REMEDIES FOR DRIVER ERROR

FINAL REPORT 567

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16. Abstract

Driver error is estimated to cause about half of all traffic accidents in Arizona and the United States. To understand driver error and related remedies, this reference document provides results from a literature review, a survey of state agencies, and a number of case studies to identify innovative and effective remedies for driver error as well as factors affecting their success.

The literature review outlines the different types of driver error and contributing factors as well as the effects of risk homeostasis and motivation. The literature review also provides information on a range of education, enforcement, and engineering measures used to reduce the frequency of these errors and address the perceived costs or risks associated with different driver behaviors.

A survey of state practices highlights effective strategies such as targeted campaigns integrating education and enforcement, as well as low cost, preventative engineering solutions such as rumble strips and improved signage and pavement markings. More detailed descriptions of strategies are also provided in five best practice case studies from around the United States.

Literature, survey, and case study information provide a number of lessons regarding the features of a successful program of remedies for driver error.

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SI (MODERN METRIC) CONVERSION FACTORS*

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
	AREA			
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
	VOLUME			
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: Volumes greater than 1000L shall be shown in m^3.			
	MASS			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000lb)	0.907	megagrams (or "metric ton")	mg (or "t")
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C
	ILLUMINATION			
fc	foot candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
	FORCE AND PRESSURE OR STRESS			
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
	AREA			
mm^2	Square millimeters	0.0016	square inches	in^2
m^2	Square meters	10.764	square feet	ft^2
m^2	Square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	Square kilometers	0.386	square miles	mi^2
	VOLUME			
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	Cubic meters	35.315	cubic feet	ft^3
m^3	Cubic meters	1.308	cubic yards	yd^3
	MASS			
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (or "metric ton")	1.102	short tons (2000lb)	T
	TEMPERATURE (exact)			
°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F
	ILLUMINATION			
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
	FORCE AND PRESSURE OR STRESS			
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380

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GLOSSARY OF ACRONYMS

3D	Drugged and Drunk Driving
3R	Reconstruction, Rehabilitation and Restoration
AAA	American Automobile Association
AARP	American Association of Retired Persons
AASHTO	American Association of State Highway Transportation Officials
ACRS	Australian College of Road Safety
ADOT	Arizona Department of Transportation
AGOHS	Arizona Governor's Office of Highway Safety
ATRC	Arizona Transportation Research Center
BAC	Blood Alcohol Content
Caltrans	California Department of Transportation
CDC	Centers for Disease Control and Prevention
CHP	California Highway Patrol
CIOT	Click It or Ticket
CMS	Changeable message sign
CSRS	Continuous shoulder rumble strip
DFZ	Double fine zone
DMV	Department of Motor Vehicles
DOT	Department of Transportation
DUI	Driving Under the Influence (of alcohol or drugs)
DWI	Driving While Intoxicated
EMS	Emergency Medical Services
FFY	Federal Fiscal Year
FHWA	Federal Highway Administration
GDL	Graduated drivers license
GHSO	Governor's Highway Safety Office
HOS	Hours of Service
HSIP	Highway Safety Improvement Program
IID	Ignition interlock device
IIHS	Insurance Institute for Highway Safety
IOP	Independent oversight program
ISAP	Intersection Safety Action Plan
ISMP	Integrated Safety Management Process
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation Systems
KDOT	Kansas Department of Transportation
LHSC	Louisiana Highway Safety Commission
LSU	Louisiana State University
MADD	Mothers Against Drunk Driving
MAG	Maricopa Association of Governments
MoDOT	Missouri Department of Transportation
mph	Miles per hour
MPO	Metropolitan planning organization
MTC	Metropolitan Transportation Commission

NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
OHP	Oklahoma Highway Patrol
OHSP	Office of Highway Safety Planning
OP	Occupant Protection
PATH	Partners for Advanced Transit and Highways
PDO	Property damage only
PENNDOT	Pennsylvania Department of Transportation
RWIS	Road Weather Information System
SAMI	Safety and Mobility Initiative
SPUI	Single-point urban interchange
STEP	Special Traffic Enforcement Program
TEA-21	Transportation Equity Act for the 21st Century
TRB	Transportation Research Board
TTI	Texas Transportation Institute
US	United States
VDOT	Virginia Department of Transportation
VMS	Variable messaging system
VMT	Vehicle miles traveled
YDYDYL	You Drink You Drive You Lose

EXECUTIVE SUMMARY

Driver error is related to about half of all motor vehicle accidents in Arizona and in the United States, resulting in enormous costs in terms of loss of life, medical expenses, property damage, and lost productivity.

A review of recent literature on driver error highlights the existence of three types of driver error and a number of personal factors that may contribute to driver error. Types of driver error include:

- Perception errors due to driver distraction and inattention;
- Decision errors such as excessive speed, tailgating and improper technique; and
- Performance errors as a result of improper evasive action, nonperformance, and non-accidents.

These errors may also be influenced by personal factors such as the level of driver skill and knowledge, impairment due to illness, drowsiness and drug use, and willful inappropriate behavior. Furthermore, driver behavior may be affected by risk tolerance, or homeostasis, whereby adjustments are made to the level of driver behavior in response to the perceived level of safety or danger in the surrounding vehicle, road, and environment.

Remedies to address driver error include: education and information strategies; enforcement and incentives; and engineering and infrastructure strategies. These approaches may target any of the driver errors and/or contributing factors, as well as incorporating ways to address the perceived costs or risks associated with different driver behaviors. As highlighted in recent literature, education and information strategies encompass improved crash reporting and analysis, improved driver education and licensing procedures to encourage safer driving and greater driving experience for novice drivers, and public education and awareness campaigns. Enforcement and incentive strategies include strategic planning and policy development, increased enforcement and citations, higher penalties for driving infringements, amended road rules and licensing requirements, and incentives for appropriate driver behavior. Engineering strategies cover changes to traffic operations, roadway design, vehicle design, and implementation of traffic monitoring systems and safety audits.

Using a survey of state departments of transportation and offices of highway safety, information was obtained regarding the implementation, effectiveness, and factors contributing to the success of each of the above strategies. The survey achieved a 54 percent response rate, with responses obtained from all regions of the United States.

Survey responses in the area of education and information emphasize the importance of media and public education strategies targeted to key issues, time periods, and populations, and supported by enhanced enforcement efforts. They also indicate the importance of improving training and testing programs for young, novice, and elderly

drivers, as well as the need to improving data collection and analysis to provide a quantitative basis for selection and assessment of effective remedies to driver error.

In relation to enforcement and incentives, survey comments highlight the need for interagency cooperation, partnerships and community involvement to garner political and public support, as well as the effectiveness of targeted enforcement campaigns with heavy publicity, adequate funding, and automated enforcement mechanisms where favorable legal conditions exist. Higher penalties and double-fine zones in construction work areas are popular enforcement measures in many areas of the country, however, these measures are not ranked as effective as simply increasing the number of citations for traffic offenses. Other measures with mixed results in terms of effectiveness include graduated drivers licensing and changes in speed limit legislation.

In terms of engineering measures, survey respondents emphasize the success of low cost, preventative solutions such as rumble strips, guard cables, and improved delineation, as well as improved signage, signal coordination, ramp metering, variable message signs (VMS), Intelligent Transportation Systems (ITS) intersection crash avoidance systems, road maintenance, and local traffic calming. Higher cost options also include redesign and reconstruction of highways and intersections to improve horizontal alignment, simplify maneuvers, and address problems in high crash rate zones. Finally, respondents highlight the need for better linkages between engineering and safety officials in order to capture opportunities for cross-disciplinary actions.

In order to illustrate best practice in remedies for driver error, a number of case studies are identified including: the Statewide Pedestrian Safety campaign in California; the Seat Belt Enforcement Program in Louisiana; Intersection Safety Projects in Michigan; Advanced Engineering in Pennsylvania; and Safety Media Campaign in Texas. These case studies emphasize the importance of adopting a multijurisdictional approach with a simple message or approach to target priority concerns. The case studies also indicate the benefits of integrating education, enforcement, and/or engineering elements within a program of activities, as well as the benefits of having public and political support and champions for the issue.

From recent literature, survey responses, and case study, a successful program of activities to address driver error is likely to include improved reporting and analysis, integrated enforcement and public education campaigns, interagency cooperation and stakeholder involvement, and improved roadway design features, such as rumble strips. By integrating education, enforcement, and engineering strategies and targeting principle sources of driver error, traffic safety practitioners can reduce driver error and improve road safety both within Arizona and across the United States.

1. INTRODUCTION

Across the United States, driver error is estimated to cause between 45 percent and 75 percent of all crashes and is a contributing factor in the majority of crashes (FHWA, 2002). Understanding the underlying reasons for the majority of accidents and the potential range of remedies to address these causes is therefore critical to reducing the number of vehicle fatalities and crashes in Arizona and throughout the United States.

This reference document provides information on driver error as well as innovative and effective remedies used to reduce the frequency of driver error in the United States and beyond. This information is based on a review of recent literature findings as well as survey and other data obtained from state agencies across the United States.

The reference document will briefly outline the issue of driver error in Arizona in the remainder of Chapter 1, followed by a synopsis of literature on the types, contributing factors, and feedback elements of driver error in Chapter 2. In Chapter 3, information from the literature review will be discussed in relation to the issues and elements of education, enforcement, and engineering strategies that are reported to have an effect on reducing the frequency of driver error. Following this synopsis of recent literature, Chapter 4 will outline the process and findings emerging from a recent survey of state agencies regarding state-of-practice remedies for driver error in the United States. Survey data will include the range of strategies currently used to alleviate driver error, as well as their level of effectiveness and influencing factors. For a number of states reporting highly effective strategies, Chapter 5 will provide more detailed case studies on these projects. Finally, the above information will be brought together to provide a summary of effective remedies for driver error in Chapter 6.

1.1 Traffic Crashes and Driver Error in Arizona

The Arizona Governor's Office of Highway Safety (AGOHS) reports (AGOHS, 2001), that Arizona had 131,368 reportable motor vehicle crashes in 2000 involving 248,310 drivers, 82,992 property-damage-only (PDO) accidents, 76,626 injuries (people injured), and 1,036 fatalities. Driver error was the largest single cause of these crashes, with excessive speed being reported in 20 percent of cases. Other major contributing factors included failure to yield (11 percent) and driver inattention resulting in delayed problem recognition (5 percent). Given the fact that "No improper driving" and "Not stated" were reported in 52 percent of cases, statistics on driver error may be underestimated.

Table 1.1 Major Contributing Driver Errors, Arizona, 2000

Accident Type / Driver Error	Fatal (Drivers)	Injury (Drivers)	PDO (Drivers)	Total (Drivers)	Total (%)
Exceeding Lawful Speed	60	644	613	**1,317**	0.5%
Speeding	302	18,052	28,831	**47,185**	19.0%
Failed to Yield	97	11,599	15,328	**27,024**	10.9%
Ran Stop Sign	19	705	750	**1,474**	0.6%
Disregarded Signal	34	2,950	2,365	**5,349**	2.2%
Opposing Lane	75	572	801	**1,448**	0.6%
Followed too Closely	1	1,436	2,876	**4,313**	1.7%
Improper Turn	10	1,065	3,135	**4,210**	1.7%
Driver Inattention	46	3,783	8,761	**12,590**	5.1%
Other Improper Driving	58	1,979	5,052	**7,089**	2.9%
Faulty Equipment	5	105	203	**313**	0.1%
Unsafe Lane Change	13	1,102	5,147	**6,262**	2.5%
Unsafe Passing	60	644	613	**1,317**	0.5%
No Improper Driving	519	44,790	70,021	**115,330**	46.4%
Not Stated	136	3,810	9,289	**13,235**	5.3%
Totals	**1,380**	**92,838**	**154,092**	**248,310**	100.0%
(%)	0.6%	37.3%	62.1%	100.0%	

Note: There may be more than one driver or vehicle involved in a single crash.
(Source: Arizona Governor's Office of Highway Safety 2001)

These driver errors result from a number of personal factors such as the attitudes, behaviors, and capabilities of drivers. In an informal reader panel conducted by the Arizona Daily Star, inattention, impatience, and traffic congestion were cited as the biggest factors that led to collisions and dangerous driving within the state. Panelists identified traffic congestion as a trigger for impatient and aggressive driving. Most panelists also suggested that driver-education requirements failed to adequately train young drivers in the state (Wichner, 2002).

While young drivers may lack sufficient experience and training to deal with a variety of driving situations, other personal factors also influence driver behavior. For example, alcohol consumption was reported to be a contributing factor in 6 percent of all crashes in Arizona in 2001. For more serious accidents, alcohol use tends to be a more prevalent contributing factor, with 24 percent of all fatalities involving alcohol (AGOHS, 2002). As seen in Figure 1.1, the distribution of alcohol related fatalities may be related to population density, demographic factors, and other variables.

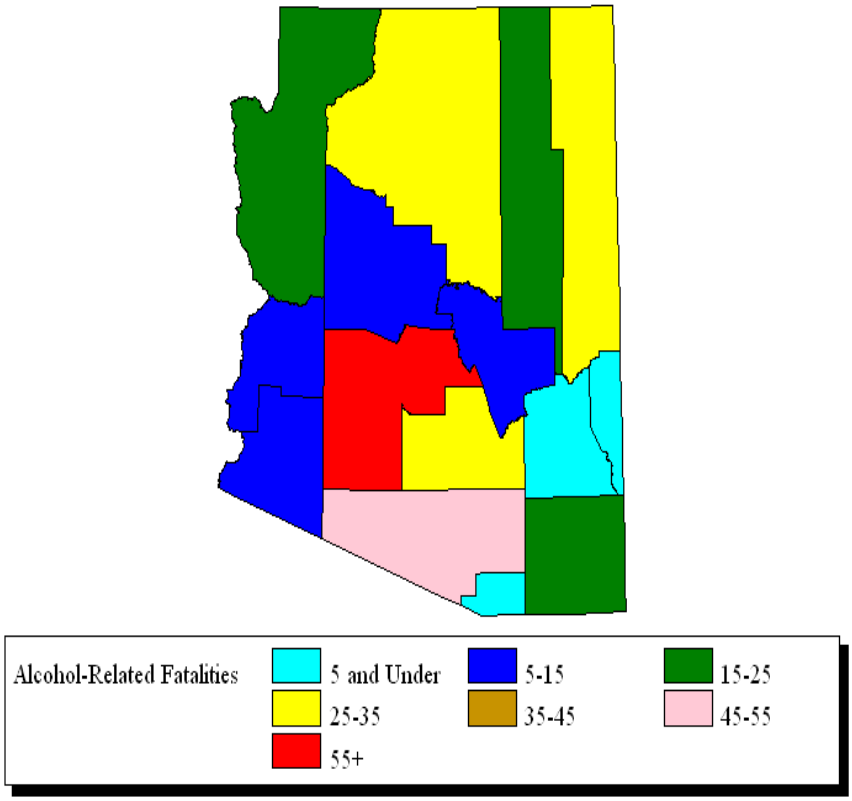

Figure 1.1 Alcohol Related Fatalities by County, 2001

Source: NHTSA State Traffic Safety Information for Year 2001

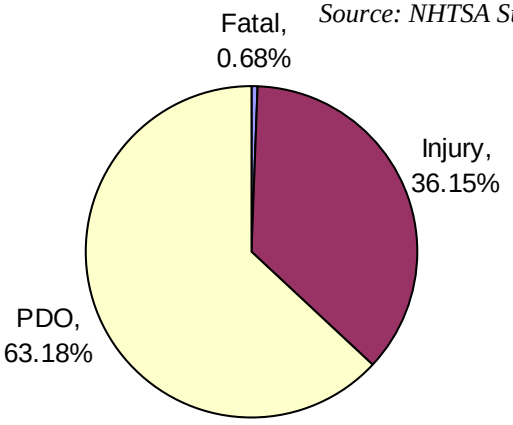

Figure 1.2 Arizona Traffic Crashes, 2000

Source: Arizona Governor's Office of Highway Safety, 2000

In terms of the severity of accidents, fatal accidents account for about 0.7 percent of all crashes in Arizona. Over time, the number of fatal road accidents has remained relatively consistent, with a tiny increase from 1,024 fatalities in 1999 to 1,036 in 2000, and to 1,052 in 2001. The rate of fatalities dropped slightly from 2.18 fatalities per 100 million vehicle miles traveled (VMT) in 1999, to 2.08 in 2000, and 2.06 in 2001 (AGOHS, 2001).

1.2 Arizona's Rising Insurance Costs

Another measure of the impact of driver error on road safety is insurance costs associated with different types of claims.

Automobile insurance rates are directly related to the frequency and severity of crashes by different categories of people and vehicles. According to the 1999 Insurance Commissioners report, Arizona ranks tenth in the nation for insurance premiums, with the average annual insurance premium being $788 per vehicle (Cañizo, 2002). Within Arizona, insurance rates also vary by city or region. For example, in 2000, the Arizona Insurance Information Association found that quotes for insurance coverage in the Tucson area were $59 to $156 less than those for the Phoenix and Glendale areas, while quotes for Scottsdale were a little higher than those for Tucson. These differences may relate to the incidences of driver error in different areas, as well as engineering factors such as the different phasing of left-turn movements at signalized intersections in the Tucson and Scottsdale areas (Cañizo, 2002).

As a major contributor to traffic accidents, driver error imposes significant costs in terms of loss of life, lost productivity, property damage, and insurance costs imposed on all drivers. In 2000, the total economic cost of motor vehicle crashes in the United States was estimated at $230.6 billion. This sum represents the present value of lifetime economic costs for 41,821 fatalities, 5.3 million non-fatal injuries, and 28 million damaged vehicles. In Arizona the total economic cost of motor vehicle accidents was $4.3 billion, including both police-reported and unreported crashes. According to the National Highway Traffic Safety Administration (NHTSA), speeding is the most common infraction in Arizona, resulting in $535 million in crash-related costs in 2000.

The burden of these motor vehicle crash costs falls upon a number of different parties including private insurers, individual crash victims, third parties. and public agencies. Private insurers are estimated to pay approximately 50 percent of all costs, while individual crash victims pay approximately 26 percent of costs. Third parties such as uninvolved motorists delayed in traffic, charities, and health care providers pay about 14 percent, while public revenues pay the remaining 9 percent of costs including approximately 6 percent from federal revenues and 3 percent from states and localities. In total, those not directly involved in crashes pay for nearly three-quarters of all crash costs, primarily through insurance premiums, trauma, taxes, and travel delay. In 2000 these cost to society totaled over $170 billion (NHTSA, 2000).

The high human, social, and economic cost of driver error in Arizona and throughout the United States, suggests the need for better understanding of the issues and available remedies. This reference document hopes to provide information on these issues and remedies.

2. DRIVER ERROR

Driving involves complex interactions between human factors and system responses. Each task or problem encountered by the driver involves a sequence of:

- Perception or problem recognition;
- Decision making;
- Execution or performance; and
- Real time system response by the vehicle, roadway and surrounding environment.

Where an error occurs in any one or more of these steps, it may lead to an incident (such as a near miss) or accident (crash). The cyclical sequence of human factors and system response is displayed in the following figure and shows the dominant role of human factors in the driving function.

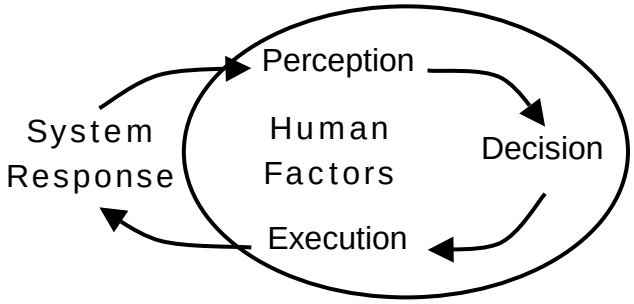

Figure 2.1 Task Sequence Involved in Driving

Source: *Kailash Thakur, 1997*

2.1 Types of Driver Errors

In different states, crash data is reported and coded differently, making it difficult to arrive at a uniform taxonomy of driver error and contributing factors throughout the country. The American Driver and Traffic Safety Education Association, describes driver error in relation to the three driver tasks of perception, decision and execution as shown below.

Table 2.1 Types of Driver Errors

Perception or problem recognition errors	Decision errors	Execution or performance errors
• Driver failed to stop for sign • Delays in problem recognition - Improper lookout - Internal distraction - Delays in recognition - Inattention - External distraction	• Excessive speed • False assumption • Improper technique / practice • Improper maneuver • Inadequate signal • Tailgating • Misjudgment of distance / closure • Pedestrian ran into traffic • Failure to turn on headlights • Excessive acceleration	• Improper evasive action • Inadequate directional control • Overcompensating • Panic or freezing • Critical non-performance (e.g. passing out, falling asleep) • Non-accident (e.g. suicide, road rage)

Source: American Driver and Traffic Safety Education Association, 2003.

The most significant source of driver error is found to be excessive speed. As discussed previously, speed is involved in about 20 percent of all accidents and 25 percent of all road fatalities within Arizona (AGOHS, 2001).

Other important sources of driver error include delays in problem recognition due to improper lookout, inattention and distraction. The Automobile Association of America (AAA) Foundation for Traffic Safety estimates that at least 25 percent of reported crashes involve some form of driver inattention or distraction, with a high proportion of distraction-related crashes among certain age groups, such as young drivers under the age of 20, 20-29 year-olds, and those age 65 and older (Stutts, 2001). Recently, particular research attention has been given to a range of technological distractions such as in-vehicle sound systems and the use of cell phones.

2.2 Factors Affecting Driver Errors

Problem recognition, decision making, and driver performance are also influenced by a range of personal factors, which may contribute to driver error. These factors include:

- Inadequate knowledge, skills, and training;
- Impairment due to:
  - Dysfunctions, disabilities, and compensating for short and long term dysfunctions,
  - Drug use, including alcohol, and over-the-counter, prescription and illicit drugs;
  - Drowsiness, fatigue, and sleep needs; and
  - Demographic characteristics such as aging; and
- Willful inappropriate behavior.

These factors describe personal triggers or features that lead to the different types of driver errors. For example, a person under the influence of alcohol, will tend to have a delay in problem recognition (a perception error), reduced ability to judge distances and select appropriate evasive actions (decision errors), and impaired ability to control the vehicle and carry out these actions (performance errors). This linkage is demonstrated in Figure 2.2.

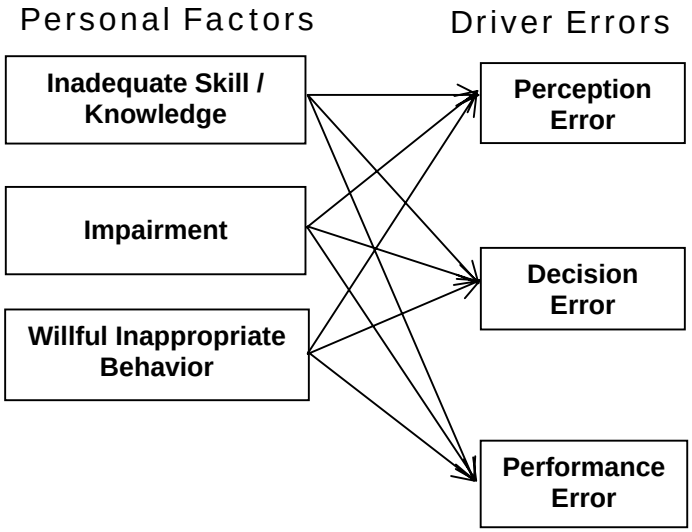

Figure 2.2 Influence of Personal Factors on Types of Driver Error

2.3 Taxonomy of Driver Errors

In order to clarify the range of possible crash-contributing factors, a taxonomy of driver errors was developed by research undertaken by Virginia Polytechnic Institute and State University (Virginia Tech) using funding from the FHWA. This taxonomy of contributing factors affecting driving performance resembles the personal factors and types of driver error listed previously. Additional environmental or infrastructure factors are included as having an influence on driver perception or problem recognition as shown in Figure 2.3.

