2. THE NEED FOR MORE AND BETTER CRASH DATA

The following paragraphs will discuss the general objectives of crash data collection, identify some specific data needs that are not now satisfied, and point out serious inadequacies in the current data file and acquisition systems. It will be shown that these needs and limitations lead to a requirement for mass acquisition of crash data, supplemented by special surveys and large scale real-life experiments.

a. THE OBJECTIVES OF COLLISION DATA COLLECTION

The cost to society of automobile death and injury is conservatively estimated[2/] at $17 billion annually. The vehicle damage adds at least another $5 billion yearly[3/]. The total, $22 billion per year, corresponds to an average of $2200 in losses per each U.S. automobile during its lifetime.

The specialists in auto safety have, as their concerted objective, the reduction of this enormous waste. A body of collision data is needed that will provide a substantial part of the means to determine the causes of accidents, of injuries, and of damage.

Professor Lawrence Patrick of Wayne State University expressed the consensus view of the Workshop participants as follows:

> "PREMISE
>
> 1. The only valid way to establish safety needs for automobiles is through examination of field data.
> 2. The only valid way to evaluate the effectiveness of safety measures is through analysis of their effect on accident data.
>
> CONCLUSION
>
> Accident data are essential."

The National Highway Traffic Safety Administration is responsible, under the National Traffic and Motor Vehicle Safety Act of 1966,* for the promulgation of Federal Motor Vehicle Safety Standards to which vehicles manufactured for sale or use in the United States must conform. Under the Motor Vehicle Information and Cost Savings Act (1972)** the Secretary of Transportation is also responsible for setting standards for damage-limiting bumpers and for evaluating automobile damageability and crash-worthiness.

Safety standards put into effect to date cost the consumer about $2.5 billion annually[4/] and standards proposed will cost another $4 billion or more each year[2/, 4/]. In addition, standards suggested in Advance Notice of Proposed Rulemaking would cost $4 billion per year in first costs plus another $4 billion in added fuel costs when fully implemented. While the more than 40 existing standards , which were based on intuition, judgment and limited experience, are believed to yield in the aggregate a societal benefit greater than their consumer cost,[2/] only four of them (seat belts, energy absorbing steering column, HPR glass and head restraints) have been shown by any authority to be beneficial based on convincing statistical evidence. The problem is that the body of data is inadequate.

Thus an initial objective of crash data collection and analysis from the standpoint of the Government rulemaker, is that of evaluating the efficacies of the existing standards to determine which should be kept on the books and which should be eliminated.

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* Public Law 89-563.

** Public Law 92-513.

A second objective from the standpoint of rulemaking is that of providing the necessary statistical support to estimates of benefits of a projected safety or damage-limiting standard. In the next section there will be discussed a projected rule that is controversial because of inadequate supporting data.

A third objective is the early identification of problem areas in automobile damage and injury so as to permit designing effective motor vehicle and highway safety programs.

The foregoing objectives from the standpoint of rulemaking have their parallel from the standpoint of the automobile manufacturers. C. Thomas Terry of General Motors has summarized [8/] the objectives of gathering accident data in the field:

a. Evaluation of production safety systems.
b. Prediction of performance of proposed safety systems.
c. Identification of problem areas and evaluation of proposed solutions on a cost/benefit basis.
d. Estimation of human tolerance to impact.

Automobile manufacturers are , of course, vitally concerned with the relative merits of specific alternative designs as well as with the validation of Safety Standards to which they are required by law to conform.

A number of universities and institutes, both profit and non-profit, have been for years involved in research in accident causation, injury causation and designs of vehicles and roads that will reduce accidents and injuries. They need accident data to discover causes of accidents and injuries; armed with this information they can accomplish and test in their laboratories design modifications and provide valuable advice to NHTSA and automobile manufacturers.

Finally, there is a need for national planners to predict the impact of new trends in automobile designs. Fuel and resource conservation programs, encouraged if not mandated by the Federal Government, will lead to lighter, lower power-to-weight ratio automobiles. Data on collision frequencies and outcome are needed as a function of these parameters to inform Federal officials.

b. UNSATISFIED NEEDS FOR CRASH DATA

The body of specialists concerned with automobile collisions -- the rulemakers, safety researchers, accident statisticians, car designers, insurers, and public interest people -- overwhelmingly agrees that there is a grave and compelling need for more and better crash data. The need is expressed by Dr. Edwin A. Kidd of CALSPAN Corporation[1/] in the following way:

> "It is essential that NHTSA have a data bank for surveillance and effectiveness studies related to the impact of standards on accident, injury and fatality frequencies. The relatively small output of the special federal teams and/or the higher quantity, but low content State data banks are inadequate for the purpose. In addition to information on the general accident environment, vehicle damage and occupant injuries, details of the impact environment -- velocity at impact, change in velocity during impact and possibly, vehicle deceleration -- are required for a sample of 100,OOO to 500,000 automobiles annually."

