PART 2 PRESENTATIONS

Roadside Safety: A National Perspective, July 1986

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Introduction

Each year millions of persons are killed or seriously injured in motor vehicle accidents. In 1984, over 46,000 people died in motor vehicle traffic accidents and another 1,700,000 persons suffered seriously disabling injuries. It is estimated that 200 persons are killed or seriously injured every hour on United States' roadways and that traffic accidents are the leading cause of death for persons age 1 to 37.

While significant progress has been achieved in reducing the number of traffic related deaths per vehicle mile of travel (VMT) in the past twenty years, accident costs continue to increase. In the past two decades the costs associated with traffic accidents, including lost wages, property damage, insurance and medical costs, have risen from 10 billion dollars in 1965 to over 50 billion dollars in 1985. During this time period accident costs per VMT have risen 250 percent.

An examination of the traffic fatality distribution by most harmful event (Figure 1) shows the serious consequences of run-off-road accidents. On all roadways, over

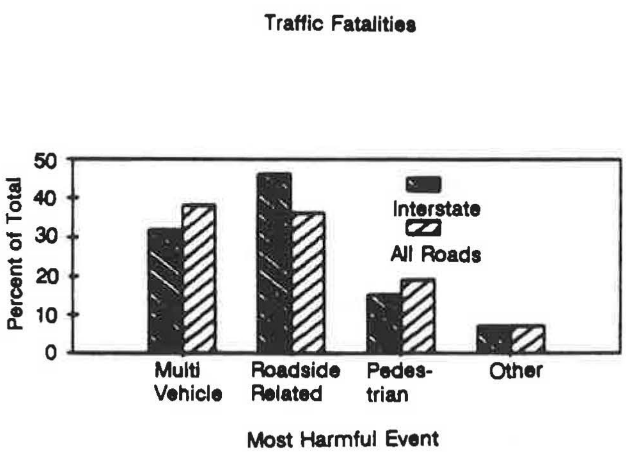

Figure 1

36 percent of the fatalities were incurred from striking roadside objects, such as trees, poles, and embankments. Similarly, a roadside feature was judged to be the most harmful event in 47 percent of the fatalities on the Interstate system. Furthermore, an examination of single-vehicle accident fatalities on the Interstate system (Figure 2) reveals that nearly one-third of the fatalities were from a vehicle striking a longitudinal barrier and another one-third were from vehicle rollover. Clearly, single-vehicle accidents represent a major highway safety problem with massive societal costs.

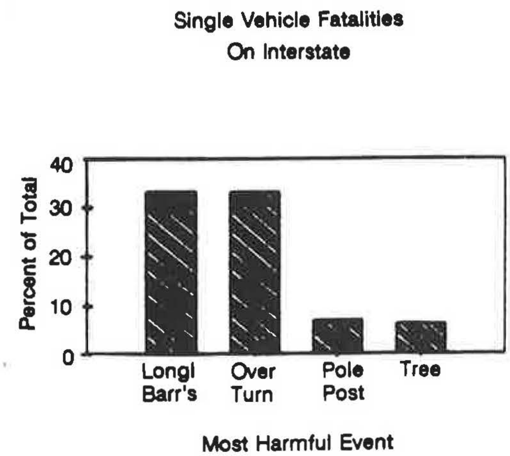

Figure 2

Solving the Problem

The Federal Highway Administration (FHWA) annually spends approximately one-to two-billion dollars in Federal-Aid Highway Safety Funds. These funds are distributed to the States for hazard elimination programs, elimination of hazards at rail-highway crossings, and various highway safety programs. Within the Federally Coordinated Program (FCP) the FHWA also administers significant efforts in research, development, and technology sharing. The FHWA Offices of Research, Development, and Technology are assigned the responsibility of monitoring a number of separate elements under the FCP structure. These include the State Highway Planning and Research Program (HP&R), the National Cooperative Highway Research

Program (NCHRP), the FHWA Administrative Contract Program, and the FHWA Staff Research Program.