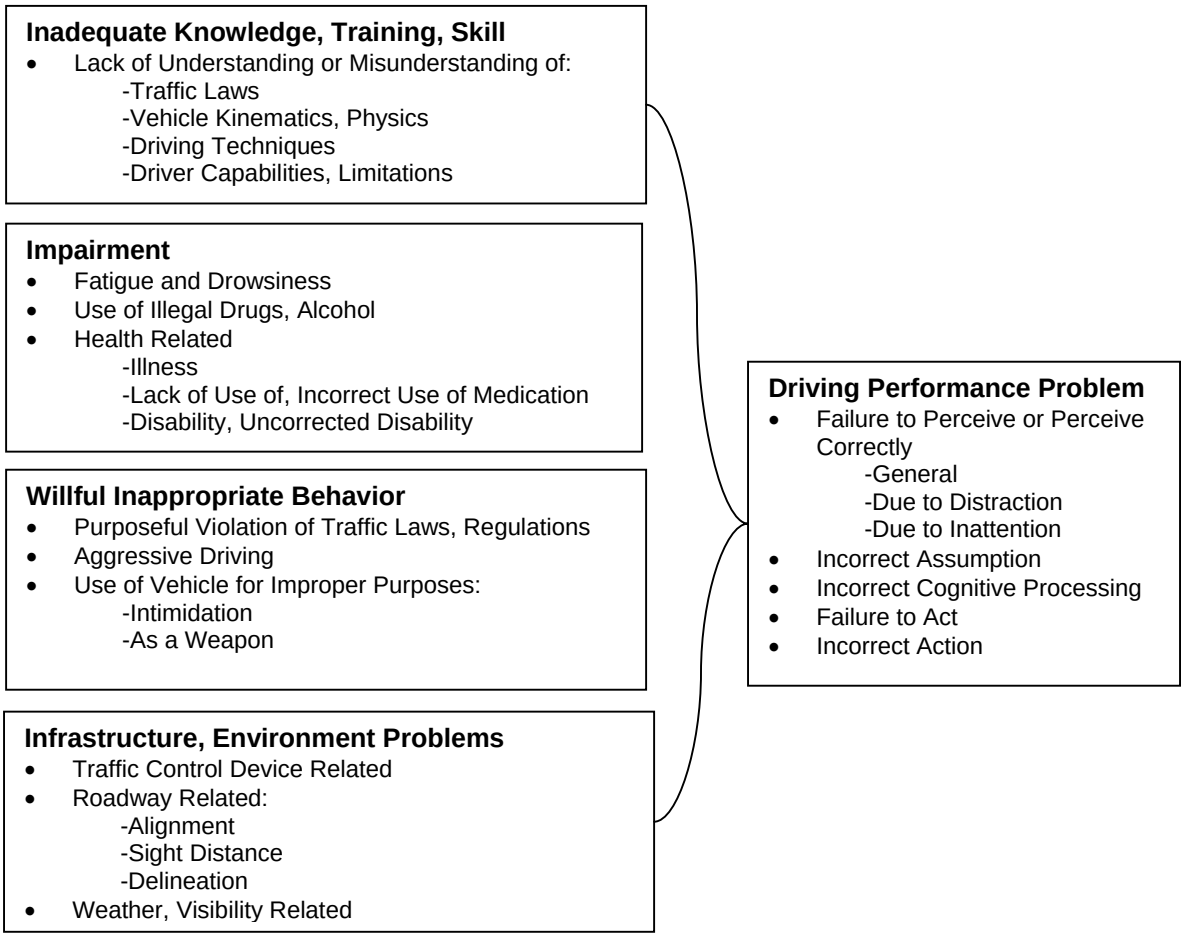

Figure 2.3 Taxonomy of Contributing Factors Affecting Driving Performance

Source: Wierwille et al, 2002

By combining this taxonomy with more detailed information on the types of driver error, a comprehensive understanding can be gained regarding the full range of driver errors and contributing factors. Generally, incidents or accidents involve at least one failure in driver performance, and each error is the result of a combination of human and environmental factors. To develop a comprehensive range of remedies to improve traffic safety and reduce driver error, there is therefore a need to ensure that all types of failures and contributing factors are addressed.

2.4 Feedback and Risk Homeostasis in Driving

The relationship between contributing factors and types of driver errors is confounded by psychological factors linked to a person's individual motivation and tolerance of risk. The phenomenon of "risk homeostasis" was documented by a Gerald Wilde at Queens University in Kingston, Ontario. Wilde describes risk homeostatis as the tendency for people to maintain equilibrium in what they consider to be an acceptable level of risk by adjusting to feedback of their perceived conditions (Wilde, 2002). This feedback interaction is illustrated below.

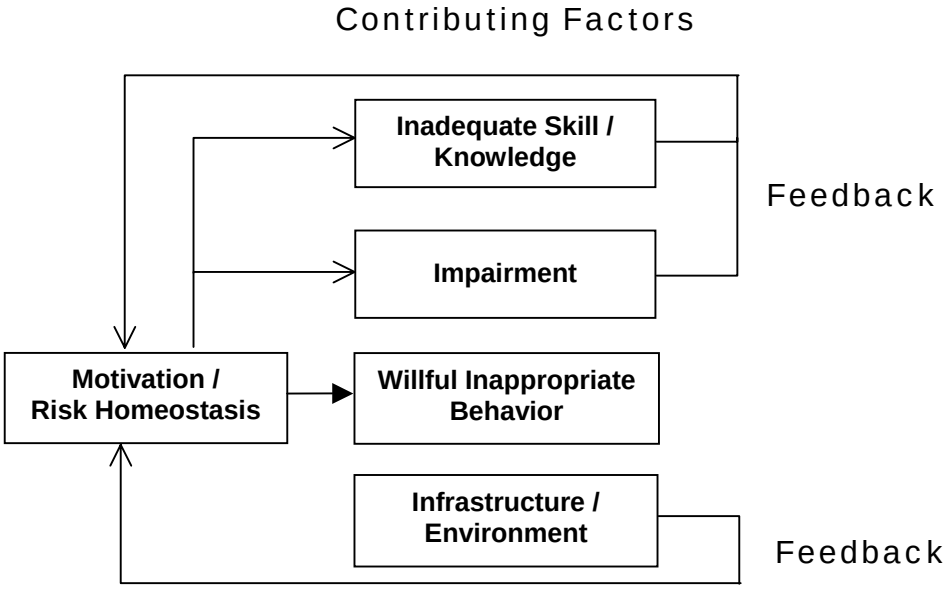

Figure 2.4 Influence of Risk and Motivation on Contributing Factors

Risk homeostasis can be seen in the case of a highly competent driver employing sloppy driving techniques, such as holding the steering wheel with one hand, undertaking other activities while driving, failing to indicate when changing lanes, and not coming to a complete stop at stop signs. The driver appears to compensate for a high perceived skill level by driving in an overconfident and less safe manner.

On the flipside, a less confident driver, or one who encounters what appears to be an unsafe situation, may tend to respond to the perceived risk by being extra careful in his driving behavior. This effect was observed in Sweden in the late 1960s when the country switched from left-hand to right-hand traffic. In anticipation of the change-over, many safety experts, politicians, and ordinary people predicted chaos and disaster on the country's roads. Driver therefore responded to this fear by driving apprehensively following the change-over and for some time afterwards. Instead of the predicted increase in accidents, there was a dip in the accident rate immediately following the

change-over, and a 17 percent reduction in total accidents the following year. Over time, traffic accident rates again returned to their previous levels (Wilde, 2002).

The above examples suggest that drivers tend to compensate for their perceived conditions by altering their personal contributing factors to driver error. In response to feedback on high levels of personal or environmental risk, drivers may alter their driving behaviors and factors that affect their potential impairment and skill: They may drive more closely to the speed limit, limit their alcohol consumption, pay attention while driving, refrain from driving when sleepy, and take lessons to improve their skills.

The phenomenon of risk homeostasis in the transportation sector was credited for a lack of significant difference in the accident rate per time unit of exposure, whereby people were observed to drive twice as fast in road sections where the spatial accident rate is half as high (Wilde, 2002). Risk homeostasis was also credited for a lack of significant long-term change in the temporal accident rate, whereby the number of traffic fatalities per 100,000 in the United States showed no clear change in the period from 1923 to 1996 despite increases in VMT and implementation of strategies to reduce the number of fatalities (Wilde, 2002). While different trends, variables, and causal relationships may be debated, Wilde's argument raises an important concern regarding the need to consider people's perception of risk and people's level of risk tolerance, rather than simply considering the level of risk itself.

In some cases, people may reduce their apparent tolerance of risk below that which is normally accepted, in response to an external stimulus such as the high probability of receiving a fine for speeding in certain locations. At a broader level, this effect was seen in lower accident rates during times of lower economic performance and high unemployment. Researchers attributed the effect to a lowering in the target level of traffic risk due to a reduction in the value of time and an increase in the perceived cost of a car accident, in terms of insurance surcharges and repair costs (Wilde, 2002). This effect highlights the potential to motivate people to alter their target level of risk through external means such as economic costs and incentives.

3. REMEDIES FOR DRIVER ERROR

While a long-term improvement in the temporal accident rate (per 100,000 residents) is difficult to detect, a range of literature supports the fact that there have been substantial and consistent improvements in the spatial accident rate (per 100 million VMT) (Wilde, 2002). Over the past three decades, the United States' total road fatality rate per 100 million VMT dropped from 5.50 in 1966 to 1.51 in 2002 (NHTSA, 2002). This improvement might be attributed to a range of highway, vehicle, and traffic safety programs implemented at the state and federal levels.

A recent national poll commissioned by Drive for Life, a national driver education and outreach program, indicated that the vast majority of people (81 percent) believe that cars are safer than in the past. Most people (57 percent) also believe that roads are safer than in the past. In contrast, only 27 percent of people think that drivers themselves are safer than in the past (ArcNetwork, 2003). This discrepancy suggests the need for greater emphasis on traffic safety programs that focus on changing driver behavior in order to reduce the frequency of driver errors.

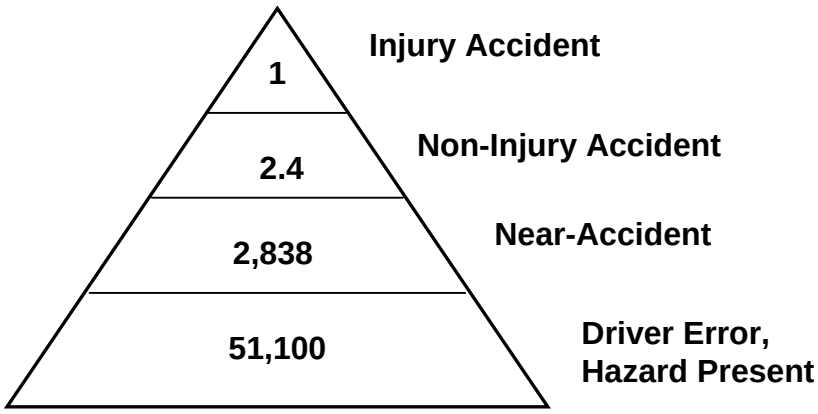

Figure 3.1 Modified Heinrich's Triangle for Driver Error

Source: T.A. Dingus, S. Hetrick & M. Mollenhauer.

By reducing the frequency of driver error, traffic safety analysts predict a proportionate reduction in accidents caused or affected by driver error. This ratio is illustrated by the modified Heinrich's Triangle in Figure 3.1, which estimates that for every injury accidents there were 51,100 errors with a hazard present. The original Heinrich's Triangle was developed for industrial accidents and estimated ratios between fatalities, severe injuries, moderate injuries, minor injuries and near-accidents. This modified triangle uses automobile driving data from Dingus, et.al. (1999). The Heinrich Triangle was part of a safety theory that focused on reducing the amount of incidents and near accidents through changing worker behavior.

3.1 Types of Remedies for Driver Error

Three types of remedies are traditionally available for reducing the frequency of driver error, namely:

- Education and information;
- Enforcement and incentives; and
- Engineering and infrastructure.

Education and information focuses on improving the quality of information on traffic safety, driver error, and the effectiveness of programs, as well as increasing driver skills and perceptions of risk in order to promote safer driving habits and behaviors. Driver education strategies may improve driving skill under a variety of road conditions and emphasize obedience to speed and other traffic signals. Public education, awareness, and social learning strategies may also target behavior changes such as using seat belts, minimizing driver distraction, combating driver fatigue by pulling over to rest, and adopting a designated driver to reduce alcohol-related incidents. Education strategies rely upon good quality information such as accident reporting statistics, program evaluation information, and other data.

Enforcement and incentives strategies include improving obedience to existing traffic devices such as traffic signals and traffic signs, as well as encouraging safer driving outcomes. Obedience to traffic safety regulations may be enhanced or targeted through public awareness campaigns, more stringent traffic enforcement, increased penalties and special campaigns at critical times and at safety hot spots. In addition, ongoing development, compliance, or streamlining of traffic laws, such as Hours of Service regulations and DUI laws, may also help to reduce incidents caused by driver error. Hours of Service regulations, enforced by the Federal Motor Carrier Safety Administration, limit the amount of driving and working time for truck drivers. Their purpose is to improve highway safety by helping reduce accidents and errors caused by truck operator drowsiness and fatigue.

Finally, engineering strategies include a range of measures aimed at reducing driver error through physical changes to the surrounding vehicle, roadway, or traffic system. For example, in-vehicle systems such as automatic lights-on systems and sun-shades improve problem recognition and reduce perception-related driver error. Road signage and real-time traffic information may also improve navigation and emphasize driver alertness. In areas of low traffic volume, speed and driver error reductions may also be achieved through street design that incorporates traffic calming features, and more prominent pedestrian facilities. Design features may include narrow, curbless streets and sidewalks; the use of paving stones or textured asphalt within crosswalks; and adding trees, planters, parking areas or other street obstacles to help slow vehicles.

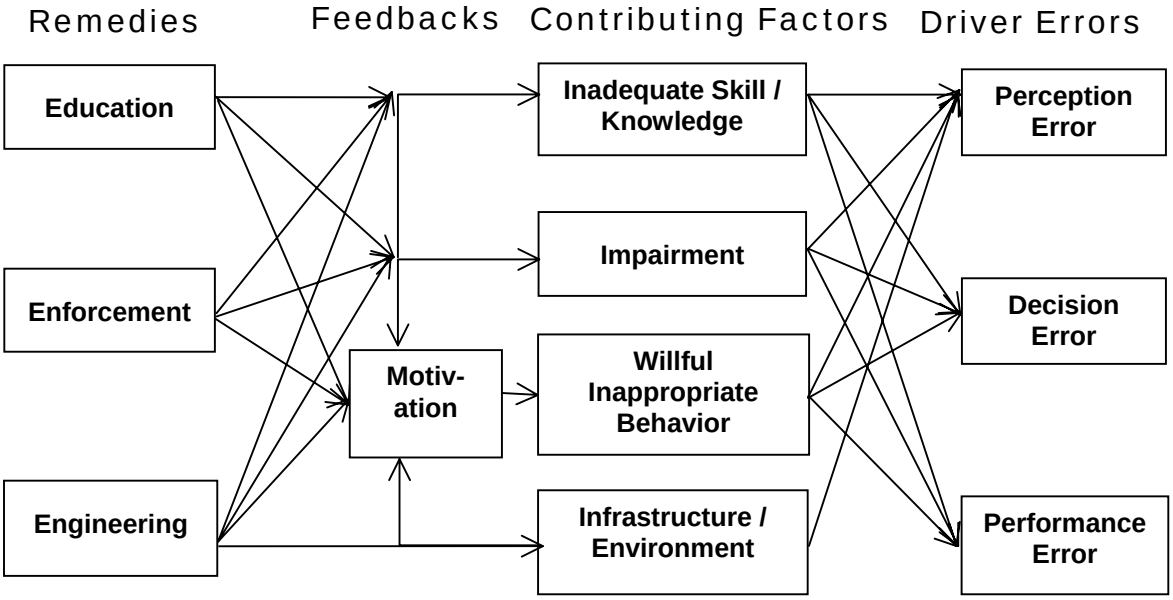

Figure 3.2 Driver Errors, Contributing Factors Remedies and Feedback

By reducing driver error, a range of strategies may assist in reducing the frequency of traffic incidents, and ultimately reduce the frequency and severity of traffic accidents. These strategies or remedies are seen on the left hand side under "Remedies" in Figure 3.2. Linking remedies to the taxonomy of driver errors and contributing factors, aids in ensuring that all aspects of driver error are addressed. The figure above explains the ways that the three traditional remedy categories of education, enforcement and engineering can be used to address the "Contributing Factors" (knowledge, impairment and behavior, and environment) directly. All three remedies can also be used to influence "Motivation" which is a key component to behavior, which will be further discussed in the chapter.

By improving the "Contributing Factors" there will be a reduction in the three types of errors: perception, decision and performance. These driver error reductions will in turn reduce the number accidents. The feedback loops in the chart help illustrate the indirect and complex process of changing driver behavior through motivation.

The chart above also provides a way of categorizing the myriad remedies available within each of the three traditional categories of driver error countermeasures. This chapter will describe countermeasures within each of these three categories as well as address the issue of risk homeostasis through considering the effects of each strategy and approach on driver motivation.

3.2 Addressing Motivation in Remedies for Driver Error

The effectiveness of countermeasures to driver error is confounded by risk homeostasis, or the tendency for people to compensate for measures in order to maintain a constant level of tolerable risk. This can result in traffic safety campaigns moving accidents around rather than reducing them, since people's overall tolerance of risk remains constant (Wilde, 2002). To address this issue, countermeasures should address motivation: incorporating ways to increase people's perception of existing risk levels or encourage people to decrease their "target level" of risk. The measures should reflect an understanding of contributing factors and driver errors, as well as feedback impacts on people's target level of accident risk. Four categories of motivating factors influence driver behavior and should be addressed in safety strategies:

- Expected benefits of comparatively risky behavior;
- Expected costs of comparatively risky behavior;
- Expected benefits of comparatively safe behavior; and
- Expected costs of comparatively safe behavior.

Countermeasures should therefore incorporate ways of increasing perceived costs of risky behavior, decreasing perceived costs of safe behavior, increasing perceived benefits of safe behavior, and decreasing perceived benefits of risky behavior, which is illustrated in Figure 3.3. For example, public education campaigns might emphasize potential risks (costs) associated with speeding and clarify the actual amount of time that people save, thereby decreasing perceived benefits. Enforcement strategies might focus on increasing the likelihood of being fined for unsafe driving and lowering the cost of registration for a cleaner driving record. Engineering strategies might reduce sight distances to make the driving environment seem more unsafe, thereby encouraging more cautious driving. The latter is the opposite approach to conventional traffic engineering.

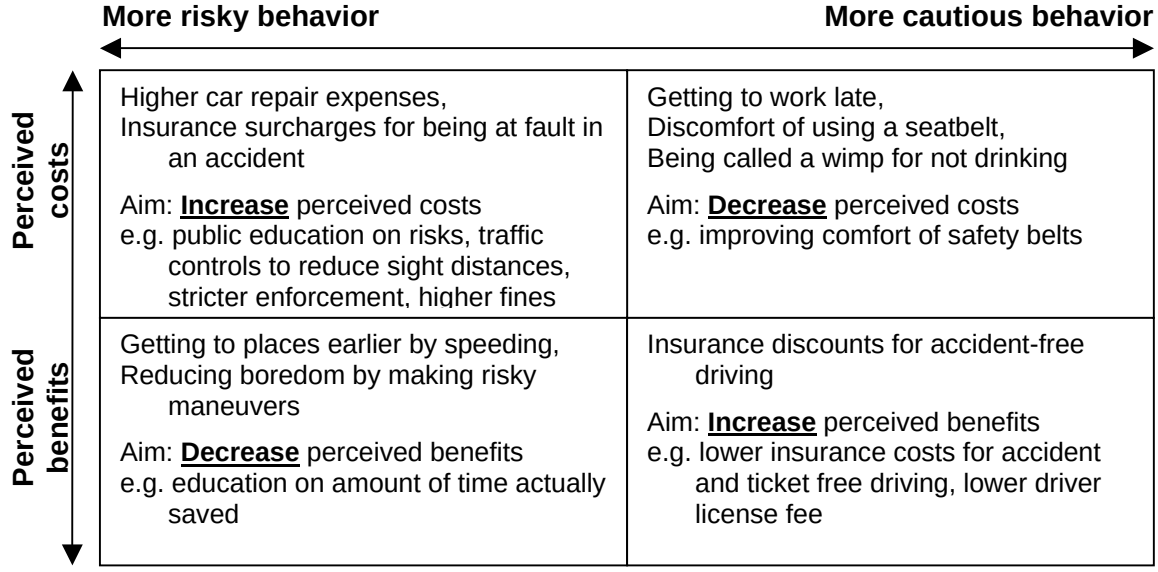

Figure 3.3 Driver Error Remedies to Address Motivation and Risk Homeostasis

3.3 Education and Information

Education and information encompasses the three areas of:

- Driver education;
- Public education and awareness; and
- Improved reporting of driver errors involved in crashes.

Driver education is aimed at improving the skills of drivers through formal and informal driver training. Public education and awareness countermeasures are primarily directed at preventing driver errors. Information and reporting are aimed at attaining a clearer picture of what driver errors are most common and what countermeasures should be targeted. This information is necessary to help identify the target audience of education-related strategies, the key themes or messages to be conveyed, and the most effective media or approaches for conveying these messages.

According to the Virginia Tech study undertaken for the FHWA, more than half of all reported crashes have unknown principal factors, and data collection on traffic crashes does not provide sufficient detail to determine the multiple factors and most critical factors involved. The taxonomy of contributing factors presented in Figure 2.3 helps to identify the causes of driver error and the multiple factors involved in traffic accidents (Wierwille, 2002). It is important that accident reporting systems provide accurate information on human factors in order to ensure that appropriate remedies are selected to address these causes. Standardization of accident report forms and coding systems by police departments in different states would be required to facilitate collection and comparison of this information among different states. A uniform coding scheme suited to state and national databases should include principal contributing factors and driver performance errors as well as soliciting officer suggestions for improvements to accident reporting forms, infrastructure, and driver problems. Implementation of uniform driver error reporting and formalization of police officer feedback will greatly assist all other efforts to address driver error (Wierwille, 2002).

A review of various sources of literature on traffic safety highlights a number of education and information strategies, as outlined in Table 3.1.

Table 3.1 Education Strategies for Addressing Driver Error

Improve Driver Education	Increase Public Education	Improve Information and Reporting
• Improve driver instruction training and resources for: - formal driver education - parents teaching teens • Improve driver education on the full driving process (Northpoint, 1995): - road rules - driving techniques - vehicle maintenance - risks related to driving - early problem recognition - dealing with emergency situations - dealing with fatigue and other conditions (Garfinkel, 2003) • Introduce graduated licenses with learner and probationary licenses having lower speed limits and blood-alcohol limits (Kluger, 1998) • Promote driving practice and experience such as - the use of driving logs for novice or learner drivers (Nagourney, 2003) - practice with braking at speed with a new vehicle	• Undertake public education campaigns including television and radio advertisements or announcements (Schulman 1998, Community Guide 2003) to: - encourage safe driving practices - increase awareness of risk or increase perceived costs of certain behaviors e.g. damage from crashing at different velocities, problems of deteriorating visual acuity (TransSafety, 1997) - increase awareness of actual benefits or decrease perceived benefits of speeding and other actions (Wilde, 2001) - encourage hope for the future and value longevity (Blackman, 1997) • Target high-risk populations including - novice / young drivers - poor sighted • Encourage community involvement and participation in policing • Intervention training programs for servers of alcohol (Community Guide, 2003)	• Streamline accident reporting forms • Standardize traffic accident reporting system nationally (NHTSA, 2002) including reporting of driver error types and contributing factors such as aggressive driving • Undertake research on the frequency, intensity and consequences of real-world driver error, e.g. distraction • Investigate trends in traffic accidents on a per capita and per vehicle miles traveled (VMT) basis • Develop electronic database on driver error

Motivation is an important component of educational strategies for reducing the frequency of driver error. These strategies include public education campaigns aimed at increasing awareness of risks (and therefore increasing perceived costs) associated with unsafe driver behaviors, and increasing awareness of the actual time saved (therefore decreasing perceived benefits) resulting from unsafe driver behaviors. In Missouri, targeted educational efforts to address driver error include a one-day traffic offenders program to help young drivers guilty of traffic offenses to understand the consequences of their actions by visiting trauma centers, morgues, and crash survivors (Kluger, 1998). Educational programs have also been implemented in Pennsylvania, Milwaukee, and Wisconsin to combat aggressive driving (NHTSA, 2000).

While strategies to increase perceived costs and decrease perceived benefits of unsafe driver behaviors have been implemented in various places, it is difficult to measure the outcome of educational strategies in terms of actual changes in driver behavior and reductions in traffic accidents. This dilemma was highlighted in a recent National Cooperative Highway Research Program (NCHRP) report (2003) that identified the need to link aggressive driving to crashes and measure the outcome of educational campaigns in terms of reductions in crashes. Improvement of information and reporting is crucial to understanding the success of educational and other strategies aimed at reducing the frequency of driver error.

While educational strategies focusing on the benefits of safe driving behavior can be expected to yield positive results, some campaigns may in fact result in people responding in the opposite direction than that intended. The tendency toward disobedience is greater where campaigns are perceived as coercive, and limiting of personal liberty, and freedom of choice. Behavior, labeled by psychologists as "reactance," has been observed in relation to some ads regarding drinking and driving. For some people, it appears that riskiness is a positive motivational force in itself, with a higher proportion of young males in particular looking favorably upon risky activities such as high-speed driving. When reactant individuals are warned about the risk involved in an activity, they are drawn to it rather than being deterred, particularly in public situations (Wilde, 2001). Addressing motivation under these circumstances may be more effective through inconspicuous economic measures such as photo enforcement of road rules (speed cameras), or family-based measures such as encouraging driving contracts between parents and teenagers (Nagourney, 2003). Some observers have suggested that reactant behavior stems from a lack of hope or concern for human life, which might be addressed through broader strategies aimed at encouraging people to value longevity and think optimistically about the future (Blackman, 1997).

3.4 Enforcement and Incentives

Enforcement measures and incentives include:

- Strategic planning and policy development regarding driver error;
- Increasing the likelihood of being caught for infringements of the law;
- Increasing penalties associated with driving infringements;
- Amending road rules and licensing requirements;
- Introducing incentives to encourage appropriate driver behavior.

In order to facilitate consistent enforcement, legislative and policy mechanisms are required to ensure funding of traffic safety programs and cooperation between multiple agencies and jurisdictions. Greater levels of cooperation may result in greater consistency of rules and enforcement, as well as more effective implementation of enforcement and incentive strategies.

Enforcement strategies primarily aim to address motivation by increasing the perceived or real cost of risky behavior and therefore deterring drivers from willful inappropriate behavior or inadvertent driver error. Inappropriate behavior and errors include speeding, running red lights, aggressive driving, drunk driving, driving without a seatbelt, and other acts that increase the risk and severity of crashes. Literature on law enforcement in various fields suggests that enforcement strategies are more effective in changing behavior when there is emphasis on increasing the certainty of enforcement, regardless of the size of the penalty. A study by the Australian College of Road Safety (ACRS) determined that overly severe penalties may in fact detract from program effectiveness, since enforcement strategies are more effective where they are seen as fair and responsive to legitimate traffic safety concerns, rather than as a means of revenue raising or even racial profiling (ACRS, 2003). The size of traffic safety penalties should not exceed popular opinion about the immorality or deviancy of the infringement (Wilde, 2001).

