APPENDIX J

MASS ACCIDENT DATA ACQUISITION AND WHY IT'S NEEDED

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OTA Automobile Collision Data Workshop

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Accident data have been collected for a long time, and we have learned a great deal from them. These data aid in establishing safety need and proper priority of effort. Government, industry, and the public can benefit from more knowledge regarding the real world of traffic. However, times change and designs change, and we believe the present rate of gathering accident information on current designs and events is not adequate. Large amounts of data, carefully collected so as to assure representativeness, are needed. In addition, special kinds of data, more accurate than numerous, perhaps, are also needed to fill in some significant research lacks.

Approaches to Data Collection

There are three basic approaches to data programs, with some variations. First, the researcher might incisively phrase the particular questions that are going to be asked of the data, and he would design a data collection program to answer those questions. A point of particular significance in this approach is that the data collection program is then part of an integrated research project. For example, both the MVMA and NHTSA have, during the past year, been conducting a study to measure the accident performance of the 1974 interlock type of restraint in comparison to the 1973 system. The number of items of data collected in each case were deliberately kept few so that investigative resources could be allocated toward getting as many cases as possible -- instead of much data on fewer cases.

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The second type of approach would be to run the study like a controlled experiment, in which the hardware to be evaluated would be assigned to members of the public in such a way that there would be both broad representativeness of use and freedom from bias, those not receiving the device being the control group. This approach is seldom practical, although manufacturers sometimes are able to equip certain cars with experimental features prior to their full market introduction in order to develop field experience with them. Again, the data collection is integrated into the research project.

The third approach to data collection -- and the one I believe we are concerned with here -- is to create a data file which is a microcosm, in all its particulars, of the real world. This approach is independent of any particular research project; its purpose is for the data file to "become" the real world insofar as any researcher is concerned. Different researchers will dip into that data file to answer questions which may arise as issues emerge, issues perhaps unforeseen by those who devised the data collection scheme. Such a method requires highly detailed recording of data on an enormous number of variables. This allows for variables previously disregarded to now be investigated, and also allows the researcher to control confounding effects by selecting for comparison only those cases in which the effect of the extraneous variables cancels out. The most desirable kind of data collection approach, providing sufficient resources can be brought to it, is this third type. If resources are not sufficient, then probably the first type of approach -- in which the data program is tailored for the specific questions to be asked of it -- would be most appropriate.

Uses for Data

Among the uses for accident data -- and each use has its own requirement on scope and precision -- are: (i) evaluating the safety performance of past and current safety designs, and most importantly, verifying that required countermeasures have, in fact, been effective; (ii) determining if particular safety problems are of such magnitude that countermeasures are needed and supporting the specifics of rulemaking; and (iii) supplying normative information about accident occurrence so the future effect of countermeasures not yet designed or produced can be anticipated and a wise policy regarding them be instituted.

In regard to this last point -- anticipating future performance -- let's consider an example. It is easy to conclude that if the 30-mph crash test requirement contributes to reducing death and injury, then surely an increase to 40, 50, perhaps even 60 mph would be proportionately better. But there is very little information available that would unequivocally support such a conclusion. Because there obviously are no cars on the road meeting such advanced requirements, we cannot test this conclusion by comparing their casualty rate to cars meeting only the 30 mph criterion -- assuming we had accident data collection and analysis procedures adequate to the task. Because there are no such cars, resort must be made to calculation.

Two things are needed to make such calculations: real inputs of population exposure -- drawn from accident data -- and theoretical system models. Validity of the models will of course be an important matter to consider.

Need for Population Exposure Data

Being able to determine whether, or in what way, to increase the test requirements of crash performance standards, or to inaugurate any rule, depends upon our being able to predict the probable effect of such actions in the future. particularly lacking as an input to any calculation of future effects, is an accurate estimate of the dynamic environment to which people are exposed.

The particular form of the exposure variable most useful for calculating the magnitude of need and in estimating the future effects is the probability distribution of collision speed (with all types of likely obstacles.)

