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DATA SOURCES TO SUPPORT
THE NHTSA DEFECTS INVESTIGATION SYSTEM

Report Number UM-HSRI-78-14

by

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The Office of Defects Investigation at NHTSA currently lists about 40 sources of information which provide data on vehicle and component failures. The majority of the input, however, comes from only three of these sources--consumer letters (directly or referred by other agencies), the telephone hotline, and a parts return program in which repair agencies participate by sending failed components to the NHTSA for examination. Other sources of information have been, and are continually being, developed by the Office of Defects Information.

The purpose of this study was to review the present information sources and the methods of processing and using such data, and to seek and recommend new sources and new methods. In the report five specific information sources are discussed, and recommendations made for their adoption or modification. These include:

1. More extensive use of the NHTSA Fatal Accident Reporting System, as well as certain modifications to that system such as better-defined data elements and a provision for rapid input to ODI of important findings.

2. The routine scanning of court records of automotive product liability suits, both at a detection mechanism and to take advantage of the technical material available in connection with such suits.

3. Routine acquisition and analysis of fire department records, either at the state or national elvel, to identify unusual propensity for fire. Mass fire data of relatively good detail is available from many states. In addition, consideration should be given to inputting data directly from fire departments through a special hotline.

4. Subscription to a newspaper clipping service, as a relatively inexpensive means of learning of the existence of unusual defects. While such a pro-

(Continue on additional pages)

cedure would require followup to fully identify makes or models of equipment, it is a rapid and efficient means of early identification.

5. Enhancement of the communication channels between the Office of Defects Information and the various NHTSA-sponsored accident investigation teams, so as to provide investigators with consultation on defect cases as well as to provide ODI personnel with information.

A method for using packaged computer programs to display over- and under-representation statistics for component defects and fires was developed and demonstrated using both the FARS data and a set of police-reported accident data. The same techniques could be used for analysis of the present ODI defect data in concert with vehicle population information as might be derived from R.L. Polk or other data sources. Using a standard SPSS "Breakdown" program, the data files may be conveniently sorted to identify almost any sub-group of vehicles--by weight, wheelbase, make, model, model year, etc.--and to compute a "defect" rate for that group relative to that of the entire or reference population.

In order to provide a common basis for communication about these recommendations, and as a first step in the development of a decision-making aid for the defect-recall process, a mathematical inventory model of the production-defect-recall and scrappage process is presented. Implementation of such a model should provide a means for estimating the reduction of loss to the public occasioned by a recall action.

A number of examples of information available from the various information sources are presented, as well as several examples of the data processing methods.

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16. Abstract
The present sources of information used by the Office of Defects Information at NHTSA are reviewed, and consideration is given to new sources as well as enhancement of some of the present ones. New sources of information studied include the NHTSA Fatal Accident Reporting System (FARS), court records, fire department records, a newspaper clipping service, and in-depth accident investigation reports.

Analytical methods for processing both the present ODI files, and for the suggested new data sources, are presented.

The accuracy and completeness of the data from the several sources are discussed, and an inventory model of the defect identification and recall process is presented.

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SECTION I

INTRODUCTION

This project was undertaken in response to the work statement set out in the request for proposal NHTSA-7-B839 entitled "Data Sources to Support the NHTSA Defects Investigation System." The Office of Defects Investigation (ODI) has the primary responsibility within NHTSA for determining whether a safety-related motor-vehicle defect exists. The objective of this project was to determine whether additional data would be useful in NHTSA's meeting its responsibility in this area, and how such data may best be utilized. Since ODI is already in operation, and has developed a large number of information sources for continuing input, the work in this contract has been oriented as much toward methods of analysis of existing data as it has toward new data sources. The intent has been to provide methods of both acquisition and analysis to enhance the effectiveness of NHTSA in minimizing the number of vehicles on the highway with serious safety problems.

The objectives of the contract have been addressed by (1) examining what is currently done, (2) judging whether additional information inputs are in order, (3) developing methods of analyzing such data, and (4) recommending modification or enhancement of the information handling processes of ODI. In particular, since the research arm of NHTSA is a resource operating in support of the enforcement functions of ODI, activities appropriate for that NHTSA function are identified.

In addition to reviewing written material about ODI information sources, the HSRI staff has had an opportunity to meet with ODI personnel and with the staff of the contractor (Kappa Systems) responsible for processing and handling much of the ODI data. The variety and number of inputs of information to ODI at the present time is large, and any changes recommended here are not expected to revise current procedures drastically. Nevertheless, our background in data acquisition and analysis is substantially different from that of the staff presently associated with ODI, and we would hope that our suggestions will be of value.

The tasks defined in the request for proposal include (1) development of a detailed work plan, (2) describing the current data sources, (3) identifying and describing data needs, (4) identifying data sources, and (5) recommending changes. The report is organized into sections indirectly reflecting the task descriptions. Section 2 of the report concerns a description of the current data inputs to ODI. Section 3 presents an inventory-like model description to provide guidance for development of other data sources and discusses the effect of priorities by defect categories. Sections 4 through 8 define and describe several potential data sources which may be expected to provide data useful to the ODI program. Section 9 concerns analysis methodology, in part to be applied to current ODI data and in part to new data; it includes examples of analytic techniques which could be implemented either by the ODI staff or by the research staff of NHTSA. Section 10 summarizes and recommends changes in the data collection and analysis procedures associated with the ODI operation.

Seven appendices have been included, primarily illustrating characteristics of some information sources and analytic methods appropriate to treating data from such sources.

