PART 4 WORKSHOP SUMMARY

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Efforts to improve roadside safety have had a dramatic impact on the number of automobile fatalities during the past 30 years. In 1983 the annual traffic fatality rate was 2.6 fatalities per 100 million vehicle miles travelled. A decade later, in 1993, the fatality rate had dropped to 1.7 fatalities per 100 million vehicle miles travelled. This impressive accomplishment has been achieved through a dedicated effort by every segment of the highway transportation industry, including the roadside design community.

The Federal Highway Administration, the American Association of State and Highway Transportation Officials, the states, the Transportation Research Board, and others have initiated a variety of research activities to improve roadside safety. These have included analyzing accident trends, formulating improved analysis procedures, developing better hardware, and promoting better understanding of the accident environment. These activities must be coordinated on the basis of a common vision of the most critical needs and expected products to ensure continued improvement in roadside safety. It is, therefore, imperative that the current state-of-the-art be reviewed, the gaps in current knowledge be identified, current trends be assessed, research opportunities be explored, products be conceptualized, and consensus be reached on an agenda to improve the processes for addressing roadside safety problems at the federal, state, and local levels.

Issues related to roadside safety are influenced by the extent and design of the existing infrastructure, agency resources, new national policies, state and local initiates, changing vehicle designs, the emergence of innovative materials and technologies, and many other factors. These must be considered in evaluating the research needs in roadside safety.

This workshop has featured invited presentations by prominent researchers that established a common background on the major issues, recent and on-going research efforts, and expected opportunities for the future. The invited presentations included discussions of:

- Evolution of Roadside Safety,
- The Roadside Safety Problem,
- The Evolution of Vehicle Safety and Crashworthiness,
- Evolution of Vehicle Crashworthiness as Influenced by the National Highway Traffic Safety Administration,
- Methods for Analyzing the Cost-Effectiveness of Roadside Features, and
- Applications of Simulation in Design and Analysis of Roadside Safety Features.

After the presentations, the workshop participants were divided into four breakout groups to pursue additional discussions of research needs and opportunities for improving roadside safety. The four groups addressed:

- Data and analysis needs,
- Selection and design of roadside safety treatments,
- Efficacy of simulation methods,
- Assessing and developing roadside hardware.

Several common themes emerged from the four discussion groups: First, roadside safety involves much more than developing new roadside safety hardware. Recent analysis of accident data has indicated that such non-impact accident types as rollovers to steep side slopes are a major portion of all run-off-road accidents. The properties of the changing vehicle fleet bring into question the appropriateness of current slope standards. A number of higher center-of-gravity vehicles like mini-vans and pickup trucks have become popular alternatives to the traditional passenger car. In addition, the clear-zone concept, though it has been a feature of highway design for many years, often cannot be used on many State and local roadways because of right-of-way limitations. The result of these limitations is that collisions with fixed objects such as trees and utility poles continue to represent the largest group of fixed-object fatalities. Issues like these involve more than designing roadside barriers and evaluating thier performance in crash tests. Roadside safety should involve the whole range of possible harmful events that could take place on the roadside.

Second, the importance of properly selecting and locating roadside safety hardware was discussed by several breakout groups. The 1988 AASHTO *Roadside Design Guide* and the 1977 *Guide for Selecting, Locating, and Designing Traffic Barriers* are the preeminent guidelines for designing safe roadsides. Additional research is needed to refine certain aspects of these documents. NCHRP Project 22-12 is expected to address many of issues related to selecting and locating roadside hardware but a larger problem is getting field practitioners to use up-to-date standards. Hardware is frequently placed on the site in such away that it could never perform correctly and even when correctly located, hardware is often not installed correctly. For example, popular breakaway cable terminals, are sometimes placed just in front of steep untraverseable slopes where, even if the terminal activates correctly, the vehicle will be gated into an area where the vehicle may roll over or strike a fixed object.

The third common theme which emerged during the breakout sessions concerned the lack of quantifiable methods for identifying hazardous situations. The encroachment-collision-severity model of off-road accidents has been available since the publication of NCHRP Report 148, *Roadside Safety Improvement Programs on Freeways*. While this method is a crisp analytical statement in the language of probability, the lack of probablistic models has greatly hampered the utility of the method to actual roadside designers. The ROADSIDE program is based on the encroachment-collision-severity method but it depends heavily on unquantifiable assumptions about the likely severity of collisions and the likely effect on encroachments of site geometry and operational conditions. Many agencies are unable to develop quantifiable input values for these types of programs. As a result, decisions about what roadside hardware to select, where it should be located and how it should be replaced are often difficult to justify in objective, quantifiable terms. This lack of a quantifiable basis for roadside safety decision making leaves agencies vulnerable to tort litigation and hinders thier ability to focus scarce roadside safety resources on the most important problems.

