Proceedings

Symposium on Effective Highway Accident Countermeasures

IDEAS INTO ACTION • HIGHWAY SAFETY •

Moving America
Into the 21st Century

U.S. Department of Transportation

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SYMPOSIUM ON EFFECTIVE HIGHWAY ACCIDENT COUNTERMEASURES

JUNE 12-14, 1990

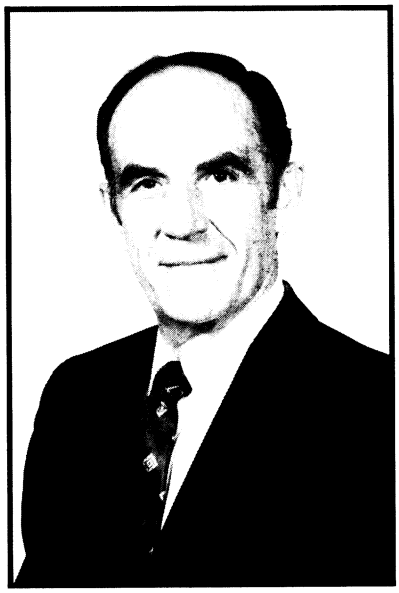
PROCEEDINGS

FEDERAL HIGHWAY ADMINISTRATION

IN COOPERATION WITH

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

AUGUST 1990



MESSAGE FROM THE

FEDERAL HIGHWAY ADMINISTRATOR

It was a tremendous challenge . . . but a challenge well met. The recommendations developed during this Symposium on countermeasures will guide future highway safety in this Nation into the 21st Century.

The Symposium had two prime objectives:

- Identify effective short-term highway accident safety countermeasures; and,
- Develop a strategy for the immediate implementation of the most promising of these measures.

As we all know, nothing is more important to the American people than their personal safety, their individual security, and the security of the Nation. Both President Bush and Secretary Skinner have stressed the importance of safety considerations to the future of the U.S. transportation system.

During this Symposium, safety professionals from across the United States—from Federal, State, and local governments . . . from universities . . . and from many private organizations—demonstrated their commitment to meet the goals set in our National Transportation Policy. That Policy calls for us to "ensure the transportation system supports public safety and national security."

The process that was utilized during this Symposium has paved the way for very effective results. Identification of the relevant accident countermeasures for each major category of concern; development of clear "implementation plans to address those countermeasures; and obstacles that might impede the implementation of effective countermeasures; those were focal points of the process. The output of that process is included in this report.

Safety is the top priority for the Department of Transportation, as it is for those at this Symposium. I am confident that by working together, with dedication and a spirit of cooperation, our efforts will be successful.

Thomas D. Larson
Administrator
Federal Highway Administration

MESSAGE FROM THE

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATOR

This symposium marked an important milestone in our march toward improved safety on our Nation's roads. It's the first time experts from so many disciplines of safety and engineering, from so many parts of the country, have come together to plan. We have long recognized that achieving worthwhile results in preventing highway accidents means working together. This symposium made cooperation possible on a larger scale by giving us a more encompassing point of view.

We have been challenged by President Bush and Secretary Skinner to make traveling in America safer. The work of the safety community during the last decade has already paid handsome dividends. The traffic fatality rate is down by one-third since 1980, and the actual number of fatalities is also lower. Today as never before, the American people are aware of threats to health and safety—and they are calling for ways to reduce those risks. This awareness is very encouraging. An informed and motivated public can give us the support we need to achieve our goals and to carry out the safety aspects of Secretary Skinner's National Transportation Policy.

During the symposium, many talented and knowledgeable people presented their best ideas on effective, practical safety measures that can be put into place in the near term. We are grateful to them for sharing their experience with us and will strive to make good use of their ideas in the years ahead.

Jerry Ralph Curry
Administrator
National Highway Traffic Safety
Administration

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EXECUTIVE SUMMARY

On June 12-14, 1990, the Federal Highway Administration (FHWA), U.S. Department of Transportation, hosted the Symposium on Effective Highway Accident Countermeasures in cooperation with the National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation. Held in Washington, DC, the Symposium took place in response to President Bush's Management by Objectives goal "to improve overall transportation safety and security" and "to reduce the highway death rate by 1992." The Symposium's stated objectives, therefore, were to identify the most effective and practical short-term (within 2 years) countermeasures to highway accidents and to develop strategies for their implementation.

More than 255 participants representing different highway safety fields (engineers, law enforcement officials, educators, researchers, and others) attended the Symposium, which featured an arduous 2½-day agenda (See appendix A). Ronald R. Fiedler, Wisconsin Secretary of Transportation and Governor's Highway Safety Representative, served as moderator. Gene McCormick, Deputy Administrator of FHWA, opened and closed the Symposium. Thomas D. Larson, Administrator of FHWA, and Jeffrey Miller, Deputy Administrator of NHTSA, officially welcomed the group.

The Symposium focused on five areas of highway safety: improving pedestrian safety, reducing accident severity, improving driver performance and control, improving commercial motor vehicle safety, and identifying and improving highway corridors. Participants had opportunities to become familiar with each of these areas via presentations made by experts during the first day's general session and by reading background papers prepared by FHWA and NHTSA personnel (See appendix B). On the afternoon of the first day and again in two sessions on the second day, the participants separated into groups to attend the five concurrent workshops, one for each of the five highway safety areas addressed by the Symposium. At the workshops, the participants identified accident countermeasures relating to their assigned areas, developed implementation plans, and identified any constraints to implementing the countermeasures identified. During the third day's concluding general session, the workshop chairpersons reported on the work completed in the workshops.

Presentations by guest authorities at the second day's general session fostered a spirit of cooperation among the various highway safety organizations and specialized fields. Terence Chorba, M.D., an epidemiologist for the Centers for Disease Control, informed the participants about the public health perspective of injuries due to highway accidents. Gil W. Bellamy, Oregon Governor's Highway Safety Representative, discussed planning and packaging an interagency/interdisciplinary highway safety program. Leonard Levine, Commissioner of the Minnesota Department of Transportation, discussed how to build support for an effective interdisciplinary program.

The following summarizes the presentations and workshop reports for the five areas of highway safety addressed at the Symposium.

MEASURES TO IMPROVE PEDESTRIAN SAFETY

At the general session, the first speaker to introduce pedestrian safety issues was Charles V. Zegeer, P.E., who is the Program Manager of Roadway Studies for the Highway Safety Research Center at the University of North Carolina. Mr. Zegeer focused on the relationship between roadway design and pedestrian safety.

Mr. Zegeer stressed that these measures work best when they are tailored to an individual location and traffic problem. He discussed the following engineering measures as part of a community's "Walk Alert" effort: (1) sidewalk installation, (2) facilities for the disabled and for older adults, (3) bus stop relocation, (4) grade separation of pedestrians from the roadway, (5) physical barriers, (6) lighting, (7) one-way streets, (8) traffic signals, (9) pedestrian signals "WALK"/"DON'T WALK," (10) signs, (11) school zone improvements, (12) safety islands, (13) parking restrictions, and (14) marked crosswalks. In addition, he presented a table that matches specific accident types to potential engineering countermeasures. Mr. Zegeer also suggested pedestrian malls as an ideal solution to the pedestrian safety problem.

Lorraine Novak, Program Manager for the Pennsylvania Department of Transportation (PennDOT) Center for Highway Safety, followed Mr. Zegeer. Ms. Novak contended that the biggest challenge to improving pedestrian safety is convincing the public that it is a serious problem. She emphasized that long-term education thus may be the key to solving the problem. Therefore, PennDOT is implementing a pedestrian safety component as part of its Comprehensive Highway Safety Project. The Highway Safety Coordinators for Pennsylvania's urban counties, where 80 percent of the State's pedestrian accidents occur, are emphasizing pedestrian safety as a priority issue.

Because school children are at greatest risk for pedestrian accidents, a major thrust of the project's pedestrian safety component is to incorporate pedestrian safety into the classroom curriculum. The curriculum uses age-appropriate materials developed, or to be developed, for three age groups: preschoolers through second graders, grades three through six; and ages 12 through 15.

For other age groups, the City of Philadelphia has produced a program called "Street Smart" that is based on the "Walk Alert" program. The "Street Smart" program incorporates several countermeasures including education, enforcement, and intersection modifications to combat pedestrian accidents.

Ms. Novak concluded her remarks by emphasizing the need for comprehensive pedestrian safety programs at both State and national levels.

The workshop, chaired by Cheryl Neverman, identified the following short-term countermeasures to pedestrian accidents, in order of priority:

1. National Awareness Campaign.

2. Designation of pedestrian safety as a national priority area.

3. Engineering improvements.

4. Pedestrian safety education.

5. Conspicuity.

6. Enforcement.

7. Data collection.

8. Improvement of visibility at intersections.

9. Problems of elderly pedestrians.

10. Community outreach.

The workshop participants selected these countermeasures from among lists of high-priority countermeasures developed by several small groups within the workshop. (For a list of the countermeasures developed by the small groups within each of the five workshops, see appendix C.)

The participants also developed implementation plans and possible constraints to those plans for the first eight countermeasures.

MEASURES TO REDUCE ACCIDENT SEVERITY

Mark A. Marek, P.E., Engineer of Geometric Design for the Texas State Department of Highways and Public Transportation, introduced the topic of reducing accident severity. Mr. Marek stressed that consideration of roadside safety must begin in the earliest stages of project planning and continue through project design, construction, and maintenance.

Mr. Marek discussed measures to reduce accident severity associated with vehicles that leave the roadway. These measures include providing a clear recovery area and installing barriers as protective devices. The use of clear recovery areas is limited by the availability of right of way, which is becoming more expensive and more difficult to obtain. However, various types of barriers, both flexible and rigid, can deflect the vehicle from its path off the roadway and thereby prevent a serious accident.

Mr. Marek emphasized that the usable resources for reducing accident severity must be applied in the right locations. Therefore, the ability to identify problem sites must be improved, highway agencies must be given the flexibility to apply their resources to these problem sites, and the design and construction techniques must be cost effective.

Next, Ralph J. Hitchcock, Director of the Office of Crashworthiness Research for NHTSA, outlined NHTSA's Vehicle Safety Programs and how they can help reduce the severity of highway accidents.

NHTSA's safety programs rely heavily on the Accident Data and Analysis Programs and their computerized accident files. These files enable safety officials to compare accident data such as time and location of the crash, weather conditions, type of crash, and extent of the resulting injuries so that countermeasures can be developed.

NHTSA attempts to reduce highway fatalities and injuries in two ways: by preventing crashes and by protecting people when crashes do occur. Crash avoidance programs focus on improving vehicle capabilities to avoid a crash (e.g., by implementing anti-skid technologies). Crashworthiness programs seek to improve vehicle design and performance to ensure greater safety for the occupants. These programs are investigating ways to improve protection in the following types of accidents: frontal crashes, side impact crashes, rollover crashes, and impacts with pedestrians. The increased use of airbags and automatic safety belts is a notable success of crashworthiness programs.

The workshop on measures to reduce accident severity, which James Roberts chaired, identified the following countermeasures, listed in order of priority:

1. Develop a program to upgrade nighttime delineation such as improved markings on curves and delineation of fixed objects.

2. Establish a program to upgrade substandard guardrail.

3. Set up speed surveillance teams for increased enforcement through work zones and high-accident locations.

4. Develop an accident record system that identifies roadside features contributing to accidents.

5. Work with utility companies to relocate utility poles with a history of being hit.

6. Identify and prioritize a list of high-accident locations for corrective action.

7/8. Allocate additional funds for accident countermeasures.

7/8. Provide better shoulder delineation through the use of rumble strips and texturing.

9. Promote additional improvements in vehicles for better crashworthiness and crash avoidance.

10. Initiate a nationwide program to have State/local governments set maintenance condition standards for safety-related items.

The workshop participants developed implementation plans for each countermeasure and considered possible constraints to their implementation.

MEASURES TO IMPROVE DRIVER PERFORMANCE AND CONTROL

Thomas Hicks, Deputy Chief Engineer—Traffic for the Maryland Department of Transportation, introduced the subject of improving driver performance and control. Mr. Hicks maintained that enhancing driver performance and control entails all of the three E's: engineering, enforcement, and education. Each discipline has a significant impact upon the others.

According to Mr. Hicks, the most important concept in highway design is consistency. The potential for accidents is reduced when the driver's expectations are reinforced through the uniform and consistent application of design and control strategies. In addition, new highway projects and rehabilitation work must have design and operational elements that help drivers stay on the road and within their own lanes.

Mr. Hicks concluded by listing suggested measures to improve driver performance and control for the following specific areas: delineation/markings, signing, attention-getting devices, traffic regulations, geometric design/channelization, congestion-alleviating techniques, work-zone traffic controls, traffic signals, incident management, railroad crossings, and lighting.

The second speaker to discuss driver performance and control, James L. Nichols, Ph.D., maintained that human error is the primary contributor to fatal and serious injury crashes. These errors are commonly caused by alcohol, speed, and fatigue. The driver's age is an important factor in these accidents. Young male drivers are most likely to be involved in accidents resulting from alcohol impairment or speeding. However, drivers aged 65 or older also have high crash rates because they have difficulty reacting to the complex traffic flow. Also, these drivers are least likely to wear safety belts, which would prevent serious injury or death.

Dr. Nichols informed the participants about various possible countermeasures to alter driver behavior and alleviate crash severity. General deterrence programs involving enhanced enforcement and aggressive public information campaigns can produce immediate reductions in speed- and alcohol-related fatal crashes. Increased use of occupant protection devices (safety belts, airbags, and motorcycle helmets) can reduce the severity of injuries, and improved emergency medical facilities can save lives. Finally, roadway improvements in marking/delineation, lighting, signing, traffic signals, use of textured surfaces, and guardrails/barriers aid driver performance and control.

The workshop on improving driver performance, chaired by Carlton Robinson, identified nine countermeasures:

1. Upgrade delineation and markings.

2. Use more "active" devices.

3. Upgrade conventional signing.

4. Establish a traffic control device management program.

5. Enhance driver knowledge.

6. Emphasize work-zone safety.

7. Expand the use of textured pavement.

8. Use site-specific overhead lighting.

9. Improve credibility.

The workshop participants developed implementation plans for each countermeasure and identified possible constraints to their implementation.

MEASURES TO IMPROVE COMMERCIAL VEHICLE SAFETY

Mr. Paul R. Henry, Motor Carrier Safety Assistant Program (MCSAP) Coordinator with the Oregon Public Utility Commission and President of the Commercial Vehicle Safety Alliance (CVSA), addressed five topics related to improving commercial vehicle safety.

First, Mr. Henry maintained that more city and county involvement is needed in commercial vehicle safety because of the recent repeal of the commercial zone exemptions. Now that regulations must be enforced within metropolitan areas, cities and counties need to set up safe inspection areas. Second, enhanced training is needed for vehicle safety enforcement personnel as the States' safety programs mature and become more sophisticated. Third, sanctions imposed for violations of safety regulations must be made uniform. Next, the States must incorporate repair verification efforts into their inspection programs. Finally, reauthorization and increased funding for MCSAP is vital to improving commercial vehicle safety.

In a presentation on coordinating efforts to improve commercial motor vehicle safety, Lieutenant Don Uelmen, California Highway Patrol, stressed the importance of communication and cooperation among the agencies involved in traffic safety for an effective, comprehensive program. He described several major programs involving commercial motor vehicle safety, including: on-highway hazardous moving violations; equipment and driver inspections; hazardous materials transportation; weight enforcement; and motor carrier safety reviews. These programs are administered by State and local governments under guidelines established by the Federal government. Also, three agencies of the U.S. Department of Transportation are involved with commercial motor vehicle safety, and separate agencies at the State and local levels often manage commercial motor vehicle programs. This approach has often resulted in confusion.

Lieutenant Uelmen offered suggestions for improving communication by establishing a forum for information exchange and by fixing responsibility for commercial motor vehicle safety efforts. As an example, he listed specific areas of responsibility for Federal, State, and local governments in combating the problem of drivers impaired by fatigue or alcohol and other drugs. In conclusion, he urged that agencies concentrate on shared concerns in a united effort rather than emphasizing traditional differences. These differences have diluted past efforts in commercial motor vehicle safety.

The workshop, chaired by Lt. Colonel James E. Daust, Michigan State Police, identified the following countermeasures, in order of priority:

1. Reauthorize MCSAP.

2. Increase education for the public, motor vehicle drivers, and motor carriers, especially new companies.

3. Enhance the identification of problem carriers and drivers (fully implement SAFETYNET).

4. Ensure uniform and comprehensive accident statistics (adopt the National Governor's Association's accident data elements).

5. Increase motor carrier enforcement.

6. Provide training for non-MCSAP officers.

7. Increase the seriousness of out-of-service order violations.

8. Increase mobile road enforcement.

9. Increase selective enforcement.

10. Increase safe areas and inspection facilities.

The workshop participants developed implementation plans for each countermeasure and identified possible constraints to their implementation.

CORRIDOR IDENTIFICATION AND IMPROVEMENT

John J. Zogby, Deputy Secretary for Safety Administration of PennDOT, addressed the topic of corridor identification and improvement by describing Pennsylvania's Corridor Highway Safety Improvement Program. Arterial corridors are often free-access, high-volume, and high-speed facilities near commercial strip developments. Approximately 50 percent of fatalities and 30 percent of injuries occur on these arterials.

The PennDOT program began with a pilot corridor and was expanded to include 55 Pennsylvania highway corridors. The program uses a comprehensive approach that integrates highway improvement, driver performance, vehicle performance, and emergency medical service initiatives. These four perspectives are used by the multidisciplinary team to evaluate each corridor and identify appropriate corrective measures.

Although this program is still in the early stages of implementation, it is regarded as a successful initiative because of the reductions in accidents. Also, a cooperative interdisciplinary approach has been generated to solve highway safety problems and gain support from community leaders and the media. The State plans to develop measures to evaluate various components of the program. PennDOT will present the program to other States interested in implementing similar initiatives as part of a joint initiative with FHWA and NHTSA.

Mr. Zogby also served as chairman for the workshop on corridor identification and improvement. The workshop participants ranked the following countermeasures in order of priority:

1. Establish a multidisciplinary safety team that would provide coordination, review physical inventory and policies, and recommend improvements.

2. Provide selective enforcement campaigns targeted to speed, impaired drivers, etc., in safety blitzes.

3. Improve delineation of a roadway through vertical and horizontal delineation devices.

4. Develop a constant and consistent public information program that includes media support, educates the public, and keeps the public aware of safety issues.

5. Make minor engineering improvements, such as channelization, access control, and pavement surface corrections.

6. Optimize signal timing and phasing.

7. Create a comprehensive highway safety community campaign that involves a cross-section of public- and private-sector people, including employers and political leaders, to support highway safety initiatives.

8. Within practical limitations, provide a clear roadside program, removing obstructions and fixed objects.

9. Provide signs with clear and visible messages to the motoring public in all environmental conditions.

10. Improve response time and upgrade the capabilities of emergency medical services (EMS) and other emergency services.

After identifying the countermeasures, the participants developed implementation plans for each countermeasure and identified possible constraints to their implementation.

SECTION I

INTRODUCTION

On June 12-14, 1990, the Federal Highway Administration (FHWA), in cooperation with the National Highway Traffic Safety Administration (NHTSA), sponsored the Symposium on Effective Highway Accident Countermeasures. More than 255 experts in the highway safety field—engineers, educators, researchers, enforcement personnel, and others—from Federal and State governments and private sector organizations attended the Symposium in Washington, DC. The Symposium was held in response to President Bush's Management by Objectives goal "to improve overall transportation safety and security" and "to reduce the highway death rate by 1992."

The purpose of the Symposium was twofold: (1) to assemble a team of highway safety experts to identify and reach a consensus on the most effective highway accident countermeasures achievable in the short term (by 1992) and (2) to develop implementation plans for the highest-priority countermeasures. Workshop groups and general session presentations focused on five areas of highway traffic safety, as follows:

- Improving Pedestrian Performance and Environment.
- Reducing Accident Severity.
- Improving Driver Performance and Control.
- Improving Commercial Motor Vehicle Safety.
- Corridor Identification and Improvement.

CONFERENCE STRUCTURE

First Day

Following opening remarks by Gene McCormick, Deputy Administrator of FHWA, and welcoming words from Thomas D. Larson, Administrator of FHWA, and Jeffrey Miller, Deputy Administrator of NHTSA, Ronald Fiedler, Wisconsin Secretary of Transportation and Governor's Highway Safety Representative, took the podium to moderate the Symposium. Mr. Fiedler introduced presentations by experts in the five subject areas above. Speakers identified important issues relating to the highway safety topic area and also identified possible countermeasures for reducing specific problems relating to their topic area. Thus, the presentations provided background information and facilitated the consensus building that took place immediately after this general session, in each of the five workshop sessions.

Each of the five concurrent workshop sessions offered a highly structured environment with the same set of objectives. All workshops were limited to 50 participants and initially divided into small groups of 10 or fewer participants. The workshops' objectives for the first day were to generate as many countermeasures as possible in the small groups and to identify the 10 highest priority countermeasures, first in the small groups, and then for the entire workshop.

Second Day

Participants returned to their workshops to hear the results of the ranking of the 10 highest priority countermeasures and the strategy for developing implementation plans that afternoon. Then, they met in a general session. The first presentation addressed the subject of injury from a public health perspective; the last two presentations focused on developing plans for implementing promising countermeasures. Following these presentations, participants met again in their workshops. There they worked in small groups to develop action plans for implementing their selected countermeasures and discussed constraints to implementation as well as solutions. A representative from each small group presented implementation plans to the workshop, and in the time allotted for each

countermeasure, participants engaged in discussion.

Final Morning

On the final morning of the Symposium, participants met in a general session in which the workshop chairpersons presented the 10 highest priority countermeasures for their workshop and summarized the implementation plans for achieving these countermeasures. The Symposium ended with the closing remarks of Ronald Fiedler and Gene McCormick.

PROCEEDINGS STRUCTURE

This proceedings document summarizes the events of the Symposium. It is divided into two sections. Section I opens with this introduction, and includes summaries of the opening remarks of Messrs. McCormick, Miller, and Larson as well as a presentation by Terence Chorba addressing injury from a public health perspective. In the subsection titled "Planning For Implementation" are two presentations that relate to development of successful implementation plans. Section I ends with the transcripts of concluding addresses delivered by Messrs. Fiedler and McCormick.

Section II is organized in five parts, each related to a topic area:

- Improving Pedestrian Performance and Environment.
- Reducing Accident Severity.
- Improving Driver Performance and Control.
- Improving Commercial Motor Vehicle Safety.
- Corridor Identification and Improvement.

Each contains summaries of speaker presentations that relate to the topic area as well as a workshop report. The workshop report enumerates the highest priority countermeasures selected by workshop participants and describes the action plans developed for implementing them.

Following Section II are five appendixes. Appendix A contains the Symposium agenda. Appendix B holds the background papers for each of the five highway safety topics; these papers were distributed to participants prior to the Symposium. Appendix C contains preliminary lists of the most highly ranked countermeasures developed by the small groups within each workshop. Included in appendix D are the names and addresses of Symposium participants. Appendix E defines the acronyms and abbreviations used in this document. Finally, appendix F contains a chart of metric and English conversion factors.

SYMPOSIUM WELCOME

OPENING REMARKS

Gene McCormick

Deputy Administrator
Federal Highway Administration

Mr. McCormick began the Symposium by noting its primary purpose: to address President Bush's Management by Objectives goal "to improve overall transportation safety and security" and "to reduce the highway death rate by 1992." The plan adopted by Secretary of Transportation Sam Skinner to achieve these objectives contains actions and events by both the Federal Highway Administration (FHWA) and the National Highway Traffic Safety Administration (NHTSA) to improve the safety of the nation's highways. Sponsorship of the Symposium on Effective Highway Accident Countermeasures, Mr. McCormick said, is one of those actions.

Mr. McCormick described the two major objectives of the Symposium: to identify the most practical and effective short-term accident countermeasures that can be implemented within 2 years, and to develop strategies for their implementation. He reminded participants that they were invited to attend the Symposium because they were leaders in the highway safety field, and he urged them to cooperatively develop and implement an effective plan of action to save lives.

Mr. McCormick noted that more than 255 highway safety professionals and practitioners, from a wide range of disciplines, were attending the Symposium. Attendees included representatives from State highway departments, State Governors' Highway Safety organizations, public and private highway safety organizations, legislative bodies, universities and research organizations, enforcement agencies, and various Federal agencies.

Mr. McCormick pointed out the commitment of each person at the Symposium to reducing fatalities and injuries on our streets and highways. Some are experts in one or more areas of highway safety, while others are better able to contribute broader experiences and perspectives to the discussions. The Symposium was designed to encourage participation by everyone, to facilitate free discussion, to reach a consensus on the most effective short-term highway traffic countermeasures, and to develop an implementation plan.

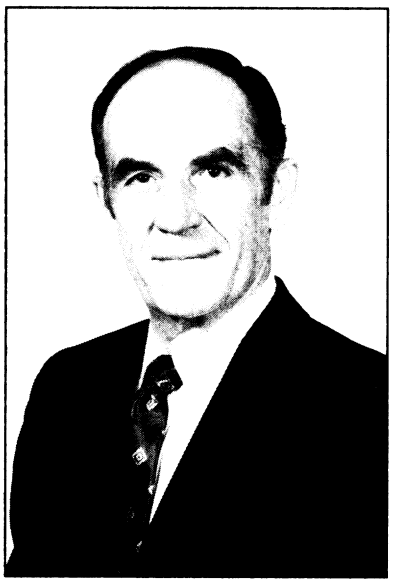
He urged participants to offer their best suggestions, share their knowledge and experience, weigh and evaluate proposals by other participants, and help develop a plan to implement the most promising countermeasures to reduce motor vehicle fatalities and injuries in the near future. He reiterated the goal of the Symposium: to

produce practical, implementable countermeasures that could be carried out with a minimum of delay.

Mr. McCormick then outlined the schedule for the next 2½ days. Participants would attend one of the five special interest area workshops. He noted that each participant had also received issue papers for each of the five topics, which discussed possible driver and roadway-related countermeasures and suggested issues to be examined in the workshop.

In addition, Mr. McCormick asked that general session speakers attend the workshop related to their area of expertise and answer questions raised by participants. He then thanked the speakers and the workshop chairpersons for agreeing to help at the Symposium.

Mr. McCormick noted that the proceedings of the Symposium will be printed and distributed to all participants. The proceedings, he said, would provide guidance for implementation of promising highway safety projects and activities over the next 2 years.



FHWA WELCOME

Thomas D. Larson

Administrator
Federal Highway Administration

After welcoming participants to the Symposium on Effective Highway Accident Countermeasures, Mr. Larson expressed his confidence that many useful ideas would be developed, bringing increased opportunities for interaction among traffic safety practitioners at the Federal, State, and local levels.

Mr. Larson noted that the Department of Transportation (DOT) had spent more than 1 year in developing the National Transportation Policy (NTP) unveiled by President Bush. The policy emphasizes transportation safety as one of its six key themes and DOT's single most important priority. He emphasized that the policy is not an academic exercise, but rather a practical, living document, which defines achievable goals, and is supported fully by Secretary of Transportation Sam Skinner. The Secretary's Safety Summit in Chicago in April 1990 and this Symposium are the direct result of safety principles stated in the NTP.

Mr. Larson stated that the FHWA transportation reauthorization legislative proposals to Congress are driven by the NTP. He then devoted the next part of his presentation to the six major themes in the policy. He gave each of them a highway emphasis, and discussed some of the provisions that will be considered for inclusion in the legislative proposal that corresponds to the themes.

IMPROVING THE NATION'S HIGHWAYS

Mr. Larson stated that if the nation is to have the transportation system it needs, the Federal Government must concentrate more of its resources on facilities and projects that advance the performance of a national transportation network. He pointed out that this objective cannot be realized without some restructuring of the current Federal-aid programs and systems.

Mr. Larson described two proposed programs that are significantly different from the current categories: the National Highway System Program and the Urban/Rural Program. The National Highway System would consist of the current interstate, other rural principal arterials, and facilities on the Defense Department's designated Strategic Highway Network. The system would be selected by the States and approved by the Secretary of Transportation.

The program would replace the current Interstate completion, Interstate 4R, and primary programs. This national system would receive the greatest

attention to ensure that minimum levels of service and performance are provided, including safety standards and criteria.

The proposed Urban/Rural Program would be designed to combine other rural and urban highway assistance, with significantly more flexibility than under current programs and with minimal Federal requirements. It would replace the current minor arterial portion of the primary system, the urban and secondary programs, and the safety construction categories. State and local agencies would have considerable flexibility to address their safety needs as they arise, with minimum categorical restrictions.

Fostering a Sound Financial Base

Mr. Larson noted that FHWA recommends an extension of the Highway Trust Fund, and that it proposes to establish funding levels that allow for spending the Trust Fund balance in a fiscally responsible way over time. Mr. Larson stated that FHWA is determined to find a solution that neither adds to the budget woes nor unnecessarily restrains highway spending.

Keeping the Highway Industry Strong

Mr. Larson commented that the NTP recognizes that the efficiency and competitiveness of transportation providers are essential to economic growth, productivity, and the ability of the United States to compete in the world market. For the legislative proposal, FHWA is considering provisions that would improve safety and productivity and strengthen the competitiveness of the motor carrier industry, such as increasing deregulation.

Environment and Quality of Life

FHWA has long been committed to environmental protection. Mr. Larson stated that in April, FHWA issued a new environmental policy statement. The new statement refers specifically to the reduction of environmental impacts and sets forth numerous policy initiatives to accomplish the agency's overall mitigation goals.

FHWA has already begun an implementation plan to establish strategies and priorities for accomplishing these initiatives and believes that the goals of protecting the environment and improving safety and mobility are compatible.

Advanced Research and Technology

Another important area for consideration is research, science, and technology. Mr. Larson pointed out that the highways of tomorrow can only be safer and more efficient if more advanced technology is incorporated in its construction and operation. Accordingly, FHWA recommends a research and technology program that provides funding to the United States to become a leader in improvements in highway safety and efficiency.

A significant program within this overall thrust is the proposed national Intelligent Vehicle-Highway Systems (IVHS) program. The IVHS technology represents the marriage of the vehicle, the driver, and the highway into a safer, a more effective, and a more efficiently integrated system.

Safety

Safety, emphasized Mr. Larson, must be an important feature of a future surface transportation bill. FHWA is considering three major initiatives. The first initiative is a requirement

for a safety management system to reduce accidents and accident severity as part of the State's overall highway management process.

Details are still being discussed, but such a system might include (1) a program for maintaining and upgrading existing safety hardware and features, (2) a program for identifying, prioritizing, and correcting hazardous roadway situations, and (3) a process for including safety needs and priorities in the development and construction of all highway improvement projects. The ultimate objective is to fully integrate safety decisions in the project development process.

Three Initiatives

FHWA has developed a model highway safety management system good-practice guide in cooperation with a field task group of FHWA safety program engineers. The American Association of State Highway and Transportation Officials (AASHTO) and others are currently commenting on the good-practice guide, which will serve as the basis of discussions for a safety management system in the post-1991 legislation.

The second initiative is a joint FHWA/NHTSA safety incentive program to reduce highway accidents and accident severity by strengthening State driver requirements and performance criteria. A State would be eligible for an incentive grant if it can fulfill traffic safety criteria and requirements in areas such as blood alcohol standards, requirements for use of occupant restraints, and laws or regulations governing suspension of a driver's license for persons convicted of serious traffic offenses.

The third initiative is a new Corridor Rail-Highway Crossing Program. The objectives of this program are to eliminate hazardous rail-highway crossings and improve the safety of both rail and highway traffic in high exposure freight or passenger rail transportation corridors. FHWA and the Federal Railroad Administration will manage the program cooperatively.

Motor Carriers

In addition, stated Mr. Larson, FHWA and NHTSA need to focus more attention on motor carrier safety and the regulation of hazardous materials transportation. FHWA will continue to place a strong emphasis on achieving uniform commercial vehicle safety regulations for both interstate and intrastate truck and bus operations.

Motor carrier safety goals include: full implementation of the commercial drivers' license program nationwide, elimination of alcohol and drug use by drivers, and increased roadside inspections and motor carrier reviews.

1992 AND BEYOND

Mr. Larson commented that the agenda for 1992 and beyond would be challenging. Pointing out that new statistics indicate rapidly increasing use of automobiles, Mr. Larson emphasized that the highway safety community cannot afford to wait. He called on participants to use anything that works immediately, or, if a countermeasure looks promising, to try it.

In this vein, noted Mr. Larson, FHWA and NHTSA are cooperating to give special emphasis and funding support to demonstrate some promising State and local programs involving pedestrian safety, traffic law compliance, and comprehensive highway corridor safety improvements. These joint efforts will include such activities as speed, alcohol, and drug enforcement, as well as safety construction and traffic operational improvements. FHWA looks forward to the participants' involvement and support in these shorter term special interest areas.

After reiterating the Symposium objectives, Mr. Larson concluded by stating that, following the Symposium, FHWA and NHTSA plan to launch cooperative short-range programs to attack those causative factors most susceptible to immediate roadway, driver, and vehicle improvements.

NHTSA WELCOME

Jeffrey Miller

Deputy Administrator
National Highway Traffic Safety Administration

Mr. Miller commented that the Symposium, which brought together highway and safety experts from FHWA, NHTSA, States, and the private sector, reflects the commitment of Administrators Larson and Curry, who said they would work for closer cooperation between FHWA and NHTSA—and meant it. He noted that the two agencies were working more closely with one another today than during any time in recent memory.

He also mentioned that the importance of highway safety in the 1990's had been highlighted in President Bush's Management by Objectives, and in Secretary Skinner's NTP document. Those high-level endorsements were also a valuable reminder that safety issues extend beyond just NHTSA; other Federal agencies, many State and local agencies, and private organizations have a stake in the highway safety issue and can play an important role in providing solutions.

He explained that those attending the Symposium need not become experts in one another's fields; however, they *do* need to become better aware of the issues, programs, and emerging developments in disciplines other than their own. He continued that such exchange must also take place at the State and local levels—between State departments of transportation and highway patrols, between traffic engineers and police departments—at the regional level—between FHWA and NHTSA field operations, and, of course, at the Federal level—between FHWA and NHTSA headquarters.

Mr. Miller also encouraged participants, as they learned more about other program areas at the Symposium, to think about how the issues interrelate. He then posed two specific questions as examples of the kind of thinking he was hoping participants would do: How can highway signing help support speed limit and safety belt-use programs? How can better data assist traffic engineers and police agencies? He then stated that DOT's highway reauthorization proposal later this year would seek to encourage that type of interaction and to provide necessary resources for FHWA, NHTSA, and the States. He noted that the most valuable type of progress will come from individuals' commitments to learn and interact with their colleagues in allied fields.

Next, Mr. Miller reviewed the purpose of the Symposium: to identify promising short-term countermeasures to reduce highway deaths and injuries. He also mentioned that NHTSA had already identified three priorities in its program areas toward that goal: vehicles, impaired driving, and occupant protection. NHTSA has

laid out these priorities in a 3-year plan, which Mr. Miller briefly reviewed.

VEHICLES

The first area Mr. Miller mentioned was vehicle improvements, which is not a short-range countermeasure. He cited these priorities: upgrading side-impact protection for passenger cars, extending all passenger car standards (including automatic safety belts and airbags) to light trucks and vans, and completing field tests of anti-lock brakes on heavy trucks.

IMPAIRED DRIVING

Mr. Miller noted that impaired driving (alcohol and other drugs) is still the number one cause of death on highways, despite the progress of 1980's. He cited these priorities: increasing the number of States with administrative license suspension laws, expanding the use of sobriety checkpoints, improving training for police (including "drug recognition"), and focusing on underage offenders, who are still over-represented in alcohol-related crashes.

OCCUPANT PROTECTION

Calling occupant protection another area of great opportunity for improved safety, Mr. Miller cited these priorities: continuing public information programs, such as the "Vince & Larry" public service announcements (PSA's), increasing the number of State safety belt laws (currently, 36 States plus the District of Columbia have safety belt laws), improving enforcement of safety belt laws and increasing usage among police themselves, increasing the correct use of child safety seats, promoting safety belt use through the workplace (Occupational Safety and Health Administration plans on-the-job safety belt use rule), and giving special recognition to those groups that exceed the 70 percent national goal of safety belt use.

OTHER TRAFFIC SAFETY INITIATIVES

Other priority actions include encouraging more States to enact motorcycle helmet use laws, placing greater emphasis on speed compliance (with *all* limits, not just focusing on rural interstates), and developing new approaches to improve pedestrian safety (e.g., new NHTSA/FHWA joint demonstration grants).

Mr. Miller closed by asking the participants to encourage each other to listen to their colleagues, learn about new ideas and different programs (especially those outside their own area), and learn where resources are located that will enable them to put the good ideas to work.

Injury From A Public Health Perspective

Injury From A Public Health Perspective

Terence L. Chorba, M.D., M.P.H.

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The Epidemiologic Approach to Injury

The Centers for Disease Control (CDC) is known for its work in epidemiology. Epidemiology is defined as the study of the distribution and determinants of disease in populations. So how is it that CDC is concerned with injuries? In our socially constructed reality, we usually do not think of injury as a disease. However, if one thinks of health as the absence of disease or injury, and of the mission of the public health community as the lessening of suffering and death, then it is easier to understand why CDC is involved in the study and prevention of injury.

In the last century, when the study of disease patterns was limited principally to infectious diseases, an epidemiologic model of disease evolved that consisted of three components: a host, an agent, and the environment.[1,2] Most infectious diseases usually have a single necessary cause (i.e., a specific agent); however, for most infectious diseases, presence of the agent is not necessarily sufficient to result in disease. For example, previous history of exposure to the influenza virus may play an important role in determining whether a person actually gets the flu upon coming into contact with someone who has influenza.

Injury is defined as physical damage due to the transfer of energy (such as kinetic, thermal, chemical, or electrical energy, or ionizing radiation), or to the absence of essential agents (such as oxygen or heat).[3] Just as epidemiologists analyze outbreaks of disease by studying who got sick and by determining what agent caused the outbreak and in what context the diseased persons were exposed, members of the public health community have begun to study patterns of injury.

In 1970, Dr. William Haddon, Jr., an internist who became the first administrator of the National Highway Traffic Safety Administration (NHTSA), developed a matrix model for looking at three factors—the host, the agent, and the environment—according to a process of phases occurring over time—pre-event, event, and post-event.[4,5] Haddon's goal was to provide a conceptual framework for studying the injury process in the interest of developing possible countermeasures for preventing injury. Over the past four decades, various countermeasures for reducing the likelihood of automotive injury have evolved in the motor vehicle arena. These

countermeasures concern public awareness and behavior change, legal proscriptions, and improvements in vehicle and equipment design, roadways, emergency medical systems, acute--care technologies, and rehabilitation programs. Each of these countermeasures can be assigned to a given cell or cells of the Haddon matrix.

THE SOCIETAL BURDEN OF INJURY

Each year, one in four U.S. residents seeks some form of medical care for injuries, and 2.3 million persons are hospitalized as a result of injury.[6] In this century, the number of deaths per 100,000 population, that is, the injury death rate, has remained relatively constant, whereas deaths from other diseases have declined markedly.[3] In the United States, injury is the fourth leading cause of death, after heart disease, cancer, and stroke—but it is the leading cause of death for persons under 45 years of age.[3] Unintentional injury alone is the greatest contributor to years of potential life lost before 65 years of age.

Of the 143,000 injury-related deaths that occur in the United States in a year, about one-third are due to homicide and suicide, one-third are motor-vehicle related, and one-third are due to other unintentional circumstances.[7] Most suicides and homicides involve firearms. Firearms are the second leading cause of injury mortality, next to the motor vehicle.

Deaths due to injury are not randomly distributed in the population, but rather have demographic and geographic patterns that merit the attention of our whole society. Homicide exemplifies the nonrandom nature of injury patterns with which we are all familiar; homicide is the leading cause of death for black males 15 to 34 years of age, and, at current rates, will cause the death of 1 black male in every 28 born. As another example, if one estimates the number of years of life expectancy remaining at the age of death and then examines the distribution of life years lost to injury by age, one sees that 82 percent of the life-years lost are lost by persons younger than 45.

Injury-related deaths represent a small part of the public health problem. For every death due to injuries, there are about 16 injuries serious enough to warrant hospital admission and almost 400 more that require some form of medical attention.[3] Whereas falls are the greatest single contributor to injury-related hospitalizations, motor vehicles and firearms are the leading contributors to injury-related fatalities, accounting for about 80,000 U.S. deaths per year.[3] Other major contributors to injury-related morbidity and mortality include poisonings, fires and burns, and drownings.

ECONOMIC CONSIDERATIONS

Economic outcomes reflect the impact of countermeasures in monetary units. Unfortunately, economic outcomes are difficult to measure. Data for direct costs are not as accurate, as complete, or even as available as data are on numbers of injuries or fatalities. Economic evaluation also must take into account costs of countermeasures and indirect cost estimates that depend heavily on assumptions. Two approaches to determining the indirect cost of injury are commonly used: the "human-capital" approach and the "willingness-to-pay" approach.[8]

In the "human-capital" approach, persons are viewed as potentially producing services or garnering wages of a certain monetary value. Unfortunately, this approach has an inherent flaw in that people without earnings (e.g., older persons) are usually assigned little, if any, value.[9] "Human-capital" cost estimates also lack humanitarian appeal, because they do not take into account pain and suffering or the nonmonetary value of life. However, they are useful to policymakers, planners, legislators, and policy-minded economists who must be concerned with tangible monetary costs. Quantifying the value of pain and suffering (from an injury) and annoyance and inconvenience (from safety belt use)

and then factoring them into the safety belt equation is difficult. Whereas the costs of inconvenience and discomfort may diminish as vehicle occupants become more accustomed to using safety belts, such costs nonetheless apparently play a significant role in the nonuse of manual belts.

Alternatives to "human-capital" approaches are "willingness-to-pay" analyses.[8,10,11] These employ a break-even approach to determine the extent to which people value convenience and comfort and thereby evaluate the social desirability or undesirability of a countermeasure. This approach incorporates both labor and nonlabor considerations, including the value of pain, suffering, and lost leisure.

NHTSA and CDC recently sponsored a study of the Cost of Injury by Dorothy Rice, Ellen J. MacKenzie & Associates.[6] This study estimated that for the 57 million Americans injured in 1985, the cost was $157.6 billion, or almost $2,800 per injured person. Direct expenditures for hospital and nursing home care, physicians' services, drugs, and other medical rehabilitation services totalled $45 billion (29 percent); morbidity costs or disability resulting from injury was $65 billion (41 percent); and losses resulting from premature injury fatalities amounted to $48 billion (30 percent) at a 6 percent discount rate. For 1988, the total economic cost of injury was estimated to have risen to $180 billion.

Applying the two economic approaches described above to injury prevention, the same *Cost of Injury* study projected potential savings, including the cost of injury control programs, to those injury preventive interventions on which we have reasonable data. For example, airbags in automobiles could result in an estimated societal dollar savings of between $4.6 billion (when one uses a "human-capital" approach) to $19 billion (when one uses a "willingness-to-pay" approach).

The Burden of Traffic-Associated Injury

Motor vehicles are integral to our lifestyles, and the number of vehicle-miles traveled per person per year continues to grow. From 1965 to 1985, motor vehicle mileage exposure for the U.S. population increased 93 percent, from about 900 billion to 1,700 billion mi per year. With about 500 million cars and commercial vehicles in use worldwide, more than 500,000 people die each year in motor vehicle crashes and about 15 million are injured.[12] In the United States, motor vehicle crashes are the leading cause of death among people between 1 and 34 years of age. Motor vehicle crashes are the third most significant cause of years of potential life lost, after cardiac disease and cancer; they are the leading cause of work-related deaths.[13] Crashes result in more than 47,000 deaths annually. They are also the second leading cause of injury hospitalizations (more than 500,000 per year) and less severe, nonhospitalized injuries (4,800,000 per year). For 1985, the estimated total lifetime economic cost to the nation for injuries from motor vehicle crashes exceeded $48 billion, of which $12 billion was for direct medical and nonmedical costs, $19 billion was for indirect costs associated with morbidity, and $17 billion was for indirect costs associated with mortality.[3]

The Public Health Community's Involvement in Injury Control

In 1947, Dr. Joseph Mountain, who helped to establish CDC, also created a Division of Accident Prevention within the U.S. Public Health Service. Most of the Division's work was done through an extramural grants program, and its interests broadened to include motor vehicle crashes, injuries in the home, and poisoning. In the early 1970's, the Division of Accident Prevention was disbanded and its activities were subsumed into NHTSA and the Consumer Prod-

uct Safety Commission, which were created to conduct research into motor vehicle injury and consumer products.

CDC has long been known for its epidemiologic work in infectious diseases, including the eradication of smallpox, the identification of the organism that causes legionnaire's disease, and landmark investigative work in toxic-shock syndrome. In the early 1970's, CDC began to investigate unintentional injuries, particularly in the home and the recreational environment. During the early 1980's, CDC began to investigate intentional injuries, particularly those injuries related to youth suicide, minority homicide, and family violence. These activities were later expanded into CDC's Division of Injury Control within the Center for Environmental Health and Injury Control.

In 1983, Congress authorized the Department of Transportation to request a study on trauma by the National Academy of Sciences to determine what the Federal Government could do to increase and improve knowledge about injury. The Committee on Trauma Research of the National Research Council's Commission on Life Sciences was established in collaboration with the Institute of Medicine to conduct this study. The Committee, consisting of leaders in the fields of physiology, pathology, surgery, biomechanics, forensic science, the neurological sciences, and public health, noted the disparity between the magnitude of the injury problem, relative to the other big killers (namely, cancer and cardiovascular diseases), and the Federal research expenditures on these problems.

In response to the Committee's recommendations, Congress established injury research and control activities within CDC and appropriated, for a pilot program, $10 million each for fiscal years 1988, 1989, and 1990. To facilitate expeditious funding of the program, Congress channeled funds through NHTSA for these purposes. Today, CDC's Division of Injury Control offers assistance to State and local health departments in addressing injury as a public health problem. With NHTSA's assistance, the Division has established an intramural research program, several university-based Injury Control Research Centers, and an extramural research grants program.

For a long time, engineering, law enforcement, and traffic safety agencies have led the effort to prevent the greatest source of injury-related deaths—traffic injuries.[14] However, injury should be viewed as a public health problem because of its magnitude and its consequences for the health of the nation.[14] Health is the absence of disease and injury, and the mission of the public health community to lessen suffering and death. To the extent that the participants at this meeting contribute to the reduction of injury and death on the nation's roads, they are engaged in the practice of public health.

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PLANNING FOR IMPLEMENTATION

PROGRAM PLANNING: A LOOK AT PACKAGING INTERAGENCY/ INTERDISCIPLINE ACTIVITIES

Gil Bellamy

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IMMATURE AND CRIMINAL DRIVERS

Motorized Wheelchair Versus Amtrak

A young woman in a battery-powered wheelchair tried to beat the train at a railroad crossing—and didn't. The train hit the footrests on her wheelchair, destroyed the chair and knocked the woman to the ground just beside the rail. She told witnesses, "This was just like the other close calls I've had." She had been in several car crashes—one in which her passenger died. She had fallen out of a building. She said, "I wasn't scared; if I get killed, I get killed."

Why was this 26-year-old woman in a wheelchair? On November 3, 1981, she was swimming alone in a lake in Florida. She dove in, hit her head on the back of an alligator, and broke her neck. She is an example of an immature driver.

Head-On Crash Put End to Criminal Career (Newspaper headline)

In one thoughtless moment, Robert Bryan Burt did what law officers and courts could not do in a decade. In a blazing head-on crash, Burt, 29, ended a criminal career that spanned his entire adult life. The trouble is, he killed two other people in the wreck.

His rap sheet lists him with 6 names, 3 social security numbers, and 25 crimes in 10 years. He is an example of a criminal driver.

