White Papers for: *"Toward Zero Deaths: A National Strategy on Highway Safety"*

A Summary of Nine White Papers

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NOTICE

PREFACE

While many highway safety stakeholder organizations have their own strategic highway safety plans, there is not a singular strategy that unites all of these common efforts. The Federal Highway Administration (FHWA) began the dialogue towards creating a national strategic highway safety plan at a workshop in Savannah, Georgia, on September 2-3, 2009. The majority of participants expressed that there should be a highway safety vision to which the nation aspires, even if at that point in the process it was not clear how or when it could be realized. The Savannah group concluded that the elimination of highway deaths is the appropriate goal, as even one death is unacceptable. With this input from over 70 workshop participants and further discussions with the Steering Committee following the workshop, the name of this effort became "Toward Zero Deaths: A National Strategy on Highway Safety." The National Strategy on Highway Safety is to be data-driven and incorporate education, enforcement, engineering, and emergency medical services. It can be used as a guide and framework by safety stakeholder organizations to enhance current national, state, and local safety planning and implementation efforts.

One of the initial efforts in the process for developing a National Strategy on Highway Safety was the preparation of white papers that highlight the key issue areas that should be addressed. Vanasse Hangen Brustlin Inc. (VHB) was awarded a task order under the Office of Safety contract (DTFH61-05-D-00024) to prepare nine white papers on the following topics:

1. Future View of Transportation: Implications for Safety
2. Safety Culture
3. Safer Drivers
4. Safer Vehicles
5. Safer Vulnerable Users
6. Safer Infrastructure
7. Emergency Medical Services
8. Data Systems and Analysis Tools
9. Lessons Learned from Other Countries

These papers were prepared by several experts in the topic areas. Individually, the papers provide a good resource for discussions as the work progresses for developing the National Strategy. To facilitate the integration of the white papers into the process, this summary has been prepared. The summary focuses on the strategies that the experts recommend for their respective areas. The last section of this summary provides the Principal Investigator's opinion as to key strategies that should be pursued in order to realize the goal of reducing fatalities towards zero.

ACKNOWLEDGEMENTS

This summary was prepared by the task order principal investigator, Hugh McGee, with the assistance of Michael Sawyer, both of VHB. In preparing the summary the author has extracted and/or paraphrased sections of the individual white papers; hence the following white paper authors are recognized:

1. Future View of Transportation: Implications for Safety—Alan Pisarski and Forrest Council
2. Safety Culture—Nicholas Ward, Jeff Likenbach, Sarah Keller, and Jay Otto
3. Safer Drivers—Neil Lerner, Jeremiah Singer, and James Jenness
4. Safer Vehicles—Richard Retting and Ron Knipling
5. Safer Vulnerable Users—Charlie Zegeer, Loren Staplin, Fran Bents, Richard Huey, Janet Barlow and William Hunter
6. Safer Infrastructure—Paul Jovanis and Eric Donnell
7. Emergency Medical Services— National Association of State Emergency Medical Services Officials (NASEMSO); Dr. Nadine Levick
8. Data Systems and Analysis Tools—Barbara DeLucia and Geni Bahar
9. Lessons Learned from Other Countries—Ezra Hauer.

INTRODUCTION

Efforts to reduce crashes and the resulting harm have been ongoing for decades with notable success. As shown in Table 1 and in Figure 1, since 1995, vehicles miles of travel have increased steadily until 2007, decreasing slightly in 2008 and 2009. Even given this increasing trend, the number of fatalities per year has stayed somewhat constant between 41,500 and 43,500 from 1995 to 2006, decreased slightly to 41,259 in 2007, and then decreased significantly to 37,261 in 2008 and 33,963 in 2009. Even during 2008 and 2009 when VMT decreased, the percentage decrease in fatalities was much greater. The total number of crashes has also followed a pattern similar to that of the fatalities, decreasing slightly across the years. When the 2008 data (i.e., the latest year that all three indicators were available) are compared to the 1995 data, VMT is 20.8 percent higher, crashes are 13.3% lower, and fatalities are 10.9% lower.

Table 1. Annual counts of fatalities, crashes, and vehicle miles of travel.

Year	Fatalities	Crashes (1,000)	VMT (Billions)
1995	41,817	6,699.4	2,422.7
1996	42,063	6,769.6	2,485.8
1997	42,013	6,624.1	2,561.7
1998	41,501	6,334.6	2,631.5
1999	41,717	6,279.0	2,691.1
2000	41,945	6,393.6	2,746.9
2001	42,196	6,322.9	2,797.3
2002	43,005	6,316.0	2,855.5
2003	42,884	6,328.0	2,890.5
2004	42,836	6,181.0	2,964.8
2005	43,510	6,159.0	2,989.4
2006	42,708	5,973.0	3,014.1
2007	41,259	6,024.0	3,029.8
2008	37,261	5,811.0	2,925.7
2009	33,963	na	2,932.4

na = not available

These data showing that fatalities and crashes have not increased with VMT indicate that safety programs have played an important part in the present level of success. These and other data have demonstrated success in driver programs[1] (e.g., occupant restraint use, DUI programs), roadway treatments (e.g., rumble strips, median barriers) and in vehicle design (e.g., airbags, rollover prevention). Treatments in all three areas have affected both the number and the severity of crashes.

[1] Note that in this document, the terms "safety programs," "treatments," "strategies" and "countermeasures" are used interchangeably to depict safety-related actions implemented to reduce crash fatalities and injuries.

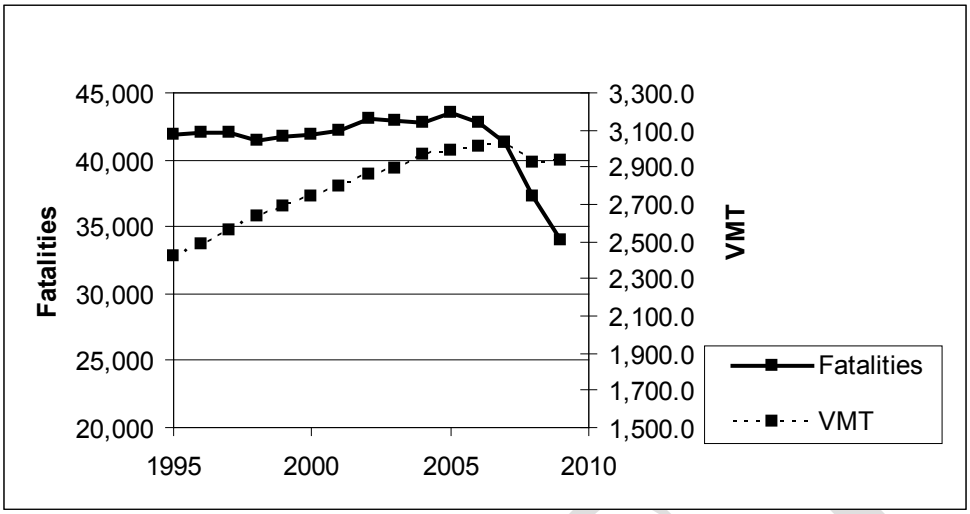

Figure 1. Annual fatalities and vehicle miles of travel (1995-2009).

However, much still remains to be done. Traffic crashes still continue to be the leading cause of death for ages 5-34, the leading cause of unintentional injury death, (i.e., 36% of all injury deaths in 2006), the leading cause of quadriplegia and paraplegia, (i.e., 42% of spinal cord injuries in 2006), the second leading cause of traumatic brain injury (i.e., 20%), and the second to only falls in injury-related emergency department visits. In 2008, before the current economic downturn, we were still seeing approximately 37,000 fatalities, 2.3 million injuries and a societal cost of over $250 billion.

Given the recognition of this problem, many highway safety stakeholder organizations have their own strategic highway safety plans. All States have a Strategic Highway Safety Plan. However, unlike many other developed nations, there is not a singular strategy – a national strategic highway safety plan, that unites all of these common efforts. This is now changing. A national consortium of safety-related organizations[2] has begun the development of a highway safety vision that the nation can aspire to – "Toward Zero Deaths: A National Strategy on Highway Safety." The National Strategy on Highway Safety will be data-driven and incorporate education, enforcement, engineering, and emergency medical services. It can be used as a guide and framework by safety stakeholder organizations to enhance current national, state, and local safety planning and implementation efforts.

One of the initial undertakings of this effort was the development of a series of nine white papers that discuss the key issue areas that may be addressed as part of the process for developing a National Strategy on Highway Safety.

[2] The steering committee includes representatives of the American Association of State Highway and Transportation Officials, American Association of Motor Vehicle Administrators, Commercial Vehicle Safety Alliance, Governors Highway Safety Association, International Association of Chiefs of Police, National Association of County Engineers, National Association of State Emergency Medical Services Officials, Transportation Research Board, Federal Highway Administration, National Highway Traffic Safety Administration, and the Federal Motor Carrier Safety Administration.

The sections that follow provide summaries of the nine white papers, focusing in on the strategies that should be considered in developing the National Strategy. The summary concludes with a listing of the top ten strategies that this summary author believes should be pursued.

FUTURE VIEW OF TRANSPORATION AND SAFETY IMPLICATIONS

The first of the nine papers, prepared by Alan Pisarski and Dr. Forrest Council, looked into the future (15 to 20 years or so) to predict what changes in demographics, licensing and vehicle ownership, travel behavior and activity, and freight growth might have on the level of safety, and specifically, roadway fatalities. This prediction was done assuming no substantial change in the number or type of safety treatments that will be implemented—a "business as usual" scenario. Actual changes in the numbers of fatalities were not predicted; rather general movements towards increases, no change, or possibly even decreases were forecasted.

If crashes, and therefore fatalities, continue to decrease as they have for the past two to three year period, we will reach our Zero Death goal by 2020 or so. However, it is much more likely that as the economy recovers and VMT increases, then crashes and fatalities will once again increase, but hopefully not at the 40,000 plus level, under a "business as usual" scenario. Notwithstanding the recent significant downturn in fatalities in the last few years, none of the expected changes in the above mentioned factors is likely to further reduce the number of fatalities. There are, however, several factors that might increase fatalities and should be of concern as policy, programs, and strategies are devised to move the nation towards zero deaths. These are enumerated in Table 2, which shows for each factor, the expected change, the effect on transportation and then how that relates to possible increases in fatalities.

The authors conclude their paper with the following admonition: If we are to reach or even see significant movement toward a true Zero Death goal, the safety community will need to recognize that travel demand and travelers will be different in the future. Some of these changes could adversely affect highway safety. Therefore, a "business as usual" scenario with respect to current safety initiative will not achieve the Zero Death goal. It will need adequate resources and will need to manage those resources even better than we are today. It will need to identify and implement programs, treatments and countermeasures that produce the largest safety benefit per dollar spent. The remaining papers, which are summarized in this document, focus on identifying the select group of strategies that the respective authors feel will move us towards zero death

Table 2. Predicted Changes in "Non-Safety Treatment Factors" on Safety

Factor	Expected Change	Effect on Transportation	Effect on Safety
Demographics			
Pre labor force (≤18 years old)	Modest (non-immigrant) growth; most growth in 5-13 year olds; very small growth in 16-18. (See "Immigration" below.)	Increase in school and trips to serve 5-13 year olds.	Limited effect. Increases in GDL could result in decreases in fatalities and injuries for 16-18 year olds.
Labor force (18-64 years old)	Much slower growth than today; work force will be younger; more women in work force; more 50-64s will not retire.	Perhaps less growth in VMT; more trips and chain-trips by women; more work driving by 50-64s.	Slow VMT growth may mean less crash injuries; crashes may decrease and be less severe since women have lower crash rate and are less likely to use motorcycles or bicycles.
Post labor force (> 65 years old	Large growth in 65-84 year olds; significant growth in the number continuing to work;	Significant growth in miles driven by both male and female 65+ drivers.	Possible increase in overall crashes if 65+ crash rate per mile is higher; probably increase in raw number of fatalities for this group given "frailty factor."
Household Size	Continuing trend to more households with fewer members	Possible more trips (higher VMT) at lower speeds and with lower vehicle occupancy	Insignificant effect
Immigration Factors	Significant growth in immigration; very volatile levels and patterns	Will increase use of transit, car-pooling, bicycling initially, then auto trips	Increased bicycling could increase fatalities; as auto trips increase, the *possibly* higher crash rate could result in increase in fatalities. Culture factor can be negative factor for crash rates
Licensing and Vehicle Ownership	Continued decreased licensing for 16-17 year olds; increased household vehicle ownership for Hispanics and African-Americans; longer vehicle-fleet replacement cycle.	Decreased VMT for 16-17 year olds; increased VMT for Hispanics and African-Americans; increased time to replace old fleet with new cars.	Decreased 16-17 year old crashes, injuries and fatalities; possible increases in crashes, injuries and fatalities for Hispanics and African-Americans; possible increase in crashes and crash severities with slower influx of new car safety technologies.