Ordinary accident investigation data can be useful in estimating crash speeds, given some care in adjusting for the mechanical nature of the struck object. However, derived speed estimates from accident reports quickly lose reliability as impacts other than head-on are considered. The ogival cumulative distribution of barrier-equivalent speed has been a prominent part of most analyses aimed at estimating population exposure and hence need, and in calculating the probable effectiveness of different restraints. A single shape and location of this curve has not been accepted among all its users. The absence of this one item of information on occupant exposure can make what should be a factual matter rather a matter of contentious advocacy. It is our belief that a crash recorder supplement to a general accident data program has the potential to assist in clarifying this particular area of need.

Accuracy of Crash Severity Data

For a successful program of crash severity determination, there must also be the right protocol for defining an accident so that the resulting distribution of measurements is not biased upwards by deliberately selecting only “interesting” cases -- an unfortunate characteristic of most data sets available today. If the speed distribution is incorrectly displaced upscale, or inflated due to errors of measurement, there will appear to be many more high speed crashes than really occur; the result will be to lean toward excessively high crash requirements, with resulting cost-effectiveness being less than it appears. While precision of measurement of crash speed is important in estimating the speed distribution, it is even more important that there be no bias in the data collected.

It may be useful here to distinguish between the accuracy of measurement and the accuracy of estimation, in the statistical sense. The former refers to the degree of correctness in any one reading, and the average measurement error is an index of this quality. Accuracy of estimation, for data analysis purposes, refers to the relative absence of bias in the sample of data: i.e., that the sample values fairly reflect the population from which they were drawn: that the sample distribution can be accepted as an estimate of the population distribution because there are no funnies in it which warp it, or skew it, or displace it except for the action of random influences.

Different data purposes place different requirements on measurement accuracy. Crash recorder data presumably are more accurate than other indices of collision severity, such as the measured vehicle deformation or the Vehicle Damage Index (VDI). Whether such accuracy is required depends on the type of study. For many purposes, plan view photographs of the case and struck vehicle would be a significant improvement over VDI, as they would allow for an energy-derived calculation of severity.

When comparing injury outcome between accident cases with, as compared to without, a side guard beam, for example, we would want to control for collision severity because the degree of injury is correlated with collision severity. The control could be effected either mathematically or by partitioning the sample of cases in groups of equal collision severity. Controlling on collision severity will do two things: increase the efficiency of the comparison and eliminate the bias that results from fortuitous concentration of milder collision cases among one or another of the groups under comparison.

Because the degree of injury depends on many factors other than impact severity --such as restraint use, occupant age, and adventitious posture -- the correlation of injury with the collision severity control variable is necessarily going to be less than perfect. As a result, increases in the precision of measurement of collision severity will not proportionally improve the efficiency of making the comparison when using it as a control variable. So, it is not so important to have high precision when doing routine accident comparison studies. The crash recorder has a different utility, and its evaluation should be based on other considerations.

Crash Recorder Use

A crash recorder will have utility for at least three types of studies. The first, as already mentioned above, is to provide correct normative information about such things as -- and particularly for correctly establishing -- the occupant exposure in terms of the probability distribution of collision speeds. To make such a determination requires a research project to be defined with this as its objective; the project could be based on the crash recorder as a particular tool of unusual usefulness. The research project could terminate when the determination has been made. Since the accuracy provided by the crash recorder is not essential for the kind of data-adjusting purposes described in the paragraph above -- i.e., in order to provide a control variable for accident case comparisons -- it would not be needed as a permanent part of a national data collection program. It should be viewed primarily as a research tool used for fairly particular purposes in a particular research program, more than an instrument for general accident investigation.

Another use for the crash recorder would be in research programs for establishing human tolerance to impact and to aid in establishing dynamic specifications for impact test devices. Thus, crash recorder data could be used as inputs in the programming of experimental crash tests or computer-simulated tests. These studies would determine the design characteristics needed in the test devices (e.g., crash dummies) so they would yield test readings comparable to those experienced by actual accident victims. This kind of research requires data that are in dynamic physical form -- not rating scale indexes or qualitative descriptions. This usage of crash recorders would be contained within a research program designed to that end, and except for considerations of administrative efficiency, not be an intrinsic part of the national accident data collection system.