SECTION 2

CURRENT DATA INPUTS

Sources

Data inputs to the Office of Defects Investigation come from a variety of sources. Those inputs which are computerized are processed into several files using the Model 204 Data Base Management system. The present computer files are described in a report by Kappa Systems, Inc., entitled "The ODI Data Information System--Systems Overview," and only a brief summary of that material will be presented here.

Data are acquired from as many as 41 named sources, and these sources are shown in Table 1. The counts indicate the number of entries in the present complaint letter file, which is the principal repository for input data.

Files

The complaint letter file contains information from (1) letters, of which there are about 1000 per month coded, (2) Hotline card returns, at about 500 per month, and (3) parts returns, of which there are 70-100 per month. All of these frequencies are estimates from recent months, and in general these are higher now than they were several years ago. The Hotline was expanded about two years ago to cover the 48 contiguous states, and had been operated in only a few eastern states prior to that time. The Parts Return Program is only a few years old. Letters and Hotline calls have increased over the past year with increased public awareness of the program--most likely because of news announcements of suspected defects along with an "800" telephone number. The number of "records" in the present complaint letter file is estimated at about 500,000, but a "record" is a single 80-column IBM card or the equivalent, and the total number of items (defects) in the file is smaller than that by perhaps a factor of four or five.

A second file encodes information from manufacturers' technical service bulletins. About 300 bulletins per month are received, many of which contain more than one safety item of interest, and this file currently contains about 10,000 "records"--evidently with the same definition of record.

The third currently active file is a record of defect reports, consisting of an initial report of a recall campaign (from the manufacturer) and quarterly progress reports (for six quarters) of the number of vehicles serviced and/or repaired.

A fourth file is planned to contain records of engineering analysis and investigations, and the inputs to this would come mainly from the ODI staff.

The majority of the complaint letter file inputs stem from letters addressed directly to NHTSA (or forwarded to NHTSA through one of the Nader affiliates), from the Hotline, and from the Parts Return Program. Special surveys, such as a 1975 survey of school buses, are capable of bringing in a significant amount of information quickly, but do not have the continuing nature of the letters, calls, and returned parts. Several of the sources are listed with zero frequency in the computer file. In particular, the codes PD, PF, and PS have only recently been assigned, and the file as of the date it was searched did not have any entries for these.

Data Coding, Storage and Retrieval

Data stored in the Model 204 computer system may be accessed directly by ODI personnel, and the detailed coding of makes, models, components, sources, failure modes, etc., allows these users to select cases of interest and print out the case material. Review of the incoming letters at ODI permits routing of safety-related material for computer input. Defects are categorized into four groups coded A, B, C, and D, in decreasing order of criticality. The "A" defects are those that could occur suddenly and without warning while the vehicle is in motion. "B" designates those defects which may occur suddenly, but with some warning. The "C" and "D" categories represent wear-related and non-safety-related defects, respectively, the latter ordinarily being referred to the manufacturer for information or action.

Coding of both vehicles and components is accomplished in an hierarchical system which allows good detail--the master cylinder cover, for example, being a subdivision of master cylinder, which is a subset of the hydraulic brake system, which is a subset of service brakes. As will be noted in Section 9 of this report, this level of detail is a challenge for most statistical analyses, but is certainly necessary in identifying the precise nature of a problem.

Other Users

As with other data sets maintained by the NHTSA, the general public may be considered a user of the ODI information bank. Computer printouts of the ODI files are prepared each quarter, and maintained in the NHTSA library where they are used by industry representatives, attorneys, and the general public in connection with their own interests. The computer interrogation system currently in use is straightforward, and is evidently easily used by persons who refer to it often. But the written record is evidently more convenient for the general public.

Expected New Inputs

The information sources for the ODI files have increased continuously since the beginning of the program. As evidenced by the data in Table 1 the bulk of the present information comes from consumer letters, the Hotline, and the Parts Return Program. A study is currently in progress to bring new car dealers into the parts return, thus enhancing the ability to identify defects in newer vehicles (most of the participants in the present Parts Return Program tend to service older or at least out-of-warranty vehicles). The school bus survey was conducted just once. It provided a substantial amount of information about this segment of the population, and it might be expected that such a survey could be repeated, or that another special population might receive similar treatment.

But assuming that serious safety defects are relatively rare, the best resource will continue to be that with the widest coverage. Serious problems should continue to generate letters, and widespread knowledge of who to write to (or how to call the Hotline) should improve this general capability.

In the present study other new data sources have been considered, and they will be treated in more detail in Sections 4 through 8.

Table 1

ODI Sources of Information[1]
and File Frequency Counts

Code	Name	Count
AC	Auto Club of Southern California	27
AM	Auto Club of Missouri	2
AN	Automotive News	1
AO	Auto Owners Action Council	7
AT	American Trucking/Transport Assn.	0
AX	American Auto Association--Other	4
BB	National Better Business Bureau	0
BR	Bureau of Auto Repairs, Dept. of CA.	138
BS	School Bus Survey	423
CG	Consumer Group	59
CL	Consumer Letter	12098
CP	Consumer Product Information Center	322
CR	Congressional Referral	657
CS	Executive Correspondence	4831
CT	Canadian Department of Transport	21
EM	Equipment Manufacturers	1
ET	Vehicle Equipment or Tire Manuf.	0
FT	Federal Trade Commission	192
GA	Government Agency	272
HL	Hotline	6681
IC	Insurance Company	17
II	Insurance Institute for Highway Safety	43
IU	Indiana University	29
MC	Bureau of Motor Carrier safety	1
MD	Multi Disciplinary Acc. Invest.	22
MR	Manufacturer	582
NA	Nader Group	5737
NM	News Media	79
PA	Spec. Asst. to President for C.A.	253
PD	Dealers	0
PF	Fleets	0
PR	Parts Return Program	3053
PS	Suppliers	0
RI	NHTSA Research Institute	17
RO	NHTSA Regional Office	617
SA	State Atty Gen. Office of Cons. Prot.	21
SO	Highway Safety State Office	230
SU	Surveys	0
TB	National Highway Safety Board	12
TS	Traffic Safety Research Corp.	5
VM	Vehicle Manufacturer	1

[1]The computer listing from which this was prepared notes that there are an additional 29,529 entries for which this field (Source) was not coded.