In some cases, legitimate increases in penalties may be introduced as a deterrent to willful inappropriate behavior through higher fines and the possibility of license revocation. Legislative amendment may also help to target new areas of traffic safety that were previously unregulated. In New Jersey for example, legislation has been enacted to prohibit driving when fatigued and to impose penalties for accidents caused by driver fatigue. While this legislation has not yet been tested by the law, its enactment has raised the profile of driver fatigue as a traffic safety violation in that state (Garfinkel, 2003).

Difficulties in measuring the effectiveness of enforcement measures in reducing driver error are compounded by evidence that where selective enforcement or surveillance is adopted regarding some aspect of road-user behavior, there tends to be a reduction in the prevalence of that type of accident but not in the overall accident rate. This manifestation of risk homeostasis results in a slight increase in other errors, where there is a reduction in one type of error (Wilde, 2001).

In addition to enforcement measures, driver motivation may also be affected by incentives that reinforce good driving behavior through lower costs or fee rebates. In a Californian study conducted in the 1970s, lower insurance costs, driver license fee rebates, and other financial incentives for drivers with a cleaner driving record were found to result in more cautious driving behaviors (Wilde, 2002).

The range of enforcement measures and incentives for addressing driver error as identified in a review of recent literature is provided in Table 3.2.

Table 3.2 Enforcement Strategies for Addressing Driver Error

Provide Leadership for Policy Change	Increase Enforcement and Penalties	Amend Legislation and Road Rules
• Provide leadership on driver error from the DOT/NHTSA and provide guidance to regional offices • Link transportation funding to enactment of laws on drunk driving and seatbelts • Create multi-agency task forces and collaborative, multi-disciplinary projects to address driver error (NCHRP, 2003)	• Increase enforcement through more frequent ticketing and revoking of licenses, and assigning more police officers to traffic duty (Schulman, 1998) • Target enforcement at critical times or locations: - increased enforcement and sobriety testing during holidays and events - photo enforcement such as red light or speed cameras at unexpected locations • Encourage citizen reporting of illegal or aggressive driving (Schulman, 1998) • Encourage driving contracts between parents and teenagers • Enhance laws through higher fines and penalties (Community Guide, 2003) • Conduct audits of child safety devices and impose fines for not using safety belts and child seats	• Increase the stringency of laws such as speed limits and Blood Alcohol Content (BAC) • Introduce graduated licenses with lower speed and BAC limits, and required hours spent driving for novice drivers (Nagourney, 2003) • Introduce laws to address specific driver errors such as: - requiring both hands to be available for driving or banning cell phone use while driving (Wald, 2003) - regulating hours of service for commercial drivers - introducing laws against driver fatigue (Garfinkel, 2003) - testing drivers for visual acuity using low-contrast letter charts and functional field measures (TranSafety, 1997) - undertaking simulated driving tests for Alzheimer's patients (Sullivan Moore, 2003)
Introduce Incentives		
• Insurance by government • Increase insurance costs for bad drivers • Decrease insurance fees for better drivers		

DOT = department of transportation
NHTSA = National Highway Traffic Safety Administration.

3.5 Engineering and Infrastructure

Engineering strategies can be used to address a range of contributing factors as well as driver perception and problem recognition. These strategies include:

- Traffic operations changes such as improved signage and traffic signals;
- Implementation of traffic monitoring systems and safety audits;
- Roadway design features to reduce the frequency and severity of conflicts;
- Roadway design features to discourage risky behavior; and
- Vehicle design features to improve problem recognition by drivers and others.

In relation to engineering strategies, opposing approaches have been adopted to address driver error. Traditional traffic engineering approaches attempt to improve the safety of roads and intersections by increasing sight distances, removing trees and other obstacles from roadside clear zones, improving traffic control devices, changing roadway delineation and geometric design to enable maneuvers to be undertaken more safely or at higher speed. These approaches have been recommended by conventional traffic engineers as a means of improving driver perception and reducing driver error, particularly at high capacity intersections and along freeways (NCHRP 2003, Lerner 1999, Wierwille et al, 2002).

Engineering strategies also include safety measures such as the provision of continuous shoulder rumble strip (CSRS) to reduce single-vehicle, high-speed run-off-road events, safe stopping locations along roadways to allow drowsy drivers to pull off and rest, and active or passive signage to alert drivers of hazardous conditions. In Stoughton, Minnesota, larger, brighter traffic signs were placed in strategic, uncluttered areas to reduce driver error by giving fair warning of hazards.

More recently, traffic calming approaches have incorporated design features that slow vehicles down by reducing sight distances, raising intersections or paving intersections differently, and inserting physical impediments, such as speed humps and dips. This approach has been implemented in many downtown areas and neighborhoods in the United States, Canada, Australia, and Europe. In Germany, this approach is epitomized by the development of “woonerven” (singular: “woonerf”), which have shared street space between vehicles and pedestrians and design features that create a residential atmosphere and convey the impression that the whole street space is usable by pedestrians (Appleyard, 1981). The intent of traffic calming is to incorporate features that bring the design speed of the roadway to a level that is consistent with adjacent land uses. These traffic calming measures signal to drivers the possible presence of nonmotorized roadway users, like pedestrians and cyclists, and encourage drivers to proceed more slowly and cautiously.

The selection of either of the above approaches to roadway design should take into account the purpose of the road, area-wide objectives, and consistency with surrounding

design. The range of engineering approaches found in current literature is listed in Table 3.3.

Table 3.3 Engineering Strategies for Addressing Driver Error

Address Traffic Operations	Address Roadway Design	Address Vehicle Design
• Select appropriate intersection traffic control to minimize crash frequency and severity (NCHRP, 2003) • Provide passive traffic control devices such as - larger, brighter signs in strategic, uncluttered areas to give fair warning of hazards (Williams, 2003) • Provide active traffic control devices - variable speed signs to achieve lower speeds in areas of high pedestrian activity - intelligent devices at intersections to alert drivers of potentially conflicting vehicles (Lerner, 1999) • Change system level signal timing • Conduct safety audits at intersections and along road segments • Install roadway systems to help achieve safe following distances (Lerner, 1999): - gap monitoring sensors - gap zone markings • Address traffic operations factors that affect driving and that apparently contribute to aggressive driving (NCHRP, 2003)	• Reduce the frequency and severity of conflicts (NCHRP, 2003) through: - improved traction at intersection approach - geometric design such as larger turning radius - longer merge lanes and separation of rightmost through lane from other lanes (Lerner, 1999) - increasing sight distance at unsignalized intersections - countdown display at traffic signals - planting guidelines and delineation of trees in hazardous locations - mowing and vegetation control guidelines - vision enhancement systems for nighttime and inclement weather (US DOT, 1997) • Incorporate traffic calming measures so that street design is consistent with adjacent land uses - shorter sight distances through narrower sections and trees (Wilde, 2001) - traffic calming devices such as speed bumps (FHWA, 2003) • Install facilities for emergency situations or warnings - safe stopping areas - rumble strips on the side of the road (Stutts, 2000) • Promote design consistency to allow more accurate driver expectancies and judgments (Lerner, 1999)	• Distribute child safety seats (Community Guide, 2003) • Introduce Intelligent Transportation Systems technologies for crash prevention (US DOT, 1997; Stutts, 2000; Garfinkel, 2003) such as: - driver status monitoring such as eye movement - performance monitoring such as response to small closing gap • Encourage vehicle on-board displays with collision avoidance warnings - obstacle detection system sensitive to fixed objects - tire pressure monitoring requirement • Encourage provision of external vehicle displays: - daytime running lights (Lerner, 1999) - rear signaling systems • Install “black box” data recorders in vehicles to record speed and other conditions during crash (Drivers.com, 1999)

In addition to roadway design, a number of technological solutions have been suggested or are being developed to address driver error at intersections and along roads. For example, intersection collision avoidance systems using intelligent transportation systems (ITS) are currently being tested along with changes in traffic signal design formulae (US DOT, 1997; Lerner, 1999). ITS is also being used to provide warnings and decision aids to drivers such as on-board systems to help with the passing maneuver and roadside systems to help pace merging vehicles into gaps or to warn exiting vehicles of queues detected on freeway off-ramps (Lerner, 1999). While these aids may assist drivers in perception and decision making tasks, the potential misuse and over-dependence on crash prevention technologies highlights the issue of driver responsibility and the need to ensure that technologies do not act as a substitute for the functional capability of the driver.

Engineering technology both within vehicles and along the roadway can play an important role in reducing driver error by helping drivers recognize problems through monitoring and detection and warning drivers. Engineering design plays an important role in reducing driver error by increasing the safety of roads through providing safe designs and facilities to address emergency situations. While these traditional techniques have been employed widely to increase traffic safety, more recently, traffic calming has been used to introduce design features that results in roadway functionality that better matches adjacent land uses. These traffic calming features signal to the driver the possible presence of pedestrians and cyclists, which encourages drivers to behave in a more cautious manner.

4. PROFILE OF STATE PRACTICES

In order to gain a better understanding of the current state of practice regarding remedies for driver error across the United States, a survey was conducted to solicit input and information on current practices and effective remedies for driver error in each state. The survey was distributed to all state departments of transportation or offices of highway safety and was designed to provide information on the range of remedies used to address driver error in the United States, as well as the education, enforcement, and engineering options that pose the greatest potential to reduce driver error under different conditions and contexts.
pickup

4.1 Survey Instrument

Using information from the literature review on remedies for driver error, a classification of education/information, enforcement/incentive and engineering/ infrastructure strategies was developed. These strategies are listed in Table 4.1 below.

Table 4.1 Survey Classification of Strategies for Addressing Driver Error

Code	Strategy
Education/Information	
EDU 1	Implement public awareness campaigns via TV, radio, print and outreach
EDU 2	Improve driving instructor training and resources
EDU 3	Improve driver training
EDU 4	Improve related industry practices and awareness activities
EDU 5	Improve reporting and analysis of driver error and contributing factors
Enforcement/ Incentive	
ENF 1	Lengthen driver training and improve testing and licensing
ENF 2	Impose tighter legislation targeting driver error and contributing factors
ENF 3	Change speed limits to reduce driver error
ENF 4	Increase targeting and frequency of enforcement and citations
ENF 5	Enhance enforcement with automated systems and photo enforcement
ENF 6	Increase the cost or severity of penalties
ENF 7	Address driver error in related legislation
ENF 8	Implement an overarching plan to reduce driver error
ENF 9	Promote interagency cooperation, partnerships and community involvement
Engineering/ Infrastructure	
ENG 1	Encourage in-vehicle simplification, information, decision aids, and external displays
ENG 2	Implement traffic calming and roadway design for slower, more cautious driving

ENG 3	Design intersections to allow maneuvers to be undertaken more safely at appropriate speeds
ENG 4	Design highways and roadways to allow maneuvers to be undertaken more safely at higher speed
ENG 5	Address roadside vegetation for longer sight distances
ENG 6	Improve road design and rest areas to address driver fatigue and inattention
ENG 7	Alter traffic operations such as signal phasing and ramp metering
ENG 8	Implement passive traffic controls such as signage and road markings
ENG 9	Implement active traffic controls such as speed sensors and variable signs
ENG 10	Implement system level changes to promote consistency and accuracy of driver expectations
ENG 11	Implement strategies to reduce impacts of nighttime driving, inclement weather and work zones
ENG 12	Install or encourage Intelligent Transportation System (ITS) warnings and decision aids
ENG 13	Conduct safety audits at intersections or along road segments

This classification of strategies was then used to develop a survey instrument aimed at obtaining information on the range of strategies implemented by different states and the relative success of these strategies. To gather this information, the survey included questions in the following areas:

- Overarching strategies for addressing driver error;
- Strategies implemented to reduce driver error through education/information;
- Strategies implemented to reduce driver error through enforcement/incentives;
- Strategies implemented to reduce driver error through engineering/infrastructure;
- Selection criteria for all of the above strategies;
- Innovation and success in the above strategies and factors affecting this success; and
- Respondent identification.

The survey was developed in consultation with the project technical advisory committee, with a draft survey undergoing internal and committee review before finalization. The final survey was presented in web-based format as shown in Appendix A.

4.2 Survey Distribution, Follow-up and Response

The survey was distributed to transportation and traffic safety officials in each of the 50 states, as well as the District of Columbia, Bureau of Indian Affairs, and federal transportation agencies. A full list of recipient agencies is listed in Appendix B.

Prior to distributing the survey, most agencies were contacted with an introductory phone call. This phone contact ascertained the correct official to receive the survey, as well as raising awareness of the project and providing personal notification of the survey.

Having compiled a list of recipients, these officials were sent email notification accompanied by an introductory letter signed by the ADOT project manager. The letter explained the project and requested completion of the web-based survey. The letter is included in Appendix C.

Two weeks after distribution of this letter, a follow-up email was sent to all recipients to remind them about the survey and request its completion. This was followed by second electronic reminder notice to those who had not yet responded four weeks after the original letter. A third follow-up email was sent to remaining recipients five weeks after the initial letter, and finally, specific emails and phone calls were made to non-respondents six weeks after the initial letter.

The survey achieved a 54 percent response rate, with respondents representing a broad spectrum of geographic regions within the United States as indicated below:

- New England – 2 responses
- Mid-Atlantic– 2 responses
- The South– 9 responses
- Midwest– 9 responses
- The Southwest– 3 responses
- The West – 4 responses

4.3 Survey Results

The survey on remedies for driver error provided a range of information on state practices in the field. This information is summarized in the following section.

4.3.1 Question 1: Overarching Strategy

Question 1 asked recipients, "Does your state have an overarching strategy for addressing driver error and/or traffic safety?" For this question, 72 percent of recipients responded in the affirmative, with specific strategies listed in Table 4.2 below.

Table 4.2 Overarching Strategies Addressing Driver Error

Agency	Strategy Name	Intent
Caltrans California Highway Patrol	Statewide "3D Month" campaign	Combats drugged and drunk driving each December
	Statewide Pedestrian Safety Public Education campaign	Implemented in 2003
New Hampshire	State Strategic Action Plan	Addresses traffic safety
Idaho	Annual Highway Safety Plan	Address problems identified through collision data
Iowa Governor's Traffic Safety Bureau	Iowa Highway Safety Plan	Section 402 and related programs for federal fiscal year 2004
Massachusetts Governor's Highway Safety Bureau for Executive Office of Public Safety	Annual Highway Safety Plan	Required by NHTSA
Kansas Department of Transportation and Districts, Kansas Highway Patrol and safety advocates	"Kansas Driving: Safe Not Sorry" highway safety initiative	Encourages good driving practices through media advertisements, educational materials and Official Road Kit
Illinois	Annual Highway Safety Plan	Deals with many behavioral areas and the 402 (State and Community Highway Safety Grant Programs), 405 (Occupant Protection, Including Child Passenger Protection, Programs), 410 (Alcohol Traffic Safety Plan) and 157 (Seat Belt Use Incentive) areas
Virginia	"Smart, Safe and Sober" program	Liaises with local and state law enforcement to target traffic safety issues geographically
Oklahoma	Highway Safety Plan	Addresses traffic safety, not just driver error
Louisiana Highway Safety Commission	Law enforcement overtime saturation patrols and checkpoints	Addresses multiple traffic safety issues, impaired driving and occupant protection

	Multiple public information and education campaigns	Addresses all NHTSA priority areas and targets occupant protection and impaired driving campaigns (with paid media)
New Mexico DOT Traffic Safety Bureau	Selective Traffic Enforcement Program	Target speed and aggressive driving behaviors
	Education and Enforcement Program	Imposes fee of $3.00 per citation to fund enforcement and education initiatives
	"Operation DWI "	Implements enforcement programs
	Community DWI Program	Distributes $75 conviction fee from all convicted DWI offenders to counties
Mississippi Office of Highway Safety	Statewide campaign	Aims to reduce driver error in safety belts and impaired driving.
	Law enforcement liaison program	Trains law enforcement in SFST, traffic stops, drug recognition
Kentucky	Integrated Safety Management Process (ISMP)	Recently started this AASHTO process
Missouri Department of Transportation (MoDOT)	"Blueprint for Safer Roadways"	Addresses both engineering issues and driver behavior to reduce road fatalities
Ohio DOT Office of Roadway Safety and Mobility	"Hot Spots" Program	Targets urban freeways and non-freeways
	Highway Safety Program	Targets rural areas
North Dakota	North Dakota Highway Safety Plan	North Dakota Highway Safety Plan

NHTSA = National Highway Traffic Safety Administration
DWI = Driving While Intoxicated
SFST = Standardized Field Sobriety Testing

Some states, such as Utah, indicated that they had a Highway Safety Plan but did not consider it to provide an overarching strategy for addressing driver error and/or traffic safety since there was a lack of interaction between different agencies in the planning of this program. Other states included their Highway Safety Plan as an overarching strategy regardless of agency interaction.

Some states also included strategies that were in the developmental stages, while others excluded apparently equivalent strategies from the overarching strategy response. Furthermore, a number of states included strategies that did not seem to provide an overarching approach to traffic safety and/or driver error.

Given the confusion in interpretation of what constitutes an overarching strategy, the results for Question 1 should be treated with caution and used in a qualitative, rather than quantitative manner. Specifically, the survey results highlighted the prevalence of statewide highway safety plans required by NHTSA, and statewide public education and enforcement campaigns.

Confusion regarding the presence or otherwise of an overarching strategy may also foreshadow the survey's finding that many state traffic safety agencies lack understanding of the comprehensive issues or range of available treatments for driver

error and traffic safety. Without an overarching understanding of issues involved in driver error and traffic safety, it is difficult to understand what would constitute an overarching strategy for addressing these issues or implementing treatments.

4.3.2 Question 2: Education/Information Strategies

Question 2 solicited information on a range of specific education and information-related strategies for addressing driver error. It asked, "Which of the following education/information strategies have been undertaken to address driver error?" and provided a ranking of effectiveness from 1 to 5, with 5 being the most effective. Average rankings for each of the five education strategies are provided in Figure 4.1 below:

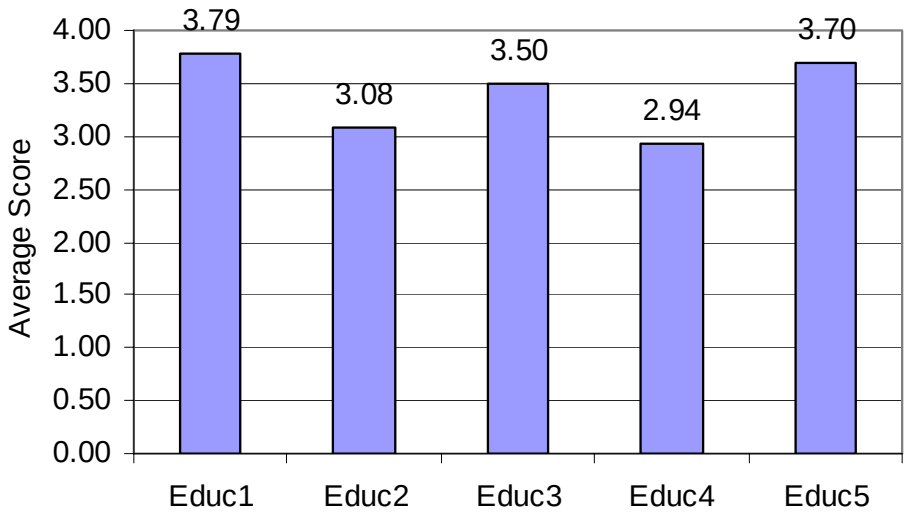

Figure 4.1 Average Rankings for Education/Information Strategies

(Full titles of strategy codes are provided in Table 4.1.)

These results indicate that implementation of public awareness campaigns via television, radio, print, and outreach (EDU 1) is considered to be the most effective education/information strategy for addressing driver error (with an average rank of 3.79). Other effective strategies include improving reporting and analysis of driver error and contributing factors (EDU 5, 3.70), and improved driver training (EDU 3, 3.50).

Media Campaigns

More specific education/information strategies that were repeatedly identified as highly effective in reducing driver error included:

- *Click It or Ticket (CIOT)* campaigns, such as those implemented in Georgia, Illinois, Missouri and Texas, which use educational materials, exhibits, radio, billboard, and television media to raise awareness of safety belt enforcement; and
- *You Drink You Drive You Lose (YDYDYL)* or *3D (Drugged and drunk driving)* campaigns, such as those implemented in California, Illinois and New Mexico, to combat impaired driving.

Comments provided by the states indicate a high level of support for public awareness campaigns conducted via a range of media. In the case of occupant protection campaigns, a number of states measured positive results in terms of substantial and rapid increases in seat belt usage following the campaign. For example, Mississippi recorded a 13 percent increase in seat belt usage in the first year of paid media, while Texas recorded an 11 percent increase sustained over two years. States such as Georgia, California, and New Mexico also indicated that campaigns targeting impaired driving had been highly successful in reaching a large proportion of the community and reducing these driver errors.

Many of these campaigns mentioned targeting particular time periods including holiday periods such as Christmas, the whole month of December (California), July 4th, Memorial Day (Texas), and Labor Day (Louisiana). Many of the responses also refer to targeting of at risk or "problem" cohorts such as young driver populations (Louisiana and Virginia) and motorists sharing the roadway with motorcycles (Ohio).

Driver Education and Training

In addition to public education campaigns, a number of states indicated their involvement in efforts to improve driver education and training for young or novice drivers. In some states, such as Mississippi, driver training is offered by private firms for first-time traffic offenders. Other states, such as California, are examining testing practices for elderly drivers. Others, such as Ohio, provide training for both beginning and experienced motorcyclists. Young drivers and traffic offenders were targeted in driver training programs offered in many states, however little information was provided by states in relation to the measured effectiveness of these strategies.

Data Collection and Analysis

A lack of quantitative analysis was highlighted by states such as New Hampshire and Nebraska, which stressed the importance of improved data collection and analysis as a basis for understanding and selecting traffic safety interventions. In Louisiana, improved reporting was seen as effective in focusing efforts on areas of particular need in relation to driver error and traffic safety.

The level and quality of data varied greatly across states. Mississippi cited an "excellent traffic records system [with] a new electronic uniform crash form with very specific analysis of driver error on each report." Other innovative crash information systems include follow-up actions from a 1999 Traffic Records Assessment in Oklahoma, and crash reporting forms for police in Pennsylvania, Utah, and Virginia. The new report (FR300) in Virginia was developed through collaboration between the department of transportation, the department of motor vehicles, state police, and local universities, and the new report form in Utah reflects factors relating to driver error and distraction.

Integration of Education and Enforcement

In addition to providing information on the relative benefits of different remedies for driver error, several states, including California, Delaware, Idaho, and Louisiana, volunteered additional comments on the positive effects of integrating education and enforcement to improve awareness and effect behavioral change.

Comments provided by states regarding the effectiveness of different education and information strategies are provided in Table 4.3 below.