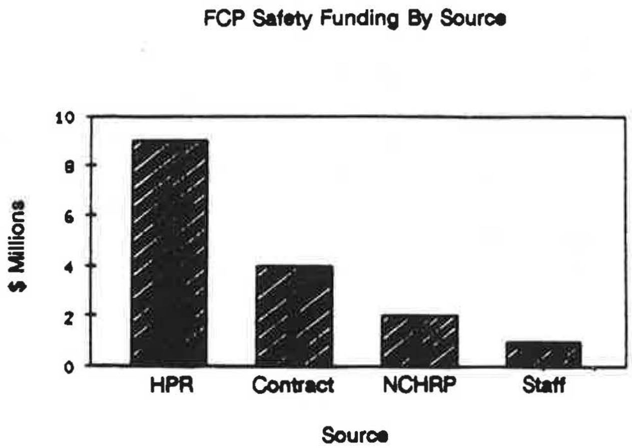

Figure 3

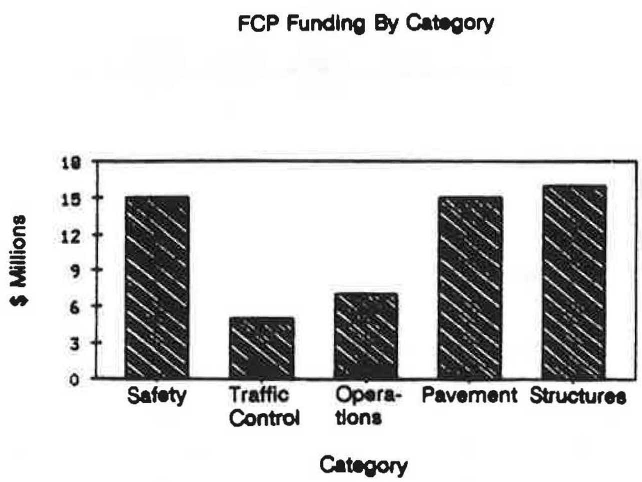

Figure 4

In fiscal year 1985 a total of 78 million dollars was spent in the FCP program (Figures 3 & 4). This included approximately 15 million dollars spent on safety related activities. These safety funds are distributed among eight different FCP project areas. Project 1T Roadside Safety Hardware accounted for approximately one-third ,nearly five million dollars, of these FCP safety funds.

The research and development efforts undertaken within Project 1T have resulted in a number of significant accomplishments in the design of traffic barriers and terminals, signs, supports, poles, and impact attenuators. Recent highlights include:

• A self-restoring barrier (SERB) that can safely redirect vehicles ranging from an 1800-pound car to a 40,000-pound intercity bus;

• A Controlled, Releasing Terminal (CRT) for straight sections of guardrail that is significantly safer for small cars;

• A Vehicle Attenuating Terminal (VAT) which provides a safe terminal where the guardrail end cannot be flared; and

• A 2,250-pound bogie vehicle has been built and validated for testing breakaway supports at the Federal Outdoor Impact Lab (FOIL).

Also within Project 1T, efforts in the development of new technology have provided analysts on-line computer access to a variety of vehicle-barrier simulations, including HVOSM, BARRIER VII, and an updated CRUNCH program. These programs and other analytic tools allow analysts to perform a more economical assessment of the performance of safety appurtenances.

Another significant accomplishment in the area of cost effective roadside safety design has been the development of improved analysis methods for justifying safety improvements and maximizing safety benefits. The use of improved computerized benefit-cost procedures, including integer programming, dynamic programming, and incremental benefit-cost methods are shown to result in significantly greater net benefits as opposed to simple benefit-cost procedures (Figure 5).

Problems in the Design of Safer Roadsides

Cost-effective treatments for run-off-road accidents require warranting criteria based upon accident or encroachment models or both, and an effectiveness estimate of the planned countermeasure. That is, in order to quantify the expected benefits of a safety improvement, estimates are needed as to the expected number and type of vehicle impacts with the safety hardware. This information can then be related to the results from full scale crash testing to estimate the benefits expected from reducing the severity of run-off-road accidents.