SECTION 3

MODELS AND PRIORITIES

We introduce the concept of a model at this point in the discussion for two reasons: (1) To formulate an overview of the problem of vehicle defects so that a common basis of communication is established, and (2) To take the first steps in the development of a decision-making aid in the conduct of ODI's day-to-day business. This model should not be construed as an attempt to automate any function of the office, nor will any model be able to replace the considered judgment of the ODI staff in its decision-making capacity.

When a product is sold to the public having the potential for some failure which may cause injury or property damage, the total damage resulting will depend on (1) the number of products in service, (2) the probability of failure (say, per unit time), (3) the damage produced by each failure, measured, for example, in dollars of loss, and (4) the length of time the defective product is in service. These four factors could constitute a simplistic model, expressed as:

$$T = \sum_{0}^{\tau} N \times P(f) \times \$$$

where T = total trouble (or dollar loss) to the public

τ = length of time the defective product is available

P(f) = the probability of failure (and loss)

\$ = actual loss per failure

From this simple model it is clear that there is a useful payoff in building products which have a low probability of failure, that products which are few in number are not much of a problem, and that those with a high cost per failure are likely to be a problem. But these factors are not really under control once the product is in service, and only τ remains. This is the time over which the defective products remain in use, and it may be modified by a recall campaign, and that may be more effective with early notice of the problem. In short, there is a payoff in reduction of "T" which is roughly inversely proportional to the time it takes to discover that a problem exists. And this is the whole basis for having a defect detection system within the National Highway Traffic Safety Administration.

The purpose of this study has been do identify data sources (and the methods for getting information from those sources) which will identify more rapidly those problems which have a high "Trouble" index--those which a high cost per failure, those with a large number of failures, or those with a large number of units in service even though the per case cost the probability of failure are small.

Inventory Model Description

An extension of this simple model could be used by ODI to assess the value of potential recall campaigns. The number of vehicles in the population actually varies with time, and would be better represented by an integral of the production rate. Failures may be represented mathematically in several ways, but it is likely that some components would exhibit a Poisson failure rate from the time they left the factory, whereas others might have a lag time before any failures occurred. A complete model should permit either of these.

The design of such a system is far beyond the scope of the present contract, but some of the groundwork for the design has been done to demonstrate the feasibility of the technique. Appendix F of this report contains the development of a mathematical model for the prediction of the number of defects of any particular type which would be present in the national vehicle population for the time period desired. The information required by the model consists of the production and scrap rates of the vehicles, the failure distributions for defective components, and the time period involved, and the output of this portion of the decision system will be the numbers of defective vehicles. This, then, can be combined with estimates having to do with the rate at which defective components fail, the rate at which failures result in accidents, and the cost distribution of the accidents, to produce the total cost that we may expect from the defect over the life of the particular model vehicle.

The institution of a recall campaign will alter the defect population, depending on the completeness of the coverage and the compliance of the owners. The altered population can then be used to measure the cost of the defect as a result of such a campaign, and the difference between this and the first cost computed represents the savings created by the recall. The savings can then be balanced against the cost of the recall.

This model will be referred to in Section 9 of this report dealing with analysis, as its use for ODI is of a general nature. The use in the analysis context would be in connection with the development of exposure information. In the present section the model is intended to provide an estimate of the number of defective components on the road for any desired time period in the future, and thus furnishes the basis for an estimate of cost savings resulting from the reduction of defects and accidents occasioned by a recall campaign. In Section 9 the use of the model will be to estimate the vehicle population for various make and model-year combinations, for comparison with the defect files containing the same detail.

SECTION 4

THE FATAL ACCIDENT REPORTING SYSTEM AS A SOURCE

One potential source of defect information which has seen little use to date within the Office of Defects Investigation is the data contained in the files of the Fatal Accident Reporting System(FARS). In order to get a better look at this source, the 1976 and 1977 FARS digital files have been analyzed--producing several two-way tabulations of information, and listing out specific defect cases by type, state, vehicle make and model, etc. For each vehicle coded into the FARS file, two "defect" entries may be made--noting what is supposed to be a contributing factor to the accident, such as a brake fault, a lighting defect, etc. In addition, the FARS file identifies vehicles which have sustained fire damage, and this identification is of potential interest to ODI.

In addition to the tabulations, visits were made to the FARS coding offices in Michigan and Ohio to read the original documentation for cases in which defects were alleged. This was done to determine whether such notations were correct, whether there was more detailed and useful information available, and to ascertain the range of practices of defect reporting in the two states.

Findings

A further description of the FARS data is given in Section 9 of this report in connection with a discussion of analytic methods. Detailed tabulations of the results of visits with FARS coders in the states are given in Appendices A through C. Selected and summary data are given in this section of the report.