Professor B. J. Campbell, Highway Research Center, University of North Carolina[10/], states:

> "In acquiring automobile accident data several approaches are used in the U.S.: First, are intensively investigated accident crashes of which several thousand have been collected. The advantage of this approach is that the cases are extremely detailed with photographs and good injury data. The most important disadvantage is that by virtue of the changing sampling criteria and the small sample size, the ability to generalize these few cases to the population is restricted heavily.
>
> I believe too much reliance has been made on this type of data for guiding NHTSA decisions. It leads one to situations in which too much is made of a small number of cases."

The critical need for better collision data to support rulemaking can be illustrated by the passive protection provisions of Motor Vehicle Safety Standard 208. Estimates of the cost to consumers of meeting passive protection requirements range from [2/], ~/ $220 to $400 per car, or a gross cost of $1.5 billion to $3 billion per year more than belt restraints now cost. There is also significant uncertainty in the incremental benefits that may be realized from passive protection. Estimates range from 3,000 to 8,900 more deaths prevented, and from 130,000 to 492,000 more injuries prevented.

One crucial lack of data leading to uncertainty can be pinpointed: the number of lives saved and injuries prevented by a restraint system in frontal collisions is estimated by NHTSA from a graph showing the percentage of injuries and deaths as a function of "equivalent barrier test speed."* This graph is shown in Exhibit A (Figure 4). The "equivalent barrier test speed" is that speed which would produce as much car damage, when the car is driven into a rigid barrier, as the car suffered in an actual collision.

The fatality curve of Figure 4 is based on judgment estimates of barrier equivalent speed of 51 fatal frontal collisions by General Motors and a small (unstated) number by Ford Motor Company; in Figure 3 of Exhibit A the NHTSA curve is replotted for comparison with the companies' judgment data.

In making an estimate of the fraction of lives saved by a restraint system, NHTSA attributes to the system a barrier equivalent speed below which it is effective and above which it is not effective (a conceptual convenience). On the basis of laboratory crashes with dummy and cadaver occupants, lap belts are taken as effective to 25 mph, lap-shoulder harnesses to 30 mph, and air-bag passive restraints to 35 mph.[6/] The intersections of these speed lines with the fatality curve of Exhibit A, Figure 4, then yield NHTSA's estimate of fraction of lives saved in frontal collisions. For example, the intrinsic effectiveness of the lap-shoulder harness in preventing fatalities in frontal collisions is thus deduced[6/] to be 37%, and for all collisions (of which frontals constitute 50%), is estimated at 31%. Yet extensive field experience in Sweden shows lap-shoulder harnesses have an overall fatality prevention effectiveness of 90%. The lap belt alone is estimated by NHTSA to have intrinsic fatality prevention effectiveness of 20% in frontal collisions, with 22% for all collisions. Yet extensive field experience from North Carolina indicates an overall fatality prevention effectiveness with lap belts of 75%.

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* Technically, these curves are cumulative distribution functions for barrier equivalent speed for fatal collisions and injury collisions.

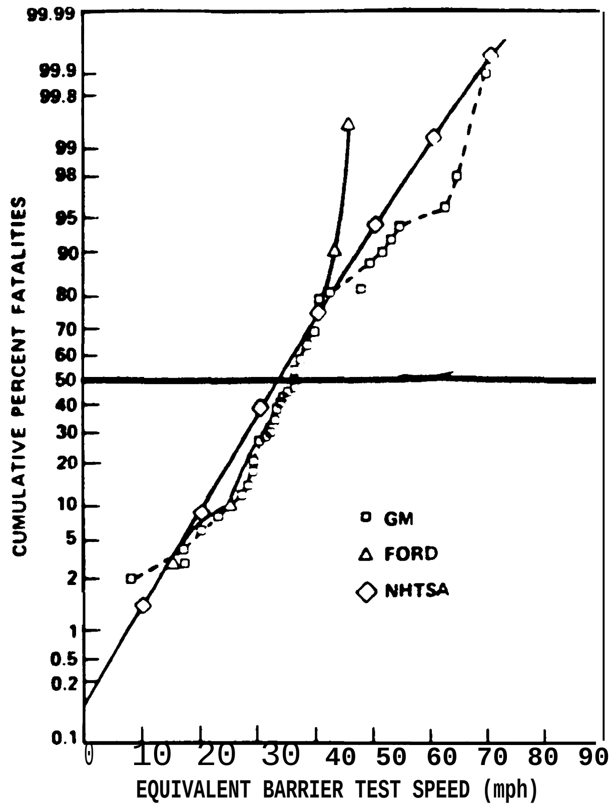

FIGURE 3 - Comparison of Fatality Distribution Data (Frontal Collisions)