Table 2. Predicted Changes in "Non-Safety Treatment Factors" on Safety (cont'd)

Travel Behavior and Activity			
Future economic activity	GDP will increase annually by 2.4% and VMT by 1.7%.	Increase in VMT	Wealthier population with different trip preferences Increase in crashes, injuries and deaths (assuming crash rate "bottom" has been exceeded)
Household spending on transportation	Continued growth at 2007 level or above	Increase in VMT	Increase in crashes, injuries and deaths (assuming crash rate "bottom" has been exceeded)
Long-distance travel	If GDP growth is sustained, a great increase in leisure travel by the older population can be expected	This can add to the amount of travel by the older population on long distance trips	Potential increases in high speed crashes on interstates and NHS facilities with great fatalities
Housing and location preference	Limited success of urbanization will generate some greater pedestrian and bicycling travel; Major trend will be broad suburbanization patterns typically in large metro areas	Increased interactions between vehicles, pedestrians and bicycles; Significant part of VMT increase will be in suburban trips	Increases in fatalities and serious injuries if pedestrian and bicycle crashes increase; crashes could be more or less severe depending on the speeds on suburban roads.
Truck Freight			
Future truck movements	Truck VMT expected to increase approximately the same as overall VMT. Required new drivers could affect overall driver skill level	Increase in truck VMT; increase in less-experienced drivers	Increase in crashes, injuries and deaths (assuming crash rate "bottom" has been exceeded); new drivers could increase actual crash rate per mile resulting in even greater increases.
Highway impacts	Increased truck-related congestion on higher speed roads and in urban delivery locations	Increased interactions between trucks and small vehicles	Increased crashes, perhaps lower severity in delivery areas but higher severity on freeways and other NHS roads.

SAFETY CULTURE

To make significant headway "Towards Zero Deaths," we will need to adopt a safety culture where individual citizens and officials will not accept fatalities from vehicle crashes as a price for mobility. In the second white paper, Professor Nicholas Ward and his associates from the Western Transportation Institute of the Montana State University examine this safety culture construct. They offer a working definition and progress through the concept to offer recommendations for how the U.S. can adopt a culture of safety.

Ward offers a working definition of safety culture based on cultural recognition, which is an important facet of culture that guides and motivates cultural-based behaviors. He defines traffic safety culture, thusly:

> *The perceptions people have about what behaviors are normal in their peer group and their expectations for how that group reacts to violations to these behavioral norms. In terms of traffic safety, this definition applies to behaviors that either increase crash risk (e.g. speeding) or are protective (e.g. wearing seat belts), as well as behaviors related to acceptance or rejection of traffic safety interventions.*

Ward makes the case that the traffic safety culture in the U.S. is lower than that of most other developed countries and has changed little over the decades. And, the lack of a strong safety culture is more prominent in rural areas where there are more incidences of speeding, alcohol involvement, and less frequent use of seat belts. Young drivers are also prone to an anti-safety culture with less concern about the safety consequences of reckless driving. The prevalence of speeding as a risk factor is sometimes used as evidence that our society motivates and condones speeding—hardly an indicator of a safety culture.

Ward provides two examples where safety interventions have impacted culture positively. In the case of seat belt usage by teen drivers and drinking and driving by young adults (21 – 34), social norms marketing campaigns were successful in improving behavior and attitudes towards these risky traits. He argues that it is not enough to expect traditional interventions, in the domains of engineering, enforcement, and education, to bring about desired safety results and that these must be combined with cultural-based interventions that bring about changes in attitudes and perceptions of normative behavior. Such interventions include mass media and interpersonal communication at the individual and community levels.

Ward emphasizes that future improvements in traffic safety must incorporate a new paradigm to support interventions that can change the prevailing traffic safety culture to value safety, motivate safety behaviors, and accept safety policy. A culture that values safety above perceived personal freedoms to do 'what I want' will more readily accept a national policy on the use of helmets for motorcyclists and bicyclists, a primary safety belt use, restrictions on cell phone use, automated enforcement for speeding and red light running, etc.

Transforming the safety culture of the U.S. will be a long-term process that will require a 'change in the public narrative' through discourse and dialogue, led by social and political leaders. Cultural transformation will require the active and consistent involvement of national leaders, including presidents, governors, congressional and state representatives, activists, and nationally know personalities. Our society has come to acknowledge that smoking is harmful and has accepted the limitations imposed upon it; so true to some extent for seat belt use and drinking and driving.

Transforming our safety culture can have a significant cost benefit in terms of fatality cost reduction. Safety culture cannot be associated with a specific type of crash or crash factor; it is presumed to have a general influence on all risk behaviors. Ward shows that even modest assumptions of fatality reductions brought about by a change in safety culture that would accept interventions could reap $28 billion annual savings compared to an estimated $6 billion annual implementation cost—a benefit to cost ratio of 4:1. Thus, he argues, perhaps funding towards developing a safety culture should be given commensurate priority when considering traditional interventions of the 4Es (education, engineering, enforcement, and emergency medical services).

Ward concludes this white paper with the following recommendations to move the discussion and implementation of traffic safety culture strategy forward:

- **Integration of traffic safety culture with public health**, both at the conceptual, but also at the strategic level with alliances formed between the U.S. Department of Transportation, Centers for Disease Control and Prevention, and National Institutes of Health.
- **Develop environment that is conducive to culture change**. This would start with changing the relationship between public and government. For example, the government could provide individual or community based incentives for a history of no fatal crashes. This would then result in the public motivation for safe behaviors and expectations that the government would implement interventions that support them to be safer in order to receive the incentive. The community based approach would also encourage the public to motivate each other to be safe and develop norms that increase the incentive.
- **Identify a federal agency to lead the development and communication of a national traffic safety culture.** This should support changes in the environment including national marking campaigns to raise the significance of the traffic safety problem and the values of a safer and healthier society.
- **Fund one or more national centers to study traffic safety culture and develop strategies for change.** The amount of funding will need to be substantial for the basic research and the cost of implementing culture-based interventions. It would seem rationale to expect that the annual funding in this area would be at the same level as is spent on tobacco advertising in the US.

SAFER DRIVERS

Driver error is the most often cited contributing factor for all crashes, so it stands to reason that strategies to address this element of the causation chain will realize significant reductions in fatalities. Driver behavior experts from WESTAT Inc., led by Dr. Neil Lerner, examined driver behavior issues in crash fatality statistics and derived a set of key strategies.

While there are many ways to categorize driver behavior issues, the ‘big three’ topics have traditionally been speeding, occupant protection, and impairment. Citing studies, it is noted that:

- About three of every ten crash fatalities come from speed-related crashes.
- About half of all fatalities in crashes are unrestrained.
- About one-third of all fatal crashes involve an alcohol-impaired driver.

It is also recognized that there are two groups of drivers that are overrepresented in fatalities: the older drivers, who have diminished driving abilities and are more prone to severe injuries and fatalities, and the novice teen drivers, who are more risky and do not have the driving experience to compensate for such behavior.

Lerner et al. narrowed down their focus areas to the following:

- Increase restraint use
- Reduce speeding.
- Reduce driver distraction
- Increase safety of young drivers.

In doing so, they eliminated driver impairment (alcohol and drugs) because aside from deterrent strategies already in place, the most effective strategy will likely be permanent interlock systems provided as original equipment in passenger vehicles—a strategy discussed under Safer Vehicles. Driver distraction was added because of the growing evidence that distraction caused by cell phone use and other attention-getting devices are significant contributors to fatal accidents. The young driver group was selected, while older drivers were not, because the latter group is handled within the Vulnerable User discussion.

Increase Restraint Use

Safety belt usage has continually increased over the last several years and fatalities with unrestrained vehicle occupants have declined as a result. But while seat belt use has increased, we are still at about 83 percent usage nationwide. Because occupant restraint systems are such an effective fatality reduction countermeasure, even small increments in the percentage of restraint system users can have significant benefits in terms of reducing fatalities. Recognizing continued implementation of tried and proven strategies, such as primary enforcement laws, high-visibility enforcement, increased penalties communications and outreach will pick away at this problem, the authors put forth five initiatives for more innovative strategies that will promote further progress toward the zero deaths goal. They are:

- **Implement effective nighttime enforcement of seat belt usage**—Nighttime use of seat belts is somewhat lower at night and may be the time when it is needed the most, due to higher alcohol use and higher speeding. Nighttime enforcement that requires night vision goggles is problematic from a public acceptance viewpoint (where safety culture takes over). Therefore, it is suggested that this initiative develop more public-friendly ways to implement night vision technology so that enforcement remains effective while public and political resistance is reduced.
- **Enhanced seat belt reminder systems—**Many vehicle manufacturers install 'enhanced' reminder systems as standard equipment, which includes more conspicuous visual or auditory signals, displays for vehicle passengers, more persistent warnings, and feedback that changes in urgency as a function of time, speed or other factors. More aggressive systems include a built-in delay in the ability to shift into gear and the lock out of infotainment features.
- **Detect and alert for unbelted rear seat passengers—**Seat belts provide important occupant protection benefits to rear passengers, and seat belt usage is lower for rear seat occupants than for front seat occupants. This initiative seeks to promote rear occupant

seat belt usage both by including these passengers in primary laws and by devising effective technology for detecting rear passenger presence.

- **Devise teen-oriented vehicle systems—**The crash rate for teen drivers is exceptionally high and teen seat belt use is lower than for the general driving public; about 55% of teen fatalities were unrestrained. Many States have seat belt use as a component of their Graduated Driver License (GDL) law, and this should be expanded to other states. In terms of technology, the use of "smart keys' and other driver recognition technologies make it feasible to determine who is driving a vehicle and adapt aspects of the vehicle system to that driver.
- **Improve system design for child safety seats—**The proper installation and use of child safety seats is difficult for many consumers. The child safety seat 'system' must be better devised for usability.

Reduce Speeding-Related Fatalities

Like other major highway safety issues, the speeding safety problem should be treated with a multidisciplinary approach that includes roadway design and treatments, vehicle design, and the efforts to include driver attitudes and behavior. With respect to the driver, the authors focus on two categorical behavioral countermeasures:

- **Expand use of in-vehicle speed monitoring technologies—**There is great potential to reduce speeding-related crashes using the speed monitoring devices as they exist today, but further refinement of the technology could yield even greater benefits. The refinements should include:
    - Improving the basis for determining the appropriateness of speed.
    - Implementing more assertive speed feedback or interventions.

- **Use automated speed enforcement (ASE) technologies to achieve broad area enforcement—**While ASE programs have generally been successful in reducing speeding at specific locations, greater benefits may be achieved by using methods and technologies that achieve enforcement and deterrence over a broader area. By applying ASE broadly, adherence to speed limits could become the norm.

The authors acknowledge the challenges in implementing these strategies which include privacy concerns.

Reduce Driver Distraction

It has been reported that distracted driving was a factor in 5,870 fatalities in 2008. The driver can be distracted in many ways including the use of personal communication devices, attention to passengers and to GPS devices, reading while driving and other multi-tasking activities. Outside attention-getters such as electronic outdoor billboards can also distract the motorist.

The authors recognize the activities that are already being pursued to address driver distraction crashed including:

- Distracted driving laws and policies
- Technologies for detecting distraction
- Guidance and standards for design of devices and displays

- Public awareness and education.