The quality of accident data has been a persistant problem in roadside safety research for many years. Collecting high-quality data relavent to a specific roadside problem is prohibitively expensive. Relying on low-cost high-volume police level accident data severely restricts the level of detail that can be examined and police level data is notoriously prone to errors and ommisions. Technology may ofer some improvements; police officers could automatically log information into portable computers, global positioning systems could be used to identify precise locations, and a host of new technologies could be used to design new data acquisition hardware. The continued expansion and refinement of the FHWA's HIghway Safety Information SYstem should do a great deal to make a relatively consistant set of accident and roadway data available to researchers and policy analysts. Another fundamental problem with accident data, however, restricts agencies to reacting to perception of past problems rather than anticipating future problems because accident data is based on what has happened rather than on why it has happened.

The fourth common theme dealt with the need for better coordination between the automotive design and manufacturing community and the roadside design community. There has been relatively little interchange between these groups because of the competitive nature of automobile design, possible exposure to litigation, and possible violations of anti-trust laws. This has resulted in the roadside safety community reacting to automotive changes, sometimes long after the change has become wide spread in the vehicle population. Typical roadside hardware crash testing uses vehicles less than seven years old at the time of testing but, by the time the research is complete and the results are to be implemented in the field, the test vehicle may be 10 or more model-years out-of-date. For this reason, the roadside hardware community has been slow to recognize problems relating to changes in the vehicle fleet. The breakaway cable terminal provides another cautionary illustration: when the testing was originally being done (1972 through 1980) using the guidelines in NCHRP Report 153, the small test vehicle was a 1020-kg passenger vehicle. The oil embargo of 1973 quickly caused automobile manufacturers to start introducing smaller cars and by 1978 820-kg vehicles like the Honda Civic and the Volkswagen Rabbit were common. By the mid 1980s researchers were beginning to observe problems in the field with these newer, smaller vehicles. The result is that researchers have been trying for more than a decade to find an inexpensive retrofit to the BCT to rectify a problem that could have been avoided if testing was done using newer vehicles in the 1970's. Roadside safety hardware has a very long service life, far longer than a typical vehicle. It is imperitive that the roadside hardware community be able not only to keep pace with changes in the vehicle but to anticipate the performance of roadside hardware with the rapidly changing vehicle fleet.

The fifth theme which emerged was the need to employ modern analytical techniques like nonlinear finite element analysis to help to understand roadside collisions and allow designers to formulate more effective designs. Once a finite element model of a roadside appurtenance has been made, possible design changes can be examined quickly and with confidence. This will allow designers to concentrate full-scale crash testing efforts on the most promising alternatives. Another significant advantage of using finite element simulations is the ability to examine the performance of vehicles that have not even been built in impacts with roadside safety hardware. The 1990 ISTEA legislation has also mandated that vehicle types other than the traditional passenger car be examined to see how well they perform on the current generation of roadside safety hardware. Simulation also allows researchers to explore impact situations that are difficult or impossible to test. For example, there is no method for performing non-tracking side impacts with roadside features so simulation can provide a way to explore this important scenario. In addition to un-testable situations, simulation provides a way to parametrically search for the real worst case scenario. The standard crash test conditions in NCHRP Report 350, like all testing specifications before it, assume that they explore the worst case impact. There may be, however, other much more severe impact conditions that, because of the limitations on testing resources, are not explored in the "standard" tests. Simulation allows the researcher to explore these situations relatively quickly once a model has been developed. Developing a finite element model of a roadside hardware collision is not inexpensive, a full model may easily cost $100,000 to develop above the cost of the vehicle model. Once a model has been developed, however, it can be easily changed allowing the analyst to parametrically explore variations in the impact conditions or the design at very little cost. Hundreds of collisions scenarios can be examined using simulations during the barrier development or evaluation phase. While there will always be a need for full-scale crash tests to unequivocally demonstrate the performance of hardware, a careful balance of analysis and testing could greatly improve roadside hardware designs. While the current generation of nonlinear finite element analysis tools like DYNA3D can be used to address many roadside hardware collision scenarios, extensions and modifications will be required to investigate a wider range of roadside safety problems. Current finite element programs probably cannot be used to investigate situations like tires rutting into soft soils, long impact events like rollovers, trajectories of vehicles after impacting a barrier, and the effect of serious suspension damage. Addressing these types of problems is feasible but will require research into improving the computer programs and analytical techniques used in simulating roadside events.

Table 1 shows some of the research issues that were identified and discussed during the workshop. Several issues overlap and additional issues will certainly become apparent in the comming years, but the table provides a good illustration of the range of issues confronting the roadside safety community in the coming years.

This document is the first step in what is hoped to be a continuing dialog among the members of the roadside safety community. The TRB Roadside Safety Features Committee (A2A04) plans to hold a follow-up meeting during the summer of 1995 to formulate a common-vision of the roadside safety research agenda for the coming decade.