In developing warrants for roadside hardware the critical need is to define the encroachment or run-off-road accident rate and type as a function of highway geometry and traffic distribution. As a minimum, this

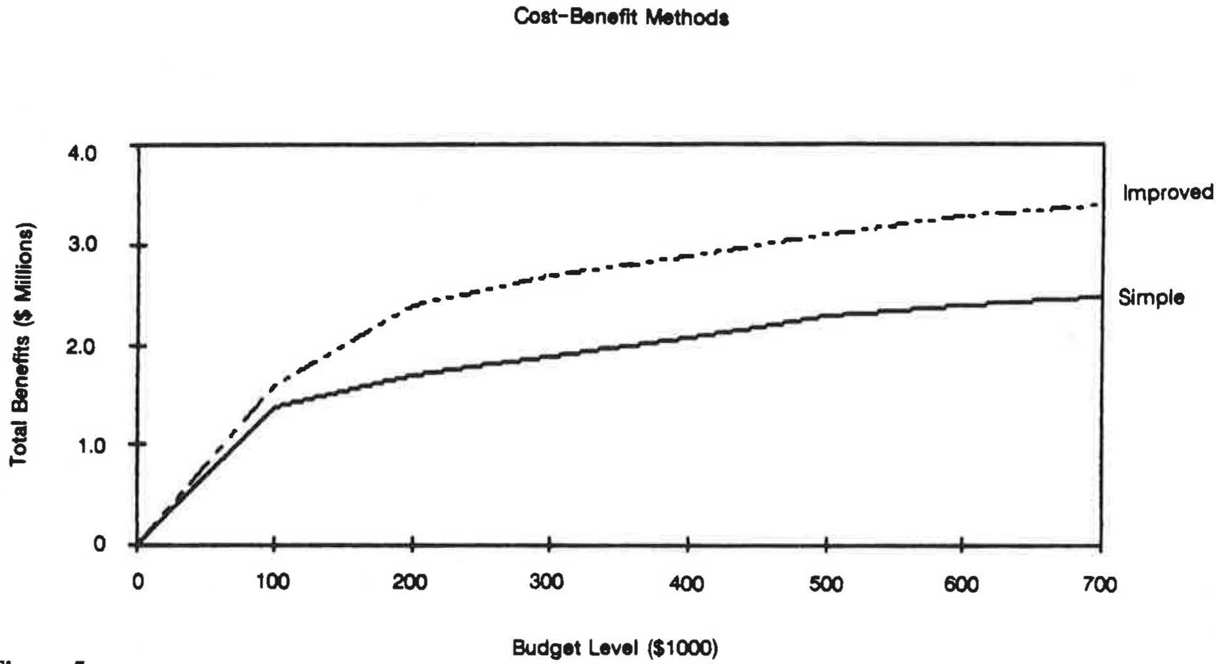

Figure 5

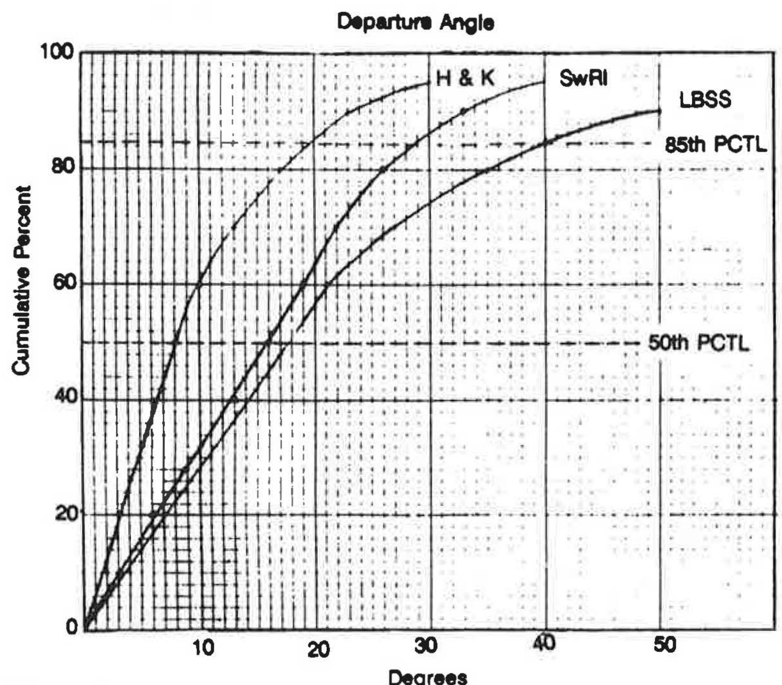

Figure 6

data should include such characteristics as vehicle speed, vehicle departure angle, and the lateral distance travelled from the edge of the roadway. Two different approaches have been used in the past to compile this information:

1. Encroachment model. Where vehicle departures from the roadway are charted and a distribution is compiled. The data collection techniques range from remote sensing equipment to manual observation of vehicle tire tracks off the roadway.

2. Accident model. Where single-vehicle accidents are investigated and reconstructed by a team of specialists to compile the data.

Figure 6 highlights the problems associated with compiling data on these characteristics. Note that the 50th percentile departure angle ranges from 8 to 18 degrees and the 85th percentile ranges from 20 to 40 degrees. The figure reveals that, in general, one can expect more severe departure angles if an accident model is used since only more severe accidents will be investigated. Reliance on such an approach will bias the distribution of both angle and speed toward more severe departures.

The development of an encroachment model also has serious drawbacks. FHWA recently spent over 800,000 dollars in a study to collect such data. A variety of techniques were used to collect the encroachment data, including continuous monitoring of highway sites with video tape recorders, remote sensing equipment and tape switch activated movie cameras. The scant data acquired show how difficult and expensive it is to collect data on such rare events. For example, 36,000 hours of video tape data, approximately 4.1 years, yielded only twelve encroachments for analysis. It should also be noted that the manual method of data collection will not furnish departure speed or vehicle type. Furthermore, there is some evidence that such methods will overestimate encroachment rates by counting vehicle departures when the driver intentionally steered off the roadway, that is, a controlled encroachment. As such, there currently exist no definitive data on these essential elements required for warranting criteria.

