after the violation. A police officer arrives at the court fifteen minutes prior to the hearing and is available to go over the evidence with the defendant and answer any and all questions that he or she might have *[141]*. Defendants have 10 days to appeal the ruling. In Mesa, violators are sentenced to a $170 fine, traffic survival school, and demerit license points.

California. The red light enforcement program in Oxnard, California, began in July 1997 with 11 camera enforcement sites. Because of its status as one of the first programs in the United States, Insurance Institute of Highway Safety researchers analyzed crash data from the California Statewide Integrated Traffic Records System from before and after the

Table 17

Communities with red light cameras in U.S. *[131]*

Arizona Chandler Mesa Paradise Valley Phoenix Scottsdale Tempe **California** Bakersfield Beverly Hills Cerritos Compton Costa Mesa Culver City Cupertino El Cajon Fremont Fresno Fullerton Garden Grove Hawthorne Indian Wells Inglewood Long Beach Los Angeles City Los Angeles County Montclair Montebello Oxnard Pasadena Rancho Cucamonga Redwood City Sacramento City Sacramento County San Diego San Francisco San Juan Capistrano Santa Ana South Gate Ventura Upland West Hollywood Whittier **Colorado** Boulder Denver Fort Collins Northglenn	**Delaware** Dover Seaford Wilmington **District of Columbia** **Georgia** Decatur Marietta Rome Savannah **Illinois** Chicago **Iowa** Davenport **Maryland** Anne Arundel County Annapolis Baltimore City Baltimore County Bel Air Bladensburg Bowie Charles County Cheverly College Park Cottage City Forest Heights Greenbelt Howard County Hyattsville Laurel Landover Hills Montgomery County Morningside Prince Georges County Riverdale Park Rockville **New York** New York City	**North Carolina** Cary Charlotte Fayetteville Greensboro High Point Indian Trail Marshville Monroe Raleigh Rocky Mount Wilmington **Ohio** Dayton Toledo **Oregon** Beaverton Medford Portland **Rhode Island** Providence **South Dakota** Sioux Falls **Tennessee** Germantown **Texas** Garland **Virginia** Alexandria Arlington Fairfax City Fairfax County Falls Church Vienna **Washington** Lakewood

cameras were implemented in Oxnard *[142]*. The study found a 29 percent reduction in injury crashes and 32 percent reduction in right angle collisions. The data from these studies serve to help cities gauge their program's effectiveness and allow the public to track the safety benefits of their local program. Researchers noted that the cameras have a spillover effect at city intersections that weren't equipped with them. Red light running fell substantially at these intersections, too, and they are included in the measurement of the overall decline in red light running violations in Oxnard.

Colorado. The Colorado state legislature requires a monetary-only penalty written against the vehicle's operator instead of citations being issued to the registered owner of the red light running vehicle. The legislature mandated for photographs to be taken only of the front of a vehicle and a citation sent to the registered owner. The state then proves without doubt that the owner and the driver of the vehicle are the same person. The citation issuance rate for front-only photography is very low because, according to Colorado law, only cars with front license plates can be sent citations. It is also often difficult to positively identify the owner as the driver. Registered owners have the option of volunteering the name of the driver, but that is strictly voluntary and few people take the option *[141]*. One more drawback of front-only photography is that the traffic signal will not be visible in the photograph, which leads to frequent doubts from the alleged violator as to whether the light was actually red.

District of Columbia. The District of Columbia's Department of Public Works purchased a series of automated cameras for installation at high-risk intersections. The cameras capture violations on film and record relevant data such as the date, time, vehicle speed, and time elapsed since the beginning of the red signal. These images are analyzed, possible extenuating circumstances are considered, and the registered owner of the vehicle is verified. A citation for $75, along with a photograph of the violation, is then mailed to the vehicle owner. Throughout the city, 39 cameras were placed at intersections that were determined to have a high incidence of traffic signal violations and crashes. Street signs alerting drivers that automated enforcement is being used are positioned at strategic positions throughout the District, including major roads leading into the city. The general public is notified at least 30 days prior to the installation of a new camera, and all current positions are posted on the Metropolitan Police Web site.

As the cameras operate 24 hours a day, the enforcement of traffic regulations is more consistent, strategic and efficient. From October 2000 to March 2001, the Automated Red Light Photo Enhancement program achieved a 59 percent reduction of red light violations at the 39 intersections where the cameras are installed, which implies 22,737 fewer violations per month *[141]*. A portion of the money collected from each citation issued is used to fund the installation and maintenance of the photo equipment and to process violations. As a result, the program does not require any outside funding.

Maryland. The red light program in Howard County, Maryland, has dealt with 1,000 crashes, and injuries have dropped significantly. The program enjoys widespread public support. The county operates the program through a public-private partnership, with the police department bearing ultimate overall responsibility. The Howard County program also depicts the needs and advantages of having a close relationship between the police department and traffic engineering. The Howard County Police usually meet with professional traffic engineers to review and analyze high crash locations and determine what engineering changes could be initiated to reduce the incidence of crashes. If an engineering change can address the problem, then that countermeasure is used. Otherwise, red light camera enforcement is considered for the site. The traffic engineering division helps to evaluate camera systems and chooses locations to be monitored, while the police department has the responsibility of operating the cameras, processing the film, and preparing the violation notices. Howard County's red light camera operation takes place at the Regional Automated Enforcement Center in Columbia, Maryland, the largest facility of its type in the USA.

North Carolina. *Charlotte's SafeLight Program* is noted for its successful communication. The *SafeLight* program details are broadcast on billboards, bumper stickers, and bookmarks. The program is publicized on posters, in English and Spanish brochures, and in lesson plans for driver education instructors. A survey conducted by MarketWise, Inc., for the Charlotte Transportation Department, in July 2001, found that most people learned about the *SafeLight* program through television news, newspaper articles, cameras, and signs *[141]*. One third of respondents agreed that the program has changed their driving behavior. According to the survey, 98 percent of residents are aware of the program, and 84 percent believe the *SafeLight* program is beneficial to the community and has helped to reduce red light running. Statistics for the first three years of operation proved the public perception right. Red light running crashes dropped by 37 percent at *SafeLight* intersections and crash severity was reduced by 16 percent.

Ohio. The red light camera program in Toledo, Ohio, began in early 2001. It includes cameras monitoring 20 approaches at 10 intersections. The program used digital photography, which required more lighting than traditional photo finishing. Due to imperfect photography, several citations had to be thrown out. The police worked with the vendor to resolve such photography issues by increasing lighting for night photography and brightening pavement markings for better visibility. The intervals between each picture also had to be reduced in order to capture a series of photographs of vehicles entering the intersections at high speeds. The problems have been largely resolved and registered owners of violating vehicles in Toledo now expect to receive a citation by mail with three clear photographs—one of their car at the red light, one of the car proceeding through the intersection on the red, and their license plate.

Virginia. The importance of police and traffic engineers working together to ensure good intersection and traffic signal engineering is demonstrated by the red light camera program in Alexandria, Virginia. Alexandria police used crash data and red light running frequency to determine the locations of their red light cameras. The program learned that very short yellow lights were causing many people to run the red light. This generated complaints from the public and led to tickets being thrown out. The problem was rectified by hiring a traffic engineering consultant to re-time the yellow lights citywide. The city also found that the location of the camera-triggering sensor in the pavement is crucial because, if it is not placed properly, the back of longer vehicles may pass over the sensor on red even though the vehicle has proceeded legally on a yellow light. The experience in Alexandria underscores the importance of conducting a complete engineering study prior to program implementation.

By reminding drivers that red light running is a serious traffic offense and implementing highly conspicuous enforcement measures, Fairfax and other cities with red light camera programs significantly changed driver behavior. A valuable component of the Arlington, Virginia, red light camera program is citizen input. Arlington police involve the local citizens in the selection of intersections that should receive red light cameras by sending out requests for suggested camera locations to local civic associations. Citizen responses are then compared to police reports of high crash and violation sites to see if they coincide. Allowing the public to recommend sites has helped in gaining support for the program *[141]*. Placing cameras at intersections that a citizen has suggested makes them feel more connected to the process. If the proposed site is not selected because an intersection study shows that the RLR problem was not as severe as the citizen thought, that knowledge is still reassuring.

The crash reduction in various jurisdictions due to the red light camera enforcement is given in table 18.

Automated Speed Enforcement Systems

Automated speed enforcement systems are triggered when a vehicle exceeds the speed limit by a predetermined amount *[138]*. Though they have been used in many cities for several years, they are not as common as red light cameras. International use is wider; speed cameras have been used successfully in about 75 countries *[131]*. The nearest example is in Canada, where researchers in British Columbia documented a decline in crashes, deaths, and injuries the first year cameras were used. British Columbia has the biggest program with 30 speed cameras rotated throughout the province and such cameras are used in several cities in Alberta. Speed cameras also are being used on London's M25, one of the busiest roads in Europe.

Table 18

Crash reduction due to red light camera enforcement *[141]*

JURISDICTION	VIOLATION/CRASH REDUTION
OXNARD, CALIFORNIA	Injury crashes at intersections with traffic signals dropped 29% after camera enforcement began in 1997, and the reduction occurred at the intersections with ad without cameras
FAIRFAX, VIRGINIA	Red light violations declined 44% after one year of camera enforcement
WASHINGTON, D.C.	Red light running fatalities were reduced from 16% to 2% in the first two years of red light cameras
CHARLOTTE, NORTH CAROLINA	Red light running violations dropped by more than 70 % the first year
NEW YORK CITY	The city experienced a 62% decline in red light violations at camera intersections
HOWARD COUNTY, MARYLAND	In the four years the camera has been operational, the number of crashes at every camera location dropped with the declines ranging from 21% to 37.5%
SAN FRANCISCO, CALIFORNIA	Red light cameras led to a 68% violation rate reduction
LOS ANGELES COUNTY, CALIFORNIA	Experienced a 92% drop in violations
NATIONWIDE	*Automated Enforcement Of Traffic Signals: A Literature Review* reported violation reductions ranging from 20% to 87%, with half of the jurisdictions reporting between 40% and 62% reductions in red light violations

Enthusiasm for speed cameras is less than for red light cameras. This may be due to the awareness about overly aggressive traffic enforcement stemming from the image of speed traps. To counter this, cameras should be set to photograph serious speed violators, not motorists going just a few miles per hour faster than the limit. The best camera locations are at high-crash sites where speeding is a problem and in neighborhoods where local residents favor cameras to slow down through traffic. The cameras should not be placed on limited access high-speed roads where they could be perceived as high-tech speed traps. In Australia, speed cameras are deployed where there is a pattern of serious crashes. In the United States, speed cameras are being used successfully in Portland and Beaverton, Oregon, where they have been placed exclusively in neighborhoods and school zones. State law has prohibited such cameras on freeways. But in Colorado, the Denver Public Works Department acquired three speed cameras, intending to deploy them in neighborhoods with verified complaints of speeding. Instead, the police department put the cameras on interstates and freeways, causing concern from state legislators. Now the city is required to post warnings about camera use, and fines are limited to $40 and no points are assessed. The entire issue has wound up in litigation. The image of speed cameras as an effective supplement to police enforcement can be improved if proper procedures are followed, which include installing speed cameras at high-crash locations, careful evaluation of their effect in reducing crashes, and publicizing the results *[143]*. A recent Institute study showed that average speeds declined 14 percent within 6 months of implementing speed cameras in the District of Columbia. Moreover, the proportion of vehicles exceeding the speed limit by more than 10 mph declined 82 percent *[131]*.

Photo Enforcement at Railroad Crossings

Photo enforcement is being successfully used at railroad crossings also. Its efficiency led the National Transportation Safety Board (NTSB) to recommend the use of photo enforcement to catch violators who run lights and barriers. The NTSB noted that the use of photo enforcement at railroad crossings has led to a substantial reduction in collisions at camera-equipped crossings ranging from 47 to 51 percent in Los Angeles and the Illinois cities of Wood Dale and Naperville. In Naperville, the American Short Line and Regional Railroad Association notes that the number of motorists who ignore the warning gates has dropped more than 80 percent since the installation of video cameras by police. The Naperville police have photographed and ticketed violators at the crossing since June 2000, when cameras caught 315 cars rushing to beat the closing gates. After a month of enforcement, citations dropped from 315 to 174. They continued to drop until there were 62 in April 2001 and leveled off in 2002 to about 50 per month. About 110 trains and 10,000 cars pass through the intersection each day *[144]*. In 1995, the Los Angeles Metropolitan Transportation Authority (MTA) started a photo enforcement program that has been credited with reducing by almost 50 percent the number of grade crossing violations detected at 17 gated crossings along the Metro Blue Line route.

Technology

Almost all the automated enforcement systems function in the same way. In the case of red light cameras, the camera is connected to the traffic signal system and is able to monitor red, yellow, and green phases. Sensors are used to detect the vehicle and its speed. Once the light turns red, a vehicle traveling over the detectors will trigger the camera, causing it to take two photographs. One photograph shows the vehicle entering the intersection while the light is red and the second photograph shows the vehicle driving through the intersection on a red light. The cameras are set to photograph vehicles that enter the intersection after the light has turned red. They are not set to photograph vehicles that enter the intersection on a yellow light. As with most technologies, the abilities of automated enforcement change frequently. New improvements to the systems currently in operation include digital cameras, which enable law enforcement officers to download the photos via phone-lines without having to develop film. Also, some devices use video-based enforcement instead of photo enforcement *[140]*. One video-based enforcement device in Vienna, Virginia, not only detects the red light violation, but also triggers an extension of the red light signal for crossing traffic to help reduce traffic crashes in the intersection.

Automated enforcement of speed violations operate similarly. The camera is connected to a speed measuring device and a computer. The speed measuring device detects speeders and triggers the camera unit *[140]*. The photos, with the date, time, and speed recorded, are then used to determine the vehicle owner and tickets are generated and distributed.

A well-executed program which includes a clear, well-defined process coupled with good legislation from the beginning can increase efficiency, facilitate public acceptance, and improve the long term success of red light camera programs *[141]*. Though there is no set permanent formula addressing the specific needs and characteristics of each jurisdiction, some common steps in successful programs include:

- Step 1: Identify the safety problem and determine if red light cameras are an appropriate solution
- Step 2: Identify and enlist the support of key players
- Step 3: Establish program goals
- Step 4: Evaluate and select sites
- Step 5: Initiate multi-faceted public awareness campaign prior to program start and continue throughout life of program
- Step 6: Resolve legislative needs
- Step 7: Choose camera system and vendor(s) based on the jurisdiction's objectives, priorities, and resources
- Step 8: Implement the program using best management practices
- Step 9: Predict, acknowledge, and address public concerns
- Step 10: Evaluate and monitor program's success

Cell Phone Enforcement Programs

Opinions differ over the effectiveness of technological solutions to driver distraction problems. New York is the only state that prohibits the use of hand-held phones while driving, and there are very few crash statistics to indicate whether hand-held phone bans improve safety. In addition, New York's law is too new it is too early to determine if it has affected safety. Since the law went into effect in December 2001, New York law enforcement officers have issued more than 140,000 tickets to drivers for using hand-held phones. A March 2003 study by the Insurance Institute for Highway Safety showed that 2.1 percent of the 12,000 New York drivers observed were using hand-held phones. In comparison, a similar study found that 2.3 percent of drivers used handsets prior to the ban, and only 1.1 percent of drivers used hand-held phones immediately following enactment

[145]. Researchers suggested that, as the initial publicity generated by the new law waned, compliance fell with it.

Many academic studies, including one published in the New England Journal of Medicine *[127]*, suggest that the cognitive distraction caused by cell phone use is a problem that cannot be eliminated by hands-free requirements. Most have concluded that there is no distinction in accident rates between drivers who use hands-free and hand-held devices.

Driver education is often touted as a potential solution to driver distraction concerns *[146]*. Several wireless service providers and automobile manufacturers have launched campaigns to improve awareness of the risks of driver inattention. Cellular Telecommunications & Internet Association (CTIA) recently released, in conjunction with the National Safety Council, a public service announcement reminding drivers that using a phone in an automobile is always secondary to operating that vehicle safely. CTIA has also developed brochures and promoted safety through radio ads and other media.

A recent survey by AAA found that many state driver education manuals do not address driver distraction concerns. According to the study, driver's license manuals in only six states include a section on distracted driving. Twenty states warn drivers about cell phone use while driving. Thirty-two states urge drivers to be cautious with emotions and concentration. Eight states warn drivers about risks with eating or drinking, while nine include information on reading, and ten warn about radios and vehicle controls.

As legislatures have debated the merits of restrictions on cell phone use while driving, a second battleground over driver cell phone use has emerged in the courts. With increasing frequency, legal cases are testing whether drivers or, in some instances, the driver's employer should be held civilly or criminally responsible for crashes caused by the driver's use of a cell phone.

Although many activities can potentially divert driver attention, the cell phone has drawn attention to the issue. The cell phone is a highly noticeable distraction in the car, which makes it any easy target for restriction *[128]*. It is easy to spot a driver with a hand to the ear and know they are distracted by a phone call.

During the next few years, states and researchers will begin to accumulate more information about the implications of mobile phones and other devices on traffic safety. In the interim, as the quantity of phones and other wireless communications devices available on the road continues to grow, greater constituent concerns, local ordinances, and judicial activity will increasingly challenge lawmakers to address driver distraction as a traffic safety concern.

Alcohol and Drug Impaired Driving Enforcement

Impaired driving is a serious problem in the United States, killing thousands every year. Impaired driving, also known as drunk and drugged driving, is one of the most frequently committed violent crimes in America. More than 40 percent of all traffic fatalities in the United States are alcohol-related. In 2002, more than 17,400 were killed in alcohol-related crashes: on average, one death occurred every 30 minutes. NHTSA hopes implementation of its impaired driving initiatives will help reduce this number by 2,000, achieving a rate of .53 alcohol-related fatalities per 100 million vehicle miles traveled by the end of 2004.

The You Drink & Drive. You Lose. Campaign

The *You Drink & Drive. You Lose*. campaign was developed as a national partnership aimed at intensifying the battle against impaired driving. The campaign targets high-risk population groups such as underage drinkers, 21- to-34-year-olds, and repeat/high-BAC offenders. *You Drink & Drive. You Lose* provides a framework for state and local impaired driving prevention programs.

NHTSA convened an Integrated Project Team (IPT) to study the issue and develop a set of recommendations. The full report of the IPT recommends 16 separate initiatives covering a broad range of strategies *[134]*. However, the agency has identified three priority strategies that are currently being emphasized:

A. High Visibility Enforcement

Periodic high intensity and sustained enforcement crackdowns, sustained by a coordinated media plan, have proven to be an effective countermeasure for reducing impaired driving fatalities. *Checkpoint Tennessee*, a yearlong high visibility enforcement effort conducted in the mid-1990s, resulted in a 20 percent reduction in alcohol-related crashes *[147]*. Similar enforcement and media approaches in safety belt use have resulted, in eight percent point increases in belt use after just two weeks of enforcement.