Immature and Criminal Drivers Waging War on the Rest of Us

The best-engineered roads by themselves cannot save us from them. A coordinated comprehensive traffic safety program is necessary if America's transportation system is to remain affordable.

That is why the U.S. Department of Transportation published *Moving America—a State of National Transportation Policy*, which states on page 81, "Safety is the top priority for the Department of Transportation."

That is why this summit for highway and traffic safety decisionmakers is taking place. That is why Secretary Skinner hosted a summit in April 1990 for the State police from the 50 States. That is why President Bush personally conducted a White House Conference on Drunk Driving in December 1989.

How can we help achieve traffic safety goals?

COORDINATION

To coordinate means to get everyone working together toward a common goal. Coordination is not an exercise of power. A coordinator does not have the authority to order, direct, or supervise. Goals are achieved by persuasion and team building.

State law authorizes coordination between Oregon traffic safety activities and all other State agencies. The law also requires the State of Oregon to work with local governments and private organizations.

MULTIAGENCY TRAFFIC SAFETY PROGRAMS

Vehicle Aspects of Traffic Safety

- Ignition interlock devices—Division of Motor Vehicles (DMV); courts; Oregon Traffic Safety Commission (OTSC)
- Airbags—National Highway Traffic Safety Administration (NHTSA), DMV, OTSC
- High-mounted brake lights—NHTSA
- Fleet purchases—running lights, anti-lock brake system, all-wheel drive

Driver Aspects of Traffic Safety

- Provisional driver license
- Driver License Denial Law
- Victim's impact panels
- Zebra stripe law
- Vehicle confiscation
- Marketing traffic safety
- Public opinion surveys
- Focus groups
- Making driving under the influence socially unacceptable (1983-1989)

Highway Aspects of Traffic Safety

Safety Priority Index System (SPIS)—OTSC, Highway Division.

In the early 1980's, Oregon did most of its prioritization of highway safety projects with a system that used accident rates (accidents per million vehicle-miles). In 1984-85, OTSC sponsored a new search to find a more complete way to identify and evaluate locations on the Oregon highway system with a high potential for accidents. This search led to a new system called SPIS that is still in use today.

SPIS evaluates not just accidents per miles traveled but places emphasis on number of accidents and severity of injuries as well. Each of these three categories is weighted with approximately one-third of the total SPIS indicator, so no one value can overshadow the others. Using a 3-year history of accidents, this indicator has given us a clearer picture of problems on our roadways. The Federal Highway Administration has mandated, and the Highway Division has developed and approved, a program for highway safety improvement called the Highway Safety Improvement Program, which addresses the need both on the State and the local level for identifying needed improvements. The suggested method of identifying these locations focuses on SPIS.

Computer Mapping

The Highway Division's Mapping and Mileage Control Unit has worked closely with the local governments to provide computerized maps of their cities or counties. Many agencies that have been helped with OTSC grants have used this service to develop their own maps using the State-developed map as a base.

Video Logging

Through a grant from OTSC, the Highway Division has replaced all the old film logs of the Oregon road system with a new modern video log. Instead of taking individual snapshots of the roadway at minute intervals, the technique has become one of driving in a van with a video camera and logging the roadway features as driven.

This technique provides the ability to view the roadway and its features and can give a real-time feel of the operation of that roadway. It has made filming the video log much faster and more economical.

Engineering Advice and Training for Locals

OTSC and the Highway Division's Traffic Section are supplying engineering assistance to local governments through the Aid to Locals Program. This funding allows the Traffic Section to offer the benefit of the Highway Division's technical resources to local governments without the expertise in Traffic Engineering. It also supplies some computer hardware or software on a limited basis for purposes of traffic safety.

Roadway Inventory

Roadway and Mileage Control of the Highway Division is currently offering a service to assist local governments in inventorying their roadways. The inventory is being done through a portable laptop computer provided through the Aid to Locals Program mentioned earlier. This automated system requires only a push button to record the mile point and type of roadside feature.

Collision Diagraming

To make engineering analysis tools more readily available, OTSC approved a grant for the Traffic Section to develop an automated collision diagraming program. This program is designed to extract certain accident data from the State's accident data base and produce a picture of how and where these accidents occurred. The program was developed over a 3-year period and is now in production on a limited basis by our accident data group. Future plans for this system include allowing local agencies to produce diagrams themselves.

First Responder

A "first responder" is a person who arrives on the scene of a traffic crash before the ambulance. OTSC provided funds to the Highway Division to train all their road workers on techniques to render medical care sufficient to save lives. Injured people who go into shock have to be treated within the "Golden Hours." Highway Division road crews have saved several lives with this program.

SYNOPSIS

Fatalities on our streets and highways account for 90 percent of all transportation fatalities in the nation—more than 45,000 in 1989—costing Americans more than $75 billion each year. It will take a coordinated effort by all relevant Federal, State, and local agencies and private groups to achieve an efficient and safe transportation system in America.

PUTTING IT ALL TOGETHER AND BUILDING SUPPORT FOR A PROGRAM OF EFFECTIVE COUNTERMEASURES

Leonard Levine

Commissioner
Minnesota Department of Transportation

"Moving America *Safely*", the statement of National Transportation Policy published in early 1990, points out that nothing is more important to the American people than their safety and security. Transportation safety concerns extend to the safety of travel on the highways, in the air, on railroads, and on water. The greatest number of transportation-related accidents each year occurs on the nation's streets and highways. President Bush has established the goal of cutting the death rate in traffic accidents to 2.2 fatalities per hundred million vehicle-miles by 1992, down from 2.3 in 1988 and 3.3 in 1978. Our goal is to continue to reduce the traffic death toll below the current level through the next decade, in spite of the expected increase in travel.

Minnesota is a national leader in transportation safety. Beginning in 1982, Minnesota has consistently ranked among the five States with the lowest highway fatality rate nationally. During the last 3 years, Minnesota has had the lowest traffic fatality rate in the United States. Although Minnesota has been a national leader in highway safety, Governor Rudy Perpich has made improved transportation safety a top priority for the State of Minnesota.

However, this outstanding safety record does not tell the whole story. This week, in Minnesota, about 1,000 citizens will be treated in a hospital for injuries resulting from road accidents. This week, 12 people will lose their lives on Minnesota roads. This week, about $12 million will be spent to provide medical care to those involved in traffic accidents in Minnesota. These figures show that more work is needed to improve the safety of highways and railroad crossings. The goal in Minnesota is to cut the highway death rate in half by the year 2000. Achieving that goal would reduce Minnesota's highway fatality rate to 0.75 per 100 million vehicle-miles traveled.

MINNESOTA'S SAFETY ACTION PLAN

Highway and motorist safety is already a top priority for the Minnesota Department of Transportation (Mn/DOT). The State's design and construction standards and annual safety improvement programs have provided a consistently high level of safety on the State's roads. In an environment where safety is already a high priority, what approaches can be taken to further improve transportation safety?

Mn/DOT believes that the answer lies in a multifaceted approach. Such an approach includes an analysis of safety-related laws, enforcement procedures, road safety technology, vehicle improvements, driver attitudes, and infrastructure improvement. It must also be recognized that progress will be incremental. Highway fatality rates have declined significantly in the last 10 years, but the improvement has occurred in small increments and as a result of a number of factors at work simultaneously.

Public Safety Forums

Obtaining citizen and driver input is a key factor in achieving progress in highway safety. In Minnesota, citizen input was obtained through a series of 14 public transportation safety forums held in the fall of 1989. Local citizens who volunteered to coordinate and chair local task forces joined with Mn/DOT in sponsoring and promoting the public forums. The dedication and hard work of these local citizen leaders and the safety concerns expressed by the hundreds of citizens who testified at these meetings were most impressive. About 2,000 people attended the safety forums and more than 700 men, women, and young people gave oral or written testimony. This citizen participation has not only helped identify many transportation safety problems but also, perhaps more importantly, raised public awareness and created a political climate in which renewed safety efforts received widespread public and legislative support.

As a result of the forums, a special safety program was created to address specific safety issues raised. Mn/DOT set aside an additional $8 million for highway safety improvements to be accomplished in 1990 and 1991. These safety projects, based on the suggestions of citizens and organizations in attendance at the safety forums, were reviewed by the Mn/DOT districts and placed on a program list. Among the items programmed for these improvements are turn lanes/bypass lanes, overhead flashers, shoulder paving jobs, pedestrian accommodations, signal installation/replacement, lighting, roadway widening, signing improvements, and pavement marking improvements. In this way, badly needed safety improvements can be made immediately while, at the same time, the more comprehensive Minnesota Safety Action plan can be undertaken.

The Safety Action Plan

In addition to the highway safety forums, public opinion surveys, accident records, and professional research in highway safety provided important input into the development of Minnesota's Transportation Safety Action Plan.

This Safety Action Plan consists of a multifaceted approach to the highway safety problem and incorporates a number of effective accident countermeasures, many of which can be implemented quickly and at relatively low cost. These countermeasures include the following:

Intersection Improvements

Approximately 40 percent of all accidents in Minnesota occur at intersections. Signal installations and refurbishments constitute a large percentage of the safety improvement projects completed; yet, in 1989, nearly 38,000 motor vehicle crashes occurred at intersections. This represents more than one-third of the total number of highway accidents. Studies show that intersection improvements can result in accident reductions of 25 to 50 percent, depending on the number of/type of improvement. A recent study of the "100 Worst Intersections" (trunk highways only) will be used to identify recurring problems at intersections to determine what improvements can be applied. A task group has been identified to further examine the needs of intersections and make recommendations on advance warning for these areas, research the use of signal optimization, study the safety and effectiveness of "RIGHT TURN ON RED" and "LEFT TURN ON ARROW" signing, and prioritize intersection improvements on a statewide basis.

Secondary Roadway Improvements

Nearly 60 percent of accidents occur on Minnesota's secondary roads. This fact indicates that the safety needs of highways under county and local jurisdiction must be addressed if the State's safety record is to show significant improvement. In 1989, more than 63,000 crashes occurred on these types of roads. Of these crashes, 287 resulted in at least 1 fatality, and almost 20,000 involved personal injury. To assist the counties in identifying their own safety initiatives, Mn/DOT proposes to expand its current highway safety effort to perform highway engineering safety studies county by county. Coordination with and encouragement of the counties are needed to implement a comprehensive safety program for each jurisdiction. Additional input will be received from a task group assigned to identify immediate safety needs and provide incentives to counties. Emphasis on roadway safety by these jurisdictions will be increased by offering support and incentives to county governments.

Roadway Lighting and Signing

Night driving accounts for 18 percent of Minnesota's auto accidents and 38 percent of the fatal crashes. Drivers base 90 percent of their driving decisions on what they can see. Reasonably then, it can be expected that improvements in lighting and signing along the roadway will result in more intelligent decisions being made by motorists. Potentially, many of these crashes could have been avoided if the driver had more information with which to make an informed decision. Mn/DOT is addressing these issues separately through two task forces assigned to identify signing and lighting needs. Improvements will include the upgrade of existing facilities, installation of new lights and signs, or changes in the current standards that apply to the placement of these important safety devices. Additionally, at the local level, Mn/DOT maintains its Hazard Elimination Safety (HES) program for the upgrade and placement of regulatory and warning signs on township roads. The program, which receives additional participants regularly, is designed to make these types of signs uniform at the local level. Statewide participation is the ultimate goal.

Pedestrian Safety

People are becoming more mobile each day. With increases in both vehicular and pedestrian traffic, it is becoming necessary to spend more time addressing the needs of both these groups. In 1988, there were 1,575 crashes that involved pedestrians. Sixty-nine of these were fatal crashes, an 11 percent increase from the previous year. Additionally, the special needs of older persons and those with disabilities must be addressed. Background information regarding the number and characteristics of pedestrian accidents is being formulated for 1989. A task force will use this information to develop a safety strategy for dealing with this issue.

Rail Grade Crossing Safety Improvements

At the Minnesota public safety forums, numerous citizens expressed concerns about the tragedies that occur at railroad crossings throughout the State. Motor vehicle/train crashes are often severe and typically receive much attention. A Mn/DOT team has been created to address this important safety issue. Safety inventories on the three most heavily used rail corridors in the State will begin soon. Planned safety improvements include the installation of brighter crossing signs and longer lasting pavement markings at public railroad crossings. Signals may also be installed or upgraded at selected crossings. These improvements will be made in two phases, as follows:

- Phase 1—Installation of new crossing materials to enhance the three most heavily travelled corridors during 1990.

- Phase 2—Installation of new crossing materials on the remaining grade crossings in Minnesota.

In addition, the Department will work with local officials and the railroads to reduce the number of lightly used or dangerous crossings. Methods to encourage public reporting of grade crossing safety problems are also being developed.

Increased Truck Inspections

Last November, Minnesota instituted an enhanced truck safety program. This program includes a statewide program to conduct air surveillance of trucks and a periodic saturation of truck inspections. This Minnesota Truck Safety Program is a result of a partnership between Mn/DOT and the Minnesota Department of Public Safety (DPS). A truck safety hotline has been established so that citizens can report suspected truck safety violations. Also, joint truck inspections have been arranged with neighboring States.

The Minnesota Transportation Safety Advisory Council

This Governor-appointed council will coordinate diverse safety interests from all areas of the State and many different safety organizations: Mothers Against Drunk Driving (MADD), Students Against Drunk Driving (SADD), senior citizens, cities, counties, etc. The makeup of the council will ensure that the perspectives of a wide variety of interest groups will be represented and that safety will be examined from many different aspects. Staff and organizational support will be provided by Mn/DOT.

The Mn/DOT-DPS Safety Committee

This group, consisting of safety representatives from both departments, will meet regularly to "compare notes" on safety activities and needs. Enforcement and education are major factors in the area of highway safety. Many citizens at the public forums spoke out about the need for enforcement against speeding, driving while intoxicated, discourteous drivers, and poor driving habits.

Ongoing Programs

In addition to the safety enhancement efforts and measures that can be implemented in the near future, a number of longer range and ongoing safety efforts are being undertaken by Mn/DOT. These efforts include an intensive statewide Work Zone Safety Program, general roadway improvements, a program to improve safety for older drivers, and an ongoing annual safety improvement program.

Work Zone Safety

Work zone safety is an important part of Minnesota's comprehensive highway safety program. More than 35 percent of Minnesota's roads are more than 50 years old. Road aging, combined with increased traffic and heavier trucks, has resulted in deteriorated roads that need significant repair and reconstruction. Unlike the major construction activities of the past, maintaining today's highways requires that the roadways remain open to the traveling public while the work activity is underway. With the increasing emphasis on rehabilitation and reconstruction at the Federal level, work zone safety will surely increase in importance in the years to come.

Mn/DOT has full-time Work Zone Safety Coordinators in the central headquarters and in each of the eight transportation districts in the State. Working closely with contractors and construction, maintenance, traffic engineering, and communications personnel, Mn/DOT has developed an extensive year-round work zone safety public awareness campaign.

One aim of the program is to assist in establishing uniform work zone traffic controls for all highways in the State, regardless of the governmental jurisdiction.

In addition, Mn/DOT is working with the American Traffic Safety Service Association (ATSSA) to certify traffic control supervisors in 1990. A complete quality assurance program is being

developed that includes all necessary standards and guidelines, training, and the development and implementation of state-of-the-art traffic controls to ensure that proper work zone safety controls are used on all projects.

A four-part public education work zone safety package is also being developed. The program includes:

- Awareness activities for kindergarten through sixth graders.
- Transportation education in social studies for seventh through twelfth graders.
- Training for beginning drivers.
- Defensive drivers' training, with emphasis on older drivers.

General Roadway Transportation

Mn/DOT safety personnel work continually to identify safety problems resulting from road design and to promote the correction of narrow roadways, fixed objects in the clear zone, and roadway conditions that lead to vehicle overturns. A systematic program of obsolete roadway upgrades is one way to ensure that all areas will be addressed.

Older Driver Improvements

As the population ages and the number of older drivers increases both nationwide and in Minnesota, the proportion of traffic accidents involving older drivers can be expected to increase. It is necessary to begin a system of roadway improvements specially designed to accommodate older drivers. To address this issue, Mn/DOT has initiated a study through the University of Minnesota Center for Transportation Studies to perform safety-related research relating to the needs of older drivers in Minnesota. The Traffic Engineering Office will work closely with the University to develop a safety plan and identify a pilot corridor to use in determining the best way to deal with the needs of this growing community.

Mn/DOT's Annual Safety Improvement Program

Annually, each of the Department's districts submits safety projects to be considered for programming by the central office. Each year, nearly $10 million of safety-related roadway improvements are accomplished under this program. Thirty-five percent of this funding is federally provided, while the State provides the remaining 65 percent. Currently, the districts are reviewing projects that will be scheduled for 1993 and beyond. Construction that is typically accomplished through this program includes turn lanes, bypass lanes, signal installations and upgrades, shoulder widening, intersection upgrades, etc. Projects are chosen based on accident rates; history and severity; project life and cost; and district priority, to mention a few parameters.

A Federal/State/Local/ Partnership

The importance of the Federal/State/local partnership in transportation safety cannot be over-emphasized. Federal efforts, such as the 402 safety program, have provided benefits far beyond the modest expenditures made under the program. The data analysis, engineering studies and analyses, technical guides, workshops, seminars, safety training, and vehicle and driver safety programs carried out by 402 funding have had a far-reaching impact on State and local highway safety efforts.

The Hazard Elimination Program has saved thousands of lives by providing special funding to make necessary improvements at high accident locations.

The Rail-Highway Crossings Program has helped to focus attention on a critical national issue and need. Public concern about the safety of rail-highway crossings was very evident at the transportation safety forums conducted throughout Minnesota.

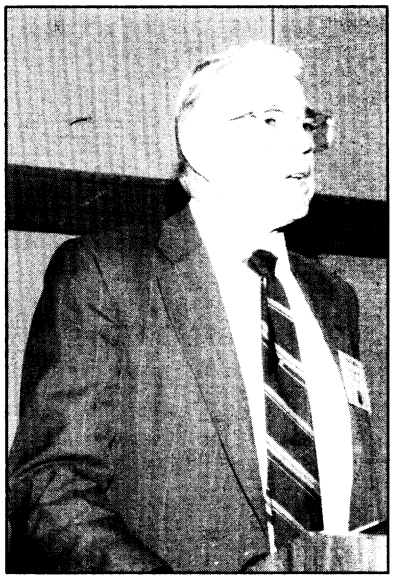
A continuation of the very fruitful Federal/State/local partnership in transportation safety is essential to continued safety improvement during the 1990's and beyond. Minnesota has received outstanding help in its safety efforts from the Federal Highway Administration. The close Federal/State relationship Minnesota enjoys under Charles Foslien, FHWA Division Administrator, is especially noteworthy. He and his office have been instrumental in assisting and supporting Mn/DOT as it has worked during the past several years to develop the nation's safest highway system.

The American Association of State Highway and Transportation Officials (AASHTO), in its recommendations on the future direction of the Federal surface transportation program, supports continued strong Federal involvement in highway and transportation safety. AASHTO's recommendation is "The safety of Americans, using the surface transportation facilities and services, should be preserved and enhanced through the continued national commitment to safety research, safety applications, and safety projects." This AASHTO recommendation deserves the wholehearted support of all who strive for further improvement in transportation safety.

An Invitation to Others

Mn/DOT invites representatives of the FHWA and other State departments of transportation to visit Minnesota to observe what is being done in terms of highway safety enhancement.

IDEAS INTO ACTION: THE FUTURE FOR HIGHWAY SAFETY



MODERATOR'S CLOSING ADDRESS*

Ronald R. Fiedler

Wisconsin Secretary of Transportation and Governor's Highway Safety Representative

You have worked with us for the last 2½ days, and, as we heard in the reports this morning, we really had a successful conference. I'm very pleased with the countermeasures that have been identified and with the implementation recommendations.

When we got here Monday evening, one of the people said to me, "We want a conference where we can enjoy, learn, and share." I think we met that objective. I've learned a lot. I'm glad we had the handouts this morning because we can take that back to our States and back to our agencies. It is important that we share what we have learned. I think the conference has given us a great opportunity to learn, and the potential to share.

I'm very pleased to see the leadership—Federal Highway Administration and National Highway Traffic Safety Administration. For Secretary Skinner and "Moving America *Safely*," safety is a top priority. Sometimes we read statements and policies and they end up on the shelf, and that is the last we hear. But that is not the case with this Administration. We have already had the law enforcement summit in Chicago, and we have had this Symposium here today, which is a joint effort by FHWA and NHTSA. I'm very pleased to see them work together and to see the leadership that they have provided for us. I'm very impressed with the countermeasures identified. I think we did a good job.

Let me speak to a couple of points, regarding what we are planning and what we are doing. In AASHTO, we revitalized the Standing Committee on Highway Traffic Safety; we have expanded it. We developed a highway safety strategic plan, mentioned here this morning. In July, new highway safety policies were activated, which not only address the infrastructure needs, but also address the other very important parts of the highway safety equation.

I think we have come a long way. We have become a part of the mainstream, and hopefully are providing leadership in highway safety. I see more and more action in the State areas. In Wisconsin, I am responsible for providing leadership and direction for a number of highway safety disciplines and activities.

*Transcript

It's not easy. Let me give one example of a situation that developed just a few weeks ago in Wisconsin. We had a fatal accident involving a youngster on a bicycle in a small community on Highway 14 west of Madison. The community has grown, and the residential areas have grown. A couple of years ago the community was going to have a major development, and it asked that the speed limits be reduced. We went through our traffic studies, and we said no; the development didn't occur. When the fatal accident occurred, the cry went out to reduce the speed limit. In fact, we got a pretty bad editorial in the local paper, and I decided to go out and take a look at the site. I went out there, and, yes, speed made a contribution to the accident, but there is more to it than that. Visibility is poor. There is a fast-food place on the corner, with a service station on the other corner. You can't see. It's congested, a lot of clutter. The signing wasn't right; the marking wasn't right. So I went back and I got hold of my district director and I said, "We need to respond, but we're not going to respond just by reducing the speed limit. We are going to put together a multidisciplinary team." We had our highway safety office—the person in charge of pedestrian considerations—and we had the State patrol, law enforcement, a public relations person, and a traffic engineer get together. And they came up with a number of ideas, which we are exploring with the community. Yes, we may reduce the speed limit, but there are a number of other considerations, countermeasures that we can do—part of which is education.

The point in bringing this up is that even in an agency such as mine, where we have good direction in the field of highway safety, we still did not get the message through. We still haven't been able to convince all our administrators. It's not a matter of engineering, or traffic engineering. We need to look beyond that in a comprehensive way.

About 3½ years ago, I attended a conference where Tom Larson was a speaker. He ended on the note that, "We can make a difference." And that stuck with me. And we *can* make a difference. That's why we're here today, in highway safety. Individually, each of us can really make a difference. But let me suggest to you that it takes more than that. Individually, yes, we can do something. And then one plus one, we can do more. But working together, in a comprehensive approach to highway safety, I think we develop a synergy that one plus one will equal three.

And we have to do that. You've seen the curves and the tally rates. We're lowering the rates, but it's flattening out. And with the increase in traffic and travel, future rates will just stay the same or decrease slightly. That is not going to be good enough. We need a breakthrough. We need to work together. And I think we have the right people, and the right time, and the right place here. And we can start that breakthrough, working together!

CLOSING REMARKS*

Gene McCormick

Deputy Administrator
Federal Highway Administrator

I am not going to spend a lot of time recapping the last 2 days. Instead, I want to discuss where we go after today based on the direction you have provided during the Symposium.

I commend all of you for participating in this Symposium, and for developing the priority list of safety countermeasures. You are a representative cross section of the transportation community at large, and I echo Ron Fiedler's statement that if we work together and know where we are going, there is nothing to stop us. I think today constitutes a springboard to the future. Let me share with you some thoughts of the future, what the schedule and activities will be, and then I'll open it up for questions and comments.

As you know, the objective of this Symposium was to identify promising short-term countermeasures that can be implemented within the next 2 years and to develop strategies for their implementation. We have an array of them before us. Further, there were some very significant themes that came out of this Symposium. Ron touched upon them: communication, working together, and developing a team approach. And that, I think, is the real foundation for our future efforts. So you accomplished more than just the initially stated goal. Both NHTSA and FHWA look forward to developing an Action Plan for the future to implement the results of this Symposium.

Let me describe what we perceive that Action Plan to be, why we think it is important to us, why we know it is important to NHTSA, and why we think it is important to you. First, we need to document the proceedings of this Symposium. But more important are the steps we should take in conjunction with NHTSA to shape the preliminary Action Plan. We need to:

1. Select the real priorities from this list of short-term implementable countermeasures.

2. Arrange to share the success stories of others so we can learn from one another.

3. Determine what the U.S. Department of Transportation can do to help implement the Symposium's recommendations.

*Transcript

There are two reasons for determining "what the U.S. DOT can do to help." First, the reauthorization bill will be up for debate in Congress next year. Safety is going to be a major element of that bill. We need your input in that effort. Second, FHWA would like to use fiscal year 1991 budget flexibility to help implement the Action Plan beginning October 1, 1990.

We would appreciate receiving any further suggestions you may want us to consider in developing the Action Plan. A draft Action Plan will be sent to you in August for any further thoughts you may have after reflecting on the last 2 days. We would like to have your reaction to the draft Action Plan so it can be put in final form for implementation.

This Action Plan will provide us with a common set of objectives, an outline of where we are heading, and an explanation of how we are going to get there. I will pause at this point and encourage you to offer any comments or suggestions you may have on my thoughts and ideas. Is that a noteworthy goal, or should we just worry about wrapping up the Symposium proceedings and go about our business? What is the attitude from the audience? Speak up. [Pause] I heard a "go for it." I don't believe we can do anything but "go for it." Doesn't that make sense? We'll go for it!

And we'll get it! If we work together, there is no doubt in my mind that we can improve safety more quickly; that's what we are after.

I want to take this opportunity to thank the speakers who participated in the Symposium, the workshop chairpersons who dedicated long hours, and the staff of FHWA and NHTSA for their support. I hope you had an opportunity to learn about new safety countermeasures, make new acquaintances, and explore ways to solve highway safety problems. These are some of the fringe benefits and byproducts of a meeting such as this.

Ron, we certainly owe you a special thanks for moderating this Symposium. I don't think we could have found anyone better than Ron because he shares our common objective. Ron, we have been blessed to have had you as our moderator, and I thank you very much.

This Symposium is just the start. Let's work together to build on it so we can improve traffic safety in our country. I would like to close this Symposium by thanking each one of you for your active participation during the last 2 days. Thank you very much.

SECTION II

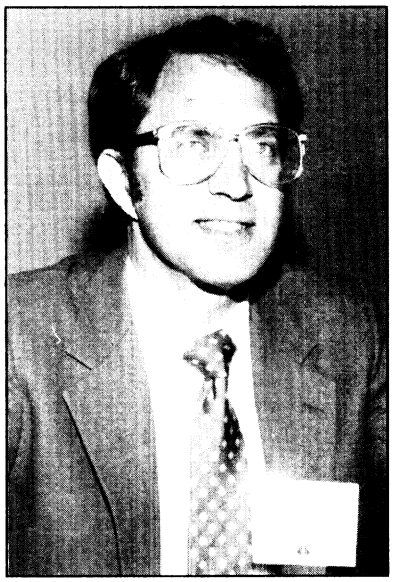
INTRODUCTION: SECTION II

Section II contains summaries of presentations as well as workshop reports for each of the five topic areas. Each workshop report lists the countermeasures selected by workshop participants as holding the most promise for short-term improvements in highway safety. The participants selected the countermeasures from among lists of short-term countermeasures developed by small groups within the workshops.

The lists of countermeasures developed by the small groups are shown in appendix C.

Also included in the workshop reports are action plans devised for implementing the countermeasures. Constraints and obstacles that may be encountered during implementation were also discussed at the workshops, and they are listed in the reports.

Improving Pedestrian Performance And Environment



ENGINEERING AND PHYSICAL MEASURES TO IMPROVE PEDESTRIAN SAFETY

Charles V. Zegeer, P.E.*

Program Manager, Roadway Studies
Highway Safety Research Center
University of North Carolina

An engineering or physical facility change to the roadway is often the most appropriate solution to a pedestrian safety hazard. Physical facility improvements work best when they are tailored to an individual location and traffic problem. Factors to consider when choosing an improvement are location characteristics, pedestrian and vehicle volume, vehicle speed, design of a given location, city laws and ordinances, and financial constraints.

The following engineering measures should be examined as a part of a community's WALK ALERT effort.

SIDEWALKS

Sidewalks have been shown to reduce the number of pedestrian accidents in residential and business areas. They separate pedestrians from the roadway. They also provide paved places for children to play rather than play in the street.

Sidewalks exist in most urban areas, but they are not usually constructed in rural areas because of low pedestrian volumes and relatively high construction costs. Sidewalk construction is often funded by property owners.

Recommended Guidelines for Sidewalk Installation

Recommended general sidewalk requirements shown are dependent on the land use, roadway functional classification, and, in the case of residential areas, dwelling unit density. These recommended guidelines are detailed in table 1.[1]

The guidelines indicate where sidewalks should be installed. Obviously the width of a sidewalk should depend on where it is installed and the anticipated usage. The following are suggested minimum specifications for the width of the sidewalk to be installed:[1]

*This report (with minor editing) is from the 1988 WALK ALERT Program Guide, which is part of the National Pedestrian Safety Program, National Safety Council (NSC). Mr. Zegeer was the original author of this paper, and it was revised by NSC prior to appearing in the program guide.

Table 1. Guidelines for installing sidewalks.

Land-Use/Roadway Functional Classification Dwelling Unit	New Urban and Suburban Streets	Existing Urban and Suburban Streets
Commercial and Industrial (All Streets)	Both sides.	Both sides. Every effort should be made to add sidewalks where they do not exist and complete missing links.
Residential (Major Arterials)	Both sides.	Both sides.
Residential (Collectors)	Both sides.	Multifamily—both sides. Single-family dwellings—prefer both sides; require at least one side.
Residential (Local Streets) More than 4 Units Per Acre	Both sides.	Prefer both sides; require at least one side.
Residential (Local Streets) 1 to 4 Units Per Acre	Prefer both sides; required at least one side.	One side preferred, at least 4-ft shoulder on both sides required.
Residential (Local Streets) Less Than 1 Unit Per Acre	One side preferred; shoulder both sides required.	At least 4-ft shoulder on both sides required.

NOTES:

1. On any local street within two blocks of a school site that would be on a walking route to school, a sidewalk is required on at least one side.

2. Sidewalks may be omitted on one side of new streets where that side clearly cannot be developed and where there are no existing or anticipated uses that would generate pedestrian trips on that side.

3. Where there are service roads, the sidewalk adjacent to the main road may be eliminated and replaced by a sidewalk adjacent to the service road on the side away from the main road.

4. For rural roads not likely to serve development, a shoulder at least 4 ft wide—preferably 8 ft on primary highways should—be provided. Surface material should provide a stable, mud-free walking surface.

Proposed Minimum Sidewalk Widths

1. Central business districts: Conduct level of service analysis according to methods in *1985 Highway Capacity Manual.*

2. Commercial/industrial areas outside a central business district: Minimum 5 ft wide with 2-ft planting strip or 6 ft wide with no planting strip.

3. Residential areas outside a central business district: Arterial and collector streets—Minimum 5 ft with minimum 2-ft planting strip.

4. Local streets:

   - Multifamily dwellings and single-family dwellings with densities greater than 4 dwelling units per acre—Minimum 5 ft with minimum 2-ft planting strip.

   - Densities up to 4 dwelling units per acre—Minimum 4 ft with minimum 2-ft planting strip.

FACILITIES FOR DISABLED PEOPLE AND OLDER ADULTS

People with disabilities who experience higher than normal levels of risk include developmentally restricted persons (mostly children), users of wheelchairs, people with impairments to lower extremities who walk with special aids, and people with severe visual impairments. Special types of engineering improvements for disabled people include: [2]

- Signal-related improvements such as audible pedestrian signals and longer "WALK" intervals activated by pedestrians.

- Sidewalk-related facilities like curb ramps, guidestrips, handrails, widened sidewalks, and careful placement of street furniture.

- Special signs, such as those warning motorists of the possible presence of blind or deaf pedestrians.

The use of special facilities for the handicapped is often required on projects constructed with Federal funding. The effectiveness of such facilities is relatively unknown. However, such facilities become more feasible at locations used by a large number of disabled people.

A recently updated implementation manual published by the Federal Highway Administration (FHWA), *Accessibility for Elderly and Handicapped Pedestrians—A Manual for Cities, 1987*, describes the four planning stages and provides guidance for planners and other officials to follow in developing an accessibility program in Part I. Part II: Design provides explanations of the details necessary to preparing the accessibility plans of Part I. Each design chapter provides definitions, Federal and other standards if they exist, illustrations, and extensive information on problems and recommended solutions.[3]

BUS STOP RELOCATION

Buses stopped on the near side of intersections may severely block the pedestrian's view of approaching traffic, and the approaching driver's view of pedestrians. Approaching motorists are often unable to stop when a pedestrian steps out into traffic from behind the front end of a bus.

Relocation of a transit or school bus stop to the far side of an intersection can improve pedestrian safety because it eliminates the sight restriction posed by the bus. There are situations where far-side bus stops are less practical, such as at intersections with heavy turning volumes.

GRADE SEPARATION

Pedestrian overpasses and underpasses allow for the free, uninterrupted flow of pedestrians, separate from vehicular traffic. Most pedestrians will not use a grade-separated facility unless it is easily accessible, provides a feeling of personal safety, and requires less time to cross than the time to cross the road at street level. Grade-separated crossings may be highly effective when pedestrian use is high. Because of their high cost, installations of grade-separated crossings are most feasible at locations with one or more of the following characteristics: [4]

- High-vehicle speed and/or traffic volumes, particularly near elementary schools.
- Wide roadways, such as freeways.
- Areas of extreme hazard to pedestrians.

PHYSICAL BARRIERS

Roadway barriers include chains, fences, or other devices that physically separate pedestrians from motor vehicles. The use of physical barriers can be a feasible method to improve pedestrian safety at intersection or midblock locations, particularly where pedestrians frequently dart out into the roadway. Physical barriers are helpful in channelizing pedestrians to intersection crosswalks. They may be less effective near high school or college campuses where students may maneuver over or under them.

Median barriers such as fences or plantings are employed where nonintersection crossings are to be prevented.

LIGHTING

Overhead street lights are often installed in urban areas to aid motorists at night and to deter crime. Well-lighted streets may also help pedestrians. Drivers can more readily avoid accidents with pedestrians when they can see them soon enough to stop on time. Although installation of roadway lighting is relatively expensive, it may be justified in areas with high nighttime pedestrian activity.

ONE-WAY STREETS

Conversion from two-way to one-way street systems has consistently been found to reduce pedestrian accidents. These systems simplify crossings for pedestrians and allow motorists to give more attention to pedestrians.

TRAFFIC SIGNALS

Traffic signals can create gaps in traffic flow so that pedestrians may cross while motor vehicles are stopped. However, traffic signals are not always programmed to provide adequate time for pedestrians to safely cross the street. Traffic signals may be highly beneficial in providing crossing opportunities for pedestrians. However, pedestrians should not rely totally on the signals as a guarantee that it is safe to cross. They must still search for traffic before leaving the curb. For additional information on traffic signals, see the *Manual on Uniform Traffic Control Devices* (MUTCD), published by the Government Printing Office.[5]

PEDESTRIAN SIGNALS

The use of "WALK"/"DON'T WALK" signals is often assumed to reduce pedestrian accidents. However, research studies have found no difference in pedestrian accidents for sites with no pedestrian signals versus those with standard-timed pedestrian signal phasing (that is, timed so pedestrians have a "WALK" interval while vehicles travel parallel to pedestrians and may turn right or left across pedestrian's paths). The use of exclusive-timed pedestrian intervals (that is, intervals of the signal cycle where all vehicle movements are given a red signal while pedestrians may cross in any direction) show fewer pedestrian accidents, but greatly increase vehicular delay.[6]

There are certain situations where pedestrian signals are necessary, such as (1) when vehicle signals are not visible to pedestrians, (2) when signal timing is complex, (3) at established school zone crossings, (4) when an exclusive pedestrian interval is provided. However, indiscriminant use of pedestrian signals is not recommended, because it may give pedestrians a false sense of security at locations where no special need exists. The use of symbolic pedestrian signals, like man and hand symbols, is acceptable as an alternative to the "WALK"/"DON'T WALK" signals. For additional information on pedestrian signals, see the MUTCD.[5]

SIGNS

Guidelines for types and placement of highway signs, signals, and markings are provided in the MUTCD. Signs are usually mounted on a post or pole and may be classified as (1) regulatory, such as "WALK ON LEFT FACING TRAFFIC" or "NO TURN ON RED" or (2) warning, such as "WATCH FOR TURNING VEHICLES" or (3) guides, such as "PUSH BUTTON FOR WALK SIGNAL." [5]

One of the primary advantages of all types of pedestrian-related signing is their low cost. In many dangerous crossing locations such as complex intersections, signs may be effective in alerting drivers or pedestrians to use extra caution, and thus could improve pedestrian safety. Some disadvantages of signs are that they are often overused, which breeds noncompliance and disrespect for signing in general; some signs are not easily understood; and new signs may require community education and publicity programs.[4]

SCHOOL ZONE IMPROVEMENTS

Numerous roadway improvements have been used in an attempt to improve the safety of children in school zones. The use of adult crossing guards, separated pedestrian paths or sidewalks, and police enforcement of vehicle speeds have been found to be quite effective in many instances. However, the use of signs like, "SLOW SPEED LIMIT 25 MPH WHEN FLASHING," and markings like "SLOW SCHOOL," are of limited or unknown effectiveness. Numerous other programs that may be useful include safe route to school programs, parking prohibitions near intersections adjacent to schools, increased supervision of children, and vehicle speed regulations. Pedestrian education programs can be of considerable value in improving child pedestrian safety in conjunction with the measures mentioned above.

SAFETY ISLANDS

Safety or refuge islands are usually constructed between opposing directions of traffic or within an intersection for use by pedestrians when crossing wide or busy streets. They are commonly used at sites where pedestrians are not provided with adequate time to completely cross wide intersections during a "WALK" phase.

They permit pedestrians to look for approaching traffic from only one direction at a time. However, there is always some risk of motorists driving onto safety islands and striking pedestrians, particularly when the islands are narrow and located on high-speed arterials.

PARKING

Many dart-out and intersection dash accidents are due to visual obstructions from vehicles parked along the curb. Restricting curb parking near crossing locations can reduce visual obstructions and improve pedestrian safety. Resistance from nearby business owners sometimes makes it difficult to eliminate parking spaces.

MARKED CROSSWALKS

Marked crosswalks are intended to do two things. First, they should indicate a location for drivers to pay attention to pedestrians. Second, they mark a location for pedestrians to cross the street, rather than crossing anywhere. Large numbers of crosswalks and advance pedestrian crossing signs may increase motorist noncompliance with these traffic control devices. Pedestrians tend to use the shortest and easiest routes in crossing, and will not use inconvenient crosswalks.

Crosswalk markings can consist of two solid parallel lines, stripes running parallel to the directions of vehicle flow (ladder type), diagonally slanted stripes (zebra), or "solid" markings made by painting the entire crosswalk areas or constructing it of material different than the roadway surface. Crosswalks can be located at midblocks or at signalized or nonsignalized intersections and may be signed with advance warning signs. Minimum striping is 6 in parallel lines.[5]

Marking a crosswalk does not always improve safety of pedestrians. There are clearly some locations where marked crosswalks are useful, such as where large pedestrian volumes cross at low-speed signalized intersections or at school crossing locations controlled by crossing guards. However, marked crosswalks may present a false sense of security to pedestrians at other location types and be harmful to pedestrian safety. An example of such locations may include uncontrolled midblock crossings with high vehicle speeds and limited sign distance.[4,8]

Recommended Guidelines for Crosswalk Markings

Crosswalk markings should be installed at:[1]

- All signalized intersections with pedestrian signal heads.
- All locations where a school crossing guard is normally stationed to assist children in crossing the street.
- All intersections and midblock crossings satisfying the minimum vehicular and pedestrian volume criteria in figure 1.[1] As long as the basic criteria governing sight distance, speed limit, etc., are met, a crosswalk is deemed appropriate if the pedestrian and vehicular volumes place it above the appropriate curve in figure 1. Each crosswalk is analyzed by approach leg, indicating that a crosswalk might be warranted on one side of an intersection and not the other. If each approach warranted a crosswalk, then all would be marked. If only peak hour volume is used in figure 1 the threshold must be increased. For streets with a median, use the one-way average daily traffic (ADT) volume.
- All other locations where there is a need to clarify the preferred crossing location when the proper location for crossing would otherwise be confusing.

The most important elements of the guidelines are the basic criteria, which place some restrictions on crosswalk applications to prevent their

being placed in locations that would be extremely hazardous to the pedestrian. Placing crosswalks in locations with high speeds or poor sight distance is never advisable. A crosswalk is not a solution to situations such as this, and other preventive measures should be carefully considered.

The volume thresholds are reduced for locations where young, elderly, or handicapped pedestrians are a significant proportion of the pedestrian population. A value of 50 percent or more is suggested, but this is best left to the judgment of the engineer.[1]

At uncontrolled intersection legs and midblock crossings with operating speeds greater than 35 mi/h, the guidelines suggest the placement of more visible markings for greater conspicuity for drivers. All crossings at uncontrolled intersection legs and midblock crossings should be supplemented with crosswalk signs, as indicated in the MUTCD.

- Crosswalks should not be marked where crossing the street may be unusually dangerous (e.g., locations with high traffic speeds, poor sight distance, or poor illumination).

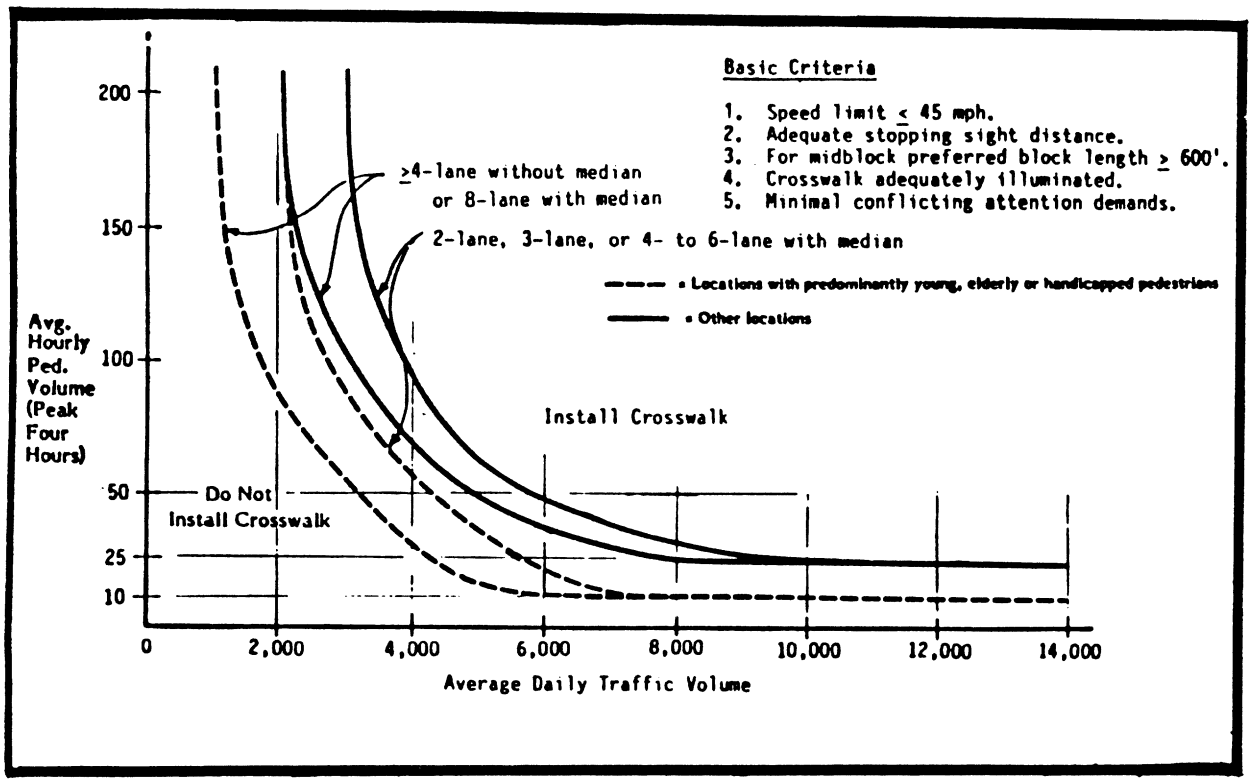


Figure 1. Guidelines for crosswalk installation at uncontrolled intersection legs, midblock crossings, and signalized intersections without ped heads.[1]

- In light of the installation and maintenance costs of pavement markings, crosswalk markings should be located at places expected to receive sufficient benefit. This suggests that crosswalks with low vehicular volume and/or low pedestrian volume do not warrant markings. The determination of minimum pedestrian and vehicle volume thresholds are an important part of establishing reasonable guidelines for installation of crosswalk markings.

- Guidelines for installing crosswalks should include the type of pedestrians expected to be crossing the street. Lower volume thresholds should be considered for areas where there is a greater proportion of less experienced and less agile pedestrians (e.g., near schools and/or elderly housing areas).

- Crosswalk markings in higher-risk crossing areas (higher traffic volumes and speeds) should be supplemented by advance warning signs, and, in some cases, advance warning pavement markings.

- Crosswalks should be used selectively. Allowing a proliferation of crosswalks reduces the overall effectiveness of each crosswalk.

- Specific variables that should be considered when locating crosswalks include activities located nearby (e.g., schools, shopping), pedestrian volume, vehicular volume, sight distance, vehicular speeds, street width and presence of a median, one-way versus two-way operation, and geometrics of the highway or intersection being crossed.[1]

With such a wide variety of engineering countermeasures applicable to pedestrian safety problems, it is often difficult to decide which countermeasure is appropriate for a specific local pedestrian problem. Table 2 from the *Model Pedestrian Safety Program User's Guide* matches specific accident types to potential engineering treatments.[9]

This table lists possible countermeasures that may be helpful for a particular problem. There is usually no single cure for a specific safety problem. At this state, it is important to keep an open mind and consider all possible solutions before making a choice. The next step will involve selecting the best alternative from among the full range of possible countermeasures.

PEDESTRIAN MALLS

An ideal solution to pedestrian safety is the construction of exclusive pedestrian malls, which provide a separated environment between pedestrians and vehicles. Pedestrian malls have been constructed in many cities, primarily in an effort to revitalize activity in downtown areas. Although pedestrian malls are rarely constructed based on pedestrian safety alone, safety may be an important result. Pedestrian malls must be planned with respect to the surrounding traffic flow network, as well as the city's plans for local development.[4]

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Table 2. Pedestrian accident types and potential engineering countermeasures.[9]

Countermeasures / Accident Type	Engineering and Physical																					
	Barrier: Median	Barrier: Roadway/Sidewalk	Barrier: Street Closure	Bus Stop Relocation	Crosswalk: Intersection	Crosswalk: Midblock	Diagonal Parking-1 Way Street	Grade Separation	Facilities for Handicapped	Lighting: Crosswalk	Lighting: Street	One-Way Streets	Retroreflective Materials	Safety Islands	Sidewalk/Pathway	Signal: Ped. (Shared)	Signal: Ped. (Delayed)	Signal: Ped. (Separated)	Signal: Traffic	Signs and Markings	Urban Ped. Environment	Vehicular Traffic Diversion
Dart-out (First Half)	●	●				●	●														●	●
Dart-out (Second half)	●	●				●	●					●		●							●	●
Midblock Dash	●	●				●								●							●	●
Intersection Dash					●			●		●	●			●			●	●		●		
Turn-Merge Conflict								●									●	●				
Turning Vehicle								●									●	●				
Multiple Threat								●		●	●					●	●	●	●		●	
Bus Stop Related				●																	●	
School Bus Stop Related				●																		
Ice Cream Vendor																				●		
Trapped					●			●						●		●	●	●				
Backup																						
Walking on Roadway		●									●		●		●					●		
Result Vehicle-Vehicle Crash																				●		
Hitchhiking											●		●									
Working in Roadway																				●		
Disabled Vehicle Related																				●		
Nighttime Situation										●	●		●									
Handicapped Pedestrians									●													

*Dots designate countermeasures believed to positively affect the indicated behavior/accident types.