In addition they offer six promising initiatives that are not widely implemented or adequately refined, but have a good potential to reduce distraction crashes:

- Promote effective enforcement of distracted driving laws
- Foster change in driver attitudes about multitasking risks and responsibilities
- Support technology developers in design of devices, tasks, interfaces
- Target teen drivers
- Develop adaptive driver interface systems
- Develop and implement criteria for design and use of digital outdoor commercial signage

Reduce Fatal Crashes Involving Teen Drivers

Young driver related fatalities (crashes where one driver was aged 15-20 years) have been on a gradual downward trend since 2004, beginning at 8,780 in 2004 and ending at 6,428 in 2008, indicating that some progress was made in the area of young driver safety. But despite the downward trend in fatalities, motor vehicle crashes remain the leading cause of death for teenagers in the U.S.

Various strategies for reducing crashes involving young drivers have been implemented or proposed; they can be grouped into four broad categories:

- Provide learning opportunities and to ensure driving competency.
- Limit exposure to dangerous driving situations.
- Involve parents in promoting safe driving behaviors.
- Reduce impaired and distracted driving.

Each of these strategies has been considered to some extent in the implementation of GDL laws. The white paper discusses these, but then the authors offer four additional initiatives as promising approaches for substantially reducing fatal crashes involving teen drivers:

- Implement and strengthen graduated driver licensing laws and enact primary seatbelt laws
- Promote enforcement of GDL restrictions and community support of GDL
- Encourage high level of parental supervision of teen driving during intermediate stage of GDL
- Promote safer vehicles for teen drivers and use of available vehicle-safety features.

SAFER VEHICLES

While driver error is more frequently cited as the primary contributing factor in crashes, it may be improvement to vehicles—automobiles, trucks, buses, etc.—in the form of improved crashworthiness and advanced safety technologies that might have the most impact on reducing fatalities. A number of important, fundamental vehicle safety improvements are long established, and credited with saving thousands of lives. These include collapsible steering columns, laminated windshields, padded dashboards, and crumple zones to absorb/dissipate

collision forces. The simple safety belt, coupled with the air bag, first frontal and now side curtain air bags, perhaps save more lives and prevent more serious injuries than any other safety devices or treatments. Electronic Stability Control (ESC), which purportedly will eliminate many fatality-producing crashes, is beginning to penetrate the vehicle fleet in large numbers.

Over the next decade, safer vehicles will usher in a new era of highway safety and assist in making the Towards Zero Deaths model a reality in the United States. The future contributions of the motor vehicle manufacturer industry to save lives and prevent injuries will be tremendous. An effective safer vehicle will have improved Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) Communications for Safety capabilities including better communication, control, conspicuity and visibility. Vehicles will naturally improve driver awareness and help to mitigate poor driver behavior. Large trucks will also be safer as truck braking, handling, and stability are improved along with collision warning systems, and Integrated Vehicle-Based Safety Systems (IVBSS). Truck drivers will benefit directly from behavior and alertness monitoring technology as well as collision aggressitivity reductions and better occupant protection.

The following specific design features and technologies have been held up by two experts, Richard Retting and Ronald Knipling, Ph.D., as offering substantial promise or proven worth in saving lives for occupants of passenger vehicles and large trucks. The first section covers high priority technologies that are applicable to both vehicle types. High priority technologies are denoted based upon their potential impact and/or ease of implementation. These technologies are ranked by an estimate of fatality reduction potential. The second section focuses on large truck countermeasures.

High Priority Cross-cutting Strategies

The high priority strategies that apply to both automobile and trucks suggested by the authors are the following:

- **Alcohol Detection & Interlock** – *Nearly 9,000 Annual Deaths prevented* – Approximately one third of all traffic deaths involve a driver with a BAC over 0.08. ADI is an in-vehicle device that prevents the vehicle from starting until the driver provides a BAC test below a set level. Technology reviews are underway to identify promising new techniques to allow it to become a standard feature in all vehicles.
- **Automated Speed Control** – *30-40% Reduction in fatal crashes* – Impact speed and the crash severity outcome are linked as crash energy increases by the square of the impact speed. A Toward Zero Deaths model requires the public to understand that speed is a primary vector in highway deaths. Intelligent Speed Adaptation (ISA) uses satellite and digital mapping to run an in-vehicle speed control system. ISA monitors vehicle speed and the current speed limit and then performs an action when the vehicle is speeding. The action can range from a visual or auditory warning to counter-pressure on the accelerator to a full speed limit governor. A more simplistic, more widespread technology that would provide some benefit, particularly on large trucks, and has the support of the American Trucking Association, is the widespread use of speed governors.
- **Electronic Stability Control** – *33% reduction in fatal crashes; 126-439 annual truck fatalities* – ESC uses automatic computer controlled braking of individual wheels to assist the driver in maintaining control in critical driving situations. A valued technology that

will prevent lane departure crashes. NHTSA is considering an ESC mandate for heavy trucks.

- **Emergency Brake Assist** - *20-40% reduction in fatal crashes* – EBA measures the speed and force of the brake pedal to determine if the driver is attempting to make an emergency stop. When EBA and ABS are used together, the results are faster, safer braking.
- **Daytime Running Lights** – *25% of fatal daytime multi-vehicle crashes*; *28% of day-time pedestrian fatalities* – DRLs provide a constant beam whenever the vehicle is operational to increase conspicuity.
- **Lane Departure Warning System** (IVBSS Initiative) – *10-40% Reduction in fatal lane departure crashes; 250 fatal truck crashes* – LDWS provides audio, visual, and tactile alerts to drivers that are beginning to leave the roadway and function as an in-vehicle rumble strip. Systems with intervention capabilities will either automatically brake or correctively steer.
- **Driver Alertness Monitoring** – *5-10% reduction in fatal crashes; 100 fatal truck crashes* – These systems monitor the performance of the driver by measuring slow eyelid closure, pupil movement, and face orientation. They provide visual, auditory, or haptic alerts if the driver is impaired or inattentive and can even take control of the vehicle and bring it to a stop. Alertness monitoring may replace Electronic Onboard Monitoring which monitors commercial driver Hours-of-Service compliance.
- **Ejection Mitigation** – *5-10% reduction in occupant deaths* – Measures under consideration include side curtain airbags, advanced window glazing, and roof-mounted inflatable tubular structures.
- **Improved Side Impact Protection** – *5-10% reduction in occupant deaths* – More focus and protection is required to protect the far-side occupants in a side impact crash.
- **Forward Collision Warning Systems** (IVBSS Initiative) – *2-3% reduction in fatal crashes; 320 large truck fatalities* – FCWS produce an audible and/or visual alert when the vehicle is too close to another object. FCWS can be combined with Adaptive Cruise Control and tied to automated braking. Truck striking rearend crashes were 14% of serious truck involved crashes.
- **Side-Object Detection Systems** (IVBSS Initiative) – *Estimated 79 truck-involved fatal crashes* – SODS warns drivers of objects located in blind spots on the side of the vehicle. They function as supplements to mirrors to assist in lane changes, particularly to the right where there are large blind areas with trucks. Large trucks and buses have been the primary focus of deployment.

Large Truck Strategies

Combination-unit Trucks (CT) had five times more VMT than Single-unit Trucks (ST). In 2008, CT trucks were 25% of the registered trucks and 74% of the truck-involved fatal crashes. 80 to 90 percent of large truck crashes involve trucks weighing over 26,000 pounds. Truck involved crashes tend to be less frequent, but more severe than passenger vehicle crashes.

The motor carrier industry has a great economic and moral incentive to reduce severe truck involved crashes. Return on Investment (ROI) is perhaps the single most important measure of truck safety because it represents how carriers make decisions on which technologies become widespread. Concerns from the industry about data privacy, security, and litigation over constant monitoring of driver actions and vehicle status must be bridged. Technology vendors should anticipate these concerns and overcome them in their products.

The CT fleet provides an excellent test bed for testing advanced technology to save lives and prevent serious injuries. The operational setting and superior economic prospects found within the industry emphasize the importance of large trucks in the advancement of Safer Vehicles and the Toward Zero Death model. The authors provide the following high priority technological advances to create safer large truck operations in the U.S. High priority technologies are denoted based upon the size of the crash problem and their potential impact and positive cost-benefits have been identified. These technologies are ranked by an estimate of fatality reduction potential.

- **Stronger Brakes** – *227 lives saved* – Loaded CT stopping distances are currently 60 percent greater than passenger vehicles. Improved drum brakes, new disc and disc-drum hybrid brakes are improving stopping distances. Beginning in 2011, NHTSA has mandated a 30% reduction in stopping distances. Air disc brakes have the potential for better stability during hard braking situations.
- **On-Board Monitoring and Recording** – *None cited* – Commercial driving involves performance monitoring and the direct monitoring of driving behaviors. OBSM is the continuous measurement of safety-related driving behaviors such as speed, acceleration, and braking force. It can provide real time hazard warnings as well as post-trip reviews by the operator and their safety manager. OBSM is a carrier safety management initiative and not just a vehicle technology. It has been shown that just providing feedback and carrier expectations to drivers reduces risky behavior by one-third.
- **Additional Large Truck Strategies**
  - **Reduced Aggressivity** – *200 lives saved*
  - **Roll Stability Control** – *106 lives*
  - **Enhanced Occupant Protection** – *100 lives saved*
  - **Video Mirrors** – *50 lives saved*
  - **Tire Pressure Monitors** – *20 lives saved*
  - **Automated Transmissions** – *25% crash reduction for new drivers*
  - **Truck-specific Navigational Aids** – *None cited*
  - **Truck Conspicuity & Enhanced Lighting / Signaling** – *29% crash reduction*

Success of Safer Vehicles Initiative

The ultimate success of the Safer Vehicles initiative will depend on a complex array of technical, regulatory, and market factors. Favorable industry standards, manufacturer preferences, consumer demand, government safety regulations, and economic pressures are all required to see future technology in widespread use in vehicles in the United States over the next decade. Mechanisms need to be created to encourage financial investment in R&D efforts. These could include: low interest loans, tax incentives, financial prizes for major safety achievements etc. Equally important is the sharing of early, reliable technology success stories of real-world crash effectiveness. Multiple methods for compliance with NHTSA safety regulations should be offered to generate flexibility while achieving common goals and to spark creativity in problem solving. Measures also need to be pursued to increase market penetration such as social networking, publicizing results, and offering insurance discounts. Human factors research will be required for the public to be trained and to fully understand automated driving. The research should monitor potential driver behavior changes and ensure warning systems are understood and false positives are minimized. Certification by the USDOT of new technology should help to mitigate the liability issues associated with crash avoidance technology. Automated speed management may be embraced by the public and political realm through social marketing, substantial speeding penalties, context sensitive roadway designs, and automated speed enforcement.

With these factors in mind and facing challenges with a determined spirit, there is considerable opportunity for Safer Vehicles to avoid crashes and achieve the Toward Zero Death model.

SAFER VULNERABLE USERS

A certain group of road users are particularly vulnerable to become a fatality if involved in a vehicle crash including pedestrians, especially those with disabilities, bicyclists, motorcyclists and all of those users who have diminished abilities due to aging. Strategies for addressing these groups were presented in the white paper by a team of experts including Charlie Zegeer (pedestrians), Janet Barlow (pedestrians with disabilities), William Hunter (bicyclists), Frances Bents (motorcyclists) and Loren Stalin (aging road users).

In terms of nationwide fatalities, these vulnerable groups accounts for the following approximate numbers of fatalities:

- Pedestrians—4,800
- Bicyclists—700
- Motorcyclists—5,200
- Drivers 70 or above—5,000.

Collectively, the vulnerable users (including those with disabilities) account for about 15,700 fatalities per year, which is 46% of the total fatalities for 2009. Although there is not good exposure data for pedestrians, bicyclists, motorcyclists, and older age drivers on a nationwide basis, the pure numbers of traffic fatalities for VRU's reflects a serious safety problem for which aggressive and innovative solutions are needed if we wish to move towards zero deaths. Each of these groups will be examined below.