High visibility enforcement programs, such as NHTSA's *You Drink & Drive. You Lose.* and *Click it or Ticket* campaigns, affect behavior by increasing the public's perception that people who violate the law will be ticketed, arrested, convicted, and punished, thus convincing them to adhere to the law. NHTSA's objective is to work with State Highway Safety Offices and national law enforcement organizations to engage additional law enforcement agencies in both periodic impaired driving crackdowns and sustained impaired driving enforcement throughout the year, and to ensure that enforcement efforts are highly visible and well publicized through paid and earned media support *[148]*.

NHTSA offers a variety of resources, including training programs addressing both alcohol- and drug-impaired driving, to support increased law enforcement participation.

B. Support for Prosecutors and DWI Courts

DWI cases are complex and in many jurisdictions, they are assigned to inexperienced prosecutors. Moreover, the turnover rate among prosecutors is high. According to a 2001 Bureau of Justice Statistics (BJS) survey, 58 percent of prosecutor offices in large districts have reported problems in recruiting staff attorneys and 72 percent have reported problems retaining them. A 2002 study by the Traffic Injury Research Foundation (TIRF) reports that 48 percent of prosecutors surveyed believe that the training they received prior to assuming their positions was inadequate. Encouraging jurisdictions to assign cases to more experienced prosecutors and promoting an infrastructure that ensures adequate training and sharing of knowledge among all prosecutors who handle DWI cases are critical elements in the effective prosecution and disposition of these cases. Also, many sentences are not completed and DWI offenders have a high rate of recidivism. Drug courts have been established to ensure drug offenders comply with sanctions after sentencing, and they have been successful in reducing recidivism rates *[148]*. Similar findings have been observed in DWI courts, which employ the same type of close supervision used by drug courts.

C. Screening and Brief Intervention

Impaired driving is often a symptom of alcohol misuse. Screening and brief intervention is found to be effective in reducing drinking and impaired driving behaviors among problem drinkers.

More than 100 million people seek care in emergency departments every year. Almost one in six traffic crash victims treated in these departments is alcohol positive and one-third or more of crash victims admitted to trauma centers, those with the most serious injuries, test positive for alcohol. These patients pose not only a public health problem but also an opportunity for intervention. NHTSA is working with physicians and other health care providers to increase routine screening of adults and adolescent patients for alcohol abuse problems, and facilitate brief counseling and referral of patients for treatment of alcohol dependency, as appropriate *[148]*. To help achieve this goal, the agency seeks endorsements and enlists the support of leaders in the medical and health care community.

Checkpoint Laws

Sobriety checkpoints stop every vehicle or a specific sequence of vehicles at a predetermined, fixed location to detect impaired drivers. Sobriety checkpoints allow officers to stop vehicles without any suspicion of wrongdoing. To be judicially acceptable, sobriety checkpoints must satisfy two general goals:

- The checkpoint should be reasonably effective in detecting and preventing impaired driving.
- The checkpoint should be minimally intrusive to the motorist.

Successful sobriety checkpoint strategists advocate that this type of enforcement activity be integrated aggressively with a continuous, systematic public information and education effort. This approach maximizes the general deterrent effect and increases the perception that motorists who operate a vehicle while impaired by alcohol or other drugs are apprehended.

Sobriety checkpoints have long been recognized as an effective impaired driving enforcement method. Until recently, checkpoints have generally been implemented in the United States on a local level. While these results have been encouraging, very few states in the U.S. have embarked on statewide sobriety checkpoint programs. Based upon their potential effectiveness, and the strong evidence from Australia on their random breath testing (RBT) program, the NHTSA conducted a demonstration project in a state that was willing to change its philosophy and approach about checkpoints.

In 1993, NHTSA entered into a cooperative agreement with the State of Tennessee to conduct a highly publicized sobriety checkpoint program throughout the state and evaluate the effects of that program *[147]*. In March 1994, Tennessee initiated a statewide impaired driving checkpoint program named *Checkpoint Tennessee*. The NHTSA grant funded equipment purchases, some logistics, and the evaluation. The personnel required to staff the checkpoints were provided though diversion of existing resources in the Tennessee Highway Patrol. Four sets of three checkpoints were conducted throughout the state every weekend using specially equipped vans with generators, lights, cones, signs, video taping, and evidential breath testing equipment. Officers also used passive alcohol sensors in flashlights to detect the odor of alcoholic beverages, and used standardized field sobriety tests to detect impaired drivers. On five weekends during the project year, checkpoints were scheduled in each of the 95 counties in the state.

The checkpoints were coordinated and conducted primarily by the Tennessee Highway Patrol with support from local law enforcement agencies. Publicity in support of the program was gained through special cooperation of a single television station in each of the five major markets in the state. They each broadcast *Checkpoint Tennessee* as a special project. This publicity was enhanced by news coverage from other outlets, a statewide billboard campaign, and press releases announcing individual checkpoints, followed up by reports of the results in terms of arrests, etc. Television, radio, and print media coverage was extensive during the 12-month operations phase of the program.

Three waves of a paper and pencil survey were administered in several drivers' license renewal offices to measure knowledge and attitudes about the program. The results of several questions indicated that the *Checkpoint Tennessee* program was not only recognized, but also widely supported. Between April 1, 1994, and March 31, 1995, a total of 882 checkpoints were held. A total of 144,299 drivers passed through these checkpoints, with 773 arrested for driving under the influence of alcohol (DUI) or driving while intoxicated (DWI). An additional 201 drivers were arrested for drug violations, 84 for youth offender violations, 35 felony arrests were made, 49 weapons were seized, 1,517 were cited for safety belt or child restraint violations, and 7,351 were given other traffic citations.

While other statewide sobriety checkpoint programs have been initiated in the U.S., Tennessee's program is of interest because it resulted in a significant decrease in alcohol-related traffic fatalities with relatively low implementation costs. The total cost of the two-year demonstration project was $927,594, with federal funding at $452,255, and state matching funding at $475,339. The state contribution covered police salaries, publicity costs, and other program expenses. The police salary contribution was accomplished by a reallocation of effort to this endeavor rather than through additional funding. NHTSA funding covered some public information and education materials, equipment, and program evaluation. The Tennessee approach to checkpoint scheduling might be characterized as a "sustained checkpoint blitz" effort with several checkpoints each weekend as opposed to a quarterly or bimonthly blitz as implemented in North Carolina and New Mexico, respectively.

Many of the reasons for not using sobriety checkpoints (e.g., they are too expensive, require too much personnel, do not yield enough DWI arrests) are being overcome by the results of this program and of those in North Carolina and New Mexico. A recent study shows that sobriety checkpoints yield greater public awareness of the program and greater decreases in alcohol-related crashes than an enforcement program involving roving patrols *[147]*. The premise of highly visible, highly publicized, frequent sobriety checkpoints conducted on a statewide basis appears to be a viable, effective deterrent to impaired driving.

An effective sobriety checkpoint program consists of the following components:

- Ongoing program to deter impaired driving
- Judicial support
- Existing departmental policy
- Site selection
- Special warning devices
- Visible police authority
- Chemical testing logistics
- Contingency planning
- Detection and investigation techniques
- Operational briefings
- Comprehensive public information and education programs
- Data collection and evaluation

Suspended License Program

Driving with a suspended or revoked license is not a new phenomenon. It reflects a rising number of drivers with multiple suspensions or revocations who are identified and arrested after causing a major crash *[149]*. State motor vehicle officials estimate that as much as 80 percent of drivers with suspended or revoked licenses are continuing to operate motor vehicles.

A study by the National Sheriff's Association disclosed numerous programs focusing on the operator or the vehicle. A program named "Hot Sheet," used by the Ohio and Florida State Highway Patrols, was determined to be the most viable. By scrutinizing a computer printout supplied by the Department of Motor Vehicles, law enforcement officers can extract the names of the most chronic offenders. The program was modified to meet the needs of local law enforcement agencies and then pilot tested for nine months in Ohio County, West Virginia and Salt Lake County, Utah.

Salt Lake County, a community of 850,000 people, has an average of 50,000 suspended drivers at any given time. The target populations for their program were the 3,000 drivers whose licenses were suspended for impaired driving. As the list of offenders was being formalized, local officials found one individual who had been suspended 50 times! The pilot test in Salt Lake County produced 131 separate "hot sheets." Working from these sheets, deputies increased the number of persons arrested for operating after suspension or revocation by 14 percent.

Ohio County experienced their greatest success when using the "Hot Sheet" program at traffic check points. The biggest problem in Ohio County was its close proximity to Pennsylvania and Ohio. Operators facing suspension or revocation sanctions could obtain a legal driver's license from either of the two neighboring States before their names were entered into the National Driver Register (a National Highway Traffic Safety Administration program designed to prohibit multiple licenses).

Operating with a suspended or revoked license is an undetectable offense to the eye of law enforcement officers. Because no clues draw attention to the violator, officers refer to this as an "invisible traffic violation." Unlike speeding, non-use of safety belts, or driving while impaired, driving with a suspended or revoked license is an offense that cannot be observed by patrol officers and clues cannot be articulated to justify a legal traffic stop. Enforcement personnel may stop a vehicle only with other justification, such as another traffic violation, lawfully approved checkpoints, or have prior knowledge that the vehicle is being operated by a suspended or revoked driver. As more States pass legislation invoking administrative license sanctions, the number of drivers operating with suspended or revoked licenses will grow.

Youth Programs

States and communities have conducted extensive youth drinking and driving programs in the past two decades. These programs seek to motivate youth not to drink and drive through positive means—such as by education on crash and injury risks posed by drinking and driving and the effects of alcohol use and abuse, by providing positive role models that discourage alcohol use, by establishing youth norms that do not include alcohol, and by encouraging youth activities that do not involve or lead to alcohol use. Other organizations concerned with traffic safety like insurance companies, automobile manufacturers, Mothers Against Drunk Driving (MADD), and many others do the same through public education and specific program activities.

Little direct evidence exists on the effects produced by these activities. Very few have been evaluated to determine their effects on youth knowledge, attitudes, behavior, traffic violations, or crashes. A few well-organized and well-funded community programs have reduced youth drinking and driving after drinking. Some school programs have affected students' knowledge and attitudes and may have affected their behavior. But no direct evidence proves that the youth safety programs not involving laws and enforcement have had a direct effect on youth drinking and driving or not. The accumulation of information, education, skills, role models, and the like provided by these programs may have been a crucial influence in the youth attitude, behavior, and crash changes that have occurred.

California Programs

Over the past several years, the California Department of Transportation (Caltrans) has developed and implemented a variety of successful and innovative enforcement programs, many of which have been adopted by other law enforcement agencies throughout the nation, and in some cases throughout the world. These DUI countermeasures include:

Active Support of California's Tough DUI Laws - Caltrans aggressively enforces the state's 0.08 percent BAC law, Administrative Per Se (immediate driver license suspension), 0.04 percent BAC law for commercial vehicle drivers, 0.01 percent BAC out-of-service requirement for commercial vehicle drivers (24-hour tie-up), and the 0.01 percent BAC limit for drivers under 21 years of age.

Sobriety Checkpoint Operations - Sobriety checkpoints are staffed by California Highway Patrol (CHP) officers who are trained in the detection of alcohol and/or drug impaired drivers. CHP's goal in conducting these checkpoints is to ensure the safety of each motorist traveling on California's roadways by targeting areas noted for high frequency of alcohol and/or drug impaired driving. The Department began sobriety checkpoint operations in 1984 and by December 31, 1995, had conducted 2,036 sobriety checkpoints throughout the state, which resulted in 1,150,180 vehicles being screened; 28,940 field sobriety tests (FSTs) conducted; 9,777 impaired drivers arrested, and citing and/or arresting 2,944 persons for other violations. In addition to assisting the Department in its effort to detect and remove alcohol and/or drug impaired drivers from California's roadways, these sobriety checkpoint operations also increase the public's awareness of the hazards of drinking and driving, and in many cases serve as a deterrent to those drivers who might otherwise drive while impaired.

DUI Proactive Overtime Enforcement Programs - The use of grant-funded overtime programs enable the Department to significantly increase the number of officers on patrol statewide and to deploy them at times and locations where a high incidence of DUI-related traffic accidents have occurred. The additional resources have enabled the Department to significantly reduce the number of DUI-related traffic accidents in the targeted areas.

DUI Task Force Operations - As resources permit, specialized enforcement units, or task forces, are established to target DUI enforcement in CHP areas experiencing a high incidence of DUI-related traffic accidents. These task forces operate from a central location, providing on-site chemical testing and processing of prisoners. This stream-lined operation allows for a quicker return of field officers to DUI enforcement duties and greatly enhances CHP's ability to position a maximum number of available officers to detect and arrest impaired drivers.

Drug Recognition Expert (DRE) Program - Over 1,300 CHP officers are trained in the specialized skill of detecting drug influence through a twelve-step evaluation process. These specialized skills have greatly improved the CHP's ability to remove the substance-impaired driver from the state's highways. Over 5,400 evaluations of suspected impaired individuals were performed in 2001. Additionally, CHP's DRE instructors have trained over 500 allied agency officers in these specialized skills.

DUI Cost Recovery Program – As specified in the California Government Code (Section 53150), any person who is under the influence of an alcoholic beverage and/or any drug, whose negligent operation of a motor vehicle causes any incident resulting in an emergency response, is responsible for the costs associated with a public agency's emergency response to the incident. The Department began billing for DUI cost recovery on a statewide basis on January 1, 1989. Currently, only those drivers who are determined to be under the influence of alcohol and are at fault in traffic accidents investigated by the Department are billed for DUI response costs. From January 1, 1991, through August 1, 1995, the Department billed for approximately $9,306,476 in DUI emergency response costs (38,897 incidents), of which approximately $4,728,350 was collected. The average invoice amount is $239.26, and the money collected through the DUI cost recovery program goes to the Motor Vehicle Account (MVA). This program holds DUI drivers accountable for their actions by making them criminally and financially responsible.

Misdemeanor DUI Cite and Release Program - The objective of this program is to increase available patrol hours for detection and apprehension of DUI violators, as well as other emergency services to the public. Under this program, a suspected DUI driver is arrested, required to provide a chemical test of their blood, breath or urine, and, if they meet established criteria (e.g., proper identification, no prior DUI convictions, not under the influence of drugs, not violent, not a danger to themselves or others), they are released to a responsible sober adult. CHP areas that operate this program within their jurisdictions have received the endorsement of local sheriff's departments, prosecutors, and courts.

Non-consensual Chemical Testing Program - Implied consent laws were intended to avoid confrontations with intoxicated persons by providing for the suspension of their driving privilege for refusing to submit to a chemical test. The enactment of implied consent laws did not, however, eliminate the option of forcibly taking blood samples from persons arrested for DUI who refuse to consent to a chemical test to determine their BAC. The Department has two non-consensual chemical testing (NCT) programs: the standard NCT program and the enhanced NCT program. The standard NCT program applies to all felony arrests where alcohol or drug influence is an element of the offense, and the enhanced NCT program applies to all arrests where alcohol or drug influence is an element of the offense.

Drug Interdiction Activities - The Department became involved in drug interdiction activities in 1988, after realizing the increased potential of departmental personnel stopping and contacting drug traffickers. In 1995, the CHP ranked number one in both heroin and methamphetamine seizures throughout the nation. Additionally, the Department's drug interdiction program resulted in 13,506 pounds of marijuana being removed from the state's highways in 1995 alone. Seizures of this magnitude help reduce the quantity of drugs available in California, thereby reducing the likelihood of a drug impaired driver getting behind the wheel of a motor vehicle.

Preliminary Alcohol Screening (PAS) Device Program - Through federal grant funding, the Department has equipped CHP officers with over 2,200 PAS devices and has given over 2,400 PAS devices to law enforcement agencies throughout California. Preliminary Alcohol Screening devices are state-of-the-art hand-held breath testing instruments that provide an on-the-spot accurate measurement of blood alcohol concentrations of suspected drunk drivers. These devices are also used to refute or negate a driver's contention that their impairment is based upon alcohol consumption when they are suspected of being under the influence of an illicit drug.

Occupant Protection Enforcement Programs

Although seatbelts have been installed in automobiles since the 1950s, the seatbelt use rate was only 14 percent as late as 1984. The use rate grew rapidly to 42 percent by 1987, as 31 states passed seatbelt use laws, and the rate continued to increase each year as additional states adopted seatbelt legislation. In 1998, the national seatbelt use rate was 69 percent. In 1997, President Clinton initiated the Buckle Up America Campaign. The goal of the campaign was to increase seatbelt use to 90 percent by 2005. The four elements of the plan are building public-private partnerships, enacting strong legislation, conducting well-coordinated education, and maintaining active, high-visibility enforcement *[150]*. Recent advances have been made in achieving and publicizing high-visibility enforcement will enable communities to reach the 90 percent belt use goal.

Buckle Up America

Buckle Up America is a national campaign to increase the correct use of safety belts and child safety seats—changes that will save lives and prevent injuries. The Buckle Up America Initiative (BUA) began when the Secretary of Transportation was directed to prepare a plan to increase seatbelt use nationwide. In response, the NHTSA developed a plan calling for new partnerships, enactment of new legislation, strong enforcement, and expanded public information & education efforts *[151]*. The specific goals of the plan aimed to increase seatbelt use to 85 percent by 2000 and 90 percent by 2005, and to decrease fatalities in children under the age of five by 15 percent by 2000 and by 25 percent by 2005.

Occupant Restraint Use. National Occupant Protection Usage Survey (NOPUS) results indicated that belt usage increased from 1994 to 1996 and even more so during the early years of BUA, from 1996 to 1998. NOPUS data for 2000 indicated that the usage rate was still improving (figure 19).

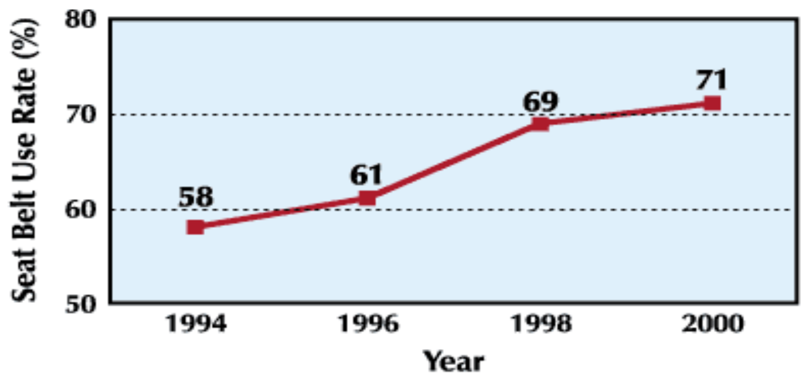


Figure 19

National occupant protection use survey front seatbelt use rate *[151]*

State-reported belt use rates for 1998 indicated that usage was above 85 percent in only one state, California, and at or above 80 percent in four states (MD, NM, OR, HI) and the District of Columbia. All of these locations allow primary enforcement of the seatbelt law (figure 20).