Still another useful purpose for the crash recorder would be to calibrate or to improve the more subjectively determined indexes which are now commonly used in accident investigation. Again, once that calibration has been effected, there would be no on-going necessity for the crash recorder.

Other Data Needs

There are two other areas of safety evaluation to which there has been inadequate attention. The first is to measure the overlapping and interactive effect of different safety requirements: e.g., strength of door fixtures and occupant restraints. Some safety evaluations, carried out in different studies, can count the same persons as being saved more than once by different means in each study, so that the total of the saved casualties might even exceed the population at risk. Our own studies have had this problem.

But even more significant is the almost total lack of information regarding the safety benefit in the 100-series federal standards. The whole concept of accident causation and avoidance needs to be clarified: to date it has been expressed more figuratively than in quantitative terms which will relate to vehicle design. Lack of good ideas in this area suggests that a conceptual breakthrough must be made before we are able to properly attribute that part of causation/reduction to the vehicle and its design, separate from the mediating influence of the driver and of the roadway, and so cost-effective countermeasures can be imposed at the right place in the system for each aspect of accident causation, and in such a way -- and this is crucial -- that the specific effect can be evaluated, both prospectively and retrospectively, in accident data.

Procedures for establishing the safety effectiveness of both the current and proposed 100-series standards should be a major research challenge to the government and industry in the years to come. Current government accident avoidance research emphasis is to experimentally compare different vehicles on arbitrary control tasks. But programs of a different type are also needed, programs that will define measures of accident avoidance performance and then from that establish minimum criterion levels for performance, but the kind of performance that can be validated by accident statistics in the long run. For example, the effectiveness of existing braking and handling capability has not been definitely established in a real world context, much less the need for any changes. This is admittedly a difficult area in which to do research; there are very difficult conceptual problems. It is here, especially, that an interdisciplinary approach is needed.

Need for Greater Quantity of Data

Over the years, the Safety Administration has done an admirable job of developing in-depth studies (referred to as multidisciplinary accident investigations) of limited numbers of accidents, providing some information on how effectively certain designs may be functioning in specific instances. On the other hand, these special studies have not adequately revealed from a national viewpoint safety effectiveness on a representative basis. Thus, the accident teams which are employed for these in-depth studies can usually give a reasonably accurate description of any one accident -- and sometimes its causes or at least the causes of the injuries -- but they are not satisfying our current pressing need for a comprehensive estimate of the nationwide accident picture.

A detailed and highly precise description of any one accident cannot by itself reveal where the overall priorities lic. There are three reasons why accident data must be collected in great quantity: First, there is considerable variability in the injury resulting from accidents that are, on the surface, similar; second, some accident features are quite infrequent and thus comparisons are often based on so little data they are unreliable; and third, we have to account for so many factors which can affect the outcome of each accident.

The first of these reasons -- variability in injury among similar accidents -- is seen when some people can get out of a total wreck and walk away with only minor injuries while in other crashes people sometimes die even though the car is so little damaged it can be driven away. A great number of crashes must be examined so that the entire range of injuries in any one type of crash can be accounted for.

secondly, certain events are relatively rare because most accidents are of comparatively low intensity and the injuries are of correspondingly low grade. It has been common to combine the counts of severely injured cases with the counts of fatalities in order to get a large enough total count to allow reliable comparisons to be made. Furthermore, some factors of interest -- such as restraints -- have had a relatively low rate of usage so not many cases have been available for investigation. It was only until B. J. Campbell, at North Carolina, was able to examine a few hundred thousand cases that he could find enough applicable ones to reliably detect the profound effect of the lap belt on the fatality rate -- as distinguished from its effect on the rate of severe injury or the rate of combined severe-plus-fatality. The base fatality rate is quite a bit less than one percent; he found an overall 70 percent reduction in that rate in the lap-belted cases.