Table 4.3 Comments on Effectiveness of Education/Information Strategies

Strategy	Focus	Comments
EDU 1: Implement public awareness campaigns via TV, radio, print and outreach	Encourage use of safety devices, e.g., seat belts, helmets, child seats, child restraints	"Media campaigns for seat belts, child safety seats, aggressive driving, and impaired driving have been developed and implemented. We believe the media campaigns are effective when conducted in conjunction with increased enforcement activities." (California) "Safety belt usage rate increased by 13% in the first year of paid media purchases. 2001" (Mississippi) "Much to our surprise, Click It or Ticket was very effective in getting law enforcement officers to issue citations for failure to wear safety belts. The outcome has been a sustained yearlong safety belt use campaign by law enforcement in the 10 major metropolitan areas in the state. Safety belt use rate has increased from 76% to 87% in 2 years." (Texas)
	Discourage unsafe driving practices e.g. DUI, speeding	"Statewide Pedestrian Safety Public Education campaign- This grant funded public education campaign took place during the year of 2003. Using public service announcements, and other innovative means of advertising, California Drivers were urged to Look (when driving in areas where pedestrians frequent you should look carefully and look again before completing driving maneuvers), Slow Down (Slow down when driving through school zones or areas that pedestrians may be encountered) and Focus (Pay attention to your driving tasks, hang up that cell phone!) to enhance pedestrian safety. The campaign was very successful and follow-up focus groups indicated that the theme Look Slow Down and Focus had become a recognizable theme for Californians." (California) "Public awareness campaigns implemented as part of our Anti-Aggressive Driving 'Take It Easy' campaign are not effective in and of themselves but are moderately effective when combined with enforcement. Our public information campaigns to combat DUI, especially when combined with enforcement were very successful in reducing the occurrence of alcohol-related fatalities" (Delaware) "Georgia implements public awareness campaigns via TV and radio, such as Click It or Ticket and Operation Zero Tolerance, and they have been very successful" (Georgia) "Education and information activities should be done in conjunction with enforcement activities - gives the incentive to learn." (Idaho) "Enforcement makes a significant impact; however, adding a paid media campaign that supports the heavy enforcement increases the perceived risk of drivers and has an even greater result." (Louisiana)

EDU 1	Discourage unsafe driving practices	"Participated in You Drink You Drive, You Lose campaign. Additional funding used throughout the year to provide DWI checkpoints and saturation patrols. Over 85% of the state's population are covered by Operation DWI activities." (New Mexico) "Texas spends an average $3 million annually on media campaigns, including $1.6 million of state dollars. We have a top notch advertising agency on call to design, produce spots and purchase media time. The agency has us in 125 radio markets weekly (free air time), and we are in all 14 TV markets at least 4 times a year 9 (paid media)." (Texas)
EDU 2 Improve driving instructor training and resources		"While driving instructor training and resources have been improved, the Department of Education is the oversight agency in this area. [There is] annual training of all public and private driving instructors; [and a] recent update of the driver manual to reflect current law" (Virginia)
EDU 3 Improve driver training	Ongoing training for high risk groups	"Driver education programs in the high schools have been proven to reduce traffic violations in youth nationwide." (Mississippi)
EDU 4 Improve related industry practices…		"Louisiana has conducted multiple employer programs; however, none have been formally evaluated. On-site observation surveys for seat belt use and self reported usage and educational improvements have indicated moderate success - not necessarily long lasting results." (Louisiana)
EDU 5 Improve reporting and analysis of driver error and contributing factors		"Improved reporting has led to more accurate statistics which aids the Highway Safety Office in developing policy and concentrating in high need areas." (Louisiana) "These strategies should not be broad based but concentrated on those driving errors that make up the majority of fatal and injury crash contributing factors." (Nebraska) "We are not yet at the point where we can measure the effectiveness of any intervention. We are getting close to having that capability (i.e. linking driving records, driver ed, etc. to crash files and similar analytical approaches), but we're not there yet." (New Hampshire)

DUI = Driving Under the Influence (of alcohol or drugs)
DWI = Driving While Intoxicated

4.3.3 Question 3: Enforcement/Incentive Strategies

Question 3 solicited information on a range of enforcement and incentive related strategies for addressing driver error. It asked, "Which of the following enforcement/incentive strategies have been undertaken to address driver error?" and provided a ranking of effectiveness from 1 to 5, with 5 being the most effective. Average rankings for each of the nine enforcement strategies are provided in Figure 4.2 below:

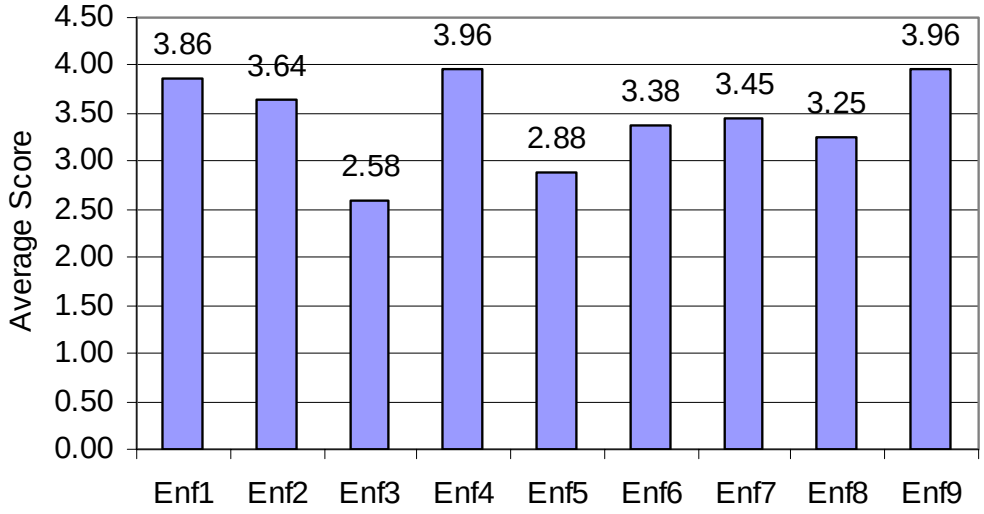

Figure 4.2 Average Rankings for Enforcement/Incentive Strategies

(Full titles of strategy codes are provided in Table 4.1.)

These results indicate that increasing targeting and frequency of enforcement (ENF 4) and promoting interagency cooperation, partnerships and community involvement (ENF 9) are considered to be the most effective enforcement/incentive strategy for addressing driver error (with an average rank of 3.96). Other effective strategies include lengthening driver training and improving driver testing (ENF 1, with a rank of 3.86) and imposing tighter legislation targeting driver error and contributing factors (ENF 2, 3.64).

More specific enforcement/incentive strategies that were repeatedly identified by survey respondents included: graduated drivers licensing; Blood Alcohol Content (BAC) legislation; changed speed limits; targeted enforcement; increased penalties and double fine zones. A summary of descriptions and comments provided by survey respondents regarding these strategies is included in the following sections.

Graduated Drivers Licensing

According to the survey, Graduated Drivers Licenses (GDL) have been introduced in states such as Delaware, Georgia, Idaho, Kentucky, Louisiana, Missouri, Ohio, Oklahoma and Virginia. These licenses may include restrictions on young or novice

drivers, such as the age and number of passengers, specific BAC limits, and restrictions or curfews on nighttime driving. They also require holders to have a certain amount or period of instruction and/or behind-the-wheel experience before graduating to a regular license. For example, GDL legislation imposes a six-month novice period in Oklahoma, and 20 hours of on-road instruction in Missouri.

Respondents gave mixed reviews regarding the effectiveness of GDLs in improving safety outcomes for target populations. In Delaware and Ohio, GDLs were shown to have a positive effect on young drivers. In Idaho, they were seen to have a positive effect for 15-year-old drivers, but this benefit did not appear to continue as they get older. In Kentucky and Louisiana, GDLs appear to have a positive effect for the initial year of driving, however, crash rates actually increased in the following year. The cause or conditions surrounding this reversal of safety benefits is unclear, but may be due to lower driving exposure of young drivers during their GDL period.

Blood Alcohol Content (BAC) Limits

Other legislation cited by states as reducing driver error includes a range of BAC legislation. California was early to enact .08 BAC legislation which makes it illegal to drive with a BAC of .08% or more for drivers 21 and older, .04% or more for drivers of commercial vehicles, or .01% or more for drivers under 21. Legislation in other states includes .08 BAC laws in Kentucky, .08 BAC for Driving Under the Influence (DUI) offenders and .02 BAC for drivers under 21 in Mississippi.

The widespread adoption of BAC limits among states may suggest its effectiveness in reducing the incidence of impaired driving, however, states did not explicitly comment on the effectiveness of this measure.

Changed Speed Limits

Given the prevalence of excessive speed as a crash-contributing factor, many states also highlighted speed controls among their traffic safety efforts. For example, in Ohio speed limits have been altered in locations with dense driveway access. In Virginia, regulatory speed limits are set using the crash history of a corridor and are reduced through construction zones. Horizontal curves are also posted with reduced speed limit warning signs, and occasionally speed limits are reduced to provide additional reaction time prior to isolated traffic signals along high-speed roads.

Survey respondents highlighted the need for speed limits to be supported by engineering and traffic surveys to ensure their effectiveness as well as determining which direction the change in speed should go. In Kentucky, evaluations of changed speed limits indicated that reducing speed limits seemed to reduce the severity of accidents. In Wisconsin, however, *increased* speed limits on rural interstates were found to improve safety by reducing the difference in travel speeds.

Increased Enforcement and Targeting

In addition to new or more stringent legislation, another type of remedy highlighted by many respondents was increased and targeted enforcement of existing legislation on alcohol, seat belt usage, speed, and aggressive driving. Survey responses highlighted programs such as a new speed enforcement campaign undertaken by the California Highway Patrol and the California Department of Transportation (Caltrans) in various parts of California, and saturation patrols to address identified problems such as impaired driving and aggressive driving in Idaho. Many of these enforcement measures, such as in Missouri, New Mexico, and Texas, are supported by overtime selective traffic enforcement funds to law enforcement agencies. These funds are used for enforcement efforts focused on: high accident locations; high-visibility seat belt and drunk driving mobilization efforts; and targeted enforcement periods, such as Kansas' May enforcement period, and Mississippi's May, July, Thanksgiving, and Christmas enforcement periods. In about 20 states, increased seatbelt enforcement efforts are made easier by primary seatbelt legislation, which means that police may stop and ticket motorists simply for not wearing a seatbelt. In other states, such as Mississippi, secondary seatbelt laws do not allow police to pull people over for not wearing a seatbelt. They must be pulled over for another reason.

As noted in Section 4.3.2, survey respondents considered increased and targeted enforcement efforts to be very effective in changing behavior and improving safety, especially when they are conducted in conjunction with educational and media campaigns. In Mississippi, the greatest drop in road fatalities was associated with the "Click It or Ticket" campaign targeting seat belt usage.

Automated Enforcement

Enforcement efforts undertaken using automated systems such as speed cameras and red light running cameras were also considered to be highly effective in reducing these errors and related crashes in several parts of the country such as six localities in Virginia. Survey respondents indicated that automated systems have also been implemented recently in Georgia, as well as pilot projects being undertaken in Albuquerque, New Mexico, and the City of Toledo, Ohio.

While these systems appear to provide effective improvements in traffic safety and reduced driver error, two states reported on legal obstacles hindering implementation of these systems. Legal issues have delayed implementation of automated and photo enforcement devices in California, while photo enforcement of speed limits has been statutorily prohibited in Wisconsin.

Double Fine Zones

In addition to increasing the frequency of enforcement, quite a number of survey responses included higher fines to encourage greater care and reduced human error in construction work zones or targeted enforcement zones. Survey responses from

Kentucky, Missouri, and Pennsylvania indicated that double fines (accompanied by greater enforcement) were in force in construction work zones within their states. In Mississippi, double fines will go into effect in highway work zones beginning July 21, 2004. In California, a recent report from Caltrans to the legislature recommended that existing double fine zones (DFZs) be allowed to be established administratively, like a speed zone, rather than by legislation, in order to enable them to be established where they are needed for targeted enforcement efforts over a short period of time and then relocated to other places where different traffic enforcement problems present themselves. Pennsylvania also indicated their support for increased penalties in proposed corridors under the Highway Safety Corridor program of 2004.

Increased Severity of DUI Penalties

Other efforts to discourage driver error through more severe penalties include a range of penalties for DUI offences in many states. These include heavy fines, driving restrictions, license suspension, compulsory participation in a DUI program, vehicle confiscation, and installation of ignition interlock devices, which require drivers to verify they are sober before the ignition will operate. Responses from California, New Mexico, and Wisconsin also noted that penalties have been increased for repeat and aggravated offenders in these states.

Interagency Cooperation and Planning

In relation to overarching and cooperative planning efforts to address driver error, a number of respondents highlighted statewide and collaborative processes and strategies. These include the California Pedestrian Safety Task Force, which was enacted in 1997 to develop a comprehensive plan to improve pedestrian safety led by Caltrans and its partners in traffic safety. They also include the "Safe Not Sorry" driver campaign in Kansas, the Highway Safety task teams in Kentucky and the "Blueprint" effort in Missouri.

Across the United States, survey respondents supported efforts to collaborate with other agencies and stakeholders in programs to share information and address driver error through programs such as: the Highway Safety Corridors, work zone and police crash report revision initiatives in Virginia; the seatbelt survey revision in New Mexico; and the Integrated Safety Management Process (ISMP) in Kentucky. Parties involved in these processes include: user groups; community groups (such as Mothers Against Drunk Driving); industry stakeholders; local governments; program providers; law enforcement agencies; universities; and state agencies for highway safety, transportation, health, motor vehicles, public safety, and revenue.

Respondents indicated that these types of collaborative efforts had positive results in involving stakeholders, improving traffic safety and reducing driver error. In Louisiana, the Highway Safety Commission found that partnerships with multiple agencies tended to enhance overall goals and detailed analyses. In Texas, participatory processes were also seen as useful in ensuring that minority communities were not disadvantaged by

implementation of new traffic safety laws and enforcement efforts. In Mississippi, a collaborative network process was seen as useful in effecting legislative change to implement remedies for driver error, while in Nebraska, public and political support via interagency and community involvement were seen as the most critical element in enforcement/incentive strategies. As with education/information strategies, respondents indicated the need for improved data to provide a basis for greater objectivity in selecting the most effective enforcement strategies.

Specific comments on the effectiveness of different enforcement/incentive strategies are provided in Table 4.4 below:

Table 4.4 Comments on Effectiveness of Enforcement/Incentive Strategies

Strategy	Comments
ENF 1 Lengthen driver training and improve driver testing	"Although enhanced enforcement to address aggressive driving was implemented at statistically identified high crash dates and locations, between 55% and 60% of all fatal crashes continue to involve acts of aggressive driving. However, Graduated Driver Licensing (GDL) has been effective in significantly reducing the number of crashes involving 16-year old drivers, and to a less extent… 17-year-old drivers." (Delaware) "GDL legislation took effect January 2001. While the lengthened training has had a positive effect for 15-year-old drivers, we haven't seen this translate into lower crash involvement rates for these drivers as they get older." (Idaho) "GDL reduced 16-year-old [accident rate], but increase 17-year-old [rate]." (Kentucky) "The driver training/Graduate Licensing Law implemented had an immediate impact on 15-year-old drivers; however, the 16-year-old driver crash rate increased." (Louisiana) "Ohio's GDL law, which went into effect on October 31, 1997, was shown to have a positive effect on young drivers. The GDL law's purpose was to improve the skills of Ohio's young drivers through more training and experience." (Ohio)
ENF 2 Impose tighter legislation…	"When "good" legislation is actively publicized and enforced, there is a direct result in fewer driver errors/crashes. Without education and enforcement, law doesn't make change by itself." (Louisiana)
ENF 3 Change speed limits to reduce driver error	"This is not an effective strategy unless it is supported by an Engineering and traffic survey." (California) "Reducing speed limits seems to reduce fatalities, but too many other factors have been introduced in our state to get an effective picture." (Kentucky) "The most obvious change in speed limits has recently occurred and statistics are not available to determine effectiveness." (Louisiana) "Increasing speed limit to 65 mph on rural interstate highways in 1987 actually improved safety on those roads by decreasing the speed range (the differential of travel speeds from high to low)." (Wisconsin)

ENF 4 Increase targeting and frequency of enforcement and citations	"Through campaigns like Click It or Ticket and Operation Zero Tolerance, Georgia has been successful with targeted enforcement." (Georgia) "Highway Safety Task Teams include targeted enforcement and reduces collisions." (Kentucky) "Joint efforts of paid media and publicized overtime enforcement have made an obvious impact on seat belt usage. Similar efforts in a concentrated area have also proven successful for impaired driving." (Louisiana) "Enforcement activities combined with media message. New Mexico has a high seat belt usage rate (86%). Voluntary compliance due to several factors, but especially enforcement and education initiatives. Public awareness and education has led to a very high seat belt usage rate." (New Mexico) "Oklahoma Highway Patrol has a no-tolerance policy on belts and hits speeding heavy. Belt survey and citation totals measured." (Oklahoma) "Ohio has participated in the national seat belt mobilizations since 2001 which increase the frequency of enforcement. The GHSO funds seven countywide DUI task forces which result in coordination of local enforcement efforts and targeting of alcohol-[related errors]." (Ohio) "Aggressive driving enforcement campaigns are underway. Unknown long-term results." (Utah)
ENF 5 Enhance enforcement with automated systems and photo enforcement	"Legal issues delay implementation of this tool." (California) "In Virginia, there are six localities that have photo red light monitoring. Most localities feel that this effort has been effective in reducing red light running and crashes. Evaluations of the programs would need to be requested from the specific localities." (Virginia) "Photo speed enforcement is statutorily prohibited in Wisconsin." (Wisconsin)
ENF 6 Increase the cost or severity of penalties	"If publicized, increases in penalties make an initial change; however, we have found that some penalties with high levels of judicial discretion are not assigned to the convicted. The result of pleas/lower fines then has a negative impact on the intent of the more severe penalty." (Louisiana)
ENF 7 Address driver error in related legislation	"California was an early state to adopt legislation requiring seatbelts for all passengers in cars. Legislation requiring hands-free cell phone use has been introduced in previous sessions but has not been successful to date." (California)
ENF 8 Implement overarching plan to reduce driver error	"While we have several facets involved, our fatalities have remained somewhat constant. Our biggest drop was seen in 2001 with Click it or Ticket." (Mississippi) "Again, we have undertaken most of the listed initiatives, but we cannot establish a cause-effect relationship that would accurately measure the effectiveness of any intervention. Until we link the data on all crashes, causes and interventions we will continue to be stuck with an inaccurate subjective assessment." (New Hampshire) "As a result of implementing the following programs driver errors will reduce: Highway Safety Corridor, Highway Safety Improvement Program (HSIP), and DMV educational programs." (Virginia)

ENF 9 Promote inter-agency cooperation, partnerships and community involvement	"The California Pedestrian Safety Task Force was enacted in 1997. It developed a comprehensive plan to improve pedestrian safety that was developed by Caltrans and its partners in traffic safety. The plan and all of its components have been successfully implemented with positive results." "This is a new priority for the state of Georgia and something that is improving every day through safety-conscious planning with various state and local entities, coalitions and networks." (Georgia) "New GDL law, use of well publicized STEP (special traffic enforcement program), corridor enforcement events, strong state and local interagency cooperation have been keys" (Iowa) "The Louisiana Highway Safety Commission strives to partner with multiple agencies and organizations. We find the partnerships enhance the overall goals and often results in specialty groups that develop to concentrate on very specific issues." (Louisiana) "We have a multi-agency group that meets monthly to network and discuss highway safety issues. This group is very involved with legislation and has been responsible for the passage of several highway safety related bills. Mississippi Association of Highway Safety Leaders." (Mississippi) "The most critical element in the enforcement/incentive strategies is to get the 'political/public' permission. This involves establishing broad agency/community support via coalitions and organizations." (Nebraska) "We work with local law enforcement daily, and reach into minority organizations when major campaigns are scheduled to make these segments of the population well aware of any impending enforcement campaigns. This allows us to offset charges of profiling to a degree." (Texas)

GHSO = Governor's Highway Safety Office
DUI = Driving Under the Influence (of alcohol or drugs)
DMV = Department of Motor Vehicles
GDL = Graduated Drivers Licenses

4.3.4 Question 4: Engineering/Infrastructure Strategies

Question 4 solicited information on a range of engineering and infrastructure related strategies for addressing driver error. It asked, "Which of the following engineering/infrastructure strategies have been undertaken to address driver error?" and provided a ranking of effectiveness from 1 to 5 with 5 being the most effective. Average rankings for each of the thirteen enforcement strategies are provided in Figure 4.3 below:

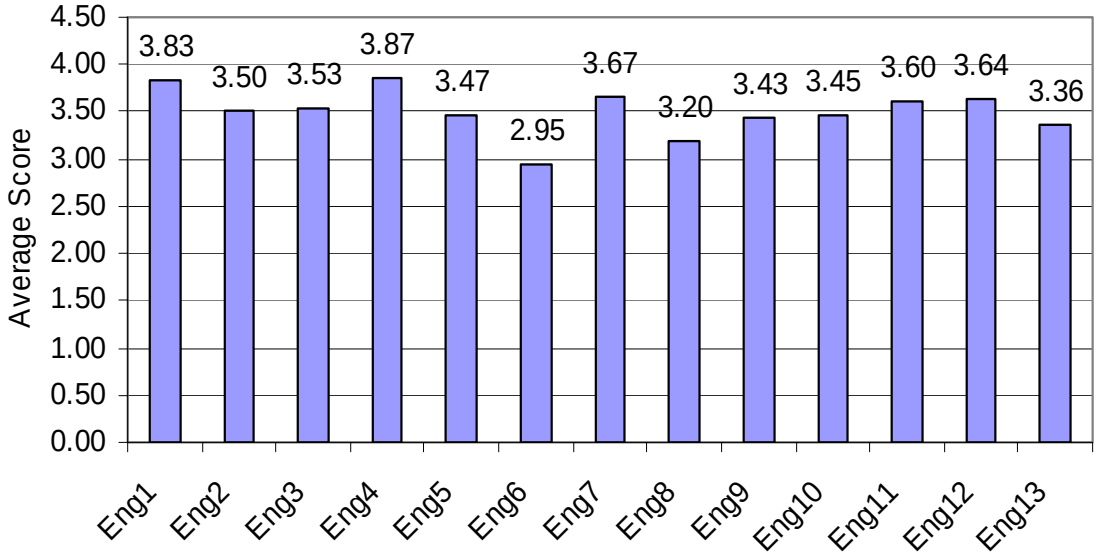

Figure 4.3 Average Rankings for Engineering/Infrastructure Strategies

(Full titles of strategy codes are provided in Table 4.1.)

These results indicate that designing highways and roadways to allow maneuvers to be undertaken more safely at higher speeds (ENG 4) are considered to be the most effective engineering/infrastructure strategy for addressing driver error (with an average rank of 3.87). Other effective strategies include encouraging in-vehicle simplification, information, decision aids, and external displays (ENG 1, with a rank of 3.83), followed by altering traffic operations such as signal phasing and ramp metering (ENG 7, 3.67), installing or encouraging ITS warnings and decision aids (ENG 12, 3.64) and implementing strategies to reduce impacts of nighttime driving, inclement weather and work zones (ENG 11, 3.60). Additionally, designing intersections to allow maneuvers to be undertaken more safely at appropriate speeds was also seen as effective (ENG 3, 3.53), along with implementing traffic calming and roadway design for slower, more cautious driving (ENG 2, 3.50). More specific features that were identified in relation to each strategy are discussed in the following section.

Improved highway design

Improved highway design (ENG 4) was ranked as the most important factor in reducing driver error through engineering means. Respondents referred to a number of features such as: straightened horizontal curves to make a less drastic speed differential between entering speed and curve speed (Ohio); improved roadway geometry to allow higher speeds on limited access freeways (California); and design reviews in appropriate locations such as high crash rate zones (New Mexico).

Driver fatigue and highway shoulder treatments

A number of related highway features aimed at preventing accidents caused by driver fatigue or crossover errors were also repeatedly raised by respondents (ENG 6 and ENG 4). These included: wider paved roadway shoulders (Iowa, Missouri, Virginia); rumble strips (Iowa, Mississippi, Missouri, North Dakota, Ohio, Pennsylvania, Virginia); installation of high tension guard cable (Iowa, Missouri); and provision of rest areas or rest havens for trucks and other commercial vehicles (California, Kentucky). Rumble strips were the engineering feature referred to by the greatest number of respondents, including innovative rumble strips for edge lines, centerlines. and bicycle-tolerable shoulders in Pennsylvania. While these features did not rank as highly as others in reducing driver error, they had effectively achieved widespread implementation and were seen as providing very low cost solutions to accidents caused by driver fatigue.

Traffic operations, management and metering

Several respondents, such as Ohio, commented on the effectiveness of traffic management actions in improving safety (ENG 7). Features mentioned by respondents included: signal coordination, phasing, delays on red lights, and traffic operations (California, Mississippi, Missouri, New Mexico, Ohio, Virginia); as well as ramp metering in urban areas (Pennsylvania, Virginia, Wisconsin).

In-vehicle improvements

States ranked in-vehicle displays, technologies and simplifications (ENG 1) as one of the most important strategies in reducing driver error, however they did not provide much detail on implementation within their state. This lack of detail may be due to the fact that these features are developed and implemented by the private sector automotive industry. One example of efforts in this area is the Innovative Vehicle Initiative of the Partners for Advanced Transit and Highways (PATH) program at University of California, Berkeley.

Intelligent Transportation System (ITS) treatments

Roadway ITS technologies (ENG 12) were also cited as important in reducing driver error and improving traffic safety and a number of examples were provided by respondents. These include: automated tolling (Virginia); ITS intersection crash avoidance systems and research (California, Pennsylvania); variable message signing

(Pennsylvania, Virginia); ITS ramp metering systems (Pennsylvania), and other urban ITS treatments (Missouri).

Engineering Features for Dangerous Conditions

A wide range of technologies aimed at reducing impacts of nighttime driving, inclement weather, and work zones (ENG 11) were cited by respondents as useful within their states. Features that were cited by respondents include: rumble strips; more reflective signs (Pennsylvania, Virginia); clearer work zone standards (Mississippi); improved lane, roadside, and tree delineation (Mississippi, Missouri, Pennsylvania, Virginia); improved delineation in work zones (Ohio); ITS weather sensors (Pennsylvania); fog warning systems and variable message signs (Virginia, Pennsylvania); winter pretreatment and maintenance of roads (New Mexico, Ohio); and online or telephone reports on road construction and weather conditions (Idaho, Pennsylvania).

Traffic Calming

Traffic calming (ENG 2) was seen by respondents as important in reducing driver error in local streets and urban areas. Traffic calming is generally implemented at the local rather than state level, however, California and Virginia have state guidelines for traffic calming and context sensitive design. The main feature provided by respondents was roundabouts (Missouri, Pennsylvania, Virginia, Wisconsin), while other features included pedestrian channelization (Missouri). Respondents indicated that traffic calming is generally implemented for more reasons than traffic safety and that anecdotal evidence suggests that these strategies are effective in achieving their aims of improved livability, safety, and efficiency.

Interchange Design

In addition to roundabouts, a number of other intersection treatments were highlighted by respondents. In Ohio, redesigned skewed intersections and installation of single-point urban interchanges (SPUI) improved intersection capacity and provided safety benefits. In New Mexico, a “black spot” approach, focusing on individual accident causes, was taken to reviewing high crash intersections for potential engineering treatments. Other intersection treatments included improved turning radii and channelized left turns to reduce the potential for driver error.

Traffic Operations, Management and Metering

Several respondents also commented on the effectiveness of traffic management actions in improving safety. Features mentioned by respondents included: signal coordination, phasing, delays on red lights and traffic operations (California, Mississippi, Missouri, New Mexico, Ohio, Virginia); and ramp metering in urban areas (Virginia, Wisconsin).