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IMPROVING PEDESTRIAN SAFETY

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Every year in the United States, nearly 88,000 pedestrians are involved in accidents with vehicles. These accidents result in 7,300 deaths and many thousands of serious injuries. Youngsters under the age of 15 are involved in more than 33 percent of pedestrian accidents. Senior citizens, who represent a growing population, are involved in 9 percent of the total pedestrian accidents; however, they represent 22 percent of accidents resulting in death.

PROBLEM

By its very nature, pedestrian safety is not a sexy topic. Without question, development and implementation of effective pedestrian safety programming is one of the difficult challenges facing the Pennsylvania Department of Transportation (PennDOT).

Convincing people that pedestrian safety is a serious problem continues to be a difficult challenge. The very small child does not fear traffic. Older school age children think they are invincible (and resent "crossing the street" type programming). Adults think pedestrian safety is an issue for children. Older citizens remain either fearful of street crossing or—worse—overconfident and "traffic arrogant." Again, pedestrian safety is not a glamorous topic. The public is not "jumping on the bandwagon" as with other highway safety issues, such as driving under the influence of alcohol (DUI).

Long-term education may be the key to reducing the pedestrian safety problem in the Commonwealth. Until highway safety officials focus as much attention on pedestrian safety as on DUI and occupant protection, the public will not view pedestrian safety as a major problem.

COUNTERMEASURES—STATEWIDE

To combat pedestrian accidents in Pennsylvania, PennDOT is implementing a pedestrian safety component as part of its Comprehensive Highway Safety Project.

The Department is funding, through the Federal 402 Highway Safety Program, Comprehensive Highway Safety Projects. The projects provide highway safety programming to 64 of Pennsylvania's 67 counties. The Comprehensive Highway Safety Projects are community immersion programs designed to reduce the number of vehicle-related deaths and injuries through pro-

ject intervention strategies. The highway safety areas addressed include:

- Motorcycle safety.
- DUI.
- Safe driving and vehicle characteristics.
- Occupant protection.
- Pedestrian safety.

By using a community immersion plan involving local groups, health care facilities, industry, media, law enforcement agencies, and schools, the comprehensive projects are able to promote traffic safety issues in a highly visible manner. The project goals are achieved through public awareness campaigns and the implementation of education programs. The Department is currently implementing "Walk Smart," a statewide pedestrian public information/education campaign.

Urban Emphasis

Though pedestrian safety is a component of *all* Comprehensive Highway Safety Projects, the Highway Safety Coordinators responsible for several urban counties will emphasize pedestrian safety as a priority issue. The urban counties are Allegheny (Pittsburgh), Berks, Chester, Erie, Lackawanna, Lehigh, Luzerne, Montgomery, Northampton, Philadelphia, and York. Approximately 80 percent of Pennsylvania's pedestrian accidents occur in these 11 counties. Pennsylvania has 67 counties.

Children at Risk

On a statewide basis, PennDOT and the Pennsylvania Department of Education have entered into a joint project with the full support of each agency to assure that each student in the State receives the critical information to survive in our mobile society. Most educators are shocked to learn how much children are at risk for pedestrian accidents. The Pennsylvania Accident Record System tells us that:

- Approximately 1,500 children in kindergarten through third grade are hit by vehicles each year.

- In Philadelphia alone, an average of three students are struck by vehicles each day of the year.

Figure 2 shows the number of pedestrian accidents in 1988, broken down by severity, age, and sex.

There are many advantages to having pedestrian safety (as well as other highway safety issues) taught as part of the classroom curriculum. Pedestrian safety can be covered more thoroughly when woven into the regular curriculum, allowing more time for questions and discussions. Also, children learn by doing. An integrated lesson will permit educators to take children outside for walks to reinforce lessons taught in the classroom. Hands on learning is not possible during one-time safety assemblies presented by an outside agency.

Table 3 illustrates the number of highway safety units that the State Departments of Transportation and Education recommend be implemented in the schools for kindergarten through twelfth grade every school year.

Age-Appropriate Materials

The recommended age-appropriate materials that are or will be provided to the schools include three age ranges: pre-school through second grade; third through sixth grade; and seventh through twelfth grade.

Pre-School - Second Grade. Watchful Willie is a puppet who helps teach young children five basic safety messages. This program uses elementary vocabulary and presents ideas one at a time. This program avoids presenting bad examples that children might mimic. Instead, it establishes a basis for developing safe habits.

The safety messages that Willie presents are:

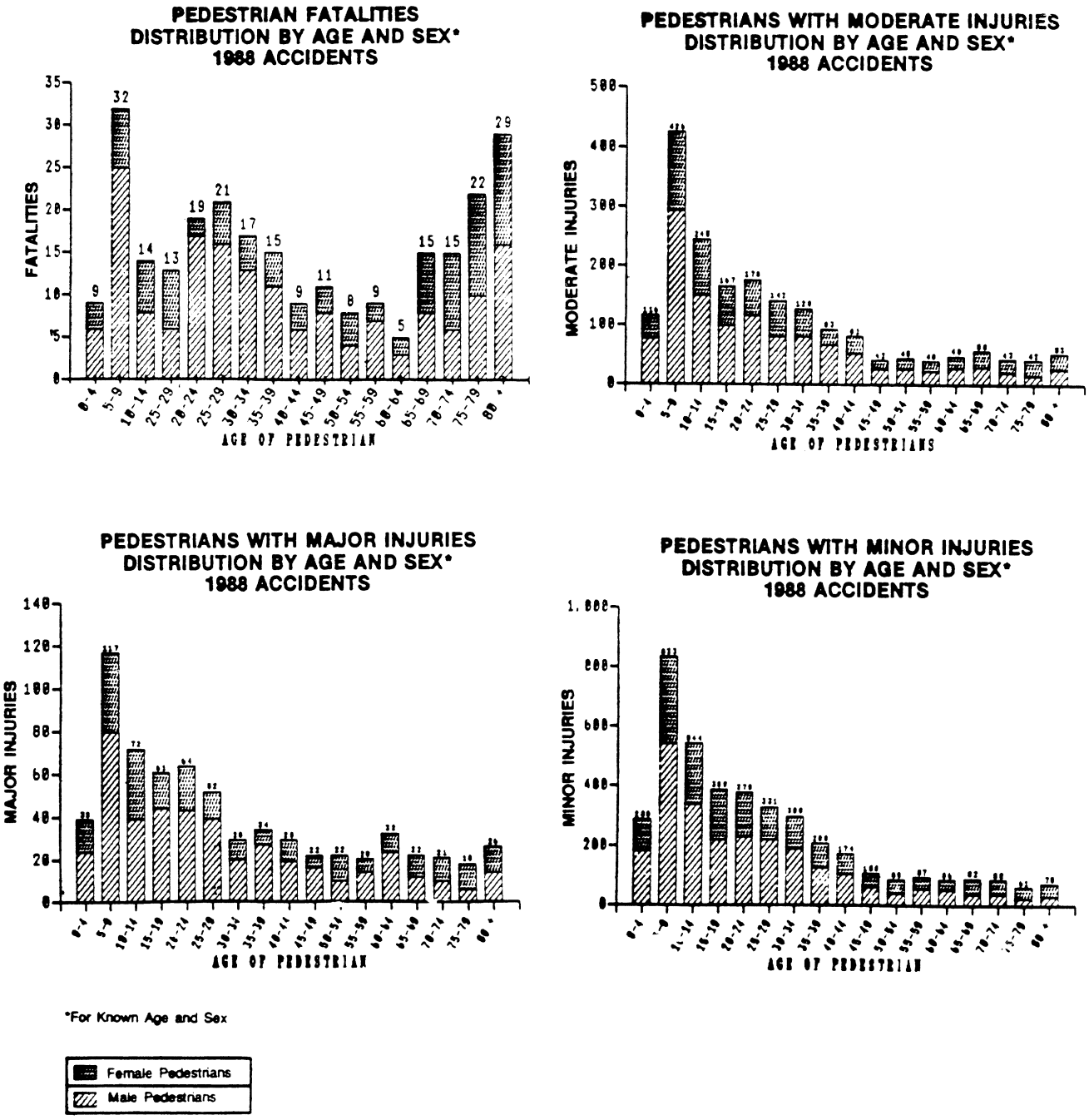


Figure 2. Pedestrian accidents in 1988, by age, sex, and level of severity.

- Streets are dangerous for small children.
- Sidewalks are safe for walkers.
- Always stop at the curb.
- Cars are bigger than I am.
- Always cross with someone older.

Hand-outs include:

- Watchful Willie coloring sheets.
- About Children in Traffic (for parents).

Third through Sixth Grades. For this group, a combined program (safety belts and pedestrian and bicycle) is more effective. It starts by covering the Who, What, When, Where, and Whys about safety belts, followed up with a discussion of either pedestrian or bicycle safety. The safety messages addressed to this age group fall into five categories. They are:

- Search Behavior
  - Always stop at the curb or edge of the road before entering.
  - Always look left, right, and left again when crossing.
  - Watch for cars backing out.
- Be Seen
  - Walking at night is dangerous. Children should wear retroreflective materials and/or carry a flashlight.

Table 3. Suggested units of presentation of highway safety topics.

Grade	Safety Belts	Drinking and Driving	Pedestrian Safety	Bicycle Safety	School Bus Safety	Speeding/ Risk Taking
K	1-2*		2-3	1	1	
1	1-2		2-3	1	1	
2	1-2		2-3	1	1	
3	1-2		2-3	1	1	
4	1-2		1-2	1	1	
5	1-2	1	1	1	1	
6	1-2	1	1	1	1	1
7	1-2	1-2	1	1	1	1
8	1-2	1-2	1		1	1
9	1-2	2-3	1		1	1
10	1-2	2-3			1	1-2
11	1-2	2-3	1			1-2
12	1-2	2-3				1-2

*Units of Presentation per school year.

- Traffic Signs, Signals, and Markings

  - Provide basic instruction on traffic signs, signals, rules, and crosswalks.
  - Green lights do not mean it is safe to cross. You must stop, and look left-right-left to be sure it is safe to cross.
  - Flashing "DON'T WALK" means wait for next "WALK" signal.
  - Use sidewalks.
  - Always walk facing traffic—as far to the left as possible.
  - Do not "jaywalk."

- School Bus

  - When waiting, stand well off the road.
  - When walking from the bus stop:
    - -- Stay on the sidewalk or the shoulder.
    - -- Cross five giant steps in front of the bus, so the driver can see you.
    - -- Stop at the edge of the bus.
    - -- Look left-right-left.
    - -- Wait for vehicles to stop, then make eye contact with drivers.
    - -- Search again.
    - -- Cross when all vehicles have stopped.

- Recreation

  - Streets are not safe places for children to play. Parks and playgrounds are better alternatives.

Suggested films for this group are:

- *Getting to School the Safe Way*
- *Be Safe on your Bike*
- *I'm No Fool on a Bicycle*

Seventh - Twelfth Grades. After reviewing the pedestrian materials available, it was determined that suitable materials for this age group do not exist. The Department is currently funding (through the Erie Comprehensive Highway Safety Project) a production of a pedestrian safety rap video titled "Wanda Walker," and targeted for teenagers aged 12 to 15.

COUNTERMEASURES - LOCAL

Comprehensive Philadelphia "Street Smart" Program

As discussed previously, all the Pennsylvania Comprehensive Highway Safety Projects have a pedestrian component. However, in the urban areas, special pedestrian programs are being implemented or will be soon. The City of Philadelphia produced such a program.

The Philadelphia "Street Smart" comprehensive pedestrian safety program is designed to reduce pedestrian accidents by developing safer walkers, more attentive drivers, and a safe environment for pedestrians. The Philadelphia project will be based on the "Walk Alert" program, which incorporates public information/education, law enforcement, and traffic engineering. To date, analyses of the following issues—as they relate to the Philadelphia Pedestrian Accident Problem—are under way:

- Accident location
- Accident type
- Pedestrian actions
- Pedestrian age
- Pedestrian drinking
- Night versus day
- Signalized and non-signalized intersections
- Mid-block locations
- Traffic volumes
- Operating speeds
- Other data (such as injury severity, pedestrian and/or driver maneuvers, etc.)

The approach in Philadelphia is to work with City of Philadelphia Traffic Engineers, City of Philadelphia Police, and the Philadelphia Comprehensive Highway Safety Coordinator to review the pedestrian problem in the city, target specific problem areas and types, and define and

implement appropriate engineering, education, and enforcement countermeasures.

One decision already reached is that a concentrated pedestrian campaign will be targeted for Broad Street (one of the areas in the city where more than 850 people have been struck by vehicles over the past 5 years). Broad Street is a high-volume four-lane roadway between 75 ft and 80 ft (including parking on either side and a median strip or painted section in the center) wide with relatively high operating speeds and significant numbers of crossing pedestrians.

Among the countermeasures to be implemented as part of "Street Smart" are:

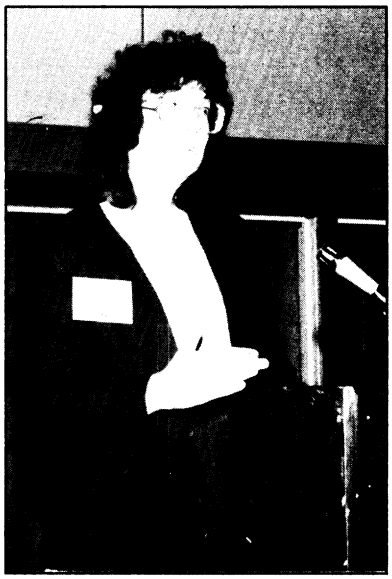
- Modifications of signal timing to provide increased pedestrian crossing time (from 90 seconds cycle length to 100 seconds in order to cross Broad Street).
- Refurbishing of pavement markings.
- Potential inclusion of pedestrian refuge islands at specific intersections.
- "Kick-off" of the new pedestrian public information/education Campaign. *Philadelphia Kids Walk Smart,* to coincide with the physical improvements to Broad Street.
- Publicized selective police enforcement during the kick-off period and continue selected enforcement periods throughout the year.

CONCLUSION

Those who reviewed pedestrian materials available on both a State and national level found a definite need to implement comprehensive pedestrian programs in urbanized areas.

Programs should include the following major components:

- National campaign designed to increase public awareness that there is a pedestrian safety problem.
- Development of a program in which parents take a more active role in teaching their children the proper way to cross the street (based on the Hugo H. VanderMolen study).
- Development of a middle and senior high school pedestrian program (print and video).
- Campaigns targeted for the older pedestrian, using videos.
- Campaigns targeted to the dangers of drinking and walking—to combat the message that if you are too drunk to drive, walk home.
- Campaigns to educate motorists to be more aware of pedestrian rights.
- Selective, low-cost engineering improvements at locations that have a history of, or the potential for, pedestrian accident occurrences.
- Selective enforcement programs, which are well publicized, in areas that have pedestrian accident occurrences.
- Integrated and highly targeted education, enforcement, and engineering initiatives on specific arterials that have a major pedestrian accident problem.



IMPROVING PEDESTRIAN PERFORMANCE AND ENVIRONMENT: WORKSHOP REPORT

Chairperson: Cheryl Neverman
Director of Community Education
New York City Department of Transportation

FHWA Technical Representatives: Howard Hanna and Pat Ehrlich
NHTSA Technical Representative: Ronald E. Engle

TOP 10 COUNTERMEASURES

The workshop participants ranked the following 10 countermeasures as the top short-term priorities, in order of priority:

1. National awareness campaign
2. Designate pedestrian safety as a national priority area
3. Engineering improvements
4. Pedestrian safety education
5. Conspicuity
6. Enforcement
7. Data Collection
8. Improve visibility at intersections
9. Problems of elderly pedestrians
10. Community outreach

Workshop participants developed implementation plans for countermeasures 1 through 8. The plans are presented below. Because successful implementation of one countermeasure hinges on implementation of the other two, the plans for countermeasures 1, 2, and 7 are presented as a unit. The same approach has been taken with countermeasures 3, 5, and 8. Plans for countermeasures 4 and 6 are presented independently.

COUNTERMEASURE 1/ COUNTERMEASURE 2/ COUNTERMEASURE 7

1. Develop a national awareness campaign. 2. Designate pedestrian safety as a national priority area. 7. Data collection. Countermeasures 1 and 2 ranked equally as the top countermeasure for this workshop. Widespread conviction that pedestrian safety is a serious issue motivates a response to develop and implement related countermeasures. (In fact, the first implementation step to other countermeasures often is to instill awareness of the objective—pedestrian safety—before tackling complex and technical solutions.)

In establishing pedestrian safety as a national priority and developing a national campaign to promote this cause, the participants believed that a wide audience must be reached: citizens of all ages and backgrounds, law enforcement personnel, educators, politicians, and servers and sellers of alcoholic beverages. The national awareness campaign is envisioned as a joint effort between the National Highway Traffic Safety Administration (NHTSA) and the Federal Highway Administration (FHWA) in terms of priority and funding.

Countermeasure 7 was presented with the above countermeasures because data collection fits in with their objectives. Accessible and accurate information on pedestrian safety-related topics is needed to support the pedestrian safety cause. The objective of data collection is to develop the capability to obtain and analyze the pedestrian accident database on a national level to categorize pedestrian accidents and sites.

Constraints

There is a problem with Federal funds being used to purchase advertising for a national awareness campaign. Some areas of pedestrian safety, such as bicycle safety, do not often generate interest in the public's eye. Joint agency involvement creates difficulties in promoting a national awareness campaign. Expediting the procurement process is often difficult. Limited funds and personnel are available for data collection and analysis.

Implementation Plans

To implement countermeasure 2, the rulemaking process must be initiated. The following action steps are needed before rulemaking can become a reality: analyze and publicize available data (using NHTSA data bases) on pedestrian safety issues and identify and develop a constituency who could function as a grassroots support system to convince the Administration that rulemaking is essential that would include pedestrian safety as a national priority area.

402/403 funds should be used to help make pedestrian safety a national priority and support its importance by funding more projects and activities.

The group recommended that a series of FHWA/NHTSA Town Hall meetings be conducted to increase public awareness and gain support for the rulemaking process. (Town Hall meetings allow people at all levels to meet each other. Community-based programs are an important component of Town Hall meetings. Once constituencies are established, information is then communicated throughout the communities.)

Countermeasure 1 could be initiated at the same time other efforts are made to make pedestrian safety a national priority area. By waging a national campaign, communities can work together to promote awareness of the pedestrian traffic safety problem. (The "Vince & Larry" campaign, developed through the NHTSA Safety Belt contract, is an example of a national campaign that worked.) To generate more interest in pedestrian/bicycle safety, the participants recommended that school bus safety education—an issue that receives more attention (due to local grass roots efforts often initiated through emotional responses to a local crash)—be expanded to include pedestrian safety education.

To produce an effective campaign, the following action steps are needed: identify a national theme and spokesperson; procure a contractor to develop the campaign; initiate a high-level kickoff, use a combination of advertising and media blitz; produce materials that are not copyrighted so that they can be easily reproduced and widely disseminated to the public, and possibly use an incentive approach to advertising. Campaign support could also come from national associations such as the American Automobile Association (AAA), National Safety Council, International Association of Chiefs of Police (IACP), or from corporate sponsorship, such as shoe companies.

To increase data collection (countermeasure 7), the participants recommended the following action steps: identify potential data bases; identify available funds, existing and new; develop a sampling plan; obtain needed data; analyze and categorize data; disseminate findings to appropriate agencies; and develop guidelines and workbooks for use by Government agencies on how to identify pedestrian problems and the available countermeasures. Available data bases are the Centers for Disease Control, the Fatal Accident Reporting System (FARS), the National Accident Sampling System (NASS), the Highway Safety Improvement System (HSIS), the General Estimate System in NHTSA, and State data bases.

COUNTERMEASURE 3/ COUNTERMEASURE 8/ COUNTERMEASURE 5

3. Engineering improvements. 8. Improve visibility at intersections. 5. Conspicuity. Making the pedestrian environment safe requires a broad spectrum of engineering improvements as well as pedestrian-initiated safety measures. An example of an engineering improvement is the installation of sidewalks.

Intersections represent a significant part of the pedestrian environment; workshop participants felt that visibility at intersections should be a focus for engineering improvements. From a motorist's perspective, pedestrians are also part of the environment; thus, pedestrians can contribute to their own safety by becoming more visible. Conspicuity refers to making pedestrians more visible. Retroreflective clothing and materials were cited as ways to increase visibility.

Constraints

Funding to improve or replace sidewalks can add to a city's percentage of highway safety funding, where sidewalks are optional. Studies show that in locations using Right Turn on Red, motorists sometimes feel they are not responsible for pedestrians who cross their path. Pedestrians and drivers are not often aware of the differences between visual perceptions during the day versus night. Pedestrians are not motivated to wear retroreflective clothing/materials. Manufacturers do not often supply enough retroreflective clothing; they prefer to restock when supply runs low.

Implementation Plans

To implement countermeasure 3, the first step is to modify Federal policies so that pedestrian safety issues are included as a priority issue. Then, the following action steps are needed:

1. FHWA should review Federal policies related to pedestrian safety to evaluate which ones need modification to include pedestrian considerations, or, where necessary, more clearly define the intent of pedestrian considerations. FHWA should also suggest key items for States and local policymakers to review.

2. State and local governments should review these policies with or without FHWA assistance. Guidelines are available from the American Association of State Highway and Transportation Officials (AASHTO) and the Institute of Transportation Engineers (ITE). Policies should be compared to the MUTCD and other technology transfer (T^2) materials. Once policies have been reviewed and updated, they must be given as much priority as those at the Federal level.

3. Professional training and awareness must be provided in the pedestrian safety area. Objectives are to develop a National Highway Institute (NHI) course on pedestrian facilities, available at no cost; review T^2 materials in pedestrian improvement areas to see if other resources are needed and ensure that information reaches the Government officials who need it, and provide training courses at no cost; distribute the courses through AASHTO, ITE, and National League of

Cities; ensure that users are aware of these materials; and check the Hazardous Elimination Safety (HES) Program regulations to see if changes are needed to give States the flexibility to include pedestrian safety improvements, and see if regulations should be changed to allow the use of traffic conflict analyses to identify projects.

4. FHWA and local governments need to reach out to land use planners/developers to also plan facilities for pedestrian use and control vehicle access points.

5. To counter local jurisdictions' resistance to putting sidewalks into transportation arteries, AASHTO should review policies regarding when to install sidewalks.

To implement countermeasure 8, "Improve visibility at intersections," high hazard and corridor problems should be evaluated. In the short-term, one of the easiest areas to improve is the intersections. Mechanisms for improving intersection visibility include, but are not limited to, effective street lighting, landscaping cleanup, far-side bus stops, one-way streets, police as crossing guards during peak periods or special events, signals that are more visible, pavement markings, proper signing, and, where necessary, highly reflective signing. Mechanisms for improving other hazardous areas include constructing natural barriers to keep people from crossing where they are instructed not to cross in the first place. Creating safe route continuity—especially to schools, worksites, community centers, and places frequently trafficked by many older pedestrians—also contribute to pedestrian safety.

Another step to implementing countermeasure 8 is to evaluate the use of Right Turn on Red, especially where pedestrian usage is heavy and/or violations of Right Turn on Red are frequent.

To implement countermeasure 5, conspicuity, we need to educate pedestrians about the differences between human visual perception during the day versus at night; and pedestrians need to be educated about the *various* ways to become more visible by day and night. Pedestrians can become visible by wearing retroreflective clothing and materials; but they are also noticed by wearing bright colors or white and/or using a flashlight. Retroreflective materials can be placed on items such as wheelchairs, baby strollers, and walking canes. Simultaneously, manufacturers must be encouraged to market retroreflective clothing and materials and keep them in adequate supply. Finally, manufacturers must be encouraged to build retroreflective materials into both hardware (i.e., strollers, shopping carts) and software (i.e., clothing).

COUNTERMEASURE 4

Pedestrian safety education. The participants agreed that pedestrian safety education should target pedestrians of all ages as well as professionals, including engineers, enforcement officials, and educators.

The participants stressed the importance of using—wherever possible—existing materials for dissemination. While significant information is available for the preschool and elementary school age child, educational materials for the following three age groups are lacking: middle school and high school children, drivers, and the elderly. Older adults bring special problems to the educational process. They are often reluctant to listen to any messages so it becomes a challenge to make them aware of their responsibilities as pedestrians. Messages to this audience must stress good safety practices and pedestrians' susceptibility. Finally, professionals, including educators, enforcement personnel, and engineers, also need up-to-date accurate information on pedestrian safety needs and principles so they can better apply this knowledge to their everyday work.

Constraints

Constraints include locating the resources to produce educational materials and finding ways to produce the materials within limited budgets. Additionally, systems must be established to ensure that the products will be reproduced after they have sold out. Determining the most effective ways to market materials, coordinating product-research development, and competing with other traffic safety areas in terms of design and packaging of educational materials were also concerns raised by participants.

Implementation Plan

To implement countermeasure 4, one action step is to disseminate the variety of educational materials that already meet established criteria. Thus, the participants recommended that the following materials be actively disseminated:

- NHTSA's "Walking in Traffic Safely," a guide for preschoolers, which teaches street nomenclature and tips for crossing the street safely.
- The Safe Street Crossing Program and "Walk Alert" brochure, for kindergartners through third graders.
- "And Keep on Looking," for fourth through seventh graders.
- "Mission Impossible: Operation Safewalk," American Association for Retired Persons' "Safety Steps for Pedestrians" slide/tape show, and NHTSA's safety materials, for older pedestrians.
- Public service announcements on television and radio on the driver's role in preventing pedestrian accidents, providing information on topics like Right Turn on Red laws, targeted to the driver.
- Highway Safety Representative's Resource packages, for State and local highway safety officials to use to help all professionals implement pedestrian safety programs.

Participants also recommended finding other ways to disseminate, and market information on pedestrian safety, including the T^2 centers and the Pedestrian Federation.

The participants recommended revising the outdated and/or other unsuitable elements of Willy Whistle, a pedestrian safety guide for kindergartners through third graders and then actively disseminating this program with the other two programs for this age group.

Another urgent action step is to develop, produce, and disseminate educational materials for 12- to 18-year-olds. (Suitable materials are not currently available for this age group, although one State department of transportation is developing a rap video safety program.) Participants recommended that FHWA and NHTSA produce and disseminate courses on pedestrian safety training for professionals, including educators, enforcement personnel, and engineers.

Besides developing and disseminating educational materials, the participants recommended the following action steps to make the teaching process and production of educational materials more cost-effective: (1) train older persons to teach others, and in the process, they can learn as they teach. (This plan can be implemented through schools, nonprofit and civic organizations, and the media.) (2) make alliances among private industry, nonprofit organizations, and others so that educational materials can be produced at lower costs and attractive. (An excellent example is the "Walking in Traffic Safely" program and "Children Riding on Sidewalks Safely" by NHTSA that was enhanced by the National Association of Educators of Young Children (NAEYC) by taking a black and white product, printing it in color, and distributing it throughout the country—at cost.)

COUNTERMEASURE 6

Enforcement. The participants felt that the priorities for pedestrian safety are important and must be evaluated through the law enforcement community. Within the broad scope of this countermeasure, participants developed three specific areas of focus: (1) elevate awareness of the pedestrian safety priority from the top down, (2) enhance enforcement education, and (3) pass laws and local ordinances. Community outreach is needed to achieve successful implementation of this countermeasure.

Constraints

Several concerns were raised, some of them pertaining to developing guidelines to help enforcement officials address safety issues, locating appropriate safety information, and determining how to make that information available through the enforcement community.

Another issue raised concerned the question of how police can enforce pedestrian safety when they do not have the power to arrest people for "drunk walking." "Don't Drink and Drive" implies that it is acceptable to walk while intoxicated; yet this concept should not be promoted. The benefits of pushing for a law that would require the arrest of pedestrians picked up for drunk walking were questioned. Should enforcement be pushed into doing something that is not needed?

Public perception is seen as an additional constraint. Enforcement of laws and ordinances against jaywalking and drunk driving is often perceived by the public as harassment. Perhaps the goal should be to change public perception.

Finally, inherent difficulties exist when working within a legal system that is reluctant to pass laws and ordinances, and when attempting to get adequate funding to increase law enforcement.

Implementation Plan

The steps to implement area (1) of countermeasure 6 are to ensure that pedestrian safety is elevated as a priority first by law enforcement officials and then with the general enforcement community. Only then can the community at large participate in this campaign. Also, the pedestrian safety priority must become a policy of IACP and the National Sheriffs Association. Then, the Selective Traffic Enforcement Program (STEP) must develop a creative enforcement program. Finally, the Conference of Mayors must support pedestrian safety as an enforcement priority. National enforcement can be sought as a national policy. Organizations (like IACP) need to develop a program emphasis with funding incentives that are appropriate in this area. (The stipulation is to use new dollars, so that existing funds are not used—especially 403 money.)

To implement area (2) of this countermeasure, chief enforcement management, especially those in urban areas, must establish enforcement education as an equal priority. Pedestrian safety must become an important part of traffic enforcement. Action steps are to: disseminate existing educational information used in the enforcement setting and distribute them during roll call, and to hold awareness seminars. Topics at these seminars might include problem identification, accident analysis, high incidence accident "types" and sites, and countermeasures.

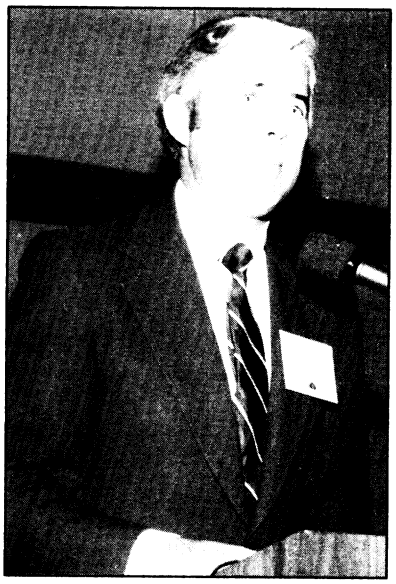
Once areas (1) and (2) have been successfully implemented, area (3) can be implemented. To accomplish this, laws and ordinances to increase enforcement rates should be adopted. Jaywalking laws are one example. Public drunkenness is another area that may require legislation and/or police enforcement. Impaired driving gets a lot of attention, but impaired "walking" may be just as serious. Local ordinances should be promoted to require responsible alcohol service training for servers/sellers of alcoholic beverages. The goal is to increase awareness of existing legal liability for serving minors and/or visibly intoxicated

patrons. The "impaired walking" message should be included so that walking, as an alternative to driving impaired, is not suggested.

Current laws and ordinances should be reviewed for their applicability to enhancing pedestrian safety. Some current ordinances may even reduce pedestrian safety.

Other steps to achieving implementation of countermeasure 6, which fall outside the three main areas, include the following: use auxiliary forces such as crossing guards and other volunteer citizens to enhance police efforts to increase pedestrian safety; implement public information and education; and improve motorist assistance so that persons in disabled vehicles are not at high risk on the road.

REDUCING ACCIDENT SEVERITY



MEASURES TO REDUCE ACCIDENT SEVERITY: AN INTEGRATED ROADSIDE SAFETY CONCEPT

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To reduce accident severity associated with vehicles that leave the roadway, roadside safety must first be improved. However, the subject of roadside safety, or roadside improvement, cannot be separated from accident severity. To provide a roadside environment that is truly more forgiving, improved roadside safety must begin in the earliest stages of project planning and right-of-way acquisition. A safer roadside must be designed as project plans are produced. Quality control at the construction stage must ensure that the roadside enhancements are actually built into the project. And, finally, a comprehensive maintenance program must continually maintain the roadside environment so that safety is not degraded over time.

Only an integrated approach to roadside safety can provide a reduction in accident severity for vehicles that errantly leave the travelway. And certainly the area of roadside safety is fertile ground to effect changes in accident severity. Of the total number of fatalities that occur on the nation's roadways, approximately 30 to 35 percent can be attributed in some way to a single vehicle run-off-the-road accident—one fatality out of every three that occur.

Preventing run-off-the-road accidents or improving roadside safety is certainly not easy to accomplish because there are hundreds or thousands of miles of roadside and median conditions on every State, county, and city roadway system, representing a variety of traffic speeds, traffic volumes, and operating conditions. With limited resources and an extensive national roadway system, the ability to apply improvements at the locations where the greatest reduction in accident severity can be accomplished becomes a critical decision matrix.

CONSIDERATIONS FOR IMPROVING ROADSIDE SAFETY

Several considerations arise in improving the safety of the roadside environment. Each area of consideration has certain benefits and costs associated with the improvement. The provision of a clear recovery area or a clear zone is one example.

Providing Clear Recovery

A clear recovery area has been defined as a traversable and unobstructed roadside area or

slope extending beyond the edge of the travelway or driving lane. Because of efforts to provide a clear recovery area or adequate protection against obstructions, many obstacles located within a clear zone distance have been removed, redesigned, or shielded with longitudinal barrier and vehicle impact attenuators. While a wide, flat side slope is no doubt safer for the errant motorist than a narrow, steeper side slope, the question continues to be just how wide, and how flat, should a side slope be to provide an adequate margin of safety.

In 1974, the American Association of State Highway and Transportation Officials (AASHTO) issued a report that suggested that on high-speed roadways, a lateral width of 30 ft or more would permit approximately 80 percent of vehicles encroaching beyond the edge of the travelway to recover. The 1977 AASHTO *Guide for Selecting, Locating, and Designing Traffic Barriers* suggested variable clear zone distances based on traffic volumes, speeds, and slope rates. The 1989 AASHTO *Roadside Design Guide* while recognizing that clear zone distances are not precise, suggested limited ranges of values rather than a specific number for varying roadway conditions. However, all these numbers are approximations. The distances were originally developed based on relatively limited data, which were then extrapolated to cover a variety of conditions.

The reason for the limited data goes back to the variety of roadside conditions which exist. Added to this is the variance of orientations under which an errant driver may encroach on a side slope. While limited modeling and vehicle testing have been done on controlled side slope conditions and the results have established desirable values, the caveat remains that clear recovery areas as wide as possible should be provided where practical.

The limitations to providing clear recovery areas are numerous. The national highway system is, for the most part, established. Most current roadway transportation improvements lie in the areas of rehabilitating and adding capacity to the existing system. Therefore, to provide a wider, clear recovery area or flatten side slopes, right of way must be purchased along the existing highway corridor.

Purchasing Right of Way

In urban areas, the availability of additional right of way can be extremely limited. In some metropolitan areas, land values have increased to the point that right of way is purchased by the square foot. Resources can be quickly exhausted when values become inflated. Also, damages must be paid to some businesses and homeowners when the value of their property is degraded through partial land takings. For example, a shopping area that loses one-half or two-thirds of its parking area can claim a substantial portion of its entire property value in damages. Additional right of way may simply be unavailable in some urban areas because of political or societal considerations. In past decades, many towns or small cities wanted the new highway to come through the urbanized area. Now many towns raise serious objections and want the highway to be as unobtrusive as possible or to go around their city.

In rural areas, right of way is also becoming more difficult to obtain. Environmental considerations are at the forefront of society's concern for future generations. Wetlands can no longer be destroyed without adapting or building suitable replacement areas. Extensive investigations of future highway sites or expansions are necessary to determine whether artifacts or archeological sites could be destroyed. Slopes must often be constructed in such a way to prevent contaminated runoff from directly reaching streams or ground water sources. Trees are beautiful natural resources that can take years to develop, but may represent a significant hazard when located near the driving lane in the roadside environment.

The public demands that these environmental limitations be considered when trying to provide a sufficient recovery area along the roadside.

Highway engineers have devoted countless hours to working on these environmental issues and finding ways to mitigate potentially harmful effects. Transportation needs and environmental protection need not be mutually exclusive items.

Using Barriers as Protective Devices

When obstacles exist near the side of the roadway and a sufficient clear zone cannot be provided, other alternatives to protect the errant driver and reduce potential accident severity may be selected. When the obstacles are numerous and extend over a significant section of roadway, a longitudinal barrier may be chosen as a protective device. However, when a barrier is installed at the edge of the roadway, the likelihood of impacting the barrier is increased because of its proximity to the driving lane. Therefore, a barrier should only be installed if the result of the vehicle striking the barrier is less severe than the result of a vehicle encountering the obstacle on the roadside slope.

Combined with high speeds, longitudinal barriers such as guardrail can be extremely formidable hazards. Table 4 shows fixed object fatalities. Guardrail accidents rank third only behind trees and utility poles. Placing barriers where they are not needed can be as detrimental to roadside safety as not having necessary barrier protection. Many agencies have developed charts or scales of relative severity for vehicle encroachment, under different slope conditions, to aid the engineer in determining whether roadside or median barrier is necessary. An example of one chart type is given in figure 3. However, no charts evaluate every roadside condition, and sound engineering judgment, tempered with experience, has to remain a critical factor in determining barrier placement to ensure that the safest possible transportation facility is provided.

Guardrails are probably among the most common types of longitudinal barriers, which are classified as flexible systems. As the name implies, a flexible system will flex, or deflect, over some lateral distance when subjected to impact load-

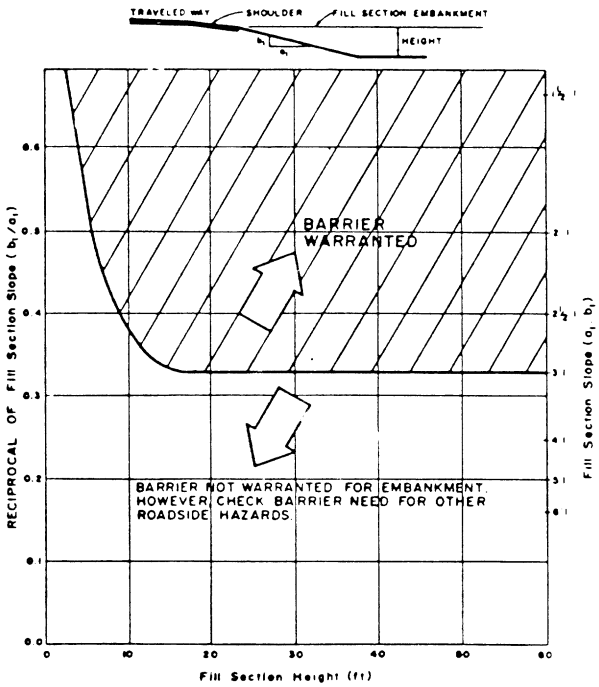

Figure 3. Comparative risk warrants for embankments.

ings. The amount of deflection depends on the system and the circumstances of the impact. Flexible systems, such as 3-strand cable, have greater deflection, and others, such as thrie beam, have less deflection. All these systems work very well when installed properly and loaded during impacts within normally expected conditions. Adequate space must be available behind the installation to accommodate the expected deflection for that particular system.

The deflection of a system may serve the advantage of errant vehicles that strike the barrier. Because the system deflects, the deceleration forces that the vehicle experiences will be lessened. In other words, the vehicle will take a "softer" hit because of the energy dissipated in the deflection of the barrier system.

Table 4. Fixed object fatalities by object type.*

Fixed Object	1985	1986	1987	1988
Tree/shrub	2989	3444	3299	3328
Utility pole	1298	1495	1406	1476
Guardrail	1258	1374	1326	1384
Embankment	1211	1332	1396	1360
Culvert/ditch	1337	1472	1393	1475
Curb/wall	982	960	861	892
Bridge/overpass	628	577	571	553
Concrete barrier	225	197	203	248
Sign or light support	508	551	538	576
Other pole/support	481	518	495	501
Fence	431	478	484	482
Building	101	100	108	106
Impact attenuator	14	9	18	15
Other fixed object	630	699	729	636
TOTALS	12093	13206	12827	13032

*Source: Fatal Accident Reporting System (FARS), NHTSA

Flexible barrier systems vary in the type of end treatment protection required. Cable systems, for example, generally have adequate tie downs at the groundline that represent no hazard to vehicles. Guardrail installations have various types of end treatments with associated advantages and disadvantages. The old stand up end was known to spear vehicles under some impact conditions. One method to overcome the spearing action was to twist the rail downward and anchor it to the ground. This treatment is known as the turn down end and eliminated the spearing potential. However, in some impact situations, the vehicle may ride up the rail and vault the installation. Efforts have been made to overcome the vaulting action by allowing the rail to drop down or by flaring the end treatment to reduce the chances of a vehicle impacting the turned down end.

Using End Treatments

Another end treatment is called the breakaway cable terminal (BCT). BCT successfully eliminated the spearing or vaulting action, but may be difficult to install correctly. In addition, the terminal has been shown to provide unacceptable deceleration forces for some smaller vehicles. Again, efforts have been made to modify the system to overcome these difficulties.

Patented end treatments such as the Safety Barrier End Treatment (SENTRE) can be used, but these items are costly and suitable for fewer locations. An experimental unit called the guardrail extruder terminal has recently been tested successfully. It consists of a box that flattens the rail element and bends it away from the vehicle under headon impact conditions.

Some of these units are currently being installed for field evaluation.

Other end treatments have also been used with varying success. Whenever a longitudinal barrier is introduced, it must be terminated in such a way that a potential roadside obstacle is not left at the edge of the roadway.

Where flexible barrier systems are not appropriate, a rigid system such as concrete barrier may be considered. Rigid barrier systems may be used in situations where large deflections cannot be tolerated, where a significant percentage of heavier vehicles exists in the traffic stream, or where decreasing the potential of vehicles penetrating the barrier system is necessary.

While rigid systems such as concrete barrier appear to have significant advantages over flexible systems such as guardrails, consider the following items. First, rigid systems can be expected to perform satisfactorily under a normal range of conditions without deflection; however, the barriers can deflect or be penetrated by certain vehicles under adverse impact situations. The amount of deflection will be dependent on the amount of anchorage in the barrier, the strength of any existing joints in the barrier, and the energy generated by the impact. Second, rigid systems represent a significant increase in initial cost compared to flexible systems, but the maintenance associated with concrete barriers is usually much less. Rigid systems will rarely be justified for roadways with low traffic volumes.

The most common rigid barrier is the concrete safety shape or Jersey barrier as shown in figure 4. The concrete safety shape is widely used throughout the country. Because of the differential in the sloping faces, a vehicle will tend to ride up the barrier and have a roll angle imparted to it. This action dissipates or redirects the energy of the vehicle longitudinally down the barrier and affords a lessened impact force. Because of the roll imparted to the vehicle, some very shallow angle impacts result in only moderate vehicle damage.

Some testing and field experience with the concrete safety shape suggested that the barrier might increase the possibility of vehicle rollover. To compensate for that possibility, the F-shape barrier shown in figure 4 was developed, which lowered the height of the upper near vertical face. Recent studies, however, have suggested that the rollover potential is not as great as originally thought and the F-shape shows little, if any, improvement in performance.

The single slope barrier in figure 4 eliminated the lower sloping face of the concrete safety shape. While this shape allows for future overlays next to the barrier without having to adjust the height of the barrier, preliminary performance data appear to be essentially the same as that of the concrete safety shape. A vertical concrete barrier (shown in the figure) is used in some instances, particularly as bridge rails. The vehicle remains very stable because no roll angle is imparted by the vertical face; yet the deceleration forces are higher for this barrier shape.

End treatment for rigid barriers, or any single point hazard, is normally handled by some type of vehicle impact attenuator or crash cushion, unless the obstacle can be repositioned or eliminated. The two types of attenuators include compression crash cushions and inertial barriers. Compression crash cushions absorb the kinetic energy of a vehicle by crushing or plastically deforming the material in the cushion. The Guard Rail Energy Absorbing Terminal (GREAT) is one such patented crash cushion. GREAT is very effective in decelerating a headon impact or redirecting a side impact. Of course, many portions of the unit are sacrificial and must be replaced in the event of a significant impact. Unit placement is limited by cost considerations. One experimental unit consisting of rubber cells is not sacrificial and can be pulled back into shape after an impact. This unit is very costly and can only be justified for locations where two to three impacts can reasonably be expected to occur annually. Several other compression cushions are available for general or specialized applications.

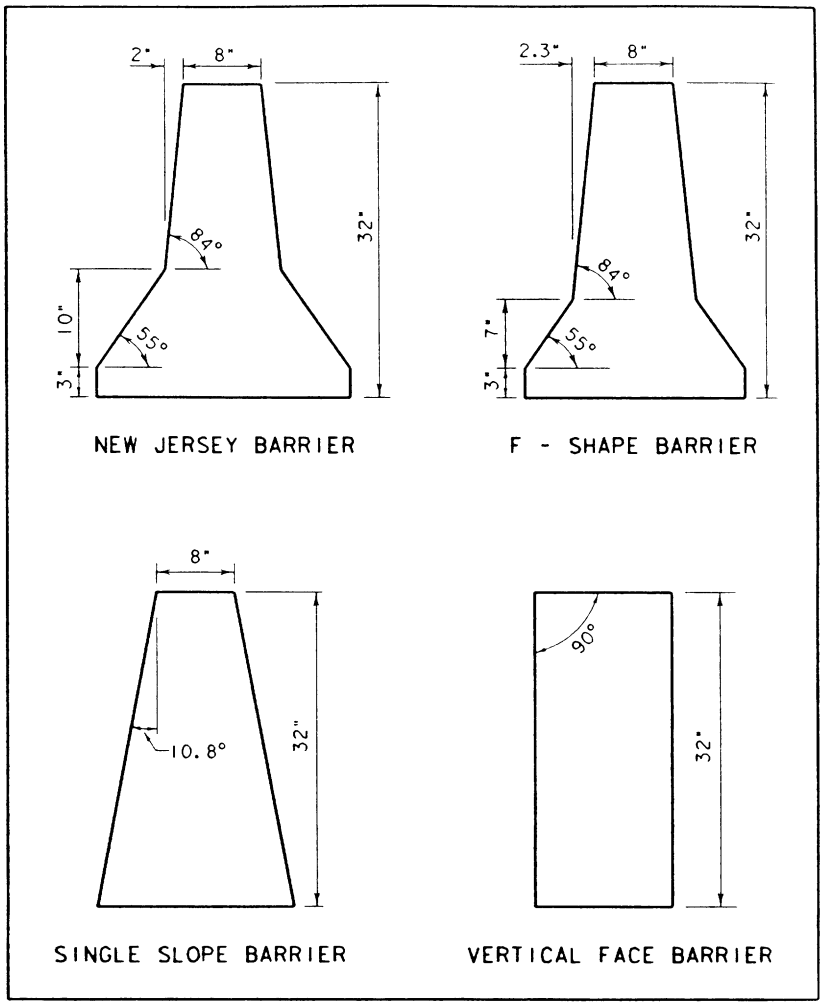

Figure 4. Various concrete barrier shapes.

Inertial barriers change the momentum of a vehicle by transferring the force to an expendable mass of material located in the vehicle's path. One such barrier is represented by sand-filled plastic modules. These modules, while not as costly, are not as effective for side impacts and are more subject to maintenance considerations. Hydraulic cells are also used in cushions to mitigate the hazard represented by a fixed object. Selection guidelines for all vehicle impact attenuators depend on site characteristics, structural/safety considerations, cost, and maintenance characteristics.