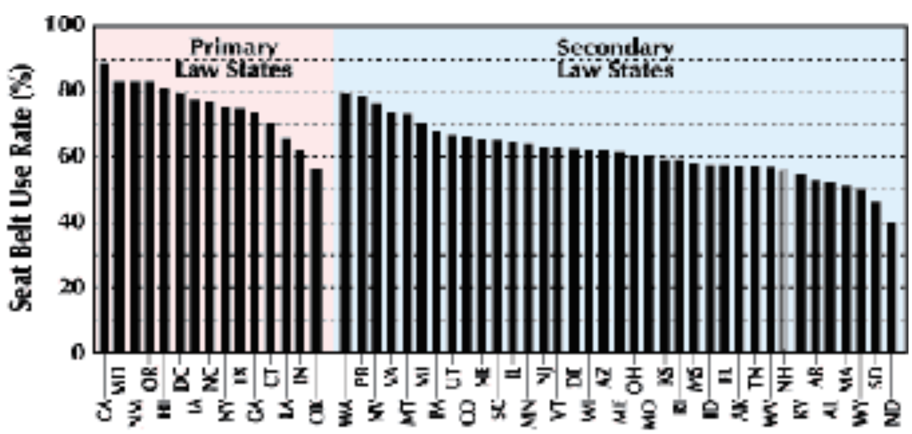


Figure 20

State reported seatbelt use rates, 1998 *[151]*

NOPUS results of child safety seat usage indicated that the use rate improved from 1996 to 1998 (1998 results are preliminary). The largest improvement was for children ages one through four. Improvement also occurred for older children, ages five through fifteen (figure 21).

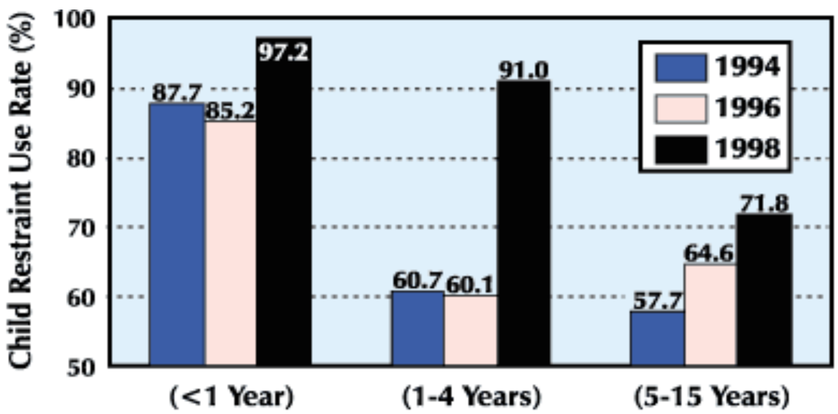


Figure 21

National occupant protection use survey children <5 Years *[151]*

Fatalities to Children under Age Five. Table 19 presents the number of child fatalities by type of restraint. During BUA, large strides to decrease fatalities to children under age five were accomplished. Fatalities decreased dramatically for children under age one (-20.9 percent) and were noticeably reduced for children ages one through four (-8.6 percent). Fewer fatalities occurred in situations where no restraint was used, and fewer occurred for children using child seats. The fatality data support the conclusion that more children were buckled up over time.

Enforcement. Seatbelt and child safety seat enforcement increased under the umbrella of BUA programs. Seatbelt enforcement data, collected from 32 states, indicated that citations issued increased in number (7.8 percent across all states) and on a per-resident basis (5.7 percent). Child seat enforcement data, collected from 29 states, indicated that citations issued also increased in number (8.3 percent across all states) and on a per-resident basis (6.1 percent). Results varied according to city size, state police, and type of law, primary or secondary.

Buckle Up America is still far from its goal of 85 percent belt usage nationwide in 2000, though progress has been made *[151]*. Buckle Up America has made remarkable progress towards its goal of decreasing fatalities of children under five years of age.

Table 19

Number of child fatalities by type of restraint *[150]*

	1996	1997	1998	1996-1998 Percent Change
Under Age 1	**177**	**135**	**140**	**-20.9**
None used	85	62	75	-11.8
Child Seat	86	71	61	-29.1
Adult Seatbelt	6	2	4	-33.3
1-4 Years Old	**476**	**468**	**435**	**-8.6**
None used	253	266	219	-13.4
Child Seat	137	123	123	-10.2
Adult Seatbelt	86	79	93	8.1
Total	**653**	**604**	**575**	**-11.9**
None used	338	329	293	-13.3
Child Seat	223	194	184	-17.5
Adult Seatbelt	92	81	97	5.4

Selective Traffic Enforcement Program (sTEP)

High seatbelt use rates are directly related to vigorous enforcement of a comprehensive belt use law. A Selective Traffic Enforcement Program (sTEP) produces large gains in belt use over short periods of time *[150]*. Continuing enforcement between periods of sTEP activity maintains these gains.

Canada was the first country in North America to demonstrate that highly publicized occupant protection enforcement can increase compliance with seatbelt laws. In the mid-70s, following passage of Canada's mandatory seatbelt laws, usage surged as high as 71 percent within months, but then declined. High visibility, short-duration enforcement programs, conducted in several provinces, led to sharp increases in belt use. Continued use of occupant protection sTEPs contributed to Canada's achievement of an 87 percent use rate by the early 1990s. New York State experienced a similar rise and subsequent decline in belt use rates following its passage of the first statewide seatbelt law in 1984.

In 1985, Chemung County, New York, implemented an enforcement program based on the Canadian model. The *Elmira Program* demonstrated that periodic sTEPs can increase use of passenger restraints in the U.S. The first sTEP conducted in Chemung County increased belt use from 49 percent to 77 percent in three weeks. A second sTEP conducted in spring 1986 produced a peak belt use rate of 80 percent. In North Carolina, seatbelt use rates rose to 78 percent shortly after a primary law was passed in 1986, but then declined to 65 percent by

1993. The state conducted a series of occupant protection sTEPs in 1994 and increased driver belt use to 81 percent. Later in 1994, NHTSA funded further tests of statewide sTEPs in New Mexico, South Carolina, Vermont, and Oregon. The result was an overall increase of four percentage points in belt use in participating communities. NHTSA's Campaign Safe and Sober funded sTEPs in 20 states in 1996 and 1997. More than a quarter million seatbelt citations were written as part of sTEP enforcement activity. Belt use increases averaged +8 percentage points in secondary law states (where an officer needs some other reason to stop a vehicle) and +21 percentage points in states with primary laws (where an officer can stop a vehicle based on an observed belt law violation alone). In the states completing at least five sTEP waves, the largest increases in belt use rates occurred during the first sTEP (wave 1). Smaller increases were seen through each successive sTEP wave (waves 2-5) in both primary and secondary law states.

Buckle Up NOW in Elmira

In October 1999, NHTSA and the Insurance Institute for Highway Safety contracted with the Preusser Research Group, Inc., to conduct an updated "Elmira" sTEP in Chemung County, New York. The goal was to demonstrate that seatbelt use can be increased to achieve the President's 90 percent goal. The belt use rate in Chemung County on October 1, 1999, was 63 percent. In just three weeks, belt use increased to 90 percent. Occupant restraint sTEP enforcement has been evolving as public attitudes change and new strategies are developed and tested. The primary goal of the Buckle Up NOW sTEP in Elmira was to develop an updated program capable of achieving 90 percent belt use. The first 1985 Elmira sTEP was a three-week program of publicity, followed by warnings and publicity, followed by citations and publicity. Over the course of this program, approximately three warnings were issued for every citation. While some belt use checkpoints were implemented, checkpoints were not a central component of the first Elmira sTEP. In later sTEPs, as belt use laws became more widely accepted by the public, warnings were issued less frequently. The 2nd generation sTEP model called for a period of "soft" publicity about the value of wearing a seatbelt; followed by a brief period of "hard" publicity during which the public was told that intensified enforcement was coming; followed by a period of intensive enforcement with continued publicity. The Buckle Up NOW sTEP in Elmira began with a brief period of direct, sharply focused, "hard" publicity, and then moved immediately to no-excuses high-visibility enforcement. The media plan was designed to reach every motorist in the target area *[152]*. Checkpoints were used extensively since they are the most visible enforcement strategy. The enforcement goal was to make it virtually impossible to drive without getting a citation when not wearing a seatbelt.

Enforcement for Buckle Up NOW! in Chemung County. The two-week enforcement blitz conducted in Chemung County included the following:

- 32 seatbelt checkpoints conducted throughout the county in a 12-day period
- At least 3 checkpoints conducted each weekday
- 823 traffic tickets written
  - 474 seatbelt citations
  - 10 child restraint citations
  - 236 tickets for other non-moving violations
  - 103 citations for moving traffic violations
- 1 person arrested for DWI and 4 persons arrested for non-traffic related crimes

Click It or Ticket (CIOT)

Selective Traffic Enforcement Programs (sTEP) for seatbelt enforcement are now almost commonplace in most states. The enforcement period is usually supported by a public information and education campaign alerting motorists that they will be ticketed for non-compliance with the seatbelt law. Federal funding for paid advertisements are leading states into committing resources towards the placement of enforcement-focused advertisements that warn motorists to buckle their seatbelt or receive a ticket *[153]*. Currently sTEP programs are beginning to rely on large amounts of paid advertising to quickly and substantially increase the seatbelt use rate. The most notable sTEP model is Click It or Ticket (CIOT).

Click It or Ticket is an intensive and short duration traffic law enforcement program with the objective to raise seatbelt use statewide. The program consists of intensive, widespread enforcement of states' seatbelt laws coupled with earned and paid media that publicize the enforcement effort. Specifically, paid advertisements directly inform the motoring public about the enforcement campaign and the paid media employs "Click It or Ticket," or similar direct enforcement message, as its tag line. CIOT has positively influenced belt use in a number of states in the southeastern U.S. CIOT relies heavily on paid media to reach all motorists. Ten states that implemented CIOT during May 2002 were compared with four states that conducted belt use enforcement with limited specific paid advertisement placement and four states that conducted enforcement without specific paid advertisement placement. Belt use increased an average of 8.6 percentage points across the ten CIOT states; 2.7 percentage points across the four limited paid advertisement placement states; and 0.5 percentage points across the four states using no specific paid advertisement placement. Phone and paper and pencil surveys verified that more drivers in the CIOT states were aware of the heightened enforcement than in the limited or no specific paid advertisement placement states *[153]*. Belt use enforcement that is highly publicized through paid media can achieve a substantial increase in a state's overall belt rate.

Occupant Protection Special Traffic Enforcement Programs (OP sTEP*)*
Occupant Protection Special Traffic Enforcement Programs consist of highly visible seatbelt law enforcement combined with extensive media support. Beginning in the last calendar quarter of 1995, 20 states participated in NHTSA funded OP sTEP programs. States awarded a demonstration grant were required to carry out periodic waves of highly visible law enforcement coupled with extensive media support. Seatbelts, child restraints, and impaired driving were to be emphasized. Participants were asked to follow a five-step demonstration model as a guide and report on activities. At the conclusion of all activities, states would provide a final report that comprehensively documented all program activity over the grant period and related outcomes. State programs varied, but all committed to periodic waves of increased publicity and enforcement. Activity was generated from both state and local levels *[154]*. The goal was a coordinated, multi-agency effort indicating a unified state concern for occupant protection issues.

The foremost focus for OP sTEP programs was seatbelt use. During periodic waves enforcement, one-quarter of a million seatbelt citations (273,437) were issued; only speeding citations were more numerous (391,605). Additionally, over half a million other citations were issued. Secondary law states issued fewer seatbelt citations than primary law states, 21 percent versus 46 percent respectively. Nevertheless, case studies found that programs were noticeably effective in changing police officers' practices regarding seatbelt enforcement, especially in secondary law states.

Widespread publicity efforts usually accompanied periods of enforcement. Nearly 300,000 various public information and education (PI&E) items were printed, aired or distributed to the public, a number known to underestimate what actually occurred. Press releases appearing in newspapers were most common. Other PI&E items included public service announcements, interviews, handouts, and billboards. Local law enforcement agencies generated a significant proportion of the publicity. Seatbelt use rates improved every calendar quarter with the greatest gains in the first three quarters. Secondary law states did not achieve the same level of positive change as primary law states. Figure 22 presents the results for some states. The average percentage point difference across secondary law states was +5.6 percentage points compared to +16.8 percentage points for primary law states.

OP sTEP program grants generated incremental enforcement efforts against seatbelt violations supported by extensive publicity efforts. Primary law states, as a group, achieved higher increases in belt use than secondary law states. Stricter laws supported with serious enforcement and publicity send the motorists a stronger message that the state is concerned for the motorist's risk of injury.

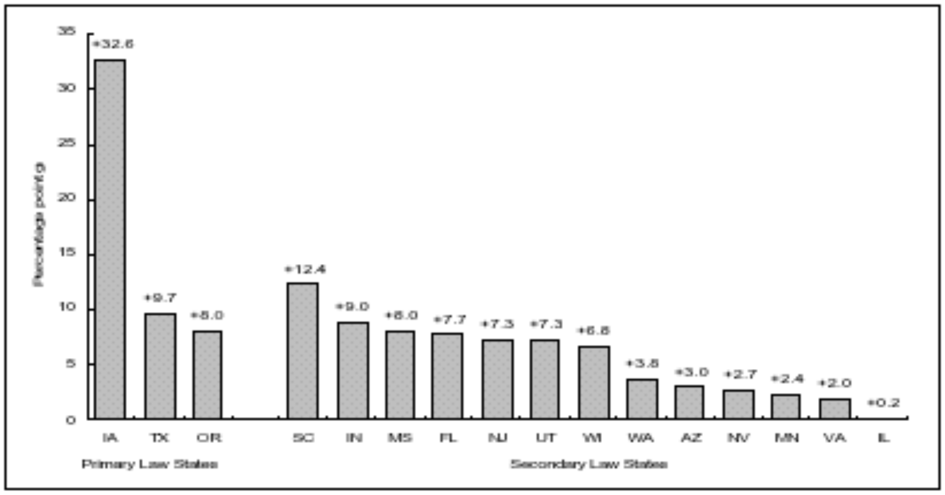


Figure 22
Percentage point difference in seatbelt use rates *[154]*

Achieving a High Seatbelt Use Rate
Research has found that lap/shoulder safety belts, when used, reduce the risk of fatal injury to front-seat passenger car occupants by 45 percent and the risk of moderate-to-critical injury by 50 percent. For light truck occupants, safety belts reduce the risk of fatal injury by 60 percent and moderate-to-critical injury by 65 percent. The first mandatory belt use law was enacted in the State of New York in 1984. As of December 2000, 49 states and the District of Columbia had belt use laws in effect. The laws differ from state to state, according to the type and age of the vehicle, occupant seating position, etc.

A 1995 NHTSA study, *Safety Belt Use Laws: An Evaluation of Primary Enforcement and Other Provisions*, indicates that states with primary enforcement safety belt laws achieved significantly higher belt use than did those with secondary enforcement laws. The analysis suggests that belt use among fatally injured occupants was at least 15 percent higher in states with primary enforcement laws. States that have passed and effectively implemented standard enforcement laws have seen their seatbelt use increase from 10 to 18 percentage points. Some states have sustained belt use in the mid and high 80 percent range for several years.

Two key ingredients are essential: enforcement actions by police and publicity around the enforcement, so even those who never get ticketed might change their behavior by observing others who are ticketed. States that have successfully implemented standard laws and have seen seatbelt use rise dramatically emphasize that it is a combination of repeated high visibility law enforcement and widespread promotion of enforcement efforts that gets people to put their seatbelts on—every time they get in a car.

Some key enforcement practices in various states are explained below:

North Carolina. North Carolina's ongoing CIOT campaign has propelled statewide seatbelt use to 82 percent—one of the highest in the nation. In the fall of 1993, the CIOT campaign followed a combination enforcement/education approach and saw seatbelt use go up 17 percentage points. In the spring of 1994, however, only the public information and education component was employed, without enforcement. Belt use went down 8 percentage points and the combination model was validated as the most effective strategy. At the beginning of 2000, the revitalization of CIOT increased seatbelt use to above the 80 percent level again.

Indiana. In Indiana, the Marion County Traffic Safety Partnership created "Enforcement Zones." Enforcement Zones are not checkpoints, but are designated areas where police are stationed to stop cars whose drivers or passengers are not using seatbelts or child restraints. Posted signs advise motorists that they are passing through an Enforcement Zone and other signs show the current seatbelt use rate, as well as the highest previously recorded rate. Curb lanes are coned off, violators are stopped and ticketed, safety materials are handed out, and officers call dispatch on drivers without licenses, registrations, or in other unusual situations. Each Enforcement Zone lasts two to four hours. They are held primarily at high-crash areas, school zones and areas with low seatbelt usage. During the first six months of Enforcement Zones, in combination with public awareness, Indiana's passenger car seatbelt use rate increased 5 percentage points and pickup truck seatbelt use rose 12 percentage points, even though the State's law does not apply to pickup trucks.

South Carolina. South Carolina's secondary seatbelt law allows for primary enforcement during safety checkpoints. As part of its CIOT checkpoint program in late 2000, the State spent nearly $500,000 on a statewide paid media campaign, in addition to extensive earned media efforts. The television and radio advertisements that ran over a two-week period before and during enforcement waves were highly targeted and contained a clear enforcement message. Pre- and post-effort surveys showed that the paid media spots generated the most awareness. More people were aware of the campaign through TV ads (63 percent) than through TV news (25 percent), newspapers (24 percent) or radio ads (18 percent). All population segments surveyed (urban/rural, black/white, male/female, low/high income) responded highest to the paid television spots. Overall observed seatbelt use in the State increased by eight percentage points.

Enforcement Strategies

Enforcement efforts involve checkpoints, saturation patrols, regular patrols, or a combination. The particular type of enforcement will vary based on state laws, size of agency, and staff resources *[150]*. The goal in selecting enforcement strategies is to let the road users know that there is near certainty of a ticket if they don't wear their seatbelt.