Other Strategies

A number of other engineering strategies were identified by several agencies despite having a lower average score. These strategies include:

- Clearing and grubbing of trees and addressing roadside vegetation (ENG 5) to increase sight distances in Kentucky, Mississippi, Missouri, New Mexico, and Virginia;
- Passive traffic controls (ENG 8) such as improved signage (New Mexico, Ohio), active work zone signage and flashing lights (Pennsylvania), raised pavement markings (Ohio), advanced curve warning markings (Pennsylvania), chevron pavement markings (Wisconsin), "DOT" tailgating treatments which are "dot" pavement markings and signs warning drivers to avoid tailgating and leave two "dots" or two seconds between themselves and the driver ahead of them (Pennsylvania), improved railway crossings (Mississippi), and DUI victim signs and safety corridor signing (Pennsylvania);
- Active traffic controls (ENG 9) such as smart traffic sensors (Virginia), changeable message boards (Ohio, Pennsylvania), ITS intersection crash avoidance systems (California, Pennsylvania), flashing warning lights for vehicles traveling too fast on curves (Missouri), and radar trailers linked with enforcement blitzes (Kentucky);
- System level changes (ENG 10) such as traffic management strategies and Integrated Safety Management Processes (Kentucky, Pennsylvania), consistent signage and pavement markings (Ohio), and standardized yellow change interval (Virginia); and
- Safety audits (ENG 13) such as the Statewide Road Safety Audit Initiative (Pennsylvania), safety audits for 3R (resurfacing, restoration, and rehabilitation) projects (Iowa), and traffic engineering and multi-agency studies (Ohio).

Comments provided in relation to the effectiveness of the above strategies can be seen in Table 4.5. Road safety officials from almost half of the respondent states (Alabama, Delaware, Georgia, Idaho, Illinois, Louisiana, Mississippi, Missouri, Ohio, Oklahoma, Texas, and Utah) expressed a lack of familiarity and knowledge with respect to engineering strategies for reducing driver error and their relative effectiveness. In many cases, traffic safety offices were situated in a different state government agency than transportation engineering officials, or engineering strategies were undertaken at the local government level while traffic safety activities were undertaken at the state level. This lack of understanding and communication regarding the range of different remedies suggests that important comparisons of strategies are lost as well as opportunities for multidisciplinary actions involving engineering treatments.

Some respondents highlighted the importance of reinforcing engineering solutions with public education and information efforts, as well as the importance of implementing low cost, responsive and preventative engineering measures instead of expensive, long term reconstruction options. Respondents also expressed concern regarding the lack of reliable data and methods to measure the effectiveness of engineering remedies in terms of reducing driver error and improving safety.

Table 4.5 Comments on Effectiveness of Engineering/Infrastructure Strategies

Strategy	Comments
ENG 1: Encourage in-vehicle simplification, information, decision aids, and external displays	"Auto industry currently setting standards." (Pennsylvania)
ENG 2: Implement traffic calming and roadway design for slower, more cautious driving	"VDOT has developed a traffic calming guide and evaluated the guide, but we have not evaluated the effectiveness of the traffic calming measures in reducing speeding. Anecdotal information indicates moderate effectiveness." (Virginia)
ENG 3: Design intersections to allow maneuvers to be undertaken more safely at appropriate speeds	"This requires a trade off between pedestrian and bicycle safety and convenience for drivers of automobiles. Shame on you!" (California) [Note: This response was for the pilot survey which was worded "ENG 3… at high speeds"] "HSIP and Transfer programs are used to improve intersections. In addition, we have recently begun to consider roundabouts on more Intersection designs. We have not yet done a formal evaluation, but have relied on results from other states." (Virginia)
ENG 4: Design highways and roadways to allow maneuvers to be undertaken more safely at higher speed	"There are places for improving roadway geometry to allow higher speed maneuvers specifically on limited access freeways. They should have speed limits set accordingly." (California) "NMDOT reviews high-crash areas for engineering considerations." (New Mexico) "HSIP and Transfer HSIP and Transfer programs are used to improve highways and roadways." (Virginia)
ENG 5: Address roadside vegetation for longer sight distances	"This is a standard practice." (California) "Clearing and grubbing of shrubs and trees that limit sight distance have proven effective at reducing crashes due to poor sight distance." (Ohio)
ENG 6: Improve road design to address driver fatigue and inattention	"Rumble strips have been installed on highways to awaken drowsy drivers who might cross a line." (Mississippi) "Edge-line rumble strips, bicycle-tolerable shoulder rumble strips, centerline rumble strips are used to reduce crashes involving sleepy, drowsy, or inattentive drivers." (Pennsylvania)
ENG 7: Alter traffic operations such as signal phasing and ramp metering	"Delays on red lights have been in place and seem to be helping, although no formal evaluation has been conducted" (Mississippi) "Signal coordination has proven effective and increased system efficiency." (Ohio) "Ramp metering is working very well in Madison and Milwaukee." (Wisconsin)
ENG 8: Implement passive traffic controls such as signs and gap zone markings	"Test sites being evaluated for "DOT" tailgating treatment." (Pennsylvania) "HSIP and Transfer programs are used to implement active traffic controls. As well as 80% of Virginia's interstate shoulder miles have rumble strips installed." (Virginia)
ENG 9: Implement active traffic controls such as speed sensors and variable signs	"Pilot projects have been done in this area on rural freeways near large grades as well as on freeway ramps to identify commercial vehicles and warn of potential truck roll over danger." (California) "Variable message signs have and are being installed throughout the state to inform of crashes, stopped traffic, and estimated travel times." (Ohio)

ENG 10: Implement system level changes to increase accuracy of driver expectations	"Have been flattening in-slopes on a system basis. Beginning to install T-intersections recovery approaches at all major intersections." (North Dakota) "VDOT standardized amber traffic signal phasing statewide to promote consistency and accuracy." (Virginia)
ENG 13: Conduct safety audits at intersections and along road segments	"We annually assess the "problem" intersections and road sections on the state highway system." (Idaho)
Other Comments	"I cannot comment on the effectiveness of engineering strategies because that falls under the domain of the Department of Transportation - which is separate from the Office of Highway Safety." (Delaware) "As traffic increases, there is a more pressing need to consider implementing minor, short duration, low cost, and responsive engineering solutions to driver error problems instead of the waiting for expensive, long term reconstruction options. Also, every engineering solution must be accompanied by a public information/education component." (Nebraska) "Again, we have implemented most of the above interventions, but lack any reliable method to measure effectiveness until we can get better data on traffic flow, exposure to crash risk, etc." (New Hampshire)

VDOT = Virginia Department of Transportatin
NMDOT = New Mexico Department of Transportation
HSIP = Highway Safety Improvement Program
Transfer Programs = Penalize states that have not complied with federal requirements for enacting repeat-offender and open container laws to limit alcohol-impaired driving. Under these transfer programs, noncompliant states are required to shift certain funds from federal-aid highway programs to projects that concern or improve highway safety
"DOT" Tailgating Treatments = White elliptical dots painted in the center of traffic lanes. The dots are placed at 2-seconds intervals for prevailing traffic speeds and enforceable signs instruct drivers to place themselves 1 space apart

4.3.5 Questions 2-4: Comparison across Regions

By comparing results on education/information, enforcement/incentive and engineering/infrastructure strategies across regions, a number of observations can be seen. As illustrated in Figure 4.4, it appears that enforcement/incentive strategies ranked relatively higher than other types of strategies in the South and Mid-Atlantic regions. On the other hand, education/information strategies ranked relatively higher in the Southwest, West and Northeast regions of the country. Engineering/infrastructure measures did not appear to be as attractive as education and enforcement strategies in any regions, except the Mid-Atlantic where it had a higher average score than education strategies and the Northeast where it was on par with enforcement strategies. As seen in Table 4.5, a higher number of engineering/infrastructure applications were cited by respondents from the Northeast.

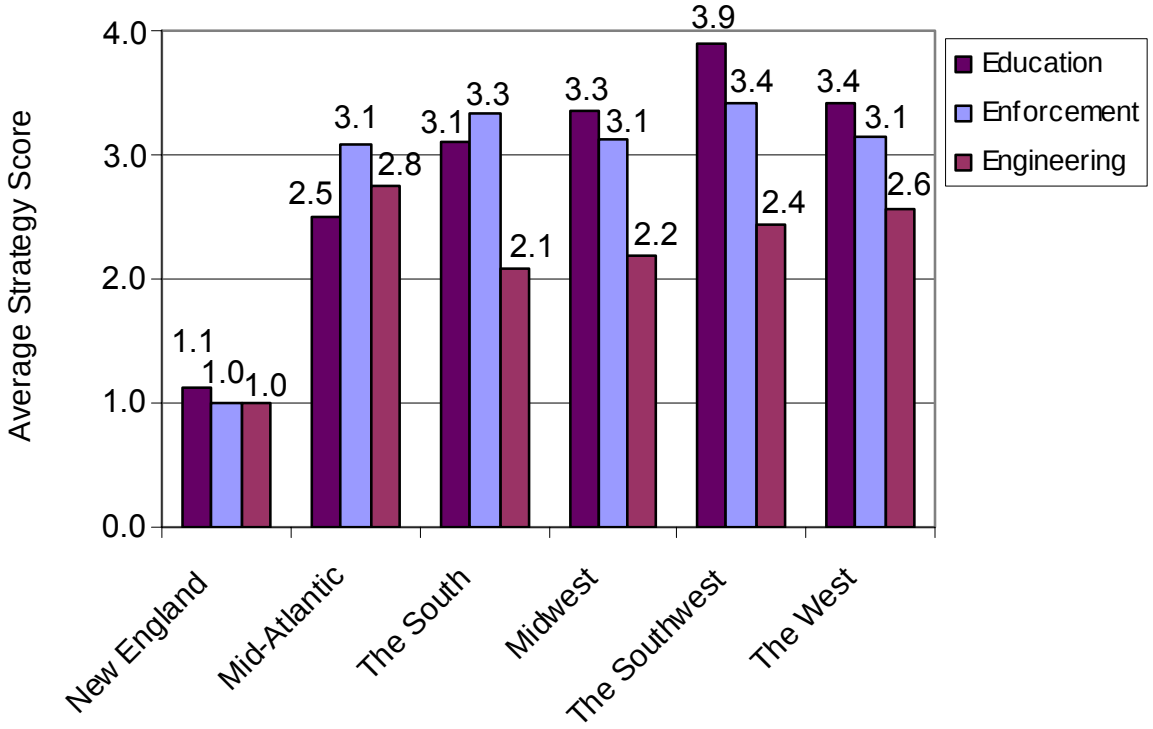

Figure 4.4 Average Rankings for Strategy Type by Region

While small sample sizes, particularly in New England and the Mid-Atlantic, limit the potential to draw conclusions on this data, regional differences may suggest differences in the suitability of types of remedies in different regions according to physical, economic, and cultural differences. For example, extreme physical conditions in the Northeast and Mid-Atlantic region may lend themselves to greater emphasis on engineering remedies, while a more media-oriented culture in the in the West and Southwest may be more receptive to education strategies. As mentioned previously, many respondents also highlighted the benefits of integrating more than one of the three approaches to addressing driver error.

4.3.6 Question 5: Strategy Determination

Question 5 asked recipients, "How are traffic safety target areas and strategies for driver error/traffic safety activities in you state determined?" Responses suggested that a range of data sources and techniques were used to select appropriate targets and remedies for driver error.

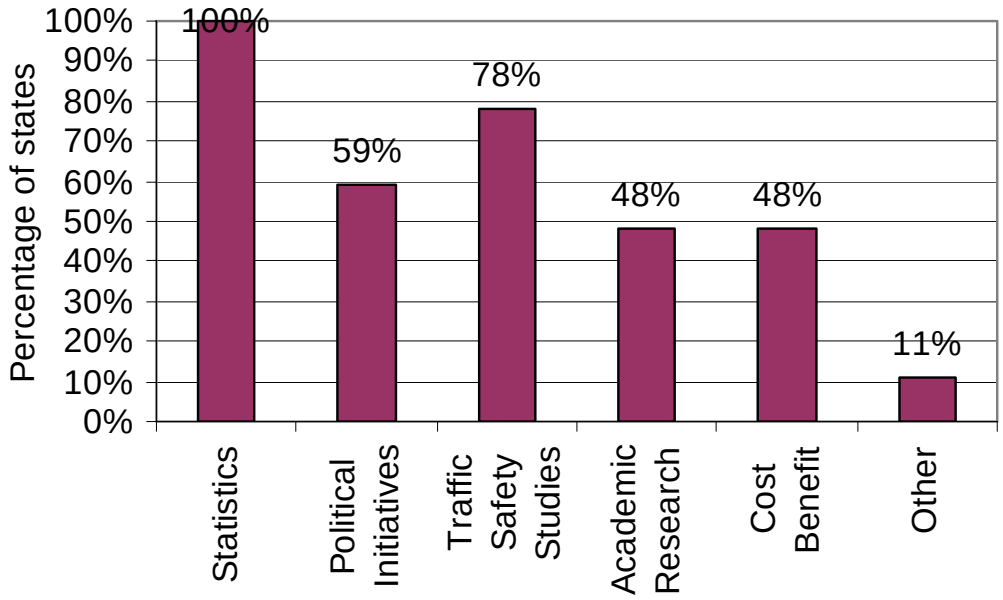

Figure 4.5 Methods used to Determine Targets and Remedies for Driver Error

As illustrated in Figure 4.4, all respondents employed statistics to assist in determining appropriate strategies. Most states also cited traffic safety studies (78 percent) and political initiatives (59 percent) as important in the selection process, while cost benefit analyses and academic research were used by almost half of the survey respondents (48 percent each). Finally, a number of other methods used by individual states included:

- observations and suggestions by traffic enforcement and motorists;
- internal state and local police analysis; and
- historic crash data for specific behavior being targeted.

Additional comments emphasized the importance of certain elements in determining targets and remedies for driver error. These elements include:

- appropriate data collection and analysis;
- multidisciplinary efforts and cooperation;
- problem prioritization; and
- use of trial-and-error.

Comments are provided in Table 4.6 below:

Table 4.6 Comments on Strategy Determination

Comments
"We examine numbers of events in relation to contributing factors reported on the crash reports, but we do not have traffic flow or other crucial data to enable us to identify the real 'worst locations' or roadway configurations." (New Hampshire)
"All of our highway safety activities in Idaho are data driven." (Idaho)
"Utilizing all of the information above, a coalition of traffic safety professionals, enforcement, engineering, traffic safety advocates, educators, social scientists, and policy makers then prioritize those driver related problems to be addressed most immediately." (Nebraska)
"Agencies have to address this issue from many different fronts and hope one of them works." (Illinois)
"Information is available in crash facts, crash severity scores by locality, department of transportation studies of roadways, on-site observation by law enforcement, red light cameras." (Virginia)
"Ranking reports are developed." (Georgia)
"No statewide program, similar programs by agencies in various locations." (Nevada)

4.3.7 Questions 6-8: Innovative and Effective Strategies and Related Factors

After obtaining information on the range of different remedies for driver error, Questions 6 and 7 sought information on the initiatives that respondents considered to be most innovative and effective.

Question 6 asked "In your opinion, what have been the most innovative strategies for reducing driver error?" In response to this question, many states highlighted progress in public education and enforcement campaigns targeting impaired driving and seatbelt usage, while a number of states highlighted overarching approaches such as California's Pedestrian Safety Task Force and Kentucky's Integrated Safety Management Process. Other innovative education and enforcement initiatives included "Ride Safe" motorcycle education in Missouri, integrated crash reporting and data analysis in New Hampshire, Ignition Interlock legislation in Pennsylvania, "Where's Metro?" undercover traffic enforcement in Nevada, and insurance incentives for good driving in Illinois. Innovative engineering initiatives included on-board collision avoidance systems in Pennsylvania, raised pavement markings in Ohio, chevron markings in Wisconsin, "DOT" tailgating treatments in Pennsylvania, which are white elliptical dots painted in the center of traffic lanes that instruct drivers to place themselves 1 space apart, the "511 Program" (a traffic information system) in Virginia, and ITS traveler information and variable message signs in Pennsylvania.

A full list of responses to this question is provided in Table 4.7.

Table 4.7 Strategies Considered Most Innovative

Education/Information strategies
• Educational programs such as Community Traffic Safety Programs (Alabama) • Strong public information and education effort to complement enforcement (Georgia, Iowa) • Good driver education programs (Illinois) • "Ride Safe" motorcycle rider education program (Missouri) • Linking exposure, risk, driver history, emergency medical services and hospital data to crash record and analyses (New Hampshire)
Enforcement/Incentive strategies
• Graduated drivers licensing (Nebraska) • Ignition interlock • 65 mph speed limits in 1995 (California) • Increased selective traffic enforcement coordinated with public awareness on DUI and seatbelts (Georgia, Mississippi, Nebraska, New Mexico, Pennsylvania) • Statewide and corridor enforcement programs (Alabama, Iowa, Illinois) • Use of cell phones by other drivers on the road to report aggressive driving (Pennsylvania) • "Where's Metro?" undercover traffic enforcement (Nevada) • Red light, rail crossing and speed cameras (Nebraska, Pennsylvania, Virginia) • Increasing violation penalties using points and fines (Nebraska) • Insurance programs for error free drivers—incentives (Illinois)

Overarching strategies
• Pedestrian Safety Task Force (California) • Implementing Integrated Safety Management Process (Kentucky) • Using “Task Team” approach for highway safety (Kentucky) • Focus on belt use and impaired driving (Iowa) • Very strong multidisciplinary cooperation on state/local level (Iowa)
Engineering/Infrastructure strategies
• Better designed vehicles (Illinois) • In-vehicle "smart" systems to prevent crashes, e.g., collision avoidance systems, driver fatigue countermeasures (Pennsylvania) • Engineering safety improvements and design (Kansas) • Rumble strips (California, Mississippi, Nebraska) • Clearing trees, widening shoulders (Mississippi) • Delays on stop lights when changing from red to green to prevent collisions at intersections (Mississippi) • Good highway guidance systems (Illinois) • Use of pavement markings and signage to affect driver behavior, e.g., “DOT” Tailgating Treatment, advance curve warning signing and markings (Ohio, Pennsylvania) • Use of chevrons (in pavement marking) to reduce large truck rollover on left hand exit ramp (Wisconsin) • ITS, 511 Program, warning systems and variable message boards (Ohio, Virginia)

DUI = Driving Under the Influence (of alcohol or drugs)
ITS = Intelligent Transportation Systems

Having obtained information on innovative strategies, Question 7 requested information on effective strategies, asking, “In your opinion, what have been the most effective strategies for reducing driver error?” while Question 8 asked, “In your opinion, what factors contributed to the above strategies’ success?”

Targeted enforcement and education campaigns

In response to these questions, 75 percent of respondents indicated that targeted high visibility traffic enforcement operations (ENF 4) and strong public information and education programs to complement this enforcement (EDU 1) were the most effective strategies for addressing driver error. Respondents indicated that these strategies were highly effective under the following circumstances:

- Education and enforcement components were conducted concurrently;
- Different highway safety partners such as police and community organizations were actively involved in program implementation;
- Implementation was conducted over a sustained period;
- Programs targeted problem behaviors (e.g., impaired driving, speed and not using a seat belt), high crash locations, and at risk populations (e.g., young drivers);
- Enforcement was highly visible and conducted at a statewide level with coordinated efforts between different jurisdictions and law enforcement agencies;
- Education included paid media and well-funded, lengthy public information campaigns;
- Programs were backed by good legislation; and
- Programs were supported by good traffic crash data collection and records.

Overarching strategies for addressing driver error

A third (33 percent) of respondents also indicated that implementation of overarching strategies to address driver error (ENF 8) were also highly effective in achieving improvements in traffic safety as a result of reducing driver error. Factors which contribute to the success of these overarching strategies include:

- Availability and use of federal funds;
- Strong support from executive management and politicians;
- Strong cooperation and collaboration between agencies and organizations;
- Collection, availability, and use of good data on safety, crashes and conditions;
- Focus on key problems (alcohol, seat belt use, speed) and at-risk populations; and
- Intelligent and innovative planning.

Rumble strips and engineering improvements

Rumble strips were seen by 25 percent of respondents as highly effective in providing a low cost solution to reducing accidents arising from driver error, while other engineering safety improvements and design were seen as highly effective by three additional respondents. These engineering strategies were most effective when supported by public policy makers such as state governors and local officials.

Other effective strategies

Other strategies which were identified by one or more respondents as highly effective in addressing driver error include:

- Automated enforcement systems such as red-light and speed cameras;
- Graduated drivers licensing especially with community support and collaboration;
- Cooperative county, corridor and multidisciplinary approaches to traffic safety programs;
- Brighter highway signs, raised pavement markers, three-string guard cable, and use of pavement markings and signage to affect driver behavior;
- Monitoring and improvement of driving schools and examiners;
- Installation of ignition interlock devices (assume this is explained earlier) on vehicles of DUI offenders;
- Tougher judges and zero tolerance by the police community; and
- Increased speed limits to promote greater compliance with traffic laws.

A full list of responses to this question is provided in Table 4.8.

Table 4.8 Comments on Effectiveness of Engineering/Infrastructure Strategies

Code	Effective strategies	Factors affecting effectiveness	State
ENF8	**Implementing an overarching strategy** This might incorporate: • Principles • Public awareness & enforcement campaigns • Committed police presence • "Smart" vehicles • Traffic management & ITS • Pavement markings and signage • Phased-in licensing	• Good safety data widely available to users / Traffic records analyses of dangerous intersections and roadways • Good planning by administration / "Thinking outside of the box" • Availability and use of federal funds or incentive grants with flexibility to determine the most appropriate usage, e.g., for safety belt and DUI programs and highway construction hazard elimination • Strong support by the governor / Mandates by Congress / Progressive and supportive executive management within state agencies • Strong multiagency cooperation at state and local level / Good working relationships between agencies and the safety community / Collaboration among public and private stakeholders • Focus on main contributors to highway death or injury (belt use, impaired driving and speed) • Awareness of at risk driving populations (young/old) • Consistent and repetitive education for drivers, law enforcement, judicial personnel, and law makers • Legislation / Strong DUI legislation and enforcement • Good traffic engineering implementation	Iowa Illinois Louisiana Mississippi North Dakota Pennsylvania Virginia
	Implementing ISMP	• Team effort (using Task Team approach for highway safety)	Kentucky
	Pedestrian Safety Task Force		California

ENF4	**Targeted high visibility traffic enforcement operations** e.g., safety belt enforcement, DUI checkpoints, speed, aggressive driving	• Statewide efforts • High visibility • Cooperation and partnership • Willing and able enforcement officers • Involvement of highway safety partners in the problem identification, selection and planning process • Ability to use paid media • Combined with media • Sustained effort instead of a once per year • Increasing visibility of enforcement efforts • Increasing public perception of enforcement through coordinated efforts • Campaign acceptance and promotion by an ever-increasing number of partners	Delaware Georgia Louisiana Iowa Illinois Kansas Massachusetts Mississippi Missouri Nebraska New Hampshire New Mexico North Dakota Ohio Oklahoma Pennsylvania South Carolina Virginia Wisconsin
	Targeted enforcement at high crash locations & safety corridors		Alabama Pennsylvania Wisconsin
EDU1	**Strong public information and education effort to complement enforcement** e.g., safety belts	• Well funded • Lengthy • High visibility • Cooperation and partnership • Combined with enforcement • Good legislation that is both publicized and enforced	Georgia Iowa Louisiana Mississippi Missouri New Mexico Pennsylvania Texas Virginia Wisconsin
	Education & media campaigns	• Good traffic records system data collection • Paid media	Alabama Oklahoma Nebraska North Dakota South Carolina
ENG6	**Rumble strips**	• Low cost • Support by the public policy makers (governor, legislators, city and county officials)	California Mississippi Missouri Nebraska Pennsylvania Virginia Missouri

ENG4	Engineering safety improvements & design		Iowa Kansas South Carolina
ENF5	Red light running and speed cameras	• Effect warning to drive	Nebraska Pennsylvania Virginia
ENF1	Graduated drivers licensing	• Community/public collaboration and support	Nebraska New Mexico Pennsylvania
ENF9	Countywide DUI task forces	• Increasing public perception of enforcement through coordinated efforts	Ohio
	Very strong multidisciplinary cooperation on state/local level		Iowa
	Empowering local level enforcement to determine the best use of traffic safety enforcement funds per geography and statistics		Virginia
ENF2	Ignition Interlock DUI Program		New Mexico Pennsylvania
EDU3	Monitoring our driving schools		Illinois New Hampshire
ENG8	Brighter highway signs / Raised pavement markers		Illinois
	Use of pavement markings and signage to affect driver behavior (i.e., “DOT” Tailgating Treatment, advance curve warning markings		Pennsylvania
EDU2	Improved training for examiners	• Unable to measure effectiveness with true statistical significance	New Hampshire
ENF3	65 mph speed limits in 1995	• Increase compliance with traffic laws	California
ENF4	Corridor programs	• Local involvement	Alabama
ENF6	Tough judges, Zero tolerance by the police community.		Illinois
ENG6	3-string guard cable	• Structural modifications to prevent crashes	Missouri

ISMP = Integrated Safety Management Process
DUI = Driving Under the Influence (of alcohol or drugs)
“DOT” Tailgating Treatment = White elliptical dots painted in the center of traffic lanes. The dots are placed at 2-seconds intervals for prevailing traffic speeds and enforceable signs instruct drivers to place themselves 1 space apart

4.3.8 Question 9: Other Comments

Question 9 asked recipients, "Do you have any additional comments on remedies for driver error?" In responding to this question, states emphasized the importance of improved crash data and reporting, increased funding and prioritization of available funds, investigation of legislation to address driver distraction such as cell phone usage, and more thorough driver education and testing.

Additional comments not included in the preceding sections are included below.