Some miscellaneous roadside features should be mentioned and considered in the design process. Drainage structures, particularly side road pipes, are being addressed and safety features are being added. The headwall at the end of a pipe can represent a significant obstacle to the errant motorist. Tapering the ends of the pipes can be an effective way of mitigating these obstacles

and is sufficient for smaller pipes. Larger pipes, even though tapered, still offer a significant opening adversely affecting a vehicle's performance upon leaving the roadway. Safety pipe runners have been suggested as a protection method for these openings. The pipes or bars are located perpendicular to the direction of vehicular travel. The problem with these runners is that they are very susceptible to clogging and hindering the flow of water through the pipe. In some cases, flooding of the adjacent roadway has occurred causing a hazardous situation in the driving lanes. Adjacent property owners have also experienced flooding because of pipe runners catching debris and stopping the water flow. The designer must be allowed to consider all options at individual sites including (1) eliminating the drainage structure, if possible, (2) safety treatment, (3) meeting clear zone requirements, (4) shielding with an appropriate barrier, and (5) orienting the pipe to minimize the obstacle presented. Little can be gained by protecting one point hazard and creating another hazard closer to, or in, the driving lane.

Sign supports and barricades should not represent an undue hazard to cars that leave the travel lane. Breakaway connections and proper mounting heights can enhance the safety of these traffic control devices. Utility poles are also a significant obstacle in the roadside environment. While poles can have breakaway features, their cost is prohibitive. Effective placement considerations are the most promising mitigating procedure. Construction zones should be properly delineated and meet reasonable driver expectations. Good geometric alignment and expedient construction operations will minimize the roadside exposure within detours or construction zones. Pavement dropoffs, both permanent and temporary, should be mitigated where possible. Permanent shallow dropoffs due to pavement edge deterioration should be repaired in a timely manner. Dropoffs greater than 2 in have been shown to contribute to loss of control when the edge is remounted. Temporary dropoffs in construction zones should be adequately delineated, protected with a sloped wedge of fill material, or protected with an appropriate barrier depending on dropoff depth, traffic volume/speed, and lateral distance to the dropoff.

Usable Resources

Again, the area of roadside safety is fertile ground for reducing accident severity. However, the preceding discussion indicates just a portion of the broad spectrum that the subject encompasses. To actually reduce the number of fatalities associated with single vehicle run-off-the-road accidents in the short term, the usable resources must be specifically applied in the areas where reductions can be made. Three suggestions could enable the application of these limited funds to directly reduce the greatest percentages of accident frequency and severity.

First, the ability to identify the particular problem sites along a section of roadway needs to be improved. Planning engineers and designers need to use traffic volume data and associated accident data in developing their plans and designs. A methodology needs to be in place to collect and analyze accident data. This methodology should be specific enough in detail to allow improvements to be made. Accident data needs to include location information that identifies direction of travel as well as the point of occurrence. Law enforcement agencies need to be encouraged to detail accident reports to the extent that the information can be used to reduce accidents at that location in the future. Highway planners and designers need to spend some time in preliminary engineering to analyze the accident data and to make some specific site investigations to determine what measures may be taken to reduce potential accidents.

Second, highway agencies need flexibility to apply the resources to those specific sites where accident reductions can be realized. Too often, highway agencies are faced with a situation where making any roadside improvement during a construction project means that every feature along a highway must be brought up to current standards. With design standards constantly

under review and change, such a scenario results in one of two possibilities. If all features along a roadway are addressed, the pool of resources is exhausted after a few projects are completed. Many other projects with roadside safety needs must be left for future funding programs. Or, if the agency recognizes that bringing all features up to current standards will severely limit other roadway improvements, the project is abandoned, and none of the roadside improvements are accomplished.

The expenditure of limited safety funds at locations where past experience indicates a small probability of reducing accident severity does not represent sound fiscal practice. Once the problem sites are identified, engineers need the flexibility to apply their resources to the specific locations that offer the best opportunity to reduce accidents and moderate their severity.

Third, design applications and construction techniques used to decrease roadside accident severity must be cost effective, which does not imply that raising accident and injury costs to make a roadside application appear more cost effective is the answer. Cost-effective designs commonly run 5- or 10-to-1 when current benefit/cost calculations are made. Increasing this ratio to 20- or 30-to-1 will not make the resources magically appear to accomplish the task. On the other hand, merely stating that every improvement with a ratio greater than 1 should be applied is not realistic either.

A better approach is to measure the improvements at specific locations, and then apply the funds to those areas that show the most cost-effective improvement possibilities. Any improvement should also be examined to guard against improving one safety feature while degrading another. Regardless of funding levels, such an approach represents a workable solution for attacking the greatest accident potential with the available resources and for gaining an immediate impact on accident frequency and severity reduction for the traveling public.

MEASURES TO REDUCE ACCIDENT SEVERITY: NHTSA'S VEHICLE SAFETY PROGRAM

Ralph J. Hitchcock

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NHTSA'S SAFETY PLAN: "MOVING AMERICA *SAFELY*"

Secretary Skinner often notes that when President Bush announced the National Transportation Policy, he made it clear that "safety is the top priority" of the Department of Transportation. In support of that policy, the National Highway Traffic Safety Administration (NHTSA) has developed a strategic plan, "Moving America *Safely*" (See the attachment). The plan clearly delineates the ways in which NHTSA will work with the public and private sectors to reduce the tragic deaths, injuries, and economic losses resulting from crashes on the nation's roadways.

NHTSA's programs generally may be classified into two broad categories:

1. Traffic safety programs relating to Federal, State, and local programs mainly focused on improving human behavior such as "Buckle Up," alcohol, and speed programs.

2. Vehicle safety programs relating to improving the safety performance of vehicles mainly focused on vehicle features that either enable crashes to be prevented, i.e., crash avoidance, or enable people to survive crashes, i.e., crashworthiness.

These two program areas are complementary approaches to this major national problem of automotive injury. Dr. Nichols' paper, titled "Driver Characteristics and Impairment: Implications for Behavioral and Environmental Countermeasures," addresses NHTSA's traffic safety programs; this paper addresses NHTSA's vehicle safety programs.

NHTSA'S ACCIDENT DATA AND ANALYSIS PROGRAMS

NHTSA's safety programs rely heavily on several computerized accident data files. Here is a brief description of the major files.

FARS

NHTSA operates a Fatal Accident Reporting System (FARS) that collects data from the States on all fatal motor vehicle crashes on all public roads in which a person died within 30 days of the crash. This file, dating back to 1975, contains crash information on about 700,000 fatalities. The data that is collected and computerized

includes driver information (with privacy protected) such as age and sex, vehicle information such as vehicle type (e.g., pick-up truck), and accident information such as time and location of the crash and weather conditions.

NASS

NHTSA also operates a crash injury data collection system known as the National Accident Sampling System (NASS). Unlike FARS, which is a census-type file on all fatal crashes, NASS is an automotive injury accident data file that obtains more detailed crash data on the vehicles and crash conditions. NASS strives to obtain statistical representativeness of crashes. Under the NASS program, a few thousand detailed crash investigations are conducted each year. The data are available to researchers in both computerized and hard-copy formats with privacy protected.

State Files

NHTSA also operates an automated collection of files of State accident data based on police reports. These files provide much more limited detail than NASS files, but they represent a much larger number of crashes, enabling some accident trends to be discerned sooner.

Maryland Rollover File

One of NHTSA's latest crash data files focuses specifically on rollover crashes—a particularly dangerous crash mode that often results in occupant deaths and serious injuries, such as paraplegia and quadriplegia. This file of 3,000 rollover crashes permits examination of this type of crash with an unsurpassed level of statistical detail.

THE MOTOR VEHICLE SAFETY PROBLEM

The historical magnitude of the motor vehicle fatality problem may be grasped by comparing the total number of deaths that have occurred on U.S. roads (2,766,590) since 1900 with the total number of deaths of Americans that occurred in *all* U.S. wars since the nation was founded in 1776 (1,186,654). Each year in this nation, about 47,000 people die as a result of motor vehicle crashes. That amounts to five deaths per hour. About 3.3 million more are injured each year (376 per hour)—210,000 of them seriously. Each year, the years of potential life lost amount to 1.4 million, and the related economic losses total $75 billion.

As illustrated in table 5, occupant fatalities resulting from motor vehicle accidents are most frequently associated with passenger cars. The vast majority of nonoccupant fatalities are pedestrians. Not illustrated in the table is the fact that 44 percent of all occupant fatalities occur in small cars.

Table 5. Statistical distribution of fatalities among vehicle occupants and nonoccupants.

	Total	Percent
Occupant Fatalities		
Passenger cars	26,000	55
Light trucks	7,000	15
Multipurpose vehicles	1,000	2
Motorcycles	3,500	7
Heavy trucks	800	2
Others	700	2
Subtotal	39,000	83
Nonoccupant Fatalities		
Pedestrians	7,000	15
Pedalcyclists	900	2
Others	100	—
Subtotal	8,000	17
TOTAL FATALITIES	47,000	100

NHTSA's Motor Vehicle Safety Program

NHTSA's Motor Vehicle Safety program approaches the reduction of losses in crashes in two ways. These two approaches aim to improve the safety performance of vehicles in preventing crashes, and protecting people when crashes inevitably occur. Crash Avoidance programs focus on improving vehicles so that the likelihood of crashes is reduced. The development and application of anti-skid technologies is an example of a crash avoidance program. Crashworthiness programs focus on improving vehicles to reduce the likelihood of death and serious injuries in crashes. The development and widespread application of airbags and other automatic crash protection technologies is an example of a crashworthiness program. These two program areas are complementary approaches to resolving the major national problem of automotive injury.

NHTSA's Crash Avoidance Program

NHTSA's Crash Avoidance program is directed at the development and application of safety technologies in three major areas of current concern: (1) heavy truck safety (using anti-lock brakes), (2) rollover research (reducing the number of rollover crashes), and (3) intelligent vehicles/highways systems (developing electronic systems to reduce the risk and severity of crashes).

NHTSA's Crashworthiness Program

NHTSA's Crashworthiness research program aims to prevent death and serious injuries in the approximately 2 million crashes that result in injuries each year. The program's objective is to reduce the nearly 40,000 occupant deaths and more than 100,000 serious injuries occurring in crashes each year by improving vehicle design to ensure greater safety in crashes.

Crashworthiness research focuses on the four major crash modes for protecting occupants of passenger cars, trucks, and vans: (1) frontal crashes (13,500 fatalities each year), (2) side impact crashes (8,500 people killed each year), (3) rollover crashes (10,000), and (4) rear impact crashes (1,000). Crashworthiness research is also designed to improve protection against pedestrian deaths and injuries (7,000 fatalities each year). In addition, research is being conducted on improving school bus safety, child safety, and transportation for disabled people.

NHTSA's crashworthiness research program consists of four components:

- Research on crashes and the biomechanics, or mechanisms, of injuries in crashes.
- Development of measurement techniques to determine injury risks in crashes and safety technologies to prevent injuries.
- Testing of potential safety technologies.
- Evaluation of safety technologies.

Figure 5 shows some of the elements that crashworthiness research is concerned with as it studies the improvement of vehicle safety performance in crashes. These include development of injury criteria based on human tolerance limits to crash forces and crash test dummies capable of measuring crash forces.

Figure 6 illustrates occupant packaging research to develop safety technologies capable of reducing crash forces felt by an occupant during a crash and thereby reducing the risk of death and serious injury in a crash.

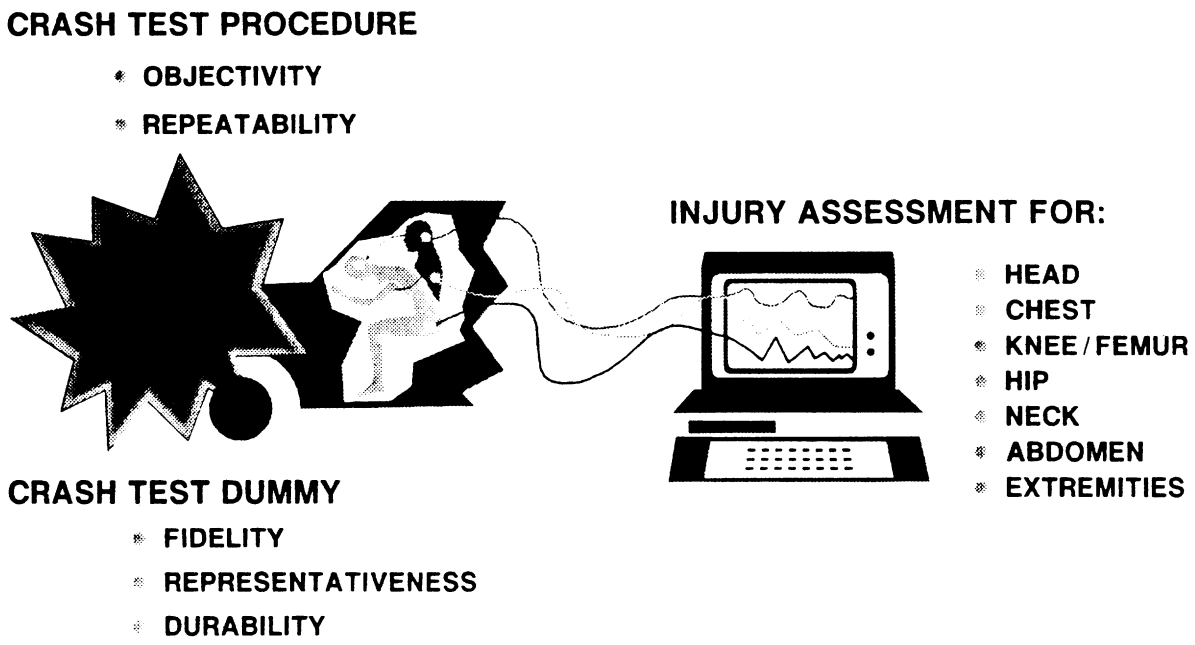

Figure 5. Elements of crashworthiness research.

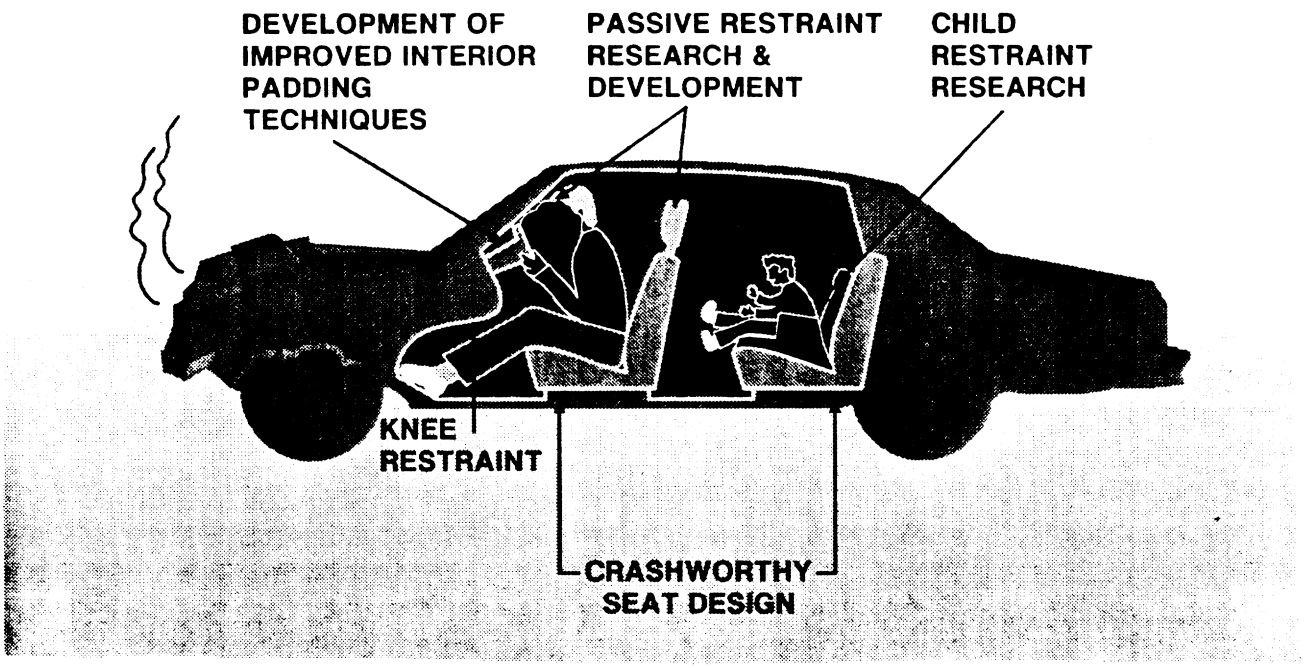

Figure 6. Occupant packaging research.

Frontal Crash Protection

NHTSA's crashworthiness program has resulted in millions of new cars being equipped with airbags or automatic belts. Federal Motor Vehicle Safety Standard (FMVSS) 208 requires that, beginning with 1990 models, all cars must, by Federal regulation, be equipped with automatic belts or airbags. Phased in since 1987, when just 10 percent of new cars had to meet this protection standard, NHTSA estimates that when all cars on the road are so equipped, this standard will save thousands of lives each year. Compliance with FMVSS 208 is based on measurements of force by a crash test dummy in a crash at 30 mi/h into a barrier. The vehicle must prevent crash forces on the head, chest, and legs from exceeding limits set in FMVSS 208. NHTSA estimates that vehicles that meet FMVSS 208 will reduce the risk of death in a crash by as much as 50 percent.

Side-Impact Crash Protection

Side-impact crash protection is the next major rule expected to improve the crashworthiness of new cars. It is scheduled to be promulgated this year. About 7,700 people die in side-impact crashes each year and 23,500 are seriously injured. NHTSA estimates that, depending on the level set in the rule, as many as 1,000 lives and 3,000 serious injuries may ultimately be saved each year in cars built to meet the new side-impact crashworthiness safety requirements.

Figure 7 illustrates the elements of a proposed side-impact crashworthiness test. It will employ a Side Impact Dummy to measure acceleration of the upper and lower spine, the upper and lower ribs, and the pelvis. Injury criteria will be established to measure the potential for injuries to the chest (thoracic trauma indices the potential for (TTI) (rib and spine accelerations)) and the spine (max G's). Characteristics of the crash test include a moving deformable barrier weight of 3,000 lb; a crabbed barrier impact angle of 26 degrees; and a barrier impact speed of 33.5 mi/h.

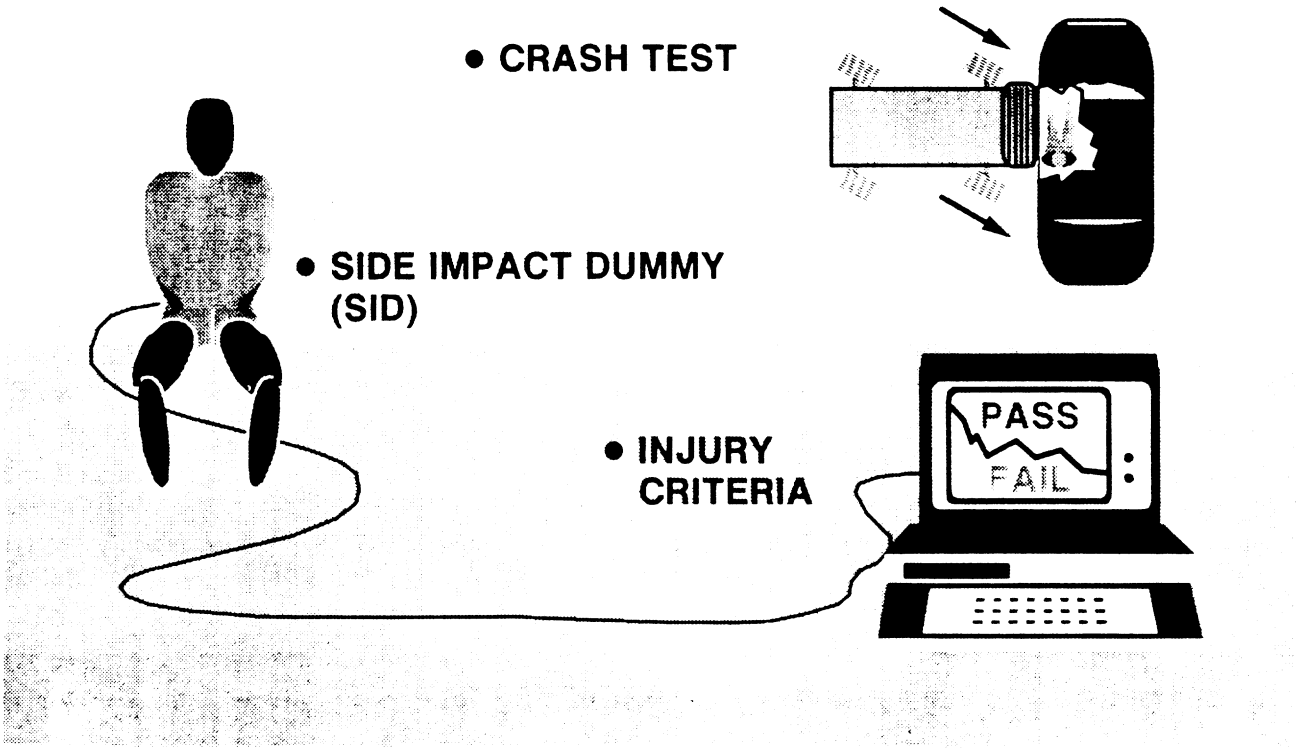

Figure 7. Elements of proposed side-impact crashworthiness test.

Table 6 shows that some 1988 model year cars already achieve side-impact performance levels better (lower) than performance levels proposed for the forthcoming standard. NHTSA research on side impact injury criteria and development of test devices and test procedures, along with the potential for rulemaking, have advanced the application of improved side-impact crash protection technologies. Pre-model 1988 vehicles had a wider range of side-impact protection capabilities based on crash test measurements.

Table 6. Comparison of Thoracic Trauma Indices for model year 1988 production cars in side-impact tests.

Vehicle	TTI(d)G
Chevrolet Caprice	58
Ford Taurus	78
Pontiac Bonneville	79
Toyota Tercel	80
Chevrolet Cavalier	85
Hyundai Excel	89
Volkswagen Golf	108
Chevrolet Sprint	110

Rollover Crash Protection

Rollover crashes, a complex and growing problem, caused 8,196 fatalities in 1985 and 10,029 fatalities in 1988, plus many thousands more serious injuries each year. Rollover crashes are a major source of very serious injuries resulting in paraplegia and quadriplegia. NHTSA is conducting research on improving the vehicle design to reduce both the risk of occurrence of rollover crashes and the risk of injury in a rollover crash. NHTSA plans regulatory decisions regarding rollover crash protection improvements during 1990-1992.

Pedestrian Crash Protection

A research bumper for pedestrian protection has been developed, the product of pedestrian protection safety technology development work sponsored by NHTSA.

NHTSA'S VEHICLE SAFETY PROGRESS

Vehicle Crashworthiness Improvements

Vehicle crashworthiness has been steadily improving, as measured by crash tests performed under NHTSA's New Car Assessment Program (NCAP). The percentage of the vehicle fleet found to have high-risk crash test scores has declined steadily from more than 50 percent in 1979 to less than 25 percent in 1988.

Airbag Fleet Experience

NHTSA has documented the "real world" safety performance of airbag technology in several fleets of vehicles. This experience demonstrates that airbags save lives, and has contributed to the increasingly widespread application of this life-saving technology. Among the statistics gathered by NHTSA are these:

- Police—539 cars, 65 million mi (1983-present) —41 airbag deployment crashes, injuries typically minor.
- GSA—6,800 Ford Tempos, 250 million mi (1985-present)—126 airbag deployment crashes, injuries typically minor.
- Travelers—3400 cars (1986-present), complete fleet—48 airbag deployment crashes in 4 years (23 totaled), "only 3 hospitalized" (longest < 1 week).

One result is that Chrysler has begun equipping all its 1990 model year cars made in the U.S. with airbags.

The following is one example of the growing number of airbag "success stories" of crashes that agency investigation found to be significantly violent and an airbag contributed to the occupant's survival.

An 81-year-old male driver, traveling with a 60-year-old female passenger in a 1989 Lincoln Continental equipped with driver and passenger airbags ran off the road and vaulted an embankment. Both driver and passenger wore safety belts. The car traveled 58 ft airborne in an end-over-side roll, hit the ground (deploying the airbags), and slid 20 ft on its roof. The driver's injuries? Complaints of left shoulder pain. The passenger's injuries? Skull fracture (a moderate injury). Both were released from the hospital within 6 days.

Contributing Factors

Many positive factors contribute to safety progress. Today, a growing number of people are protected by airbags and automatic belts, use of safety belts, child safety seats, and anti-lock brakes is on the rise, and the level of alcohol involvement in fatal crashes is declining.

NHTSA analyses estimate that other vehicle improvements required by Federal Crashworthiness safety standards save several thousands of lives and prevent more than 100,000 injuries each year as shown in table 7.

These programs, along with the safety benefits from highway safety improvements, have resulted in 1989 recording the lowest U.S. fatality rate (2.2 fatalities per 100 million vehicle-miles traveled) in the nation's history.

As the attached NHTSA plan indicates, efforts will continue to reduce further the numbers of crash-related injuries and deaths.

Table 7. Benefits of vehicle safety improvements—mid-80's versus mid-70's.

Improvement	Annual Savings Lives	Annual Savings Injuries
Front padding	700	Unknown
Head restraints	Unknown	64,000
Steering assemblies	1300	23,000
Windshields	105	47,000
Door retention	400	Unknown
Roof strength	110	Unknown
Side protection	480	9,400
Child safety	192	Unknown
Fuel tanks	400	520
Brake improvements	324	29,700

ATTACHMENT

MOVING AMERICA *SAFELY*[*]

The *National Transportation Policy* emphatically makes "safety . . . the top priority for the Department of Transportation." (page 81) Our "aim must be . . . to cut the death rate and reduce the traffic death toll . . . through the next decade." (page 83)

It is Federal transportation policy to:

- Encourage all States to enact laws requiring use of safety belts and motorcycle helmets, and to strengthen laws against drunk and drugged driving.

- Conduct a coordinated national campaign to increase public awareness of traffic safety issues, promote improved driver training, achieve more effective driver licensing and driver records, build support for traffic safety laws, and change unsafe driving behavior.

- Target Federal financial support and technical assistance to promoting more effective enforcement of laws and regulations governing speed limits, motor carrier safety, drunk and drugged driving, and use of safety belts, child safety seats, and motorcycle helmets.

- Develop rules to require vehicle design improvements to increase occupant protection and improve vehicle crash avoidance capabilities, and continue efforts to keep unsafe vehicles off the roads, through close monitoring and recalls of defective vehicles.

The National Highway Traffic Safety Administration has marshalled its resources and focused its energies to make these goals a reality. The agency's strategic plan clearly delineates the way that we in the National Highway Traffic Safety Administration will work with the public and private sector to materially reduce the all too common tragedies that are the unacceptable by-product of mobility in twentieth century America.

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[*]Moving America *Safely*, set out here and on the following five pages, is a strategic plan developed by NHTSA in support of the National Transportation Policy.

April 18, 1990

MOTOR VEHICLE SAFETY

	1990	1991	1992
PASSENGER CARS	COMPLETE RULEMAKING ON PASSENGER CAR SIDE IMPACT	REGULATORY DECISION ON INTERIOR HEAD PROTECTION	REGULATORY DECISION ON DOOR RETENTION COMPONENTS AND EJECTION REDUCTION
LIGHT TRUCKS & VANS	LIGHT TRUCKS: COMPLETE RULEMAKING ON: AUTOMATIC CRASH PROTECTION, STATIC SIDE IMPACT, AND HIGH MOUNTED STOP LIGHTS ROLLOVER: REGULATORY DECISIONS ON POTENTIAL CRASH AVOIDANCE STANDARDS		
HEAVY TRUCKS		HEAVY TRUCKS: REGULATORY DECISIONS ON STOPPING DISTANCE, CONSPICUITY AND UNDERRIDE COMPLETION OF THE ANTI-LOCK FIELD STUDY	REGULATORY DECISION ON HEAVY TRUCK ANTI-LOCK REQUIREMENTS
CHILD PROTECTION	CHILD SAFETY: REGULATORY DECISIONS ON NEWBORN DUMMY, CHILD SEAT TESTING REGULATORY DECISION ON CHILD SEAT REGISTRATION SCHOOL BUSES: REGULATORY DECISIONS ON MIRRORS, WINDOW RETENTION, BODY JOINT STRENGTH, AND FLAMMABILITY. ALSO COMPLETE RULEMAKING ON STOP ARMS		

OTHER MOTOR VEHICLE INITIATIVES

1990	1991	1992
COMPLETE RULEMAKING ON LIGHT TRUCK FUEL ECONOMY STANDARDS FOR MODEL YEAR 1992 AND FOR MODEL YEARS 1993 THROUGH 1994	REGULATORY DECISION ON FUEL ECONOMY STANDARDS BEYOND MODEL YEAR 1994	

IMPAIRED DRIVERS

	1990	1991	1992
FEDERAL			REDUCE THE PERCENTAGE OF ALCOHOL RELATED FATALITIES BY TEN PERCENT
	INCREASE THE NUMBER OF STATES WITH PROMPT LICENSE SUSPENSION USING ADMINISTRATIVE PER SE AND OTHER MEASURES FROM 34 NOW TO 37	INCREASE THE NUMBER OF STATES WITH PROMPT LICENSE SUSPENSION USING ADMINISTRATIVE PER SE AND OTHER MEASURES TO 41	INCREASE THE NUMBER OF STATES WITH PROMPT LICENSE SUSPENSION USING ADMINISTRATIVE PER SE AND OTHER MEASURES TO 44
		CONTINGENT UPON A FAVORABLE SUPREME COURT RULING, EXPAND THE NUMBER OF STATES THAT REGULARLY USE ROADSIDE CHECK-POINTS FROM 6 NOW TO 15	CONTINGENT UPON A FAVORABLE SUPREME COURT RULING, EXPAND THE NUMBER OF STATES THAT REGULARLY USE ROADSIDE CHECKPOINTS TO 20
		INCREASE THE NUMBER OF STATES IN THE NATIONAL DRIVER REGIS-TER USING THE PROBLEM DRIVER POINTER SYSTEM FROM 4 NOW TO 8	INCREASE THE NUMBER OF STATES IN THE NATIONAL DRIVER REGIS-TER USING THE PROBLEM DRIVER POINTER SYSTEM TO 13
		INCREASE THE NUMBER OF SELF-SUFFICIENT STATE AND LOCAL ALCOHOL PROGRAMS FROM 1 STATE NOW TO 3 STATES	INCREASE THE NUMBER OF SELF-SUFFICIENT STATE AND LOCAL ALCOHOL PROGRAMS TO 5 STATES
STATE	INCREASE THE NUMBER OF SITES WITH DRUG EVALUATION CLASSIFI-CATION FROM 23 NOW TO 30	INCREASE THE NUMBER OF SITES WITH DRUG EVALUATION CLASSIFI-CATION TO 50	INCREASE THE NUMBER OF SITES WITH DRUG EVALUATION CLASSIFI-CATION TO 70
	IMPLEMENT TRAFFIC SAFETY SUMMIT STRATEGY TO INCREASE NUMBER OF STATES WITH LAWS AND ENFORCEMENT PROGRAMS DESIGNED TO REDUCE IMPAIRED DRIVING BY YOUTH	→	
	IMPLEMENT TRAFFIC SAFETY SUMMIT STRATEGY TO IMPLEMENT NATIONAL PROGRAM TO INCREASE SUPPORT FOR DWI ISSUES AMONG POLICE, JUDGES AND LEGISLATORS	→	
	IMPLEMENT TRAFFIC SAFETY SUMMIT STRATEGY TO DEVELOP AND IMPLEMENT DRUG AWARENESS SCREENING TRAINING FOR ALL TRAFFIC ENFORCEMENT PERSONNEL	→	
		IMPLEMENT JUDICIAL STRATEGIES REGARDING IMPAIRED DRIVING DEVELOPED AT THE NATIONAL JUDICIAL SUMMIT	→
	PREPARE GUIDELINES FOR THE DEVELOPMENT OF EFFECTIVE PROGRAMS FOR STATES REGARDING IMPAIRED DRIVING		
MEDIA	INTRODUCE A NEW MEDIA CAMPAIGN FOR DRUNK DRIVING IN COOPERATION WITH THE AD COUNCIL	EVALUATE, UPDATE, AND DISSEMINATE NEW MEDIA CAMPAIGNS	→
INDUSTRY	EXPAND COVERAGE OF TEAM TO ADDITIONAL MAJOR SPORTS	→	
	ESTABLISH COOPERATIVE CAMPAIGN AGAINST DRUNK DRIVING WITH THE INSURANCE INDUSTRY	→	
	WORK WITH THE NETWORK OF EMPLOYERS FOR TRAFFIC SAFETY (NETS) TO PUT PROGRAMS IN PLACE IN 200 CORPORATIONS REGARDING DRUNK DRIVING		

April 18, 1990

OCCUPANT PROTECTION

	1990	1991	1992
FEDERAL			HAVE SOME TYPE OF BELT USE LAW IN ALL STATES ACHIEVE 70% SAFETY BELT USE NATION-WIDE
STATE	ACHIEVE UPGRADED BELT USE LAWS IN 3 STATES	ACHIEVE UPGRADED BELT USE LAWS IN 6 STATES	
	GIVE AWARDS TO THE FIRST STATES, COMMUNITIES, EMPLOYERS, AND OTHER ORGANIZATIONS FOR ACHIEVING 70% BELT USE	→	→
	IMPLEMENT TRAFFIC SAFETY SUMMIT STRATEGY TO DEVELOP MODEL STATE BELT USE PROGRAM FOR LAW ENFORCEMENT	→	→
	IMPLEMENT TRAFFIC SAFETY SUMMIT STRATEGY TO DEVELOP ENFORCEMENT ORIENTED PUBLIC INFORMATION AND EDUCATION MATERIALS	→	→
	PROMOTE THE DEVELOPMENT AND ADOPTION OF ACCEPTABLE BELT USE SURVEY METHODS BY STATES	→	→
	PREPARE GUIDELINES FOR THE DEVELOPMENT OF EFFECTIVE PROGRAMS FOR STATES REGARDING OCCUPANT PROTECTION		
	PROMOTE EFFECTIVE ADVOCACY PROGRAMS FOR CHILD SAFETY	→	→
		PROMOTE CHILD SAFETY SEAT REGISTRATION	
MEDIA	CONTINUE TO DEVELOP AND DISSEMINATE THE NATIONAL OCCUPANT PROTECTION MEDIA CAMPAIGN (VINCE & LARRY) IN COOPERATION WITH THE AD COUNCIL	→	→
INDUSTRY	CONDUCT A COOPERATIVE PROGRAM WITH THE INSURANCE INDUSTRY THAT PROVIDES INCENTIVES FOR SAFETY BELT USE	→	→
	WORK WITH THE NETWORK OF EMPLOYERS FOR TRAFFIC SAFETY (NETS) TO INCREASE BELT USE BY EMPLOYEES IN 200 CORPORATIONS		
	ASSIST OSHA IN REQUIRING EMPLOYEE BELT USE ON THE JOB	→	→
PROMOTING MOTOR VEHICLE SAFETY	PROMOTE TECHNOLOGIES FOR AUTOMATIC CRASH PROTECTION	CONTINUE TO PROMOTE TECHNOLOGIES FOR AUTOMATIC CRASH PROTECTION, INCLUDING LIGHT TRUCKS AND VANS	→
	PREPARE AN EVALUATION PLAN ON THE AUTOMATIC CRASH PROTECTION STANDARD	COMPLETE THE FIRST INTERIM REPORT ON THE EVALUATION OF THE AUTOMATIC CRASH PROTECTION STANDARD	COMPLETE THE SECOND INTERIM REPORT ON THE EVALUATION OF THE AUTOMATIC CRASH PROTECTION STANDARD

OTHER TRAFFIC SAFETY INITIATIVES

	1990	1991	1992
FEDERAL		HIGHWAY SAFETY PROGRAM REAUTHORIZATION	IMPLEMENTATION OF NEW HIGHWAY SAFETY LEGISLATION
	IMPLEMENT TRAFFIC SAFETY SUMMIT STRATEGY TO WORK WITH THE FCC TO PERMIT THE USE OF DRONE RADAR	→	→
STATE	INCREASE NUMBER OF STATES WITH MOTORCYCLE HELMET USE LAWS FOR ALL AGES FROM 22 NOW TO 24	INCREASE NUMBER OF STATES WITH MOTORCYCLE HELMET USE LAWS FOR ALL AGES TO 35	INCREASE NUMBER OF STATES WITH MOTORCYCLE HELMET USE LAWS FOR ALL AGES TO 50
	CONTINUE ASSESSMENTS OF STATE EMERGENCY MEDICAL SERVICES PROGRAMS, NOW COMPLETED IN 10 STATES, IN 7 MORE STATES	CONTINUE ASSESSMENTS OF STATE EMERGENCY MEDICAL SERVICES PROGRAMS IN 12 MORE STATES FOR A TOTAL OF 29	COMPLETE ASSESSMENTS OF STATE EMERGENCY MEDICAL SERVICES PROGRAMS IN ALL STATES
	IMPLEMENT TRAFFIC SAFETY SUMMIT STRATEGY TO PROMOTE TECHNIQUES TO ENFORCE THE COMBINATION OF ALCOHOL, BELT AND SPEED LAWS	→	→
		IMPLEMENT JUDICIAL STRATEGIES REGARDING SPEED DEVELOPED AT THE NATIONAL JUDICIAL SUMMIT	→
	PREPARE GUIDELINES FOR THE DEVELOPMENT OF EFFECTIVE PROGRAMS FOR STATES IN MOTOR-CYCLE SAFETY, TRAFFIC RECORDS, POLICE TRAFFIC SERVICES, AND EMERGENCY MEDICAL SERVICES		
MEDIA	DEVELOP PUBLIC INFORMATION AND EDUCATIONAL MATERIAL REGARDING SPEED	→	→
RESEARCH & TECHNOLOGY ASSESSMENT	INITIATE NHTSA/FHWA PEDESTRIAN DEMONSTRATION PROJECT		COMPLETE EVALUATION OF NHTSA/FHWA PEDESTRIAN DEMONSTRATION PROJECT
	IMPLEMENT TRAFFIC SAFETY SUMMIT STRATEGY TO EVALUATE THE EFFECTIVENESS OF PHOTO RADAR, LASER SPEED MEASURING DEVICES, AND OTHER TECHNOLOGIES FOR SPEED ENFORCEMENT	→	→

April 18, 1990

TECHNOLOGY AND INNOVATION

	1990	1991	1992
MOTOR VEHICLE PROGRAMS	PUBLISH NHTSA REPORT ON RELATIONSHIP BETWEEN VEHICLE SIZE AND SAFETY	PREPARE FINAL CONTRACT SPECIFICATIONS FOR CONSTRUCTION OF A RESEARCH DRIVING SIMULATOR AND DEVELOP A PUBLIC/PRIVATE INTERACTION PLAN	
	DEVELOP NHTSA ROLE IN THE INTELLIGENT VEHICLE/HIGHWAY SYSTEM RESEARCH PROGRAM	EXPAND THE NHTSA INTELLIGENT VEHICLE/HIGHWAY SYSTEM RESEARCH PROGRAM CONCENTRATING ON ADVANCED CRASH AVOIDANCE TECHNOLOGY AND HUMAN FACTORS	
CRASH DATA	IDENTIFY AGENCY DATA COLLECTION NEEDS AND EVALUATE ALTERNATIVE DATA COLLECTION OPTIONS	DECIDE ON NEW APPROACH TO CRASH DATA COLLECTION AND BEGIN FIELD TESTING	COMPLETE FIELD TESTING OF THE NEW CRASH DATA COLLECTION PROGRAM AND BEGIN IMPLEMENTATION
	DEVELOP A COMMON SET OF STATE CRASH DATA ELEMENTS AND PROMOTE THEIR ADOPTION BY STATES	→	→
PUBLICATIONS	PUBLISH THE FIRST ISSUE OF NHTSA PERIODIC RESEARCH JOURNAL		
	INITIATE "TRAFFIC TECH" NOTES ON TRAFFIC SAFETY ISSUES		
	PUBLISH AN ANNUAL CATALOG OF AVAILABLE TRAFFIC SAFETY TRAINING COURSES AND MATERIALS		
CONFERENCES	ANNUAL LIFESAVERS CONFERENCE	→	→
	NATIONAL TRAFFIC SAFETY SUMMIT — TO DEVELOP LAW ENFORCEMENT STRATEGIES REGARDING IMPAIRED DRIVING, OCCUPANT PROTECTION, AND SPEED	NATIONAL JUDICIAL SUMMIT — TO DEVELOP JUDICIAL STRATEGIES REGARDING IMPAIRED DRIVING AND SPEED	
		ESV CONFERENCE	
RESEARCH & EVALUATION		DEVELOP A MODEL FOR EXPANDED PUBLIC/PRIVATE SUPPORT OF BASIC AND LONG RANGE TRAFFIC AND MOTOR VEHICLE SAFETY R&D	

REDUCING ACCIDENT SEVERITY: WORKSHOP REPORT

Chairperson: James Roberts
Division Engineer, Design
Missouri Highway and Transportation Department

FHWA Technical Resource Representatives: Joseph Lasek, Harry Taylor
NHTSA Technical Resource Representatives: Ralph J. Hitchcock, Louis V. Lombardo

TOP 10 COUNTERMEASURES

The workshop participants ranked the following 10 countermeasures as the top short-term priorities, in order of priority.

1. Develop a program to upgrade nighttime delineation such as improved markings on curves and delineation of fixed objects.

2. Establish a program to upgrade substandard guardrail.

3. Set up speed surveillance teams for increased enforcement through work zones and high accident locations.

4. Develop an accident record system that identifies roadside features contributing to accidents.

5. Work with the utility companies to relocate or eliminate utility poles with a history of being hit.

6. Identify and prioritize a list of high accident locations for corrective action.

7/8. Allocate additional funds for accident countermeasures.

7/8. Provide better shoulder delineation through the use of rumble strips and texturing.

9. Promote additional improvements in vehicles for better crashworthiness and crash avoidance.

10. Initiate a nationwide program to have State and local governments set maintenance condition standards for safety-related items.

COUNTERMEASURE 1

Develop a program to upgrade nighttime delineation such as improved markings on curves and delineation of fixed objects. More than one-third of all fatal accidents involve a car running off the road. By keeping cars on the road, the highway safety community can reduce the number and severity of accidents.

Constraints

The group identified six potential constraints for this countermeasure: lack of funding, lack of manpower, lack of support for the program (because the need for the program is not realized), difficulty identifying all the substandard areas, lack of technical knowledge or product

knowledge, and lack of equipment. The group also developed a solution for each of the constraints. They are as follows: designate special funding, use contract forces, market the program (emphasize that it will reduce fatalities), perform maintenance reviews and contract with consultants, provide adequate training for the implementing group, and provide sufficient funding for materials and equipment.

Implementation Plan

One action needed to accomplish this countermeasure is to promote *designated* funding for such a program by State and local agencies. Safety has generally not received full recognition as a major problem and normally competes against other needs for funds. Proposed highway legislation seems to be aimed at limiting federal involvement to such things as "Highways of National Significance." This could further reduce emphasis on safety as a separate program. One solution to the funding problem might be to assign a percentage of general highway funds to safety improvements, rather than a special category of funds. Another action needed is to develop simplified plans, specifications, and contract documents. Still another action needed at the national level is to provide basic signing and marking recommendations for a set of standard conditions.

COUNTERMEASURE 2

Establish a program to upgrade substandard guardrail. A substantial amount of work is needed to maintain guardrail at today's standards. Guardrail consistently is among the top three objects resulting in fatalities due to vehicles striking them after leaving the road.

Constraints

Constraints to this countermeasure include lack of an accurate inventory of existing guardrail, lack of funding, lack of equipment/manpower and/or training for crews, no perceived need to upgrade guardrail by leaders and/or the public, and the rapid change in standards.

Implementation Plan

The group suggested that the highway community develop a program to replace substandard guardrail. It would include a development phase where States develop an inventory of all guardrails in service and their condition; review and update guardrail standards; develop a replacement program and replacement guidelines starting with priority segments; present the program to management for funds; implement and develop projects; and begin a public information campaign to continue as needed thereafter.

COUNTERMEASURE 3

Set up speed surveillance teams for increased enforcement through work zones and high accident locations. Controlling speed, particularly in work zones and high accident locations, has proven to be effective in reducing accidents. At least in these two areas, there is an over representation of accidents that could be partially corrected through speed control. Many States already have such a program in place, but the group suggested such a program be initiated nationwide.

Constraints

The constraints to this countermeasure include difficulty obtaining adequate manpower, equipment, and funds; lack of legal authority; poor identification of high accident locations that may be affected; lack of support from the judiciary system, etc.; and lack of public acceptance. To gain support and counterbalance the constraints, the group came up with the following solutions: provide information to the public emphasizing the seriousness of the problem, use of public service announcements (PSA's) and special teams, hold public information meetings, provide legislatures with drafts of revised laws, and provide training for judiciary system personnel, including judges and prosecutors.

Implementation Plan

To implement the countermeasure, the group formulated a plan that would begin with the formation of a multidisciplinary task force comprised of local police, patrol members, DOT personnel, government safety group members, legislative safety leaders, and representatives of the judiciary system. The task force would define goals and objectives. The next step would be to define tasks and a schedule for implementation, define survey methods, and identify funding sources and applicable laws. The final step would be the actual implementation of the countermeasure.

COUNTERMEASURE 4

Develop an accident record system that identifies roadside features contributing to accidents. The group found it essential that the highway safety community have the kind of information it needs to identify those roadside conditions that contribute to accident severity. The information needed includes design standards, roadway locations, and roadway conditions that have contributed to accident severity. At the present time, this information is not available on a nationwide basis.

Constraints

Constraints to this countermeasure include problems upgrading hardware and software, tort liability, conflicting priorities, lack of in-house expertise, lack of accident data or roadway data of questionable reliability, lack of funds, and the complexity of interagency relationships. Solutions corresponding to this list of constraints are to contract work out and/or adopt computer software sharing practices, adopt Title 23 immunity in State law, obtain management support by identifying costs and benefits, obtain support from the legislature, obtain university assistance or contract work out, develop an adequate data base and establish quality control, utilize demonstration funds if available, and establish an interagency advisory group to keep agencies updated on progress.

Implementation Plan

The implementation plan for this countermeasure begins with phase I, comprised of a review of existing records, determination of needs for data, and an estimate of costs and benefits. The group noted that benefits cannot be measured in terms of dollars at this point, but clear benefits do exist. The second phase is to develop a plan and sell it to management. The third phase is to actually implement the plan and evaluate the results.

COUNTERMEASURE 5

Work with the utility companies to relocate utility poles with a history of being hit. This countermeasure addresses a long standing problem that has received little attention. Utility poles are one of the top three fixed objects involved in fatal accidents. A number of specific actions such as relocation of poles, underground burial and use of breakaway poles may assist with this countermeasure. However, this issue is very difficult to solve. It requires the participation of utility companies, consideration of economic issues, and could require some changes in laws.

Constraints

Constraints to the countermeasure include bureaucracy, cost, legal, identification/ prioritization, physical constraints, and technological constraints.

Implementation Plan

The implementation plan developed by the group includes the following actions: provide Federal programming and funding to focus attention on this problem, revise permit procedures to specify placement of new poles in areas where there is less chance they will be hit, establish a cooperative group between highways and utilities, identi-

fy hazardous poles, establish guidelines for treatment, and followup procedures to measure results.

COUNTERMEASURE 6

Identify and prioritize a list of high accident locations for corrective action. This type of system exists to some degree in most States. However, it is of limited value in its present form.

Constraints

Constraints to this countermeasure include the fragmentation of data, inadequacy of reporting, varying levels of detail on accident reports, time lag in reporting data, poor location references, inadequate procedures for using data, and a lack of funding to treat accident sites.

Implementation Plan

The implementation plan for this countermeasure calls for reaffirming and strengthening HSIP/HSES (Highway Safety Improvement Program/Highway Safety Engineering Studies), providing additional staff and training, increasing cooperation between law enforcement and transportation agencies, increasing funding for safety projects, and simplifying funding and design procedures.