Pedestrian Safety

There are many factors that can affect the risk and/or severity of a pedestrian crash; hence, it is difficult to isolate the key factors that would provide a basis for selecting strategies. Some pedestrian fatality statistics that give some clues are as follows:

- Pedestrian crash trends continue to show greater problems for children and older adult pedestrians. Children under age 15 account for 23 percent of pedestrian crashes. Pedestrians over 70 account for about 16 % of pedestrian deaths (2007).
- Males of all ages account for 70 % of pedestrian deaths.
- Pedestrians are more than 2.3 times more likely to die from a pedestrian crash in rural areas than urban areas, which is attributed in part due to higher speeds and less pedestrian accommodations.
- 77 % of pedestrian fatalities happen at non-intersections.
- Two-thirds of pedestrian fatalities occur at night or under low-light conditions.

Given that the pedestrian safety problem is multi-faceted, it will require a variety of strategies to make a significant impact on the reduction of pedestrian fatalities. The authors identified eight broad strategies that are considered to be most likely to result in a reduction in pedestrian deaths. They are by title:

- Complete and market a revised AASHTO Pedestrian Guide to local and state officials—such guide would embrace the "Complete Streets" approach.
- Further refine the MUTCD to address pedestrian safety problems—several traffic control devices proven to provide increased safety for pedestrians should be adopted within the MUTCD.
- Expend funding and implementation of a national Safe Routes To School program with a national safety education program.
- Develop and implement specific national guidelines for safer bus stop design and placement.
- Promote and advance the use of automated photo enforcement of speeding and red light running.
- Expand pedestrian safety training to engineers, planners and other professionals.
- Improve the reflectorization/conspicuity of pedestrians – to make pedestrians more visible at night.
- Develop and implement pedestrian friendly ITS vehicle and roadway features

Bicyclist Safety

A review of Fatality Analysis Reporting System (FARS) data for 1998-2008 indicates that for those 10 years there has been an average of 717 bicyclist and other cyclist fatalities (includes riders of two-wheel non-motorized vehicles, tricycles, and unicycles powered solely by pedals). Other highlights from the FARS data include:

- The 716 fatalities in 2008 represent 2 percent of all traffic fatalities for that year.
- 12 percent of the pedalcyclists killed in traffic crashes were 5 to 15 years of age.
- 36 percent of the fatalities occurred at intersection locations.
- 91 percent of the bicyclists killed in 2008 were not wearing helmets.

While not a significant portion of the fatality problem, the expected increase in bicycle travel for all trip purposes is likely to increase these numbers. State and local agencies are providing more bicycle lanes within the road right of way, which will increase bicycle traffic and thereby increase the exposure of these users to crashes and resulting injuries and fatalities.

Dr.William Hunter, author of this portion of the Vulnerable User white paper, suggests the following five strategies for reducing fatalities:

- Reduce motor vehicle speed in urban and suburban areas. Reducing the speed differential between motor vehicles and bikes will decrease the probability of a crash and, if one, the likelihood of a fatality.
- Reduce distracted driving by motorists and riding by bicyclists. Both users are culprits in the ever increasing problem of distraction causing crashes. Legislation will be needed to curtail cell phone use and other forms of distraction by motorists and bicyclists.
- Educate motorists about how to share the road with bicyclists. Through driver education, public service announcements and other outreach methods, motorists need to be reminded of being observant of bicyclists and taking due care in various motor vehicle movements.
- Educate bicyclists about how to ride in traffic and use of proper equipment. Included in this recommendation is the use of helmets for bicyclists of all ages.
- Reduce intersection conflicts. With a high percentage of fatal crashes at intersections, there is a variety of countermeasures suggested to minimize the conflicts near and within the intersection.

Aging Road User Safety

As older Americans make up an increasing proportion of those who use our nation's highways, it is clear that meaningful progress toward zero deaths from motor vehicle fatalities will depend significantly upon ensuring safe mobility for this segment of the society, so states Dr. Loren Staplin, who authored this portion of the white paper. The aging road user is singled out because of their over representation in fatalities, which is due to their frailty and reduced driving capabilities, which are not totally compensated for by their reduced driving and higher safety awareness. Data provided by Dr. Loren shows that fatalities for drivers age 70 and above as a percentage of all traffic fatalities have increased in the last three years.

Dr. Staplin is quick to point out that it is not age per se that determines fitness to drive and therefore, chronological age should never be determinative for license renewal. It is in our society's, as well as the individuals', best interest for older people who are fully capable to keep driving as long as they wish.

Dr. Staplin offers five specific recommendations for general strategies:

- Incorporate into national standards such as the MUTCD and the AASHTO Green Book and State-level design manuals highway design and engineering measures proven to assist older drivers and pedestrians.
- Mandate a one-time 'refresher' course for older persons wishing to retain an unrestricted driving license.

- As a condition for every driver's license renewal, without regard to age, individuals should be required to demonstrate minimal levels of visual, mental, and physical capability.
- Immunity from tort liability provided to physicians and other medical and health professionals who report medical conditions that significantly impair driving.
- National system for labeling medications indicating the risk for impairment of driving.

And on a much wider scale, success in moving toward zero deaths among our older citizens will depend upon improving the availability of alternate transportation options that offer this group a replacement for the private automobile.

Motorcyclist Safety

Up until 2009, motorcycle fatalities have increased at higher rate than any other vehicle or driver group, more than doubling in number from 2,294 in 1998 to 5,290 fatalities in 2008. In 2009, the number decreased to 4,762 for reasons that are not entirely evident. But even at this reduced level, motorcycle fatalities account for over 13% of the fatalities, a disproportionate high value since motorcyclists represent only about 3 % of registered motorists. Hence, it is a particularly significant vulnerable user group.

A number of factors have been proposed as potential causes for the rising number of motorcyclist fatalities. Among them, changes in the vehicle and rider populations (bigger motorcycles, greater power/weight ratio, young/older riders, and military veterans) have been hypothesized; however, there has been little research focused on motorcycle crash causation, or on the potential safety benefits of related countermeasures.

As noted by Frances Bents of Westat Inc., an expert in motorcycle safety who authored this section of the white paper, motorcyclists represent a unique facet of the motoring public because they can operate vehicles at high speeds, are integral to the traffic mix on all road types, require specialized driving skills, and are virtually unprotected by their vehicle's design. Consequently, in order to reduce motorcycle fatalities, changes in rider training and behavior, infrastructure design and maintenance, motorcycle conspicuity and driver behavior will need to be considered.

The top strategies for reducing motorcyclist fatalities recommended by Ms Bents are enumerated in Table 3. The table also lists to whom the strategy is aimed, the potential fatality reduction, who bears the cost of the strategy, what the cost involve, and obstacles for implementation.

Table 3. Strategies to reduce motorcyclist fatalities.

STRATEGY	AIMED AT	POTENTIAL FATALITY REDUCTION (% OR #)	WHO BEARS COST	COSTS (IMPLEMENT/ MAINTAIN)	OBSTACLES TO IMPLEMENTATION
Advisory Councils for the Federal and State Governments	Highway design and maintenance agencies	10%	Government agencies and advisors	Labor hours for government agencies. Volunteer time for advisors.	Public and political acceptance of motorcyclist advisors
AASHTO Highway Design Handbook for Motorcyclists	Highway design and maintenance agencies	10%	AASHTO Members	R&D and production costs	Establishing motorcyclist safety as an AASHTO priority
National Motorcycle Helmet Law	Unhelmeted or non-compliant helmeted motorcyclists	20% of Unhelmeted Fatalities	Motorcyclists	Federal legislation, law enforcement initiatives	Consumer resistance
Rider to Driver Communication	All drivers and riders	20% of Vehicle to vehicle collisions	Consumer using Bluetooth technology	Development of standard technology base for inter-operator communication	Added vehicle costs, and time required for fleet penetration
Standard Motorcycle Lighting Displays	All motorcycles and scooters	5% of Vehicle to Vehicle Collisions	Motorcycle manufacturers	Development of lighting standards, and industry retooling	Resistance to standard designs; time needed for fleet penetration
More Rider Training and Certification	All motorcycle riders	10%	Motorcycle riders and/or insurers	Motor vehicle administration tracking and research	Resistance from riders and motor vehicle administrations

SAFER INFRASTRUCTURE

The highway infrastructure is rarely cited as the sole or primary contributing factor in crashes, but when combined with the driver and vehicle, the roadway is cited as a contributing factor in 34 percent of traffic crashes. Treating the approximately 4 million miles of public roads to make them as safe as feasible would require an enormous investment of funds that most likely would never be garnered. Still there are numerous strategies that can be advanced that will cost-effectively reduce fatalities. In this white paper, highway engineering experts, Dr. Paul Jovanis and Dr. Eric Donnell of Pennsylvania State University's Larson Transportation Institute, propose a set of long-term strategies to provide a safer infrastructure.

The following fatality statistics are highlighted that gave guidance as to the strategies needed:

- Speeding related fatalities as a percentage of all fatalities has been near 31% for the last several years.
- Roadway departure crashes represent a large percentage, over 40% in 2008.
- Intersection related fatalities as a percentage of all fatalities have remained at about 18% for the last few years.

The authors recognize that there are many positive initiatives in safer infrastructure currently underway; those mentioned include:

- **Enhanced Analytical Tools for Road Safety Analysis**. These include:
    - NCHRP 500 series of reports on problems and countermeasures
    - Highway Safety Manual
    - Interactive Highway Safety Design Model
    - SafetyAnalyst
- **Strategic Highway Safety Plans.** The adoption of an SHSP by all States has brought focus and direction to a statewide safety program that addresses identified safety problems involving the roadway, vehicle and road user.
- **Transportation Safety Planning**. The recognition that safety needs to be considered from the initial planning stages of a project at the State, regional, and local level that are typically driven by congestion mitigation.
- **Countermeasure Implementation**. There are many roadway infrastructure countermeasures, such as cable median barriers, rumble strips, etc., that have proven to reduce fatalities. These have tended to be spot improvements, and there is evidence of broader benefits from systemic safety investments.
- **Advanced Technology.** The used of advanced computing, communications and sensing technologies cuts across many possible strategies for safety improvement. The authors cite two technology-based efforts that are likely to provide safety benefits in the long run—the SHRP 2 program that will provide a better understanding of crash etiology and

the Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) Communications for Safety programs program that seeks to test and evaluate the ability to use real-time vehicle-to-vehicle and infrastructure-to-vehicle communications to improve travel efficiency and safety.

As noted by the authors there are a myriad of infrastructure-related safety strategies already being deployed to reduce these fatalities. Success stories abound where a specific countermeasure or combinations have reduced crashes and fatalities at specific locations. However, given the vastness of our highway system and the limited funds available, widespread implementation of these measures will likely not be as robust as desired to bring about significant reductions in fatalities. Hence, the authors offer three strategic, long-range strategies to realize fatality reduction in relation to the infrastructure.

1. **Automated enforcement of speed violations**. The high percentage of speeding-related crashes and the success of automated speed enforcement programs in reducing fatalities in other countries, points to the adoption of this strategy as part of a U.S. program. The authors estimate a 20 % reduction in fatalities and serious injuries with widespread use of automated speed enforcement. However, the authors note some significant challenges that need to be addressed and resolved for acceptance of this strategy by the public, namely:

    a. Reliability and accuracy of the equipment to maintain system credibility.
    b. Acceptance by the motoring public that speeding is a serious problem and directly connected to fatalities. The notion that speeding is a right needs to be changed as part of a new safety culture.
    c. Overcoming the perception of a tax through the issuance of fines.
    d. The covert/overt deployment decision needs to be considered given the sometimes violent opposition to the cameras.

2. **Safety Center of Excellence**. It is proposed that FHWA and NHTSA develop regional Safety Centers of Excellence to support rigorous scientific implementation of SHSP and other institutional elements in safety. The Centers would be responsible for working with the States to improve their SHSP and HSIP using state-of-the-art methods. The vision is one of regional subcontractors positioned to provide local support on the ground, but also use electronic media to brief States on how to improve their plans. The authors estimate that the eventual benefit from this strategy to be a 15-20 % reduction in serious crashes per year, primarily through the better selection of sites for treatment and more effective selection of countermeasures.