Table 2 shows the proportion of vehicle defect cases for vehicles in fatal accidents in 1976 in several states, and indicates the broad range of this factor. One is quickly led to the conclusion that there are either differences in reporting practice, or differences in interpretation of the coding rules; it seems rather unlikely that actual defect rates would vary so widely across states.

Table 2

Defective Vehicles in Fatal Accidents
Selected States

State	No Defect	Defect	Unknown	Total
Alabama . .	867 (72.5%)	70 (5.9%)	259 (21.7%)	1196 (100%)
Connecticut	438 (85.9%)	66 (12.9%)	6 (1.2%)	510 (100%)
Delaware .	130 (87.2%)	19 (12.8%)	0 (0%)	149 (100%)
Iowa . . .	447 (46.9%)	36 (3.8%)	471 (49.4%)	954 (100%)
Michigan .	2517 (98.7%)	32 (1.3%)	2 (0.1%)	2551 (100%)
Ohio . . .	1839 (76.4%)	238 (9.9%)	331 (13.7%)	2408 (100%)
Utah . . .	14 (4.5%)	14 (4.5%)	280 (90,0%)	308 (100%)
Wyoming . .	245 (88.8%)	27 (9.8%)	4 (1.4%)	276 (100%)

The distribution of reported defects in the 1976 Fatal Accident reporting System is shown in Table 3. Note that tires and brakes predominate, but that with the large number of vehicles in the whole file (on the order of 50,000) there is a substantial number of other defect types. Errors in recording defects (and vehicle makes/models) are unfortunately not uncommon; examples of such errors are reported in the tables in appendices A, B, and C. One interesting interpretation in recording is the use of "steering" defect to record stuck throttle linkages--evidently because this category was not initially planned for. It would be appropriate for the ODI staff to review the FARS coding conventions to insure that the items of interest to ODI would be properly noted.

Table 3

Vehicle Defects as Coded in 1976 FARS File

Defective Component	Coded as Defect No. 1	Coded as Defect No. 2	Total Defects
Tires/Wheels . .	1342	22	1364
Brakes	422	44	466
Steering	91	27	118
Suspension . . .	26	13	39
Power Train . .	77	7	84
Exhaust	11	3	14
Headlights . . .	128	16	144
Signal Lights .	33	11	44
Other Lights . .	63	22	85
Horn	6	5	11
Mirrors	2	1	3
Wipers	6	0	6
Seating/Controls	5	5	10
Body/Doors . . .	59	12	71
Trailer Hitch .	30	3	33

In Michigan as well as in Ohio FARS coders use the written police reports as well as a variety of backup material (death certificates, driver license files, autopsy reports, and in rare instances expert mechanical opinion). In the states that we searched for this study, backup material was most likely to be available when the accidents were investigated by the state police or highway patrol agency, and least likely when investigated by local police departments.

"Vehicle defects" listed in the FARS coding tend to result from any mention of a component problem--including drivers' statements ("My brakes didn't work properly"), witnesses reports ("The tire blew out before the crash"). Reports seem to be dominated by maintenance or wear problems such as bald tires, worn out brakes, or mixed tire types.

While the defect coded in FARS is listed (by the FARS coding rules) as a contributing factor, it is often clearly not a cause of the crash or the fatality.

The Ohio reporting form (OH-1) instructs the police investigators to list separately (by checking a specific box) the cause of the crash. Tires or brakes may be cited as defects, but causes such as "drove left of center," DUIL, recklessness, or speeding, may also be reported. When the data are entered into the FARS system, the coders interpret the defect notations broadly, and have more than once listed bald tires on a stationary vehicle as "contributing factors."

Sixty-four 1976 fatal crashes in Michigan listed a vehicle defect and/or a fire. Thirty-two (half of the 64) were fire related. Appendix A provides, case by case, a brief description of Michigan's defect-related fatal crashes.

In Ohio, where the hard copy of 248 defect and/or fire related crashes was scrutinized, 47 (19%) were fire related. This seems to be mainly due to the fact that "tires" as a defective item are cited in 177 crashes in Ohio vs. only 12 in Michigan--and these states are roughly the same size. If all of the tire-involved crashes were eliminated in both states, the data from the two states look much more similar, as shown in Table 4.

It may well be that because the Ohio reporting form allows an officer to classify a defect observation in addition to coding the cause of the crash, he can freely observe that a vehicle has poor tire tread, low pressure, or a mixture of tire types. In Michigan, the equivalent reporting form (the Michigan UD-10) does not provide this same encouragement for reporting, and officers are evidently much less likely to note tire condition unless they feel that the tires played a significant role in the collision.

Table 4

Fires and Defects in Ohio and Michigan
Fatal Crashes

State	Number of Fire Crashes	Total Defect and Fire Crashes	Percent Fire Crashes
Ohio . .	47	71	66
Michigan	32	52	62

Fatal crashes involving fires in Michigan and Ohio for the year 1976 numbered 79. These 79 crashes involved 87 vehicles, and a tabulation of these vehicles may be found in Appendices A and C. While the FARS coding procedures eliminate the coding of empty parked vehicles, in several instances it was such a vehicle which burst into flames upon impact, causing the fire in the crash. These vehicles have been included in this tabulation.

<u>What could be done with the fatal data</u>

Close reading of the original case materials provides information about certain defects which should be of interest to ODI--stuck throttles, for example--but, it seems unlikely that the coded defect data in its present state will be of much value.