COUNTERMEASURE 7 (TIE WITH 8)

Allocate additional funds for accident countermeasures. This countermeasure suggests establishing special funds for safety. This may run counter to what AASHTO is advocating, but the group felt that, because safety competes with all other highway needs, it often comes out second best and the only sure way to address the issue of safety is to have special funds earmarked for that purpose.

Constraints

Constraints to this countermeasure include other priorities, national and State policies, lack of funds (competing needs), and public perception of the need for safety improvements. Actions to overcome these constraints are to define safety problems and their costs to society; sell the results of that definition in terms of savings for society to management, politicians, and the public; pass a tax increase; redistribute existing funds or use incentive funding; and market safety to the public.

Implementation Plan

The implementation plan that the group developed for this countermeasure requires some actions that may take more than 2 years to accomplish. These actions include assessing needs, establishing funding levels, and marketing. One step, however, can be accomplished immediately: support AASHTO's Highway Safety Strategic Plan, which will involve spending $1,465,000,000 each year from 1991 to 2000 and will save a minimum of 64,000 lives during the last decade of this century and prevent an economic loss of at least $96 billion.

COUNTERMEASURE 8 (TIE WITH 7)

Provide better shoulder delineation through the use of rumble strips and texturing. Keeping the driver in the lane and allowing time to recover if he or she strays off the road is essential to reducing highway accident severity.

Constraints

Constraints to this countermeasure include verification of effectiveness, additional cost of retrofitting, materials selection, structural adequacy, conflicts with other shoulder use, such as bicycles, and interference with drainage. To gain support to overcome these obstacles, the group recommended the following measures: review data (reports), develop safety effectiveness documentation, develop construction practices

and specifications, and develop guidelines for use.

Implementation Plan

The implementation plan will require marketing; compiling data on safety effectiveness, design and construction practices, specifications, and guidelines for use; and actual implementation.

COUNTERMEASURE 9

Promote additional improvements in vehicles for better crashworthiness and crash avoidance.

Constraints

Constraints to this countermeasure include resistance by car companies, resistance by consumers who must pay higher prices, time constraints, funding constraints, interplay with other standards (e.g., Air Quality), possibility of reduced competition, and resistance from agencies (particularly to fleet requirements).

Implementation Plan

The implementation plan requires four steps: identify and prioritize areas of crashworthiness and crash avoidance as related to highway architecture, identify specific items of crashworthiness and crash avoidance equipment available for purchase as options such as air bags and antilock brakes, develop suggested optional equipment for crashworthiness and crash avoidance, and begin a public information campaign to promote and encourage fleet purchase of vehicles equipped with the recommended optional equipment.

COUNTERMEASURE 10

Initiate a nationwide program to have State and local governments set maintenance condition standards for safety-related items. Not all States and communities have an inventory of safety hardware. Standards must be developed to encourage governmental agencies to examine the condition of these items and correct any deficiencies.

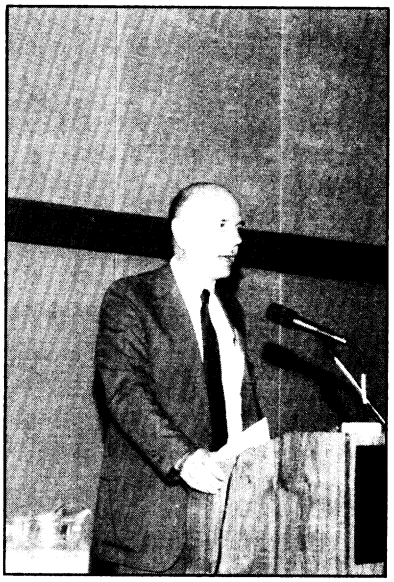
Constraints

Constraints to this countermeasure include lack of manpower, lack of management support, and possible resistance by maintenance forces because of the extra work required and possible low performance ratings.

Implementation Plan

The implementation plan includes the following actions: use conference findings to support the program—develop supporting benefits to promote the program, incorporate improved maintenance for safety as part of safety management plans, have FHWA Regional Offices make this a high priority item and a part of their safety action plans, send Florida maintenance condition standards as an example, and solicit other examples from State and local agencies for distribution.

Improving Driver Performance And Control



MINIMIZING LOSS: DRIVER PERFORMANCE AND CONTROL

Thomas Hicks, P.E.

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The Symposium on Effective Highway Accident Countermeasures' primary objective is to identify and list strategies for improving the nation's fatality rate over the next 2 years. It is envisioned that specific countermeasures can be quantified and presented that will enable transportation and safety agencies to immediately undertake programs that will yield positive results in the short term.

This paper explores a distinct element of the overall program—the improvement of driver performance and control. Enhancing driver performance and control will entail all of the three E's—engineering, enforcement, and education—and to succeed, the program must necessarily involve a comprehensive, interdisciplinary approach. Each of the three disciplines has a significant impact upon the others in the fulfillment of its highway safety program objectives. As the nation strives to make do with existing highway transportation facilities that feature minimal new construction, effective management of these facilities becomes increasingly important. This problem cannot wait for future solutions. Today more drivers and pedestrians must share essentially the same space, and they must do so more efficiently and safely. The time spent at this Symposium will be devoted to this latter point—safer travel.

THE FATAL ACCIDENT PROBLEM

The stated goal is to attain a U.S. fatality rate of 2.2 deaths per 100 million vehicle-miles of travel by 1992. One might question if this goal is valid and attainable within the stated guidelines of the Symposium, or should these discussions, findings, and recommendations be directed to fulfilling the objective along a different path. The problem in dealing mainly with highway fatalities is that they are difficult to explain and relatively small in number and causes and solutions can seldom be pinpointed. The vagaries of the fatal accident problem are, in the view of many, overwhelming, and observation of accident numbers and severity might better serve our needs. (Perhaps these thoughts are unique to the driver performance and control workshop, and even if thoughts are redirected toward total accident numbers, the data elements related to fatal accidents should still be thoroughly examined.)

A fatal accident differs little from an injury or property-damage-only (PDO) accident. The

accident elements of a small versus a large car, the driver's age, the use of vehicle restraints, and the point of impact, among other factors, significantly influence the severity of the incident. Rarely does more than one fatal accident occur at a single site in 1 year. Emergency Medical Services (EMS) programs and vehicle safety efforts would therefore likely yield more positive results in reducing the fatality rate than would traffic/highway engineering operational improvements.

While the fatal accident rate has been on a downward trend for years, the total accident rate appears to be increasing slightly. Reduced accident reporting by many police agencies makes the actual accident rate difficult to assess with certainty. However, it appears that highway and traffic engineers should attack the total accident problem, giving special care and weight to the more severe types of accidents, because improvements will eventually reduce fatal accidents as well as accidents involving injuries and property damage only. Traffic engineers must decide whether preventing 100 PDO accidents and 100 injuries in 10 years is more important than preventing 10 PDO's, 10 injuries, and 1 fatal accident. If the overall accident rate is reduced, it is expected that about one-half of 1 percent of accidents will be fatal. We should be aware of the high cost associated with the 99 1/2 percent nonfatal accidents.

ACCIDENT TYPES

Two severe types of accidents—those involving pedestrians and those involving opposite-direction collisions—occur relatively infrequently and are probably the most difficult to correct. Another severe "manner of collision" accident that appears to occur frequently is the "fixed object" type. This accident type will be discussed in this part of the Symposium and later during the discussion on providing a more forgiving highway.

The most important concept in highway design and operations is consistency. Minimizing violations of driver expectancies through uniform and consistent application of design and control strategies will probably reduce the potential for accidents. New highway projects and rehabilitation work must meet certain standards and have design and operational elements that help drivers stay on the roadway and within their own lane. Two leading accident types resulting in severe incidents are the single vehicle (run-off-the-road) and opposite-direction types; the primary causes for these types of accidents are "failure to drive in lane" and "failure to keep to right of center." The workshop discussions should carefully consider this accident information and the listing of accident types and relative severity, which is shown in table 8.

In developing lists of control and performance strategies designed to lessen the degree of accident severity occurring along our highway system, certain conclusions have been drawn. These conclusions are based upon a review of accident data, which will be helpful in guiding the workshop discussions. General conclusions include the following:

- Accident rates vary by type of control (full, partial, none) of the highway and whether the highway is in an urban or a rural area.
- The manner of collision varies by the type of control.
- Accident severity varies by urban or rural location.
- Urban accident rates are higher than rural rates.
- Rural severity is higher than urban severity.

Table 8. Accident manner-of-collision types (Maryland 1986 - 1988).

By Frequency	
Read end	47 [1]
Fixed object	30
Others	24
Angle	23
Left turn	17
Sideswipe	15
Single vehicle	9
Opposite direction	6
Parked vehicle	4
Pedestrian	3

[1] Number of accidents per 100 motor vehicle miles

By Severity	
Pedestrian	36 [2]
Opposite direction	30
Fixed object	12
Parked vehicle	11
Angle	10
Left turn	10
Rear end	9
Others	8
Sideswipe	7
Single vehicle	6

[2] Accident cost ($1,000's)

Additional findings and points to consider by the workshop participants include the following:

1. A growing tendency in the area of traffic control is to do too much, to overregulate. This tendency has resulted in what appears to many to be a growing wave of disobedience to and noncompliance with traffic controls and regulations.

2. To a large degree, the things that should be done are not being accomplished. Many excellent standards and guidelines exist, but they are not being followed. The result is widespread inconsistencies in the application of needed traffic control strategies.

3. For purposes of these discussions, traffic control devices include signs, traffic signals, pavement markings, highway lighting, and geometric design and channelization.

4. Congestion management is a growing concern as more drivers and pedestrians are asked to share the same space. Incident management, real-time traffic control, and agency credibility with the traveling public are key issues closely related to congestion management and the public's willingness to follow directions and properly learn and react to various traffic control applications.

5. Getting the driver's attention in an environment of many competing stimuli is an issue in itself, but it is also closely related to the other operational issues. In an accident situation, an appropriate question might be, "Was the driver sufficiently aware of the circumstances?"

6. As noted earlier, a major issue involves an interdisciplinary approach to safety situations—using the full resources of engineering, enforcement, and education agencies.

7. Other elements and issues have been identified that, when fully considered, may help to reduce accident severity along our highways. These issues include truck operations, problems involving the elderly, work zone traffic control, risk management, the adequacy of the reported accident data, staff training, public information and education, and research. Most of these elements have at least some parts that can be quickly applied to an immediate highway safety program.

POSSIBLE COUNTERMEASURES

The goals of the Symposium are to develop a listing of possible countermeasures to the identified problems and to rate them in some sort of priority. Separate listings of possible countermeasures have been prepared for 11 specific improvement areas, and a 12th listing is provided for miscellaneous actions. The complete lists are provided in table 9 to this paper; however, based upon the accident data analysis, the countermeasures that seem most likely to produce the desired results include improving delineation, providing clear warnings with time for response, providing means of getting the driver's attention, using devices and strategies that meet the five basic requirements set forth in the *Manual on Uniform Traffic Control Devices* (MUTCD), recognizing pertinent human behavioral factors, applying congestion-alleviating techniques, following the fundamental principles for work-zone traffic control, employing a risk management program, developing a strong engineering-enforcement relationship, encouraging a driver's education/public awareness program, providing long-term general area or statewide purchasing and construction contracts as time-saving procedures, and following existing standards and guidelines unless there are compelling reasons not to do so.

Listing the strategies to lessen the accident and severity rates is relatively easy; however, listing them in some sort of order of priority is far more difficult. Conditions along the highway system and those at any one accident situation can vary widely, and countermeasures are usually applied in combination with others, all making any effectiveness analysis difficult to develop. The specific changes in accident experience due to any one countermeasure are very difficult to measure, and this difficulty in evaluation is especially true for the more severe type of accident. Therefore, any ranking of countermeasures should be done in a way that relates a specific countermeasure to the identified type of accident, manner of collision, and probable cause.

OBSTACLES AND CONSTRAINTS

Finally, for any program of applying countermeasures to identified accident situations with timeliness and effectiveness, certain obstacles and constraints must be overcome. Listed below are those that come readily to mind:

1. Lack of desire/knowledge. Top management must be informed and sold on the program in order to provide the needed resources and other support. At the technical level this involves increased training and employee education.

2. Lack of interdisciplinary approach. The lack of an interdisciplinary approach will seriously retard a highway safety program, particularly where a solid engineering-enforcement relationship exhibiting the 3C's—communication, coordination, and cooperation—does not exist.

3. Budget. Top management must be convinced that the benefits to be derived far outweigh the costs expended and that this program will be one of the agency's most effective ones. Public information and awareness programs will help here.

4. Time. Everything today seems to take too much time. Known time-saving techniques and procedures should be used to get needed improvements from the design table onto the street quickly. General contracts for purchasing and construction that may be used by both local and State agencies significantly reduce the time to implement improvements. The use of computer-assisted design (CAD) and other computer-assisted programs also provide time savings.

Table 9. Twelve specific improvement areas.

SPECIFIC TECHNICAL SOLUTIONS (1)

Delineation/Markings

- RPM's
- wide edge lines
- clear path/follow vehicle paths
- bright lines
- chevrons
- ramps
- barriers
- word and symbol use
- post mounted

SPECIFIC TECHNICAL SOLUTIONS (2)

Signing

- fulfill a need
- location/placement
- spacing/time for response/clutter
- advanced street name signs
- size
- non-standard
- inconsistent use
- message content/too much/symbology
- diagrammatic
- TOD's/generator signs
- maintenance/foliage
- special needs/trucks/oversize
- hierarchy

SPECIFIC TECHNICAL SOLUTIONS (3)

Attention Getting Devices

- rumble strips
- oversize
- special short term
- VMS
- ICB's
- HIB's
- strobes

SPECIFIC TECHNICAL SOLUTIONS (4)

Realistic Traffic Regulations

- correctly respond to/solve the problem
- meet warrant
- overregulation
- speed zoning

SPECIFIC TECHNICAL SOLUTIONS (5)

Geometric design/Channelization

- driver expectancy
- compatibility of design elements
- fundamentals of channelization
- lines of sight
- auxiliary lanes
- adequate transitions/tapers
- lane drops and choice lanes

SPECIFIC TECHNICAL SOLUTIONS (6)

Congestion alleviating techniques

- intersection widening
- shoulder use (part-time or narrow lanes)
- auxiliary lanes
- avoid local street use
- signal coordination (systems)/phasing

SPECIFIC TECHNICAL SOLUTIONS (7)

Work Zone traffic controls

- fundamental principles
- keep conditions as normal as possible
- avoid overcontrol
- use of police
- lighting night operations
- advance notice of work (in time)
- VMS/TAR use
- incident management/data & evaluation
- delineation
- public information

Table 9. Twelve specific improvement areas. (Cont'd)

SPECIFIC TECHNICAL SOLUTIONS (8)

Traffic Signals

- not warranted
- not visible
- poorly timed/phased/coordination
- not favoring main road/majority
- elderly consideration

SPECIFIC TECHNICAL SOLUTIONS (9)

Incident Management

- interdisciplinary/responsibility assignment
- good communications
- marked routes
- rapid identification & response
- rapid clearing of roadway
- real time (and accurate) info to public

SPECIFIC TECHNICAL SOLUTIONS (10)

Railroad Crossings

- constant warning time signals
- sight distance
- lighting
- crossing surface
- grades (trucks)
- RR responsibilities

SPECIFIC TECHNICAL SOLUTIONS (11)

Highway Lighting

- warrants/expand NCHRP #152
- WZTC
- pedestrians/elderly/school

SPECIFIC TECHNICAL SOLUTIONS (12)

Risk Management

Accident Records/Data

Engineering/Enforcement

Off System TCD's (eg: Shopping centers)

Driver's Education/Public Awareness/Testing

Special Events

Time Savings

- Areawide Annual Contracts
- Annual Purchasing Contracts
- Local use of state contracts
- Fast Track CPM/Star Process
- Computer/CAD

5. Local opposition and political problems. These problems must be resolved through personal contact and "salesmanship." Well-developed studies in which the alternatives are clearly and accurately shown will usually gain the needed local support. The request for an unwarranted or improper device or control strategy must be rebuffed. The prudent engineer has alternatives readily at hand that, though not as desirable, are nevertheless acceptable.

The challenge is before this Symposium and its several workshops to define and delineate the problems and to develop logical, reasonable, and workable solutions that meet the stated goals and objectives. The participants already possess so much knowledge that, with careful and deliberate thought, the efforts of this Symposium should result in the formulation of a plan that will yield the desired outcome.

DRIVER CHARACTERISTICS AND IMPAIRMENT: IMPLICATIONS FOR BEHAVIORAL AND ENVIRONMENTAL COUNTERMEASURES

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It is difficult to understand why the public is not more concerned about highway crashes. The 47,093 deaths that occurred in 1988 were the equivalent of approximately three wide-body jets crashing every week. Recent efforts to decrease drunk driving and to get vehicle occupants to use their safety belts have helped "keep the lid on" highway fatalities, in spite of the dramatically increasing numbers of miles driven. Still, despite the moderate gains in these areas, the rate of highway fatalities per 100,000 population has increased slightly since 1982.

HUMAN FACTOR CONTRIBUTIONS TO FATAL CRASHES

The primary contributor to fatal and serious injury crashes is human error. Such errors are often related to speed, alcohol impairment, and fatigue. Age is also a factor. Young drivers between 15 to 24 years of age and drivers 65 years of age and older have the highest crash rates.

Alcohol and fatigue commonly contribute to fatal crashes. They seriously impair functions required by the driving task, particularly among young and elderly drivers.

Laboratory studies have shown that alcohol quickly begins to impair divided attention and thus reduces the driver's ability to handle multiple tasks at the same time. It also impairs tracking performance, eye muscle control, dark adaptation, glare recovery, and peripheral vision. Finally, alcohol impairs information processing ability, reduces ability to concentrate, and impairs psychomotor performance.[1] These impairments begin at alcohol concentrations significantly lower than those required for legal intoxication. In simulator and closed-course settings, alcohol concentrations of .08 have been shown to degrade accuracy of steering, braking, speed control, lane tracking, gear change, and judgments of speed and distance. Alcohol concentrations as low as .04 have been found to impair responses in emergency situations.

Largely because of these kinds of impairment, alcohol is involved in approximately 50 percent

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of all fatal crashes, involving more than 23,000 fatalities annually. In 40 percent of all fatal crashes, a legally intoxicated driver or a pedestrian is involved. These crashes are most often late-night, single vehicle, run-off-the-road crashes. They frequently involve fatigue, as well as alcohol impairment.[2] Young drivers who are on the road during these times and who have been drinking have—by far—the highest probability of being involved in a serious injury crash.

Young male drivers between 16 and 24 years of age are particularly high risk drivers, but they often perceive themselves to be good drivers. They also tend to involve themselves in high-risk situations (e.g., driving at night, speeding, and using alcohol), and they commit more driver violations than other age groups. To make matters worse, their inexperience in driving is frequently combined with volatile personality dispositions.[3] As a result, fatal crashes involving young drivers frequently involve alcohol, are likely to be nighttime crashes, and are likely to involve speeding.

Older drivers have problems with the complexity of the traffic flow around them, primarily during daytime hours when they drive most. Problems with lane changing, turning, passing, crossing intersections, and backing are most evident. Both inattention and stimulus overload may affect the older driver. Night vision is a major problem, especially with regard to contrast sensitivity, low illumination acuity, dark adaptation, and glare recovery. Older drivers have trouble reading traffic signs, particularly under degraded illumination. Because of a slowing of visual search, they may miss red lights and stop signs. Some of the more pervasive impairments such as night vision are recognized by some (but not all) older drivers, who restrict their night driving. Consequently, older drivers are most often involved in fatal crashes that occur during daylight hours.

Another important human factor that turns many crashes into fatal crashes is failure to use safety belts. Young drivers, older drivers, speeders, and drinking drivers (and their passengers) are least likely to use safety belts—one of the most important actions they could take to prevent serious injury and death in a highway crash.

Effective Measures to Impact Driver Behavior

General deterrence programs involving enhanced enforcement and aggressive public information and education programs can produce immediate reductions in both speed- and alcohol-related fatal crashes. In fact, roadside sobriety checkpoints and swift and certain license sanctions, combined with media attention, have more often been shown to reduce alcohol-related fatal crashes than other safety approaches. In addition, special license sanctions for youth and minimum drinking age laws have frequently resulted in significant (10 to 15 percent) and sometimes major (30 to 50 percent) reductions in alcohol-related crashes among affected age groups. If all States conducted high visibility enforcement and media efforts *on a regular basis*, imposed swift and certain license suspensions for *all* DWI offenders, and obtained media attention for these actions, the alcohol-related proportion of fatal crashes could quickly be reduced by an additional 10 to 15 percent. Similar programs conducted in local areas have shown that reductions in alcohol-related fatal crashes begin immediately and sometimes prior to full implementation of such deterrent programs. Cooperative public/private sector efforts to encourage more responsible alcohol serving and use practices would add to the impact of these deterrent measures.

Occupant Protection and Emergency Medical Services

Safety belt use laws, combined with automatic restraints, could save many additional lives. Of the restrained passenger car occupants in fatal crashes in 1988, about one-fourth (5,362) were fatally injured, while nearly one-half (17,570) of

the unrestrained occupants were killed.[4] Given the average safety belt use rate of about 50 percent, States with safety belt use laws are estimated to have 7 percent fewer fatalities than would be expected without such laws. If all States achieved 70 percent safety belt usage rates, many more lives would be saved, because proportionately more high-risk drivers and occupants would be protected.

Unfortunately, younger drivers, older drivers, and drivers who drink are among the last to buckle-up. For these occupants, automatic crash protection (particularly airbags) provide an effective way to reduce death and injury. Even with airbags, however, many additional deaths and injuries could be avoided if drinking drivers and young drivers could be convinced to use safety belts. Safety belts are needed because airbags do not have the same effectiveness potential as safety belts in the run-off-the-road, rollover crashes, which are so common among these drivers. Safety belts can be nearly 100 percent effective in reducing major injuries and fatalities in most rollover situations.

To round out this list of effective nonhighway, nonenvironmental countermeasures, motorcycle helmet laws and emergency medical services must not be ignored. Motorcycle helmets, combined with increased conspicuity of motorcyclists, are among the most effective ways to reduce fatal crashes in this high-risk mode of travel. Again, without helmet use laws, high-risk riders are the least likely to use helmets. Finally, improvements in State emergency medical services have resulted in significant, if not always documented, reductions in fatalities in several States. Conducting statewide assessments of existing emergency medical services is an important way to begin to improve these services and to ensure that the crash victim receives the most appropriate care.

HIGHWAY AND ENVIRONMENTAL ACTIONS

While it is reasonably clear that major injury and fatality reductions could be realized through better enforcement, occupant protection, and emergency medical services, equally effective highway and environmental changes could be implemented that would reduce the occurrence and severity of most types of fatal and serious injury crashes. These measures are not new, but perhaps a new emphasis should be given to them in the context of the driving task, high-risk groups, and the locations where crashes occur. This should be done, of course, with an eye toward measures that can be implemented most rapidly. Before reviewing these actions, the characteristics of the driving task should be reviewed.

THE DRIVING TASK

To researchers, the driving task is primarily a "tracking" or guidance task whereby a driver attempts to keep his or her vehicle in the center of its proper lane. While performing this task, however, all drivers divide their attention between a number of driving- and nondriving-related activities: watching for oncoming vehicles from the periphery, attending to signs and signals, monitoring vehicles approaching from the front or the rear, worrying about next month's bills, listening to the radio, talking on the car phone, etc. Under normal circumstances, many drivers feel that they have so much "spare capacity" that much of the guidance-related information processing and most control actions are performed at "pre-attentive" levels. When a hazardous situation presents itself or when a driver is fatigued or alcohol impaired, dangers are not always immediately or accurately perceived and, as a result, the driver responds improperly.

ROADWAY AND ENVIRONMENTAL TREATMENTS

FHWA and various researchers have suggested several ways that the roadway environment can be made to improve driver performance and control under both normal and hazardous circumstances. First, pavement markings and roadway delineators can help drivers perform their basic job of tracking the highway.

Second, improvements in illumination, sight distance, and signing can help create accurate driver expectations and perceptions regarding the highway environment. These treatments improve drivers' ability to detect hazards, to process information, and to make appropriate decisions. Control devices such as stop signs and traffic lights impose even more control over driver behavior.

In high-risk situations, raised pavement markers and rumble strips can be used to *alert* inattentive drivers. Paved and even shoulders and anti-skid pavement surfaces can help drivers regain control of the vehicles, and state-of-the-art guardrail and barrier systems can be used to guide errant vehicles into less hazardous pathways, thus minimizing crash severity.

ESTIMATED EFFECTIVENESS

After reviewing measures for reducing fatal multivehicle crashes for the period of 1974-1989, FHWA estimated the effectiveness of various measures as follows: improving sight distance (32 percent), turning lanes and traffic channelization (25 percent) improving illumination (22 percent), upgrading traffic signals (21 percent), upgrading guardrails (10 percent), installing new median barriers (9 percent), and upgrading median barriers (9 percent).[5] This specific comparison did not include roadway markings or delineators. However, in terms of mitigating specific hazardous situations, FHWA estimated the effectiveness of roadway markers to be 20 to 60 percent, and the effectiveness of roadway delineators to be as high as 30 percent.[6] In addition, controlled experimental research has shown that improved roadway delineation reduces run-off-the-road errors made by drinking drivers when compared to sober (control) drivers.[7] Other research has emphasized the importance of pavement markings in compensating for the impairment of drinking drivers.[8]

RECOMMENDATIONS RELATED TO CRASH CHARACTERISTICS

In this paper, an emphasis will be given to more general circumstances for roadway and environmental improvements, because this is where the majority of serious injury crashes occur and thus where the greatest savings in lives can be made. The most important recommendation is that each State conduct an assessment of its own roadway system relative to the "checklist" of potential actions provided by FHWA. This assessment should take into account the distribution of high-risk drivers contributing to its crashes, the roadway characteristics where fatal and serious injury crashes occur, and the types of driver control and performance functions that are to be affected. Some of the observations that seem apparent when reviewing national level data are as follows:

- **Fatal Crash Characteristics.** Approximately 87 percent of fatalities occur on primary and minor arteries, collectors, and local roadways, not on interstates or other freeways. Most fatalities (27,500) occur in rural areas, but urban areas also account for a substantial number of fatalities (19,500) and therefore must be considered prominent in any assessment. Similarly, while three-fourths (30,900) of fatal crashes occur on straight roadways, curves account for one-fourth (11,100) of all fatal crashes and thus deserve attention. Three-fourths (30,800) of all fatal crashes occur where there is an intersection or other junction, but nearly one-

fourth (10,000) occur at an intersection, most often in an urban area.

While the majority of fatalities occur at night (25,900), a substantial number (20,800) occur during the day. The nighttime crashes are primarily single-vehicle, run-off-the-road crashes that involve youth, alcohol, and fatigue. Nearly always, the most harmful event in these single-vehicle crashes involves hitting a fixed object or a rollover. Daytime crashes more frequently involve several vehicles and less often involve alcohol or fatigue. Older driver crashes nearly always occur during the daytime.

- **General Considerations.** These data suggest two very basic treatments that should be considered: pavement markings and roadway delineators. These treatments are appropriate considerations for the majority of fatal crash situations: single vehicle or multi-vehicle; those involving road tangents or curves; primary, secondary, and collector roads; crashes occurring during the day or at night; and crashes involving most high-risk groups. Improving sight distance is another priority consideration for preventing crashes in most situations, primarily during the daytime. At night, when most young drivers, drinking drivers, and fatigued drivers are on the road, sight distance and correct anticipation can be enhanced through improvements in illumination, pavement markings, roadway delineators, and signing.

- **Curves and Intersections.** Even though most fatal crashes occur on straight stretches of roadway, curves have a much higher crash rate (relative to roadway miles) than road tangents. This increased risk is not as related to the degree of curvature as it is to the discrepancy between actual and perceived curvature. Perceived curvature is affected by combinations of vertical and horizontal curvature and the degree to which the total curve is visible to the driver.[9] Curves in which curvature increases throughout the curve are particularly dangerous. Possible short-term improvements include extending sight distance throughout the curve and illuminating the curve at night. Delineation can be enhanced by the use of chevron signs. As a general rule, raised pavement markers can be used to get drivers to move away from the center line, while post-mounted delineators and wider edge stripping can be used to make drivers move away from the edgeline. Innovative perceptual cues (e.g., cross striping) can also be used to make the road appear narrower or the curve appear sharper.[9,10]

The use of signs is the most common way of shaping motorists' expectancy regarding a curve. While research suggests that signs may be largely ignored in the daytime, some studies suggest that signs are twice as likely to be noticed at night (in the absence of other visual cues) than during the day. Wherever possible, retroreflective materials, which focus maximum available light back to the driver, should be used. However, as a more general rule, clear, simple, and unobstructed signs should be provided in situations wherever regulatory, advisory, or warning information is required. It is important that the pavement on curves remains highly skid-resistant. Other actions such as changing the radius of the curve or its super-elevation could be undertaken, but these are not considered to be short-term solutions.

FHWA data suggest that the installation of turning lanes is an effective way to reduce intersection crashes. In addition, the adequacy and visibility of control devices at all major intersections should be assessed. The fact that the majority of intersection crashes (particularly in rural areas) occur where there are either no control devices or only stop signs present suggests that existing control devices *may* not be adequate at many of these locations. Again, sight distance and warning signs are important in creating

accurate driver expectancies regarding the roadway ahead.

- **Interstate and Divided Highways.** Rollovers are the most frequent harmful event in rural, single-vehicle freeway crashes. This suggests the need for similar kinds of remedies as for other run-off-the-road crashes, but it also points out the importance of getting occupants to buckle-up, perhaps through more effective signing. Second, a crash with a guardrail is the most harmful event in proportionately more urban interstate crashes than on any other roadway type. This suggests a reexamination of the use and quality of guardrails in urban (and to some extent rural) freeway applications. The guardrail is potentially one of the most important safety devices on the roadway. However, as FHWA has indicated, terminals and end treatments continue to be weak links in this important safety mechanism. This appears to be particularly true on urban freeway systems. Finally, the relative high frequency of striking fixed objects, other than trees and poles, points to assessing the need for more effective warning signs, hazardous object delineators, and impact attenuators.

Crossings of medians and center dividers on divided roadways are infrequent but, when they occur, the consequences are often severe. Median barriers, heavy shrubs, emphasized pavement markings, and delineation, particularly on sharp curves, can help reduce the severity of this type of crash. Finally, the use of rumble strips in the median shoulder of hazardous locations can help reduce such crashes by alerting inattentive or fatigued drivers.

In conclusion, there are several behavioral and environmental actions that can be taken immediately to reduce fatal and serious injury crashes. One approach is through behavioral channels and relies heavily on enforcement and education, primarily with regard to behavior such as speed, alcohol impairment, and occupant protection. Another approach is through engineering, which involves roadway delineation, improving sight distance, and other measures discussed in this paper. Improving the latter requires an understanding of where most fatal and serious crashes occur, the types of high-risk drivers involved, and the types of driver errors involved in such crashes.

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IMPROVING DRIVER PERFORMANCE AND CONTROL: WORKSHOP REPORT

Chairperson: Carlton Robinson
Executive Vice President
Highway Users Federation for Safety and Mobility

FHWA Technical Resource Representatives: R. Clarke Bennett and Jose Sepulveda
NHTSA Technical Resource Representative: James L. Nichols

TOP COUNTERMEASURES

The workshop participants ranked the following nine countermeasures as the top short-term priorities, in order of priority:

1. Upgrade delineation and markings.
2. Use more "active" devices.
3. Upgrade conventional signing.
4. Establish a traffic control device management program.
5. Enhance driver knowledge.
6. Emphasize work zone safety.
7. Expand the use of textured pavement.
8. Use site-specific overhead lighting.
9. Improve credibility.

COUNTERMEASURE 1

Upgrade delineation and markings. The objectives are to keep the driver on the road and to prevent him or her from getting into an accident. To meet these objectives, the information provided to the driver on the road must first be reviewed. This information must be provided with advance warning, be consistent with general information expectancy, and meet special information needs.

Constraints

A workcrew's ability to lay striping on a road is greatly determined by the weather, the amount of traffic, the timing of rush hour, and the cost of laying the striping. Other constraints are the availability of materials, the ability to inventory needs, maintenance of the implemented countermeasures, resistance to earmarking specific monies, and the rank of system priorities.

Implementation Plan

Implementation steps to upgrade delineation and markings include the following: The first step is to review the delineation and marking standards by road classes. The objective is to assume that

drivers will have consistent sets of markings on each class of roads. This step requires communication between State and local agencies. The second step is to establish a time- and system-specific program to meet all standards. The third step is to establish priorities for special efforts based on accident records and high accident potential. The delineation of driveways and other entrances require particular attention. Additional targets are rural areas with unusual geometrics, urban intersections, railroads in rural areas, and curves greater than 6 degrees. The final implementation step is to establish a follow-up evaluation. Continual review and evaluation are needed to ensure that the countermeasure is in place, properly maintained, and effective.

COUNTERMEASURE 2

Use more "active" devices. Passive signs have a tendency to become mundane, thus, both temporary and permanent "active" devices are needed. The benefits of using "active" devices are that they can display variable messages, they are condition responsive, and they have a high visibility. "Active" devices can also provide advance warnings that are vehicular or environmentally activated.

Constraints

The constraints to using "active" devices are lack of available monies and the possibility that the drivers may confuse devices with advertisements.

Implementation Plan

The implementation steps to ensure more widespread use of "active" devices are as follows: The first step is to develop experience-based standards. Thus, those individuals responsible for establishing and maintaining "active" devices will have guidelines to help ensure the devices' effectiveness. The second step is for the Federal Highway Administration (FHWA), as well as other involved agencies, to promote the use of "active" devices. Two issues need to be stressed: short-term use of real-time messages and the condition-dependent nature of "active" devices. The third step is to establish regional demonstration projects to show both users and decision-makers where and how well a program can work so that they will openly accept changes. In addition, day and night inspection as well as appropriate enforcement will increase the success of "active" devices.

Workshop participants targeted Federal-aid primary and secondary roads for implementation because most fatal crashes occur on these roads. Relatively few occur on interstates or freeways. The group targeted this rather large system in order to have an impact. A second point was that, because funding would not allow the ultimate in delineation at all locations, a least common denominator would be applied at all locations and progressively more effective applications would be made in higher-risk locations. This concept of a broad application combined with progressively more effective application seems essential if any measurable impact is to be made.

COUNTERMEASURE 3

Upgrade conventional signing. Many variables need to be considered immediately when identifying a conventional sign that needs to be upgraded: its visibility, its ability to maintain reflectivity, and its need for maintenance. Another important consideration is the balance of information array. In other words, is the driver expected to understand too many directions during too short a time period?

Constraints

The availability of safety monies (versus construction monies) is a major constraint to upgrading conventional signing. The consistency of treatment application needs to be ensured when upgrading signing so the driver expectations are not violated.

Implementation Plan

The first step in implementing the upgrading of signs is to require a complete Traffic Control Device (TCD) inventory. This inventory should include signs' effectiveness both during the day and at night. The inventory should not be merely an item count; it should note the condition of all signs and indicate where signs are needed and the locations of unreadable or nonstandard signs can be received. In addition, areas with poor performance records based on accidents, unusual geometric layout, and those subject to severe environmental conditions should be noted so that signs there can be upgraded. The second step is to program day and night field reviews to record the appropriateness of signs. Priority should be placed on increasing the time given for warning drivers of intersections they are approaching. Therefore, step three is implementing the advanced placement of intersection signs in both rural and urban areas. A study of the whole highway system is needed so that locations can be identified where increased warning time can be given. (An added second can make a noted difference in the driver's ability to react.) In addition, deadlines must be set and program dollars must be acquired for implementing this countermeasure.

COUNTERMEASURE 4

Establish a traffic control device management program. This program would standardize time-specific, routine inspections in both the day and night and would use the *Manual of Uniform Traffic Control Devices* (MUTCD) as the standard for applicability and replacement criteria for signs, markings, and signals. To ensure the effectiveness of the program, a database system must be established that can maintain a system-wide inventory, provide prompt routine inspection scheduling, verify replacements, report on replacement frequency, analyze the life cycle of products, and estimate the annual costs of material and maintenance.

Constraints

Constraints include an inaccurate or incomplete inventory of traffic control devices, a weak or ineffective preventive maintenance program, poorly defined standards for replacement, lack of manpower and money, and low political importance.

Implementation Plan

Establishing a traffic control device management program requires four steps: (1) ensuring coordination of all affected agencies; (2) obtaining dedicated resources in both trained manpower and monies; (3) establishing and publicizing a reporting system that can handle problems reported by the public, allow followup responses to the public and highlight initial improvements through the media; and (4) establishing a program evaluation process. Despite the competition for public funds, this program would help ensure that monies are appropriated to maintain a traffic control device management program. This program would not only help solve highway safety problems; it would also use the eyes and ears of the public as a type of workforce while maintaining a highly visible public relations program.

COUNTERMEASURE 5

Enhance driver knowledge. Approaches to enhancing driver knowledge are mutually dependent, and information systems must be coordinated. In addition, decisionmakers and implementers need to be aware of the driver's perception.

Constraints

The constraints to enhancing driver knowledge are the lack of the following necessary ingredients: monies, commitment to education, manpower to work on an interdisciplinary committee, and willingness to work as a team and to share knowledge.

Implementation Plan

The first step in enhancing driver knowledge is to establish an interdisciplinary committee to study drivers' knowledge of traffic control devices. This committee should include both local and State members.

The second step is to establish a multidisciplinary action program of public information. To be effective, all agencies—engineers, safety officials, and driver education organizations—must work together. As engineers implement changes on the roads and highways, driver knowledge must continue to grow. Investments made in enhancing driver knowledge are small, and the payoff is larger as different audiences are targeted with the same information.

The third step is to coordinate education and enforcement with the traffic control device management program so that, as engineering changes are made, the public is kept abreast of the changes. Public awareness ensures that enforcement needed as a result of the changes is credible.

COUNTERMEASURE 6

Emphasize work zone safety. Work zones involve maintenance, utility activities, and routine inspection as well as major construction-reconstruction sites.

Constraints

The constraints to emphasizing a safe work zone are the lack of manpower and monies devoted to training, incorrect traffic control plans, and infrequent inspections.

Implementation Plan

The first step in ensuring work zone safety is to clearly assign the responsibility for safety in each work situation and establish an effective safety plan. Those assigned responsibility should receive training and certification as well as renewed training, when warranted. Compliance with plan elements should be assured through regular inspection under both day and night conditions. A penalty should be given for noncompliance with the traffic control plan, and work zones should be properly monitored. Enforcement of safe work zones is the responsibility of the project supervisor.

COUNTERMEASURE 7

Expand the use of textured pavement. Textured pavement serves as an audible warning device on shoulders and center lines to keep the driver on the road and in the correct lane. Similarly, rumble strips are used to warn the driver of hidden intersections or surprise situations. Textured pavement can improve the quality of raised pavement markers, all weather markers, skid resistance, and reflectivity.

Constraints

The constraints of expanding the use of textured pavement are lack of monies and the inability to agree on maintenance standards and application guidelines.

Implementation Plan

This countermeasure can be implemented by the following steps: reviewing construction and maintenance standards on texture, developing application guidelines, establishing a special funding process, and establishing an evaluation process.

COUNTERMEASURE 8

Use site-specific overhead lighting. Overhead lighting delineates the roadway, intersections, interchanges, curves, etc., for the driver. Increased lighting gives the driver advance warning for earlier decisionmaking.

Constraints

The potential constraints to using site-specific overhead lighting are concerns about energy costs and safe pole placement, and the time required for installation. Compliance with AASHTO guidelines and warrants is important because the number of requests for unwarranted installations may be high.

Implementation Plan

Implementation of this countermeasure begins with establishing cost-effective guidelines. Then, criteria must be selected for a pilot program. The next step is to implement the pilot program that will give a credible example of how site-specific overhead lighting works. The final step is to evaluate the results and share the information with related agencies and the public.

COUNTERMEASURE 9

Improve credibility. The final countermeasure, the improvement of our credibility, should actually be at the beginning of this Workshop's list of countermeasures. Credibility means adherence to our own guidelines and regulations. We cannot violate our own standards. We must improve the way we get information to the driver and deliver uncluttered messages.

Credibility is the ability to ensure that the engineers provide the driver with what is expected, in all aspects and situations. Credibility is also the ability to ensure that the implementations are standardized so that the driver knows what a sign indicates in any locality or on any highway. Conversely, the driver needs to know what reaction the engineers expect. Therefore, engineers and nonengineers must work together and use their knowledge toward the goal of safe highways.

IMPROVING COMMERCIAL MOTOR VEHICLE SAFETY

IMPORTANT CONSIDERATIONS FOR IMPROVING COMMERCIAL VEHICLE SAFETY

Paul R. Henry

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Oregon Public Utility
Commission and President of CVSA

This presentation paper addresses five topics: city/county involvement in commercial vehicle safety, training and inspection facilities, uniform sanctions, defect repair verification, and reauthorization of Motor Carrier Safety Assistance Program (MCSAP).

ONE: CITY/COUNTY INVOLVEMENT IN COMMERCIAL VEHICLE SAFETY

A little more than 1 year ago, the Federal Highway Administration (FHWA) repealed the commercial zone exemptions. Historically, both commercial vehicles and their drivers were exempt from most of the motor carrier safety regulations while operating within defined metropolitan areas. What did this exemption mean? Simply stated, unqualified drivers and defective equipment could be operated within the defined zones.

Decades ago this problem may have been a nonissue. However, today this issue has become important in view of beltways and high-speed freeways and 48-ft semis, doubles, and triples operating at weights exceeding 100,000 lb. FHWA did the most responsible thing it could to address the commercial zone concern by repealing these exemptions.

How can we bring a visible level of commercial vehicle enforcement to our major metropolitan areas? With few exceptions, no fixed-site inspection facilities exist; therefore, efforts must be made to identify safe stopping areas within our cities for the conduct of these inspections.

The current Motor Carrier Safety Assistance Program (MCSAP) effort is a partnership between FHWA and the States. In most States, local governments are not directly involved in commercial vehicle/driver safety enforcement. If sufficient funds exist and quality control is maintained, making more use of local law enforcement officers to promote commercial vehicle safety offers numerous benefits. Some local governments are already involved and doing very well. Many others wish to be integrated into the Federal/State MCSAP partnership.

The risk in moving in the local government direction is a loss of control by the State element. This loss of control may lead to substandard inspections and unequal treatment to the operating industry. To safeguard against these

legitimate concerns and protect the inspection uniformity advances achieved to date, the State must be the responsible element.

Commercial Vehicle Safety Alliance (CVSA's) bylaws contain guidance for this State/local government relationship. Essentially, the State must provide training, inspection documentation, monitoring, and technical and legal support under a written agreement with the city or county participant. In turn, the city or county agrees to inspect to CVSA standards; enforce the driver, vehicle, and hazardous materials out-of-service standards; and issue alliance decals when appropriate. These State and local government relationships significantly increase vehicle/driver inspections within the commercial zones and enhance government relationships without sacrificing the degree of inspection uniformity demanded by the operating industry.

TWO: TRAINING AND INSPECTION FACILITIES

Good training is the key to any successful enterprise. In the area of commercial vehicle safety enforcement, it is essential that good training is available in both a timely and cost-effective fashion. Today, all States require commercial vehicle enforcement personnel to receive training in performing on-highway Level I (North American Standard) inspections. Some States also need Level II (walk around) inspection training. As the States' safety programs mature and become more sophisticated, it is likely that they will need training in hazardous materials, hazardous waste, compliance reviews or audits, radioactive materials and hazardous material cargo tank inspections. What is the best way to deliver training in each of these elements?

Historically, safety training was provided at the Federal Transportation Safety Institute in Oklahoma City. When MCSAP was in its infancy, it was apparent that the institute could not accommodate the new inspection training demands of the States. Therefore, they moved to a training-the-trainer approach in the field. As the size of the State inspection resources has grown from very few to some 5,900 today, the size of the Federal Office of Motor Carriers (OMC) has increased significantly. Currently, OMC is hiring and training 150 more men and women. Collectively, the training demands of our Federal and State safety specialists far outweigh the capacity of the training institute. To answer the long-term training commitment to an investment in highway safety resources, an investment must be made in the institute's ability to deliver a higher level and more frequent degree of training. This investment could be accomplished with two or more satellite facilities under the management and direction of the institute and located at strategic geographic locations.

Relating to inspection facilities, Congress established the MCSAP in the Surface Transportation Assistance Act of 1982. In fiscal year 1984, the first year of the program, Congress appropriated $8 million. Generally, the MCSAP appropriation has increased each year. MCSAP is funded through fiscal year 1991 at $60 million, minus $13 million to support State commercial drivers' licensing programs.

The backbone of MCSAP is the on-highway Level I inspection. However, some States must discontinue their Level I inspection efforts and engage in other allied activities until weather conditions such as extreme heat, cold, rain, or snow become more moderate.To facilitate year-round Level I inspection work, these jurisdictions need well-constructed, covered, drive-through inspection buildings. For 7 years or longer, significant funds have been invested in our nation's commercial vehicle safety program. Now is the time to recognize both the need and the long-term investment in our nation's truck inspection program. Criteria should be established to ensure that the location of these facilities is sound and that a uniform approach is used by each State in siting its inspection facility locations. A generic set of construction plans would help establish uniform facilities and reduce associated costs. To make year-round

Level I inspections possible, a Federal funding apparatus must be identified to help offset State construction costs for inspection facilities.

THREE: UNIFORM SANCTIONS

From a motor carrier's perspective, uniform inspections that are compatible with the operational demands of the truck and bus industry are a must. Eight to 10 years ago, this same industry was telling the CVSA that standardizing and modernizing the vehicle, driver, and hazardous materials out-of-service criteria were essential to improving our commercial vehicle safety program. The parties of interest (State, provincial, Federal, and industry) have made great strides on each of these four fronts. Now, because the regulators and enforcers are being told to further improve North America's truck safety program, it is imperative that uniformity be established for the issuance of fines.

Industry says, "We support our nation's inspection program, but it must be uniform." Industry says, "We support the identification of very serious defects and noncompliance elements as warranting out-of-service action, but these actions must be uniform." Finally, industry says, "If fines must be assessed, please make them uniform." Is this request reasonable? How bad is this area of enforcement? The alliance's literature search revealed fines for exactly the same violation ranging from 0 to $1,600 depending on which jurisdiction stopped the driver.

Two years ago, when the President of the American Trucking Associations communicated his concerns on this subject to FHWA, there was strong concurrence and an identification of the CVSA as the best vehicle to undertake the task. Therefore, for nearly 2 years, the Alliance's Uniform Sanctions Committee has been laboring to develop a recommended maximum fine schedule for specific vehicle, driver, and hazardous materials violations. Violations have been separated into two broad categories: out of service and other. Within each out-of-service element (vehicle/driver/hazardous materials) are three separate categories. (See the attachment.)

The first phase, the establishment of a recommended uniform commercial vehicle fine schedule, will be completed this October. What then? Through its MCSAP, FHWA must help to encourage the other parties involved: States, to adopt the new fine schedule; the National Conference of State Legislators, to understand the product and adopt it in their States, where necessary; the operating industry, to demand that the States adopt and implement the fine schedule; and the judiciary, to administer this new product.

FOUR: DEFECT REPAIR VERIFICATION

It is essential that reasonable defect repair verification efforts be incorporated into each State's inspection program. In June 1988, a report completed by the Congressional Research Service, entitled "MCSAP: Options Intended to Improve a Generally Successful and Cooperative Federal/State Partnership Promoting Truck and Bus Safety," identified the lack of roadside reinspection requirements within the MCSAP as a deficiency that needed to be addressed. In fiscal year 1989, the State of Michigan agreed to conduct a verification study to determine the percentage of critical defects discovered during MCSAP inspections that were not repaired properly. Results of the study indicated that the location of the out-of-service vehicle (i.e., open scale house, closed scale house, roadside, etc.) may have an effect on whether the driver complies with the out-of-service action. In addition, the types of violations (brakes, tires, hours of service) appear to be a significant indicator of possible noncompliance with the out-of-service action.