3. **Application of performance-based design.** Performance-based design is the explicit consideration of safety in establishing design criteria, and the holistic application of tools and processes to evaluate the performance of roadway and roadside design decisions. The goal is to incorporate objective safety metrics in the project development process, rather than implicitly relying on the application of design policies, criteria, or standards. The authors acknowledge that the adoption of performance-based design will require a change in safety culture of transportation organizations both in how they deal with the public and within their own organization. Also, the development of this strategy will require a strategic research effort at an estimated cost of $10 million. However, the

ambitious goal of reducing all fatalities solely attributed to the 'roadway' is the expected benefit by implementing this strategy.

EMERGENCY MEDICAL SERVICES

Emergency Medical Services (EMS), once the newest component of a comprehensive traffic safety management system, continues to be an integrated partner with education, engineering and enforcement. An effective EMS system focuses on transport of an injured person to the right level of care at the right facility within the right time. Once an injury occurs, EMS provides the last opportunity to improve the patient's health outcome. A 25 percent reduction in mortality has been demonstrated when severely injured patients are transported to and treated at an appropriate trauma center. EMS is a complex system comprising of the following components:

- Incident detection including an indication that victims are injured
- Access to 9-1-1 (public safety answering point) and 9-1-1 system capabilities
- Safe EMS response and capacity to care for trauma victims both on scene and during transportation to a medical facility
- Expeditious triage, treatment, and patient transportation standardized through evidence-based guidelines
- Hospital and specialty care facility (e.g., trauma center) infrastructure and proximity

Any improvement to the EMS system that benefits persons injured in traffic crashes will have lasting carryover benefits to patients experiencing other time-sensitive medical emergencies that exceed the goal of reducing death and injury outcomes occurring from motor vehicle crashes. Two background documents, one from Dr. Nadine Levick, MD, MPH and one from the National Association of State EMS Officials (NASEMSO), were synthesized to develop recommendations to improve the EMS System. These papers pointed to the following areas in order to improve EMS systems nationwide:

- **EMS Partners for Highway Safety** – The NHTSA Office of EMS should continue to serve in its longstanding role as a champion for EMS and highway safety by supporting the improvement of EMS systems that benefit persons injured in motor vehicle crashes and those with other health emergencies and by supporting the work of the Federal Interagency Committee on EMS (FICEMS). That effort should be enhanced through additional partnerships with the Federal Highway Administration Office of Safety, NASEMSO, and other external partners. The partnership should be charged with prioritizing and implementing the EMS portion of the Toward Zero Deaths vision.
- **Problem Identification** – There is a need for timely and accurate data in order to develop national EMS strategies for reducing roadway fatalities. Resources should be developed to improve, or expand, and implement the following:
    - States' use of the most recent version of the National Emergency Medical Services Information System (NEMSIS) and submission to the National EMS Database

  - States' use of the National Trauma Data Standards and submission to the National Trauma Data Bank
  - Dynamic linkage of hospital, ambulance, and trauma registry data with crash records, citation, and roadway inventories
  - Identification of rural roadways and population centers where significantly higher rates of motor vehicle related injury occur and that are more than a one hour transport time from Level I and II trauma systems by both air and ground.

- **Evidence-based EMS Practice -** Develop, implement and evaluate regional evidence-based guidelines, standards, and protocols for patient care, equipment, vehicle safety, and systems operation. Guidelines should incorporate the latest state-of-the-practice information and practices from the domestic and international literature in medicine, public health and safety, engineering, and behavioral sciences.
- **Communication** – In order to be effective, a comprehensive network of stakeholders need to be engaged to implement the national strategy. As EMS issues are identified and solutions offered, stakeholders need consistent information and feedback to adopt new and innovative practices.
- **Technology –** Research about and deployment of recent technological advances will assist in identifying the exact location of crashes, determining the correct emergency response configuration to each crash based on likely injury severity, operating safe EMS vehicles, and communicating real-time patient information to receiving hospitals and trauma centers. Resources should be devoted to implement the following:
  - Nationwide Enhanced 9-1-1 and Phase II Compliance
  - Next Generation 9-1-1
  - A single evidence-based urgency algorithm for the Advanced Automatic Collision Notification and future reliable telematics data to indicate need for extrication equipment
  - Telematics data definitions and transmission standards
  - Tele-presence and tele-trauma technology to allow video/audio file exchange with prehospital and interfacility telemedicine applications
- **EMS Fleet / EMS Personnel Safety** – In an ambulance crash, two-thirds of fatalities are outside the ambulance as pedestrians or occupants of other vehicles. EMS personnel and other first responders at crash scenes are naturally exposed to many hazards and need consistent training to prevent injury or death. Resources should be developed to implement and expand the following:
  - Improve the vehicle safety engineering and design standards for ambulances with integrated ambulance-based safety systems and Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) Communications for Safety to see real-time traffic and approaching weather for better route selection and response.
  - Develop and implement contemporary educational programs on safe EMS vehicle operations and scene operating standards
  - Nationwide EMS system standardization of resources and practices through the development, implementation, and evaluation of:

  - Clinical guidelines for utilization of ground and air ambulances for victims of roadway incidents that take into account geography and distance variables
  - National Unified Goal for Traffic Incident Management
  - National EMS Education Standards
  - National EMS Scope of Practice Model
  - Vehicle Extrication Education and Competency Standards
  - National Trauma Triage Protocol Field Triage Decision Scheme
  - Emergency Vehicle Operations Standards

- **Performance Measurement** – In order to continually monitor and improve the EMS System, consistent trauma patient management and trauma system performance indicators should be adopted.
- **Funding / Implementation** – Within the EMS community, many needs go unmet. Numerous critical issues have been identified for which no standards or evidence-based paradigms have been developed as solutions. In order to upgrade America's EMS system, sustainable funding resources are required to implement selected strategies that can be deployed on a nationwide basis to see a marked improvement in getting the person with a time-sensitive medical condition to the right level of care at the right facility within the right time frame, resulting in more lives saved.

DATA SYSTEMS AND ANALYSIS TOOLS

Good data and good tools to analyze the data are the foundation for sound safety decisions. The more important determinants of success for data systems are collecting timely, relevant, accurate, and complete data efficiently, coupled with the ease of integrating and accessing the data for reporting and analysis. One of the tenants to the National Strategy is that it be evidence based, which requires the proper analyses with comprehensive data. Co-authors Barbara Hilger Delucia and Geni Bahar examined the importance and future of data systems and analysis tools and the role of each in working towards zero deaths.

The authors initiate their paper with following vision of data systems and analysis by the year 2020:

> *Imagine the day when a crash occurs, the location is known by its geographic position immediately, the driver, passengers, and other road users are issued an incident number that will allow us to follow up on the impact of the crash using data from other systems, facilitating adjudication, medical care, training, licensing, vehicle use, and other key safety aspects of transportation.*
>
> *Imagine the day when crash data are transmitted from the vehicle, accurately located by GPS to link with roadway and traffic conditions. The event data recorder from the vehicle transfers information about the moments before the crash to a data warehouse or knowledge base of analysts, thereby providing linkage to further data sources for safety analysis.*
>
> *Imagine the day when traffic movements are continuously assessed at real time and these data are analyzed for instant response and prevention of collisions.*

Imagine the day when data systems and analysis tools are available to evaluate the strategies and initiatives discussed in the white papers for the other key areas, as well as, for assessing progress in the implementation of the national strategy for highway safety Toward Zero Deaths and significant decreases in seriously injured persons.

These analyses and the frequent dissemination of their results to experts and decision makers are fundamental to gain continuous support for the advancements and innovations in safety, and develop confidence in strategies for new implementations. These include infrastructure treatments, driver-based vehicle tools, changes in emergency medical services, etc.

Moving effectively *Toward Zero Deaths: A National Strategy in Highway Safety* requires that serious thought be given to the data systems and analysis tools that will be required to measure the efficacy and progress toward achieving that strategy. New data sources, yet unidentified or available, maybe needed to facilitate more effective safety data collection, quality, and completeness. The TZD vision requires: 1) a sound identification of where specific strategies would be effective in bringing the severity of the crashes down, 2) how they are being implemented, 3) whether the performance of these strategies are or not meeting the expected outcome. These need sound data systems and analytical tools. Thus, the determinants of success for data systems are collecting timely, accurate, and complete data efficiently, coupled with the ease of integrating (or linkages) and accessing the data for reporting and analysis; and that the analyses are carried out by means of sound analytical methods. The days of simplistic analyses comparing before- and after- implementation periods and claiming success whenever the number of crashes dropped between these two slices in time is rapidly drawing to a close. The release of the Highway Safety Manual is a signpost on the road to a more scientific approach. It gives practitioners the guidance they need to do a better job of using the available data to make highway safety decisions. To aid in this transition NHTSA, FHWA, AASHTO, TRB, university-based researchers, and state DOTs are all working to develop, release and maintain a series of tools and electronic resources.

Strategies and Initiatives

Three strategies specific to data systems development and management are outlined below:

- **Strategy 1 - Location Strategies**

  Geographic Information Systems (GIS) similarly to the pilot test of this enterprise-wide strategy for location data sharing as described in Tennessee's Information Systems Plan for 2008.

- **Strategy 2 - Linkage Strategies**

  Through the E-9-1-1 enhanced computer-aided dispatch (CAD) system, and next Generation 9-1-1 (NG9-1-1)

- **Strategy 3 - Customer Service Improvements**

Well-trained, effective information systems workforce

Three strategies specific to data analysis are outlined below:

- **Strategy 1: Implement state-of-the-art tools**

Significant resources have been devoted to the development of tools such as HSM, SafetyAnalyst, IHSDM. PLAN4SAFE, etc. Their implementation in the agencies has been slow. Toward Zero Deaths goal requires day-to-day actions and they need to be universally used at all highway agencies. Institutionalization of explicit safety quantification is a must. The sub-strategies to support this strategy are:

Strategy 1.1 Establish Resources, Training, and Outreach

A national effort in the following aspects is necessary; they are:

- Establish a group of highway safety professionals trained in the analytical methods
- Adapt analytical tools for each agency (e.g., calibration of SPFs, data management)
- Provide venues for multi-disciplinary, and multi-departmental peer exchange
- Establish lead agencies` programs
- Establish a media national outreach channel (reaching the general public) to report on the results of the tools and other strategies

Strategy 1.2 Present tools and their requirements; establish agencies' needs to implement the tools; provide resources to implement the tools

While Strategy 1.1 is a critical one to create the momentum, it is absolutely critical to implement the state-of the-art analytical tools at every agency in the nation, We need to understand and resolve the challenges of current implementation of tools such as the *SafetyAnalyst*.

- **Strategy 2 – Expand on methods and application tools**

Three sub-strategies will support the Toward Zero Deaths goal. They are:

Strategy 2.1 Development and inclusion of expected crash analysis within existing and future capacity and other operational analytical tools

The state-of-the-art methods found in the HSM provide the foundation to develop models to integrate safety explicitly in other non-safety tools, such as operational and capacity tools. In addition, the interrelationship of driver performance and behavior with roadway design and traffic conditions, that are some of the anticipated results of SHRP 2, will provide information to develop and expand the models suitable for these non-safety tools.

Strategy 2.2 Development and inclusion of crash costs (government and other real costs) within existing transportation and other cost analysis tools

Strategies toward the Toward Zero Deaths goal will be assessed in many ways, including their benefits in terms of prevented costs of crashes. As of today, there is not a comprehensive warehouse of government and public crash costs in the U.S. The execution of this strategy will assist in getting legislators and decision makers to realize the importance of TDZ goal, especially in times of resource limitations.

Strategy 2.3 Development of climate change models and road safety analytical tools for proactive treatments and driver information systems

Climate change has not been studied to determine how these changes influence the frequency and severity of crashes. In a climate change impact analysis, it is important to separate natural climate variability and climate change signal. Thus, it will be important to collect sufficient data of climatological records and crashes to establish a good understanding of the problem.

The analytical methods and prediction models will enable an intelligent management procedure by advising about travel conditions ahead so that drivers and highway agencies alike will be able to modify their travel plans accordingly.

- **Strategy 3 – Develop and Implement new methods and tools**

Strategies 1 and 2 are set to implement and expand state-of-the-art methods and tools. Strategy 3 supports the critical need for new analytical methods and tools to further support the Toward Zero Deaths goal.