Checkpoints. Checkpoints are the most visible type of occupant protection enforcement. Productivity is highest when checkpoints are done in daylight hours and when officers are posted to spot violators before the vehicles reach the checkpoint location. Checkpoints should be conducted on weekdays and weekends, at different locations, and at different times of the day. Checkpoint Advantages include the following:

- Checkpoints offer the opportunity to make many contacts with drivers in a short time period
- They usually earn a great deal of news coverage
- Occupant protection checkpoints can be performed successfully with as few as two to four police officers
- Sometimes arrests are made for other criminal offenses
- Checkpoints involving several enforcement agencies reinforce a unified enforcement image.

Saturation Patrols. Checkpoints may be supplemented with saturation and foot patrols. Saturation-type enforcement may be necessary in secondary law states and in jurisdictions that do not permit checkpoints. Saturation patrols assign officers to a designated area, which includes posting officers at intersections along a corridor or assigning roving patrols to an area of the city. They are a good strategy for several law enforcement agencies working together because a united front is presented. Saturation enforcement may be achieved by re-deploying officers on regular shifts to a concentrated area or by bringing in extra officers on overtime. The purpose is to raise the perception of risk among the public by making the enforcement activities highly visible.

Regular Patrols. Enforcement of seatbelt and child passenger safety laws should occur also on regular patrols. During the sTEP enforcement blitz, all officers emphasize safety belts. This is particularly important for those law enforcement agencies working in states where belt enforcement is secondary. Command staff and patrol supervisors emphasize to officers working regular patrol that enforcement of occupant restraint must occur during every enforcement contact.

Use Available Training. Officers working the sTEP will be more effective and motivated if properly trained. Several courses are available. NHTSA recently published a new training curriculum for enforcement officers named Traffic Occupant Protection Strategies (TOPS). The course encourages enforcement agencies to enforce occupant protection laws, reach out to the community with presentations and media messages, and have strong seatbelt agency policies that insure high belt use among officers.

In developing a comprehensive program, states should consider that statewide belt use rates are related both to the state's belt use law and to enforcement of that law. Higher belt use rates are associated with:

- Primary laws versus secondary laws
- Laws that cover trucks, vans, and utility vehicles versus laws that cover only passenger cars
- Laws that provide higher fines
- Higher levels of ticketing

Helmet Law Enforcement Programs

In 2003, the National Highway Traffic Safety Administration’s Fatality Analysis Reporting System (FARS) and General Estimates System (GES) revealed that approximately 3,751 people were killed and another 64,000 were injured in motorcycle related crashes.

In 1997, NHTSA partnered with the Motorcycle Safety Foundation (MSF), a National, nonprofit organization promoting safer motorcycling, to provide the leadership and resources to create the *National Agenda for Motorcycle Safety (National Agenda).* The *National Agenda* is a strategic planning document intended to provide a shared national vision for future motorcycle safety efforts by incorporating input from a broad, multi-disciplinary spectrum of stakeholders. Developing this framework involved participation by experts in industry, research, training, and rider communities (law enforcement, health care, media, and insurance companies). The result was a collaborative document that examines components of motorcycle safety programs at the Federal, State, and local levels. The document also offers strategies for broad-based support and action

Since the release of the *National Agenda* in December 2000, motorcycle fatalities have continued to increase. The *National Agenda* action items were based on data from 1998 and

1999. Data from 2000 and 2001 revealed emerging trends involving rises in rural versus urban fatalities and deaths among older riders on larger motorcycles. These trends were not known and, consequently, not addressed in the *National Agenda*. NHTSA's *Motorcycle Safety Program* aligns with the *National Agenda* on some efforts, but also focuses its efforts on the more recent trends revealed by the 2000 and 2001 data. The program builds on current and past efforts, and also addresses a number of concerns raised in the *National Agenda*.

As with other traffic safety programs, NHTSA's *Motorcycle Safety Program* is based on a comprehensive approach, as shown in table 20, that works to: (1) prevent motorcycle crashes; (2) mitigate rider injury when crashes do occur; and (3) provide rapid and appropriate emergency medical services response and better treatment for crash victims. The problems and proposed initiatives are organized into three time phases of a crash event (Crash Prevention – Pre-Crash, Injury Mitigation – Crash, and Emergency Response – Post-Crash), along with the three areas influencing each of the crash time phases (Human Factors, Vehicle Role, and Environmental Conditions).

Table 20
NHTSA's motorcycle safety program *[155]*

	Human Factors	**Vehicle Role**	**Environmental Conditions**
Crash Prevention (Pre-Crash)	• Rider Education/Licensing • Impaired Riding • Motorist Awareness • State Safety Programs	• Brakes, Tires, and Controls • Lighting and Visibility • Compliance Testing and Investigations	• *Roadway Design, Construction, Operations and Preservation* • *Roadway Maintenance*
Injury Mitigation (Crash)	• Use of Protective Gear	• Occupant Protection	• *Roadside Design, Construction, and Preservation*
Emergency Response (Post-Crash)		• Automatic Crash Notification	• Education and Assistance to EMS • Bystander Care • Training for Law Enforcement • Data collection & analysis

Although national data show that trends in crashes involving motorcycles shift over time, the big issues surrounding motorcycle safety, such as rider protection during crashes, the need for more frequent and improved rider training, and the impairing effects of alcohol, are extant from year to year. Personal protective gear, rider education and training, and riding sober are the best defenses to prevent crashes and mitigate injuries when a crash does occur. Like other road users who are urged to protect themselves, and others, from injury or death by wearing safety belts, driving unimpaired, and observing traffic rules, motorcyclists must ensure that they have done everything possible to make the ride safe by taking training, wearing protective gear, and riding alcohol and drug free.

Motorcycle organizations, as well as NHTSA, are increasing their activities aimed at reducing motorcyclist fatalities. For instance, the MSF has announced the establishment of a grass-roots, small-award grant program to help support the implementation of the recommendations of the National Agenda. The program enables any person, organization, or business to submit an application with award amounts ranging from $1,000 to $10,000 to institute programs that will be recognizable, measurable, and have immediate returns. In addition to supporting the implementation of the National Agenda, the MSF has offered to provide free training and education materials to state motorcycle safety and highway safety offices, event planners, enthusiast organizations, and others to promote Motorcycle Safety Awareness Month, which occurs each May *[155]*. May is designated Motorcycle Safety Awareness Month. States and motorcycle organizations across the country conduct a variety of activities to promote the importance of motorist awareness and sharing the road with motorcyclists.

The following describes the NHTSA's Motorcycle Safety Program.

Crash Prevention

Preventing crashes before they occur is a major component of any comprehensive traffic safety program, including motorcycle safety. NHTSA's crash prevention activities focus mainly on variables that affect and contribute to crashes such as operator fitness, experience and training, and licensing. Operator impairment alone is a contributing factor in more than half of all fatal single-vehicle motorcycle crashes. The agency supports effective State rider education and training programs and encourages proper licensing for all motorcyclists *[155]*. NHTSA also promotes "share the road" and other motorist awareness efforts to raise the motoring public's awareness of the various mix of vehicles and non-vehicle users using the Nation's roadways.

Research and Data Collection Efforts. Collecting and analyzing data on rider education and training, licensing, length of time riding a motorcycle and specific attributes of the motorcycle being operated, riding habits—alone or in a group—and other similar data are important in assisting in crash prevention. NHTSA's research efforts are trying to resolve questions surrounding the medical outcomes of crashes involving motorcyclists, including short and long term effects and the costs of rehabilitation for injured operators.

Rider Impairment. Like operators of other vehicles, motorcycle operator impairment, mainly from the use of alcohol, is a serious problem. In 2001, motorcycle operators in fatal crashes had higher intoxication rates than any other type of driver. Twenty-nine percent of fatally injured motorcycle operators were intoxicated at 0.08 or greater blood alcohol concentration (BAC), and another 7 percent were reported to be at BAC 0.01 to 0.07. In single vehicle motorcycle crashes, 41 percent of the fatally injured motorcyclists were intoxicated with a BAC $\geq$.08.

In order to combat the impaired rider problem, NHTSA has ongoing programs and is currently developing new strategies based on knowledge learned from recent studies. The agency is working with law enforcement organizations at the National, State, and local levels to develop strategies to more aggressively enforce impaired riding laws.

Rider Education and Training. There is an increasing demand for rider education and training courses and some States have difficulty meeting this demand. Though many states have legislated rider education, many report that waiting times to complete a course range from 6 months to a year, and program content and administration vary widely from State to State. The NHTSA works with MSF and the National Association of State Motorcycle Safety Administrators (SMSA) to provide assistance to States in developing, implementing, administering, and evaluating State motorcycle rider education programs.

Motorcycle Operator Licensing. Motorcycle operator licensing is another major component in a comprehensive motorcycle safety program. By obtaining a specialized motorcycle license, a motorcyclist demonstrates the minimum ability to safely operate a motorcycle on the roadway. Approximately one out of four motorcycle operators (27 percent) involved in fatal crashes in 2001 was not properly licensed ("improperly licensed" is defined as not licensed to operate a motorcycle, or a license suspended, revoked, expired, canceled, or denied). Motorcycle operators involved in fatal traffic crashes were more than 1.4 times as likely as passenger vehicle drivers to have a previous license suspension or revocation.

Motorist Awareness Activities. It is critical for motorists to learn to identify motor cyclists and share the road safely. This is an important element in NHTSA's motorcycle safety program. Because of the motorcycle's size and unique handling characteristics, other roadway users may not understand the actions that motorcyclists take to safely interact in traffic *[155]*. NHTSA, while enhancing its existing highway safety partnerships, is planning to engage key National organizations in promoting motorcycle awareness to their members. They will also encourage these organizations to include safety awareness messages in their materials, as appropriate.

Injury Mitigation
While crash prevention is the primary focus of NHTSA's motorcycle safety program, motorcycle crashes will obviously still occur. Thus, injury prevention becomes an important component in reversing the upward trend in the number of motorcyclist fatalities each year. Injury mitigation promotes the use of protective gear, including helmets that comply with Federal Motor Vehicle Safety Standard No. 218, Motorcycle Helmets (FMVSS No. 218) and supports helmet usage laws governing riders of all ages.

Motorcycle Helmet Laws and the Use of FMVSS 218 Compliant Helmets. Helmets worn as part of a motorcyclist's protective gear are known to be very effective in a crash. NHTSA has estimated that helmets have saved the lives of 674 motorcyclists in 2001, and that 444 more lives could have been saved if all motorcyclists had worn helmets. Helmets are estimated to be 29 percent effective in preventing fatal injuries to motorcyclists and 67 percent effective in preventing brain injuries. According to NHTSA's NOPUS, helmet use for motorcycle operators fell from 71 percent in 2000 to 58 percent in 2002 (figure 23). This drop is significant and corresponds to a striking 45 percent increase in nonuse. According to previous NHTSA surveys, helmet use was reported to be near 100 percent at sites with State helmet use laws governing all motorcycle riders, as compared to 34 to 54 percent at sites with no helmet use laws or laws limited to minors.

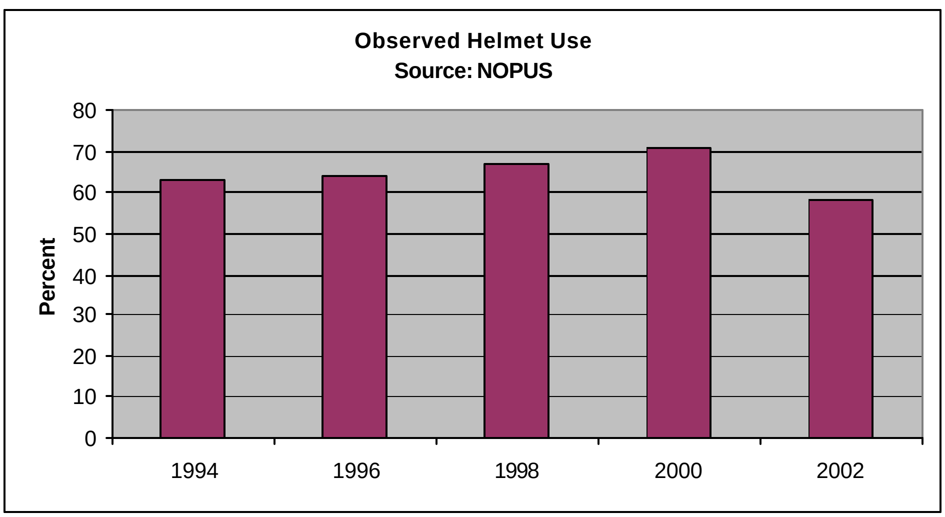


Figure 23
Observed helmet use

While some States have chosen not to enact helmet laws for all riders, NHTSA continues to work with the motorcycling, traffic safety, and health communities to educate and promote the voluntary use of helmets that meet FMVSS No. 218, along with the use of other types of personal protective gear as the last line of defense against serious injury for crash-involved motorcyclists. Wearing protective gear is the best weapon against injury when a crash does occur but many motorcyclists continue to ride with improper attire and non-compliant helmets or no helmets at all.

As part of a nationwide protective gear campaign, NHTSA is developing consumer information to better inform motorcyclists of the characteristics of compliant helmets and the lack of safety provided by noncompliant helmets.

Emergency Response

After a crash has occurred, an injured rider's life can depend on rapid and appropriate emergency medical response. Emergency medical service (EMS) personnel provide medical support at the scene and during the transport to optimal emergency care facilities. NHTSA continues to work with its partners to provide education and assistance to EMS professionals and the law enforcement community. Also, in ensuring that this information reaches the motoring public, NHTSA has expanded its outreach efforts to all motorists by working with medical and health care organizations *[155]*. Similarly, the agency works with motorcycling organizations to distribute bystander care information to motorcyclists nationwide. Bystander care information has proven to be very beneficial in the event of a motor vehicle crash. It assists crash victims by providing bystanders with knowledge in reacting to a crash situation and seeking out appropriate emergency medical response.

Older Driver Laws

People must make adjustments to their driving due to conditions accompanying the aging process, such as loss of vision, diminished hearing, and slowed reaction time. These adjustments are important in promoting safe driving. Efficient partnership between law enforcement and the older driver community has to be established and maintained to keep the older person mobile and driving safe for as long as possible.

Older drivers (70+ years) make up 10 percent of all licensed drivers. In 2000, about 18.9 million older drivers were licensed in the United States, and that number is projected to grow to 30 million by 2020. Between 1990 and 2000, this segment of the population grew nearly twice as fast as the population as a whole. Also, while the older population makes up approximately 9 percent of the U.S. population, it accounts for 13 percent of all traffic fatalities and 18 percent of all pedestrian fatalities.

In 2002, the NHTSA started to gather information from law enforcement agencies to document strategies to reduce collisions involving older drivers. As a result, a resource guide of older driver programs was developed to assist law enforcement agencies and serve as a clearinghouse for older driver programs in law enforcement. This resource guide was generated from interviews conducted in 2002-2003 with law enforcement agencies that responded to a NHTSA information request. Law enforcement involvement in older driver improvement programs such as the American Association of Retired Persons (AARP) Driver Safety Program and AAA Foundation for Traffic Safety Mature Operator Course are examples of training programs outlined in the guide. Programs outlining training courses for officers, such as elderly sensitivity training and dementia identification, are highlighted in some of the law enforcement programs.

In this guide, multiple law enforcement programs address effective partnerships between law enforcement and entities, such as senior citizen groups, roadway signage committees, and family help networks, social service agencies, public transportation, private transportation, media, motor vehicle departments, and medical review boards *[156]*.

Following are some examples of enforcement programs, strategic planning, and problem-orientated policing approaches designed to reduce crashes involving older drivers:

Alabama
Certified AARP Driver Safety Program Instructors teach eight-hour courses to the senior citizen group several times throughout the year, at community locations such as banks, churches, and senior citizen centers. The courses are supplemented with videos titled, "Going Through the Years," which address older pedestrian safety. In addition to the Driver Safety Program, literature and pamphlets from AAA Foundation for Traffic Safety and NHTSA are placed at senior citizen centers concerning alternative transportation and driver self-assessment. The senior citizen groups are also taught the "Operation Lifesavers Course" concerning railroad-crossing safety.

Arizona
The Arizona Department of Public Safety and the NHTSA entered into a one-year cooperative agreement in 2002 to conduct research on older driver law enforcement programs in a project titled, "Data Collection on Law Enforcement's Older Driver Programs". During this research project, programs identified consisted of enforcement, education, engineering, emergency service, networks, and referral systems.

California
The California Highway Patrol has formed a team to lead a statewide traffic safety program for older adults. The California Task Force on Older Adults and Traffic Safety Center for Injury Prevention Policy and Practice at San Diego State University recommended the

Highway Patrol as the state agency to foster the development and implementation of a comprehensive statewide strategic initiative on traffic safety among older adults.

The task force outlined a seven-point agenda, which calls for:

1. Building a statewide system to reduce traffic-related injuries among older adults.
2. Creating an equitable assessment/licensing structure within the Department of Motor Vehicles, including eventual adoption of a three-tiered process.
3. Helping seniors and those who influence seniors to recognize functional changes that create safety risks, and how to reduce those risks.
4. Improving the ability of health care providers both to assess risks in seniors and help them seek rehabilitation.
5. Promoting engineering and land use policies that simplify driving for seniors.
6. Promoting safer vehicle designs.
7. Encouraging expanded research.

In 2001, the San Diego, California, Police Department secured a two-year Senior Citizen's Pedestrian Grant through the California Office of Traffic Safety. It allowed the department's senior citizen volunteers to teach a traffic safety class to senior citizen groups across the city. During the one- to two-hour class titled "Look Out Before You Step Out," volunteers presented a Power Point presentation. Initial findings show that fatalities are decreasing in the target areas.

In addition to the pedestrian safety course, Community Safety Officers teach "Awareness Training" to senior citizens. The one- to two-hour presentation focuses on the local street conditions and preparing for a person's decreased ability to drive as the body ages. Both programs are advertised in the local paper and at senior citizen/community centers.

Connecticut

The Connecticut Police Department, Shelton Senior Center, and People's Bank developed the "Yellow Dot" program, which is aimed at saving older people in automobiles *[156]*. The three organizations make up a triad that works collectively to develop programs to help keep senior citizens safe based upon the particular needs of their community. The triad developed a yellow card for senior citizens to fill out providing information about the occupant's medication, allergies, doctor, hospital preference, and relative contact information. The completed card is placed in a manila envelope and remains in the glove box. The triad also developed a yellow sticker to be affixed to the inside rear window of a senior citizen's vehicle, alerting first responders to look in the glove box for emergency information about the driver and significant other passengers during an emergency. The triad conducts monthly events at the senior center for registering participating citizens.

The low cost program, implemented in spring 2002, is funded through People's Bank as a public service. Volunteers assist the older drivers with affixing the yellow dots and filling out the pertinent card information. There is no cost to citizens who participate in the program. The Connecticut Post Newspaper has published numerous articles on the Yellow Dot Program.