Three more States have recently completed similar studies, and FHWA is analyzing the results to determine the extent of the problem and to further develop ways to reduce the operation of imminently hazardous vehicles.

Nationally, we conduct nearly 2 million vehicle inspections annually at a cost to society that approaches tens of millions of dollars. Our national inspection program must deter those who would violate an out-of-service notice and must incorporate reasonable defect repair verification methodologies.

The CVSA has also recently developed procedures for the performance of verification programs. The alliance has also established an international goal of verifying the repair of 15 percent of the out-of-service violations discovered by each member jurisdiction during its roadside inspection program.

The verification package being implemented by the alliance is divided into out-of-service defects and non-out-of-service defects. This policy is further divided into on-site and off-site verification practices. The basics of the program include the following requirements:

- As many out-of-service on-site verifications should be made as resources permit. These verification inspections can be made by any CVSA-certified officer and can be conducted while the inspection facility is open.

- Unmarked radio-equipped cars downstream from the inspection site will be used to relay pertinent vehicle, driver, and violation information from the inspection facility just before it closes. Out-of-service vehicles leaving the closed site within 1 or 2 hours of closing time should be stopped, and repair verifications should be made.

- Non-out-of-service violations may be reinspected at the request of the vehicle's operator. When such request is made and the defects have been corrected at the inspection site, a CVSA reciprocity decal can be issued. If the reinspection is made after the vehicle leaves the inspection site, a complete reinspection must be made before a decal can be issued. Further, States engaged in terminal audits should incorporate a comparison of pertinent inspection documents in the carrier's maintenance records, and every effort should be made to inspect vehicles that had reported defects during previous inspections on the road.

Adherence to the foregoing recommended policies will deter violation of out-of-service notices by drivers and enhance the regulatory community's ability to control this difficult element.

FIVE: REAUTHORIZATION OF MCSAP

MCSAP has been a successful Federal/State effort in promoting commercial vehicle safety; its reauthorization and increased level of funding is vital. Increased funding will provide additional opportunities for reduction of commercial vehicle accidents.

MCSAP is 7 years old. When the program was first conceived, the monies were to be distributed among the States based on an allocation formula that uses factors such as the number of commercial vehicles registered in a State, the number of miles of interstate highway, and the amount of fuel used. As a part of the reauthorization process, it may be time to reevaluate the manner in which MCSAP funds are distributed with consideration of the level of commercial vehicle safety programs active in each State.

Increasing effectiveness of the MCSAP program will result in an improvement in commercial vehicle safety. It can be achieved in the following ways, among others.

Commercial Driver's License

The Commercial Vehicle Safety Act of 1986 called for implementation of a standard or national commercial driver's license. The purpose was to remove drivers with multiple licenses, because they were frequently found to have numerous violations and accidents. If all these

violations appeared on one license rather than being spread over two or three different licenses, that license would be revoked—obviously, spelling disaster for a commercial driver. The Commercial Driver's License (CDL) further sought to ensure that commercial drivers are properly trained and experienced to drive the type of vehicle they actually operate over public highways. Initially when license was implemented, hundreds of drivers with multiple licenses were detected. The majority of them turned in all but one license under an amnesty program, and those with disqualifying offenses were suspended from driving. CDL will be fully implemented by 1992. As part of the MCSAP roadside inspection process, drivers should be checked randomly to ensure compliance with licensing requirements. This check will help ensure that only qualified drivers are being employed by motor carriers. It will also remove drivers who do not meet the license, requirements from the highway.

Education

Federal and State regulatory agencies promulgate hundreds of laws affecting the operating industry. However, all too often industry relates that its members were not aware of a new regulatory requirement. Use of MCSAP funds to promote education for the industry could have a significant impact on reducing accidents. Additionally, media announcements, inclusion of certain information in drivers' manuals, and presentations at schools and social organizations would all serve to inform the public of the special considerations necessary when the average four-wheel drivers are sharing the highway with commercial vehicles.

Level II Inspections

When first implemented, MCSAP provided for only one type of roadside inspection, now known as a Level I or full inspection. This inspection includes an examination of both the driver and the vehicle. It soon became apparent, however, that the inspection procedure needed modifications to permit uniformed law enforcement officers to conduct a modified driver/vehicle inspection in conjunction with a probable-cause stop. This type of inspection came to be known as a Level II inspection.

The Level II inspection soon began to reveal an added benefit: it is vastly more effective in detecting driver hours-of-service violations. This benefit is true primarily because Level II inspections occur unexpectedly, unlike fixed-site inspections, which afford a driver time to prepare what are often falsified records to conceal the fact that they have been driving far beyond the allowed hours. One State's statistics indicate a 34 percent hours-of-service violation rate using a Level II inspection compared to a 6 percent rate for the same violation at fixed sites incorporating the Level I inspection.

Based on its apparent effectiveness in detecting hours-of-service violations, Level II inspections, in conjunction with probable-cause stops, should be a required percentage of all State MCSAP plans.

Truck Speed

Truck speed has been identified as a major cause or contributing factor in commercial vehicle accidents for years. Complaints to law enforcement and regulatory agencies from the public frequently reveal the commercial driver to be speeding and tailgating. If meaningful accident reduction strides are to be made under the MCSAP program, reasonable speed abatement practices should be incorporated into each State's MCSAP enforcement plan.

Drugs and Alcohol

The number of people who die in traffic accidents every year is greater than the number who died in the Vietnam War. Much of this carnage is caused by drivers who are operating their vehicles under the influence of alcohol or drugs—or both! It is believed that involvement of commercial vehicle drivers in drug use is

quite low; alcohol use is higher, but it is well below the national average. Nevertheless, no professional driver should be operating his or her vehicle while under the influence of drugs or alcohol, and even one such driver on the highway must be unacceptable.

MCSAP needs to continue its emphasis on eliminating drug and alcohol use by commercial drivers. Detecting and removing these drivers is paramount to highway safety. Dedicating a portion of the MCSAP to this purpose will ensure that efforts in this most important area are continued.

ATTACHMENT

UNIFORM

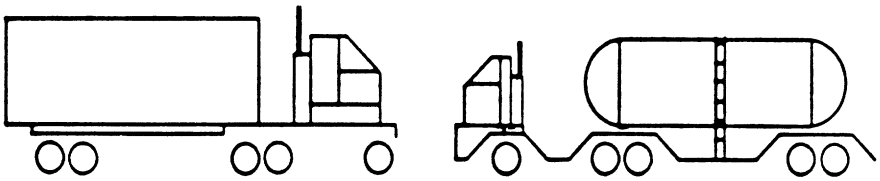
SEVERITY RATING

of

Out of Service Violations

and

Recommended Maximum Fine Schedules



Commercial Vehicle Safety Alliance

VEHICLE

GROUP 1

VIOLATIONS		Maximum Fine
Braking Action Absent	Steering Gear Box	1 Violation =
Missing/Broken Brake Component	Steering Modification	$100
Air Drop Test	Steering Wheel Play	2 Violations =
Safety Devices-Chains or Hooks	Coupling, Towing Devices	$150
Tires, Retreads on Buses	Frames	3 Violations =
Steering Column	Tires, Front Axle	$600 *
Other Steering Components	Safe Loading	
Violation of Out-of-Service Notice (Each Notice, not each Offense)		$1000

GROUP 2

VIOLATIONS		Maximum Fine
Brake Pad	Lamps on the Rear	1 Violation =
Brake Hose, Tube	Lamps on Projecting Load	$50
Parking Brake	Turn Signal-Rear	2 Violations =
Low Air Warning Device	Fuel Tank Not Secured	$150
Air Reservoir	Adjustable Axle	3 Violations =
Brake Adjustment	Wheels and Rims	$250 *
Headlight Inoperative	Front End Structure	
Stop Lamp Inoperative	Suspension	
Violation of Out-of-Service Notice (Each Notice, not each Offense)		$1000

GROUP 3

VIOLATIONS		Maximum Fine
Fuel Tank Cap Missing	Audible Air Leak	1 Violation =
Fuel System	Exhaust System	$30
Windshield Glazing	Tires, Other Axles	2 Violations =
Windshield Wipers		$90
		3 Violations =
		$150 *
Violation of Out-of-Service Notice (Each Notice, not each Offense)		$1000

* Maximum Accumulated Fine for each group is the highest fine indicated for each group.

DRIVER

GROUP 1

VIOLATIONS	Maximum Fine
Disqualifying Offenses	1 Violation =
Drugs - Under the Influence	$500
Drugs - Possessing	2 Violations =
Intoxicants - Under the Influence	$1000
Intoxicants - Consumption	3 Violations =
	$1500 *
Violation of Out-of-Service Notice (Each Notice, not each Offense)	$1000

GROUP 2

VIOLATIONS	Maximum Fine
Record of Duty Status	1 Violation =
10 Hour Violation	$100
15 Hour Violation	2 Violations =
60 in 7, or 70 in 8	$200
None in Possession	3 Violations =
Not Current	$300 *
Falsification of Record of Duty Status (intentional) $300	
Violation of Out-of-Service Notice Each Notice, not each Offense)	$1000

GROUP 3

VIOLATION	Maximum Fine
Age	1 Violation =
Intoxicants - Possession in Cab	$30
License - Inproper Class	2 Violations =
Waiver of Physical Disqualification	$90
Radioactive Material Training Certificate	3 Violations =
	$150 *
Violation of Out-of-Service Notice (Each Notice, not each Offence)	$1000

* Maximum Accumulated Fine for each group is the highest fine indicated for each group.

HAZARDOUS MATERIALS

GROUP 1

VIOLATIONS	Maximum Fine
No Placards	1 Violation =
Non-Spec Cargo Tank	$250
Internal Valve	2 Violations =
Packaging	$500
Load Securement	3 Violations =
Forbidden Items	$1000 *
Violation of Out-of-Service Notice (Each Notice, Not each Offence)	$1000

GROUP 2

VIOLATIONS	Maximum Fine
Instructions - Flammable	Any
Cryogenic Liquid	Violation =
Documents - A & B Explosives	$100 *
Violation of Out-of Service Notice (Each Notice, not each Offence)	$1000

GROUP 3

VIOLATIONS	Maximum Fine
Radioactive Route Plan	1 Violation =
Route Plan A & B Explosive	$30
Shipping Papers	2 Violations =
Hazardous Waste Manifest	$90
Bulk Packaging Marking	3 Violations =
Cargo Tank Marking	$150 *
Violation of Out-of-Service Notice (Each Notice, not each Offence)	$1000

* Maximum Accumulated Fine for each group is the highest fine indicated for each group.

Coordinating Efforts To Improve Commercial Motor Vehicle Safety

Lieutenant Don Uelmen

California Highway Patrol
Assigned to:
U.S. Department of Transportation
National Highway Traffic Safety Administration

It is exciting to enter the decade of the 1990's, especially working in the field of commercial motor vehicle safety. During the 1980's, commercial motor vehicle safety programs advanced from a secondary role to a primary national highway safety concern. The best evidence of this is its selection as a discussion topic at this Symposium and for the Traffic Safety Summit conducted recently in Chicago. The reason for this increased attention on commercial motor vehicle safety can be found almost daily in news media coverage of truck accidents and incidents.

Crashes involving large trucks are rarely a minor traffic incident. The physical difference between smaller and lighter automobiles—and longer, wider, and heavier trucks—equates to an escalated danger to car occupants—in spite of the increasing use of safety belts and installation of passive restraints. Even a "property damage only" collision impacts traffic flow to such a degree that 'congested traffic' ceases to be an adequate description of the resulting chaos on major transportation arteries.

The economic loss is staggering. A study by the AAA Foundation for Traffic Safety estimates the total annual costs of truck incidents on the Los Angeles freeway system is in the range of $107 to $189 million. Effects on public health and safety and government agency costs are multiplied when the incident involves a cargo of hazardous materials.

The development of commercial motor vehicle safety programs is the result of numerous independent efforts to address specific problems. Consequently, commercial motor vehicle safety programs do not appear to be synchronized, and effective communication seems to be lacking between different, yet related, programs.

Presentation Points

The major programs related to commercial motor vehicle safety include the following:

- On-Highway Hazardous Moving Violations are the responsibility of State and local traffic enforcement agencies. Included are violations of speeding, unsafe lane changes, following too closely, and intoxication.

- Equipment and Driver Inspections are primarily performed at the State and local level and based on regulations developed at the Federal level.

- Hazardous Materials Transportation also involves regulations established at the Federal level and enforcement at the State and local levels.

- Weight Enforcement is not only an effort to save the roadway surface and bridges from disintegration, but also has some direct bearing on highway safety. Consider the results of truck combination with marginal brakes descending a steep downgrade carrying 30,000 lb over the legal limit.

- Motor Carrier Safety Reviews are an important step toward voluntary compliance by the trucking industry. Performed by Federal and State inspectors, the reviews affect motor carrier safety ratings.

All these programs have a primary purpose in eliminating the necessity for the last program, which is Incident Response/Accident Investigation and Reporting.

These commercial motor vehicle safety program descriptions are very general and must take into account distinctions between interstate and intrastate commerce.

It would be impossible for a single agency or organization to perform all these elements. For example, because of the expertise and specialized background of each element, the Department of Transportation has three separate entities directly involved with commercial motor vehicle safety:

Federal Highway Administration

Motor Carrier Regulations
Equipment and Driver Inspections
Motor Carrier Safety Reviews
Weight Enforcement
Highway Design (Weighing Facilities and Inspection Turn-Outs)

National Highway Traffic Safety Administration

On-Highway Hazardous Moving Violations (alcohol and safety belts)
Vehicle Design Standards (anti-lock braking systems)
Accident Investigation and Reporting (Fatal Accident Reporting System)

Research and Special Programs Administration

Hazardous Materials Transportation

On the State level, and in some local governmental subdivisions, program management elements of commercial motor vehicle safety are the responsibility of separate agencies. These elements include:

- Regulation—enacting laws and rulemaking relating to interstate commerce.

- Inspection—ensuring that regulations are being complied with and identifying drivers and motor carriers who fail to comply.

- Enforcement—taking action against violators of the regulations.

- Compliance (Courts)—ensuring that regulations will be followed.

- Accident Investigation and Reporting—providing information on causes and locations of crashes to serve as foundational data for other elements.

The result of this approach to commercial motor vehicle safety has sometimes led to confusion by other governmental agencies, the trucking industry, and public and private traffic safety advocacy groups as to who or how to access information and resources.

Therefore, one of the first steps toward improving commercial motor vehicle safety might be an evaluation of traditional approaches in order to:

- Manage the program elements more efficiently.

- Combine or restructure overlapping responsibilities.

- Avoid duplication of programs.

If these steps are too difficult or impossible, at least we can improve communication between all levels of government, program elements, and government and industry. We can accomplish this by:

- Establishing a forum for exchanging information between the various elements and programs, including parties of interest from all levels of government, the motor carrier industry, trucking and driver's associations, and public advocacy groups concerned with commercial motor vehicle safety.

- Fixing responsibility for coordinating and updating commercial motor vehicle safety efforts—to serve as a resource and provide assistance to the parties of interest. This would also avoid duplication of effort and save the unnecessary commitment of resources.

For example, an estimated 85 percent of truck-at-fault crashes are the result of driver error and/or impairment. National Transportation Safety Board findings revealed that fatigue was the most frequently cited cause, of truck-at-fault crashes and alcohol- or other drug-impairment was the second most frequently cited cause of death in a recent fatal-to-the-driver heavy truck crash study. Specific actions to combat the problem of fatigued and impaired commercial motor vehicle operators could include Federal, State, and local government.

Federal resources might be directed toward the following areas:

- Development of and training in the use of on board computers to replace easily altered logbooks. This procedure would assist commercial vehicle enforcement of driver's hours of service and inspire voluntary compliance by drivers and motor carriers.

- Recommendations and guidelines using of passive alcohol sensing devices and training in recognizing the symptoms of drug and alcohol impairment to benefit both enforcement personnel and industry supervisors.

State and local traffic administrators might develop truck enforcement strategies directed toward the following areas:

- Formulating effective countermeasures to combat the unlawful and dangerous operation of heavy trucks by fatigued or impaired drivers.

- Providing support and assistance to motor carriers for effective safety programs directed toward awareness of the hazards of fatigue and impairment to commercial motor vehicle operators.

The motor carrier industry, trucking and driver's associations, and public advocacy groups concerned with commercial motor vehicle safety could support legislation and assist in development of technology and guidelines to eliminate fatigued and impaired drivers of commercial motor vehicles.

It is interesting to note that the first three of the Secretary of Transportation's Traffic Safety Summit Recommendations on Commercial Motor Vehicle Safety are directly related to communication. These recommendations are as follows:

- Allocate more resources to the education of commercial motor vehicle drivers in order to reduce commercial motor vehicle crashes.

- Utilize more effectively the existing data systems that provide information on the commercial vehicle driver, employing motor carriers, equipment violations, crash data,

and safety and compliance reviews. All data must be made available upon request for these information systems to be effective.

- Initiate a judicial outreach program that provides information and training to prosecutors and judges on the severe and negative impact of motor carrier safety violations on traffic safety.

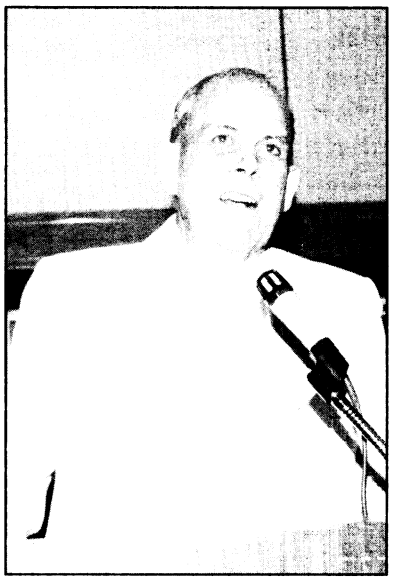
In our search for solutions to problems, we often overlook basic problem-solving principles such as communication. We may forget that communication involves both providing information and listening for responses.

CONCLUSION

Here is a final point on the subject of the importance of communication, and the seemingly impossible task of formulating a comprehensive commercial motor vehicle safety program. This presentation began by mentioning that 1990 is the start of a new decade. We have a fascination with designating time periods. For example, President Bush declared 1990 as the year for reading the Bible. The Bible contains some excellent insights and wisdom pertaining to human nature. Probably one of the best principles regarding the importance of communication is in Genesis Chapter 11—the story about the Tower of Babel. The earth's population came together to build a tower to reach heaven, thereby eliminating any necessity for help from God. The story relates that God confused their language in order to defeat their project. This quote of verse 6 is taken from the New International Version. "The Lord said 'If as one people speaking the same language, they have begun to do this, then nothing they plan to do will be impossible for them'." Planners, engineers, and police officers may not speak the same "language," but we can talk and listen to one another.

The number of fatalities and serious injuries resulting from crashes involving large trucks, and the financial impact caused by congestion and damages, calls for an evaluation of current commercial vehicle enforcement programs and development of new strategies to combat this problem. Past efforts toward accomplishing a common goal, such as reducing the number, frequency, and severity of heavy truck crashes, have sometimes been diluted by separate agendas of the entities involved in commercial motor vehicle safety programs. Concentration on shared concerns must replace the emphasis on traditional differences that resulted in a lack of a united effort.

Commercial enforcement programs directed toward driver's qualification and equipment inspection, such as the Motor Carrier Safety Assistance Program (MCSAP), requires a compatible program focusing on moving violations and driver intoxication and/or fatigue. The cornerstone to this approach is a spirit of unity in attacking the cause of so much waste in lives and resources. It has begun, with organizations such as CVSA, between the agencies within the Federal government, agencies within State government, between all levels of government, and between all governmental agencies and the trucking industry. This Symposium can be the continuation for improving commercial motor vehicle safety through enhanced communication and cooperation.



IMPROVING COMMERCIAL MOTOR VEHICLE SAFETY: WORKSHOP REPORT

Chairperson: James E. Daust
Lt. Colonel, Michigan State Police

NHTSA Technical Resource Representative: Don Uelmen, California Highway Patrol
FHWA Technical Resource Representatives: Thomas Hall and David Osiecki

TOP 10 COUNTERMEASURES

The workshop participants ranked the following 10 countermeasures as the top short-term priorities, in order of priority:

1. Reauthorize the Motor Carrier Safety Assistance Program (MCSAP).
2. Increase education for the public, motor vehicle drivers, and motor carriers, especially new companies.
3. Enhance the identification of problem carriers and drivers (fully implement SAFETYNET).
4. Ensure uniform and comprehensive accident statistics (adopt National Governor's Association (NGA) accident data elements).
5. Increase motor carrier enforcement.
6. Provide training for non-MCSAP officers.
7. Increase the seriousness of out-of-service order violations.
8. Increase mobile road enforcement.
9. Increase selective enforcement.
10. Increase safe areas and inspection facilities.

COUNTERMEASURE 1

Reauthorize the Motor Carrier Safety Assistance Program (MCSAP). The Motor Carrier Safety Assistance Program, established in the Surface Transportation Act of 1982, provides Federal funds to States for commercial motor vehicle safety initiatives, such as inspecting vehicles and driver records, training personnel in the safety requirements, conducting reviews of carrier operations, and promoting public awareness about commercial vehicle laws and safety. In fiscal year 1984, the first year of the program, Congress appropriated $8 million. In fiscal year 1986, that total was increased to $17 million. MCSAP is funded through fiscal year 1991 at $60 million annually, less $13 million to support State Commercial Drivers' License (CDL) programs. Its current authorization will expire in 1992. Participants' top priority was the reauthorization of this program. This recommendation includes a potentially higher funding level and the possibility for adding funding for traffic enforcement.

Constraints

The constraints that participants foresaw with this countermeasure were an inadequate budgetary allocation, a difference in emphasis with some people who may want a more comprehensive MCSAP, a different preference for emphasis by FHWA, and sensitivity of States regarding intrastate regulatory compatibility.

Implementation Plan

The participants recommended the following activities to implement this countermeasure:

Develop grassroots support for a reauthorization of MCSAP with increased funding levels; support must be developed immediately and continue throughout the enactment of the program.

Encourage States to contact FHWA with their support for a comprehensive safety program. In addition to support at the community level, participants recommended that States be encouraged to contact FHWA directly and urge their support. As in the above step, this action was recommended to start now and continue through reissuance of the regulation implementing the 1992 reauthorization.

Revisit the intrastate tolerance guidelines established 2 years ago governing intrastate compatibility. The compatibility issue among States is a source of sensitivity. Participants recommended a review of the tolerance guidelines established 2 years ago that govern this issue.

Allow States to use additional MCSAP funds for moving traffic violations. Participants recommended that support for this objective be developed concurrent with support for reauthorization of MCSAP in general.

COUNTERMEASURE 2

Increase education for the public; motor vehicle drivers; and motor carriers, especially new companies. This countermeasure advocates increased educational information to be made available by a range of sources including Federal agencies and the media.

Constraints

The Constraints foreseen to this countermeasure were the size and diversity of the industry, resources, politics, and the continual change of both regulations and the industry.

Implementation Plan

The activities recommended to implement this countermeasure are as follows:

Establish a clearinghouse to disseminate and coordinate information. Clearinghouses are an efficient, centralized means of getting information into the right hands.

Conduct a comprehensive judicial outreach program. Participants recommended a comprehensive effort to reach judicial officials with their concerns. They recommended creating and publishing a list of those officials and a list of the conferences they attend. They recommended that this be followed by distributing the list to commercial vehicle regulatory personnel so that they can attend these conferences and present their concerns.

Develop a model curriculum, such as a CVSA training package, for commercial vehicle enforcement officers to be used at law enforcement academies. Encourage volunteers to attend State conferences to gain acceptance of the curriculum.

Arrange to have public service announcements aired in the time periods when drivers, including commercial vehicle drivers, are on the road (such as rush hour).

Create a dialogue for regulatory change regarding shipper/consignee liability, with a view towards developing aiding and abetting legislation.

Incorporate commercial motor vehicle awareness (how to mix trucks and cars) in driver education curriculum. Participants discussed the value of incorporating training on the interrelationship of commercial and noncommercial traffic into existing and new educational curriculum.

Encourage State departments of transportation to develop more creative signing, with high impact, for commercial motor vehicles and recommended that State departments of transportation develop such signing.

COUNTERMEASURE 3

Enhance the identification of problem carriers and drivers (fully implement SAFETYNET). The identification of problem carriers and drivers is an ongoing problem. The Federal government currently maintains a computerized data base that States may access known as SAFETYNET. This system provides data on the performance of both interstate and intrastate motor carriers. It allows FHWA and States to manage and share data collected during safety inspections of commercial vehicles. States use the data to help analyze safety measures such as relationships between vehicle inspections and accidents.

Thirty-six States have installed SAFETYNET and are electronically transmitting roadside inspection and other data to the FHWA. However, a few States do not participate in the system. This countermeasure advocates nationwide participation in SAFETYNET and the provision of equipment to ensure participation.

Constraints

The constraints to this countermeasure are funding, defining the problem driver, tracking violators who constantly violate hours of service, the lack of specific information regarding drivers in the SAFETYNET data base, and the lack of availability of data.

Implementation Plan

The activities recommended to implement this countermeasure are as follows:

Support Congressional action for increased MCSAP funding, especially for the support of data systems such as SAFETYNET. Participants recommended lobbying for funding.

Develop a definition of the problem driver. One problem in identifying problem drivers is the lack of a functional definition. Participants recommended consulting the 1984 Act that gives guidance on civil penalties and the 1986 Act that gives guidance on commercial driver's licenses. They also recommended consulting legal counsel on a proper definition.

Develop a system that targets consistent hours-of-service violators and makes repetitive hours-of-service rule violations a serious offense. Problem drivers include those who frequently operate vehicles outside the allowed hours of service. Participants recommended that these violators be penalized more severely by assessing a heavier fine to these violations—perhaps $1000—but acknowledged that a Department of Transportation rule or policy may be needed to accomplish this. Participants recommended the implementation of this action immediately.

Ensure that technical problems do not impair SAFETYNET. Steps to improve the SAFETYNET system could be implemented immediately to assure that problem drivers are identified. Participants recommended that the technical problems be worked out of the system and that the system be modified to assure the availability of information.

Charge a user fee for information requests by the industry to offset the costs of providing information. Investigate the operational and legal constraints of performing this action. Cost is a major impediment to perfecting SAFETYNET.

COUNTERMEASURE 4

Ensure Uniform and Comprehensive Accident Statistics (Adopt NGA Accident Data Elements). States record accident data on a variety of State-designed forms. These forms are not standardized and often do not capture critical information. A State may not, for example, distinguish between an interstate and an intrastate driver. The NGA has recently developed a comprehensive list of accident data elements. This countermeasure recommends the nationwide adoption of these data elements.

Constraints

The constraints to this countermeasure are getting States to use standard data elements, the costs of implementation, training, and coordinating with the Critical Automated Data Reporting Elements (CADRE).

Implementation Plan

The activities recommended to implement this countermeasure are as follows:

Require the use of the NGA data elements in MCSAP State Enforcement Plans.

Obtain funds from MCSAP, user's fees, 402 funds, etc. to implement a comprehensive system.

Develop a generic training package that can be used in any State, develop or use recently developed videotapes and monitor the training and accident gathering information.
If videotapes are not obtainable, or are not useful, participants recommended developing new tapes.

Coordinate the above implementation efforts with CADRE.

COUNTERMEASURE 5

Increase Motor Carrier Enforcement. This countermeasure proposes increased enforcement of current laws addressing motor carriers, from licensing to speed. This countermeasure is independent from the first countermeasure, which may or may not address traffic enforcement.

Constraints

The constraints to this countermeasure are funding, jurisdiction, training, and human resource allocation.

Implementation Plan

The activities recommended to implement this countermeasure fall into two areas: resources and enforcement.

Make efforts to ensure reauthorization of MCSAP and increased funding for traffic enforcement. The reauthorization of MCSAP is of primary importance to enforcement, as it has been in previous countermeasures. Thus, participants prioritized the need for efforts to ensure this reauthorization and, in this case, to lobby for increased funding for traffic enforcement.

Include trucking in HS 402 programs, such as alcohol and safety belts, as a means of raising resources for motor carrier enforcement.

Develop a self sufficiency program, as a means of developing resources, i.e., fees attached to citation, which are returned to the enforcement agencies. Participants recommended that funds be directed back into the program and that this step begin immediately.

Make a broader enforcement effort. Participants recommended involving various police agencies to accomplish this.

Assign a liaison officer to coordinate traffic and inspection. Participants recommended that a liaison be assigned to take responsibility for this

function and that this action be implemented immediately.

Establish minimum training standards and certifications for each level of MCSAP inspection. Participants recommended adopting standards which are already established.

Allocate human resources efficiently. Participants noted that, by allocating human resources more efficiently, existing resources could be conserved.

Conduct a media blitz to get information out. This blitz would convey enforcement information to the general public.

COUNTERMEASURE 6

Provide training for non-MCSAP officers. Two categories of officers enforce motor carrier regulations: those paid with MCSAP funds and those supported with State or local monies. Individuals paid under MCSAP receive training specific to motor carriers. Participants developed this countermeasure to provide similar motor carrier training to non-MCSAP law enforcement officers (troopers, local officers, county sheriffs, etc.).

Constraints

The constraints to this countermeasure were financial resources, the need for training, and a lack of coordination.

Implementation Plan

The activities recommended to implement this countermeasure are as follows:

Once again, resources are the top priority to achieve this objective. Participants recommended obtaining resources through MCSAP, by reverting fines back to the agency to maintain self sufficiency, from industry, and through State legislatures. They recommended this task begin immediately.

Designate training agencies to conduct the needed training. These agencies might include academies (basic law enforcement officer training), TSI (train the trainers), and regional training centers.

Coordinate new training activities by involving the State MCSAP coordinator, CVSA/FHWA, and State Training Councils for Law Enforcement.

Train those jurisdictions permitted to enforce commercial vehicle legislation first and encourage those agencies without authority to seek legislative changes.

COUNTERMEASURE 7

Increase the seriousness of out-of-service order violations. Some motor carrier drivers who have been placed out-of-service resume operation without remedying the problem. Workshop participants recommended upgrading this violation to a more serious category of CDL violation.

Constraints

The constraints to this countermeasure are the ability to identify the out-of-service vehicle, lack of legislation to support seriousness of out-of-service order violations, opposition by independent owners/operators, enforcement, and funding.

Implementation Plan

The activities recommended to implement this countermeasure are as follows:

Implement a central computer system or rectify present data systems so that out-of-service vehicles and drivers can readily be identified. This system should have immediate entry capability

and should be accessible by all law enforcement personnel.

Work with special interest groups to enact legislation that would upgrade the seriousness of this violation and implement stronger fines.

Conduct a public relations effort with industry to sell the need for legislation and enforcement.

Direct efforts towards increased MCSAP authorization and for fines for violations to be reverted to supporting this effort.

COUNTERMEASURE 8

Increase mobile road enforcement. This countermeasure was nominated to increase the enforcement of operators bypassing roadside inspection stations. This countermeasure is independent of countermeasure 5; its emphasis is on moving violations such as bypassing weight scales.

Constraints

Constraints to this countermeasure are funding, geography, safety of operation, and lack of authority.

Implementation Plan

The activities recommended to implement this countermeasure are as follows:

Support the reauthorization of MCSAP. Once again, funding is critical.

Include mobile road enforcement goals on State enforcement plans.

Work with local agencies in other States and localities to identify safe inspection areas. Safe inspection areas are needed critically.

Obtain needed legislation for the above objectives.

COUNTERMEASURE 9

Increase selective enforcement. This countermeasure proposes increased target inspections based on identified problem carriers. Participants recommended increasing selective safety reviews (SR's) and compliance reviews (CR's).

Constraints

The main constraints to this countermeasure are the incompatibility of data elements and the incompatibility of computer equipment. Participants agreed that this constraint has been a long-time problem with a difficult solution.

Implementation Plan

The activity recommended to implement this countermeasure is to make compatible data elements a requirement for funding under MCSAP.

COUNTERMEASURE 10

Increase safe areas and inspection facilities. The final countermeasure advocates an increase in the number of safe areas, and in the number of all-weather facilities to inspect vehicles. Implementation of this countermeasure will help to increase safety in inclement weather.

Constraints

Constraints to this countermeasure are resources, physical space, local level opposition, and environmental opposition.

Implementation Plan

The activities recommended to implement this countermeasure are as follows:

Obtain joint funding from States and industry. Resources are a critical requirement for implementing this countermeasure.

Instigate the utilization of condemnation proceedings to acquire the needed space. Because of the length of time required for these proceedings, participants recommended that a feasibility study be undertaken, to be completed by fiscal year 1992.

Conduct public information and educational campaigns to gain public support.

Plan aesthetically pleasing facilities to gain support from environmentalists.

Construct additional ramps, as needed to assure the adequate number of safe areas. This recommendation can only be implemented after the needed space, funding, and public approval have been acquired.

Corridor Identification And Improvement

CORRIDOR HIGHWAY SAFETY IMPROVEMENT PROGRAM

John J. Zogby

Deputy Secretary for Safety Administration
Pennsylvania Department of Transportation

Every State has arterial corridors with severe accident problems. Approximately 50 percent of the fatalities and 30 percent of the injuries occur on the arterials.

Many of these corridors are characterized as free-access, high-volume facilities with speeds of 40 mi/h or greater, and adjacent to commercial strip development. In many cases, these safety problems cannot be readily resolved by replacing the existing free-access highway with an expressway/freeway because of major financial, environmental, or social impacts.

The Corridor Safety Program is designed to address this problem by using a comprehensive approach to highway safety that integrates highway improvements, driver performance, vehicle, and emergency medical service initiatives. These initiatives are integrated into a unified safety effort to reduce future severe accident potential on long sections of arterial highways (corridors).

Several State highway agencies are considering a comprehensive approach to this problem. The Pennsylvania Department of Transportation (PennDOT) has developed and is implementing a safety initiative on selected corridors. This paper will explore the Pennsylvania Corridor Safety Initiative.

PENNSYLVANIA'S CORRIDOR SAFETY INITIATIVE

In Pennsylvania, 55 highway corridors (approximately 880 mi) were studied. The corridor lengths range from 1 mi to 72 mi; the average length is approximately 10 mi. Improvements identified for these corridors have the following characteristics:

- They are safety-related.
- The cost is low.
- Lengthy design, major right-of-way acquisition, and environmental study are not needed.
- They can be implemented within a 2-year period.

The improvement efforts are applied over long sections of highway rather that at random spot locations. Thus, the continuity of the improvements has a compounding effect on overall highway safety throughout the corridor. The comprehensive corridor safety approach encompasses highway, driver performance, vehicle, and emergency medical services initiatives.

To integrate all aspects of safety, the Corridor Safety Program requires the combined efforts of three Pennsylvania agencies: the department of transportation, the department of health, and State/local Police. The Federal Highway Administration (FHWA), the National Highway Traffic Safety Administration (NHTSA) 402 Funds, and State funding is used to implement the program objective of reducing accidents, particularly fatalities, on specific high-accident highway corridors.

Background

The concept of the Corridor Safety Program began with a pilot corridor, US 322 (locally called the Conchester Highway) in Delaware County, Pennsylvania. Route 322 is a two- and four-lane high-volume, more than 20,000 average daily traffic (ADT), high-speed highway, approximately 5 mi in length. Truck travel comprises 25 percent of total traffic volume on this highway.

As a result of a serious accident involving fatalities, the Governor requested that the Department study the problem and identify a plan to reduce accidents. A multidisciplinary team was assembled. The team included the Chief Safety Engineer, Traffic Engineer, Maintenance Engineer, local officials, and local police.

The team identified a 14-point action plan to improve safety along the corridor. The plan, which was fully implemented, included the following improvements: signing and pavement marking improvements, speed limit reductions, increased local police enforcement, concrete median barrier installation, placement of antiskid pavement surfaces, and the establishment of an area to perform Motor Carrier Safety Assistance Program (MCSAP) inspections. The cost of the 14 safety improvements was approximately $600,000. The identified improvements were implemented within 6 months of the plan's development. This quick implementation prompted very positive feedback.

Program Expansion and Corridor Selection

The success of the Conchester Highway corridor also prompted a decision to implement this comprehensive safety approach on additional corridors that have exhibited major safety concerns. Pennsylvania accident data were studied carefully to identify similar corridors that had severe accident problems. In addition, sites were identified by the Department's Engineering District Offices and through information received at public hearings that were conducted across the State by the Transportation Commission. As a result of this analysis, 55 corridors were selected to receive various remedial engineering improvements. These 55 corridors were selected because they were considered to have the greatest potential for accident reduction through the implementation of low-cost safety improvements.

IMPLEMENTATION

Each of the 55 corridors were assessed and initiatives were implemented based on these four areas: highway design, driver performance, vehicle performance, and emergency medical services.

Highway Perspective

Highway initiatives included the following:

- Analyzing the safety problem including the location of accident clusters, the identification of roadway deficiencies, the analysis of contributing factors, and the development of roadway improvements.

- Implementing roadway enhancements to improve the safety and operating characteristics of the highway. Improvement types included upgraded intersections including left-turn lanes, improved signing and pavement markings, median barriers, increased skid resistance, red revert signal systems, establishment of MCSAP inspection sites,

removal of fixed objects, dual center-turn lanes, etc.

Driver Performance Perspective

The accident data were also analyzed to determine driver performance failures associated with the accident problem. Activities in the driver performance area included the following:

1. Educational and media programs directed at the driver to improve safe driving along the corridor. General program areas included:

   - Safety belt usage.
   - Drinking and driving.
   - Speeding.
   - Unsafe driving practices.
   - Pedestrian actions.

2. Supplemental selective police enforcement strategies to improve the effectiveness of educational initiatives. Federal grant funds were provided to State and local police along the corridors to purchase traffic enforcement equipment such as speed timing devices and to fund salary costs incurred during the safety blitzes. A safety blitz is concentrated surveillance on the corridor by several police departments at the same time. Also, a total of five local driver performance coordinators were hired to initiate and coordinate the driver performance component of the program at the district level.

Vehicle Perspective

Initiatives in the vehicle area included:

- Implementing commercial truck safety inspections (MCSAP) along corridors that have truck safety problems.

- Informing motorists of dangerous vehicle alterations.

- Encouraging the motorists to be aware of their vehicle's operating condition at all times.

Emergency Medical Services Perspective

Activities in the emergency medical services area concentrated on increasing the survivability of accident victims through improved emergency medical services. Improvement areas included:

- Communications, which resulted in quicker response time.

- Training and equipment, which resulted in selective upgrade from basic life support to advanced life support (paramedic).

- Effective use of trauma centers.

- Effective patient triage, the transfer of patient from accident scene to appropriate medical facility.

A Challenging Experience

Implementing an innovative program, particularly one involving multiagencies, is a challenging experience. Some of the more complex tasks included coordinating program development between agencies to ensure a cooperative approach and incorporating driver performance initiatives into the engineering plans of the technically oriented PennDOT District offices.

Despite the challenges, the program is regarded as a successful initiative. The program has generated a cooperative interdisciplinary approach to solving highway safety problems. In addition to the involvement of various agencies, major support has come from community leaders, municipal officials, and media adjacent to the corridors. This involvement has fostered communication and cooperation among neighboring municipalities and improved liaison relations between PennDOT and the local municipalities. The program has also been successful in provid-

ing a mechanism for targeting long sections of highway for improvement rather than spot locations.

PROGRAM EVALUATION

Pennsylvania's program is still in the early stages of implementation. As the program expands and is implemented on additional corridors, PennDOT will be conducting evaluations of each corridor.

PennDOT is developing measures of effectiveness to evaluate the impact of various components of the program. These measures include methods of evaluating the effectiveness of public information and education programs on driver performance, methods to evaluate improved emergency medical services, and studies of corridor accident data before and after the program was implemented.

Preliminary evaluation on one of the selected corridors, Route 65 in Allegheny County, has been positive to date. The following results are based on data collected 1 year before and 1 year after the program's implementation there:

- 22 percent reduction in total accidents.
- 67 percent reduction in alcohol-related accidents.
- 41 percent reduction in the accident rate.

Because only one engineering project has been implemented to date (a red revert signal system), these results are attributed to the driver performance component of the program. Eight additional engineering projects are scheduled for Route 65.

PLANS FOR PROGRAM REPLICATION

The U.S. Department of Transportation has identified corridor safety as one of the three major safety initiatives to be implemented nationwide. These initiatives were selected based on potential to reduce the number of fatal accidents on the nation's highways. Because Pennsylvania has already developed and implemented a corridor safety initiative, the Federal Highway Administration has requested that PennDOT present Pennsylvania's Corridor Safety Program to other States interested in implementing a similar program.

CORRIDOR IDENTIFICATION AND IMPROVEMENT: WORKSHOP REPORT

Chairperson: John J. Zogby
Deputy Secretary for Safety Administration
Pennsylvania Department of Transportation

FHWA Technical Resource Representatives: Rudolph M. Umbs and John Chernisky
NHTSA Technical Resource Representative: Clayton J. Hall

TOP 10 COUNTERMEASURES

The workshop participants ranked the following 10 countermeasures as the top short-term priorities, in order of priority:

1. Establish a multidisciplinary safety team that would provide coordination, review physical inventory and policies, and recommend improvements.

2. Provide selective enforcement campaigns targeted at speed, impaired drivers, etc., in safety blitzes.

3. Improve delineation of a roadway through vertical and horizontal delineation devices.

4. Develop a constant and consistent public information program that includes media support, educates the public, and keeps the public aware of safety issues.

5. Make minor engineering improvements, such as channelization, access control, and pavement surface corrections.

6. Optimize signal timing and phasing.

7. Create a comprehensive highway safety community campaign that involves a cross-section of public and private sector people, including employers and political leaders, to support highway safety initiatives.

8. Within practical limitations, provide a clear roadside program, removing obstructions and fixed objects.

9. Provide signs with clear and visible messages to the motoring public under all environmental conditions.

10. Improve response time and upgrade the capabilities of emergency medical services (EMS) and other emergency services.

COUNTERMEASURE 1

Establish a multidisciplinary safety team that would provide coordination, review physical inventory and policies, and recommend improvements.

Constraints

1. Assembling a "dedicated" staff and a team leader who can be responsible for the program.

2. Selecting team members who can ensure the success of the program. They must:

   - Have authority in decisionmaking.
   - Be experienced in relevant disciplines.

3. Providing the team with the authority, funding, and people needed to conduct program activities. (Support must come from the highest level of management, whether the governor, Department of Transportation chief executive officer, etc.)

4. Gaining and maintaining program support from:

   - Local politicians.
   - Community leaders.
   - Safety organizations.
   - Public relations professionals (TV, radio, newspaper).

5. Assigning responsibilities and objectives to the members involved (especially challenging because various agencies and organizations will be involved).

Implementation Plan

Participants recommended the following activities to implement countermeasure 1:

1. Establish team support among politicians.

2. Decide which types of disciplines should be represented within the team. The team must be multidisciplinary. Among the people who might be chosen for the team are traffic engineers, highway designers, law enforcement officials, emergency medical services and other safety professionals, and public relations managers.

3. Decide which agencies or groups should be represented on the team. Cross-sections of representatives are crucial to the team's success. Agencies that might be tapped for team membership include the State Department of Transportation or highway patrol; the governor's highway safety office; local public works, police, or transit departments; the Federal Highway Administration (FHWA) or the National Highway Traffic Safety Administration (NHTSA); the motor carrier industry; businesses along the corridor; local media outlets; and chambers of commerce.

COUNTERMEASURE 2

Provide selective enforcement campaigns targeted to speed, impaired drivers, etc., in safety blitzes.

Constraints

1. Overcoming any limitations that may be present. The various law enforcement agencies involved should agree on:

   - The program priorities.
   - Commitment of available manpower.
   - Mitigation of any conflicting internal politics.
   - Jurisdictional conflicts and/or incompatibility.

2. Gaining political, public, media (TV, radio, newspaper), legal (Federal, State, local), and business support.

3. Overcoming any physical roadway limitations and traffic volume limitations to enforcement.

4. Initiating and maintaining high program visibility. (The key to success is driver perception of around-the-clock enforcement).

Implementation Plan

Participants recommended the following activities to implement countermeasure 2:

1. Identify the enforcement agencies that have authority in the selected corridor. The agencies might include more than police—motor carriers, for example.

2. Use citation and accident data to analyze enforcement-related problems and assess the safety issues that are problem areas in the corridor.

3. Identify judicial offices and bodies (such as the district attorney and local judges) who have worked with enforcement problems. Look for trends such as how one or two parts of this network proved important to the success of similar campaigns conducted elsewhere in the area.

4. Determine what equipment (radar and breathalyzers, for example) is available.

5. Develop a countermeasure program that is coordinated among jurisdictions along the corridor. Estimate the money involved in the various program elements. Determine what is legal within each jurisdiction. There could be numerous communities along a corridor that must cooperate and communicate with each other. Communities could take charge of the campaign and the department of transportation could be less involved.

6. Develop political support, particularly regarding enforcement elements. Get community backing.

7. Develop good relations with television, radio, and print media.

8. Seek program money from 402 grants, State and local budgets, and private sources. Leverage all available resources, and consider using volunteers, as appropriate.

9. Train all enforcement officers.

COUNTERMEASURE 3

Improve delineation of a roadway through vertical and horizontal delineation devices.

Constraints

1. Needed additional funds.

2. Personnel and equipment limitations.

3. Environmental limitations (climate and weather conditions may affect pavement marking work).

4. Local government participation for the maintenance of the devices.

5. Scheduling of delineation work around other construction and maintenance activities.

Implementation Plan

Participants recommended the following activities to implement countermeasure 3:

1. Identify funding sources.

2. Inventory what personnel and equipment are available.

3. Get local governments to help maintain delineation devices.

4. Make sure other maintenance activities are not scheduled along the corridor after the delineation work is done. (Workshop participants concurred that many highway departments have completed a project only to realize that the same road had to be resurfaced in 2 weeks).

5. Install traffic control-type measures.

COUNTERMEASURE 4

Develop a constant and consistent public information program that includes media support, educates the public, and keeps the public aware of safety issues.

Constraints

1. Funding sources.

2. Getting various agencies and interest groups working toward a common objective:

   - Interest groups may have conflicting or parallel agendas.
   - Other agencies may have differing priorities.

3. Available public relations expertise.

4. Getting the public to buy into the safety concerns on the corridor(s).

5. Getting prime time airing for psa's and other public information and education information.

Implementation Plan

Participants recommended the following activities to implement countermeasure 4:

1. Identify a continuous source of funding.

2. Target the program's audiences. Citation and accident data should be helpful in this step.

3. Assemble a team of public information officers from cooperating agencies to discuss an action plan and decide if outside public relations professionals are needed. Involve people who have unique perspectives, such as local health officials and police.

4. Develop a memorandum of understanding for all agencies involved. Make everyone aware of each agency's responsibilities.

5. Initiate the program with a kick-off campaign that involves elected officials, agency heads, and private sector people who are located along the corridor. Once influential people are convinced of the value of a program, they usually support it wholeheartedly.

COUNTERMEASURE 5

Make minor engineering improvements, such as channelization, access control, and pavement surface corrections.

Constraints

1. Funding sources.

2. Obtaining right-of-way, if needed, in a timely fashion.

3. Working with adjacent property owners to achieve safe access points.

4. Working with utility companies, if necessary, to obtain timely improvements.

5. Communication with corridor business establishments to minimize project delays caused by improvement opposition.

Implementation Plan

Participants recommended the following activities to implement countermeasure 5:

1. Get property owners involved, possibly through a public relations effort, in establishing access points, combining driveways, and establishing public parking. Access points, driveways, and parking can be very important to the success of a corridor improvement program.