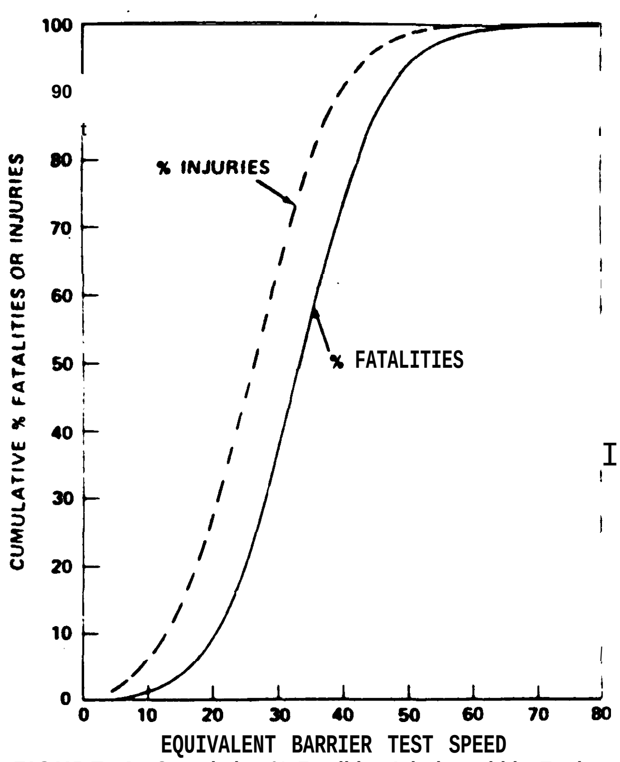

FIGURE 4- Cumulative % Fatalities Injuries within Equivalent Test Speed Range

EXHIBIT A

Curves from NHTSA's "Passive Protection at 50 Miles Per hour"

These discrepancies can be explained in three principal ways, any of which may be correct: 1) The Swedish and North Carolina experience is not representative of the population of U.S. car collisions; 2) The barrier equivalent speeds up to which restraint systems are effective are underestimated by NHTSA; or 3) The barrier equivalent speeds at which fatalities occur were over-estimated in the original material of Ford and General Motors.

All of these questions can be resolved by more and better data.

The uncertainty about these curves as a basis for rulemaking is confirmed by National Highway Traffic Safety Administrator James Gregory in Congressional testimony:

> ". . . .we have gone out on an advanced notice of proposed rulemaking at the same time that we went out with the passive restraint notice to say that we are moving in the direction of a standard for occupant crash protection at the level of 45 to 50 miles per hour. We figure when we get there we will have pretty much attained what is cost effective and technologically feasible in today's world.
>
> "We feel, by the way, that this would still be worthwhile doing. Yet, as we move toward that, <u>without quantitative data, without persuasive data</u>, even in the public interest, <u>without being able to substantiate a standard</u> we feel is reasonable and in the public interest, the challenge would be sufficient to provide that type of occupant protection. . .
>
> "...The reason I have to be rather vague about this is that most curves that have been derived by experts and <u>from data that have been collected get very fuzzy</u> when you get much above 40 miles an hour as far as what percentage of the fatalities occur at these particular speeds.*

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* Excerpts from Dr. Gregory's testimony before the Transportation Subcommittee of the Committee on Appropriates, House of Representatives, 93rd Congress 2nd Session 1974, Part 3, pp. 41 - 43 [emphasis ours].

...To establish crashworthiness, we need to know what to do to an automobile and what we need to do to the occupants from the standpoint of restraint protection under a given crash condition. These precise data we now lack. . .

"At the present time we cannot make a judgment with accuracy and that makes us guess. And those guesses could cost, unnecessarily as far as the consumer is concerned, untold millions of dollars for protection that we may actually not need. . ."**

The doubts the Administrator expresses about the curves at speeds of 40 mph and above, we believe, as indicated earlier, also should apply to speeds lower than 40 mph.