Table 4.9 Other Comments on Remedies for Driver Error

Comments
"It is estimated that driver error is responsible for 75%-92% of all crashes. You will never change the fact that people in the United States of America expect to drive a vehicle at their own terms and when they want too. You have to live with it or change your mode of transportation." (Illinois)
"Focus on the main categories of driver contributions to death/injury (nonbelt use, impaired driving, moving violations, distracted/drowsy driving, run-off-road crashes) utilizing multidisciplinary approach" (Iowa)
"Mississippi has a long way to go in this area. Although we are working very hard on these strategies, our fatalities only decreased slightly from 2002 to 2003. Hopefully with the implementation of the new electronic crash form, we will have a better idea of exactly what our problems are involving driver error. The highest numbers in driver error are always inattention. How can that be addressed? Campaigns targeting cell phone usage and other distractions would be a beginning. We are still trying to pass a primary safety belt law! We feel that bill would show the greatest reduction in driver error. When drivers are buckled, they have much more control of the vehicle in crashes at lower speeds." (Mississippi)
"I believe that it is essential to identify and prioritize the driver error problems and address those that contribute most significantly to fatal and serious injury crashes. Attempting to address all of the contributing factors dilutes the attention of the drivers from the most serious crash error contributions." (Nebraska)
"Limited resources, money, and personnel, are requiring action on only the top priorities to prevent injury/deaths, typically seat-belts and impaired driving." (Nevada)
"I think that you've probably gotten tired of my constant ravings about our lack of objective analytical methods and the data necessary to support them. I think that it is important to note that we are moving towards risk-based analysis and improved crash data. I think that we're headed in the right direction. We're just not there yet. I expect that you'll find many other states in a similar position. If you find any that have solved the problem(s), please let me know." (New Hampshire)
"More federal funding to address driver behavior and especially aggressive driving behavior." (Pennsylvania)
"Increased driver training aimed at improving driver skill sets and eliminating low skill drivers is essential, but politically unpopular. This should include a written and physical retesting of drivers every 4 years, regardless of age, and remedial training of drivers who fail either one or both parts of the test. Your license will be immediately suspended if you fail either the written or physical test, and is not reinstated until you complete the remedial training and successfully retest. There should not be occupational licenses or other methodologies allowed to avoid the effects of suspension. Such a program is politically impossible in Texas." (Texas)
"Additional legislation would assist with decreasing driver errors (i.e., cell phone usage while driving)." (Virginia)

4.4 Summary of Survey Results

A survey was undertaken regarding the implementation and effectiveness of different remedies for driver error by different states in the United States. The survey was directed at state traffic safety officials and achieved a 54 percent response rate representing all regions of the country. The survey responses highlighted a number of education, enforcement, and engineering strategies that were popular and/or effective in addressing driver error. In the area of education and information, survey responses emphasized the importance of:

- Implementing media and public education strategies to encourage use of occupant protection devices such as seatbelts and reduce dangerous behaviors such as driving under the influence (DUI) of alcohol or other drugs;
- Targeting education and media strategies to key time periods such as holidays and key populations such as youth;
- Supporting educational strategies, paid or earned media with increased enforcement of these driver errors such as in the "Click it or Ticket" and "You Drink You Drive You Lose" campaigns;
- Improving training and testing programs for young and novice drivers as well as other road users such as motorcyclists and the elderly; and
- Improving data collection and analysis to provide a quantitative basis for selection and assessment of effective remedies to driver error.

In relation to enforcement and incentives, the survey comments highlight a range of measures that have been implemented to reduce the frequency and severity of driver error related accidents. Findings with respect to enforcement remedies are listed below:

- One of the elements identified as critical to reducing driver error was interagency cooperation, partnerships, and community involvement in developing and implementing remedies. These processes helped identify appropriate strategies as well as increased their political and public support.
- Targeted enforcement campaigns (such as "Click it or Ticket"), which combine enforcement, paid media/public education, and appropriate legislation, were found by some states to be one of the most effective means of reducing traffic accidents and fatalities resulting from driver error. Their success was attributed to the greater perceived risk of dangerous driving generated by the enforcement and publicity. Respondents noted that the success of enforcement measures is dependent on available funds.
- Other mechanisms to increase the likelihood of enforcement through automated and photo enforcement devices (such as speed cameras and red light cameras) were found to be effective in localities where they were implemented, however these mechanisms were blocked or delayed by legal issues and obstacles in some states.
- Many states reported measures that increased the severity of penalties through "Double Fine Zones" in construction work areas and traffic safety hot spots.

Respondents did not comment on whether higher fines improved driver behavior over and above that generated by increases in enforcement. In Louisiana, more severe penalties (such as felony charges) were found to have a negative effect on driver behavior since they introduced a higher level of judicial discretion and lower level of public respect.

- Introduction of Graduated Drivers Licensing was found to improve traffic safety in the initial year of driving, but was had mixed results for subsequent years.
- Changes in speed limit legislation also had mixed results for different states with some reporting that reduced speed limits reduced fatalities and other reporting that increased speed limits reduced accidents (due to smaller speed differentials).

With respect to engineering measures, survey responses indicated:

- There is a need for better understanding and communication between engineering and safety officials to ensure better comparison of all remedies and to identify potential opportunities for cross-disciplinary actions such as public education to reinforce engineering measures.
- Many states supported implementation of a wide range of low cost, responsive engineering solutions such as rumble strips, guard cables, and improved delineation.
- Redesign and reconstruction of highways and intersections to improve horizontal curves, simplify maneuvers, and address high crash rate zones were seen as highly effective at reducing driver error but at much higher cost.
- In urban areas, improved traffic management, traveler information, and consistency of signage were also seen to be effective in reducing driver error. Strategies supported by respondents included improved signage, signal coordination, ramp metering, variable message signs, and ITS intersection crash avoidance systems.
- Improved signage, roadway delineation, road maintenance and real time warnings were seen as especially important in reducing driver error in regions affected by snow, ice, fog, high gradients, high elevations and other extreme conditions.
- Respondents emphasized the need for engineering design to promote driving speeds consistent with adjacent land uses, rather than encouraging excessive speed. In urban areas, traffic calming measures such as roundabouts were seen as important in moderating traffic speeds and improving safety while also achieving other goals.

While there was a high degree of agreement on suitable remedies for driver error across the different regions of the United States, responses suggested that media-oriented education measures were seen as more effective in most of the country, particularly the West and Southwest, while enforcement measures were seen as more effective in the South and Mid-Atlantic, and engineering measures marginally more effective in the Northeast and Mid-Atlantic.

Respondents indicated that statistics, traffic safety studies, and political initiatives were key drivers in developing these strategies and emphasized the need for improved data to

assist in prioritizing problems and solutions. They also indicated that there was a lack of integration and communication between those undertaking engineering strategies and the other two areas of effort. Respondents also indicated that the most effective remedies involved integrated efforts for targeted enforcement and public education involving paid media and strong collaborations between different stakeholders. Other effective remedies emerging from the survey included overarching strategies and rumble strips on edgelines, centerlines, and shoulders of roadways.

5. BEST PRACTICE CASE STUDIES

While the survey of state agencies provided information on the state of practice and relative effectiveness of different remedies for driver error, this chapter focuses on a number of best-practice examples with a view to highlighting key features and processes involved in implementing a range of effective remedies for driver error.

5.1 Case Study Selection

In order to select best-practice case studies, survey data were used to select groups of strategies that were ranked by respondents as most effective in reducing driver error and improving traffic safety. As outlined in Chapter 4, this process highlighted the positive impacts of the following strategies:

- EDU 1: Implement public awareness campaigns via TV, radio, print, and outreach;
- EDU 5: Improve reporting and analysis of driver error and contributing factors;
- ENF 4: Increase targeting and frequency of enforcement and citations;
- ENF 9: Promote interagency cooperation, partnerships, and community involvement;
- ENG 1: Encourage in-vehicle simplification, information, decision aids, and external displays;
- ENG 4: Design highways and roadways to allow maneuvers to be undertaken more safely at higher speeds; and
- ENG 7: Alter traffic operations such as signal phasing and ramp metering.

The survey also highlighted a number of states that rated highly on the self-scoring analysis regarding the effectiveness of countermeasures for driver error. Top scoring states from the sample of respondents in each region of the country were:

- Mid-Atlantic: Pennsylvania;
- South: Georgia, Louisiana and Virginia;
- Midwest: Michigan, Missouri and Ohio;
- Southwest: Texas; and
- West: California.

For these top-rating states, survey responses were analyzed for individual strategy codes in order to identify potential case studies in each area. All case studies were therefore selected for top-ranking strategies in top-rating states, where the strategies were highly rated within that state. In this way, each of the case studies represents best practice in remedies for driver error.

Case studies were also chosen where they seemed to reflect an innovative approach and where they had achieved measured or anecdotal success in improving traffic safety. Case

studies represent a broad spectrum of efforts from different regions of the United States with distinct physical and cultural attributes. Some of the case studies represent a discrete program or project, while other case studies represent a string of related efforts to reduce driver error in the respective state.

From this analysis, a total of five case studies were selected as listed in Table 5.1.

Table 5.1 Comments on Strategies

Strategy Codes	Case Study	State	Region
EDU 1, ENF 8, 9	Statewide Pedestrian Safety Campaign	California	West
EDU 5, ENF 4	Seat Belt Enforcement Program	Louisiana	South
ENG 3, 4	Intersection Safety Projects	Michigan	Midwest
ENG 6, 7, 12	Advanced Engineering	Pennsylvania	Mid-Atlantic
EDU 1, ENF 4	Safety Media Campaign	Texas	Southwest

For each case study, information gleaned from survey input was supplemented with additional information provided by state traffic safety contacts. This information was gained through a series of interviews, email correspondence, internet resources, and literature or samples provided by state agencies. Interview notes are provided in Appendix C. Interviews investigated the impetus or rationale for the work and organizational conditions and collaborations, as well as details of program implementation and evaluation.

This chapter will outlined each of the above five case studies and its role in addressing driver error and traffic safety in different parts of the United States.

5.2 Statewide Pedestrian Safety Campaign, California

Mission and Rationale

The FHWA reports that a motorist injures or kills a pedestrian every seven minutes in the United States. In California, pedestrian-involved collisions make up 17 percent of the state's fatal collisions. Too often, the victims are children and senior citizens.

In an effort to curb these pedestrian-involved accidents, the Statewide Pedestrian Safety campaign was launched to develop a plan of action to improve pedestrian safety involving more than highway improvements and including enforcement, education, and health.

Case Study Description

The Statewide Pedestrian Safety campaign was a grant funded public education campaign which took place during the year of 2003. Public service announcements and other innovative means of advertising were used to reinforce the campaign's main theme of "Look, Slow Down, and Focus" to enhance pedestrian safety. California drivers were urged to:

- *Look* carefully and look again before completing driving maneuvers when driving in areas where pedestrians frequent;
- *Slow Down* when driving through school zones or areas where pedestrians may be encountered; and
- *Focus* on driving tasks and hang up cell phones.

Figure 5.1: Mayor Willie Brown at the School's Out Safety Jam in Columbia Park, San Francisco, June 2003

The campaign focused on the four major markets of California through radio spots, interviews, and bus advertisements. Materials were provided in English and Spanish and were shown during the beginning and end of the school year. Public education events entitled the "School's Out Safety Jam" were also held in San Francisco, Los Angeles, and

Sacramento to encourage proper pedestrian behavior among children between 5 and 11 years old.

Process of Implementation and Participation

The Statewide Pedestrian Safety campaign was developed by the Safe Routes for School program. The California Department of Health Services coordinated this program and prepared a 1999 report on safety strategies called "Pedestrian Safety Best Practices." They also created a position for a full-time pedestrian safety coordinator to work on these issues and liaise with a Pedestrian Safety Task Force.

Figure 5.2: School's Out Safety Jam, Los Angeles

Members of the Pedestrian Safety Task Force represent a number of agencies including Caltrans, CHP, Department of Health Services, DMV, and Caltrans district representatives. The task force is still operating, and members provide a mix of views and ideas on how to address pedestrian safety concerns.

In addition to those involved on the task force, the Statewide Pedestrian Safety campaign involved metropolitan planning organizations (MPOs), city governments and police departments, the disabled community, and other interested people.

Effectiveness and Related Factors

The campaign was well-received with follow-up focus groups indicating that the theme "Look, Slow Down, and Focus" had become a recognizable theme for Californians. This success may be due to the campaign's simple message and widespread publicity.

In addition, there was a measured drop of approximately 5 percent in the number of pedestrian fatalities over the course of the campaign, with no subsequent increase in accident rates since the campaign ended.

5.3 Seat Belt Enforcement Program, Louisiana

Mission and Rationale

In Louisiana, not wearing a seat belt was a factor in 59 percent of the non-pedestrian traffic fatalities that occurred in 1999. While use of seat belts in the state has increased in recent years, many people still use the belts only on major highways or long trips.

To reduce highway injury and death by promoting greater use of seatbelts, the Louisiana Highway Safety Commission (LHSC) implemented the Seat Belt Enforcement program in connection with NHTSA's "Buckle Up America" campaign. Louisiana's campaign aims to increase statewide safety belt use from 64 percent to 87 percent by 2007 for adults and 2006 for children.

Figure 5.3 Louisiana's Buckle Up Campaign Logo

Case Study Description

To assess the effect of different levels of enforcement and complementary media publicity, Louisiana conducted an evaluation of four different combinations of seat belt enforcement, earned media, and paid media (television and radio), as shown below:

Table 5.2 Different seat belt enforcement and publicity options, Louisiana

Enforcement / Media	**Existing Enforcement**	**Enhanced Enforcement**
Earned Media Only	Treatment 2: **Alexandria**	Treatment 4: **Lake Charles**
Paid Media	Treatment 3: **Baton Rouge**	Treatment 1: **Shreveport**

Process of Implementation and Participation

The LHSC, under direction from NHTSA, contracted with local law enforcement agencies and paid overtime rates for enforcement work under this effort. These grants amounted to 4,955 overtime hours during the Buckle Up America's November 2002 Operation ABC (America Buckles Up Children) mobilization and the May 2003 Buckle Up America! Week, plus 15,235 overtime hours for yearlong enforcement by large agencies. These efforts were conducted in the Shreveport, Lake Charles, and New Orleans areas and resulted in 40 seat belt checkpoints and 11,162 citations during

November 2002 and May 2003, plus 232 check points and 25,267 citations for yearlong efforts.

To reinforce seat belt enforcement, three people acted as liaisons between the LHSC and the agencies. These liaison people visited law enforcement agencies, offered technical assistance, and helped coordinate media events on seat belt laws and compliance. Non-paid media efforts included: press events; speaking engagements at schools, businesses and community functions; and newspaper articles on seat belt issues in Alexandria, Baton Rouge, Lafayette, Lake Charles, Monroe, New Orleans, and Shreveport.

In Shreveport and Baton Rouge, additional paid media effects included $1 million for 30,000 paid television spots and 5,000 radio spots, plus 85,000 free spots. These commercials were aired during November 2002, May 2003, and November 2003 in two media markets with demographic concentrations of 18 to –34-year-old males. Another $124,000 was spent on 25,125 radio and television spots in the New Orleans area, although this was not part of the evaluation. Paid and non-paid media efforts are summarized in Table 5.3.

Table 5.3 Seat belt enforcement media effort costs

Media Efforts	Paid television spots	Paid radio spots	Earned spots	**TOTAL SPOTS**	Produc-tion cost	**TOTAL COST**
November 2002 & May 2003	9,140	4,918	40,000	54,000	$49,662	$749,662
November 2003	22,056	0	44,000	66,000	$2,599	$224,599
Capstar: May 2003*	0	480	960	1,440	$0	$25,350
Public information	Coordinated media efforts in non-paid media areas					$39,000
LSU Evaluator	Evaluated the paid media effort					$64,388
TOTAL						**$1,103,000**

Capstar = Capstar Broadcasting
LSU = Louisiana State University
* Shreveport, Baton Rouge and New Orleans

Effectiveness and Related Factors

The comprehensive media, enforcement, and public information campaign resulted in increased seat belt usage for two consecutive years, with 73.8 percent seat belt usage in 2003 being 5.2 percentage points higher than 2002. An evaluation of Louisiana's seat belt enforcement program found that enforcement is essential to bringing about behavior change and compliance with traffic safety laws. The use of paid or earned media, however, results in much greater behavior change than enforcement on its own. This difference may be due to the greater perceived risk of enforcement by the public. Based on the success of this program, the strategy of combining enforcement and paid media has been replicated in other areas such as enforcement of Driving While Intoxicated (DWI) legislation in Louisiana. Less stringent DWI legislation is expected to yield lower results.

5.4 Intersection Safety Projects, Michigan

Mission and Rationale

In Michigan, driver behavior is the primary cause factor in crashes. Speeding, failure to yield, violation of traffic control, and driving left of center were cited in 31 percent of all fatal crashes in 2002. Additionally, 29 percent of all fatal crashes in 2002 occurred at or within 150 feet of an intersection.

To address these issues, the Michigan Office of Highway Safety Planning (OHSP) developed an overarching performance plan for 2004, with the aim of saving lives and reducing injuries on Michigan roads through leadership, innovation, facilitation, and program support in partnership with other public and private organizations. One component of their strategy was roadway safety measures aimed at reducing the number of crashes at intersections by 10 percent from 141,052 in 1999 to 126,947 in 2004.

Case Study Description

Roadway safety measures undertaken in Michigan include:

- Implementing the Road Improvement Demonstration Project;
- Developing a draft Intersection Safety Action Plan;
- Delivering traffic safety engineering training; and
- Improving traffic crash data analysis.

The Road Improvement Demonstration project identified intersections in Michigan that have higher than normal crash rates. These intersections were subsequently treated using low cost improvements, such as signal re-timing, sign upgrades, and larger signal heads. These changes reduce the potential for human error and other accident contributing factors at these intersections.

Figure 5.4: Michigan Intersection Safety Strategy and Near-Term Action Plan
Source: Michigan GTSAC, 2004)

The Michigan Intersection Safety Action Plan (ISAP) was developed using guidance from the American Association of State Highway and Transportation Official (AASHTO) national agenda for intersection safety. ISAP provides an outline of issues, strategies, near-term action plans, and resources in a number of areas affecting

intersection safety. These areas include legislative/political outreach, safety management, research data, safety analysis tools and practices, engineering countermeasures, red-light running, enforcement, and communication and education. The plan therefore integrates engineering, enforcement, and education strategies to ameliorate driver error and other hazards at intersections.

To assist with implementing intersection improvements at the local level, the Michigan OHSP also helped to enhance traffic safety engineering knowledge in local communities by providing a class on topics such as School Safety Planning and Introduction to Sight Distance (Michigan OHSP, 2003).

Process of Implementation and Participation

The Michigan ISAP was developed by the Michigan Governor's Traffic Safety Advisory Commission (GTRSAC), comprising the Michigan Department of Transportation, Michigan OHSP, Department of State, state police, Office of Services to the Aging, Department of Education and Department of Community Health. The plan therefore represents a multi-agency and multidisciplinary approach to addressing driver error and traffic safety at intersections. The plan also drew upon the input and expertise of other individuals and organizations such as local cities, counties, councils of governments, universities, engineering consultants, the AAA Michigan and the FHWA.

Effectiveness and Related Factors

Michigan's intersection safety measures have been highly effective, with a 13 percent drop in crashes occurring at intersections between 1999 and 2003. In 2001 and 2002, the decrease in crashes occurring at intersections exceeded the 2004 goal of 126,947.

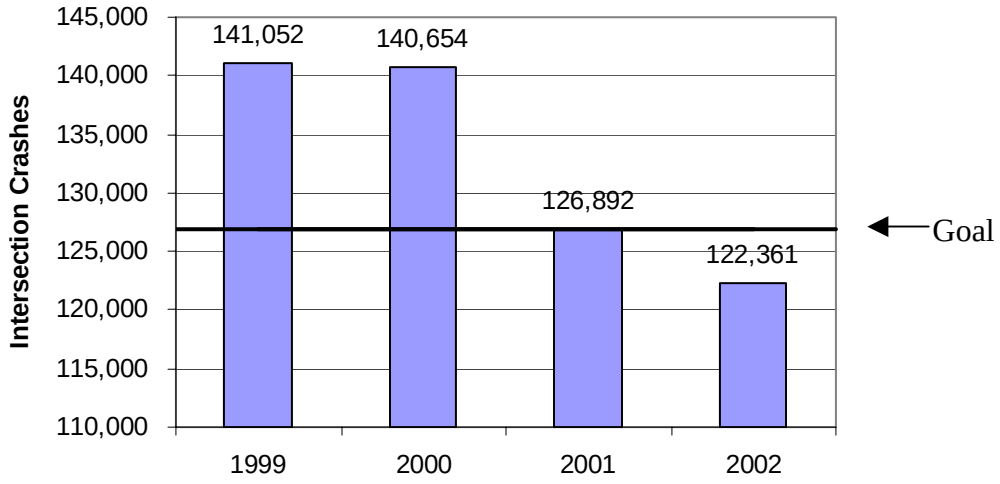

Figure 5.5 Intersection Crashes Compared to 2004 Goal, 1999-2002

5.5 Advanced Engineering, Pennsylvania

Mission and Rationale

The Pennsylvania Department of Transportation (PENNDOT)'s Bureau of Highway Safety and Traffic Engineering aims to provide leadership, guidance, and support for advancing effective highway safety and congestion management efforts to meet the needs of customers and partners. In this context, many of the best practice safety countermeasures emerging from Pennsylvania are engineering approaches with the dual aim of containing congestion and improving safety. With the shift toward devolution of transportation funding to regional agencies, PENNDOT adopted a strategy to promote effective, low cost safety improvements for local implementation at targeted high crash sites.

Case Study Description

PENNDOT's low cost engineering innovations to address driver error include:

- The "DOT" tailgating treatment;
- Advanced curve warning pavement markings and signage;
- Raised and recessed pavement markers;
- Centerline, edge line and bicycle-tolerable shoulder rumble strips;
- Improved roadside, guide rail utility pole, and tree delineation; and
- Increased paint line visibility and sign reflectivity.

Figure 5.6: PENNDOT's DOT Tailgating Treatment, 2000
Source: Bryer 2000

The "DOT tailgating treatment involves white elliptical dots being painted in the center of traffic lanes. The dots are placed at 2-seconds intervals for prevailing traffic speeds and enforceable signs instruct drivers to place themselves 1 space apart.

In addition to passive traffic controls, PENNDOT has implemented ITS technologies and traffic signalization treatments that were initially developed to address urban congestion. Today these systems also provide traffic safety and incident detection/response benefits. They include:

- Variable message signs (VMSs);
- ITS intersection crash avoidance systems;

- Ice and weather sensors with ITS support systems; and
- ITS ramp metering system.

Automated truck rollover systems have been implemented in a few highway ramp sites where the geometry leads to a higher incidence of rollover accidents but where complete reconstruction is cost prohibitive. These systems contain sensors to detect vehicle speed and weight, and assess the potential for rollover. When vehicles approach dangerous speeds, message signs flash a warning for the vehicle to slow down.

Figure 5.7: Advanced Curve Warning Markings
Source: Bryer 2000

Road Weather Information System (RWIS) are also used to assist during the winter by allowing winter maintenance crews to remotely monitor remotely ambient air temperatures, pavement moisture levels, and the amount of chemical on the pavement. This information is used as a decision aid for travelers (via the internet), maintenance crews, and automated anti-icing sprayer systems in the case of bridge decks.

Process of Implementation and Participation

In Pennsylvania, the program of low cost engineering solutions was assembled following the state's participation in an independent oversight program (IOP) to evaluate Section 152 Hazard Elimination expenditures. Section 152 is part of the Surface Transportation Program under the federal ISTEA/TEA-21 transportation legislation. ISTEA/TEA-21 gave more power to metropolitan planning organizations in determining the use of federal transportation monies, and the IOP evaluation revealed that MPOs were spending less money on the larger engineering projects that had traditionally been used, in part, to address traffic safety issues. In order to cater for MPO priorities while addressing transportation safety, PENNDOT therefore put together a program containing a collection of lower cost engineering solutions to address human error.

Many of the roadway, signalization, and ITS solutions under this program were imported and adapted from other states where they had been successfully employed. In the case of the DOT tailgating treatment, the concept was adapted from Europe's chevron (V) pavement markings. Pennsylvania's safety staff developed the elliptical dots to alleviate concerns about making the road surface more slippery.

In the case of electronic cameras, devices, variable message signs and highway advisor radio, these were implemented to reduce congestion in metropolitan areas by providing up-to-date information about traffic conditions. Reduced number of traffic incidents in congested areas was a secondary benefit of these systems.

Many of Pennsylvania's countermeasures were implemented with involvement from other agencies. For example, Pennsylvania's bicycle-tolerable rumble strips were developed with research assistance and cooperation from the Pennsylvania Transportation Institute. Engineering and ITS countermeasures benefiting from enforcement also involve partnerships with state and local police agencies.

Figure 5.8: Pennsylvania's Bicycle Tolerable Rumble Strips
Source: Bryer 2000

In addition to interagency cooperation, a number of Pennsylvania's engineering strategies implemented at the local level are accompanied by educational components. The level of complementary education and integration, however, is dependent upon the local implementing agency.

Effectiveness and Related Factors

PENNDOT's low cost and ITS engineering solutions are considered to be effective in reducing driver error and improving traffic safety. Most of the solutions, however, have not been evaluated within Pennsylvania. Instead, these remedies are benchmarked against best practice in other states and adapted for use within the state.

The DOT tailgating treatment has been evaluated and found to be moderately successful. One district reported a 60 percent reduction in rear end and tailgating crashes after implementation of the strategy. In other districts, however, there has been an increase in congestion following implementation of the strategy, and these conditions can lead to more impatient and aggressive driving therefore reversing the desired effects.

PENNDOT's assessments of the DOT tailgating treatments found that the dots were effective in changing behavior for most drivers. In areas where the strategy was not enforced by police, however, the dots were not effective in changing the behavior of people who were already driving aggressively when they entered the treated area. Complementary enforcement of the DOT tailgating treatment is therefore required to provide incentive for aggressive drivers to cooperate.