Roadside hardware is subjected to full-scale crash tests prior to its acceptance for deployment in the field. The acceptance standards are based upon the appurtenance's structural adequacy, the resulting occupant risk, and the vehicle's after collision trajectory. At issue is whether the current set of test matrices accurately reflect the real world accident characteristics. This is a critical factor in evaluating the hardware's anticipated effectiveness.

Recent analysis of investigated injury accidents at narrow bridge sites related the actual accident impact conditions to the conditions imposed in crash test matrices. As shown in Figure 7, a large number of these severe accidents exceeded at least one of the crash test conditions.

Although these investigated accidents represent a very small sample (n = 81) of severe accidents (injuries and fatalities), the data provide important insight into the actual dynamics of run-off-road accidents. In 70 percent of the reconstructed accidents from Figure 7, the vehicle sustained a secondary impact following a smooth redirection from the initial impact with the barrier. Such secondary impacts tend to dramatically increase the occupant risk due to higher impact angles, vehicle not tracking at impact, collision with unprotected fixed objects, and vehicle rollover. Figure 8 shows that vehicle rollover and secondary impacts with fixed objectives subsequent to the first barrier impact constitute a major safety hazard. As such, the importance of the vehicle's post impact trajectory in current hardware acceptance criteria cannot be overemphasized.

Finally, in addressing the current hardware acceptance standards in terms of cost-effective design, it is useful to examine impact speed distribution as a function of roadway type. Figure 9 shows three such distributions compiled from narrow bridge and pole accident data bases. If one chooses to base the hardware acceptance standard on the 85th percentile impact speed, the appropriate crash test speed will range from 40 m.p.h. on urban arterials to 60 m.p.h. on freeway facilities. Clearly the data indicates the desirability of using a multi-service level approach to roadside safety design in order to maximize the benefit-cost ratio for safety related improvements.