Florida

The resource guide "Older Drivers, Cues for Law Enforcement" was developed through NHTSA by the Florida Highway Patrol Lieutenant. This publication provides cues for law enforcement officers to help them determine the safe operational needs of older drivers. The publication also provides the field officer with safe operational mobility cues to look for when encountering an older driver. Law enforcement intervention, such as referrals to local assistance agencies, seeking information from family members, recommending public transportation systems, restricting certain types of motor vehicle operation, offering driver training, and reminding the older driver that self-assessment is an important step in maintaining safe operational mobility, are also outlined in the publication.

Illinois

The Illinois Police Department Crime Prevention Unit participated in the "Safety Tips for Mature Driver Program" that was presented to address highway-rail grade crossings. Failure to yield the right-of-way was found to be a primary collision cause involving the older driver. Seventy-five participants were provided information on railroad signs and signals to be aware of as well as the optical illusion that makes a train seem farther away and slower than it really is. Participant evaluations indicated that the attendees welcomed the addition of safe crossing information to the "Safety Tips For Mature Drivers Program."

Iowa

Troopers from the Iowa State Patrol's Safety and Education Office teach the "Older and Wiser Driver" program and the "Senior Safe Driver" program to older drivers throughout the state. The program provides students with traffic safety information specifically for senior drivers.

Kentucky

The Kentucky State Police participate in the Green River triad. A trooper instructs the eight-hour "Safe Driving for Mature Operators" course to older drivers in the seven counties served by the Green River TRIAD. Since funding for the course is provided through local sponsorships, training for the participants is free. The troopers provide traffic safety tips and instruction annually at the Senior Center Safety Day. In addition to general safety tips, certified Child Safety Seat Technicians instruct grandparents how to safely use and install child safety seats when transporting their grandchildren. Local media covers the Senior Center Safety Day and provides citizens with useful information as a public service. The local electric company, in coordination with the Green River triad, publishes a monthly magazine containing driving safety tips from the triad, and distributes it to 47,000 households.

Massachusetts

The Massachusetts Police Department launched its older driver programs in 2000. The department's triad officer coordinates the programs. A one-hour training session was developed for older drivers, "Driving Safety for Older Drivers," which consists of rules of the road, driving safety tips for older drivers, and the aging effect on the body. The program is given at senior citizen centers, outreach agencies, and other locations as requested.

The department follows up on collision reports when it is suspected that an older driver may be incapable of driving safely. The triad officer visits with the driver to assess his or her needs. Often, family members are contacted to assist the driver and police department. When an "immediate threat" is noted, the officer will contact the State Registry of Motor Vehicles in writing to request a medical review and/or re-examination. At the time of the follow-up, the police department provides the driver and/or family with information on local alternative transportation availability, social services, and medical services.

Missouri

The Missouri State Highway Patrol has a wide variety of older driver programs. The department's public information office has at least one trooper assigned to all 12 statewide patrol troops. In a program titled, "Senior Drivers," troopers regularly speak to senior citizens groups on topics such as occupant safety, child passenger safety, defensive driving, and winter driving hazards. The Missouri AAA office provides the troopers a video about older driver issues that is shown during class. A pamphlet published by the patrol, "Security Tips for Seniors," addresses what to do when involved in a collision. The State Highway Patrol has provided in-service training to troopers on how to recognize and interact with people who suffer from Alzheimer's disease and other problems.

New Jersey

The Manchester Township, New Jersey, Police Department teaches the "National Safety Council Defensive Driving Course" to senior citizens. Traffic Safety Officers instruct an eight-hour program that teaches drivers to evaluate the hazards of driving and to self evaluate their skills. Older drivers who have completed the course say they enjoy police officers teaching the course because of their understanding of the local roadways and rules of the road. The police department reviews all collision reports and refers drivers to the Division of Motor Vehicles in Trenton, New Jersey, for a driver's license re-examination and/or medical evaluation if evidence from the collision show that the driver was suspected of medical or other impairments

New York

The New York State Police helped develop a handbook, “When You Are Concerned,” with the New York State Office for the Aging *[156]*. The New York State Police provided law enforcement perspectives concerning older driver issues and defined what roles the law enforcement community can play in assisting older drivers and their families. The handbook outlined the following:

1. An overview of families concerned about the safety of an aging driver in the family.
2. How to monitor an aging driver when you don't live nearby.
3. Where to find assistance.
4. Discussion and intervention techniques.
5. How to cope with an aging family driver.
6. Transportation alternatives.
7. How to keep the older family member driving safely.
8. Mobility for life.

The state troopers provide information on older driving issues through pamphlets provided by the New York State Office for the Aging.

Ontario, Canada

The Ontario Provincial Police (OPP) has three traffic safety programs specific to older drivers:

1. “Drive Wise” is a 1 hour, 30 minute comprehensive education and awareness presentation that is delivered to older drivers by OPP officers. The course serves as a refresher and reminder of current rules, trends, and safety tips. Issues related to testing, health/medication, techniques, automatic breaking systems, air bags, and child safety seats are addressed during the class.
2. “Fatigued Drivers (Seniors).” The OPP provides this program to all age groups, including older drivers. The OPP breaks this program down into high-risk group education programs, "driver reviver" stations (free refreshment stations at rest stops), and public education programs through the media.

3. “Winter Driving for Seniors.” Two presentations, 40 minutes in length, by OPP Officers prepare older drivers for the harsh winter driving conditions in Canada.

ANALYTICAL TOOLS AND PROCEDURES

An Overview of Methodological Issues

Data Issues in Traffic Safety Analysis

Crash data are the basis for any safety analysis. However, the ability to collect crash information and efficiently share it across jurisdictions is often unfortunately hindered by many factors. Usually crash information is derived from police report forms completed by investigating police officers at the scene of the crash. A typical police crash report contains information on the crash location, time, environmental/road conditions, the people, and the vehicle that are involved in the crash. The total number of data items could be as high as 200. However, the quality of crash data depends greatly on the subjective judgment of the reporting officer. Studies have shown *[157]*,*[158]* that police reports are most valid with respect to crash descriptors and least valid with respect to driver/vehicle variables. The validity of the stated cause of the crash also varies considerably. Moreover, the accuracy and completeness of data vary from jurisdiction to jurisdiction.

Another issue related to crash data is quantity. The NHTSA estimates that only half of motor vehicle crashes in the country are reported to the police *[159]*. The crash count for individual intersections and road sections, which are the desirable unit for traffic safety analysis, tend to be statistically small with large random fluctuations. As a result statistically significant crash data is difficult to get at individual locations.

Methodological Issues in Safety Analysis

Because of the data problems discussed above, highway safety analysis is not well suited to conventional statistical methodology. Persaud *et al*. *[160]* point out the following issues that are of particular concern:

1. Because of the random fluctuation of crash counts, conventional procedures tend to select sites with high crash counts and/or crash rates for improvement, resulting in inefficient allocation of safety improvement resources. The Empirical Bayes (EB) approaches have been proposed to overcome such difficulties *[161]*.
2. Because of the tendency of regression to the mean (RTM), conventional before and after studies, which simply compare the crash experience before and after an improvement, can overestimate treatment benefits if the selected sites have unusual high crash count in recent years. EB approaches or selecting a comparison group can provide better estimates.
3. Developing Accident Modification Factors (AMFs) is vital to evaluating effectiveness of safety treatment. However, sufficient data are often not available to

develop AMFs. The use of regression models with multiple independent variables for deriving AMFs mitigates the difficulties.

4. Because of the difference in crash reporting across jurisdictions, the transfer of important tools, such as AMFs and safety performance functions, require considerable care in their application.
5. Traffic volume changes coexist with the changes in crash trends, making it difficult for highway safety analysis to account for the general trends in crash experience in analyzing time series-data.
6. Uncertainty in estimation is a frequently overlooked aspect of highway safety analysis. Estimates are often provided without stipulating the level of uncertainty associated with the estimate by measures such as the variance, or incorrect methods are used to calculate the measure. Sometimes, incorrect tests are used to interpret the results.

In addition, the following observations can also be made:

1. Using raw crash counts is not suitable for a cost benefit analysis because of the large differences between the cost of fatal, injury and property-damage-only crashes. Most high crash locations have a high number of PDO crashes. However, in cost terms, based on the information from Blincoe et al. *[1]*, one injury crash is approximately equivalent to 20 PDO crashes and one fatality crash is approximately equivalent to 400 PDO crashes.
2. Using crash rates in selecting improvement projects favors locations with low traffic volume because crash rates tend to decrease with increasing traffic volume. Also, the variations tend to be higher for low volume roads.

Modeling Crash Frequencies

It is difficult to fit any known distribution to crash data. The Poisson model is often used to describe the distribution of events over time. However, three assumptions have to be fulfilled to allow use of the Poisson distribution. First, the number of trials must be large if the probability of occurrence is very small. Second, the trials have to be independent, and third, the probability has to be constant from trial to trial. The latter assumption is not fulfilled for the occurrence of crashes by location on highways. An analysis of five years of Louisiana crash data shows that the average number of crashes varies substantially between locations. Thus, use of the regular Poisson distribution is not suitable for modeling the number of crashes.

To overcome the problem of constant probability, a compound Poisson distribution can be used. A compound Poisson distribution is constructed by assuming the expected value of the Poisson distribution is a random variable described by a distribution. Using various distributions for the averages of crashes of different locations gives the Poisson distribution a high flexibility in modeling crash data. Any distribution may be used to construct a compound Poisson distribution, but the most popular one used for crash statistics is the gamma distribution. The compound Poisson distribution with gamma distributed mean results in a negative binomial distribution. The first application of the negative binomial distribution to accident statistics was discussed by Greenwood *[162]* and Arbous *[163]*. More recently, Miaou *[164]* and Poch *[165]* applied the negative binomial distribution to crash statistics on roads. However, the excess number of locations with zero crashes sometimes makes it difficult to fit the negative binomial distribution. To deal with the excess number of zeroes, Shankar et al. *[166]* proposed the use of a zero-inflated negative binomial distribution assigning one state to "inherent safe" roadway, where "no accidents will ever be observed." However, accidents are, to a large extent caused by drivers as mentioned above. Assuming that there is an "inherent safe" road would require that no driver will have a tire blow out, be distracted, drive drunk, or speed on such a road section. A better approach is to find a distribution that better describes the variation in the mean number of crashes. For instance, Katti and Rao *[167]* used a logarithmic series distribution for the mean of the Poisson distribution and added extra probability to the event of zero counts. They fitted the data to 35 different data sets and showed that the so-called Log-Zero-Poisson distribution performed quite well. Other Empirical models based on the negative binomial distribution and mixed distributions, such as the zero-inflated Poisson distribution, are presented and discussed in terms of their applicability to pedestrian crash phenomena by Shankar et al. *[168]*. Key modeling issues relating to the presence of excess zeros as well as unobserved heterogeneity in pedestrian crash distributions are addressed in the paper.

Selection of road improvement projects and allocating limited funds to safety projects is a challenging task involving three main phases: identifying abnormal crash locations from among thousands of crashes, providing a cost benefit analysis for the abnormal locations, and selecting a finite optimum number of projects subject to budget constraints. Schneider and Kelle *[169]* discuss the use of linear regression analysis to model "abnormal" crash locations based on partitions of variation of crash rates using road characteristics available from crash reports. After fitting a linear regression model the concept of common cause variation and special cause variation used in quality management is applied to identify abnormal crash locations. Issues to be considered in a cost benefit analysis are discussed and a modified knapsack method is presented using a utility function to include risk assessment. This type of analysis could be extended in Phase II of this project to include additional variables. The approach also shows that using crash cost rather than crash count leads to different conclusions regarding “abnormal” crash locations.

State of Practice among Procedures used in Highway Safety Analysis

A survey was conducted by Persaud et al. *[160]* on the types of safety analyses typically conducted by highway agencies. The results are listed below with the percentage of responding jurisdictions utilizing the type of analysis in parentheses:

1. Identification of hazardous locations	(100%)
2. Before-and-after evaluations	(97%)
3. Cost-benefit analysis in development of countermeasures	(88%)
4. Analysis of collision trends	(81%)
5. Collision rate comparisons of locations with different features	(72%)
6. Cross-sectional evaluations	(25%)
7. Comparison group evaluations	(31%)
8. Risk estimation/analyses/evaluations	(16%)

The above types of analysis can be categorized into two groups. They are methodologies for identifying hazardous locations for improvement and methodologies for evaluating treatment effects.

It is important to correctly identify potential sites for improvement in order to efficiently utilize limited safety resources. Due to the Regression to the Mean phenomenon, simply selecting sites with high crash counts and/or rates is not a valid option. Attempts have been made to use an “upper control limit” to determine if a site has high count or rate *[160]*. This limit is based on the mean and standard deviation of crash information from similar sites. However, the selection of similar sites can be a challenge. The Empirical Bayes approach has been proposed to overcome the above difficulty. However, the applications of this approach have been rare among highway agencies. The reasons include lack of necessary data, limited validation and testing of the approach, and the lack of understanding of the new technique. Because of the non-linear relationship between crash and traffic volume, crash rates usually decrease with traffic volume and therefore low volume sites tend to be selected if crash rate is used as a sole selection criterion. As a result, many jurisdictions require a minimum crash count for a site to be selected for potential improvement.

The purpose of evaluating treatment effects is to determine whether the strategies and/or countermeasures are successful in reaching their intended goals, not only ensuring that the resources are used in the most effective and efficient manner, but also provide feedback for future improvements. Two approaches to conduct the evaluations are before-and-after studies and cross-section studies. Before-and-after studies range from simple before-and-after comparison of crash counts to the more sophisticated EB approaches *[170]*. A cross-sectional study can be conducted in two approaches. One way is to use collision rate comparison of locations with different features, considering differences in collision rates and differences in features. A normalized collision rate is typically used to account for differences in exposure to risk (such as traffic volumes). The other way involves statistical regression modeling, where crashes are modeled as a function of a variety of highway features (such as traffic volumes and the geometry of the intersection/road segment). The safety impact of certain improvements can be estimated using the model, accounting for the changes of other variables that may take place at the same time, such as traffic volume. Where appropriate data are available, the before-and-after method is generally preferred.

The regression equations that relate crash experience to the traffic and other characteristics of locations are often referred to, in some safety literature, as multivariate accident models *[161]*. Such models can be classified into two categories: crash causation and crash prediction models. The causation models relate crashes to factors that explain the cause of crashes. This kind of model often experiences difficulties in model calibration *[87], [171]* because of small datasets, lack of variation in the factors, and strong correlations among factors. As a result, causation models contain very few variables. On the other hand, crash prediction models are not necessarily built from causal factors. They tend to include more variables that are associated with the crashes for which there is readily available data.

In addition to the mainstream highway safety analysis discussed above, which are mainly safety estimation of hazardous identification and treatment evaluation, other types of safety analysis have been used. Some of them are related to drivers and vehicles. They are listed below *[160]*:

- Log-linear analysis
- Contingency table analysis
- Induced exposure/risk estimation
- Logit models
- Ordered probit models
- Logistic models
- Meta analysis
- Factor analysis
- Data imputation

One example of these other types of safety analysis would be the study conducted by Lee and Mannering *[172]*. They investigated the relationships among roadway geometry, roadside characteristics, and run-off-roadway accident frequency and severity. Using data gathered from the northbound direction of State Route 3 in Washington State, negative binomial and zero-inflated negative binomial models were used to estimate monthly accident frequency, as a function of, among others, roadway geometry and roadside features. A nested logit model was used to estimate the severity of run-off-roadway accidents. In addition to roadway geometry and roadside features, roadway environment, such as weather, dry/wet road surface, etc., and driver characteristics, such as old/young driver, whether alcohol impaired driving was involved, etc., were included in the model. The study successfully incorporated all three aspects of the roadway environment factors in studying crash frequency and severity.

Major Tools for Safety Analysis

There are many safety-related tools/procedures that have been developed or are being developed. Some of the important ones include the Comprehensive Highway Safety Improvement Model (CHSIM), the Interactive Highway Safety Design Model (IHSDM), the Highway Safety Manual (HSM), SafetyAnalyst, Road Safety Audits (RSAs), Integrated Safety Management Process, AASHTO Strategic Highway Safety Plan implementation guides, and the Critical Analysis Reporting Environment (CARE). Among them, CHSIM, SafetyAnalyst, and RSA are more site-specific tools. Some of them are in the form of software packages and some are in the form of a manual or procedure. Except for the AASHTO implementation guides which only deal with countermeasures, all the rest are comprehensive, covering multiple aspects of a traffic safety study.

Comprehensive Highway Safety Improvement Model (CHSIM)

Having recognized the need for improved analytical tools for safety professionals, the FHWA is developing a software tool named the Comprehensive Highway Safety Improvement Model (CHSIM) *[160], [173]*. The purpose is to help safety engineers identify site-specific safety improvements for existing highways. The effort will develop analytical tools to improve the process of highway safety improvement programs, which typically aim to allocate resources to achieve the greatest safety benefits and follow a four-step sequential process: identification, investigation, program implementation, and evaluation. Engineering countermeasures are the primary focus of the project. CHSIM consists of six computerized analytical modules:

- Identification of potential crash sites
- Safety problem diagnosis at specific sites

- Countermeasure selections
- Ranking priorities/economic appraisal
- Programming and implementing projects
- Project evaluation

CHSIM is expected to be available in 2005 and be readily used by state and local highway agencies.

SafetyAnalyst

SafetyAnalyst is a current FHWA project. It is being developed through a cooperative effort of FHWA and 13 state departments of transportation. The purpose is to provide state-of-the-art analytical tools, including software, for the decision-making process to identify and manage a system-wide program of site-specific improvements in order to enhance highway safety cost-effectively.

Traditional ways to develop crash countermeasures tend to address the engineering and human factors separately. As a result, the ability to mitigate human errors through road design to reduce traffic crashes is ignored. SafetyAnalyst is an integrated approach that considers human and engineering factors in developing countermeasures. Unlike such programs as graduated licensing, occupant restraints, or alcohol/drug use programs, which aim at improving safety for all highway travels, SafetyAnalyst addresses site-specific safety improvements that involve physical modifications to the highway system. It provides the capability to identify accident patterns at specific locations and determine whether those crash types are overrepresented. It is also capable of determining the frequency and percentage of particular accident types system-wide or for specified portions of the systems. SafetyAnalyst is also capable of conducting cost-effective analysis.

SafetyAnalyst has following tools *[174]*:

- A *Network Screening Tool* that identifies "sites with promise" for safety improvements.
- A *Diagnosis Tool* that can be used to diagnose the nature of safety problems at specific sites.
- A *Countermeasure Selection Tool* that assists users in the selection of countermeasures to reduce accident frequency and severity at specific sites.
- An *Economic Appraisal Tool* that performs an economic appraisal of a specific countermeasure or several alternative countermeasures for a specific site.