The kinds of information needed to mitigate much of the uncertainty about the prospective incremental benefits of passive restraints are, first, a file of representative collision data from which it is possible to derive the incidence figures for injury and fatality of belted occupants, in order to establish as a baseline the capabilities for the current belt restraints; second, results of a large-scale field experiment to establish the relative capabilities of passive restraints; and third, representative files of fatal and injury collisions (involving unrestrained and restrained occupants) for which causal severity magnitudes such as BEV have been quantitatively established. With this information the lifesaving and injury prevention potential of restraint systems and the speeds to which the systems are effective can be established.

** Excerpts from Dr. Gregory's testimony before the Senate Committee on Appropriations (Hearings on FY 1974 supplemental appropriations, HR 11576) 93rd Congress, first session, part 2, pp. 1509-1510. [emphasis ours]

Fundamental to the statistics of accidents are the cum ulative probability distribution functions of severity for all accidents, for injury accidents, and for fatal accidents. These, though badly needed, are not now being obtained from large quantities of real-life accident data. In order to establish them, measurement and reporting of causal severity is required.

C. LIMITATIONS OF THE CURRENT DATA SYSTEM

In a later section we address the question of collision data requirements. The basic needs can be summarized as follows:

(1) The data should be representative of the population of u. s. automobile crashes.

(2) The data should be gathered in sufficient quantity to be useful, at a sufficient rate to be timely.

(3) The data should be in adequate detail and precision to permit its analysis to determine causes of accidents, injury and death (and the functional relationships between these causal factors and the probabilities of accidents, injury and death) ; and to permit answering questions that may arise relative to traffic safety and motor vehicle safety standard efficacy.

The inability of the current files to meet each of these needs is expressed by several investigators.

O'Day of the Highway Safety Research Institute, says:[9/]

"A random sample is the best way of insuring represen-nativeness. Unfortunately, no random sample of United States crashes exists."

Kidd 15/ comments:

> "For too long, those concerned with accident studies of the effects of safety standards already in force have had to make do with either too small samples of reasonably good data or relatively large samples of data whose content is inadequate for the purpose. In the first category is the data bank (and "bank" is too grandiose a term) that has resulted from the individual federal teams of multidisciplinary, professional investigators. These teams can serve useful purposes in special studies, in discovery of problems that would otherwise go undetected and, particularly, in the area of accident causation. By their very nature, they cannot provide a sufficiently large data sample relevant to the implementation of standards aimed at injury and fatality reduction without excessive expenditure of funds."

MDAI -- Multidisciplinary Accident Investigation[14/] -- is conducted by about 20 teams scattered throughout the country and sponsored by the National Highway Traffic Safety Administration and the Motor Vehicle Manufacturers Association. These teams have been performing clinical in-depth studies (both on-scene and off-scene) of selected accidents in the United States, primarily on new cars, since 1969. The accidents selected for data collection have been strongly influenced by the specific interests of the individual teams. Although the information gathered is accurate and detailed, only about 6,000 cases have been investigated and 2,500 of these have entered the computerized file in the five years since the program started. The MDAI favors accidents in which there was injury or severe damage or in which there were large disparities between the degree of damage and the degree of injury; as a consequence, there is significant bias in the file. B. J. Campbell states,[10/] "I believe too much reliance has been made on this type of data for guiding NHTSA decision. It leads one to situations in which too much is made of a small number of cases." According to Marie Eldridge of NHTSA, "As a system for producing statistical information needed for supporting our safety standards, the on-scene in-depth investigations cannot be regarded as cost effective. The average cost per case is about $2,000. The cost decreases to about $800 per in-depth case if the on-scene investigation requirement is eliminated." Moreover, as indicated by O'Day, "The present collection of MDAI cases is a sample of an undefined and relatively undefinable population, thus limiting severely the capability to draw inferences to the national accident picture."

A program that has long been established but only recently has become operational is "FARS" -- the Fatal Accident Reporting System.[16/] This system involves NHTSA collection of state data on all fatal accidents, with recording into a uniform format that will permit central storage, retrieval, sorting and analysis. Police data plus later medical reports are included. Reports are made on each occupant, each vehicle and each accident, so that about 200,000 reports are expected to enter the file yearly. Since the file will cover all and only fatal accidents, it will be representative, but only of fatal accidents. Without supplementary information from a sample.of all accidents whose intrinsic severity distribution is the same as that for the fatals, inferences cannot be drawn as to, for example, whether sobriety or use of belt restraints affects the incidence of fatalities in crashes.