Strategy 3.1 Real-time (ITS) information tools

Analysis tools for real time assessment of traffic operations and intelligent prevention of crashes – with inclusion of road conditions, vehicular movements, weather conditions, and driver conditions (integrates the vehicular information, the traffic assessment, the individual driver's condition) – these will use GPS, GIS and other technologies using pre-crash conditions to provide intelligent information to drivers (supportive of the safety culture's involvement of the public) as well as to the road operations' managers toward the Toward Zero Deaths goal. Similarly to the ITS showcases carried out in past years, a showcase demonstrating the implementation of the new tools would be very helpful to get legislators and decision-makers on board.

Strategy 3.2 Expansion of historical integrated (warehouse) data and analysis tools

Crash, traffic and road data analysis tools for assessment of road networks, critical linkages for the assessment of safety performance on our roads, the identification of sites with promise, and assessment of countermeasures, are included in Strategy 1, as they are fundamental for the implementation of the HSM, *SafetyAnalyst* and other tools. These linkages are now expanded to include other facilities, drivers' and other road users' data, and vehicle elements.

This data warehouse will allow new analysis toward better understanding of causes and contributing crash factors, and the effectiveness of treatments. It is envisioned that the

warehouse will be online and the analytical tools available for all local and non-local safety and transportation analysts toward supporting the actions toward the Toward Zero Deaths goal.

Strategy 3.3 Evaluation Methods to assess pre-defined performance indicators

There is a need to establish an on-going performance measurement system to evaluate the strategies adopted toward Toward Zero Deaths goal. This sub-strategy provides the methods to assess, among others, the following aspects:

- safety and other impacts of the initiatives and strategies
- global impact of safety programs
- implementation progress
- coordination among agencies and departments
- analytical methods sufficiency and application

LESSONS LEARNED FROM OTHER COUNTRIES

In this final paper, Dr. Ezra Hauer, noted international highway safety expert, examines how five European countries developed their safety programs, what successes they achieved, and most importantly, what lessons can be drawn that would guide the development of a National Strategy on Highway Safety for the United States.

First, Dr. Hauer warns us to not assume that there are simple reasons for observed changes in fatalities; not every change in a time series is the result of the most recent intervention. The 'fatality mountain,' as depicted in Figure 2 showing the decrease in fatalities in Holland over time, is found in nearly all the five European countries. It can be attributed to the consequence of constantly rising amount of travel and a constantly declining of risk of fatality per unit of travel. The steady decline in risk is usually attributed to nearly continuous improvements in safer vehicles, better roads, improved EMS, changed social norms, etc. To link effect to a single or a specific group of 'causes' (interventions or measures) may be unrealistic and misdirect our actions. Sivak and Schoettle[3] attrribute the steady decline in fatalities in the U.S. since 2005 to 21 circumstances and explanations including: decreased commuter travel during rush hours and leisure travel on interstates, but more leisure travel on local streets; more side airbags in side crashes; decreased speeds and more or better air bags in frontal crashes, to name a few.

[3] Sivak, M. and Schotettle, B. Toward Understanding the Recent Large Reduction in U.S. Road Fatalities. Report No. UMTRI-2010-12, May 2010.

Figure 2. Traffic Fatalities in Holland since 1950

France

France has experienced a dramatic reduction in fatalities over 40 years, starting with a halving by the year 2000 (to 8,170) and then another almost halving to 4,278 in year 2008. This significant reduction has been attributed to three interventions: 1) a blanket speed limit, 2) compulsory wearing of seatbelts, and 3) major law on drink-driving limits.

Dr. Hauer draws the following lessons to be learned that could be applied to the U.S.:

- **Public support and political will**. The French citizenry and the government embraced a safety culture and took road safety seriously. This seems to have come about after a gestation period during which the population became convinced that road deaths and injuries are a serious health problem and are preventable. This adoption of a safety culture allowed the government to adopt programs such as automated speed enforcement.
- **Timely facts help**. The Road Safety Observatory was set up as part of organizing for serious action in road safety. This organization amasses the data and conducts the analyses that are provided to decision makers. This observation supports the need for a comprehensive safety data base and analysis program to allow for a data-driven safety program.
- **Automated speed enforcement.** France has an extensive system of automated speed enforcement that has purported to account for 75 % of the 30 % decrease in fatalities between 2002 and 2005.
- **Seat belts and helmets**. Both seat belts and helmets for motorcyclists are mandatory in France. These devices are inexpensive and effective countermeasures. Persons who initially buckle-up because to do so is the law will, in time, adopt new safety-focused attitudes towards risk taking.

Sweden

The evolution of Swedish road accident fatalities has the mountain shape mentioned above. Fatalities increased till they reached a peak between 1964 and 1970 at around 1300 deaths/year and declined thereafter to only 397 in 2008.

The root of the renaissance of road safety management throughout Europe is in Sweden and its Vision Zero, which was adopted by the new Minister of Transportation in 1994 and adopted by the Parliament in 1997. It is based on the premise that even if crashes cannot be avoided altogether, one can ensure that they do not lead to death or severe injury. Vision Zero means that eventually no one will be killed or seriously injured within the road traffic system.

Instead of trying to reduce accidents, Vision Zero design strategy is to reduce the injurious energy to which the road user is exposed by following some simple rules. Thus, e.g., that pedestrians should not be exposed to cars exceeding 30 km/h (18.6 mph); that car occupants should not be exposed to right-angle collisions with cars exceeding 50 km/h (31 mph) and head-on collisions with cars moving faster than 70 km/h (43.5 mph).

Vision Zero is a new allocation of responsibility:

- The designers of the system are always ultimately responsible for the design, operations and use of the road transport system and are thereby responsible for the level of safety within the entire system.
- Road users are responsible for following the rules for using the road transport system set by the system designers.
- If road users fail to obey these rules due to a lack of knowledge, acceptance or ability, or if injuries do occur, the system designers are required to take the necessary further steps to counteract people being killed and seriously injured."

The shift is from a 'blame the user' paradigm to *"*the producer is responsible for the safety of the product*"* attitude; from basing road design on an unspecified 'safety factor' to designing and operating roads so that the level of violence that humans can tolerate is not exceeded.

To ensure that the new interim target for 2020 is met the aforementioned management-by-objectives mechanism was put in place It consists of three main elements:

- Cooperation between all parties when drawing up interim targets;
- Use of interim targets and measurable 'Safety Performance Indicators';
- An annual conference to review trends and target achievements.

From Sweden's safety program and their experiences, Dr. Hauer sees the following lessons to be learned.

1. The New Paradigm

Vision Zero and Towards Zero Deaths strive for the same goal of eventually eliminating fatalities and '…neither can be achieved by just chipping away at the fatality mountain with picks and chisels; both require a change in paradigm." However, there is a fundamental difference between Vision Zero and the current North American attitudes to managing road safety. The Swedes (as well as the Norwegians, Dutch, New Zealanders, Australians, World Bank, OECD etc.) say that the transport systems should be designed so that there will be no

fatalities. In those systems, when fatalities occasionally occur, they are viewed as a failure the causes of which need to be remedied. The road transport system, so the Swedes (and the others) say, was not designed to be fatality free. This, they say, is not acceptable any more in their society. Through the workings of politics, their society chose to strive for a road system that is designed and operated so that fatal and incapacitating injuries do not occur.

In North America, in contrast, the guiding principle seems to be one of comparing benefits and costs. Even if we do not do the benefit-cost calculations explicitly, the thinking is that one should invest public money in the same manner in which citizens would elect to spend their own money. You do not spend public money on saving an anonymous life if doing so costs more than what people say (or imply by action) is the Value of a Statistical Life (VSL). Civil servants and politicians place their trust in the ability of economists to come up with a reasonable guidance VSL.

To saves lives one has to pay in money, time and freedom. It must be clear that to adopt TZD as a guiding principle is to abandon the cost-benefit frame of thought. With TZD the customary trade-offs between travel time and chance of injury will not be made. Choices will have to be guided by the primacy of saving life and this primacy will have to rest on a choice made by politicians as representing the will of the public, not by the methods of economists as the interpreters of people's values.

2. How to Deal with Speed

In Vision Zero speed is not just something to be enforced; it is the organizing principle for practice. Thus, where pedestrians cross the road traffic must not move faster than what the pedestrian can usually survive. That is, unless pedestrians can be given their physically separated right of way, traffic must be limited to 30 km/h (18.6 mph). Similarly, where vehicle paths cross at right angles, the speed of conflicting streams must be less than 50 km/h (31 mph). You may build a roundabout with an appropriate deflection angle so that traffic moves at less than 50 km/h (31 mph) or, if not, you have to correspondingly limit the approach speed. Similarly, where vehicles can collide head on the speed must not exceed 70 km/h (43.5 mph); either you build a barrier or you limit the speed.

This kind of attitude to speed does not prevail in North America. And therefore the question is whether it is possible for the U.S. to approach the 'Zero Death' goal without a fundamental change of thinking about speed. Vision Zero and similar national programs are built on the premise that the human body inside a car cannot withstand collisions at the speeds at which cars and roads are now used. It follows that to approach zero death one must either eliminate the possibility of collisions at death-generating speed or reduce the speed.

3. How to Deal with Infrastructure?

According to Vision Zero when the speed exceeds 70 km/h (43.5 mph) oncoming vehicles must be separated by a barrier. This led Sweden to embark an innovative program of road re-design. Thus, e.g., rural two-lane rural roads are being converted to the innovative 2+1 design. Similar innovative upgrades are applied to run-off-the-road accidents, intersections etc. Similarly, considerations motivate the conversion of right-angle intersections with high-speed approaches to roundabouts.

4. TZD and Management by Objectives

Sweden's failure to meet its 2007 target triggered a thorough rethinking. It became obvious that:

- There needs to be a knowledge-based plan of actions designed to meet the target;
- For the actions to be implemented there needs to be buy-in by those who have to implement the required actions;
- One has to specify several measurable indicators or interim targets;
- Change in these indicators need to be monitored;
- Progress towards the interim targets has to be periodically discussed by all involved parties.

The lesson for TZD is obvious. If there is to be a target and a target date then there should exist a plan of actions. That plan of actions has to be prepared on the basis of cost-benefit considerations and it has to be prepared with the participation of those will have to implement it. The actions to be undertaken will have consequences which have to be measurable and have to be periodically measured.

Norway

Norway is comparable in population to Colorado or Alabama and in size to New Mexico. The evolution of Norwegian road accident fatalities over time shows the fatality mountain typical of all developed countries. Since 1970, when there were fatalities, there has been a steady decline to about half (255) in 2008. In recent years, the decline in fatalities is more erratic because the numbers are small and the effect of random variation more pronounced.

The 'success' of achieving the goal of reducing fatalities has not been associated with any specific or group of interventions by Hauer in his white paper, but he does draw two key lessons:

1. **Safety as part of a national transport plan**. In Norway, a national transport plan covering a future period of ten years is adopted by the parliament every four years. The plan for road safety is part of that plan and it is one four overall objectives. In this way, road safety takes it place as a cost of mobility and not as independent or overriding goal.

2. **Setting targets for fatality reductions**. The National Transport Plan sets out overall quantitative safety targets (e.g.*, "reduce by 2020… by at least a third, compared with 2005-2008."*) To achieve these one has to prepare a plan of diverse actions and these, in turn, also require quantified targets. Management by quantitative objectives is well accepted and makes good sense. But there are two pitfalls to be concerned about: 1) how does one decide on the number or percentage reduction , and 2) what if the interim goal is not reached and with that the possible damage to the road safety program. In the final account what matters are the actions that bring about the achievement of indicator targets. These can be selected on the basis of cost-effectiveness considerations and the best present understanding of cause and effect.

Holland

The evolution of the Dutch road accident fatalities over 40 years is similar to other countries already discussed. In 1970 there were 3181 fatalities. The number of fatalities has been cut to less than a quarter (677) in 2008.