Additional Problems

Besides the problems cited above, difficulties experienced in the implementation, installation, and maintenance of roadside hardware continue to represent troublesome issues to the highway safety practitioner. In general, each roadside safety appurtenance proceeds through five separate stages along the path toward full scale implementation; design, testing, experimental deployment, inservice evaluation, and implementation. Given the interactive nature of these stages, the actual time required to implement new technology often exceeds a 10 year span from its initial conception. Even in a smooth transition through the evaluation stage, there is no guarantee that a wide scale implementation will follow. Given the seriousness of the roadside safety problem confronting us today, the length of time it takes for implementation could use considerable improvement.

Improper installation and maintenance of safety hardware also constitutes a major safety hazard to the driving public as well as an increased liability burden to State and local agencies. Cases recently discovered, for example, include:

- Deformable guardrails to shield non-breakaway poles installed to within 8 inches of the poles;

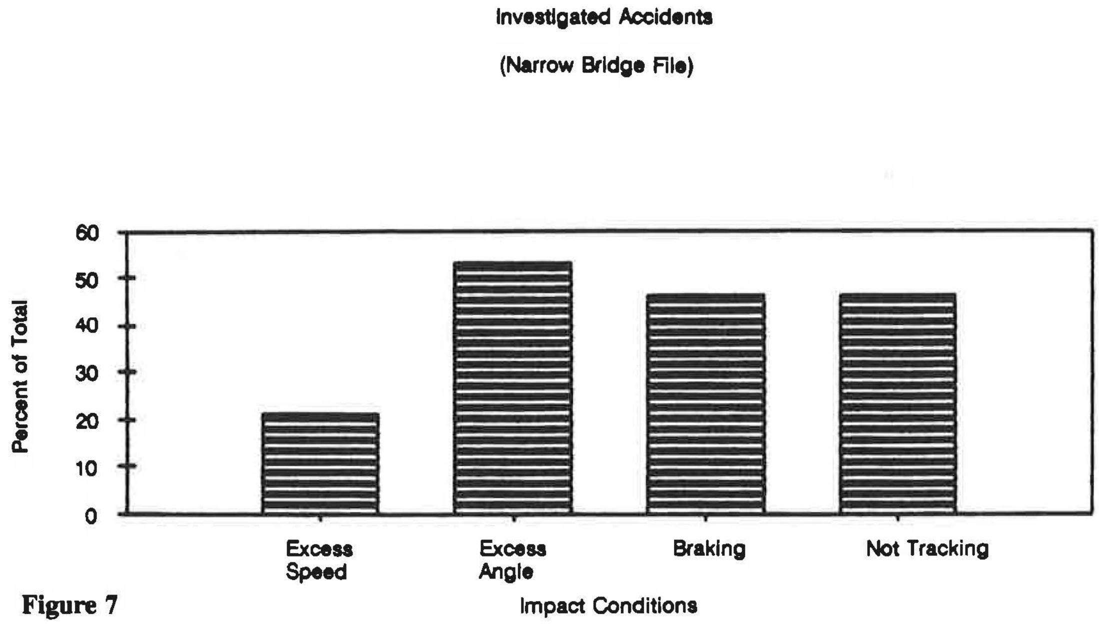

Figure 7

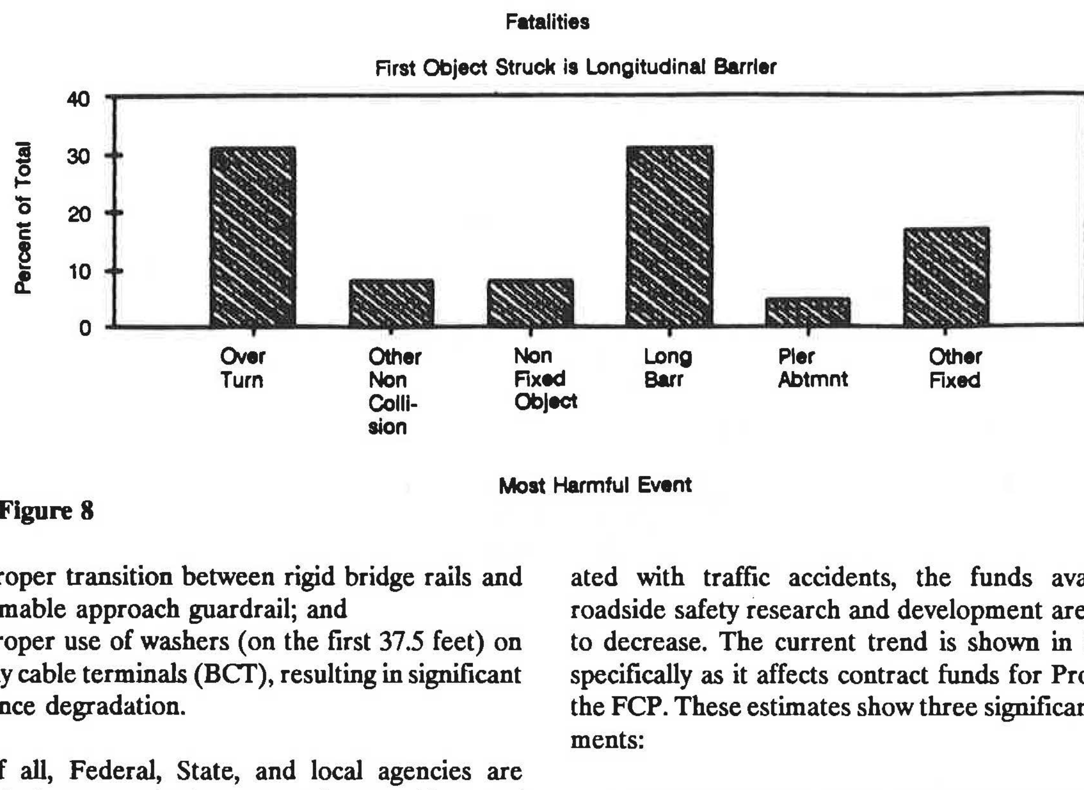

Figure 8

• Improper transition between rigid bridge rails and the deformable approach guardrail; and

• Improper use of washers (on the first 37.5 feet) on breakaway cable terminals (BCT), resulting in significant performance degradation.

Last of all, Federal, State, and local agencies are currently facing severe budget constraints. In this era of Gramm-Rudman-Hollings there is little chance for an expansion of the Federal Government's role in highway safety research. In fact, despite the massive costs associated with traffic accidents, the funds available for roadside safety research and development are projected to decrease. The current trend is shown in Figure 10, specifically as it affects contract funds for Project 1T in the FCP. These estimates show three significant developments:

• Less total safety research funds available,

• Less total funds available for Project 1T, and

• Fewer new starts within Project 1T due to increased use of multi-year programming of funds.