5.6 Safety Media Campaign, Texas

Mission and Rationale

In 2000, 3,769 drivers and passengers died on Texas highways, with over 48 percent of the fatalities involving an impaired driver. Texas leads the nation in alcohol-related traffic deaths, with young adults between the ages of 21 and 34 more likely to be in drunk driving crashes or to be arrested for driving while intoxicated than those in other age groups. Additionally, while 82 percent of highway travelers in Texas use safety belts, 1,300 passengers and drivers might have lived and another 38,000 might have avoided injury in crashes had they been wearing seat belts in 2000.

To address this problem and conform with NHTSA directives, local law enforcement of traffic safety issues has been increased in Texas, and the Texas Department of Transportation has undertaken extensive safety media campaigns to raise awareness of increased enforcement and encourage safer driving practices.

Case Study Description

Each year, $3 million are spent on media campaigns targeting traffic safety and driver error in Texas. The campaigns focus on the areas of alcohol and occupant protection, and include radio commercials, television commercials, information kits for school students and billboards. Materials are produced in English and Spanish. Spanish materials provide a culturally appropriate translation rather than a direct translation of materials to address the same issues.

The occupant protection media program is part of Texas' "Click It or Ticket" (CIOT) campaign which was initiated to provide support to local law enforcement and publicize the fact that there would be a greater number of police officers enforcing seat belt rules. This campaign is run around the Memorial Day holiday, from about May to mid-June.

Figure 5.9: Texas' Click it or Ticket Campaign

The alcohol program is focused largely on the story of Jacqueline Saburido, a Venezuelan college student who was hit by a drunk driver, trapped inside her burning car and burned over 60% of her body. After surviving the crash and numerous surgical operations, she has become a champion for the issue, with the theme of Texas' drunk driving becoming "Not everyone who gets hit by a drunk driver dies." The DWI message is targeted at youth and high school age children and emphasizes the consequences of drinking under the influence of alcohol. The Jacqui story includes visual images of Jacqui Saburido before and after the crash, as well as footage of the drunk driver, Reggie Stephey, a young man and local football star who is now serving a seven-year sentence in prison.

While the CIOT campaign is featured on television, radio and billboards, the DWI campaign is more prevalent on television due to the visual images involved. The Jacqui story was also featured in an 18-page section of a local newspaper, and this material was reprinted at cost for the Traffic Safety Office as part of their educational materials for schools.

Process of Implementation and Participation

The Texas safety media campaign is currently in its third year with $3 million being spent annually on the paid media campaign. Previously, the state spent $1.5 million of its own money on paid media. After receiving federal funding, the state continues to spend $1.5 million on paid media and uses the federal funds to further bolster this effort.

The CIOT campaign was developed using prototypes from NHTSA and other states. Commercials adopted concepts used by other states but adapted these messages to the particular audiences being targeted in Texas.

The DWI campaign converged from national prototypes, with NHTSA strongly recommending a more mellow message and strongly discouraging the graphic imagery associated with the Jacqui story.

Figure5.10: The Jacqui Story

Effectiveness and Related Factors

Texas's CIOT campaign was considered to be successful, with the use of safety belts in Texas increasing from 81 percent to almost 85 percent in 2003. This increase was largely attributed to the combination of extensive advertising and enhanced enforcement of the state's safety belt and child safety seat laws.

Texas' DWI campaign was also regarded as highly successful in raising awareness and understanding of traffic safety and the dangers of impaired driving. Focus testing on the

story demonstrated that young people were able to grasp the campaign message and understand the consequences associated with drunk driving at a personal level. Focus tests were conducted on people in the age brackets 12 to 14, 14 to 18, 18 to 21, and 21-25 years. Females in these focus tests saw a girl who had had her life destroyed by drunk driving, while males saw a young man with a promising football career who got drunk and wound up in prison for hitting another car, injuring, and killing people. The success of the campaign was therefore attributed to the personal element as well as the willingness of Jacqueline Saburido to become a champion for this issue.

In terms of crash statistics, the effects of the paid media campaign are not known due to the backlog of work on compilation and upgrading of crash reporting information in Texas. The state is currently working to undertake a major upgrade of crash statistics and will assess trends and effects when upgrading work is completed in 2005.

6. SUMMARY AND CONCLUSIONS

In Arizona and throughout the United States, driver error costs a great deal in terms of crash-related congestion, property damage, loss of economic productivity and loss of human life. The state and federal governments, private companies and individuals spend millions of dollars each year on traffic safety programs directed toward improving the safety of vehicles and roadways. However, less attention has been paid to crash contributing factors that involve human factors or driver error. This reference document provides a review of current literature and practices to reduce the frequency of driver error and the severity of driver error related accidents.

6.1 Elements to Consider

In order to select appropriate remedies for driver error, planners and decision makers need to make sure that they understand the scope, nature, and contributing factors of driver error. Ameliorative strategies may then be selected and designed to focus on priority issues and ensure that the range of driver error related concerns is addressed.

Driver errors include errors in perception or problem recognition, decision making, and execution of actions or reactions to surrounding conditions. These errors may result from a range of personal factors such as driver skill, knowledge, impairment, behavior and attitude, as well as the infrastructure and environment in which the driving task is being undertaken. Perceived risk and driver risk tolerance also affects driver perception, decision making and performance.

All of these elements play a role in driver error and should be considered when developing and implementing strategies to ameliorate driver error. These elements are summarized in Table 6.1 below:

Table 6.1 Elements to Consider in Selection of Remedies for Driver Error

Motivation	Contributing Factors	Types of Driver Error
Effect on increasing perceived cost of risky behavior Effect on decreasing perceived cost of cautious behavior Effect on decreasing perceived benefit of risky behavior Effect on increasing perceived benefit of cautious behavior	Inadequate knowledge, skills and training • Lack of understanding or misunderstanding of: - Traffic laws - Vehicle kinematics, physics - Driving techniques - Driver capabilities, limitations Impairment • Health related - Illness - Disabilities, uncorrected disabilities - Compensation for dysfunctions - Incorrect use of medication • Drug use - Alcohol - Illicit drugs • Drowsiness, fatigue, sleep needs • Demographic characteristics - Aging - Limited English and/or literacy Willful inappropriate behavior • Purposeful violation of traffic laws, regulations • Aggressive driving • Use of vehicle for improper purposes	Perception or problem recognition error • Driver failed to stop for sign • Delays in problem recognition - Improper lookout - Internal distraction - External distraction - Inattention - Delays in recognition Decision error • Excessive speed • False assumption • Improper technique / practice • Improper maneuver • Inadequate signal • Tailgating • Misjudgment of distance / closure • Pedestrian ran into traffic • Failure to turn on headlights • Excessive acceleration Execution or performance error • Improper evasive action • Inadequate directional control • Overcompensating • Panic or freezing • Critical nonperformance • Non-accident

6.2 General Strategies to Address Driver Error

In order to reduce the frequency of driver error and the likelihood and severity of associated accidents, a range of strategies can be implemented in the areas of:

- Education and information;
- Enforcement and incentives; and
- Engineering and infrastructure.

These strategies may be implemented in a piecemeal or incremental manner or may be a part of a wider program of activities. Statewide programs include annual highway safety plans required by NHTSA as well as statewide strategies and campaigns to address driver error or particular safety concerns such as pedestrian safety and impaired driving in a comprehensive or integrated manner. These ***overarching programs*** allow more holistic

understanding of problems, collaboration and involvement of stakeholders, comprehensive assessment of strategies, and effective prioritization of solutions.

According to recent literature, the effectiveness of strategies in altering safety outcomes is also affected by risk homeostasis whereby driver behavior is influenced by the ***perceived risks, costs, and benefits*** of driving conditions. Strategies that increase the probable or perceived consequences of unsafe driving behavior are therefore seen as more effective in reducing driver error. Alternately, strategies may also reward or decrease the perceived costs of *safe* driving behavior.

Other factors that influence the effectiveness of remedies for driver error were highlighted in recent literature, state survey findings, and interview responses. These factors include:

- ***Collection and availability of data*** on specific crash contributing factors and the link between crashes, causes, and interventions;
- ***Broad political, agency, and public support,*** which may be obtained via coalitions and organizational involvement;
- ***Strong state and local interagency cooperation,*** including cooperation of law enforcement agencies;
- ***Availability of funds*** for development and deployment of remedies for driver error;
- ***Targeting of key issues and locations*** affected by driver error;
- ***Use of supplementary public information and education*** for enforcement and engineering treatments, and ***supplementary enforcement*** for public education and engineering treatments; and
- ***Focusing on low-cost, responsive and preventative measures*** instead of expensive, long term reconstruction options.

In addition to these overall findings that relate to all remedies for driver error, the effectiveness of individual education, enforcement, and engineering efforts is affected by various factors, which are outlined in the following sections.

6.3 Education/Information Remedies for Driver Error

The most effective education and information strategies that emerged from primary and secondary research include: public education and information; improvement of data collection and analysis of traffic accidents and human factors; and driver education and training.

As shown in Table 6.2, education and information strategies generally have a positive effect on motivation and risk homeostasis due to their role in heightening awareness of dangers and penalties associated with unsafe driving behaviors. In relation to training and licensing of drivers and other road users, some sources cite negative motivational

effects, with novice drivers (who have already passed their licensing test) generally being involved in more accidents than learner drivers. Similarly, children who have passed bicycle safety training courses are generally granted more freedom than those who have not participated, with the result of maintaining a constant accident rate due to increased exposure. These risk homeostasis effects may be addressed through greater emphasis on safety concerns and risks during the training process.

Research indicated that the effectiveness of public education and information campaigns is enhanced by the use of paid media, supplementary enhancement of enforcement efforts, and targeting of efforts toward major issue areas and locations. The effectiveness of data collection and analysis is enhanced by the use of standardized state or national crash forms and crash contributing factors that relate to driver error. Multi-agency involvement was also reported to enhance the effectiveness of all strategies.

Table 6.2 outlines the range of education and information strategies and their associated effects on motivation, estimated level of effectiveness, and factors affecting their success.

Table 6.2 Education/Information Remedies for Driver Error

Remedy	Effect on Motivation	Cited as Effective*	Factors Affecting Effectiveness
EDU 1: Implement public awareness campaigns	+ (Positive)	✓✓✓	• Targeted to main issue areas: speed, DWI, seat belts, aggressive driving • Targeted to problem cohorts: young, novice drivers, aging • Use of paid media • Sustained and lengthy • Conducted in conjunction with increased enforcement • Multi-agency involvement • Supported by appropriate legislation • Supported by good crash data
EDU 2: Improve driving instructor training and resources	+	✓	• Use of certification courses • Provision of materials for parent/caregiver training of teens • Provision of school driver education
EDU 3: Improve driver training	+	✓✓	
EDU 4: Improve related industry practices and awareness activities			
EDU 5: Improve reporting and analysis of driver error and contributing factors	+	✓✓✓	• Uniform crash form • Electronic crash reporting systems • Inclusion of factors relating to driver error and distraction • Development and use of nationwide crash reporting guidelines

DWI = Driving While Intoxicated

** From 0 – 3, with 3 ticks being the highest average effectiveness from survey and other sources.*

6.4 Enforcement/Incentive Remedies for Driver Error

In relation to enforcement and incentive measures, research highlighted the effectiveness of focusing on increasing the probability of enforcement through targeted campaigns and increased frequency of citation, as well as the importance of interagency cooperation partnerships and community involvement to provide greater visibility and support for efforts to address driver error. Other measures seen as moderately effective include introducing or increasing the stringency of legislation on driver error, and lengthening driver training through graduated drivers licensing. Some agencies, however, reported a decline in safety outcomes for second-year novice drivers following introduction of the latter policy.

On the whole, enforcement strategies have a positive effect on motivation and risk homoeostasis as a result of increasing the perceived cost of unsafe driving behavior. The perceived cost of unsafe driving appears to be affected more strongly by the probability of enforcement than the level of the associated penalty. In fact, where penalties are set at a very high level (such as high fines and felony charges), this has been found to diminish motivational effects due to the increased likelihood of penalties being challenged and greater use of judicial discretion.

Research found that the effectiveness of enforcement remedies is enhanced by the use of public education campaigns to reinforce law enforcement efforts, as well as enactment of appropriate legislation, targeting of priority issues and locations, and involvement of multiple agencies in program development and implementation. Greater participation by different agencies and organizations can benefit enforcement efforts by providing consistency between different jurisdictions and incorporation of different interests. Enforcement efforts are may also be enhanced where there is overarching leadership and/or community-based champions for issues associated with driver error and traffic safety.

In addition to penalties for driver errors, a smaller number of references were found for incentive programs to reward safe driving practices through discounts on insurance and registration. These strategies are seen as more effective when they provide advance notice, address behavior-analysis theory, and encourage road users to develop internal controls (Lonero *et al*., 1998).

Table 6.3 outlines the range of enforcement strategies and their associated effects on motivation, estimated level of effectiveness, and factors affecting their success.

Table 6.3 Enforcement / Incentive Remedies for Driver Error

Remedy	Effect on Motivation	Cited as Effective*	Factors Affecting Effectiveness
ENF 1: Lengthen driver training and improve testing and licensing	**+/-**	✓✓ Mixed results	• Address second year driving effects
ENF 2: Impose tighter legislation targeting driver error and contributing factors	**+**	✓✓	• Enactment of "good" legislation that enhances respect for road law • Emphasis on certainty of detection and punishment through active enforcement and active publicity • Road users safety as a primary concern and rejection of implications of revenue raising
ENF 3: Change speed limits to reduce driver error		✓ (Mixed direction of change)	• Supported by engineering and traffic survey
ENF 4: Increase targeting and frequency of enforcement and citations	**+**	✓✓✓	• Targeted to high crash rate or fatality rate areas, corridors • Targeted to priority issues: speeding, aggressive driving, DUI, seat belt usage • Heavy enforcement • Use of complementary paid media campaign to increase perceived risk of enforcement
ENF 5: Enhance enforcement with automated systems and photo enforcement	**+**	✓	• Favorable legislative environment for implementation or addressing of legal issues
ENF 6: Increase the cost or severity of penalties	**+/-**	Mixed	• Supportive legislation, e.g., DWI, DFZs • Widespread publicity penalty increase • Avoidance of introducing greater judicial discretion or accusations of excessive charges
ENF 7: Address driver error in related legislation		✓✓	
ENF 8: Implement an overarching plan to reduce driver error		✓	• Statewide programs and implementation • Multi-agency involvement in plan development
ENF 9: Promote inter-agency cooperation, partnerships and community involvement		✓✓✓	• Multi-agency involvement • Outreach to minority communities to offset profiling charges

** From 0 – 3, with 3 ticks being the highest average effectiveness from survey and other sources.*
DUI = Driving Under the Influence
DWI = Driving While Intoxicated
DFZs= Safety Enhancement-Double Fine Zones

6.5 Engineering/Infrastructure Remedies for Driver Error

Finally, effective engineering strategies to address driver error included in-vehicle improvements and improvements to highway and roadway design. The latter design changes allow maneuvers to be undertaken more safely at higher speeds, lengthen sight distances, and address driver fatigue and inattention. These strategies include straightening of curves and low-cost measures such as installation of rumble strips and management of roadside vegetation. Other engineering treatments that were cited as effective included upgrading of intersections, altered traffic operations such as signal phasing and ramp metering, and implementation of active traffic controls such as speed sensors, variable message signs,, ITS technologies, and weather systems.

Traditionally, engineering strategies have aimed to provide means of carrying out movements more safely or at higher speed, thereby increasing sight lines and reducing the perceived risks of higher speed driving. While these strategies generally address external obstacles to problem recognition and driver performance, they have a negative impact on motivation by way of risk homeostasis (e.g., drivers drive at higher speeds where conditions seem safer). Engineering approaches that have a positive effect on motivation include systems to provide travelers with information on travel times, changed traffic conditions, incidents, inclement weather, and enforcement activities. Also, in more urban settings, traffic calming and pedestrian-oriented planning addresses motivation by matching roadway design with adjacent land uses.

According to literature review, survey, and interview data, the effectiveness of engineering strategies can be addressed through engineering analyses and traffic surveys. Strategy effectiveness is also enhanced by adopting preventative measures, considering all road users, adapting strategies to local conditions, and focusing efforts on traffic safety hot spots. In developing engineering strategies, multi-agency involvement, statewide standardization and integration with land use planning also enhances the effectiveness of strategies.

Table 6.4 outlines the range of engineering and infrastructure strategies and their associated effects on motivation, estimated level of effectiveness, and factors affecting their success.

Table 6.4 Engineering / Infrastructure Remedies for Driver Error

Remedy	Effect on Motivation	Cited as Effective	Factors Affecting Effectiveness
ENG 1: Encourage in-vehicle simplification, information, decision aids, and external displays	**-** (Negative)	✓✓✓	
ENG 2: Implement traffic calming and roadway design for slower, more cautious driving	**+**	✓	• Provision and evaluation of traffic calming design policy • Integration with area-wide land use planning
ENG 3: Design intersections to allow maneuvers to be undertaken more safely at appropriate speeds	**-**	✓✓	• Implementation and integration of pedestrian, bicycle and vehicular transportation planning • Consideration of area-wide land uses • Supported by engineering analysis
ENG 4-6: Improve highway and roadway design for high speed maneuvers, including rumble strips and vegetation management	**-**	✓✓✓	• Focus on low-cost, responsive, preventative measures instead of expensive, long term reconstruction • Implementation of statewide program • Multi-agency involvement • Consideration of all road users including bicycles • Supported by engineering and surveys
ENG 7: Alter traffic operations such as signal phasing and ramp metering	**-**	✓✓	• Supported by engineering and traffic survey
ENG 8: Implement passive traffic controls such as signage and road markings	**+/-**	✓	• Improvement of existing signage • Design adaptation to local conditions • Targeting driver errors, e.g. DUI, speed • Supplementary enforcement of traffic controls
ENG 9, 11-12: Implement active traffic controls such as speed sensors, variable signs, ITS and weather systems	**+/-**	✓✓	• Focus on hot spots, e.g. intersection crash avoidance, ramp rollover • Provision of traveler information on changed traffic conditions • Supplementary speed enforcement
ENG 10: Implement system level changes to promote consistency and accuracy of driver expectations		✓	• Standardization of traffic signals and signage • Provision of traveler information on changed traffic conditions • Consideration of area-wide land uses
ENG 13: Conduct safety audits at intersections or along road segments		✓	• Statewide implementation • Partnering with local/regional agencies • Identifying problem locations • Safety audits in conjunction with construction and 3R projects

DUI = Driving Under the Influence (of drugs or alcohol)
3R = Reconstruction, Rehabilitation and Restoration

6.6 Conclusions

Driver error is estimated to cause about half of all motor vehicle accidents in Arizona and the United States. These accidents result in enormous loss of life, medical and insurance costs, property damage and lost productivity through injuries and congestion. The damage and costs associated with driver error also detract from substantial progress and expenditure that has been made in improving the safety of roads and vehicles over the past two decades. In order to successfully improve road safety it is therefore necessary to understand and address driver error and contributing factors in analysis and implementation of traffic safety programs.

Driver error may encompass errors in the perception, decision making and performance of driving tasks, which may in turn result from personal factors such as driver skill and knowledge levels, driver impairment due to health conditions, drowsiness and drug use, and willful inappropriate behavior. Strategies to combat driver error should therefore consider each of these error types and contributing factors in order to devise the most appropriate course of action.

Literature and survey research on remedies for driver error suggested that a successful program of actions to ameliorate driver error should include:

- Improved reporting and analysis of driver error and crash contributing factors;
- Integrated enforcement and public education campaigns on priority issues such as speeding, impaired driving and occupant protection;
- Interagency cooperation, partnerships and broad stakeholder involvement; and
- Improved highway and roadway design including the use of low cost options such as rumble strips.

By targeting principle sources of driver error through an integrated program of education/information, enforcement/incentive, and engineering/infrastructure strategies, traffic safety agencies and stakeholders can make substantial progress in reducing the frequency of driver error and the impact of associated incidents and accidents.

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Arizona Department of Transportation Traffic Safety Survey

Strategies to Remedy Driver Error

This survey explores the strategies used to address driver error in your state. We are interested in learning about the remedies that you have found to work in your state/region and any overarching strategies you have for Traffic Safety or Driver Error. This survey will be used to develop a reference document on State-of-Practice and Best Practice remedies for driver error. By sharing your experiences and solutions you can help the Arizona Department of Transportation and other states understand driver error and improve traffic safety.

To assist you in completing this survey on remedies to driver error, the following table lists the range in types of driver errors and contributing factors:

Categories of driver error and contributing factors	

Perception error or problem recognition errors	• Driver failed to stop for sign
	• Delays in problem recognition
	  ○ Improper lookout
	  ○ Internal distraction
	  ○ Delays in recognition
	  ○ Inattention
	  ○ External distraction

Decision errors	• Excessive speed • F alse assumption • Improper technique / practice • Improper maneuver • Inadequate signal • Tailgating • Misj udgment of distance / closure • Pedestrian ran into traffic • F ailure to turn on headlights • Excessive acceleration
Execution or performance errors	• Improper evasive action • Inadequate directional control • Overcompensating • Panic or freezing • Critical non-performance (e.g. passing out, falling asleep) • Non-accident (e.g. suicide, road rage)

Inadequate Knowledge, Training, Skill	• LLack of understanding or misunderstanding of
	  ○ Traffic laws
	  ○ V ehicle kinematics, physics
	  ○ Driving techniques
	  ○ Driver capabilities, limitations
	• Y outh or novice driving
	• Lack of English comprehension

Impairment	• F atigue and drowsiness
	• U se of illegal drugs, alcohol
	• Health related
	  ○ Illness
	  ○ Lack of use or, incorrect use of medication
	  ○ Disability, uncorrected disability
	• Conditions associated with aging

Willful Inappropriate Behavior	• Purposeful violation of traffic laws, regulations
	• Aggressive driving
	• Use of vehicle for improper purposes:
	  ○ Intimidation
	  ○ As a weapon

Infrastructure, Environment Problems	• Traffic control device related
	• R oadway related:
	  ○ Alignment
	  ○ Sight distance
	  ○ Delineation
	• Weather, visibility related

Risk Tolerance/Homeostasis	• Compensating for low perceived risk through different driver behaviors which alter the above variables

Question 1

Does your state have an overarching strategy for addressing driver error and/ or traffic safety?

- (•) Y es (Please explain e.g. strategy name, date, description agency, U R L , contact information)
- ( ) N o
- ( ) Don'tKnow

Question 2

Which of the following education/ information strategies have been undertaken to address driver error?

Remedies/Programs	N/A	Effectiveness (1=not effective; 5 = very effective) 1 2 3 4 5	Formal Evaluation Conducted	Specifics
Education/ Information				
Implement public awareness campaigns via TV, radio, print and outreach	○	○ ○ ○ ○ ○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Improve driving instructor training and resources	○	○ ○ ○ ○ ○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Improve driver training	○	○ ○ ○ ○ ○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Improve related industry practices and awareness activities	○	○ ○ ○ ○ ○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Improve reporting and analysis of driver error and contributing factors	○	○ ○ ○ ○ ○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Other (Please specify):	○	○ ○ ○ ○ ○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Comments on Education/Information Strategies:				

Question 3

Which of the following enforcement/ incentive strategies have been undertaken to address driver error?

Remedies/Programs	N/A	Effectiveness (1=not effective; 5 = very effective) 1 2 3 4 5	Formal Evaluation Conducted	Specifics
Enforcement/ Incentive				
Lengthen driver training and improve testing and licensing	○	○ ○ ○ ○ ○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.

Impose tighter legislation targeting driver error and contributing factors	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Change speed limits to reduce driver error	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Increase targeting and frequency of enforcement and citations	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Enhance enforcement with automated systems and photo enforcement	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Increase the cost or severity of penalties	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Address driver error in related legislation	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Implement an overarching plan to reduce driver error	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Promote inter-agency cooperation, partnerships and community involvement	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Other (Please specify):	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Comments on Enforcement/Incentives Strategies:								

Question 4

Which of the following engineering/ infrastructure strategies have been undertaken to address driver error?

Remedies/Programs	N/A	Effectiveness (1=not effective; 5 = very effective)					Formal Evaluation	Specifics
		1	2	3	4	5	Conducted	
Engineering/ Infrastructure								
Encourage in-vehicle simplification, information, decision aids, and external displays	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Implement traffic calming and roadway design for slower, more cautious driving	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Design intersections to allow maneuvers to be undertaken more safely at appropriate speeds	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Design highw ays and roadways to allow maneuvers to be undertaken more safely at higher speed	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Address roadside vegetation for longer sight distances	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Improve road design and rest areas to address driver fatigue and inattention	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Alter traffic operations such as signal phasing and ramp metering	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Implement passive traffic controls such as signage and road markings	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Implement active traffic controls such as speed sensors and variable signs	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Implement system level changes to promote consistency and accuracy of driver expectations	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.

Implement strategies to reduce impacts of nighttime driving, inclement weather and work zones	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Install or encourage Intelligent Transportation System (ITS) warnings and decision aids	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Conduct safety audits at intersections or along road segments	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Other (Please specify):	○	○	○	○	○	○	☐	Strategies, descriptions, areas of application, agencies, dates, etc.
Comments on Engineering Strategies:								

Question 5

How are traffic safety target areas and strategies for driver error/traffic safety activities in your state determined?

- ☐ Statistics
- ☐ In response to directives or inquiries from political authorities (i.e., governor, legislators)
- ☐ Traffic safety studies
- ☐ Academic research
- ☐ Cost benefit analysis
- ☐ Other:

Comments:

Question 6

In your opinion, what have been the most innovative strategies for reducing driver error?