The Dutch embarked on defining their vision around the notion of Sustainable Safety. The aim of Sustainable Safety is to leave for future generations an inherently safe road environment. As originally conceived, the sustainably-safe system is based upon three principles: functionality (there are to be only three road types, those that serve through traffic, those that distribute it, and those which serve for access) , homogeneity (there are to be no big speed and mass differences on the road), and predictability (the infrastructure should be "self-explaining" and elicit from the user the required, safe behavior.) In 2005, the sustainable safe vision was updated with two new principles added: 'forgivingness' (creating surroundings that ensure that the consequences of errors remain limited and fostering behavior when road users allow for each other's shortcomings) and 'state awareness' (the ability of users to match their performance capacity to the requirements of the task).

How these principles are translated into a safety program is not discussed by Hauer, but he notes that the system-wide implementation of the plan based on these principles did not materialize, partly because of a pervasive policy of decentralization. While on the national level there is support for sustainable safety, implementation is at the local level and under control of regional governments.

Dr. Hauer uses the experiences of Holland to draw out the following issues and lessons:

1. Political Support

The concept and aims of sustainable safety were coined by scientists. Scientists are good at saying by what means these aims and targets might be reached. The aims themselves, however, are political and require the support of those in power. Policy is made by politicians, not by scientists or research institutes. Inasmuch as the political philosophy of those in power may change every few years, it is difficult to count on the same safety vision to be in place for decades. There may be two lessons in this for the TZD.

One lesson is that to ensure the survival of TZD for the long term one has to have the support of both Democrats and Republicans. Dr. Hauer is quick to note that he is not competent enough to express views on how that is attained. [*Editor's note: The goal of TZD should surely be embraceable by all politicians spanning the spectrum of liberalism to conservatism, but the means of achieving this will likely not. Achieving a TZD National Strategy will require balancing strategies that impose government programs upon the public with the 'freedom' that is intrinsic to American culture.]* However, there is one issue that may merit thought. Both Republican and Democratic administrations seem to have relied on the device of cost-benefit analysis for major regulatory action. The TZD should make the same its kingpin. The cost-benefit framework is adaptable in several ways. First, only actions that reach a certain limiting ratio of benefits to costs are deemed justified. An administration wanting to invest more in safety will require a smaller benefit-cost ratio. Second, there is considerable uncertainty about the Value of Statistical Life and Injury. An administration with more concern about road safety will use larger values. In this way the continued support of all future administrations could be maintained.

2. The Role of Professionals

While high level decisions may be made by politicians and senior civil servants, our transport environment is shaped by urban planners, transportation planners, highway designers, traffic engineers and other professionals. If professionals shape our road safety future in important ways should one not examine how they play this role and think about how it should be played? The decision which professionals make and how these affect our safety future are determined by the training they receive, by the traditions of their professions, and by the tools in their toolbox. In contrast to the unpredictable fortunes and upheavals of politics, professional practices and traditions have a long shelf-life. It follows that to ensure the continuity and effectiveness of TZD the role of the professions should not be overlooked. How is road safety considered in urban planning? How should it be considered? What must urban planners know to take road safety into account? These and similar questions should be asked and answered for transportation planners, highway designers and traffic engineers.

3. How Far Should the Tail Wag the Dog?

The 'sustainability' idea was that we should leave to our children a road system that is 'inherently safe' even if to build it will cost a lot of money. Nowadays in Holland mobility is the dog and road safety is the tail. For the moment the Dutch are not going to spend a lot of money to make their roads inherently safe. A decade or two ago the balance may have been different. One generation's vision is not the dream of the next one.

But the nature of the road system is that its principal features lasts for generations. One can invest a lot now to make it safer for future generations or one can continue to build roads on which too many fatalities will continue to occur with statistical regularity and shift this burden to our grandchildren. Global warming and the environment in general present us with same dilemma and the same question: how much of the burden should this generation face? This question is not answerable by objective and dispassionate economics. Nevertheless, the TZD will have to face the question and may find guidance in the corresponding environmental debate.

4. The Little Orphans

The Dutch embraced mainly the traditional ways to manage road safety. What is perhaps innovative and unique in their panoply of measures is the emphasis on the safety of residential areas; the 30km/h (18.6 mph) areas, calming measures, the co-existence of cars and vulnerable users in the woonerven. In the U.S. residential areas are road safety orphans. Much of what you see did not exist a few decades ago. It has all been built without any thought being given to how future safety of residential areas depends on the choices we make today. There is a lot to be learned from the Dutch attention to the matter and their experience.

5. The Big Orphans

Residential areas are the little safety orphan; the big orphans are the urban areas. In Holland an effort was made to involve all jurisdictions road safety delivery. Perhaps because of the nature of the country and its administrative setup there does not seem to be an urban-rural dichotomy. In the U.S. the road safety eye hovers mainly over rural roads. But fatalities and injuries occur not only on roads for which the States are responsible; a large and growing share of these occurs in urban areas. In this sense there is neglect and imbalance. This

imbalance should worry TZD thinkers. One cannot approach zero if nearly half of the problem will remains largely outside of the purview of TZD. Clearly a TZD management system must find legal, administrative and fiscal ways to strike a balance, to view urban and rural safety as one whole. *[Editor's note: While Dr. Hauer speaks to rural vs. urban, the same conclusion could be applied to State-owned vs. Local-owned, regardless of whether the road facility is rural vs. urban.]*

6. The Role of an Independent Research Institute

The Institute for Road Safety Research (Stichting Wetenschappelijk Onderzoek Verkeersveiligheid SWOV) is an independent research institute funded by grants from the Ministry of Transport and the European Union. SWOV's mission is to promote road safety by means of knowledge from a scientific research program determinded by SWOV itself. However, its functioning in Holland goes beyond creating and disseminating knowledge. The prestige of the institute and the gravitas of its directors seem to carry weight with the Minister and influence what the Ministry does.

There are several road safety research institutes in the U.S.A. They differ from SWOV in that their main funding does not come from grants and therefore their program of research and of knowledge dissemination are not determined internally. They are contractors that compete in bidding on work the purpose and scope of which is determined by others. The U.S. model by which research institutes compete for research projects formulated by the government is not the only way to create and disseminate knowledge; the SWOV is another way. Outwardly the U.S. model may be in line with an ideological commitment to laissez faire competition. In reality, a large part of its attraction is that it gives the source-of-money control over the questions asked and, to some extent, the advice given. Those who will shape the TZD may want to consider the main options; the dependent and the independent research institutes. An independent institute must be funded by grants. [*Editor's note: Given the diversity of research agencies/funders—Federal agencies (e.g. NHTSA, FHWA), 50 State DOTs, private entities (e.g. AAA, IIHS)— the likelihood and desirability of a single national research agency is problematic; however, what should be considered is a unifying safety research program that all parties could participate in and be directed by.]*

The United Kingdom

In the UK, there were 7,771 fatalities in 1970, and by 2008, that was reduced to 2,675.

In April 2009 the Department for Transport published its consultation document that "*seeks views on the vision, targets, and measures for improving road safety in Great Britain for the period beyond 2010*." Till then the UK relied on targets and plans to deliver road safety; there was no 'Vision', no principles, and no guiding ideology. The consultation document breaks with this tradition and proposes to adopt the vision of *"Making Britain's roads the safest in the world"* The yardstick for comparison with other countries is to be the number of road deaths/100,000 population.

In the consultation document the proposed goals for the safety strategy are to reduce:

1. road deaths by at least 33 per cent by 2020 compared to the baseline of the 2004–08 average;

2. the annual total of serious injuries on our roads by 2020 by at least 33 per cent compared to the baseline;
3. the annual total of road deaths and serious injuries to children and young people (aged 0–17) by at least 50 per cent against a baseline of the 2004–08 average by 2020.
4. by at least 50 per cent by 2020 the rate of KSI per km travelled by pedestrians and cyclists, compared with the 2004–08 average.

To reach these targets several actions are mentioned specifically. Thus, on rural two-lane roads with many casualties the current speed limit (of 60 mph) may have to be reduced. Engineering measures are to be used to reduce pedestrian and cyclist deaths and the speed limit in residential and other streets with many pedestrians reduced to 20 mph. To support responsible use of roads various initiatives will continue. Similarly, various measures will be considered to reduce irresponsible road use (drink-driving, failure to wear a seatbelt, careless or dangerous driving, and excessive speed). To monitor progress towards the target to be reached in 2020, thirteen 'Key Performance Indicators' will be used.

The UK was and is a road safety leader. It leads by research and innovation – many practices started in the UK, and it leads by performance – it is amongst the best in road safety no matter what yardstick is used to measure it. All this has been achieved without the fanfare of a 'vision'. It seems to be the result of solid, science and common-sense based work. The following lessons are drawn from their success in safety:

1. Is there something that stands out?

While road safety delivery in the UK is a success story, there is no specific program or countermeasure that is not already being used in the U.S. The lesson is that for TZD to succeed it is not necessary to pull new rabbits out of the road safety delivery hat. Rather, than thinking in terms of breakthroughs (SHRP2), nano-technological wizardry (some FHWA proposals) or place one's hope in inventing novel countermeasures in causation studies, the UK relied on professionalism, and on co-operation between research, civil service and elected representatives.

2. Do we need the TZD vision?

The UK experience shows that road safety can be successfully delivered without having a vision. Perhaps the U.S. is at that point in history where a new start on road safety delivery is needed. On the other hand, perhaps one can achieve substantive reform without invoking a vision the wording of which is bound to be misinterpreted, and the intent of which runs counter to the tradition of spending public money only when benefits exceed costs by a substantial margin.

3. Setting Targets and Monitoring Progress

The setting of numerical targets presents significant challenges. One has to prepare a counterfactual prediction of what would happen with 'business–as-usual' if no new programs and initiatives were implemented, one has to prepare a cost-effective program of initiatives and predict its impact on fatalities and serious injuries, and one has to set up a system for monitoring progress. To do all this is not a trivial undertaking.

4. Between the two Poles.

In the UK, there are the two poles of the transport policy: one stresses the positive role of mobility in productivity and competitiveness, the other report points to the harm mobility does to the environment. The road safety strategy has to fit between these poles. The interest of road safety is better aligned with that of the environment than with that of mobility. This leads to two observation of relevance to the TZD.

First, the outcome of economic analyses of this kind depends on what is used for 'Value of Time' and 'Value of Statistical Death and Injury'. Guidance about these is currently based on estimates produced by econometric method. The scientific community as well as the DOT know that these estimates are all over the place and that the values in use may have the virtue of uniformity but lack the virtue of believability. If the profile of road safety is to be elevated while retaining the benefit-cost frame of reference, the relative values of time and life need re-examination.

Second, better mobility means more and faster travel while the opposite serves the interest of the environment (as well as of national security and foreign policy). This means that TZD allies will be found in the environmental camp.

CLOSURE AND KEY STRATEGIES

The above material has provided a concise summary of the nine white papers. The initial paper provided predictions of changes in demographic and other factors that might affect highway safety under a "business as usual" scenario. The second paper took on the subject of 'safety culture', defined it, described how it is formed, and provide suggestions for improving it in the U.S. The next five papers outlined a series of strategies related to: the driver, vehicle, highway infrastructure, vulnerable users, emergency medical services, and data systems and analysis tools. The last paper examined the safety programs of five European countries, all of whom have been successful in reducing fatalities, and drew lessons learned that might be applicable to the U.S. in developing our National Strategy.

In the last three years there has been a continuing decline in fatalities, which has been attributed to the downturn in the economy (changes in travel patterns, if not outright reductions in miles traveled), safer vehicles and the affect of various driver and roadway safety initiatives from the implementation of the States' Strategic Highway Safety Plans. As forecasted in the Future View white paper, if this trend in declining fatalities continues, theoretically we could reach zero deaths by about 2020. However, as warned by Dr. Hauer, this decline is not likely to continue and is more likely to reverse itself, especially when the economy rebounds to the pre-recession period levels. This being true, the continuation of safety initiatives and programs already in place will not attain the zero death goal we desire.

The authors of the papers were asked to identify new and bold strategies that would make a significant contribution to the reduction of fatalities. From the white papers we see that the safety community pretty well knows what strategies are necessary to reduce fatalities. What is needed is a stronger commitment by the public to accept these strategies and support their implementation through appropriate legislative actions, appropriate government (federal, state and local) interventions, adequate funding for known cost-effective programs, and their own personal commitment to drive safely.