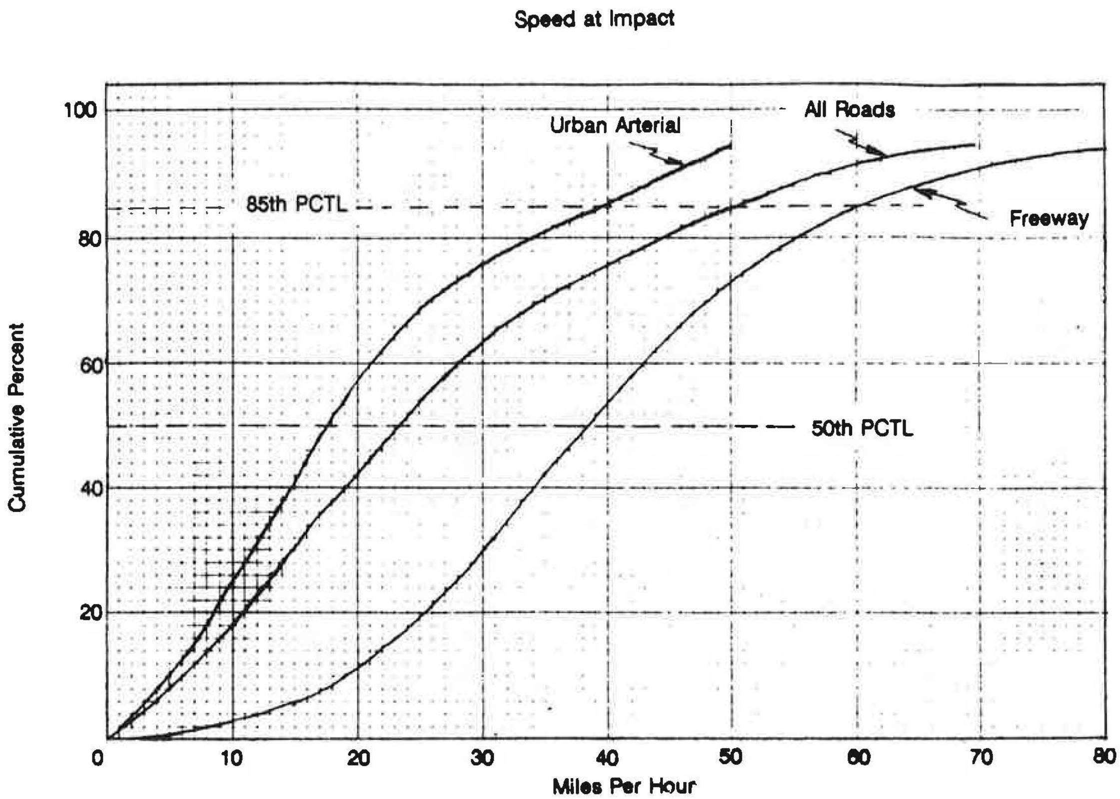

Figure 9

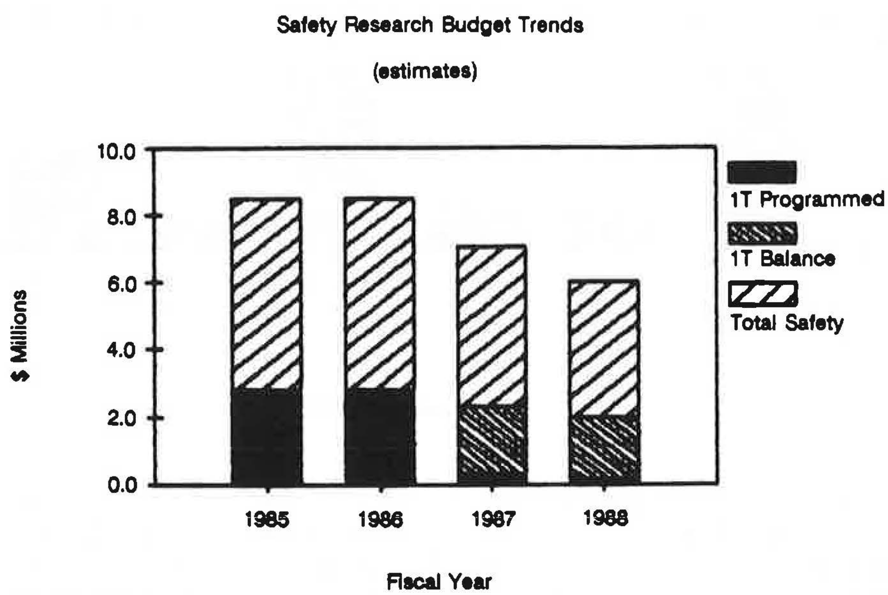

Figure 10

Summary

Although powerful procedures and analytical tools have been developed, critical deficits in the input data continue to undermine researchers' efforts in the cost-effective design of safer roadsides. Careful investigation of the available data shows that closer attention needs to be paid to hardware acceptance criteria such that these standards accurately reflect the real-world dynamics of single-vehicle accidents. The high incidence of multipleimpact accidents graphically demonstrates the significance of this need. These difficulties are compounded by the delays experienced in the deployment of effective hardware as well as the complications arising from improper installation and maintenance. Clearly, significant and continuing commitments in research, development, and technology sharing are urgently needed to address the roadside safety problem.

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