- A *Priority Ranking Tool* that provides a priority ranking of sites and proposed improvement projects based on the benefit and cost estimates determined by the economic appraisal tool.
- An *Evaluation Tool* that provides the capability to conduct before/after evaluations of implemented safety improvement projects.

Planning for SafetyAnalyst development began in 2001, the final software tools are planned for release in 2006. Table 21 summarizes the development.

Table 21

SafetyAnalyst activities *[175]*

Year	**Activity**
2002	Plan capabilities for specific ***SafetyAnalyst*** tools
2003	Develop software for interim tools
2004	Test and release software for interim tools
2005	Assess user experience with interim tools and develop software for final tools
2006	Release final tools

Road Safety Audits

According to the web site of Road Safety Audit *[176]*, a road safety audit (RSA) is a formal safety performance examination of an existing or future road or intersection by an independent audit team. RSA is a proactive low-cost approach to improve safety where an independent, qualified auditor reports on safety issues. It can be used in any phase of project development and on any size project. RSAs have been used worldwide with success but had not been applied in the U.S. until several years ago. There are at least 10 state departments of transportation in the U.S. that have subsequently begun RSA programs.

The basic steps involved in conducting an RSA are listed below. The process requires the cooperation of the audit team and other agencies

1. Identifying project or existing road to be audited
2. Selecting interdisciplinary audit team
3. Conducting pre-audit meeting to review project information and drawings
4. Performing field reviews under various conditions
5. Conducting audit analysis and prepare report of findings
6. Presenting audit findings to project owner/design team
7. Preparing formal response
8. Incorporating findings into the project when appropriate

Interactive Highway Safety Design Model (IHSDM)

Interactive Highway Safety Design Model **(**IHSDM) is an extensive tool that is being developed by FHWA for highway design or redesign *[39]*. It is a decision support suite of software tools designed for rural two-lane highways. Its purpose is to evaluate safety implications of design decisions. IHSDM has six evaluation modules:

- *Crash Prediction Module*. This module estimates the expected crash frequency on a highway with the information from geometric design and traffic characteristics.
- *Design Consistency Module*. This module helps to identify and diagnose safety concerns at horizontal curves through the estimation of the magnitude of potential speed inconsistencies.
- *Driver/Vehicle Module*. This module estimates a driver's speed and path along a two-lane rural highway in the absence of other vehicles and corresponding measures of vehicle dynamics.
- *Intersection Review Module*. This module systematically evaluates an intersection design for typical safety concerns through a diagnostic review.
- *Policy Review Module*. This module checks highway segment design elements relative to design policy.
- *Traffic Analysis Module*. This module estimates operational quality-of-service measures for a highway under current or projected future traffic flows.

The Driver/Vehicle model is now under development. The 2003 release of IHSDM is available for testing and evaluation purposes free of charge. The potential users are state and local highway agencies and engineering consulting companies that are involved in highway design, highway project management, and traffic safety reviewers.

Critical Analysis Reporting Environment (CARE)

CARE *[177]* stands for Critical Analysis Reporting Environment. It is a sophisticated analytical tool that has been specifically developed for accident countermeasure problem identification and evaluation. The software was developed by the CARE Research & Development Laboratory (CRDL) at the University of Alabama. It is a free downloadable package with both a desktop Windows and a Web version. It is also one of the software packages recommended in NCHRP Report 501 *[178]*. Its greatest strength is the ability to quickly make subsets of datasets and allow analyses and comparative analyses of these subsets, without requiring users to know how to make sophisticated database queries. In addition to the ability to generate reports, major CARE capabilities include:

- *Creating Filters*. A filter is a definition of the subset of safety data that enables detailed analysis of the subset. There are two kinds of filters: predefined and user created. Predefined filters are those whose subsets of interest are well known. Examples of frequently predefined filters in crash analysis include alcohol, driver, fatality, and age. Users can create additional filters by using an intuitive interface through the selection of any combination of variables and values from the database. A user defined filter, once created, has the same status as a predefined filter. Filters can be combined to create new filters using Boolean operators, such as AND and OR.
- *Frequency distributions and cross-tabulation*. CARE can provide frequency distributions for any or all variables of any subset. The distributions can be presented graphically as well as in a tabular form, which provides visual help in identifying potential problem areas. Examples are the frequency distribution of time of day, day of the week, age, etc. In addition, fully-labeled cross-tabulations of any two variables for any subsets of the database can be obtained.
- *Information Mining (IMPACT)*. This is a very good feature of CARE. The module systematically searches information in an automatic way to find over-representations between any two subsets. The output can be presented both graphically and tabularly in a worst-first order. This is a powerful tool in CARE, which finds and prioritizes over-representations without user intervention or user knowledge of the database.
- *Locations*. This model identifies high crash locations for any subset of the dataset. Examples include intersections, non-mileposted segments, as well as mileposted segments. For each of the identified locations, frequency distributions, crosstabs, and information mining can also be performed.
- *Area Criticality Technique (ACT)*. This capability provides a prioritized worst-first list by rate using demographic information. The list is typically composed of cities by crash per city population. Crashes can be for any subset of data.
- *Intersection Magic*. This module provides the capability to generate collision diagram for any location specified with CARE.

CARE is now being implemented in the states of Florida, North Carolina, Iowa, Georgia and Alabama. Currently, seven states have their data in the CARE format, which can be accessed at the CARE web site for downloading and analysis.

Highway Safety Manual

TRB is currently developing a Highway Safety Manual (HSM) *[179]* with the support of the FHWA, AASHTO, and Institute of Transportation Engineers (ITE). Similar to the Highway Capacity Manual, HSM will serve as a useful tool for practitioners. The purpose of the HSM is to provide the best factual information and tools to facilitate roadway design and operational decisions based upon explicit consideration of their safety consequences. This manual would greatly strengthen the role of safety in road planning, design, maintenance, construction, and operations decision making. The current proposed HSM is organized in the following five parts: Introduction and Fundamentals, Knowledge, Predictive Methods, Safety Management of a Roadway System, and Safety Evaluation. Figure 24 provides a schematic diagram *[180]* explaining the content of each of the five parts.

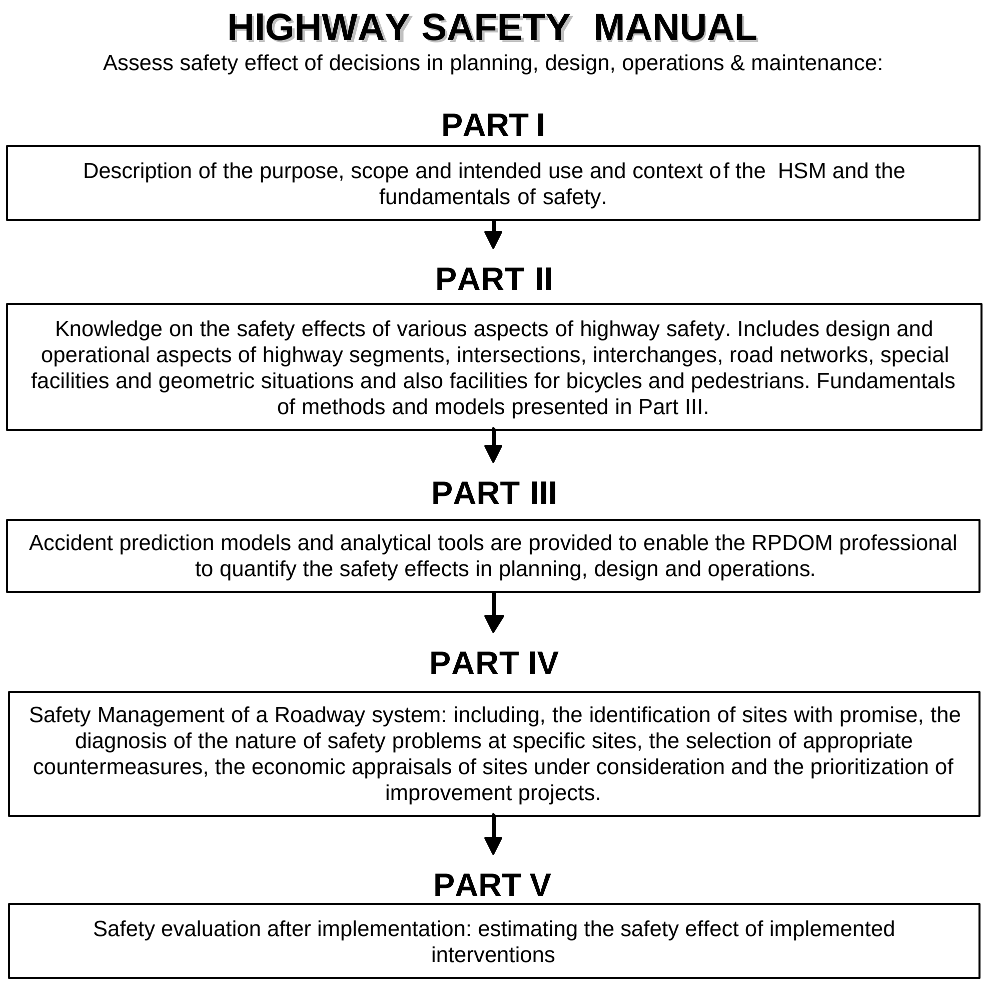


Figure 24

Highway Safety Manual Content *[180]*

The development process of the HSM is supposed to be like that of the Highway Capacity Manual. The first edition of the HSM will include the best available factual information, while the subsequent editions will incorporate materials not covered in the previous edition and those from the continuing research efforts. The complete version of the HSM is anticipated to be available to the public in 2007. However, several interim products may be available prior to that.

AASHTO Implementation Guides

The AASHTO *[181]* Strategic Highway Safety Plan includes 6 elements and 22 key emphasis areas that affect highway safety. Each of the emphasis areas includes strategies and an outline of what is needed to implement each strategy. NCHRP Project 17-18(3) is currently developing a series of implementation guides to assist state and local agencies in reducing injuries and fatalities in targeted emphasis areas. The guides correspond to the AASHTO emphasis areas. Each guide includes a brief introduction, a general description of the problem, the strategies/countermeasures to address the problem, and a model implementation process. To date, 13 guides have been published as part of NCHRP Report 500. These are guides for:

1. Addressing aggressive-driving collisions
2. Addressing collisions involving unlicensed drivers and drivers with suspended or revoked licenses
3. Addressing collisions with trees in hazardous locations
4. Addressing head-on collisions
5. Addressing unsignalized intersection collisions
6. Addressing run-off-road collisions
7. Reducing collisions on horizontal curves
8. Reducing collisions involving utility poles
9. Reducing collisions involving older drivers
10. Reducing collisions involving pedestrians
11. Increasing seatbelt use
12. Reducing collisions at signalized intersections
13. Reducing collisions involving heavy trucks

Integrated Safety Management Process

The implementation guides (NCHRP Report 500) are in development for the 22 emphasis areas selected by AASHTO. However, to implement the emphasis areas and their strategies described in the guides, a safety management system is necessary for the implementing agencies. NCHRP Report 501 *[178]* describes the Integrated Safety Management System (ISMSystem), which is an organizational structure supported by resources and defined in terms of leadership, mission and vision statements, and the Integrated Safety Management Process (ISMProcess). Figure 25 depicts the components of the ISMSystem.

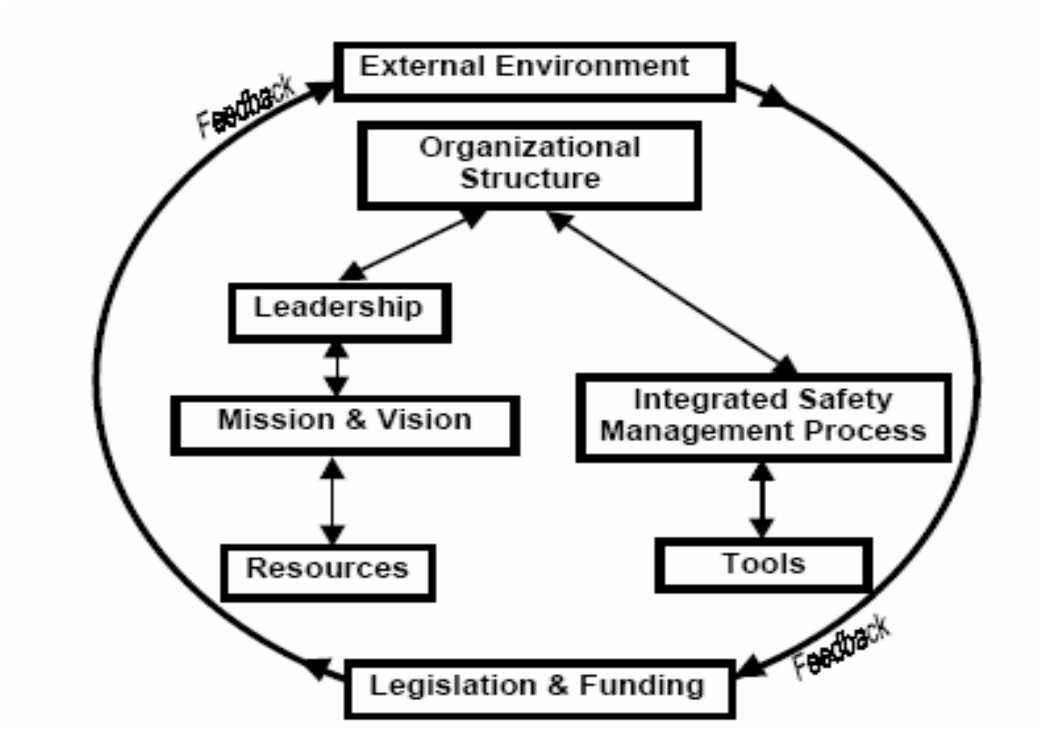


Figure 25
Components of the ISMSystem *[178]*

The organizational structure of a model ISMSystem is depicted in figure 26. The Safety Program Leadership (SPL) is the top management of the system and provides direction and support to the organization that is formed by a coalition of the agencies represented in the SPL. However, the day-to-day operation is delegated to the Operations Manager (OM), who coordinates the system activities. The Risk Analysis and Evaluation (RAE) group performs the quantitative and other safety analysis. The Task Teams are nonpermanent members who are recruited from the state's implementing agencies as the safety needs and priorities change. The ISMSystem's organizational structure depends upon existing agencies forming a coalition, instead of being a new bureaucracy.

The ISMProcess is a crucial component of the ISMSystem that identifies the steps necessary to maximize highway safety. The ISMProcess is an integrated process that transforms the inputs from different disciplines and role-players with safety interests, such as resources, skills, and information, into safety strategies that can be implemented to address major safety concerns (also called emphasis areas).

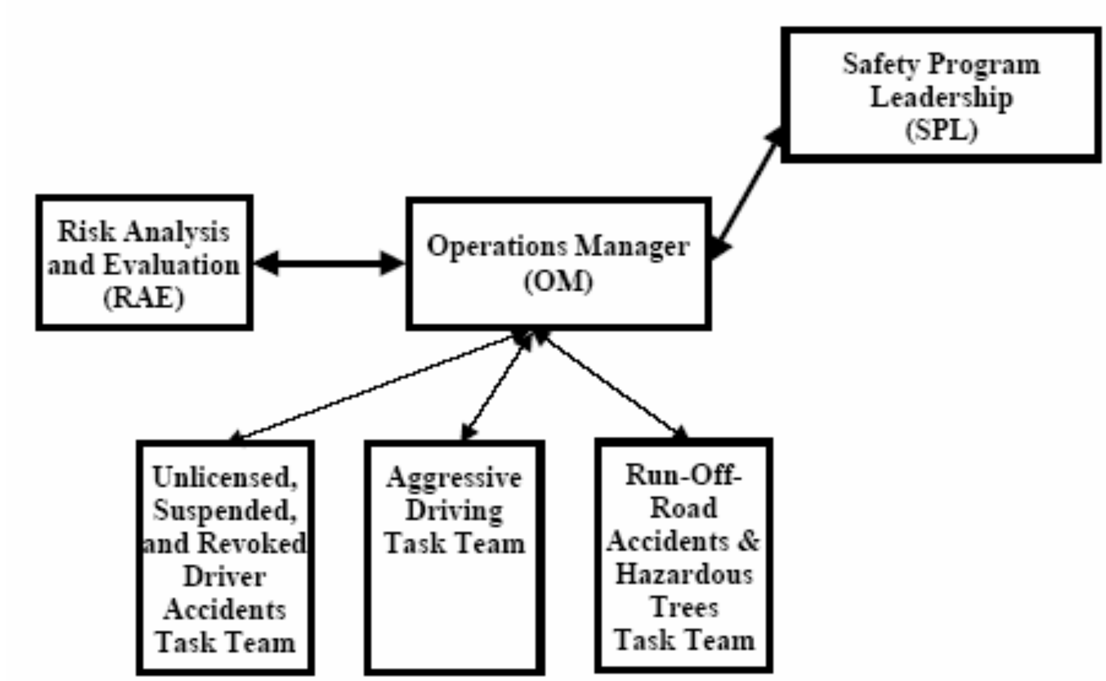


Figure 26

Example of an organizational structure of a model ISMSystem *[178]*

Figure 27 presents selected products of the ISMProcess. The process has the following six major steps:

1. Reviewing highway safety information
2. Establishing emphasis areas and goals
3. Developing objectives, strategies, and preliminary action plans to address the emphasis areas
4. Determining the appropriate combination of strategies for identified emphasis areas
5. Developing detailed action plans
6. Implementing Integrated Safety Highway Strategic Plan (ISHSPlan) and evaluating performance