The Fatal Accident Reporting System is intended to be a census of all fatal crashes occurring in the United States, and to contain detail not available in any other set of data. In order to determine the national frequency of relatively rare events, such as fire in fatal accidents, it is necessary to have such a complete record. Also, in order to get a statistically meaningful estimate of the incidence of certain types of defects in fatal crashes, the same census is necessary. It is unfortunate that the present file has so much variation in reporting and coding, because this limits its usefulness to ODI. Tire and brake data, both because they represent primarily wear-out problems, and because they are often noted even though they have little or nothing to do with the cause of the crash, seem to be of little value. Other components (steering, power train, etc.,) would seem to be of most value in supporting other findings of defects.

With respect to fire incidence, however, the data are likely to be more complete. Errors in make and model observed during the study of hard copy in two states suggest that even these elements should be improved before any great dependence is placed on them.

Two kinds of changes are recommended: first, modification of the FARS reporting and coding, and second, the development of analysis methods for ODI interpretation of the FARS output.

<u>What should be done with FARS</u>

1. More detailed codes for defects should be defined, with the interests of ODI in mind. Steering faults should be separated from stuck throttles, of course, but in addition the coders (and ultimately the reporting officers) should be asked to make a judgment as to whether a fault resulted from wear and lack or maintenance, or from a defective component. These new codes should be added to the FARS digital file,, and periodic outputs furnished to ODI.

2. Consideration should be given to asking police agencies to report suspected component defects in fatal accidents directly to ODI, perhaps by using the Hotline. Alternatively, the FARS coding clerks in the several states could do this reporting. This would get such data into the ODI system many months before it would arrive via the normal file build and analysis procedures.

3. Fire reports in the FARS data are recorded in digital codes without much detail. It is generally not possible to separate engine fires from fuel tank (or even passenger compartment) fires. Further, there are occasions in which the vehicle which burned (or caused the fire) is not even reported--as

when a parked car bursts into flame when it has been impacted from the rear. More detail about fires would help ODI assign proper codes in placing such cases into its defect files.

<u>What should be done to enhance analysis capability</u>

This subject is treated in more detail in Section 9, but a review of the present FARS data suggests that there may be many cases which would either (1)identify new defect problems or (2) support enforcement actions of already suspected defect cases. The process of reading over hard copies of cases identified by the digital file as "of interest"--e.g., all of the steering defects--could be accomplished by either ODI or other NHTSA personnel on a routine basis. While it is recognized that police officers are often not in a position to make a complete analysis of a vehicle with respect to accident-causing defects, they often do just that in the event of flagrant problems. Such findings as result from those investigations are currently handled routinely--they are simply noted as a checked box on the FARS form and carry no more information than the finding of bald tires on a stopped car. But careful reading of the record by someone interested in the defect problem would provide a more useful input to ODI. Finally, the FARS coders interviewed in the course of this study are dedicated to their work, and have more capability than they are currently being called upon to use. ODI might profit from providing the FARS coders throughout the country with a current listing of vehicles (VIN's) subject to recall, asking them to check against this list when working up their reports. Notation of a match between an accident vehicle and the defect list could be noted on the report, or forwarded immediately to ODI for consideration.

SECTION 5

COURT RECORDS AS A SOURCE

Court records of products liability suits against vehicle manufacturers are a potential source of information that would support two major ODI investigatory functions: first, identifying potential safety related defects that should be investigated; and second, strengthening existing investigations and recall proceedings against manufacturers.

The primary sources of court records are state trial-level courts throughout the nation. Records of cases are maintained in court clerks' offices in courthouses which in turn are normally located in county seats. State laws and local court rules permit a plaintiff, the individual who claims to have been damaged while using the products of a manufacturing firm, to sue anywhere that firm does business. It is necessary, however, that the court in which the plaintiff brings his suit have some relationship to the parties involved; either the plaintiff must reside in the same county or district as the court, or the events that brought about the suit must have taken place there. It is evident that suits alleging defects in motor vehicles are filed in courts throughout the nation.

Slight differences exist from state to state concerning what the plaintiff must prove in order to prevail in a products liability suit against a vehicle manufacturer, but two elements must be established in any such suit: first, that the vehicle contained a defect in design or manufacturing, and second, that the defect resulted in death, injury, property harm, or other damage to the plaintiff. These elements at least incorporate and likely go beyond those needed to establish a basis for ordering a manufacturer to recall vehicles on account of safety related defects.

There may be several court systems that theoretically have jurisdiction over a vehicle defect suit, but most such actions will likely be brought in state trial courts that have general jurisdiction.

HSRI Exploratory Study of Court Records

HSRI staff conducted an exploratory study of the records of one state trial court, the Wayne County Circuit Court. In Michigan, circuit courts may hear any civil matter which has some connection with the state and in which damage of more than $10,000 is claimed to have occurred. The Wayne County Circuit court is the largest in Michigan, serving a population of approximately three million. The courthouses are located in Detroit, where all court records for that circuit are maintained.

Wayne County Circuit Court records are filed according to a complicated manual system which groups cases alphabetically by the names of the parties and also by the chronological order in which they were filed. Each case is assigned a docket number, followed by a two-letter suffix indicating its general subject matter. The suffix "NP" denotes products liability cases, and would include cases in which safety related defects are alleged to exist in vehicles.