The third reason for needing a lot of data is the presence of numerous variables which affect the accident. The art of doing research and arriving at findings and conclusions about any aspect of accident or injury prevention is still fairly experimental. It is experimental because we do not have unequivocal, established scientific methods to cope with the present accident data. The reason for this is most of it fails to satisfy the basic requirements of analysis: that comparisons be made on an "all else equal" basis. By "all else equal" I mean that conclusions about the effectiveness of, say, the side guard beam must be made on data from crashes involving the same kind of vehicles in the same kind of trajectory with the same kind of people at risk, etc. However, given the diversity of vehicle models, it takes a lot of accident chasing to find enough crashes of the same type, of the same severity, and with the same type of vehicles and drivers, etc. -- that is, in which all else is equal. Mathematical adjustment of the data can take care of some confounding of variables in the data, but to be confident a considerable degree of representativeness in the original data is still needed.

Not the least consideration for achieving the proper representativeness of data is that there should be standardized definitions and protocols used by all the investigating agencies. Since a future investigator will query the data file as a microcosm of the universe of accidents, it would be most disagreeable that cases which are essentially similar were described in the same file differently only because the data were collected by different agencies using their own interpretations.

Need for Scientific Sampling

Not only is an increased quantity of data required but the sampling of the accident universe must be by sophisticated protocol. The last of the three reasons given above implies the need for a disciplined approach to the data, to avoid ending up with data which are biased in the factors underlying them. That requires a scientific approach to data collection, not just pouring more dollars into it and cranking Up the administrative machine to get a bigger program going but doing it in the same old way. Data gathering programs must be designed by the same people as will design the analyses that will be applied to the data. No less expertise than the Census Bureau applies, or the Gallup Poll, will suffice. Fortunately, NHTSA has been bringing in very competent people of late, people who know that a data collection scheme must be designed from the start with the method of analysis of the resulting data a key determiner of how the data should be gathered.

It is the Government Who Should Collect Data

Mass accident data acquisition, processing, analysis, and broad scale distribution requires great effort and much resource. Only the federal government has the necessary resource and easy access to the agencies which can supply information. Furthermore, it seems that it is the responsibility of the federal government to assemble data which will allow an accurate public review of the real dimensions of the crash and injury problem on our highways.

We appreciate the difficulty of developing and implementing a large scale, comprehensive plan for the acquisition of detailed data on motor vehicle related injuries and fatalities. We are aware that the Safety Administration has over the past several years developed and implemented a portion of such a plan which is related to fatalities. This effort has resulted in what is known as the "Fatality Analysis File." We believe that data from most of the 50 states is going into that file and are hopeful that all interested parties will have access to that file in order that we all may comprehend the true and detailed dimensions of the fatality problem in the United States.

The Safety Administration has also requested funds for a large scale field survey of automobile accidents in which crash recorders would be employed. The data from this program is equally important to that from the Fatality Analysis File and would provide an accurate determination of the crash speeds at which the several levels of injury and fatality occur and can be employed as a basis for defining the performance levels needed in crashworthiness standards. We support a crash recorder program.

Certain fundamental questions cannot be answered without first having an adequate base of public data: What do we really know about the need for increased performance -- increased performance on the types of test criteria in the rules -- based on what is happening out there on the highway? What will be the effect on injury at lower speed levels when systems designed for a high speed compliance test are used? What are the proper speed levels to target for? While accident data are important, they are of course insufficient in themselves; other questions must still be considered: Can we mass produce these cars to provide such protection at reasonable cost? Should we approach an increased performance level in one massive jump or would we be better served to work toward it incrementally? What lead times are required to achieve these goals? These are obvious questions that should be considered before such rules are proposed.

In summary, we believe it is necesary to greatly expand accident data collection, in a well-disciplined scientifically devised program. Crash recorders cannot supplant an accident investigation program. Crash recorders will be most useful in research projects whose ends specifically require the dynamics information which only such a tool can provide rather than in general data collection programs. There is a great challenge to undertake new studies of need in the accident avoidance area; indeed, new concepts, of pragmatic utility and based on what is actually happening on the roads, are needed in order to get a grasp on the whole issue of vehicle control and its relation to accidents. It is the government which has the responsibility and the resources for carrying out such programs.