2. Look for split funding ideas and contributions. Write a good safety-oriented proposal.

3. Build good relationships with businesses along the corridor by communicating with establishments whose business may be disrupted. Direct contractors regarding hours of work, limited disruptions to access, etc. Carefully select the right person to be a liaison with businesses.

4. If necessary, seek donation of right-of-way, or purchase it.

5. Ensure that there is adequate lead time and payment for adjustments, particularly if utilities are involved.

COUNTERMEASURE 6

Optimize signal timing and phasing.

Constraints

1. Funding limitations:

   - Initial start-up and operational costs.
   - Annual maintenance fees.

2. Getting the buy-in of local jurisdictions to:

   - Maintaining and operating the system with their money (need signed maintenance agreement).
   - Training local personnel to operate the new equipment.

3. Getting adjacent local jurisdictions to work together.

4. Pedestrian understanding of signals.

5. How to incorporate new equipment that is compatible with currently used equipment.

6. Gaining public support for the revised timing schemes. (The new timings may initially be reviewed adversely.)

Implementation Plan

Participants recommended the following activities to implement countermeasure 6:

1. Use well-written specifications and good bidding practices to make sure that new equipment is compatible with existing signal hardware.

2. Have local jurisdictions furnish the necessary equipment.

3. Identify available equipment.

4. Write a good safety-oriented proposal for funding.

5. Use computer programs to optimize signal timing plans.

6. Supplement pedestrian signals to explain the proper meaning of signal indications.

7. Require suppliers to train city workers on the correct installation and maintenance of signals.

8. Identify funding for training of technicians, i.e., 402 funds, other T^2 sources.

9. Prepare a precise memorandum of understanding that clarifies responsibilities of involved agencies.

10. Take advantage of new Federal legislation, which permits a 2-year period for start-up operational costs.

COUNTERMEASURE 7

Create a comprehensive highway safety community campaign that involves a cross-section of public and private sector people, including employers and political leaders, to support highway safety initiatives.

Constraints

1. Funding sources.

2. Gaining support and interest for a safety campaign through such entities as:

   - Community.
   - Political.
   - Business.
   - Media (TV, radio, newspaper).

3. Identifying the proper people to be involved and to establish an appropriate campaign staff.

4. Locating safety campaign expertise at the lead organization.

5. Establishing a networking system to carry out the campaign.

6. Maintaining momentum throughout the campaign.

7. Setting up a working campaign within any issued time constraints.

Implementation Plan

Participants recommended the following activities to implement countermeasure 7:

1. Select a program coordinator—from the department of transportation or from a local agency—who has the needed expertise. This step is essential to the countermeasure's success.

1a. Secure commitments for staffing the activity.

2. Identify resources and contact people in public and private organizations.

3. Sell and promote the need for the improvements and solicit community cooperation.

4. Form working committees and assign tasks to appropriate community representatives to carry out the campaign's objectives.

5. Provide support: funding, expertise, materials, etc.

COUNTERMEASURE 8

Within practical limitations, provide a clear roadside program, removing obstructions and fixed objects.

Constraints

1. Needed additional funds.

2. Obtaining right-of-way, if needed, in a timely fashion so as not to delay the project.

3. Opposition to removing some objects (such as trees or long standing objects that may have some environmental or historical significance).

4. Defining a practical clear roadside program based on safety, funding, and time constraints.

5. Manpower limitations.

Implementation Plan

Participants recommended the following activities to implement countermeasure 8:

1. Inventory all roadside obstacles (including mailboxes) and define right-of-way limits.

2. Determine the project's scope—how far out it will go, what kind of obstacles need to be addressed, etc.

3. Locate and designate funding.

4. If needed, conduct a public relations effort.

5. Identify scheduled construction projects and include some of the improvements that were identified in step two. Have maintenance do some of the minor work.

6. Implement improvements—remove or relocate obstacles, make sure the devices that must remain in the corridor are of breakaway design.

COUNTERMEASURE 9

Provide signs with clear messages, which are visible under all environmental conditions, to highway users.

Constraints

1. Seeing that signs are being installed and maintained uniformly throughout the corridor.

2. Removing or consolidating signs to avoid clutter:
   - Too many signs (most important signs may not be read).
   - Business advertising signs may compete with traffic signs (traffic signs lose visibility).

3. Training sign designers and installers in the practice of human factors engineering.

4. Funding.

5. Evaluating the effectiveness of the messages conveyed by signs.

6. Getting drivers to pay attention to signs, whether existing or new.

7. Overcoming any limitations caused by the notion that everyone thinks they are a sign expert.

Implementation Plan

Participants recommended the following activities to implement countermeasure 9:

1. Inventory existing signs.

2. Conduct day and night operational reviews using community leaders, people from outside organizations (such as retirees), and unfamiliar observers to make sure that signs are visible and convey the correct message.

3. Reduce business sign clutter by cooperative efforts or through ordinances.

4. Develop sign replacement and maintenance plans.

5. Provide funding.

6. Implement and review work.

COUNTERMEASURE 10

Improve response time and upgrade the capabilities of emergency medical services (EMS) and other emergency services.

Constraints

1. Ensuring quick and adequate response through proper communication among the local jurisdictions, fire department, police department, emergency medical services, hospitals, etc.

2. Providing properly trained emergency response teams.

3. Identifying all available emergency medical services along the corridor.

4. Obtaining a professional working relationship between neighboring jurisdictions so that manpower and equipment may be shared.

5. Ensuring the public is aware of how to get EMS.

Implementation Plan

Participants recommended the following activities to implement countermeasure 10:

1. Identify what EMS response units and organizations are available. Determine the number of police departments available, what hospital services are available (this is especially important if a triage initiative is included), who provides what kind of emergency aid, if paramedics are available, if plans for hazardous materials accidents are in effect, who handles hazardous materials accidents, etc.

2. Assess training needs.

3. Evaluate the existing communications systems, and assure that the various communities and EMS systems are interconnected.

3a. Develop an improved communications system, if required.

4. Evaluate existing emergency response plans; develop a plan if none is available.

4a. Develop an information program on how to access EMS. (Don't guess! Call EMS).

5. Implement as much of this countermeasure as quickly as possible to get something going and visible to public.

6. Leverage funds to expand EMS services.

APPENDIX A
AGENDA

Symposium on Effective Highway Accident Countermeasures

Grand Hyatt Hotel, Washington, D.C.
June 12-14, 1990

Sponsor:
Federal Highway Administration
U.S. Department of Transportation
In Cooperation With the National Highway Traffic Safety Administration

IDEAS INTO ACTION • HIGHWAY SAFETY •

Moderator:
Ronald R. Fiedler
Wisconsin Secretary of Transportation and Governor's Highway Safety Representative

Monday, June 11, 1990

5:30 pm - 7:30 pm Registration

6:30 pm - 8:30 pm Reception

Tuesday, June 12, 1990

7:30 am Registration and Beverage Service

General Session

8:30 am Opening Remarks
Gene McCormick
Deputy Administrator
FHWA

8:40 am Welcome
Jeffrey Miller
Deputy Administrator
NHTSA
Tom Larson
Administrator, FHWA

9:10 am Measures To Improve Pedestrian Safety
Charles Zegeer
Staff Associate, Highway Safety Research Center
University of North Carolina
Lorraine Novak
Program Manager
Pennsylvania Department of Transportation, Center for Highway Safety

9:50 am Refreshment Break

10:10 am Measures to Reduce Accident Severity
Mark Marek
Geometric Design Engineer
Texas Department of Highways and Public Transportation
Ralph Hitchcook
Director
Office of Crashworthiness Research, NHTSA

11:00 am Measures for Improving Driver Performance and Control
Thomas Hicks
Deputy Chief Engineer
Maryland State Highway Administration

Dr. James Nichols
Deputy Director
Office of Alcohol and State Programs, NHTSA

12:00 pm Lunch Break *(On your own)*

1:10 pm Measures to Improve Commercial Vehicle Safety
Paul Henry
MCSAP Coordinator
Oregon Public Utility Commission and President of CVSA
Lt. Don Uelmen
California Highway Patrol
NHTSA Temporary Assignment

2:00 pm Corridor Highway Safety Improvement Program
John Zogby
Deputy Secretary for Safety Administration
Pennsylvania Department of Transportation

2:30 pm Refreshment Break

Concurrent Workshops

2:50 pm Workshops One - Five

Workshop One Improving Pedestrian Performance and Environment
Chairperson: ***Cheryl Neverman***
Director of Community Education
New York City Department of Transportation, Safety Education

Workshop Two Reducing Accident Severity
Chairperson: ***James Roberts***
Division Engineer, Design
Missouri Highway and Transportation Department

Workshop Three Improving Driver Performance and Control
Chairperson: ***Carlton Robinson***
Executive Vice-President
Highway Users Federation for Safety and Mobility

Workshop Four Improving Commercial Motor Vehicle Safety
Chairperson: ***James Daust***
Lt. Colonel
Michigan State Police

Workshop Five Corridor Identification and Improvement
Chairperson: ***John Zogby***
Deputy Secretary for Safety Administration
Pennsylvania Department of Transportation

4:30 pm End of Day One

Wednesday, June 13, 1990

7:30 am Beverage Service

Concurrent Workshops

8:30 am Continuation of Workshops

9:50 am Refreshment Break

General Session

10:10 am Injury from a Public Health Perspective
Terence Chorba, M.D.
Epidemiologist
Centers for Disease Control

10:30 am Program Planning: A Look at Packaging Interagency/ Interdiscipline Activities
Gil W. Bellamy
Oregon Governor's Highway Safety Representative

11:00 am Putting It All Together and Building Support for a Program of Effective Countermeasures
Leonard Levine
Commissioner
Minnesota Department of Transportation

11:45 am Luncheon

Concurrent Workshops

1:15 pm Continuation of Workshops

2:30 pm Refreshment Break

2:50 pm Continuation of Workshops

4:30 pm End of Day Two

Thursday, June 14, 1990

General Session

8:00 am Beverage Service

9:00 am Workshop Summaries and Report: *Chairpersons of the Five Workshops*

10:00 am Refreshment Break

10:20 am Continuation of Workshop Summaries and Reports: *Chairpersons of the Five Workshops*

11:00 am Closing Remarks
Conclusions, Observations, and Future Actions
Gene McCormick

11:30 am Conclusion of Symposium

APPENDIX B
BACKGROUND PAPERS

IMPROVING PEDESTRIAN SAFETY

Pat Ehrlich
Office of Highway Safety
Federal Highway Administration

INTRODUCTION

Pedestrian fatalities account for about 16 percent of all highway related deaths each year, numbering about 7,000. The societal cost for pedestrian fatalities is estimated to be $3.5 billion per year. Pedestrians represent about 1 in every 30 persons injured in traffic crashes. Young pedestrians (ages 5 through 14) are over-represented among injured pedestrians while older persons are over-represented in pedestrian fatalities. In some major metropolitan areas, pedestrian deaths account for 40 to 50 percent of all traffic fatalities.

Most pedestrian injury accidents occur in the daytime between 6 a.m. and 6 p.m. while a greater percentage of the pedestrian fatalities occur in the nighttime. About three-fourths of the pedestrian injury accidents occur between noon and midnight; a similar amount of the fatalities occur between 3 p.m. and 3 a.m. In urban areas, more pedestrian injury accidents occur per day on weekdays than on weekends, while the reverse applies to urban fatalities and rural injury accidents and fatalities, when weekends predominate. Weekdays have a high incidence of daytime accidents while weekends have a high incidence of nighttime fatalities.

CAUSE OF THE PROBLEM

Primary problem locations for both injuries and fatalities are in urban areas (90 percent and 66 percent, respectively), and away from intersections (about 70 percent of the accidents and 80 percent of the fatalities). The roadway classification breakdown where fatal pedestrian accidents occur is principal arterials (30 percent), minor arterials (20 percent), local streets (18 percent), and collectors (16 percent). In addition, sixteen percent of the pedestrian fatal accidents occur on roadways classified as Interstate, freeways and, expressways where pedestrians normally are not allowed.

Pedestrian accident data has been analyzed to learn what people did that lead to these accidents. While each pedestrian accident is a unique event, there are repeatable features in the accidents which can be grouped to identify types of behavior involved in the accidents. The major accident types in urban areas include dart-out (pedestrian suddenly appears in the street midblock), midblock dash (pedestrian running across street midblock), intersection dash, and vehicle turn-merge (pedestrian hit by vehicle turning into and merging with traffic). In rural areas major accident types include walking along roadway, dart-out, midblock and intersection dash, and disabled vehicle related (person struck while working on or next to a disabled vehicle). Along freeways the primary accident types are related to disabled vehicles (either working on the vehicle or going to/from the vehicle), hitchhiking, and the pedestrian being hit by one of the vehicles following a vehicle-vehicle crash.

Over 70 percent of the identified behavioral errors in pedestrian crashes can be attributed to the pedestrian versus 30 percent to the driver. Alcohol impairment on either the part of the driver or the pedestrian continues to be a major factor (50 percent) in pedestrian crashes. The percentage of fatally injured pedestrians that had been drinking has remained at about the same level, 40 percent of all fatally injured pedestrians, for a number of years. About a third of the fatally injured pedestrians are legally drunk. Among the drivers who fatally injure pedestrians, nearly 25 percent had been drinking (about 17 percent are legally drunk).

Information on exposure and pedestrian accidents was analyzed to determine situations which are hazardous because there are a high number of pedestrian accidents compared to the number of pedestrians and vehicles in those locations. Relatively hazardous roadway characteristics found in densely populated areas include major

arterials and local streets, locations with no sidewalks or pathways, and areas without marked crosswalks. The following lists features which are particular problems related to the identified hazardous roadway characteristics.

Major arterials - Features related to major arterials which are particular problems include 100 percent or mixed residential land use, 2 or fewer lanes, block length less than 250 feet, left turn channelization, and parking prohibited on both sides. The problem accident type of major arterials is the midblock dart-out.

Local streets - Problem local street features include locations with no sidewalks, where parking is allowed, and where there is no street lighting. On local streets it is more hazardous to cross outside of, but within 50-feet of, a crosswalk than crossing midblock. Midblock dart-out is the most hazardous accident type on local streets, although intersection dash and playing in the roadway are also a problem.

Sidewalks - The lack of sidewalks is particularly hazardous in residential areas, in locations with 2 or fewer traffic lanes, and where there are regularly spaced street lights.

Crosswalks - For nearly all variables analyzed, locations with marked crosswalks were found to be safer than those with unmarked crosswalks. Particular problem features where crosswalks were unmarked included collector-distributor streets, where there were more than 2 lanes, at channelized intersections, where there were no sidewalks, in commercial land use areas, and where there were standard traffic signals.

It should be noted that the occurrence of pedestrian accidents at these types of locations may be due to other factors common to these locations. For example, street lights may be located at sites having higher numbers of pedestrians. Thus, the number of pedestrian accidents is not due to the lighting, but to the number of pedestrians present.

POSSIBLE COUNTERMEASURES

Comprehensive Areawide/Corridor Programs

Walk Alert is a comprehensive local level program to reduce pedestrian traffic accidents by developing safer walkers, more attentive drivers, and a safer environment for pedestrians. The program addresses pedestrian safety from three points of view: public education, traffic engineering, and law enforcement. Public education can inform pedestrians and drivers of proper search behavior before entering roadways, the meanings of traffic signals, the benefits of wearing bright clothing and retroreflective materials, and the need for proper supervision of children. Planning and creating a safer roadway environment for pedestrians is the role of traffic engineering. The safety of pedestrians is enhanced by designing and constructing pedestrian facilities into existing and new streets and highways and the placement of traffic control devices to accommodate pedestrians. Enforcing traffic laws and ordinances provides education toward improving the safe actions of pedestrians. Guidance for implementing a Walk Alert program is available in the "Walk Alert Program Guide," the "Model Pedestrian Safety Program User's Guide and Supplement," and "Community Pedestrian Safety Plans." The Walk Alert program is in various stages of implementation in more than 10 States. None of the programs have been in place long enough to be evaluated.

A **corridor program** was implemented in New York City based on the identification of an accident prone corridor through a study of accident data and plan maps. Based on a detailed analysis of fatality and injury data, site specific countermeasures were formulated. Among the countermeasures implemented were modifications of signal timing to provide increased pedestrian crossing time, refurbishing pavement markings, and installation of oversized speed limit signs. The city also implemented target traffic and police enforcement and conducted an extensive public information campaign. Studies conducted for the 30 months after implementation showed that pedestrian deaths and severe injuries declined by more than 50 percent.

The City of Denver implemented an **areawide** four point program which included traffic engineering and educational programs, enforcement efforts, and a public information campaign. Traffic engineering additions/modifications were implemented at locations with a past pedestrian accident history. Activities included installation of pedestrian signals, widening selected crosswalks, increasing the size of some pedestrian islands, and installing lanes for handicapped pedestrians. Signals were retimed at locations with a high proportion of elderly pedestrians. A new speed limit signing program was implemented in school areas. Crosswalks near schools and on designated school routes were painted in a design to increase their visibility. These school area changes in conjunction with mid-block pedestrian-actuated signals provided a significantly higher level of safety for elementary school children. The program also included an education program for K-3 children and a public information effort focusing on child dart-out and turning vehicle accident types as well as the magnitude of the pedestrian safety problem. Information was also presented on the use of pedestrian pushbuttons on signals. The enforcement efforts included enforcement of pedestrian laws in high risk locations. A pedestrian violators school was established. The K-3 program was the most successful component of the project in terms of accident reduction; accidents involving 5-9 year olds decreased 40 percent from the average rate prior to the program. In 1980 shortly after the conclusion of the project there were 17 percent fewer pedestrian accidents in the city than were projected by regression analysis.

The City of Seattle has implemented a variety of pedestrian programs over the years. Their **comprehensive** program in the late 1970's and early 1980's included emphasis on enforcement of pedestrian laws, pedestrian safety television public service announcements and the testing of innovative traffic control devices. It appears that these programs contributed to a significant decrease in reported pedestrian collisions—from an average of 476 per year for the period 1974 to 1979, to 430 in 1980.

Engineering Countermeasures

Barriers - Chains, fences or similar devices can be used to separate pedestrian and vehicular traffic, to channel pedestrians to safe crossings, or to prevent pedestrians from crossing at hazardous locations. Barriers can be located along or near the edge of a sidewalk, alongside a highway or freeway, or in medians. Depending upon the type of barrier installed, instances of midblock crossings, running into the roadway, or pedestrians darting into the roadway form between parked cars can be reduced. People do climb barriers or cut holes in them when they are determined to cross the roadway. It has been estimated that 14 percent of the freeway pedestrian accidents could be prevented with freeway barriers.

Bus Stop Relocation - Locating bus stops on the near side of an intersection can be hazardous to pedestrians crossing in front of the bus because motorists are unable to see them. Pedestrian safety can be improved by moving the stop to the far side of the intersection so crossings are made in back of the bus where the visibility is greater. Consideration needs to be given to other actions at the intersection such as turning volume, transfer activities, and sight distances when determining the best placement for bus stops. Accident experience with far-side locations indicate that bus stop related pedestrian accidents can be reduced as much as two-thirds.

Facilities for the Handicapped and Older Adults - Modifications can be made to traffic signals, signs, sidewalks, and crosswalks to assist handicapped and older adult pedestrians. Traffic signals can be augmented with audible and/or tactile devices to assist persons with vision problems. The timing of signals can be modified at locations with a high number of elderly crossing. Signs can be provided in braille to provide information for the blind and warning signs can be installed to indicate the presence of handicapped people in the area. Sidewalk enhancements include installing curb ramps, guidestrips, and handrails and carefully locating street furniture. Guidestrips can be added to crosswalks to serve as a guide for blind people crossing the street.

Grade Separations - Grade separated pedestrian crossings allow for the free-flowing movement of vehicles and pedestrians. These facilities include an overpass/bridge and an underpass/tunnel. The installation of new grade separations is a long term countermeasure beyond the scope of the symposium. However, means of increasing the use of currently installed separations or making existing bridges or tunnels accessible to pedestrians could be

implemented on a shorter term. The installation of railings, fencing, or median barriers can discourage grade level crossings and direct pedestrians to the separation. Lighting can be installed in tunnels to improve safety and discourage littering, vandalism, and crime.

Horizontal Separation - Pedestrian Priority Zones - Horizontal separation of pedestrians and vehicles improves pedestrian safety by reducing conflicts between people and vehicles and by selectively reducing traffic volumes and speeds. Separation techniques include pedestrian malls, auto restricted zones, and temporary street closings for play streets, school access, or for special events. Auto restricted zones can be implemented throughout the use of (1) geometric design features to control vehicle speed, (2) changes in traffic circulation patterns or roadway use to discourage through traffic, (3) traffic control devices, and (4) regulatory and enforcement practices. Potential strategies for these control categories are as follows:

> **Geometric Design** includes serpentine roadway alignment, sidewalk widening, islands or median barrier across intersection, street narrowing or necked intersections, rumble strips or speed humps, traffic circles, and channelization.
>
> **Circulation and roadway** strategies include one-way streets, one-way entrances or exits to two-way streets, parking configurations, street closings, temporary traffic diverters, and turn restrictions.
>
> **Traffic Control Device** applications include the use of traffic signals, stop signs, and speed limit and warning signs.
>
> **Regulatory and enforcement programs** include low speed limits, strict enforcement, truck size and weight restrictions, turn restrictions, and parking regulation.

Lighting - Lighting involves the nighttime illumination of roads, sidewalks, and crosswalks. Crosswalk lighting is special illumination of crosswalks to increase the visibility of pedestrians. Improved lighting may reduce pedestrian accidents at night by almost one-half and pedestrians at well lit locations choose larger gaps for crossing. Care must be taken in placing overhead lighting more than the pedestrian's head is illuminated.

One-Way Streets - Conversion to one-way streets can reduce pedestrian accidents 20 to 50 percent by improving the driver's field of vision and necessitating that pedestrians have to look only in one direction when crossing.

Parking Regulations - Limitations of a driver's field of vision by vehicles parked at or near crosswalks and intersections lead to pedestrian mishaps and other accidents. Generally parking is prohibited within a crosswalk within 20 feet of a crosswalk at an intersection. Such provisions may not include marked midblock crossing locations. It may be necessary to increase the restricted parking distance from a crosswalk due to traffic volumes, speed, or other hazards.

Pavement Markings - Painted crosswalks and stop lines are the primary types of pavement markings used for pedestrian safety and movement. Painted crosswalks can be installed at an intersection or midblock to provide a delineated path for the pedestrian crossing. They can be used to indicate the safest route for crossing the street. Marked crosswalks should be installed only where they are justified and where they will be seen easily by approaching motorists. Stop lines can be placed further away from the crosswalk area than normal to enhance the visibility of pedestrians particularly on multi-lane facilities. Another means of improving safety on multi-lane roadways is to use an offset stop line where the lines for the left or middle lanes are moved back about 6 to 10 feet. This can be helpful in reducing accidents involving vehicles turning right on red. While painted crosswalks can position pedestrians where they can best be seen, there is some concern pedestrians may feel overly secure in these crosswalks. Pedestrians are more likely to cross in a crosswalk at signalized intersections than at unsignalized intersections.

San Francisco had an 825 foot long block with a marked but unsignalized mid-block crosswalk. Drivers were alerted by a message on the pavement preceding the crosswalk and by signs at the crosswalk. Pedestrians who were not properly scanning for cars and motorists were caught by surprise by the midblock crosswalk and did not always yield to pedestrians. The city installed thermoplastic markings to define the crosswalk and flashing yellow beacons on mastarms at the crosswalk. Painted messages were placed at the curb and midpoint of the crosswalk to remind pedestrians to look left and right as they crossed. The pedestrian messages resulted in a significant decrease in pedestrian non-compliance. The beacons did not have a significant effect on driver behavior.

An innovative pavement marking consisting of a figure of a walking person painted approximately 100 feet in advance of high pedestrian collision locations outside of the central business district was tested in Seattle. The marking was similar to the advance pedestrian crossing warning sign and was used to supplement other forms of advance pedestrian warning signs. The legend test resulted in a small but significant reduction in pedestrian collisions at 2 of the 21 sites where they were installed. No sites experienced a significant increase in collisions.

Another pavement legend tested in Seattle was an outline of a two-headed gazelle with a message to "Look Both Ways." The legends were installed at 28 hazardous signalized intersections in the central business district and at each end of marked school crosswalks. Initial test results showed a significant reduction in child pedestrian collisions at the school crosswalks. The legend test results in the central business district showed small but significant reductions in pedestrian collisions at 5 of the 28 hazardous sites where they were installed.

Retroreflective Materials - The visibility of a person wearing retroreflective materials is increased because of the light reflected from the headlights back to the driver. The effectiveness of retroreflective materials on nighttime pedestrian safety depends on the proportion of pedestrians who wear them and the amount of retroreflective materials worn by each pedestrian.

Safety Islands - Pedestrian refuge between opposing traffic lanes or within an intersection can be provided with safety islands which were originally installed to channel vehicular traffic. Islands are generally marked with a distinguishing material or are raised above the level of the road and designated with a curb. Islands allow pedestrians to cross wide or busy roads in stages. The requirements of handicapped or older pedestrians need to be considered when installing safety islands as well as a method for activating a pedestrian signal when they are present. On wider streets about 18 percent of all pedestrians use islands to avoid conflicts.

Sidewalks - Sidewalks are temporary or permanent walkways installed in areas alongside the roadway or separated from the road by a curb or gutter. Sidewalks provide a separation between pedestrians and motor vehicles and have been shown to reduce pedestrian accidents in residential and business areas. Locations without sidewalks in urban and densely populated suburban and rural areas are at least two times more likely to have pedestrian accidents than sites with sidewalks. Pedestrian safety can be enhanced by extending the part of the sidewalk which adjoins the crosswalk out to the edge of the parking lanes. These extensions make the pedestrian more visible, make it easier to see oncoming vehicles, reduce the width of the street to be crossed, and reduce the speed of both turning and through vehicles.

Signalization - Traffic signals include those installed primarily for vehicular traffic control as well as pedestrian signals which supplement traffic signals. Pedestrian signals can be timed so pedestrians cross at the same time as a parallel moving vehicles, before vehicles are allowed to turn, after a portion of the phase has been given to turning vehicles, or to provide a totally separate phase. Pedestrians are generally more observant of signalization in central business districts than other areas. Pedestrians continue to be confused about the meaning of the phases of pedestrian signals. Right-turn-on-red is associated with an increase in the potential for pedestrian accidents.

Baltimore, Maryland introduced a 7-second delay to turning traffic at several intersections controlled by standard two-phase signals which had very high turning movements and pedestrian volumes. They filmed action before

and after the changes and found the conflicts between pedestrians and turning vehicles were greatly reduced. Accident data suggests the modifications may have reduced accidents.

Boulder, Colorado experienced a jaywalking problem and found a strong correlation between the amount of delay a group of pedestrians experienced at a signalized intersection and the amount of jaywalking at the signal. A 100-second cycle was observed to induce more than 50 percent of the crossing pedestrians to jaywalk. When cycle time was reduced to 50-seconds, the amount of jaywalking dropped to nearly zero.

Traffic Signs - Regulatory, warning, and guide signs provide information to both pedestrians and motorists. Some signs regulate the actions of pedestrians such as those presenting the following messages: "pedestrians prohibited," "no hitchhiking," and "push button for walk signal." Examples of regulatory signs directed at motorists which could affect pedestrian flow include turn prohibition, stop, and yield signs. Warning signs generally alert motorists of areas where there may be pedestrians such as roadway crossings, playgrounds, or school areas. Guide signs are sometimes used to direct pedestrians to sidewalks, trails, overpasses and other types of facilities and can keep them out of dangerous locations and areas. Signs can be effective in alerting pedestrians or motorists to potential dangers and often provide a low-cost and easy treatment for an apparent pedestrian-safety problem. Signs, however, may only represent a temporary treatment when a major improvement is needed to solve the problem.

Seattle tested two unique signs to reduce pedestrian accidents. One sign was black on yellow with the legend, "HIGH PEDESTRIAN COLLISION LOCATION" and a silhouette of a car with a pedestrian above and in front of the car's hood. A similar "HIGH PEDESTRIAN COLLISION ROUTE" sign was used to denote routes which had experienced pedestrian accident problems. These signs were generally located where no other engineering solution could be applied. The two signs were effective in increasing driver awareness of the pedestrian problem locations on routes on which they were installed. There were small but significant reductions in reported pedestrian collisions at 5 of the 37 installation sites where they were tested. Three sites experienced a small but significant increase in pedestrian collisions. The signs' use should be limited to locations where increased driver awareness is needed until a more permanent or more effective countermeasure can be initiated.

Ordinances

The Model Ice Cream Truck Ordinance is designed to prevent young children from being hit while going to or from ice cream trucks by requiring drivers of passing motor vehicles to stop and then proceed when encountering a vending truck that is actively selling. This type of countermeasure has proven effective in reducing vending vehicle-related dart-out accidents in many locations.

Education Countermeasures

Educational programs can be focused on drivers and pedestrians. Some programs focus on proper behavior such as drivers yielding to pedestrians when turning or pedestrians looking left-right-left before crossing the street. Other programs inform road users on the meaning and importance of signs, signals, and pavement markings. Of particular concern in the letter type of program is the need for all pedestrians to understand the meaning of pedestrian signal indications—WALK, flashing DON'T WALK, and steady DON'T WALK. One educational method is to install a small sign on a post at the crossing that explains the meaning of the pedestrian signal. Pedestrians also need to understand the necessity of searching for vehicles prior to crossing with a green or WALK indication.

Willy Whistle - The Willy Whistle Program is designed to teach pedestrian skills to elementary school-age children. Comprised of a video starring an animated character and a teacher's guide, the program offers information on simpler traffic situations to children in grades K-3 and information on more complex traffic situations to children in grades 4-7. The program also includes a teacher's guide that offers background information, suggested curriculum activities, information on where to obtain additional information and resources,

and a letter to parents. The program then offers a combination of classroom and practical activities for the student. Thorough testing has shown the Willy Whistle program to reduce child pedestrian accidents by 30 percent or more.

Safe Street Crossing - The Safe Street Crossing for Kids Program provides traffic safety planners and educators with information and guidance for the development and implementation of a children's pedestrian safety program that targets children age 5-14 years. The program teaches proper safe street crossing techniques through information, training, and reinforcement opportunities. The key to the program is actual street-crossing training opportunities as this approach is most likely to be received and retained by the target audience.

Walking in Traffic Safely (WTS) and **Children Riding on Sidewalks Safely (CROSS)** - WITS and CROSS are two sets of children's pedestrian safety materials. For use by preschool teachers, these packets offer storybooks, a teacher's guide, a parent's brochure, and a poster designed to teach basic pedestrian safety skills to preschool children. The basic premise is that children of this age are not to enter the street without a parent. The materials offer parents and teachers information on teaching (through the storybooks and practical training) children how to safely cross while accompanied by a parent or adult.

Enforcement Countermeasures

Enforcement programs can be focused on pedestrians for risk-taking behavior or on motorists for failure to obey laws or traffic controls which could lead to conflicts with pedestrians. Enforcement also includes ensuring compliance by construction personnel with requirements to provide pedestrian facilities in construction areas.

A successful pedestrian enforcement program is one that consistently enforces pedestrian traffic ordinances for both the driver and the pedestrian. The key is consistent enforcement that avoids sweeps and drives that are limited in time. Consistent application of traffic ordinances begins with commitment and education of top ranking police officials followed by commitment, education, and training of the street officers that is accompanied by routine encouragement and follow-up by the police agency.

Essential to any enforcement program is the commitment by the judicial system. Judges, prosecutors and others must become educated and committed to the issue, or commitment by the law enforcement agency and behavioral changes by the public will be hampered.

Engineering, education, and enforcement countermeasures are most effective when applied at the same time.

ISSUES TO BE EXAMINED

- How to sell or "market" the need for pedestrian safety programs
- How to provide the appropriate technical information to local officials responsible for pedestrian safety
- How to initiate local comprehensive projects
- How to gain agency support for countermeasure implementation
- How to gain public acceptance and use of countermeasures where applicable
- Innovative approaches to enhancing pedestrian safety
- Methods for balancing needs of pedestrians with needs of traffic flow
- What is the relationship between education, enforcement, and the engineering of pedestrian facilities?
- How to know when to use which countermeasures?

REDUCING ACCIDENT SEVERITY

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INTRODUCTION

It is difficult to identify all the factors that contribute to severity of highway accidents. Obviously, due to the law of physics, speed is a factor that will increase accident severity. Besides speed controls, there are other areas such as improved vehicle occupant protection, forgiving roadsides, and increased/improved emergency medical services which can reduce the severity consequence of accidents.

Examples of improved vehicle occupant protection are increased seat belt usage and safer vehicle design, especially in the driver/passenger compartment area. Approximately 22,000 deaths and 300,000 injuries resulting in hospitalization occur to front seat occupants each year.

Forgiving roadside measures include the engineering of necessary roadway appurtenances (light poles, sign supports, etc.) to be either crashworthy to reduce the severity of inadvertent hits by vehicles, or to shield or remove those obstacles that cannot be made safe. From 1984 to 1988, accidents with fixed objects averaged 12,700 fatalities annually.

An example of the third area, especially in rural areas, is the development and deployment of trained medical care specialists and emergency equipment to cover all parts of a geographical area in order to get quick life-saving medical treatment accident victims.

CAUSE OF PROBLEM

Driver, Occupant, and Pedestrian Related

- The fatality rate for drivers 20 years and younger is seven times greater than middle age (35-39 years old) drivers.
- The fatality rate for drivers age 75 and older is almost three times greater than middle age (35-39 years old) drivers.
- Over 17,000 passenger car drivers and occupants died without a safety belt on. This figure represents 75 percent of the passenger car occupant fatalities which could be identified with certainty as either using or not using car restraints.
- Over 7.800 pedestrians were struck and killed by motor vehicles, mainly occurring in urban areas, rural interstate, and rural principal arterials.

Highway Related

- Multi-vehicle accidents cause the most total economic loss. However, single vehicle accidents produce the largest number of fatalities, including pedestrian fatalities. Approximately 45 percent of the yearly fatal accidents involve only one vehicle excluding pedestrian fatal accidents.

- First harmful event (FHE) for single vehicle fatal accidents involved 12, 674 fatalities as a result of striking fixed objects (47.4 percent of single vehicle fatal accidents).

- Rollovers in single-vehicle accidents accounted for 4,441 fatalities or 9.6 percent of deaths.

- The most frequent types of multi-vehicle fatal accidents were angle impact (43.2 percent) and the head-on collision (34.7 percent). Head-on accidents are a major concern on two-lane, high volume, rural arterials.

The following discussion is provided to help focus on the particulars of the accident severity problem, especially as related to economic loss and hitting fixed objects.

Approximately 744,550 died in motor vehicle accidents form 1978 to 1989. About 156,000 of these fatalities were due to collisions with fixed objects. Many of these objects are man-made and introduced into the highway environment by other engineering needs (signs, structures, lighting supports, etc.). Therefore, a coordinated effort must be made to provide a roadside that will provide a chance to recover for the errant motorist that leaves the roadway.

However, with the many miles of streets and highways and the millions of existing potential obstacles, it is necessary to focus on those countermeasures that will have the greatest impact.

Table 1 is provided to help focus on those items that are frequently struck and which result in serious injuries and deaths. Information is provided based on first harmful event (FHE) and most harmful event (MHE). Although many accident reporting systems are based on first harmful event, many accidents consist of a series of events, and the first harmful event may not be the one which produced the greatest amount of trauma and property damage. Thus, relative to severity, the most harmful event is very important.

The information in Table 1 includes injury estimates extracted from the National Accident Sampling System (NASS) as well as fatalities obtained from the Fatal Accident Reporting System (FARS). The data is from 1985, the last full year for a statistically drawn sample of all accidents in the NASS. The cost values used are based on estimates of willingness to pay and are expressed in 1986 dollars.

TABLE 1 - 1985 HIGHWAY LOSSES BY FIRST HARMFUL EVENT (FHE) AND BY MOST HARMFUL EVENT (MHE)

	FHE			MHE		
Accident Type	Fatalities	Injuries	Total Cost[1] ($M)	Fatalities	Injuries	Total Cost[1] ($M)
Another Vehicle	17,866	2,282,000	61,614	17,495	1,721,000	47,396
Pedestrian/ Cyclist	7,419	181,000	13,142	7,480	114,000	12,486
Overturn	3,772	168,000	7,574	6,698	186,000	12,181
Tree	2,928	97,000	5,523	3,497	88,000	6,266
Utility Pole	1,296	83,000	2,951	1,522	110,000	3,559
Embankment	1,211	42,000	2,323	582	57,000	1,647
Parked Vehicle	719	82,000	2,611	582	57,000	1,647
Guardrail/ Other Rail	1,297	36,000	2,400	618	21,000	1,192

[1] Includes cost for fatalities, injuries and property damage.

It should be noted that other roadside items are identified in both accident record systems, but in lower numbers than the specific ones shown in Table 1. Table 2 is a more comprehensive list of fixed object-related fatalities for the years 1984 through 1988. This table shows the relative consistency of the number of fatalities by object type for the 5-year period. This consistency is both in the absolute numbers and the relative ranking between the objects.

TABLE 2 - FIXED OBJECT FATALITIES BY OBJECT TYPE

Fixed Object	1984	1985	1986	1987	1988
Tree/Shrub	3021	2989	3444	3299	3328
Utility Pole	1426	1298	1495	1406	1476
Guardrail	1446	1258	1374	1326	1384
Embankment	1264	1211	1332	1396	1360
Culvert/Ditch	1198	1337	1472	1393	1475
Curb/Wall	899	982	960	861	892
Bridge/Overpass	738	628	577	571	553
Concrete Barrier	240	225	197	203	202
Sign or Light Support	480	508	551	538	570
Other Pole/Support	434	481	518	495	501
Fence	455	431	478	484	482
Building	105	101	100	108	106
Impact Attentuator	10	14	9	18	15
Other Fixed Object	629	630	699	729	682
TOTALS	12,345	12,093	13,206	12,827	12,992

As a reminder, safety countermeasure strategies aimed at reducing collision severity for run-off-the-road accidents involve "make forgiving, remove, relocate, and shield." In all of the following countermeasures, the means of preventing a collision or vehicle damage are included as the ultimate in severity reduction.

POSSIBLE COUNTERMEASURES - HIT FIXED OBJECTS (RUN-OFF-THE-ROAD)

Tree Removal/Shielding

Trees are the fixed objects most frequently hit. these collisions result in almost 3,000 fatalities annually and they also produce the most severe injuries. Generally, a single tree with a trunk diameter greater than 4 inches is considered a hazardous fixed object.

Two ways of addressing this problem are first, try to keep the motorists on the road whenever possible; and second, to provide clear zones or safer recovery areas. The first way usually includes certain pavement markings, delineation, and warning signs. The second way involves determining which trees or groups of trees are hazardous or potentially hazardous and either removing or shielding them.

These are not new concepts and have been around for quite a while, yet tree related fatalities and injuries continue at a significantly high level.

An estimated reduction of fatal accidents for the "removal of trees" countermeasures is about 50 percent.

UTILITY POLE MITIGATION

The next most severe fixed object problem is the utility pole, again both in frequency of being struck and severity of injuries. Approximately 1,500 fatalities occur when hitting a utility pole is the most harmful event in the accident. A number of countermeasures are possible in this area:

- placing utility lines underground
- increasing lateral post offset
- reducing the number of poles by increase pole spacing or have multiple pole use by different utilities
- using breakaway design

Obviously some of these will decrease the frequency of accidental hits rather than the severity per se. For those critical locations where the poles can't be eliminated or moved, breakaway poles are a promising alternative. Since the pole lines are often controlled by the utility and not the government highway agency, economics of the countermeasure play a big part. Estimated single vehicle run-off-the-road fatal accident reduction percentages for utility pole countermeasures based on several FHWA-sponsored research reports are as follows:

Make utility poles breakaway	- 30 Percent
Relocate utility poles further from the edge of pavement (reduction is dependent on distance relocated, pole density, etc.)	- 32 Percent
Remove utility poles	- 38 Percent

Flattening or Protecting Against Steep Embankment Slopes

Encroachment by motorists on the roadside terrain (embankment fill slopes or cut back slopes) can result in severe injuries or fatalities depending on the steepness of the slopes and angles of encroachment. Note from Table 1 that embankments are approximately equal to utility poles and guardrail for first harmful event fatalities. Also while shown as the FHE, they contribute significantly to the fatalities shown for "overturn" as the MHE. Certain slopes are sufficiently flat (4:1 or flatter) that vehicles can ride on them and recover control without having a problem. Others, for economic reasons, are sufficiently steep that a vehicle can not traverse them without rolling or riding out of control into another fixed object (for example, trees).

Countermeasures include flattening slopes in critical areas or using guardrail to prevent encroachments on high fill slopes. Unfortunately, these are often expensive solutions and guardrail in itself is a fixed object. Also because of the work involved and the number of steep slopes available, these are more long term solutions.

Barrier Systems: Removal/Upgrading

Barrier system fatalities as the FHE account for about 3.3 percent of all highway-related deaths each year, numbering about 1,500 fatalities. This number constitutes approximately 1,300 guardrail fatalities, of which 400 occur at terminal sections, 220 involve concrete barriers, and about 20 involve impact attenuators. Approximately 90,000 to 110,000 injury accidents involve barriers.

It is interesting to note that impact attenuators are usually placed at very hazardous locations and are frequently struck, yet only result in about 20 fatalities annually. This shows their extreme success in reducing accident severity. On the other hand, guardrail is extensively provided to reduce the severity of accidents that may occur if a vehicle leaves the roadway on an errant path. Unfortunately, it is a fixed object also, and because of its extensive use, is involved in a high number of fatalities annually.

These fatalities often occur because of improper use of guardrail and the existence of older, very substandard guardrail. Also contributing is unsafe end treatments (e.g., rigid W-beam strong post turned-down terminals) and unsafe transitions to more unyielding objects. Sometimes the most effective countermeasure it to eliminate the hazard by removal, relocating, or redesign when cost-effective, thereby eliminating the need for guardrail.

The FHWA and several States have been leaders in crash testing and developing better guardrail and bridge railing systems and transitions. However, guardrail terminals continue to be a weak point in the overall guardrail system safety, especially for the light weight (1,800 pounds) vehicles. It is interesting to note that in a recent North Carolina Division of Highway Task Force report studying North Carolina Interstate highway safety, hit guardrail ends resulted in the second highest severity of vehicle impacts with fixed objects. Relative to frequency of fixed objects hit on the Interstate System, guardrail face was first with 30 percent of total hits and guardrail ends fifth with 7 percent of total hits.

An evaluation of safety improvements by the States for the period 1974-1989 showed an average reduction of fatal and injury accident rates of 10 percent for guardrail upgrading, 27 percent for median barrier upgrading, and 35 percent of providing impact attenuators.

Mitigation of Drainage Features

Ditches, parallel and transverse pipes and culverts, and drop inlets are common drainage system elements necessary for the proper function of the highway system. Yet they closely parallel guardrail and embankments in the number of annual fatalities that occur when hit as the FHE by errant vehicles. It is important that drainage system elements be designed, constructed, and maintained with both hydraulic efficiency and roadside safety in mind. Generally used countermeasures include:

- eliminating non-essential drainage structures,
- modifying drainage structures so they are traversable or present a minimal hazard to an errant vehicle,
- extending drainage structures beyond clear zones, and
- providing suitable traffic barriers if the drainage feature is in a vulnerable location and it cannot be redesigned or relocated.

These measures are usually expensive to do on a large scale basis and would take some time to achieve.

Narrow Bridges

Bridges are a relatively high-cost element of a highway; and, as a consequence, have traditionally been designed to minimum widths to save costs. The physical obstruction presented by the end of a bridge rail/aprapet is fixed-object hazard for motorists, especially when the bridge is narrower than the approach roadway. The change in width is thought to cause unsafe actions by drivers with resulting fixed-object and vehicle-vehicle accidents. However, accidents at narrow bridges are statistically rare events, even though a 1975 survey estimated there were approximately 37,000 narrow bridges on two-lane rural roads.

> Narrow bridges can be treated with roadside delineators, pavement markings, and warning signs to alert drivers to the restricted clearances and focus their attention on path control.

Relocation or Retrofitting Sign/Light Supports

Signs and luminaries are important to the safe operations of our highways. However, their supports (sign posts and light poles) can be fixed object hazard if not properly designed or located. Approximately 300 fatalities occur annually due to motorists striking these objects as the most harmful event. Mitigating actions are to reduce

unnecessary signing, relocate signs to unreachable areas or available overhead structures, or to make their supports yielding/breakaway. A lot of research has been conducted to identify safer supports and breakaway designs, and there is a current pooled fund study for crash testing sign supports to assure various designs will meet the latest approved American Association of State Highway and Transportation Officials (ASHTO) standards.

Because of their large numbers they are often hit, but fortunately they rarely result in very severe injuries.

POSSIBLE COUNTERMEASURES - SKIDDING ACCIDENTS

Improve Pavement Surface

Many accidents occur when a driver unexpectedly loses control of his/her vehicle due to loss of needed contact between the road pavement and the vehicle wheels. This can occur due to excessive water on the pavement (causes hydroplaning) or loss of surface friction due to pavement wear and aggregate polishing (causes slippery surfaces).

A pavement's surface characteristics influence on safety is largely related to its ability to shed surface water, particularly during rainfall, and provide adequate surface friction. Rainfall is removed by the slope of the pavement (cross slope or crown) in a straight section and by superrelevation in curves. A slope of 2 percent is typically considered a minimum for effective surface drainage. This slope is not always practical in intersections and transitions to curves. Pavement deformations, wear, and rutting can create drainage problems.

Another part of drainage is the surface drainage from beneath a vehicle's tires. This is made possible by the tire tread pattern and by the texture of the pavement. Worn pavements typically have lost the coarse surface texture (macrotexture) necessary for good water removal. Another pavement surface characteristic (microtexture) of the exposed aggregate. However, the polishing effects of traffic and some pavement failures can obliterate the microtexture of a surface.

If the pavement surface is deficient, several countermeasures are possible:

- Overlay with a skid resistant pavement. A number of designs are available: epoxy binder/aggregate seal coats, open-graded asphalt friction courses, and conventional asphalt concrete overlays. This is done not only for whole sections of roads, but also for spot locations (high friction demands).

- Rehabilitate the existing surface. Grinding and milling operations are intended to improve the pavement ride characteristics but can also improve the friction characteristics. However, the friction improvements are often temporary.

- Improve the roadside. Drainage can sometimes be improved by regarding the shoulders to prevent ponding of water on the traveled way. Curves can be improved by adding a wedge of new pavement to increase the superelevation. This reduces the friction demand of vehicles and improves the runoff of water.

- Reduce speed. Warning signs, roadside delineation, and pavement markings can be used to alert drivers to the need to reduce speed and thereby reduce friction demand.

- Improve curve superelevation. A recent study sponsored by the FHWA indicates that correcting a superelevation deficiency by 0.02 ft./ft. can reduce accidents by about 10 percent. Correcting larger deficiencies might have an even larger benefit.

Based on State-provided performance evaluations for safety improvements for the period 1974-1989, average fatal and injury accident rate reductions of 16 percent can be expected for grooving of pavements and 17 percent for overlay for skid treatments.

POSSIBLE COUNTERMEASURES - MULTI-VEHICLE ACCIDENTS

Head-on crashes result in 38 percent of the fatalities of multi-vehicle accidents and are difficult to prevent on undivided two-way roads. All year, all weather visible pavement markings are critical to assisting drivers to stay on their side of the road. Also, paved shoulders and elimination of pavement edge drop-offs allow drivers to regain control without oversteering when they have strayed off the right side of the pavement. Sudden oversteering often results in the vehicle encroaching into the oncoming lanes. Good edge markings and delineation also help the drivers from straying off the right edge in the first place.