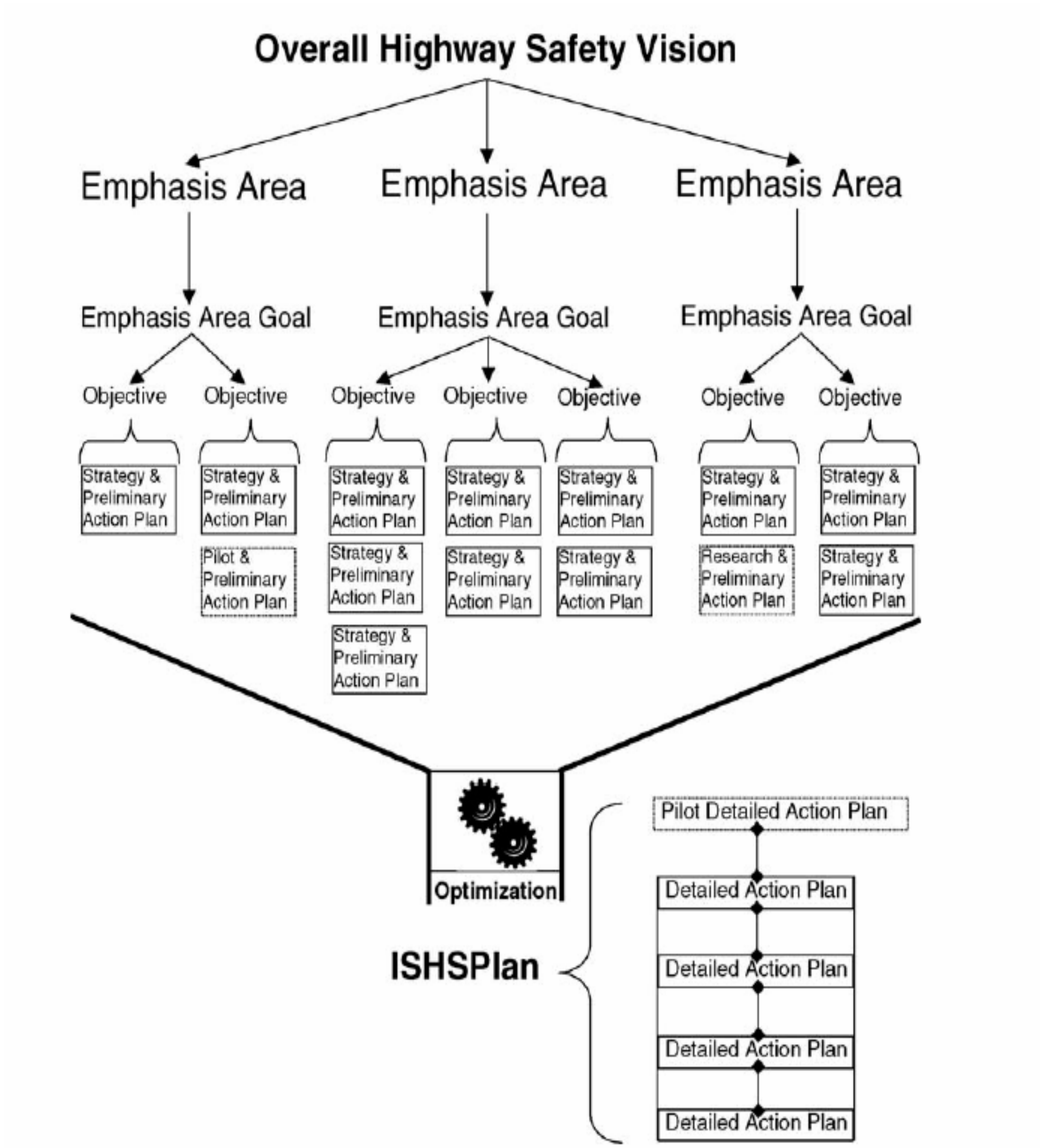


Figure 27
Selected products of the ISMProcess *[178]*

SAFETY FUNDING

Safety Funding at the Federal Level

Current traffic safety funds are provided by TEA-21 for fiscal years 1998-2003. Approximately $2.3 billion was authorized for this period *[182]*. The funds are from three sources:

1. The core Section 402 State and Community Safety Grants program,
2. Seven incentive programs, and
3. Two penalty transfer programs.

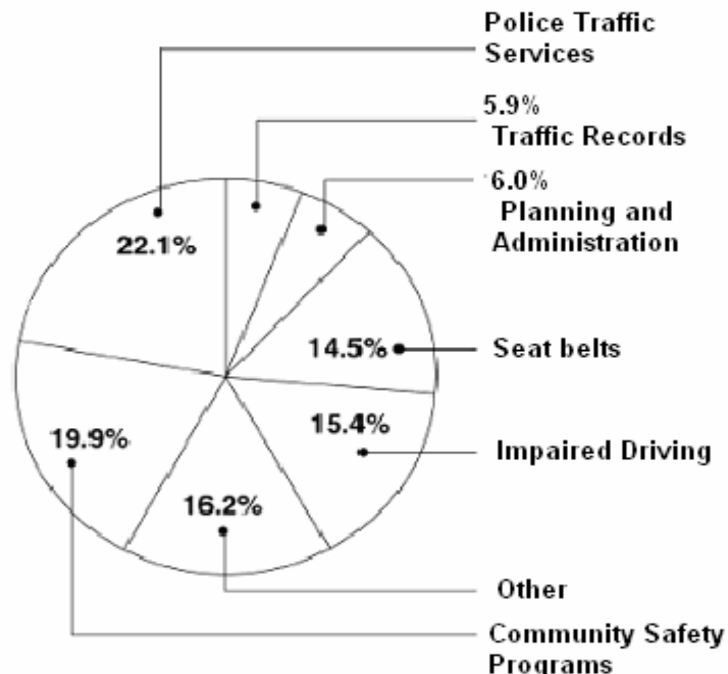
Section 402 State and Community Safety Grants Program

Under Section 402, funding of $932.5 million is provided over 6 years for traffic safety programs designed to influence driver behavior in such areas as seat-belt use, alcohol-impaired driving, and speeding. This is a formula grant program that supports planning that identifies highway safety problems, sets goals and performance measures for highway safety improvements, provides start-up money for new programs, gives new direction and support to existing safety programs, and provides funding for analyses to determine progress in improving safety. Funding for the core Section 402 State and Community Grants program has been fairly constant, according to GAO *[2]*, in constant dollars since 1991. These funds can be used in programs for police traffic services, impaired driving, seatbelts, community safety, planning and administration, traffic records, and other highway safety topics including roadway safety, pedestrian safety, emergency medical services, speed control, driver education, motorcycle safety, school bus safety, and paid advertising to support Section 402 programs. Figure 28 provides a distribution of the funds from fiscal year 1998 through 2002 at a national level.

Seven Incentive Programs

The seven incentive programs are designed to improve seat belt use, reduce drunk driving, and improve highway safety data, with funding of approximately $936 million over 6 years. Table 22 lists the highway safety incentive grant programs and their funding levels.

The funding for these programs has grown from $83.5 million in 1998 to $242 million in 2003. Except for two programs, the 0.08 percent BAC Incentive (Section 163) and the Seatbelt Use Incentive (Section 157) that could be used for any highway purposes that address safety concerns, the rest were used for funding additional behavioral safety programs. Table 23 presents information on total funding for these incentive programs and their allocation.



Source: GAO analysis of NHTSA data

Note: "Other" includes roadway safety, pedestrain safety, emergency medical services, speed control, driver education, and motorcycle safety.

Figure 28

Uses of state and community grants funds, fiscal years 1998-2002 *[2]*

Table 22

Highway safety incentive grant programs *[2]*

Incentive category	Title of incentive	Description of incentive
Seat Belt/ Occupant Protection Incentives	Section 157 Safety Incentive Grants for the Use of Seat Belts	Creates incentive grants to states to improve seat-belt use rates. A state may use these funds for any highway safety or construction program. The act authorized $563 million over 5 years.
	Section 157 Safety Innovative Grants for Increasing Seat Belt Use Rates	Provides that unallocated Section 157 incentive funds be allocated to states to carry out innovative projects to improve seat belt use.
	Section 405 Occupant Protection Incentive Grant	Creates an incentive grant program to increase seat belt and child safety-seat use. A state may use these funds only to implement occupant protection programs. The act authorized $68 million over 5 years.
	Section 2003(b) Child Passenger Protection Education Grants	Creates a program designed to prevent deaths and injuries to children, educate the public on child restraints, and train safety personnel on child restraint use. The act authorized $15 million over 2 years for Section 2003(b). However, the Congress appropriated funds to support the program for 2 additional years.
Alcohol Incentives	Section 163 Safety Incentives to Prevent the Operation of Motor Vehicles by Intoxicated Persons	Provides grants to states that have enacted and are enforcing laws stating that a person with a blood alcohol concentration (BAC) of 0.08 or higher while operating a motor vehicle has committed a per se driving-while-intoxicated (DWI) offense. A state may use these funds for any highway safety or construction program. The act provides $500 million over 3 years for the program.
	Section 410 Alcohol Impaired Driving Countermeasures	Revised an existing incentive program and provides grants to states that adopt or demonstrate specified programs, or to states that meet performance criteria showing reductions in fatalities involving impaired drivers. The act provides $219.5 million over 6 years, which are to be used for impaired driving programs.
Data Incentives	Section 411 State Highway Safety Data Improvements	Provides incentive grants to states to improve the timeliness, accuracy, completeness, uniformity and accessibility of highway safety data. The act provides $32 million over 4 years.

Table 23

State use of highway incentive funds, fiscal years 1998-2002 *[2]*

(Dollars in millions)

Incentive	Behavioral program funding	Construction program funding	Total funding
Alcohol			
Section 163 - .08 BAC	$226.0	$117.3	$343.2
Section 410 - Impaired Driving	$166.3		$166.3
Occupant Protection			
Section 157 - Seat Belt Use	$170.0	$ 29.8	$209.7
Section 157 Innovative Seat Belt Use	$112.0		$112.0
Section 2003(b) Child Occupant Protection	$ 22.4		$ 22.4
Section 405 – Occupant Protection	$ 45.6		$ 45.6
Data Improvement	$ 36.3		$ 36.3
Total	$788.6	$147.0	$935.6

Source: GAO analysis of NHTSA data.

Note: Figures may not add due to rounding.

Penalty Transfer Programs

As of 2003, $647 million has been transferred from highway construction to highway safety programs under the two penalty transfer programs set forth in the TEA-21 Restoration Act, which requires that a state must have an open container law and a repeat intoxicated driver law. States that do not meet either of the two requirements will have a percentage of their Federal-Aid Highway program funds transferred to their Section 402 State and Community Grants program. The transferred funds can be used for alcohol-related behavioral programs or for safety-related highway construction projects. All the funds are under NHTSA except for the safety construction program, which is under the FHWA's Hazard Elimination program. Fiscal years 2001 and 2002 were the first two years that the funds have been transferred. During these two years, 34 states were subject to at least one of the penalties, and about $361 million was transferred. On average, 69 percent of the funds were used for highway construction projects under the FHWA Hazard Elimination program, and 31 percent went to highway safety behavioral programs. Louisiana transferred about $6.6 and $6.8 million dollars in years 2001 and 2002, respectively, and Louisiana used all of them for highway construction projects. The amount transferred in 2003 was $15.7 million.

Safety Funds for Louisiana

Table 24 presents the traffic safety funding for Louisiana from years 1998 through 2003 for each of the programs. The data were obtained from NHTSA's web site. The table is divided into two parts. The first part includes the funds from section 402 and the seven incentive programs. The second part shows the funds from the two penalty transfer programs. Figure 29 shows the data graphically.

Table 24

Traffic safety funds ($1,000) for Louisiana from years 1998 through 2003 *[183]*

Year	1998	1999	2000	2001	2002	2003
Section 402 Formula	$2,258	$2,254	$2,297	$2,328	$2,286	$2,335
Section 157 Safety Belt Use		$680	$284	$261	$238	$0
Section 157 Safety Belt Use Innovative			$735	$1,838	$612	$456
Child Passenger Safety Grants 2003b			$123	$120	$114	$113
Section 163 .08 BAC	$0	$0	$0	$0	$0	$1,488
Section 405 Occupant Protection		$175	$179	$314	$332	$561
Section 410 Impaired Driving		$0	$625	$741	$702	$626
Section 411 Data		$63	$174	$0	$0	
Sub Total	$2,258	$3,172	$4,417	$5,601	$4,284	$5,580
Section 154 Open Container				$3,316	$3,422	$7,895
Section 164 Repeat Offender				$3,316	$3,422	$7,895
Total	$2,258	$3,172	$4,417	$12,233	$11,129	$21,371

The sub totals for the first part of funds shows that safety funds for Louisiana have more than doubled from approximately $2.3 million to approximately $5.6 million. The total safety funds for Louisiana, including both parts, have increased much more than the subtotals for the first part since 2001. This is due to the two penalty programs which began to transfer from the Federal-Aid Highway program funds from year 2001 onwards.

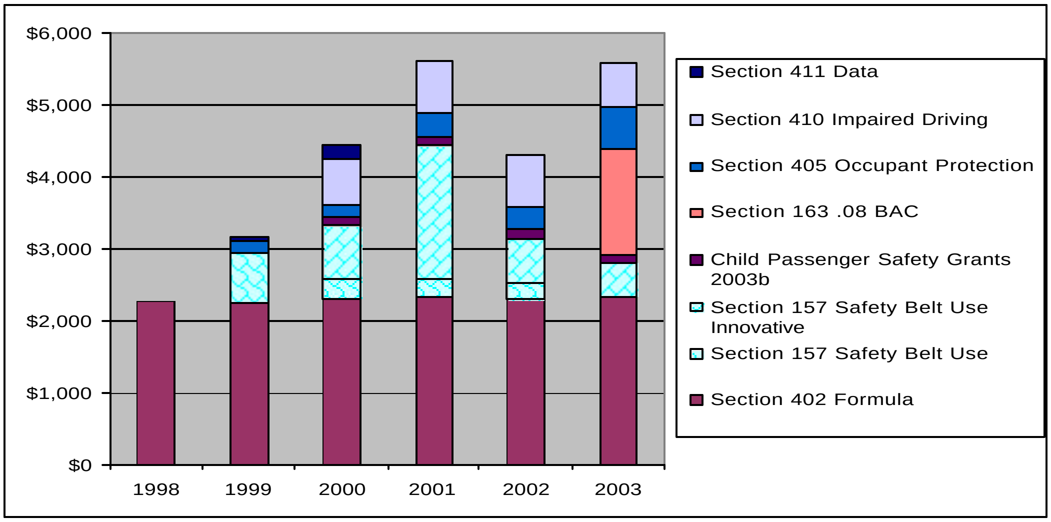


Figure 29

Traffic safety funding for Louisiana from years 1998 through 2003 *[183]*

Table 25 shows the Louisiana percentage of the national funding level for the programs, and figure 30 provides a graphical representation of the information. The Louisiana percentage, if the two penalty programs are included, increased from 1.00 percent to 3.13 percent over the years from 1998 through 2003. However, if the funds from the two penalty programs are excluded, the increase in Louisiana percentage of funding was much smaller. Nonetheless the percentage has been on the rise.

Table 25
Percent traffic safety funding for Louisiana from years 1998 through 2003 derived from NHTSA *[183]*

Year	1998	1999	2000	2001	2002	2003
Section 402 Formula	1.58%	1.58%	1.58%	1.58%	1.50%	1.50%
Section 157 Safety Belt Use		1.29%	0.52%	0.55%	0.43%	0.00%
Section 157 Safety Belt Use Innovative			2.88%	4.36%	1.38%	1.12%
Child Passenger Safety Grants 2003b			1.65%	1.60%	1.52%	1.52%
Section 163 .08 BAC	0.00%	0.00%	0.00%	0.00%	0.00%	1.72%
Section 405 Occupant Protection		1.84%	1.88%	2.54%	2.33%	2.18%
Section 410 Impaired Driving	0.00%	0.00%	1.83%	2.49%	2.03%	2.00%
Section 411 Data		1.31%	2.28%	0.00%	0.00%	
Overall Excluding Penalty Programs	1.00%	1.06%	1.25%	1.49%	1.05%	1.40%
Overall Including Penalty Programs	1.00%	1.06%	1.25%	2.08%	2.00%	3.13%

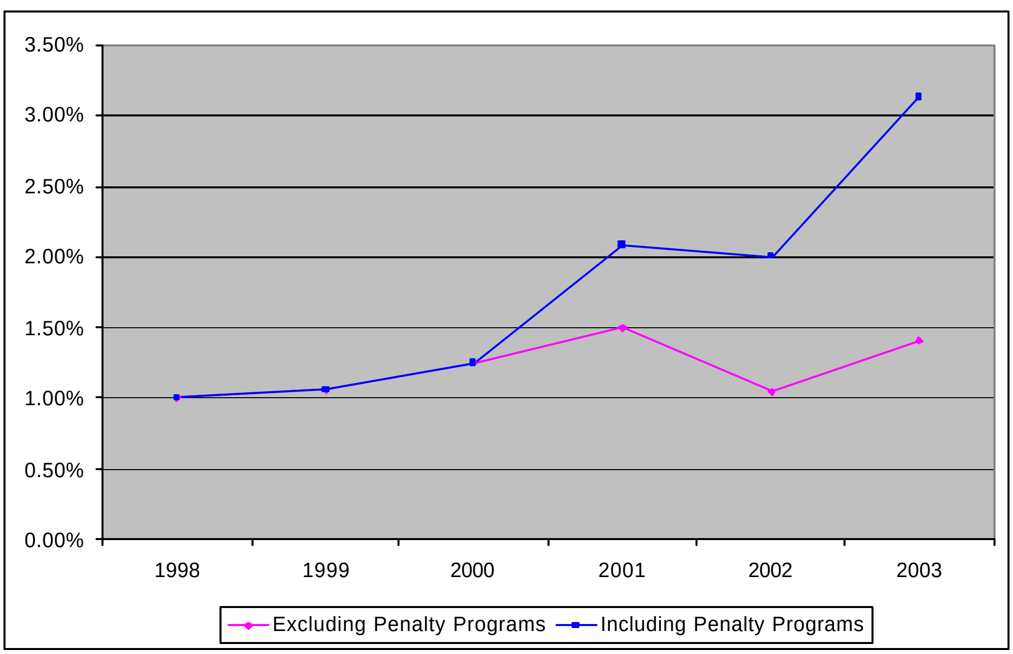


Figure 30
Percent traffic safety funding for Louisiana from years 1998 through 2003

The high percentage in year 2001 is due to the large increase in Section 157 safety belt use funding, and the high percentage in year 2003 is due to the Section 163 funding for 0.08 BAC.

In addition to the safety funding discussed above, DOTD has its own source of safety funding for each year. The estimated safety budget for fiscal year 2004-2005 is $29.9 million for highway programs and $7.8 million for rail road crossing upgrades. For fiscal year 2005-2006, these budgets are $32 million and $9.5 million, respectively *[184]*.

CRASH-RELATED DATABASES

Databases at the National Level

Fatality Analysis Reporting System

The Fatality Analysis Reporting System (FARS) is maintained by the NHTSA's National Center for Statistical Analysis *[185]*, which was established in 1975. The FARS data describes all fatal crashes occurring on public roads in the United States. Its database contains data collected by State and local police officers, coroners, emergency medical services, and State motor vehicle administrations. NHTSA is funding 125 data collectors employed by the motor vehicle authorities of the States. The data is collected from the above listed sources and encoded with relevant information using data entry programs developed by NHTSA. Data describing all fatal crashes that occurred during the previous year are transmitted electronically to NHTSA headquarters during the first half of each calendar year. More than a dozen full- and part-time NHTSA employees run automated checks at NHTSA headquarters, looking for errors in the incoming reports, and working to correct any that are found. Data describing approximately 40,000 fatal crashes are added to the FARS annually. NHTSA publishes an annual summary of the FARS data. Official data files are released on its web site. A FARS Web-Based Encyclopedia is available to the public at http://www-fars.nhtsa.dot.gov/. The encyclopedia offers retrieval of fatal crash information. Data can also be downloaded from NHTSA's ftp site (ftp://ftp.nhtsa.dot.gov/FARS/).