1.
2.
3.
4.
5.

Question 7

In your opinion, what have been the most effective strategies for reducing traffic accidents through addressing driver error?

1.
2.
3.
4.
5.

Question 8

In your opinion, what factors contributed to the above strategies' success?

1.
2.
3.
4.
5.

Question 9

Do you have any additional comments on remedies for driver error?

About You

First Name: Last Name:

State: Please select your state Department:

Title:

Phone: (include area code) E-mail:

That completes the survey. Thank you for your participation!

A confirmation page should appear after you hit "submit". If it does not, please contact Justine Lam at (925) 284-5998 or mailto:lam@jfaucett.com?subject=ADOT Survey

Submit Reset

JACK FAUCETT ASSOCIATES

Last Updated: 05/19/2004

APPENDIX B: List of Survey Recipient Agencies

State Agencies

- Alabama Highway Safety Office
- Alaska Highway Safety Office
- Arizona Governor's Office of Highway Safety
- Arkansas Governor's Highway Safety Office
- California Office of Traffic Safety Business
- California Department of Transportation (Caltrans), Traffic Operations
- Colorado Department of Transportation, Office of Transportation Safety
- Connecticut DOT, Manager of Research
- Connecticut Governor's Highway Safety Office, Department of Transportation
- Delaware Office of Highway Safety
- Florida Highway Safety Office
- Georgia Governor's Office of Highway Safety
- Hawaii Office of Highway Safety
- Idaho Office of Highway Safety
- Illinois Division of Traffic Safety
- Indiana Governor's Council on Impaired and Dangerous Driving
- Iowa Governor's Traffic Safety Bureau
- Kansas Bureau of Traffic Safety, Department of Transportation
- Kentucky State Police Governor's Highway Safety Program
- Governor's Highway Safety Office, Louisiana Highway Safety Commission
- Maine Governor's Highway Safety Office, Bureau of Highway Safety
- Maryland Highway Safety Office, State Highway Administration
- Massachusetts Governor's Highway Safety Bureau
- Michigan Office of Highway Safety Planning
- Minnesota Department of Public Safety, Office of Traffic Safety
- Mississippi Office of Highway Safety
- Missouri Division of Highway Safety
- Montana Department of Transportation, Traffic Safety Bureau
- Nebraska Office of Highway Safety
- Nevada Office of Traffic Safety
- New Hampshire Governor's Highway Safety Office
- New Jersey Division of Highway Traffic Safety
- Governor's Highway Safety Office, New Mexico Highway and Transportation Department
- New York Governor's Traffic Safety Committee
- North Carolina Governor's Highway Safety Program
- North Dakota Department of Transportation, Drivers License & Traffic Safety
- Ohio Office of Governor's Highway, Department of Public Safety
- Governor's Highway Safety Office, Oklahoma Highway Safety Office
- Oregon Department of Transportation, Transportation Safety Division

- Pennsylvania Bureau of Highway Safety and Traffic Engineering
- Rhode Island Department of Transportation
- South Carolina Department of Public Safety, Office of Highway Safety
- South Dakota Department of Commerce & Regulation, Office of Highway Safety
- Tennessee Governor's Highway Safety Program
- Texas Department of Transportation, Traffic Safety Section
- Utah Highway Safety Office
- Vermont Department of Public Safety
- Virginia Department of Transportation, Highway Safety Improvement Program / Virginia Department of Motor Vehicles
- Washington Traffic Safety Commission
- West Virginia Highway Safety Program, Department of Motor Vehicles
- Wisconsin Department of State Patrol, Transportation Safety Bureau
- Wyoming Department of Transportation, Highway Safety Program

U.S. Territories

- Indian Highway Safety Program, Bureau of Indian Affairs
- Transportation Safety Branch, D.C. Department of Public Works

Federal Agencies

- United States Department of Transportation / Federal Highway Administration
- National Highway Traffic Safety Administration
- American Association of State Highway & Transportation Officials (AASHTO)

APPENDIX C: Survey Distribution Letter

Arizona Department of Transportation
Transportation Planning Division
206 South Seventeenth Avenue Phoenix, Arizona 85007-3213

Janet Napolitano
Governor

Victor M. Mendez
Director

Dale Buskirk
Division Director

March 30, 2004

Office of Traffic Safety
State Departments of Transportation

Dear Colleagues

The Arizona Transportation Research Center of the Arizona Department of Transportation (ADOT) is currently undertaking a project to identify innovative and effective strategies for reducing the frequency of driver error, and to assess factors affecting the success of these strategies. The contractor for this work is Jack Faucett Associates (JFA) and project tasks include a literature review, a survey of all state and federal DOTs, and best practice case studies aimed at highlighting the most effective remedies for driver error across the United States.

You have been identified as a survey participant for your state, based on your expertise and role in transportation policy and safety. The survey investigates overarching strategies for traffic safety as well as specific efforts to address driver error within your state. By sharing your experiences and solutions, you can assist ADOT in developing a reference document on this topic for transportation and traffic safety policy makers and professionals.

The survey is located at http://www.jfaucett.com/649/survey.htm and is expected to take approximately 25 minutes to complete. We hope you can complete the survey and submit your responses online by **Friday, April 16, 2004**.

If you have any questions regarding this survey, or if you are not the correct person to complete this survey, please contact the consultant directly by calling Justine Lam at (925) 284 5998 or lam@jfaucett.com. If you have questions regarding the ADOT project overall, please contact John Semmens at the Arizona Transportation Research Center at (602) 712-3137 or jsemmens@dot.state.az.us.

Thank you for your help and participation.

Sincerely,

John Semmens
Project Manager

Arizona Governor's Award for Quality
2001 Award Recipient

APPENDIX D: Case Study Information and Interview Notes

CALIFORNIA

Interview conducted with Craig Copelan, Chief Traffic Safety Studies, California Department of Transportation (Caltrans). Interview by Justine Lam, 28 May 2004.

SHOWCASE PROJECT: Statewide Pedestrian Safety Campaign

What was the impetus for establishing the California Pedestrian Safety Task Force?

To develop a plan of action to improve pedestrian safety involving more than highway improvements and including enforcement, education and health.

Who was on it? Is it still operating?

The Task Force is still operating, and the members include Craig (Caltrans), a representative from the California Highway Patrol (CHP), Department of Health Services, Department of Motor Vehicles (DMV), Caltrans District representatives (District 7 Los Angeles, rural districts). The Task Force involved a mix of views and ideas on how to address pedestrian safety concerns.

What kind of interaction was there with local agencies?

The campaign involved MPOs (MTC), the City of San Francisco, the disabled community (Council for the Blind), and other interested people.

What were some of the outcomes of the taskforce?

The Department of Health Services coordinated "Safe Routes for School" and had a report developed of strategies for safety. Developed a report of strategies called "Pedestrial Safety Best Practices" written in 1998-1999. Created a position for a full-time pedestrian safety coordinator (Richard Ekstrom). Public education campaign on pedestrian safety, "Look, Slow Down, and Focus" which was focused on the four major markets of California through radio spots, interviews and bus ads. The pub ed campaign was well received, and shown during the beginning and end of the school year.

Why do you think was the campaign successful (in gaining recognition)?

It was a simple message and it was also widespread which helped in gaining recognition. People in focus groups remembered the "Look, Slow Down and Focus" idea.

Have they observed a drop in the pedestrian accident rate that can be attributed to the campaign?

There has been a drop in pedestrian accident rate which is measured in change in number of fatalities since the campaign began in 2001 and ended in 2001. The drop is approximately 5 percent. There has been no increase in accident rates since the campaign ended. Now the concern in health is the sedentary lifestyle which leads to less walking. They conducted a survey on people's pedestrian behaviors

What did the SPS campaign include? Can we get a sample of materials?

Enforcement in safety corridors, materials, lesson plans, evaluation of other parties. Materials can be found at www.calpedsafety.net , infrastructure improvements were not considered.

Are there any materials in other languages?

Yes in English and Spanish.

Where there particular areas in the state that were targeted?

Yes, enforcement was in highway safety corridors although he doesn't recall where they were (check CHP website).

Temporal targeting in December

Has the temporal targeting of enforcement been found to increase its effectiveness?

Yes, 3D month is in December. Promoted turning on lights for one week, provided Changeable Message Signs (CMS) for kick-off. Was an initiative with the Governor's Office and coordinated with Governor's Office of Traffic Safety, the CHP and Caltrans.

You mentioned that education was more effective when conducted in conjunction with increased enforcement. How was this cooperation facilitated? How were you able to determine effectiveness?

CHP puts out an Annual Report of Fatal Motor Vehicle component which documents the number of collisions. December is still the highest month for accidents despite 3D which has been done for 5-6 years. Measured also in number of media contacts.

Young drivers

What training time now and behind the wheel requirements?

This is a DMV program and they should be contacted about the Vehicle Code.

Has there been any noticeable effect on young driver accident rate?

It's been in effect for a couple of years and a survey should be done, however it is assumed to be successful. The measurement tool should compare the number of licenses and # of collisions.

Double fine zones

How effective have double fine zones been?

It is difficult to find DFZs effective, had to separate areas out to areas with improvements and areas without. For areas w/o improvements DFZs there only marginally improved and it was not significant state improvement.

Where are these zones located? Do they include construction zones and high accident rate areas?

DFZs are located at construction sites and also school zones or other places designated by the Legislature. It is used sparingly but necessarily. At the beginning of the school year CMSs advertise the DFZ and there is enhanced enforcement.

Photo or automated enforcement systems

What's the nature of the legal issues affecting photo or automated enforcement systems?

There are a plethora of legal issues from constitutional, privacy, notification. Need to talk with a different person on this issue.

Hands free cell phone use

Legislation to require hands free cell phone use has been put forward in California, but has not yet been successful. Why?

Hands-free law not yet passed because of opposition from interested parties.

LOUISIANA

Interview with Jamie Ainsworth, Louisiana Highway Safety Commission. Interview conducted by Ria Hutabarat, 1 June 2004.

SHOWCASE APPROACH: Seat Belt Enforcement Program

You mentioned the need to integrate two of the three strategies: education, enforcement & engineering.

In Louisiana, the Highway Safety Office is not under the DOT like in other states, so they have nothing to do with the engineering side, but have done work to integrate education/enforcement.

Have there been any assessments of the effect of integrating education and enforcement?

Louisiana won a NHTSA award in 2000 (or 2001) to conduct a paid media evaluation. The evaluation was implemented in 2002, with some in 2003 using a 2002 base. Cost of the work was $1 million. The State University participated. This evaluation looked at the effect of four options: 1) enforcement alone, 2) enforcement plus earned media (press conferences & public service announcements), 3) enforcement plus paid media, 4) enforcement plus earned media plus paid media.

The research found that with any media (ie 2,3 or 4) the behavior change is much greater than enforcement on its own. This change is due to a greater perceived risk of enforcement by the public. In LA, people only seem to respond if there is enforcement, but enforcement is much more effective with media.

What legislation was affected by this evaluation?

The campaign was directed toward seat belt usage – it was especially effective for this legislation. LA does not have the strongest laws in other areas such as DWI (impaired driving) so there's not as much to test. Commercials in that area have focused more on designated drivers and enforcement efforts at sobriety checkpoints.

After the successful evaluation, they have replicated the strategy in as many efforts as possible – combining enforcement with paid media.

What did the publicity include?

Mostly TV and radio commercials. Not so much print media.

Can we get some of these materials?

CD with some of the TV campaign images plus a photocopy of the evaluation report.

Were certain types of error or certain populations targeted?

Targeted population was youth. All TV commercials (14-15 commercials) over the past year or 2 have targeted that population.

How was the integration of education and enforcement facilitated? Who took the lead? What was the impetus? What agencies were involved?

Highway Safety Commission contracts with law enforcement agencies (which are part of the police) and pay overtime rate per officer. Agencies receive this grant and go and work the time. Most direction is from the NHTSA and regional office. The NHTSA award allowed the evaluation to occur.

What's the nature of partnerships between different agencies in the area?

Agency integration occurs with great difficulty. There is not much integration between enforcement agencies in different localities, although for big campaigns they do know that other agencies are targeting the same issues because there's a lot of paid media e.g. seat belts in May 2004, alcohol in August/September 2004 (Labor Day – previous years focused on Christmas and July 4 but not as much money this year). The campaigns are selected statistically.

Individual agencies didn't have much input into the program development but they do provide input on the details of implementation. There are a lot of fairs and festivals in LA so there's usually some exchange around the time of implementation to ensure that local agencies target enforcement activities to these times.

Graduated Drivers Licenses

The survey response indicated that GDLs reduced crash rates for 15 year olds but had a negative for 16 year olds. Please explain.

Only 15 year olds were required to hold provisional licenses. These stipulated that they could not drive alone but had to have an adult/parent in the car. It also set curfew limits. As a result they tended not to be on the road as much. Their reduced accident rate may reflect less driving rather than safer driving. At 16, the provisional license is lifted so they were out on the streets and getting into the accidents they would normally have had at 15. Since they didn't drive as much at 15 they were still novice drivers. The GDL therefore just postponed the novice driving period. There are discussions now about adding a curfew for 16 and 17 year old drivers.

There were no significant external factors affecting this result. It was a 1 year evaluation and there happened to be a larger cohort of 16 year olds, however this was not considered to be statistically significant.

LA does not have a drivers education program in the public school system any more so there are loose standards in drivers education which affect the GDL program.

Increase Severity of Penalties

The survey response indicated that more severe penalties can result in a negative effect due to judicial discretion. Please explain.

In LA, the third offense for a DWI was made into a felony, while the first two offenses are misdemeanors. Judges would see 27 year olds and other people coming through with their third offense and didn't want to make them a felon, especially at a young age. As a result they would offer a pre-trial diversion program or would plead down the case to a lower level so that it was not a third conviction. Anecdotally, the tougher penalty system is unpopular because:

- *Police complain that they do their job, but judges are not doing theirs.*
- *Judges are elected and claim that they are doing their best for their constituency.*
- *Consumers start to behave like they can just get away with offences because the tougher penalties are more negotiable (lower perceived risk).*
- *Traffic safety people and victims are unhappy because offenders go unpunished.*
- *There are probably higher administrative costs because cases are in the courts longer, however, most DWI costs are passed onto the offenders.*

The 3 strikes policy is not up for discussion, but the level of judicial discretion is. Some of this discretion was removed last year, but is now under review. Also, they are now working on a tracking system to improve reporting across counties because judges are not able to see if people have already been convicted in a different county so the 3 strikes policy is not being implemented across county borders.

MICHIGAN

Email correspondence from Kathy Farnum, Planning Section Manager, Office of Highway and Safety Planning. to Justine Lam, May 21, 2004.

SHOWCASE PROJECT: Intersection Safety Project

The mission of the Michigan Office of Highway Safety Planning is to save lives and reduce injuries on Michigan roads. Our mission is accomplished through leadership, innovation, facilitation, and program support in partnership with other public and private organizations. Strategies are developed to address traffic safety issues in the areas of Occupant Protection, Alcohol Impaired Driving, Police Traffic Services, Bike and Pedestrian Safety, Traffic Records, Public Information and Education, Corporate Outreach, Roadway Safety, Drivers Issues including both young and elderly drivers, and Motorcycle Safety… in an effort to provide you with information on our programs, the following is a link to our FY2004 Highway Safety Performance Plan and our FY2003 Annual Evaluation Report.

Performance Plan: http://www.michigan.gov.document/OHSP-2004PerformancePlan_84912_7.pdf
Evaluation Plan: http://www.michigan.gov.document/42903_OHSP_86506_7.pdf

These documents will provide you with an overview of the traffic safety strategies and programs we develop as well as an evaluation report of the success of those programs. Once you review these documents, please feel free to call me at 517/333-5316 if you have any questions or require any additional information. Thank you.

PENNSYLVANIA

Interview with Mike Baglio, Bureau of Highway Safety and Traffic Management, PENNDOT. Interview conducted by Ria Hutabarat, June 3, 2004.

SHOWCASE PROJECT: Advanced engineering

What was the impetus for Pennsylvania's range of advanced engineering and ITS treatments to address driver error and traffic safety?

PENNDOT used to have a Safety and Mobility Initiative (SAMI) Program funded through FHWA. When ISTEA / TEA-21 came in, it gave more say so to the MPOs and they seem to concentrate on things which increase tax revenues rather than on transportation infrastructure to increase safety.

They participated in an independent oversight program (IOP) where they evaluated how Section 152 Hazard Elimination money was being spent. From this evaluation it seems like MPOs or RPOs are not using the money for the larger engineering projects, so they did a shot gun effect and put together a program which had a collection of low cost engineering solutions to address human error.

What are some of the engineering solutions undertaken to address driver error?

The solutions include dot tailgating treatments, advanced curve warnings, intersection treatments and rumble strips. They have centerline rumble strips and edgeline rumble strips. No one else is really doing the edgeline rumble strips along the fog line (white line). Also, they have shoulder rumble strips. The Pennsylvania Transportation Institute studied should rumble strips to develop bicycle tolerable strips that are still useful for alerting drivers who are errantly leaving the road while being less aggressive and having a different depth to make them suitable for bicycles too.

Please describe some of the treatments. How does the dot tailgating treatment work?

The DOT tailgating treatment has no electronic component but is a matter of including dots on the pavement. One of the managers went on a trip to Europe and picked up information on chevron markings which are used there to address tailgating problems. They considered implementing that, but thought that it would create problems by making the road surface more slippery. Therefore they decided to go instead for elliptical dots in the center of the traffic lane where the interval between dots depends on traffic speed.

The teach about the 3 second rule but decided to go for a 2 second rule with the dot layout because they thought that the 3 second spacing might put them back too far and cause traffic congestion. In the original installation, they signs told people to place themselves 2 dots apart, but people misinterpreted the sign and tended to place themselves in the wrong spot – 3 dots apart. For that reason they changed the signs to tell people to place themselves 1 space apart (equivalent to 2 dots).

The strategy has been fairly successful. In one district, there was a 60 percent reduction in rear end and tailgating crashes after implementation of the strategy. In other districts, there has been an increase in congestion which can lead to more impatient and aggressive driving and therefore the reverse effect to that desired.

What they found out from their assessments is that in areas where it was not enforced people who were already driving aggressively didn't change their behavior when they entered the dot area. The dot signs are enforceable signs (black and white) so they can be enforced. The system works better when it's supplemented with enforcement to provide incentive for these drivers to cooperate.

How about the intersection treatments and advanced curve warning?

He'll send information on these.

How about the ITS applications?

They have an ITS crash avoidance system which is implemented by the safety division, but other ITS applications are handled by the ITS management division.

Other contacts?

ITS ramp metering is handled by ITS Management Division – speak to Bob Pento 717 783 6265 or Steve Koser (Manager) 717 787 3393. VMS actions are handled by Traffic

Engineering and Operations – speak to Mark Alexander 717 783 6261. Talk to Bob first – he might have enough information on everything.

Can we get more information and images of these programs?

He'll send the guidelines for the dot tailgating treatment, the advanced curve warning system and the intersection treatments. He'll also email images of the dot treatment and intersection treatments early next week.

PENNSYLVANIA

Interview with Bob Pento, ITS Management Division, PENNDOT. Interview conducted by Ria Hutabarat, June 3, 2004.

SHOWCASE PROJECT: Advanced engineering / ITS deployment

What was the impetus for ITS deployment in Pennsylvania?

There are a whole variety of ITS technologies which they're currently using around the state to reduce congestion, improve highway safety and improve incident detection and response.

Primarily the main reason for development and application of ITS was in metropolitan areas to address congestion. For example, electronic Variable Message Signs were implemented to provide up to date traveler information for motorists to reduce congestion. A side benefit that came from this was a reduction in traffic incidents in backed up areas.

After that they started using ITS in rural areas for more safety problems since they don't tend to have such congestion problems. These included cameras, devices, VMS, highway advisor radio to let people know about changed traffic conditions.

What are some examples of ITS deployment for traffic safety purposes?

In some sites, they have automated truck rollover systems. These are implemented on highway ramps with a higher incidence of rollovers due to geometry but where complete reconstruction is cost prohibitive. Since they can't reconstruct the ramp they provide sensors for vehicle speed and weight which is plugged into an algorithm to assess the potential for rollover. When vehicles are approaching this speed, they are flashed a "vehicle slow down" message to warn of rollover danger.

There's one of these in a rural area (outskirts of Harrisburg) and 1 in a more metropolitan area.

So there are a handful of those ITS systems specifically implemented to improve safety.

What about the ice and weather sensors?

Statewide they have a Roadway Weather Information System (RWIS) which they can monitor remotely. This provided information on ambient air temperature, whether the pavement is wet or dry, and the amount of chemical on the pavement. This is then used to help their winter maintenance crew to decide where they need to direct their resalting efforts. They also put the information on the PENNDOT website to provide traveler information, however, this was a secondary benefit of the system.

In addition, there is an automated sprayer system for bridge decks which is tied to weather monitoring on the bridges. In this system nozzleheads every few feet along the span automatically spray Calcium Chloride liquid to anti-ice (prevent icing) the deck when the conditions are approaching icy. This is used in other states and they just imported it and adapted it to their purposes.

Have there been any evaluation of these ITS treatments for safety outcomes?

Some have been evaluated. Most of them have not been evaluated per se but are benchmarked against best practice in other states and adapted for use in Pennsylvania. A number of pilot projects are also underway which are undergoing evaluation. In terms of anecdotal evidence they seem to be effective and there are always technological kinks to work out.

What about the ITS intersection crash avoidance system?

There were 2 or 3 of these designed for construction but only 1 was put in. The system is implemented at unsignalized intersections with limited or obstructed sight distances due to geometric problems. The system detects if there are approaching vehicles from the right or left that are out of vision but are at a close enough distance to cause a potential conflict with vehicles in the intersection. The system then provides advance notice of these approaching vehicles. This system was imported from something similar in Virginia.

What level of inter-agency is involved in implementing these strategies?

Not a lot. Most are installed by regional offices (there are 11 engineering districts in Penn) with guidance from the PennDOT central office.

What interaction is there with enforcement agencies?

In some cases there is police involvement. They like to enter partnerships with police such as sharing video signals with them. That improves safety outcomes. They like to look for those types of opportunities.

Was there any public education as these strategies were implemented?

There was not much public education. Some districts put out press releases, so it depends on the districts which implement the strategies.

TEXAS

Interview with Bill Strawn, Traffic Safety Planner, Texas Department of Transportation. Interview conducted by Ria Hutabarat, June 2, 2004.

EDU 1 SHOWCASE PROJECT: Safety Media Campaigns

When did you start your media campaigns?

We're in our third year of the program with $3 million spent annually on media campaigns. Previously, the state spent $1.5 million of its own money on paid media. After receiving federal funding, the state continues to spend $1.5 million on paid media and uses the federal funds to bolster this campaign.

What do the campaigns include?

Two parts: occupant protection (OP) and alcohol

What was the impetus for the OP work?

OP program is part of our CIOT campaign which was started to provide support to local law enforcement and to get the word out that there would be a greater number of police officers enforcing seat belt rules. The impetus was a combination of the NHTSA push and an internally developed method.

What is the temporal targeting of the campaigns

The CIOT campaign is run around Memorial Day i.e. from May to Mid-June.

What about the alcohol campaign?

A big push for this work was Jacqueline Saburido, a college student from Venezuela who was hit by a drunk driver, burnt and survived. She has become a champion for this issue and the campaign says "Not everyone who gets hit by a drunk driver dies". The message is aimed at youth, with kits going out to high schools. It emphasizes consequences and includes footage from the driver, Reggie Stephey, a young man and local football star who ended up in prison for 7 years, as well as visual images of Jacqui before and after the accident.

The success of the program is in large part due to the personal element. NHTSA doesn't like graphic messages and strongly recommended a more mellow message, but focus testing on the story demonstrated that young people could see what happened to both people and it made the campaign very personal. Focus tests were conducted on people in the age brackets 12-14 years, 14-18 years, 18-21 years and 21-25 years. The girls saw a girl who had had her life destroyed and the boys saw a young man with a promising football career who got drunk and ended up in prison for hitting people.

What were the main target audiences?

Youth and high school age children.

What media were used for these campaigns?

Both radio and TV, although the Jacqui story was more prevalent on TV because the images are so powerful.

A local newspaper did an 18 page story on Jacqui and the traffic safety office asked for this to be reprinted and distributed as material to schools. They reprinted it at cost but gave a cut on the cost.

There are also billboards.

Can we get a sample of materials?

http://www.dot.state.tx.us/trafficsafety/ for CIOT campaigns
http://www.texasdwi.org/ for DWI campaigns and the Jacqui story

Was the outreach to minority communities part of the media campaign.

Yes. Materials were presented in Spanish. The Spanish version is not a direct translation but content is changed to make it culturally appropriate. The context/message is the same i.e. encouraging seat belt use and discouraging drunk driving.

Have you noticed a change in safety outcomes?

Our crash statistics are so far behind that we won't know what the safety outcomes are until after they are upgraded. Texas is currently undertaking a $30 million upgrade on its crash statistics so will assess the effects when it's completed next year.

Improved Driver Training and Testing

The survey response included a suggestion fro more thorough driver training and testing. Where is this suggestion from?

This was a suggestion that came out of a biannual strategic planning meeting between a range of different agencies and the Texas Traffic Safety Office. Other agencies involved include the state Department of Health, the Texas Bicycle Coalition, the Trans Texas Alliance (pedestrian people), the American Automobile Association (AAA), AARP and MADD.

Why is this suggestion politically unpopular?

1) *People don't' like political intervention or interference in their lives*
2) *It would greatly increase the cost of licensing etc.*
3) *People find it insulting that they should be retested or trained after they already know how to drive.*

Texas has just moved to a parent taught driver education system.