The crossing of medians and center dividers on divided roadways are infrequent, but often severe. Median barriers, heavy shrub plantings, emphasized pavement markings and delineation through sharp curves can avoid or reduce the severity of this type of accident. Also, use of rumble strips in the median shoulder to alert an inattentive driver can reduce the number of median crossing occurrences, thereby reducing severe-type accidents.

About 21 percent of all fatal accidents occur at intersections or are intersection-related. The most severe accidents, of course, being angle hits. Approximately 41 percent of multi-vehicle fatalities per first harmful event are due to angle hits.

Improved lighting and improved sight distances are possible measures to make approaching vehicles at crossroads more visible.

Improved signing and/or better sign and traffic signal visibility and conspicuity help achieve better compliance with traffic control devices, avoiding vehicle conflicts.

Expected average fatal and injury accident rate reductions for various safety improvements based on safety performance evaluations by the States for the period 1974-1989 are as follows:

- New median barriers - 9 percent
- Upgraded guardrails - 10 percent
- Sight distance improvements - 32 percent
- Turning lanes and traffic channelization - 25 percent
- Illumination - 22 percent
- Upgraded traffic signals - 21 percent
- Upgraded median barriers - 9 percent

ISSUES TO BE EXAMINED

- The multi-vehicle accident produces the largest number of fatalities and injuries, and significant total economic loss. What can be done in the short-term to reduce the severity of this type of accident?

- The most severe multi-vehicle accidents are head-on crashes occurring because vehicles encroach on the opposite lane of two-lane roads or cross narrow medians on divided roadways. What specifically can be done for the head-on crashes?

- Single vehicle run-off-the-road and hitting fixed objects accidents results in a significant number of fatalities. Many of the improvements to the roadside require extensive construction/reconstruction and can be expensive and long-term to accomplish if done on a large

scale. What can be done in the short-term? Should comprehensive programs be considered or selected targets of opportunity be concentrated on?

- One of the major fixed roadside obstacles frequently struck and producing the most fatalities and injuries are trees. Removal of trees at particularly vulnerable locations is the best countermeasure, but this often encourages extreme local opposition and raises environmental concerns. What alternatives are there? Are the environmental concerns reasonable, and how can they be used to save lives?

- Utility poles are the second most critical fixed roadside obstacle being hit. Cooperation from utility companies will be needed to implement available alternative countermeasures. How can this be achieved? Economic considerations play a big part in most of the standard countermeasures. Should the government totally pay for implementing countermeasures or do the utilities also have a responsibility?

- On high speed, high volume highways, it can be cost-effective to provide a forgiving roadside; but on low volume local roads usually located on narrow right-of-way, providing clear zones and safe traversable roadsides is difficult to justify economically. Yet a significant number of fatalities and injuries occur randomly throughout the Nation on these facilities. How do we handle this situation, considering the amount of highway funds available? What are our alternatives?

- Many of the safety improvements discussed have been available to the safety engineers for a number of years. What new areas should be considered? Are there possible solutions to our safety problems in new advanced technology?

- Do we need to market our highway safety improvements/programs more to gain public support for them, both from a fiscal sense and educational sense of what we are trying to accomplish?

IMPROVING DRIVER PERFORMANCE AND CONTROL

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INTRODUCTION

About 47,000 people lose their lives in traffic accidents each year in the United States. In addition, more than 3 1/2 million people are injured in motor vehicle accidents annually. These causalities result in societal costs approaching $100 billion annually.

While these statistics are truly staggering, they have come to be viewed by many as the price we pay for our mobility--"the cost of doing business." There is a growing feeling among the highway safety community, however, that these numbers can be reduced significantly by improving the behavior and performance of highway users.

A look at some additional statistics highlights the fact that actions of drivers, motor vehicle occupants, and pedestrians weigh heavily on the complex set of events that produce traffic accidents. For example:

- Alcohol is a factor in about 40 percent of all traffic fatalities and is a major factor in pedestrian fatalities.
- Nearly 40 percent of traffic fatalities involve drivers taking major risks (speeding, following too closely, etc.)
- More than one-third of all traffic fatalities involve driver lapses such as falling asleep at the wheel or being distracted from the driving task.
- About 75 percent of vehicle occupants who die in traffic accidents do not use safety belts.
- About 7,000 pedestrians are killed each year as a result of being struck by motor vehicles on public roads.
- About 20 percent of the nearly 600 people who die each year in train-motor vehicle collisions are in vehicles which are driven around lowered crossing gates.

CAUSE OF THE PROBLEM

"Driver error" is generally considered the causative factor in at least 60 percent of all traffic accidents. Some believe the figure is even higher--possibly as high as 90 percent or more. Whatever the figure, it is reasonable to expect that anything done to positively influence driver behavior and performance should help reduce the number of traffic accidents.

A number of approaches have been tried to influence driver performance. Those which require modifying driver behavior are often the most difficult to evaluate. This is because there are usually numerous other factors in play simultaneously.

Focus highway users' attention to traffic safety issues is one possible means of influencing their performance and behavior. This has been demonstrated in a number of ways:

- Much has been accomplished at all levels of government and in the private sector to raise public awareness of the benefits of using occupant restraint systems.

- There is also no shortage of information on the dangers presented by drunk/drugged drivers and pedestrians.

- We have all been made very much aware of safety improvements made to motor vehicles in the last 20 years.

- Numerous education programs have been targeted at a variety of highway user groups--young drivers, school age pedestrians, older drivers and pedestrians, drivers convicted of violations, etc.

Another area that has received much attention in an effort to influence driver performance is enforcement of traffic laws. We have every reason to believe strict enforcement of traffic laws (especially those related to speed) should influence the way a driver operates a motor vehicle. However, only a few such programs have been evaluated for their impact on traffic safety. While driver improvement should be a primary result of enforcement programs, they often are relegated to efforts to simply prevent repeated violations by habitual offenders.

One area often overlooked among the programs devised to influence driver performance is that of highway design and operational improvements. Such actions, if combined with compatible education and enforcement measures, carry the potential to give drivers necessary and important information about the highway. This would allow them to better control and maintain their vehicles on the road and in traffic environment.

One task facing this workshop is to examine some of the highway safety improvements that have been found to be effective preventing accidents. We will then want to determine how they can best be combined with effective education and enforcement efforts to achieve an optimum short-range program.

Let's review some common highway safety improvements and what we know about them:

- **Improving Pavement Markings** - Pavement marking improvements are generally made to improve drivers' visibility and designate and regulate lane use. These types of improvements include placing markings on unmarked highways, placing wider markings, and using markings with improved durability and reflectivity. Placement of raised pavement markers is another way of improving drivers' visibility. Some States have reported accident reductions of 20 to 60 percent when markings were provided to correct certain hazardous conditions.

- **Adding Roadway Delineators** - Roadway delineation is a countermeasure aimed at reducing run-off-the-road accidents. Delineators are an effective aid for night driving, particularly on stretches of highway where there are unexpected changes in horizontal alignment or where the alignment might be confusing. Some States have reported as much as 30 percent reduction in run-off-the-road nighttime accidents at evaluated high accident locations.

- **Installing Roadside Object Markers** - Object markers are used to denote obstructions within or adjacent to the roadway. This type of fixed-object treatment may be appropriate for low volume and low speed roads but removing or shielding the objects is the preferred treatment at most locations.

- **Improving Signing** - Proper and positive driver guidance is an absolute necessity to maintain mobility and safety on our highways. Signs provide regulatory, warning, and guiding information to assist drivers to traverse safely any facility open to traffic.

Signs have been extensively used to counter hazardous conditions. For example, warning signs are typically used to alert drivers of dangerous conditions such as sharp curves, intersection approaches, and slippery pavements. Signs used as countermeasures at high accident locations have shown reductions in traffic incidents ranging from 20 to 40 percent.

- **Constructing Rumble Strips** - Driving on some rural highways cause drivers to become drowsy, or "hypnotized" by the constant speeds, lack of traffic, and the monotony of the landscape. This situation is often typical of rural freeways where run-off-the-road accidents are common. Studies have demonstrated the use of rumble strips is effective in reducing run-off-the-road accidents. Some studies showed over 40 percent reduction in run-off-the-road accidents on rural freeways.

  Rumble strips are also used to warn drivers approaching dangerous intersections, road closures, and other similar hazardous conditions.

- **Eliminating Shoulder Drop-off** - Shoulder and pavement drop-offs have long been recognized as potential safety hazards. These drop-offs include those crated by erosion along the edge of the pavement where shoulders are not paved, drop-offs created by overlay operations, and drop-offs created by shoulder or roadway excavation operations. When not properly addressed, drop-offs may cause vehicles to go out of control which could result in property damage and injuries.

- **Maintaining Traffic Control Devices** - With the exception of traffic signal systems, maintenance of traffic control devices is largely ignored as an important accident countermeasure. Keeping signs conspicuous and legible, for example, is important in conveying road information and alerting the driver to potentially hazardous conditions. Yet, proper inspections, replacement of faded signs, and removal of vegetation and road grime that obscure signs is often ignored.

- **Repairing and Updating Traffic Barriers** - Numerous studies have been conducted to evaluate the performance of barrier systems. Too often these studies find field barrier installations do not perform properly when impacted. Properly installing, maintaining, and updating barrier systems is critical in reducing the severity of vehicle-barrier collisions. Evaluations of projects in which existing barrier systems were updated show fatalities were reduced as much as 50 percent.

- **Improving and Updating Railroad-Highway Crossings** - Railroad-highway crossing fatalities involving motor vehicles declined from 978 in 1976 to 483 in 1983. Since 1983, however, fatalities have increased to nearly 600 a year despite strong efforts to provide advance warnings and modify drivers' behavior at crossings.

  Although the overall number of fatalities have increased in recent years, railroad-highway crossing improvements have been effective in reducing fatalities at high-accident locations. The most effective improvements have consisted of upgrading or installing active warning devices such as flashing lights and gates at crossings. Evaluations of these improvements show fatal accident rate reductions ranging from 87 to 92 percent.

  Other improvements aimed at modifying driver behavior must also be implemented at railroad-highway crossings. Providing constant warning time at crossings equipped with active warning devices is an example of such behavior-modifying improvements.

- **Improving Work Zone Traffic Control** - Work zone fatalities increased from about 500 in 1982 to more than 700 in 1984. Since 1984, the number of fatalities has stabilized at about 700 per year, except in 1988, when there were about 750 fatalities. Injuries and property-damage-only accidents present similar trends.

Evaluating the effectiveness of work zones is difficult because no one sequence of signs or other traffic control devices can be used as a solution to all situations encountered. Avoiding violations of drivers' expectancies is probably the most important principle to follow when designing work zone traffic control plans. Work zone roadway geometry and traffic control devices must be designed, installed, and maintained so they are comparable to those expected under normal highway driving conditions.

- **Improving Sight Distance** - The negative effect of sight distance restrictions on highway safety is obvious. An evaluation of Federal-aid highway safety projects indicated that sight distance improvements are among the most cost effective type of accident countermeasures.

  The accident rate at most evaluated project sites decreased when sight obstructions were removed. Providing illumination to assist drivers to overcome nighttime loss of vision has also been effective in reducing accidents.

Since 1974, the FHWA has evaluated typical highway safety improvements implemented by the States. The effectiveness of these short-term improvement projects is summarized in the following table:

Construction Classification	Indexed Cost of Evaluated Improvements (millions)	Percent Reduction in Accident Rates After Improvements			Indexed Cost-per-Accident Reduced (thousands)		Benefit - Cost Ratio
		Fatal	Injury	Fatal + Injury	Fatal	Fatal + Injury	
Sight Distance	8.9	47	31	32	379.7	23.0	2.3
Traffic Signs	13.2	28	8	8	231.9	20.4	3.6
Pavement Markings & Delineators	34.1	17	3	3	817.7	151.8	1.0
Upgraded Traffic Signals	75.9	37	20	21	491.1	9.8	2.3
Upgraded Bridge Rail	6.3	75	32	36	187.9	37.6	4.1
Groove Pavement for Skid Treatment	12.9	29	16	16	420.5	12.7	2.4
Upgraded Guardrail	114.6	40	8	10	192.6	36.4	4.1
Upgraded Median Barrier	9.0	45	27	27	267.2	13.8	3.3
Impact Attenuators	11.5	33	35	35	373.1	8.4	2.7
Remove Obstacles	18.7	50	23	24	233.1	17.9	3.6
Upgraded Flashing Lights	16.1	88	40	51	343.2	133.5	2.2
New Flashing Lights	55.7	87	79	80	457.2	81.4	1.7
New Flashing Lights & Gates	131.5	92	85	86	554.0	108.1	1.4
New Gates	52.8	91	75	78	396.7	94.5	1.9

Traffic costs of $1,500,000 per fatality and $11,000 per injury were used in calculating the benefits of highway safety improvements presented in the preceding table. Also, the indexed costs presented in the table are expressed in 1987 dollars.

COMMERCIAL MOTOR VEHICLE SAFETY

REDUCING ACCIDENTS INVOLVING COMMERCIAL MOTOR VEHICLES

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INTRODUCTION

Commercial motor vehicle (CMV) traffic has significantly increased in recent years. Because of this increase, both the general public and government officials have become increasingly concerned with CMV safety.

All levels of government, the public, and the motor carrier industry agree that the primary goal of commercial motor vehicle enforcement should be the reduction in the number, frequency, and severity of motor vehicle accidents and incidents involving CMVs.

A cooperative effort to identify and establish the role and responsibility of each government entity involved in CMV safety is the first step in obtaining that goal. Generally, this involves the Federal government providing guidance and monetary assistance to the State and local agencies, which, in turn, provide enforcement of the truck and bus safety regulations. The primary areas of Federal assistance to State and local CMV safety programs are training, enforcement through roadside inspections and carrier reviews, data gathering, and technology development.

Ideally, the trucking industry should also be included in this cooperative effort because voluntary compliance should be the result of a regulatory program based on reasonable safety requirements. Elimination of unfair competition by operators who gain an advantage by violating the hours of service requirements, or by failing to properly maintain their equipment, should also be incorporated in CMV safety programs.

CAUSE OF THE PROBLEM

While there are many differing opinions on the causes of the accident problem in the motor carrier industry, most people would agree that the following factors contribute to a large number of accidents:

- motor carriers failing to properly maintain their equipment;
- motor carriers employing unqualified drivers;
- drivers operating beyond their legal hours-of-service limits, and;
- drivers operating while under the influence of alcohol or drugs.

SHORT-TERM ACCIDENTS COUNTERMEASURES

- **Reinspection/Verification Programs** In June 1988, a report entitled "Motor Carrier Safety Assistance Program (MCSAP): Options Intended to Improve a Generally Successful and Cooperative Federal/State Partnership Promoting Truck and Bus Safety: completed by the Congressional Research Service, identified the lack of roadside reinspection requirements within the MCSAP as a deficiency which needed to be addressed.

- In FY 1989, the State of Michigan agreed to conduct a verification study designed to determine the percentage of critical defects discovered during MCSAP inspections that were not fixed properly. Results of the study indicated that the location of the out-of-service (OOS) vehicle (i.e., open scale house, closed scale house, roadside, etc.) may have an effect on whether the driver complies with the OOS action. In addition, the number of OOS violations and the types of violations (brakes, tires, hour-of-service) appear to be a significant indicator of possible noncompliance with an OOS action.

- An additional three States have recently completed similar studies and the FHWA is in the process of analyzing the results to determine the extent of the problem and to further develop ways to reduce the operation of imminently hazardous vehicles.

- The Commercial Vehicle Safety Alliance (CVSA) has also recently developed "draft" operational procedures for the performance of verification programs which should be finalized this fall. At that time, a General Accounting Office report on a study of verifications/reinspection procedures should also be available.

- **Commercial Motor Vehicle Driver Education** - Much can be accomplished through education and this certainly holds true in the motor carrier industry. The behavior of CMV drivers could be modified significantly by an increased level of education concerning the safety and hazardous materials regulations and vehicle braking and handling characteristics. The need for increased regulatory and vehicle education is exhibited by the 20-25% initial failure rate of the Commercial Driver's License examination in those States that have begun issuing CDLs.

  - Driver safety information maps, which highlight areas of long-term construction work and high accident frequency locations, have been well received in a number of States thus far. These maps have been distributed to drivers at toll plazas, scale locations, and inspection sites.

  - An additional safety tool of particular interest is a safe driving tape produced by Colorado Motor Carriers Association for truck drivers traveling I-70 West of Denver through the Rocky Mountains. The tape informs drivers of safe mountain speeds in addition to instructing them on where and when to gear down to reduce the possibility of runaway accidents.

- **Utilization of CMV Management Information System** - SAFETYNET, the motor carrier management information system conceived by the FHWA in cooperation with the States, is designed to capture all commercial motor vehicle enforcement data. Approximately ten States are not uploading inspection data to the system maintained in Washington, DC.

  - The need to record all commercial motor vehicle and driver violations detected by enforcement personnel is becoming increasingly important. The system's data, when provided to State and local agencies, can lead to the revocation of operating authority and reduce economic advantages gained by dangerous operators in the trucking industry. When combined with FHWA's carrier review data, the SAFETYNET information should result in further development of accurate profiles of carriers safety practices. The profiles will allow both Federal and State enforcement personnel to place greater emphasis and resources on *problem* carriers.

  - FHWA recently issued a policy requiring data uploading capabilities as a prerequisite to receiving MCSAP funding. We believe that this requirement can be met by the States within a short time period.

- **Implementation of the National Governor's Association (NGA) Accident Report Data Elements.** - As stated above, the primary goal of commercial motor vehicle enforcement is the reduction of accidents. However, the national truck accident statistics, which are based mainly on data from State police accident reports, vary tremendously from one State to another. This lack of uniformity among States in the type of truck accident data collected and the inconsistency in the definitions of those data elements makes analysis at the national level very difficult and evaluation and comparison among the States virtually impossible.

  - Recognizing these problems, the FHWA contracted with the NGA to identify a minimum set of truck accident data elements. These elements relating specifically to accidents involving trucks and buses were combined with additional data elements required by SAFETYNET, and one form was developed. Implementation of an accident form containing these uniform elements by States will enable the Federal government to better evaluate the effectiveness of the MCSAP on a State by State basis, on a regional basis, and on a national basis. Currently seven States have adopted the NGA truck accident data elements.

  - Training enforcement officers to accurately and properly compete the NGA form is essential to its implementation. Funding for this training may be available to expedite its full implementation.

- **Training of Additional State and Local Enforcement Officers Normally Assigned to "Traffic Duty"** - While the MCSAP has provided funding for the training of more than 4,000 State and local enforcement officers across the country, there are thousands of additional law enforcement personnel assigned to traffic duty who have little or no knowledge of CMV safety regulations. Because of this lack of knowledge of CMV safety regulations. Because of this lack of knowledge, these enforcement officers tend to shy away from truck and bus "rules of the road" enforcement.

  - Colorado, Montana, Michigan, and North Dakota are four States which have been training the majority of their State highway enforcement officers, i.e., non-MCSAP officers, in basic CMV safety regulations for the last few years. State officials believe that the additional commercial vehicle knowledge and inspection activity by their road troopers has been extremely beneficial to their overall truck safety program.

  - The FHWA is currently working with the National Highway Traffic Safety Administration on a program to develop strategies for CMV enforcement efforts by police personnel normally assigned to traffic-related duties.

- **Increased Hours of Service Training for CMV Inspectors** - The National Highway Traffic Safety Administration's 1988 "Summary of Fatal and Nonfatal Crashes Involving Medium and Heavy Trucks" states that commercial truck drivers involved in such crashes are rarely reported by police as being impaired by fatigue. However, other studies suggest that driver actions are the primary cause in the majority of truck accidents and driver fatigue may be playing an increasingly large role.

  - Currently, the State of Arizona is working on a "High Risk Driver" project aimed at detecting and removing fatigued drivers from the road. The CMV inspectors involved have been trained in detecting physical signs of fatigue. If a CMV inspector believes a driver is fatigued, his records of duty status are thoroughly checked and compared with additional documents to verify their accuracy. This increased emphasis on drivers has resulted in a 22 percent driver out-of-service fate in the State compared to the national average of 7 percent.

ISSUED TO BE EXAMINED

- How should reinspection/verification programs be implemented? How can support for such programs be achieved?

- How can we improve roadside detection of alcohol use? What is the potential for roadside drug detection? Is random testing practical and workable?

- What are the impediments in your State to reducing alcohol and drug-related accidents?

- What types of unique CMV driver education programs can be initiated? What types of driver education programs have been well accepted and beneficial in the past?

- What are the impediments, if any, in achieving full SAFETYNET inspection uploading capabilities?

- What can be done to obtain support of the law enforcement officer and community for collecting the NGA uniform truck accident data elements? What problems are being encountered by States with the implementation of the NGA data elements? What impediments will States encounter in attempting to upload accident information to SAFETYNET?

- To what extent should local enforcement personnel be trained in basic commercial driver and vehicle safety rules?

- How can we encourage and motivate general patrol personnel to increase "rules of the road" enforcement involving commercial vehicle drivers?

- What problems will enforcement of the CDL create?

- What amount of coordination should there be at the State level between the Governor's Highway Safety Representative (GHSR) and the MCSAP coordinator? Should the MCSAP lead agency receive a copy of the GHSR's annual Highway Safety Plan to review to ensure there is little or no duplication of effort? Should a copy of the MCSAP annual State Enforcement Plan be provided to the GHSR for review? What impediments may be encountered in achieving such coordination?

COMMERCIAL MOTOR VEHICLE SAFETY

MEASURES TO IMPROVE COMMERCIAL VEHICLE SAFETY

Lt. Don Uelmen
California Highway Patrol
On Assignment to National Highway Traffic Safety Administration

INTRODUCTION

Crashes involving large trucks are rarely a minor traffic incident. The physical differences between smaller and lighter automobiles and longer, wider and heavier trucks equate to an escalated danger to car occupants in spite of the increase in safety belt use and installation of passive restraints. Even a 'property damage only' collision impacts traffic flow to such a degree that 'congested traffic' ceases to be an adequate description of the resulting chaos on major transportation arteries. The economic loss is staggering; a study by the AAA Foundation for Traffic Safety estimates the total annual costs for truck incidents on the Los Angeles freeway system in the range of $107 to $189 million dollars.[1] Effects on public health and safety, and government agency costs are multiplied when the incident involves a cargo of hazardous materials.

An estimated eighty-five percent of truck-at-fault crashes are the result of driver error and/or impairment. National Transportation Safety Board findings revealed that fatigue was the most frequently cited cause, and impairment, because of alcohol or other drugs, was the second most cited cause in a recent fatal-to-the-driver heavy truck crash study.[2]

Shared concerns over the number of fatalities and serious injuries resulting from crashes involving large trucks, and the financial impact caused by congestion and damages, calls for an evaluation of current commercial vehicle enforcement programs and development of new strategies. Successful commercial enforcement programs directed toward driver's qualification and equipment inspection, such as the Motor Carrier Safety Assistance Program (MCSAP), requires a compatible program focusing on 'moving' violations and driver intoxication and/or fatigue. The cornerstone to this approach is a spirit of cooperation between the federal government, state and local agencies and the trucking industry, similar to the relationship between those entities in the Commercial Vehicle Safety Alliance.

CAUSE OF THE PROBLEM

Commercial Motor Vehicle Safety consists of the following major elements or programs:

- On Highway Hazardous Moving Violations
- Incident Response/Accident Investigation and Reporting
- Weight Enforcement
- Equipment and Driver Inspections
- Hazardous Materials Transportation
- Motor Carrier Safety Reviews

It would be an impossible task for a single agency to deal with all these elements in a comprehensive approach. Due to the expertise and specialized background of each element, the Department of Transportation has three separate entities directly involved with commercial motor vehicle safety:

Federal Highway Administration

Motor Carrier Regulations
Weight Enforcement
Equipment and Driver Inspections
Motor Carrier Safety Reviews
Highway Design for Weighing Facilities and Inspection Turn-outs

National Highway Traffic Safety Administration

On Highway Hazardous Moving Violations
Vehicle Design Standards
Accident Investigation and Reporting

Research and Special Programs Administration

Hazardous Materials Transportation

On the state level, and in some local governmental subdivisions, elements of Commercial motor vehicle safety are the responsibility of separate agencies.

This approach to commercial motor vehicle safety has led to some confusion by other governmental agencies, the trucking industry, and public and private traffic safety advocacy groups as to who or how to access information and resources.

Additionally, past efforts toward accomplishing a common goal, such as reducing the number, frequency and severity of heavy truck crashes, have sometimes been diluted by separate agendas of the entities involved. Concentration on shared concerns must replace the emphasis on traditional differences that resulted in a lack of consensus. The decade of the nineties can become a bench mark for a new spirit of cooperation, encompassing federal, state, local, industry and public efforts, to benefit everyone and achieve a safer environment for our highways. A more comprehensive approach to commercial motor vehicle safety would take a major step toward effectively ***moving America into the 21st Century.***

SHORT-TERM COUNTERMEASURES TO IMPROVE COMMERCIAL VEHICLE SAFETY

1. Establish a forum for an exchange of information between the various elements and programs including parties of interest from all levels of government, the motor carrier industry, trucking and driver's associations and public advocacy groups concerned with commercial motor vehicle safety.

2. Fix responsibility for coordinating and updating commercial motor vehicle safety efforts to serve as a resource and provide assistance to the parties of interest. This could also avoid duplication of effort and save unnecessary commitment of resources. Specifically:

   Federal resources could be directed toward:

   - The development of and training in the use of on board computers to replace easily altered written logbooks. This would assist commercial vehicle enforcement of driver's hours of service and inspire voluntary compliance by motor carriers.

   - Recommendations and guidelines for the use of passive alcohol sensing devices and training in recognizing the symptoms of drug and alcohol impairment to benefit both enforcement personnel and industry supervisors.

- A national informational system to record commercial violations detected by *all* enforcement personnel which could identify operators and carriers who habitually violate laws and regulations. That type of data, when made available to state and local agencies, can lead to the revocation of operating authority and eliminate unfair economic competition by dangerous elements in the trucking industry.

  State and local traffic administrators could develop commercial enforcement strategies directed toward two important objectives.

- Formulating effective countermeasures to combat the unlawful and dangerous operation of heavy trucks on the nation's highways.

- Providing support and assistance to motor carriers with effective safety programs.

  The motor carrier industry, trucking and driver's associations and public advocacy groups concerned with commercial motor vehicle safety could support legislation, and assist in development of technology and guidelines for commercial motor vehicle safety programs. These groups are an excellent resource in the development and distribution of information on vehicle operation such as trucks and cars sharing the road, and driver's safety information maps.

3. Institute a single resource clearing house containing information relating to commercial motor vehicle safety programs.

ISSUES TO BE EXAMINED

- Is the current separation of elements involved in commercial motor vehicle safety an unworkable management of responsibilities?

- Which elements could be combined to achieve a more comprehensive approach to commercial motor carrier programs?

- What is the best approach to establishing a forum for the exchange of commercial motor vehicle safety information and programs to avoid duplication of effort and unnecessary use of resources?

- What is the best approach for establishing an information center and clearing house for commercial motor vehicle safety programs which would be accessible to all parties of interest?

- Who should assume the responsibility for a workable solution to issues and recommendations on commercial motor carrier safety resulting from the symposium?[1]

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1 *Estimate The Economic Costs of Truck Incidents on Urban Freeways*, Roger F. Teal, Institute of Transportation Studies, University of California, Irvine. November, 1988.

2 *Safety Study - Fatigue, Alcohol, Other Drugs and Medical Factors in Fatal-To-The-Driver Heavy Truck Crashes*, National Transportation Safety Board, PB90-917002, NTSB/SS-90/01 February, 1990.

CORRIDOR IDENTIFICATION & IMPROVEMENT

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INTRODUCTION

Every state has arterial corridors with severe accident problems. Approximately 50% of the fatalities and 30% of the injuries occur on the arterials.

The Corridor Safety Program is designed to address this problem. It is a comprehensive approach to highway safety that integrates highway improvements, driver performance, vehicle and emergency medical service initiatives. These initiatives are integrated into a unified safety effort to reduce future severe accident potential on long sections of arterial highways (corridors).

Several State highway agencies are considering a comprehensive approach to this problem. The Pennsylvania Department of Transportation (PennDOT) has developed and is implementing a safety initiative on selected corridors. This paper will explore the Pennsylvania Corridor Safety Initiative.

PENNSYLVANIA'S CORRIDOR SAFETY INITIATIVE

PROGRAM OVERVIEW

All states have corridors with severe accident problems. Many of these corridors are characterized as free access, high volume facilities with speeds of 40 miles per hour or greater and adjacent commercial strip development. In many cases, these safety problems cannot be readily resolved by replacing the existing free access highway with an expressway/freeway because of major financial, environmental or social impacts.

In Pennsylvania, 55 highway corridors were studied (approximately 880 miles). The corridor lengths range from 1 mile to 72 miles; the average length is approximately 10 miles. Improvements identified throughout the corridor have the following characteristics:

- Safety-related
- Low cost
- Not in need of a lengthy design, major right-of-way acquisition, or environmental study, and
- Can be implemented within a two year period

The improvement efforts are applied over long sections of highway rather than random spot locations. Thus, the continuity of the improvements have a compounding effect on overall highway safety throughout the corridor. The comprehensive corridor safety approach encompasses highway, driver performance, vehicle and emergency medical services initiatives.

To integrate all aspects of safety, the Corridor Safety Program requires the combined efforts of three Pennsylvania agencies, the Department of Transportation, the Department of Health and the State/Local Police.

The combined use of Federal Highway Administration (FHWA), National Highway Traffic Safety Administration (NHTSA) (402 Funds) and State funding is used to implement the program objective of reducing accidents, particularly fatalities, on specific high accident highway corridors.

BACKGROUND

The concept of the Corridor Safety Program began with a pilot corridor, US 322 (locally called the Conchester Highway) in Delaware County, Pennsylvania. As a result of a serious accident involving fatalities, the Governor requested that the Department study the problem and identify a plan to reduce accidents. A multi-disciplinary team was assembled. The team included the Chief Safety Engineer, Traffic Engineer, Maintenance Engineer, local officials and local police.

The team identified a 14 point action plan to improve safety along the corridor. A few of the improvements included in the plan, which was fully implemented, are: signing and pavement marking improvements, speed limit reductions, increased local police enforcement, concrete median barrier installation, placement of anti-skid pavement surfaces and the establishment of an area to perform MCSAP inspections. The cost of the 14 safety improvements was approximately $600,000.

PROGRAM EXPANSION AND CORRIDOR SELECTION

Within six months of developing the plan, the identified improvements were implemented. The quickness of implementation prompted very positive feedback.

With the success of the Conchester Highway corridor, a decision was made to implement this comprehensive safety approach on additional corridors which have exhibited major safety concerns.

Pennsylvania accident data was carefully studied to identify similar corridors which have severe accident problems. In addition, sites were recommended by the districts and through information received at public hearings that were conducted across the State by the Transportation Commission. As a result of this analysis, 55 corridors were selected to receive various remedial engineering improvements. These 55 corridors were selected because they were considered to have the greatest potential to significantly reduce accidents by implementing low cost safety improvements. In addition, they were unlikely to receive major reconstruction/replacement in the near future.

IMPLEMENTATION

Each of the 55 corridors were assessed and initiatives were implemented based on these four areas: Highway, driver performance, vehicle and emergency medical services.

Highway Perspective

Highway initiatives include the following:

- Analyzing the safety problem including the location of accident clusters, the identification of roadway deficiencies, the analysis of contributing factors and the development of roadway improvements.

- Implementing roadway enhancements to improve the safety and operating characteristics of the highway. Improvement types included upgraded intersections including left turn lanes, improved signing and pavement markings, median barriers, increase skid resistance, red revert signal systems, establishment of MCSAP inspection sites, removal of fixed objects, dual center turn lanes, etc.

Driver Performance Perspective

The accident data was also analyzed to determine driver performance failures associated with the accident problem. Activities in the driver performance area included the following:

- Educational and media programs directed at the driver to improve safe driving along the corridor. General program areas include:
  - Safety belt usage
  - Drinking and driving
  - Speeding
  - Unsafe driving practices
  - Pedestrian actions
- The effectiveness of educational initiatives were improved by supplementing them with selective police enforcement strategies. Federal grant funds are provided to stat and local police along the corridors to purchase traffic enforcement equipment and to fund salary costs incurred during the safety blitzes. A safety blitz is when several police departments along the corridor concentrate surveillance on the corridor at the same time. A total of five local driver performance coordinators were hired to initiate and coordinate the Driver Performance component of the program at the district level.

Vehicle Perspective

Initiatives in the vehicle area include:

- Implementing commercial truck safety inspections (MCSAP) along corridors having truck safety problems.
- Informing motorists of dangerous vehicle alterations.
- Encouraging the motorists to be aware of their vehicles operating condition at all times.

Emergency Medical Services Perspective

Activities in the emergency medical services area concentrate on the following:

- Communications - quicker response time
- Training and Equipment - selective upgrade to advance life support (paramedic)
- Effective patient triage - transfer of patient from accident scene to appropriate medical facility.

A CHALLENGING EXPERIENCE

Implementing an innovative program, particularly one involving multi-agencies is a challenging experience. Some of the more complex tasks included coordinating program development between agencies to assure a cooperative approach. Likewise, incorporating driver performance initiatives into the engineering plans of technically oriented PennDOT District offices.

Despite the challenges, the program is regarded as a successful initiative. The program has generated a cooperative inter-disciplinary approach to solving highway safety problems. In addition to the involvement of various agencies, there has been major support from community leaders, municipal officials, and media adjacent

to the corridors. This has fostered communication and cooperation between neighboring municipalities and improved liaison relations between PennDOT and the local municipalities.

The program has also been successful in providing a mechanism for targeting long sections of highway for improvement rather than spot locations.

PROGRAM EVALUATION

Pennsylvania's program is still in early stages of implementation. As the program is expanded and implemented on additional corridors, PennDOT will be conducting evaluations of each corridor.

PennDOT is currently developing measures of effectiveness to evaluate the impact of various components of the program. This includes methods of evaluating the effectiveness of public information and education programs on driver performance, designing methods to evaluate improved emergency medical services, and studies of pre/post corridor accident data.

Preliminary evaluation on one of the selected corridors, Route 65 in Allegheny County, has been positive to date. The following results are based on one year before/after data:

- 22% reduction in total accident;
- 67% reduction in alcohol related accidents, and
- 41% reduction in the accident rate

Since only one engineering project has been implemented to date, (a red revert signal system), these results are attributed to the driver performance component of the program. Eight additional engineering projects are scheduled for Route 65.

PLANS FOR PROGRAM REPLICATION

The U.S. Department of Transportation (US DOT) has identified Corridor Safety as one of the three major safety initiatives to be implemented nationwide. These initiatives were selected based on potential to reduce the number of fatal accidents on our highways.

Since Pennsylvania has already developed and implemented a corridor safety initiative, the Federal Highway Administration (FHWA) has requested that PennDOT present Pennsylvania's Corridor Safety Program to other states interested in implementing a similar program.

APPENDIX C
ADDITIONAL HIGH PRIORITY COUNTERMEASURES

ADDITIONAL HIGH PRIORITY COUNTERMEASURES

Set out below are additional high priority countermeasures generated by the four or five small groups within each workshop. Phrasing of each countermeasure remains exactly as developed by the small groups. Countermeasures are listed by workshop.

IMPROVING PEDESTRIAN PERFORMANCE AND ENVIRONMENT

Group 1

1. National awareness campaign.
2. Increased fund discretion (FED).
3. Ped/bike 402 priority.
4. Impaired - alcohol/related drugs.
5. User-friendly traffic control devices.
6. Education for 12-18, 60 years and older, K-12, and drivers.
7. Getting media involved.
8. Parent involvement.
9. Corporate in highway projects.

Group 2

1. Data collection.
2. Community outreach.
3. Engineering improvements.
4. Retroreflective clothing.
5. Elderly problems.
6. School routes/route planning.
7. Enforcement.

Group 3

1. Designate as national priority (FHWA, NHTSA, AASHTO).
2. Improved signalization (warrants, timing, etc.).
3. Improved visibility at intersections (sight distance, signal faces, etc.).
4. Physical separation (channelization, barriers).
5. Design/operations (sensitivity awareness) (professionals).
6. Continual problem ID.

Group 4

1. Dissemination/marketing of packaged information.
2. Advocacy group.
3. Sidewalks.
4. TCD's in neighborhoods.
5. Signal enhancements.
6. Lighting.
7. New TCD's.

REDUCING ACCIDENT SEVERITY

Group 1

1. Improve/replace pavement markings and signs.
2. More designated safety funds.
3. Install rumble strips on shoulders.
4. Correct severe accident locations.
5. Eliminate/protect trees and utility poles in high accident locations.
6. Exempt safety funds from obligation limitations.
7. Eliminate/upgrade obsolete hardware.
8. Speed reduction through enforcement.

9. FHWA/State review teams.

10. Set maintenance standards related to safety.

Group 2

1. Increased enforcement of traffic laws.

2. Roadside hazard removals.

3. Better assessment of hazard conditions.

4. Improve crashworthiness and crash avoidance standards of vehicles, including purchase of fleet vehicles.

5. Improved EMS services and response.

6. Improved signing and delineation.

7. Safety training for highway designers.

8. Improved shoulder maintenance.

9. Expanded use of breakaway hardware.

10. Improved data linkages.

Group 3

1. Upgrade night sign visibility.

2. Enforce speed limits.

3. Increase usage of textured shoulders.

4. Increase awareness of belts/airbags.

5. Clear roadside.

6. Increase correct-child-restraint use.

7. Improve access management.

8. Increase curve delineation LVR (plastic delineation).

9. Administrative per se.

10. Increase usage of TMAs.

Group 4

1. Install shoulder rumble strips.
2. Upgrade existing roadside hardware.
3. Edgelines and delineation of roadside hazards.
4. Attention-getting traffic control devices.
5. Upgrade traffic records capabilities.
6. Increase enforcement visibility.
7. Incident management systems.
8. Public information and education program on safety issues.
9. Warning signs on new pavement.
10. Side impact design.

Group 5

1. Uniform and improved accident record and data systems.
2. Move and remove utility poles.
3. Tactile shoulder delineation.
4. Delineation of fixed objects.
5. Side slopes including crossings and drainage.
6. Improved lighting and markings.
7. Breakaway utility poles and others.
8. Better use of barriers and terminals.
9. Urban "clear roadside" treatments and policies.
10. Better conspicuity of traffic control devices.

IMPROVING DRIVER PERFORMANCE AND CONTROL

Group 1

1. Signing improvement: non-MUTCD:
   -(elements such as use of active warning signs) "New Generation."

2. Speed limit:
   -Establishment of realistic speed limit.
   -Improved use of signal progression.
   -Control (i.e., speed photo and progressive speeds).

3. Signing improvement: MUTCD:
   -Larger letters.
   -Reflectivity.
   -Increased attention to spacing and maintenance (no clutter).

4. Roadside obstacles:
   -Increased use of clear roadside concept.
   -Use roadside design guide.

5. Upgrade barrier systems:
   -Increase bridge rails.
   -Determination of what we have out there and how to upgrade.

6. Audible warning devices:
   -Rumble strips (especially in work zone).
   -Entering work zone and center-line.
   -Shoulder rumble strips.

7. Elimination of left turns at intersection or addition of turn bays in intersections:
   -Maneuver in a protective manner.

8. Risk management:
   -Attention highway agency give to responsibility on roadway.

9. Rural intersection lighting:
   -Urban as applied to rural: lighting, warnings, visibility, R&R crossings, intersections.

10. Cheap interim solutions:
    -Will help out in the long term.

Group 2

1. Signing visiblity: MUTCD:
   - -Retroreflectivity.
   - -Legend signs.
   - -Back of signs.
   - -Basic upgrading.

2. Better delineation
   - -Pavement.
   - -Posts.
   - -Adverse weather conditions.

3. Driver education:
   - -From beginning as a teen into adulthood.

4. Advanced warning:
   - -Use of activated signals.

5. Credibility improvements:
   - -Speed limits.
   - -Signs.

6. Rural spot lighting.

7. Technology transfer improvement:
   - -Passe to rural users.

8. Work zone operations/maintenance:
   - -Review and maintenance of signs put in work zone areas.

9. Simplified traffic control devices.

10. Traffic separation:
    - -Cars versus trucks; segregation by vehicular class.

Group 3

1. Improve roadway delineation.

2. Signs on highway relative to impaired driving (i.e., DWI).

3. Public awareness through media:
   - -Licensing, testing.
   - -Rules of the road.
   - -Safety.

4. Maintenance management program for traffic control devices.

5. Improved linking accident data to selecting countermeasures treatment.

6. Improved work zone traffic control and safety.

7. Exempt safety dollars from obligational authority limit:
   -Don't make safety dollars compete with construction dollars.

8. Aiding driver perception:
   -Better perception of geometrics of roadway.

9. Research for human factor and driver behavior.

10. Release money in highway trust fund for use.

Group 4

1. Establish minimum pavement marking maintenance level.

2. Traffic maintenance safety activities taken immediately:
   -Priority over major reconstruction.
   -Streamline contract procedures.

3. Sign management systems:
   -Content of message.
   -Consistency.
   -Size.
   -Placement.

4. Install stated delineation per MUTCD.

5. Consistent use in signing:
   -Presentation uniformity.

6. Sensory marking devices:
   -Rumble strips.
   -Pavement markings.

7. Higher technical and professional services:
   -Traffic services.

8. Work zones:
   -Short-term projects.

9. Improved maintenance of shoulder drop off:
   -Erosion

10. Better driver training.

IMPROVING COMMERCIAL MOTOR VEHICLE SAFETY[1]

1. Identification of problem motor carriers through problem drivers and vice versa: full implementation of SAFETYNET, and equipment.

2. Education: the public; drivers; and motor carriers, especially new companies.

3. Additional training for non-MCSAP officers: standard training.

4. Target inspections/reviews based on identified problem carriers.

5. Make OOS "running" a CDL serious traffic violation. (Assess a $1,000 fine.)

6. Mobile Road Enforcement/speed Abatement.

7. Truck/shoulder parking.

8. Implementation of NGA accident data elements.

9. Uniformity of inter/intra regulations.

10. Reinspection/verification program.

11. Enforcement.

12. Driver compliance with safety regulations.

13. Industry financial support for term insurance.

14. Engineering Improvements/roadway/vehicle.

15. Risk management/Insurance carriers.

16. Certification: truck driver training schools.

17. Train inspectors to recognize drug impairment.

18. Reauthorize MCSAP at a much higher level.

19. Implement CDL enforcement.

20. Increase alcohol enforcement.

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[1]The participants eliminated the redundancies from the 10 highest ranked countermeasures from each small group and generated this consolidated list.

21. Refund MCSAP: Include speed, add dollars.

22. Expand CVEPP.

23. Increase safe areas to pull off and on highway (all-weather inspection facility).

24. Ban radar detectors.

25. Selective enforcement/cooperative enforcement.

26. Media coverage (national campaign).

27. Preemployment screening of drivers.

28. Carrier in-house pretrip inspection training program.

29. Funding for problem identification.

CORRIDOR IDENTIFICATION AND IMPROVEMENT

Group 1

1. Left-turn protection.

2. Access control.

3. Pavement marking/delineation.

4. Enforcement campaign.

5. Optimize signal timing and phasing.

6. Dual center-turn lane (or median barrier).

7. Review and simplify signing.

8. Remove roadside obstacles.

9. Sight distance improvements.

10a. Right-turn lanes.

10b. Signal progression (coincide with speed limit).

Group 2

1. Signing/nighttime visibility.

2. Speed enforcement (and belts).

3. Improve delineation.
4. Improve signalization.
5. Channelization/access control.
6. Removal of fixed objects.
7. Public information and education.
8. Sight distance improvements.
9. Sobriety checkpoints.
10. Pavement surface improvements (including anti-skid).

Group 3

1. Teams.
2. Physical inventory, policies, improvements.
3. High-tech traffic control.
4. Review accident data.
5. Enforcement blitzes, sobriety checkpoints, videotaped arrests.
6. Public information campaign.
7. Faster EMS and other emergency services.
8. Comprehensive community program.
9. Employer programs.
10. Better interagency communications and administration per se.

Group 4

1. Traffic management team.
2. Maintain and improve traffic control devices.
3. Positive guidance.
4. Public information campaign.
5. Oversize signs.

6. Delineators.

7. Enforcement.

8. Wide lines.

9. Channelization.

10. Signal time.

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APPENDIX E
ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS

AAA	American Automobile Association
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
ATSSA	American Traffic Safety Service Association
BCT	Breakaway Cable Terminal
CADD	Computer-Assisted Design
CADRE	Critical Automated Data Reporting Elements
CDC	Centers for Disease Control
CDL	Commercial Driver License
CR's	Compliance Reviews
CVSA	Commercial Vehicle Safety Alliance
DMV	Department of Motor Vehicles
DPS	Department of Public Safety
DOT	Department of Transportation
DUI	Driving Under the Influence
EMS	Emergency Medical Services
FARS	Fatal Accident Reporting System
FHWA	Federal Highway Administration
FMVSS	Federal Motor Vehicle Safety Standard
GREAT	Guard Rail Energy Absorbing Terminal
HES	Hazardous Elimination Safety Program
HSES	Highway Safety Engineering Studies
HSIP	Highway Safety Improvement Plan
HSIS	Highway Safety Improvement System
IACP	International Association of Chiefs of Police
ITE	Institute of Transportation Engineers
IVHS	Intelligent Vehicle - Highway Systems
MADD	Mothers Against Drunk Driving
MCSAP	Motor Carrier Safety Assistance Program
Mn/DOT	Minnesota Department of Transportation
MUTCD	Manual on Uniform Traffic Control Devices
NAEYC	National Association of Educators of Young Children
NASS	National Accident Sampling System
NCAP	New Car Assessment Program
NGA	National Governors' Association
NHI	National Highway Institute
NHTSA	National Highway Traffic Safety Administration
NTP	National Transportation Policy
OTSC	Oregon Traffic Safety Commission
PDO	Property Damage Only
PennDOT	Pennsylvania Department of Transportation
PSA	Public Service Announcement
SADD	Students Against Drunk Driving
SENTRE	Safety Barrier End Treatment

ACRONYMS AND ABBREVIATIONS—CONT'D

SPIS	Safety Priority Index System
SR's	Selective Safety Reviews
STEP	Selective Traffic Enforcement Program
T^2	Technology Transfer
TCD	Traffic Control Device
TSI	Transportation Safety Institute
TTI	Thoracic Trauma Indices
402 Programs	23 U.S.C. 402 Highway Safety Programs. These formula grants to the States for highway safety programs are administered by the Governor's Representatives for Highway Safety.
403 Funds	Monies authorized by 23 U.S.C. 403 for FHWA and NHTSA to carry out safety research, development, training, and demonstration activities.

APPENDIX F
CHART OF METRIC AND ENGLISH CONVERSION FACTORS

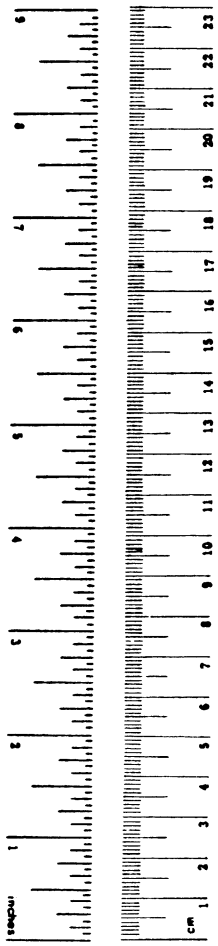
METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
	AREA			
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
	MASS (weight)			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
	VOLUME			
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

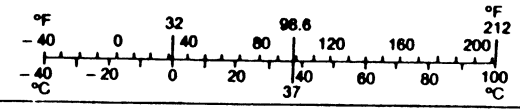
NOTE: Volumes greater than 1000 L shall be shown in m^3.

	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
	AREA			
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
	MASS (weight)			
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
	VOLUME			
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

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