A much more representative collision data sample, structured to meet limited objectives, is being collected by NHTSA.[14/] From five selected regions of the country "Level II" data is being obtained on new cars in tow-away involvements for the purpose of evaluating active and passive restraint systems. Information is assembled from the police report, a doctor's report, photographs, a brief vehicle investigation, and driver interviews. Data is collected on all occupants, whether injured or not, but information gathered is limited to that needed for the statistical analysis of restraint system effectiveness. The design of the sampling process was accomplished centrally, by NHTSA, so that the process will be free of the biasing influence of the investigators (a serious problem in MDAI investigations) . The cost is about $100 per crash. The sampling plan has been designed in such a way that NHTSA expects to be able to make national estimates based on post-stratification.

NHTSA has under development a system for sampling pedestrian and bicyclist accidents in several hundred localities. This is a "bilevel" investigation effort in which there is a supplementary investigation carried out by police (with the added costs borne by NHTSA or others) to establish the nature and location of the accidents and factors affecting visibility. It will answer questions at the level of detail needed to determine gross behavior and counter-measures.

The States, of course, collect accident reports in great number. The reporting thresholds vary from State to State. Within a State, sampling may not be representative or uniform. For example, a city with a high crime rate may devote little effort to investigating and reporting traffic accidents, while even the slightest crash may be reported in smaller towns. Efforts by the NHTSA to use collision data files directly from the States have proved unsuccessful primarily because of the nonuniformity of reports and the consequent inability to properly combine, analyze and process the information. A second problem related to the sheer volume of records that was derived from the States.

On review of the information required on HS Form 214 used in the Fatal Accident Reporting System (FARS) we observe that certain information critically required by both rulemakers and injury researchers is not supplied by the reporters. Specifically, provision of vehicle crush measurements that could be converted to Equivalent Barrier Impact Speed (EBS) using the method of K. L. Campbell[20/] would make possible construction of the cumulative distribution function of EBS in fatality accidents, a function needed by the rulemakers in analysis and prediction of the effectiveness of restraint systems. Provision of information on the vehicle interior points of impact, occupant's height and weight and more detail on the precise nature of injuries suffered by injured and killed occupants would provide vital injury cause information.

It is clear from the foregoing that there is no existing national crash data collection program that is designed to meet national needs. As indicated earlier, NHTSA has contracted with the Highway Safety Research Institute of the University of Michigan to design a national accident data sampling system based on a probability sample. NHTSA hopes that through control of the selection of accidents that a sample can be acquired whose characteristics can be generalized to the national crash population.

d. MASS ACCIDENT DATA ACQUISITION

In summary, to meet data needs and to overcome the limitations of the current national data files and collection systems, a mass accident data acquisition system is needed. In addition, measurement and reporting of accident causal severity is important to the classification and analysis of accidents and often can be important to drawing credible inferences as to the projected benefits of proposed safety standards. The following chapter will discuss the problems of design of the data acquisition system and of measurement of causal severity in more detail.

The need for more and better data does not mean the current data collection programs should be abandoned. However, each of these programs should be reviewed as to its specific objectives and upgraded as necessary to meet them. For example, MDAI team investigations should conform to a sampling plan rather than being entered into to satisfy the personal interests of the investigators. An effort should be made to get causal severity information and information on injury mechanisms into FARS reports.

An extremely important characteristic of the Fatal Accident Reporting System that might be overlooked as "just a detail" is that it provides uniformity in the reporting from all states, using computerized forms. This uniformity makes it possible to combine, sort and analyze data. Extension of this uniformity to general accident reporting systems used by states would enormously simplify the central collection and analysis of mass accident data, and should be encouraged through a system of incentives.

Even with a very good mass accident data acquisition system in being and operating, it will not be possible to answer certain questions that were unanticipated at the time the system was designed. Supplementary data acquisition systems will be needed to answer such questions; the restraint system collection system and the pedestrian cyclist system now operating are examples of systems designed and needed to answer specific questions at this time.

Mass accident data acquisition may not, by itself, answer questions with regard to the benefit of a projected safety standard. When the costs of such a standard are large, or the benefits uncertain, it may be necessary to undertake a large scale experimental program to provide the needed answers.

Section 3, following, is necessarily quite technical. However, much of the discussion is summarized in the introduction to Section 4. Readers more interested in the various alternatives for remedying deficiencies in the existing data may wish to proceed directly to Section 4.