For closure to this summary, we offer the key strategies, drawing from the white papers, that should be pursued to reach our zero death goal. While each strategy is important, they are ranked from least to most effective they could be in reducing fatalities, at least in the writer's opinion.

IMPROVED DATA SYSTEMS AND ANALYSIS TOOLS

The National Strategy on Highway Safety should be developed and guided by evidence of safety problems and strategies that will be effective in achieving the goal of moving towards zero deaths from vehicular crashes. This can only be accomplished when comprehensive data systems and analysis tools are available to: identify timely and accurate data on crashes; identify strategies and countermeasures; and assess the progress in the implementation of the National Strategy. Over the last decade or so significant progress has been made in developing data bases and analysis programs for components of the safety system involving the driver, roadway, vehicle, exposure, injury, citations and adjudication. The vision of having these systems integrated is achievable in the near future with cooperative efforts of the stakeholder agencies that have the means to collect the needed data. Further advancements in analytical tools to identify strategies and evaluate them will provide decision makers with the evidence needed to support and maintain the National Strategy. While this 'overarching' strategy will not in itself reduce fatalities, it will facilitate the continuous updating of the National Strategy-- it is likely to be a dynamic plan changing as needed to respond to changing conditions (i.e. economy, safety culture, etc.) and the successes and failures of strategies.

IMPROVE EMERGENCY MEDICAL SERVICES SYSTEMS PERFORMANCE AND SAFETY

The utilization of efficient, safe and regionalized emergency medical services (EMS) systems has been shown to reduce mortality of severe trauma patients by 25 percent when they are transported to and treated at an appropriate trauma center. The multifaceted nature of EMS systems has many components that increase the odds of survival for a person injured in a motor vehicle crash when the system is appropriately funded and managed. The EMS system includes the recognition of an incident, the notification of a 9-1-1 public safety answering point, the dispatch of trained and well equipped medical personnel, and the safe treatment and transport of an injured patient from the scene of the crash to a receiving facility. The scope of the system reaches far beyond the roadway, and EMS must be integrated with other highway and public safety agencies responding to crashes. First, in any culture of safety, must come the safety of the personnel who can save the lives of others, followed by the identification and implementation of practices proven to reduce death and disability from motor vehicle related incidents.

ADOPT NEW HIGHWAY DESIGN PARADIGM

The application of design and operations standards and guidelines found in Federal, AASHTO, State and other manuals and guides has, for the most part, resulted in a highway system that serves the public well for safe travel especially for the interstate system. However, simply applying the design policies, criteria and standards found in these guides may not optimize safety

for all road users. The safer infrastructure authors call for performance-based design where the safety needs of the all users is explicitly considered. The goal is to incorporate objective safety metrics in the project development process, rather than implicitly relying on the application of design policies, criteria, or standards. Under this design paradigm, the roadway would be designed and operated in the context of the environment and the often competing needs of automobile, truck, motorcycle, bicycle and pedestrian users. With the increasing number of older users, their needs and capabilities are explicitly considered as well.

IMPLEMENT LOW-COST HIGHWAY SAFETY IMPROVEMENTS

There is robust evidence that indicates that low-cost, or at least relatively low cost compared to full reconstruction, highway safety improvements can affect significant fatality reductions. Some notable infrastructure-type safety improvements that have done so include cable median barriers on divided highways, enhanced traffic control devices for curved roads, rumble strips on shoulders for most highway types and on centerlines for two-lane roads, and roundabouts. Improving our aging road system, especially the two-lane rural roads, to desirable design standards is likely not attainable under continuing budget constraints. But the strategic implementation of these and other measures, which have been shown to be cost effective, can play a significant role in realizing zero deaths. The implementation of this strategy will require adequate and dedicated funding and must reach down to local agencies.

INCREASE SAFETY OF YOUNGER DRIVERS

Young driver related fatalities (crashes where one driver was aged 15-20 years) have been on a gradual downward trend since 2004, beginning at 8,780 in 2004 and ending at 6,428 in 2008, indicating that some progress was made in the area of young driver safety. But despite the downward trend in fatalities, motor vehicle crashes remain the leading cause of death for teenagers in the U.S. This strategy makes the top ten list not just because younger drivers are over-represented in fatalities considering age groupings, but also because if we can instill in our 'new' drivers an appreciation of how vulnerable they are due to their inexperience and immature decision making, then they will mature into safe drivers for the many remaining years of their driving life. Programs such as graduated driving licenses have shown to be beneficial and should become commonplace. So too, are restrictions—by laws, in-vehicle devices, and most important parents— placed on teenage driving. The loss of life by drivers of all ages is painful, but more so for the youngest of them.

CURTAIL DISTRACTED DRIVING

According to NHTSA, distracted-related fatalities represented 16 percent of all traffic fatalities in the last two years. Drivers can be distracted in many ways. Sources of driver distraction include things brought into the vehicle, such as a mobile phone; vehicle information components that require monitoring or manipulation such as radio, speedometer, GPS, in-vehicle warning systems, etc; external events, such as a crash scene or outdoor advertising; and even passengers requiring the driver's attention. We can't remove all sources of distraction and we can't force the driver to pay singular attention to the driving task. However, controls can be adopted to limit

distraction by the latest, and perhaps the worst, culprit--the mobile phone, which drivers use for phone conversation and/or text messaging. Laws prohibiting the use of mobile phones, while difficult to enforce, are being adopted in many States; this should be considered by all of them. In-phone and in-vehicle technology is emerging that would prevent the use of mobile phones while driving; they need to be advanced as quickly as possible and, if appropriated required by appropriate legislation.

BUILD SAFER VEHICLES

Safer vehicles can be achieved by designing the vehicles to be more crashworthy and by installing safety-related technologies such as electronic stability control, emergency brake assist, forward and side collision warning systems, etc. The implementation of these strategies will fall mostly to the automotive industry, driven by response to consumer demand and 'willingness to pay' for additional safety; it can be spurred by federal legislation and regulations. Just as the automotive industry sells styling, reliability, and for many models power (think speeding), it can also market safety features including its crashworthiness and in-vehicle safety technology. Infusion of these safety-related design and features usually start with high-end vehicles whose customers can afford to pay for these options. It takes several years for these features to become available in less expensive cars. But as with most new technologies, as more are sold, the unit price drops making them affordable for more customers. If these features are indeed saving lives, than intervention by the government can make the fleet of safer vehicles a reality for the general public. Also, the insurance industry can play a role by providing discounts to their customers who have vehicles that are safer.

INCREASE RESTRAINT USE AND HELMET USAGE FOR MOTORCYCLES

These two strategies are combined here, because they have similar objectives of preventing a fatality for the driver or passenger should there be a crash. While we have made great strides in increasing safety belt usage, there are still many persons dying from crashes because they were not protected by restraint systems. It is reported that one-half of all fatalities were persons who were unrestrained. Nothing less than the adoption of a primary seat belt usage law by all States will bring the nation closer to 100% utilization, which would yield a significant reduction in fatalities. Alternatively, or in addition to, in-vehicle technology that promotes or even requires the use of seat belts by all occupants, will achieve the desired fatality reductions.

The same is true for motorcyclists. A high proportion of motorcyclist-related fatalities involve riders who did not have a safety helmet. Only 20 States and the District of Columbia have a motorcycle helmet law that requires all riders to wear a helmet. The conflict between 'personal freedom' and 'government-imposed safety laws' is most prominent with motorcycle helmet use. Changing the mindset of helmet-less motorcyclist to wear a helmet, will not be easily accomplished, and therefore the adoption of helmet use law by all states is needed.

ELIMINATE NUMBER OF IMPAIRED DRIVERS

Drivers impaired by alcohol and drugs account for about 30% of fatality-inducing crashes. With such a high percentage, it is clear that a reduction, preferably elimination, of this contributing

factor will move us closer to zero deaths. This goal can be accomplished through several strategies identified in the white papers. Foremost among these is changing the public's safety culture such that drivers will realize beforehand that drinking of alcohol and consuming drugs impairs their driving ability, and therefore, they should readily 'hand over the keys'. Realistically, there will be habitual impaired drivers, and therefore we will need enhanced enforcement (more frequent and widespread DUI check points), more severe consequences (penalties and incarceration), and use of "Alcolock" and other technologies to prevent this occurrence.

REDUCE 'SPEEDING'

The advertising slogan "SPEED KILLS" rings true. A fatality results when the kinetic energy of a crash is more than the human body can withstand. The higher the speed of vehicle as it crashes with another vehicle, or into an object, or rollovers, the higher the kinetic energy dissipated. The speed of the vehicle(s) is a major factor in the resulting injury severity to the driver, passenger, and to the pedestrian or bicyclists. In 2008, speeding was a factor in 31 percent of motor vehicle crash deaths, killing 11,674 people. Clearly, if 'speeding,' meaning driving too fast for the conditions and/or over the speed limit, could be reduced, there would be less crashes and less incidence of a resulting fatality. One of the lessons learned from European countries is that an effective speed management program will result in significant fatality reductions. The white paper authors note this as well, and offer several strategies to affect speed reduction; these include:

- **Automated speed enforcement**—The proven effectiveness of this strategy should not be ignored as the National Strategy unfolds. However, its implementation faces many challenges revolving around its acceptance by the American public. The issues of 'personal freedom' and 'it's just a revenue generator' will be prominent in the debate. Therefore, it is paramount that these issues be deflected by: 1) making sure that 'rational' speed limits are set, 2) that the savings in lives are demonstrated, and 3) that an ASE program is being utilized as a safety measure and not for a revenue stream for other municipal programs.
- **Highway design to reduce speed**— Safety engineers are realizing that the use of 'design speed,' with the resulting related design elements, does not necessarily produce a safe road. There are a variety of design strategies—so called "traffic calming" measures--that can affect a speed reduction and still achieve the mobility needs of all users. The application of the principles 'performance-based design', promoted by Jovanis and Donnell, and 'context sensitive design' should result in designs that will foster speeds appropriate to the facility.
- **Automatic speed control**—There are technology options for in-vehicle speed control systems that if implemented could reduce fatalities substantially. Intelligent Speed Adaption (ISA) uses satellite and digital map technology to monitor vehicle speed and the speed limit and can simply give a warning to the driver, increase the accelerator pedal pressure, or actually limit the maximum speed. A less technologically advanced approach involves the use of speed limiters and speed governors, which are already being used in large trucks.

ADOPT NATIONWIDE SAFETY CULTURE

If we are to achieve the goal of 'towards zero deaths,' we will have to improve the safety culture in the U.S. Everyone from citizens to officials at the highest level will have to embrace a culture that rejects the notion that fatalities are an acceptable price for mobility. This doesn't mean the attainment of this goal at any price or loss of all mobility "freedoms." But it does mean that the safety of the road users, motorist and non-motorist alike, is considered as high a priority as mobility. If we do not have a safety culture in the U.S., then we will not be able to implement many of the strategies that were presented by these white papers. As Ward states, " a culture that values safety above perceived personal freedoms to do 'what I want' will more readily accept a national policy on the use of helmets for motorcyclists and bicyclists, a primary safety belt use, restrictions on cell phone use, automated enforcement for speeding and red light running, etc."

Transforming the safety culture of the U.S. will be a long-term process. However, as evidenced by significant reduction in smoking in the U.S, through mass-media campaigns and some government interventions, we can achieve this number one strategy of adopting a traffic safety culture.

We will know that we have achieved a safety culture when:

- Every driver travels at a safe speed reflecting the speed limit that was rationally established.
- Every auto/truck/bus driver and passenger uses their safety belt.
- Every motorcyclist wears a safety helmet.
- Highway officials/designers consider the safety impact for all users in their decisions on design and operation of their highways.
- We have a strong multi-aspect program against DUI.
- Cell phone usage and engaging in other distracting activities while driving are viewed by all as dangerous actions and there are laws in place to restrict.
- Automobile industry incorporates state-of-the-art safety devices and design into their vehicles and advertises these features as important as style and speed.
- Insurance companies would promote and reward (lower premiums) driver safety.
- Legislators at all levels would place the safety of their constituents ahead of worrying about getting re-elected.