Findings of the HSRI Exploratory Study

Limitations of time prevented an analysis of suits involving allegedly defective vehicles, but a sample of cases was examined to determine the utility of court files in ODI investigations. The following criteria were established for selection of cases: first, the case was filed within twelve months preceding the records search; second, one of the four major domestic auto manufacturers was named as a defendant; and third, the docket number carried the suffix NP. A total of thirty-seven cases meeting these criteria were found. The files for every second case, nineteen files in all, were examined. It was found that three cases had been transferred to other circuits, and one involved an engine explosion not related to a motor vehicle. This left fifteen cases concerning which information was gathered. This information included: the docket number assigned to the case; the date the suit was filed; the names of the plaintiffs and the defendants; identifying information (make, model, VIN) concerning the vehicle; the date and place where the alleged defect took place; and a brief description of the defect and the damage it caused. This is summarized in Table 5. The chief source of such information in a court file is the complaint, a statement by the plaintiff of the damage he suffered and a description of the events that allegedly caused it to happen. Another key source of information consists of dispositions and answers to interrogations by parties and witnesses,taken in advance of trial in accordance with the court rules. These sources together provided information identifying the vehicle and the alleged defect in nearly all the cases studied.

The findings derived from examining of the group of fifteen cases included the following:

- .Suits were brought anywhere from one month to three years (the maximum period permitted in Michigan) after the occurrence of the alleged damage. The average period between occurrence of damage and filing was found to be twenty months.
- .In two cases the involved vehicle was, at the time the suit was brought, of the current model year.
- .The majority of court files identified vehicles by make, model, model year, and VIN, and specified the components alleged to have been defective.

The chief limitations of court files as a source of information for ODI were found to include the following:

- .The delay between occurrence of damage due to a defect and the start of a suit might reduce the utility of court files as a source of information concerning defects not previously investigated by ODI. It is possible that some suits were brought by plaintiffs' attorneys after they became aware that ODI had taken steps to order the recall of vehicles with similar problems. It is also possible that those events that resulted in the lawsuit had already come to the attention of ODI through owner letters, calls to the NHTSA "Hotline," or police accident reports.

- The filing of a lawsuit by itself does not establish the existence of a safety related defect. The only substantial restriction on bringing a products liability suit against a manufacturer is that the plaintiff and his attorney act in "good faith," that is, with a reasonable belief that plaintiff suffered damage because of a safety related defect.

- Most civil actions are resolved through settlement rather than a verdict by the judge or jury. Settlement agreements commonly contain provisions denying liability on the part of the defendant. In the case of suits against vehicle manufacturers, these agreements therefore are not official determinations that defects exist, and would not be decisive of other actions involving failures of similar components.

The costs of periodically searching court files would not be prohibitive. Files are maintained as public records, so access would not pose a major problem. The language of most complaints may be understood by persons having only a minimal understanding of the legal system, so an expensive training program would not be necessary. Most problems encountered in a search would be mechanical in nature, such as understanding the filing system used by a particular court. Since the purpose of this search is to identify rather than measure a problem there is little need for a random sample of cases. For economy, search efforts may concentrate on large metropolitan judicial districts, and could be conducted by persons based in Washington, in NHTSA regional offices, or both. A large expenditure of time would not be necessary, since investigators could visit many court sites, either monthly or quarterly, on a rotating basis.

From the number of cases found in Wayne County it is estimated that upwards of 2,000 suits per year alleging safety-related defects in vehicles are filed nationwide, and some three to four times that number are awaiting disposition. It should be emphasized that not all suits involving defective components will be found if search efforts are limited to cases in which a domestic auto manufacturer is named as a defendant. Defective components may be alleged in a number of other situations including: suits against foreign auto manufacturers; suits against manufacturers of trucks, buses, or components suits against dealers; and suits between individuals in which a manufacturer is later brought in as a third-party defendant. Depending on the availability of time and funds, some or all of these categories might be searched as well.

Information similar to that found in Table 5 could easily be coded and stored in the Kappa System files. Several thousand case filings would be discovered per year, and appropriate sections of the ODI computer forms could be coded and stored. Suits against vehicle manufacturers are somewhat similar to written and telephone complaints about defects, severity, and likelihood of the alleged defect which likely were made before many of these suits were brought.

Other files of products liability cases, supplementing the proposed file, might be in existence. Commercial publishing houses serving the legal profession and organizations of trial lawyers might maintain such compilations.

Conclusions

In spite of the limitations of court records, this data source may have some utility to the investigatory work of ODI. First of all, some defects alleged in complaints might be brought to the attention of ODI for the first time. Second, the discovery of fatalities or serious personal injuries resulting from alleged defects may prompt ODI to assign a higher priority to investigation of that defect or to reopen an investigation it had closed earlier. Third, testimony found in court files may inform ODI of expert witnesses, methods of testing components, and theories supporting the dangerousness of those components. Fourth, the type and severity of damage suffered by plaintiffs may provide an indication of the relative dangerousness of classes of component failures and help generate priorities among specific investigations or types of investigations. Finally, an abnormally large number of suits alleging similar defects might by themselves provide the basis for the immediate issuance of a consumer advisory.

Table 5.