General Estimates System

NHTSA's National Center for Statistical Analysis maintains the National Accident Sampling System/General Estimates System (NASS/GES) *[185]*. The NASS/GES was created in 1988. The NASS/GES contains an annual sample of police-reported traffic crashes in the United States, which is used to estimate the number of U.S. traffic accidents and their injury outcomes. The NASS/GES contains data on both fatal and nonfatal accidents. The NASS/GES data are gathered using a cluster sampling approach. Each year, about 400 police jurisdictions are selected for visits by data collectors contracted by NHTSA. The information from police accident reports are coded by data processing contractors into an electronic file using NHTSA software. These records are sent to one of NHTSA's regional data centers for quality review and processing. Police jurisdictions are selected using a weighted sampling procedure. The selection of reports within each jurisdiction is done using a sampling procedure that ensures that important but infrequent kinds of accidents are adequately represented in the sample. Mathematical weights are assigned to each record to reflect the probability of selection so that national estimates can be made. More than 50,000 accident records are recorded in the database each year. NHTSA publishes annual summaries of the records contained in the NASS/GES. Official data can be downloaded from NHTSA's ftp site (ftp://ftp.nhtsa.dot.gov/ges/).

Crashworthiness Data System

NHTSA's National Center for Statistical Analysis also maintains the National Accident Sampling System/Crashworthiness Data System (NASS/CDS) *[185]*. The NASS/CDS provides detailed information about the crashworthiness of specific models of passenger vehicles and the injuries sustained by their occupants. A crash qualifies for investigation and inclusion in the NASS/CDS if it results in the towing of at least one vehicle from the crash scene. Special crash investigators, contracted by the NHTSA, collect NASS/CDS crash data on a continuous basis from police accident reports, vehicle and on-scene inspections, medical examiner and coroner reports, emergency room and hospital records, driver and vehicle occupant interviews, and the witness interviews. Over 100 NASS/CDS investigators are divided into 24 field research teams to conduct in-depth investigations of a sample of police-reported crashes and to enter the data by computer. Completed records, after being reviewed by analysts at NHTSA headquarters, are delivered to the John A. Volpe National Transportation Systems Center in Cambridge, Massachusetts. The sampling procedure used to select police jurisdictions is similar to that used for the NASS/GES. However, the report sampling process is designed to ensure adequate representation of accidents within predefined categories. Sampling strata include:

1. Type and model year of vehicle
2. Severity of injury
3. Transport of victims to a medical facility
4. Overnight hospitalization
5. Tow status of the accident vehicles

The mathematical weightings assigned to each record reflect the probability of selection so that national estimates can be made based on the sample of accidents contained in the NASS/CDS. Approximately 5,000 police-reported crashes are investigated and included in the NASS/CDS each year. Official data files are released each year. NHTSA publishes reports summarizing NASS/CDS data every 3 years. An on-line query system is available to the public through NHTSA's web site (http://www-nass.nhtsa.dot.gov/BIN/NASSCASELIST.EXE/SETFILTER).

Highway Safety Information System

The Highway Safety Information System (HSIS) was developed by the FHWA *[186]*. The HSIS is a roadway-based system that provides quality data on a large number of accident, roadway, and traffic variables. The data are acquired annually from a select group of States, processed into a common computer format, documented, and prepared for analysis. It is a multistate database for a select group of states, namely California, Illinois, Maine, Michigan, Minnesota, North Carolina, Ohio, Utah, and Washington. Request for data for research purposes can be make on-line (http://www.hsisinfo.org//datarequest.cfm) or to the participating states directly. Some of the data files include the following information:

- **Crash:** contains type of accident, vehicle types, sex and age of occupants, accident severity and weather conditions.
- **Roadway Inventory:** contains information for types of roadway, number of lanes, lane width, rural urban designation, and functional classification.
- **Traffic Volume:** contains Annual Average Daily Traffic (AADT) data.
- **Intersection:** contains traffic control type, intersection type, signal phasing and turn lanes.

State Data System

A database is maintained by each state that contains comprehensive information about people, vehicles, and conditions recorded in Police Accident Reports (PARs) *[48]*. The information varies from state to state as each state has different data collection and reporting standards. Since the early 1980s, NHTSA has been obtaining crash data files derived from data recorded on PARs. NHTSA currently obtains state crash data from 27 states: California, Florida, Georgia, Illinois, Indiana, Kansas, Maryland, Michigan, Missouri, New Mexico, North Carolina, Ohio, Pennsylvania, Texas, Utah, Virginia, Washington, South Carolina, Kentucky, Colorado, Connecticut, Wisconsin, Delaware, Wyoming, Arkasas, Montana, and Nebraska. NHTSA requests the crash data from the participating states through its regional offices. Public access to the State Data System is prohibited unless written permission is obtained from the participating states.

The State Data System incorporates data files similar in format to the General Estimates System file format. It includes the following three files:

- **Crash file:** includes general crash characteristics describing the environmental and roadway conditions at the time of the crash.
- **Vehicle file:** contains information describing the vehicles involved in the crash.
- **Person file:** contains information describing the characteristics of the people involved in the crash: drivers, passengers, pedestrians, and pedal cyclists.

Motor Carrier Management Information System

The Motor Carrier Management Information System (MCMIS), which contains census, crash, inspection, enforcement, and compliance review information, is maintained by the Federal Motor Carrier Safety Administration's (FMCSA) Analysis Division *[185]*. The MCMIS was created in 1989. Crashes contained in the MCMIS crash data involve at least one truck or bus. Each crash must also results in at least one of the following outcomes:

1. A fatality,
2. At least one injury requiring transport to a medical facility, or
3. Damage requiring that at least one vehicle be towed from the accident scene.

The MCMIS contains data gathered from police crash reports by State agencies, which vary from state to state. The data are transferred electronically to the FMCSA for inclusion in the MCMIS. Nearly 100,000 crash records are added to the MCMIS each year. Data summaries from the MCMIS are presented in combination with other information from the NASS/GES and the FARS in the annual *Large Truck Crash Overview* published by the FMCSA. The FMCSA has a web-based A & I (Analysis and Information) tool (http://ai.fmcsa.dot.gov/) that provide access to description statistics and analyses regarding commercial vehicle, driver, and carrier safety information. Its users are federal and state enforcement personnel, the motor carrier industry, insurance companies, and the general public.

Highway Statistics

The Highway Statistics Series consists of annual reports containing analyzed statistical data on motor fuel, motor vehicles, driver licensing, highway-user taxation, State and local government highway finance, highway mileage, and Federal aid for highways *[187]*. This data, which is presented in tabular format as well as selected charts, has been published each year since 1945.

Most of the data are divided into urban and rural tables according to population and Federal-aid legislation definition and they are presented primarily on a State-by-State basis. Highway Statistics since 1992 can be accessed by the public from the FHWA's web site (http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.htm).

Louisiana Crash-Related Databases

Louisiana Crash Database

Louisiana State University (LSU) collects data for all crashes occurring on Louisiana highways and maintains a complete electronic database dating back to 1999. The database is prepared for the Louisiana DOTD and the Louisiana Department of Public Safety (DPS). The crash database includes approximately 70 crash-related elements, 100 vehicle/driver elements, 15 passenger elements, and about 15 pedestrian elements. Overall, the Louisiana crash report is about 90 percent MMUCC **(**Model Minimum Uniform Crash Criteria**)** compliant (MMUCC will be discussed shortly). The database is readily available through a Microsoft query analyzer. The potential use of this database in the Phase II of this study is to conduct the detailed analysis of the human, roadway, and environmental factors that contributed to crashes.

DOTD Segment Data

The highway segment database, maintained by DOTD, contains highway control-section and sub-control-section data that describe the location of the control section, and highway design attributes such as lane width, shoulder width, ADT, etc. In addition, the annual total number of crashes as well as the crash rate for each sub-control-section is provided. It will be a convenient source to find high crash frequency and crash rate locations. It will also be useful in determining how roadway factors contribute to crashes. Each crash in the accident database could be linked to the segment database by matching the sub-control-section number and the log mile in the two.

The sub-control-sections keep getting shorter, partly due to highway maintenance. Therefore, the consistency of each sub-control-section for each year needs to be checked before conducting the historical data comparisons.

DOTD Intersection Data

Similar to the segment database, the intersection database contains the intersection data that describes the location of each intersection, the roadway design attributes, and ADT. The annual crash frequency and the crash rate for the individual intersection is also calculated. Each crash in the accident database could be linked to the intersection database by matching the sub-control-section number and the log mile in the two. This database can potentially be used to conduct the detailed analysis on how roadway factors contribute to intersection-related crashes and identify the crash prone intersections.

DOTD Driver's Data

The sex and age of the driver/drivers who have been involved in the crash are recorded in the annual driver's database. This information could be joined with the accident database by linking the common key together. It is a good supplement to the accident database although the driver's info is also limited. The database is also maintained by DOTD.

Highway Safety Commission Crash Reports

The Louisiana Highway Safety Commission Web site (http://lhsc.lsu.edu/) provides a variety of annual crash-related reports including traffic information, safety belt usage, young driver crash, alcohol-related crashes, bicycle and pedestrian crashes, etc. Users can also build their own dynamic queries based on four categories: people, vehicle, time, and location. Query results present crash frequency information under different severity levels (fatalities, injuries, and property damage only). The potential use of these rich data and reports is to investigate the crashes by different categories and analyze the potential contributing factors under each category.

Highway Accident Data Analysis System with GIS

This is a GIS-based crash data analysis system that can provide insight into the general state of highway safety as well as contributing causes of crashes at any location *[188]*. It has easy data extraction capability and is useful for investigating the contributing factors at a disaggregated level. With this program, users can also identify crash prone locations by comparing the crash frequency and crash rate. These locations are then classified as abnormal sites warranting further studies. The system will soon be available on the DOTD intranet.

Model Minimum Uniform Crash Criteria (MMUCC)

Statewide traffic crash data system provides basic information for traffic safety efforts, including problem identification, formulation of goal and objectives, development of countermeasures, and performance evaluation for the local, state, and federal government. However, the lack of data uniformity both within and between states hinders the application of these crash data. MMUCC provides the voluntary guidelines that were originally developed in response to requests by states interested in improving and standardizing their state crash data. It is a collective effort of the National Highway Traffic Safety Association (NHTSA), Federal Highway Administration (FHWA), Federal Motor Carrier Safety Administration (FMCSA), and Governors Highway Safety Association (GHSA). A minimum set of standardized data elements were recommended to promote data uniformity within the highway safety community. These data elements represent a core set of data elements. Most of them had already been collected before the establishment of MMUCC.

The 1st edition of the MMUCC Guidelines was finished in 1998 and contained 113 data elements. Based on the emerging issues and other highway safety needs, the revised 2nd edition *[189]* now contains 111 data elements. These data elements can be classified into four categories: crash data elements, vehicle data elements, person data elements, and roadway data elements. Of the 111 data elements, 77 should be collected at the scene of crash, 10 data elements can be derived from crash scene information, and the remaining 24 data elements which are related to the person and roadway should be obtained after linking to driver history, injury and roadway inventory data. Of the 28 crash data elements, 19 are collected at the scene of the crash, and 9 are derived. All 30 vehicle data elements are collected at the scene, while 28 of the 35 person data elements are collected at the scene, 6 are derived, and 1 is obtained after linking to driver history; all the 18 roadway data elements are obtained after linking to roadway inventory data.

CONCLUDING REMARKS

This report on Phase I of the Statewide Traffic Safety Study provides a comprehensive review of the state of the art in highway traffic safety, both within the U.S. and abroad. Research on crash-related contributing factors, including human, roadway environment, and vehicle factors, were reviewed in depth. The impact of intelligent transportation systems on traffic safety was also reviewed. Traffic safety related laws, both at federal and state levels, were investigated to provide an overview of existing legislation. A variety of safety-related programs that have been implemented throughout the states have been explored. These programs include aggressive driver programs, automated enforcement programs, cell phone enforcement programs, alcohol and drug impaired driving programs, occupant protection programs, helmet law enforcement programs, and older driver laws. Analytical tools and procedures commonly used in traffic safety analysis were reviewed. These included statistical methods widely used in current practice and major ongoing initiatives (such as CHSIM, IHSDM and Highway Safety Manual), new tools (such as SafetyAnalyst, Road Safety Audits, AASHTO Implementation Guides, etc.), and software packages (such as CARE). Safety-related funding in recent years in the state of Louisiana was reviewed and the trends examined. Finally, a crash-related database inventory was presented. This was an overview of federal and Louisiana databases that are of potential importance in the next phase of the study.

The review revealed that road safety is indeed a problem in Louisiana. This is evidenced by crash rates that are consistently among the ten highest in the fifty states, alcohol-related accidents that are among the highest in the nation, and car insurance rates that have grown more rapidly than any other states. This review provides an opportunity to identify lucrative areas for further research in phase II of the project. These areas are discussed below.

The review has shown that among the human, roadway, and vehicular aspects of road travel, the human factor is by far the most influential in causing crashes. While crashes usually result from a combination of factors, several studies have shown that human factors are a definite cause in 2 out of 3 crashes and are the probable cause in 90 percent, or more, of all road crashes. Roadway factors have contributed to as many as 1 out of 3 crashes and vehicular factors to 1 out of 11 crashes in the past, although there is evidence to suggest that these rates have reduced significantly in recent times. Recent studies suggest that roadway factors and vehicular factors may contribute no more than five percent and one-half percent to crashes in modern conditions, respectively. Thus, human factors are increasingly becoming the major factor in road safety.

The most important human errors have been suggested, in order, as driver inattention/distraction, perceptual errors, excessive speed, and decision errors. Driver inattention/distraction is a contributor in approximately 25 percent of all crashes and has been estimated as the sole cause 16.7 percent of all crashes. Inattention includes the driver's drowsiness or daydreaming. It can also include cases where drivers read while driving or are involved in other activities that take their eyes off the road and their attention from the driving task. Distractions include events outside the vehicle (e.g., a crash) or distracting events within the vehicle such as communication with other occupants of the vehicle, cell phone use, tuning of the radio, or operation of an audio cassette or video. It is not clear what aspects of driver inattention/distraction could benefit from further study in phase II of this project, although the impact of cell phone use on traffic safety may be included in the study.

Perceptual errors arise from a variety of sources. Perception may be temporarily impaired due to alcohol or drug use. On the other hand, lack of perception may be due to a lack of experience, as among young drivers, or impaired judgment among older drivers. Perceptual errors are expected to play a large role in the crash rate variation observed drivers of different ages. Fatal crash rates among 16-20 year-olds are 5 times higher than those among 25-64 year-olds, and 3 times higher among drivers 75 and over. This appears to be an area requiring further research. The incidence of alcohol and drug-induced impaired driving appears to have increased significantly in the nation in the last 25 years. It also appears that alcohol-related crashes are higher in Louisiana than in many other states. Louisiana already has important impaired driving laws such as license revocation, zero tolerance, and 0.08 blood alcohol content, but this aspect of road safety in Louisiana seems to deserve further attention in phase II of the project.

Excessive speed can be included among other driver behavior choices, such as aggressive driving and traffic control violations. An NHTSA survey of drivers showed that more than 60 percent of the population have felt that unsafe driving by others imperiled the lives of themselves and their families. Three out of four drivers felt that it was "very important" that something be done about such driver behavior. However, more than half of the respondents in the survey admitted to driving recklessly themselves on occasion. While there is general condemnation of unsafe driving among the public, drivers also recognize that many of them violate the law occasionally. This suggests that the public may be supportive of a system which prosecutes regular offenders rather than the current system which prosecutes every observed offense. This may be translated into issuing speeding tickets to offenders if they have been observed speeding repeatedly in the past. Similarly, red light running could be translated into a citation for repeated offences, or exceeding a preset rate of violations per time period. Automated systems could be used to measure speed and red light violations in these cases.

Decision errors relate to the decisions made by a driver in operating a vehicle. They include judging stopping distances, gaps in the traffic stream, and traveling in the correct direction on one-way streets or on the correct path through intersections or a parking lot. They can also be considered as observing traffic signs and traffic signals, seatbelt usage, and even the decision to drive while intoxicated.

One of the decision errors that appears to hold promise for improvement in Louisiana is seatbelt usage. Seatbelt usage in the U.S. is at approximately 72 percent. In contrast, Canada is at 92 percent and several other countries (Australia, United Kingdom, Germany, and France) have even higher rates of seatbelt usage. In Canada, and particularly Australia, this has been achieved in less than a decade through an aggressive and persistent enforcement and education campaign. Louisiana's seatbelt usage is at approximately 72 percent, leaving considerable room for improvement. It is estimated that each percentage point increase in seatbelt usage prevents approximately 0.64 percent of the fatalities on the road. Since Louisiana has approximately 650 fatalities annually, nearly four lives could be saved each year for every percentage point seatbelt usage could be increased in the state. If seatbelt usage in Louisiana be increased to the levels achieved by Canada and Australia, approximately 75 lives could be saved annually in the state.

Alcohol and other drugs are a major contributor to the more serious traffic accidents. Of all fatal crashes in the nation, 41 percent are estimated to be alcohol related. Young males are disproportionately represented. Interestingly, drivers with the least formal education have the highest record of alcohol use and those with the most formal education have the lowest. If education in this case relates to an understanding and appreciation of the impacts of alcohol on driving performance, informational programs aimed at the less educated may help reduce the incidence of drunk driving.

It appears as if drunk driving is a larger problem in Louisiana than in many other states. While 41 percent of all fatal crashes in the country are alcohol-related, more than 60 percent of the fatalities in Louisiana are due to alcohol-related crashes. Identification of the extent and nature of alcohol-related accidents in Louisiana is an obvious topic of research in phase II of this project.

The impact of roadway factors on road safety has been well researched in the past. However, certain aspects of road design and road maintenance appear to hold promise for further research regarding improved safety. In particular, shoulder width, shoulder surface, and rumble strips seem to justify further investigation into their impact on road safety. On intersections, sight distance and its impairment through vegetation growth or other visual barriers seems worthy of investigation. Roundabouts may provide safety benefits in certain conditions, but their impact in a North American context needs to be studied.

Work zone safety should be studied in Louisiana to determine the nature and the extent of the safety issues surrounding work zones. Traffic control can lead to improved safety in work zones. The majority of crashes in work zones are rear-end crashes, and it has been observed that these crashes reduce significantly with the time the work zone is in existence. This suggests that most accidents result from unexpectedness of the work zone.

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