Court Records of Product Liability Suits

Last Three Digits of Docket Number[1]	Date Lawsuit was Initiated[2]	Auto Manufacturer Named as Defendant	Year, Make and Model of Vehicle Alleged to be Defective	Date of Alleged Failure	Brief Description of Alleged Failure
543	3-25-77	General Motors	1975 Chevrolet Corvette	1-9-76	Battery Explosion
457	4-1-77	General Motors	GMC Astro 95	9-24-75	Loss of Steering
959	4-26-77	Ford	1971 Ford Truck	4-30-74	Loss of Braking
051	5-20-77	Ford	1975 Ford Elite	9-28-75	Defective Tie Rod End
343	6-10-77	Ford	1972 Ford Gran Torino	5-23-77	Rotating Fan Blade Came Loose
405	6-28-77	Ford	1968 Ford Torino	1-26-76	Engine Mounts Broke
854	7-1-77	General Motors	1977 Pontiac	3-7-77	Accelerator Cable Jammed
506	7-8-77	Ford	1975 Ford Landau	5-13-76	Shift Selector Moved Into Reverse
068	7-14-77	General Motors	1974 Cadillac	7-14-74	Steering Failure
725	9-7-77	Chrysler	1966 Plymouth Fury	9-27-75	Defect Not Specified
806	9-24-77	AMC	Jeep	10-3-75	Tire Explosion
644	11-8-77	Chrysler	1973 Dodge Van	11-11-74	Lift Gate Collapsed
049	2-8-78	Ford	1975 Ford Pickup	9-30-75	Brake Failure
345	2-10-78	Chrysler	1974 Dodge B-220 Van	2-22-75	Loss of Rear Wheel
036	3-6-78	Chrysler	1978 Plymouth Fury	2-22-78	Brake and Steering Failure

[1] Example of a full Wayne County Circuit Court docket number: "77-743999NP"

[2] The data normally used was that on which the complaint was filed with the court. In some cases, however, the date appearing on the complaint was used instead; this date is probably several days earlier than the actual filing date.

SECTION 6

FIRE DEPARTMENT RECORDS AS A SOURCE

Information originating at fire departments may be of value in identifying vehicles with an unusual propensity to fire because:

1. Many fires are not crash related, and thus do not appear in police department data. But most fires are attended by some fire department, and records of them appear somewhere in the written reports associated with those departments.

2. The detail available in fire reports is better for identifying problems that that in police reports. Typical police reports of crashes simply indicate the occurrence of a fire (if they indicate fire at all). Fire department records note the location of the fire (e.g., the trunk, fuel tank, engine of a car), the type of material burned (gasoline, upholstery, etc.), whether or not arson was involved or suspected, and many other details.

3. A rather large number of car fires occur each year, and while many of these occur because of carelessness on the part of the owner (dropping lighted cigarettes in the back seat), and even from intentional setting, many may result from vehicle-related problems. Even a small sample of fire department data should serve to highlight overrepresentation in electrical fires, fuel fires, etc.

A Brief Analysis of Mass Fire Data

In many states, data from local fire departments are summarized at the state level, and are available in the form of computer files there. Michigan data is used in this section as an example, and it is typical of those states participating in the National fire statistical program. In the Michigan data for 1975 there were 7760 passenger car fires reported (approximately one car of every 550 registered in the state). Approximately one-third of these involved arson or suspected arson, and should probably not be given any further consideration relative to vehicle safety. The remainder (5253 cars) may be studied with respect to the variables in the file to identify peaks of engine fires, passenger area fires, electrical (source) fires, engine compartment fires, etc.

Vehicle identification in the digital file is about as detailed as in the older (non-VIN) coding of the police accident reports. Basically manufacturing division are identified, but there is no further identification of body size, style, etc. The written fire incident report, however, does provide for recording of the Vehicle Identification Number (VIN) at the reporter's option. In the few reports studied this entry was usually left blank, and firemen do not seem to know of the existence of the VIN labels on cars.

With the limitations of detail noted above, Table 6 shows the distribution of several different classes of fire by make of vehicle. Percentages of each sub-group involved in fires of that class are displayed, and the word HIGH and LOW indicates groups that are significantly (at about the 1% level or better) over- or underrepresented with respect to the grand mean.

Population data in the table is taken from the R. L. Polk registration record. The total number of registered passenger cars in the state is slightly larger than the sum of the cars listed, as data for "other foreign" and "other domestic" vehicles has been omitted. The percentages shown indicate the proportion of a sub-class with a particular type of involvement. A significance test has been applied, and one may read that Cadillacs and Oldsmobiles are overrepresented in the "engine fire" class. Further inspection of the data reveal that the Cadillacs achieved significance mainly because of recent models (particularly 1975), whereas the Oldsmobile overinvolvement stemmed from 1969 and earlier models.

Table 6

Car Fires in Michigan
by Vehicle Make and Fire Type
1975

Vehicle Make	Registered Vehicles	All Fires % of Class	All Fires Sig.	Fires Excluding Arson % of Class	Fires Excluding Arson Sig.	Engine Compartment Fires % of Class	Engine Compartment Fires Sig.
AMC . . .	130,733	.164%		.103%		.00306%	
Buick . .	325,267	.158%	LOW	.108%	LOW	.010%	
Cadillac	96,781	.252%	HIGH	.145%		.0186%	HIGH
Chevrolet	948,360	.163%	LOW	.113%	LOW	.0058%	LOW
Chrysler	103,747	.211%		.159%	HIGH	.0134%	
Dodge . .	231,280	.139%	LOW	.094%	LOW	.0043%	
Ford . .	855,018	.166%	LOW	.112%	LOW	.0081%	
Lincoln .	39,436	.264%	HIGH	.152%		.0126%	
Mercury .	202,446	.177%		.113%		.0119%	
Olds . .	352,759	.241%	HIGH	.173%	HIGH	.0164%	HIGH
Plymouth	300,980	.125%	LOW	.079%	LOW	.005%	
Pontiac .	380,983	.213%	HIGH	.149%	HIGH	.0092%	
VW . . .	128,908	.170%		.119%	LOW	.0085%	
Total . .	4,200,000	.185%		.125%		.00871%	

An alternative method of getting fire data

Direct contact with or from fire houses is an attractive source of information of data regarding automobile fires. Fire departments maintain rather detailed records of their runs, report such information through local, state, and sometimes federal channels, and the addition of details required by ODI would not pose an undue burden on this reporting system. What is needed in addition to details of the fire origin and extent is vehicle data--make, model, year of manufacture, and VIN. While the data are compiled through fire department channels for historical purposes, the delays of that system could be avoided by more rapid reporting.

A Rapid Fire Reporting System

The method by which ODI seeks to incorporate fire data into its operations will depend on a number of factors including cost, the number of reports acquired, the representativeness of the sample, and the quality of the data required. Final choice of a system must depend upon factors which could only be determined by further study or pilot operation. Three alternative approaches and the advantages and disadvantages of each are discussed in the following paragraphs.

1. One or more major cities : This method would take as its area of sampling a large concentration of vehicles in a relatively small geographical area. One person would be required to survey all of the fire-fighting organizations in the area and report (preferably on a daily basis) the relevant fire data to a central location for entry into a computer file. Alternatively, some contractual arrangement could be made with the fire departments or the individual fire houses to gather the data, providing that some attractive incentive could be developed so that quality data could be assured. A rough estimate of the number of reports that such a method would yield can be gotten using the Michigan fire incidence data for 1975, and that shows that the three cities of Los Angeles, Detroit, and Chicago could be expected to produce about 75 automobile fires per day.

2. Some or all of the NASS sites : This method has the distinct advantage of providing a nationally representative set of data, since the NASS design has already been worked out for this purpose. Since the data to be collected for this purpose are not as

ephemeral as are the accident data, the NASS teams might arrange to do the collection during slack periods in the accident activity. It is estimated that this would necessitate the addition of a quarter of a person to each NASS team, but would make the efficiency of the team as a whole greater. In the larger sampling units, there would have to be some sub-sampling, as is the case with the accident data in NASS, making this approach less efficient than the one above. The quality of the data derived from this method would be expected to be excellent, owing to the fact that the NASS personnel are trained professionals. But for ODI's purposes the precise sampling may be unnecessary.

3. Separate sampling system : This approach calls for the creation of an entirely new sampling system, probably modeled after the National Electronic Injury Surveillance System (NEISS). That system is run by the Consumer Product Safety Commission and samples hospitals to gather information on product-related injuries. Such a method would allow the tailoring of the data collection to meet exactly the needs of ODI. Before embarking on this tack, however, it would be wise for NHTSA to contact the National Fire Data Center of the Fire Prevention and Control Administration of the Department of Commerce. This organization may be in the process of designing a sampling system of their own, onto which ODI's requirements might be added at little extra cost.

The criteria of cost, representativeness, quality, and quantity will have to be evaluated more carefully for each of the approaches described above before NHTSA can decide which, if any, of the methods to use. An interim method that could be undertaken immediately at minimal cost would be to institute the first approach on a small scale and for a short period of time. That is, an NHTSA staff member or contractor could go to a single location for a period of about one to three months and collect automobile fire data in the same way that it would be done in a full scale operation. This experience would show up the difficulties of the process and give some indication of the worth of the data, without an excessive commitment on the part of NHTSA.

SECTION 7

NEWSPAPER CLIPPING SERVICE AS A SOURCE

News articles concerning vehicle defects and accidents are occasionally forwarded to NHTSA by interested observers. An alternative to such chance inputs would be a regular scanning of newspapers for articles about vehicle defects. In order to arrive at an estimate of the utility of such a source, HSRI subscribed to a newspaper clipping service covering the four state area of New York, Connecticut, New Jersey, and Pennsylvania. Clippings were requested from all newspapers carrying United Press and Associated Press articles, and involving vehicle crashes in which a defect was listed as a possible cause of the crash.

While both major city and small city dailies and weeklies were scanned, it is apparent from the results that most vehicle defect stories appear in newspapers serving the smaller towns. Large city papers and papers serving cosmopolitan areas tend to find enough international and national news to sell papers; small towns can make headlines from a local crash caused by failed brakes.

Figure 1 shows a selection of clippings, identifying their sources. Several cases involve fatalities, and these should later appear in the FARS data. Non-fatal cases, however, deal with such items as failed brakes, shorts in wiring, stuck gas pedals, tires (wheels) falling off, defective brake cylinders, broken steering mechanisms, and assorted alleged defective parts.

While the newspapers conventionally list the driver and owner by name, and usually state his address or city of residence, they do not concern themselves with the make or model of vehicle involved. This may result from a reluctance to say anything untoward about a product sold by a local business. As this would limit the value of such information to NHTSA, an attempt was made to get fuller

Newsday
GARDEN CITY, N. Y.
D. 453,093 SUN. 406,721

MAR 15 1978

Bus in Crash Was Unsafe, Grand Jury Says

By John Cummings 1541A

Kew Gardens—A Queens grand jury, investigating a school bus crash in ...ich two students were seriously in... ...st year, said in a report made ...rday that the bus was un... ...ion and design.

...ed a number of regulations to en... ...fety.

...ry report said the ...though in compliance ...was nevertheless an un... Grand jury reports are is... ...he jurors do not return an ...but want to point out what ...is a situation requiring re...

...ohn Santucci said ...a Queens ad... ...scho...

...ead went through... of the bus, Vincent Cas... ...-01 90th St., Ozone Park; guilty in December to a charge ...

...says many school buses have safety pro...

of reckless driving a... a year on probation. ... the Varsity Trans... Heights, which hol... supply most of the ...

The report recomm...

- Higher seat bac... the backs, only 20 ... be 28 to prevent wh... juries. That matche... of the Newsday inv...
- Narrower spaci... hold together the ou... The report said th... the truck, it was ...
- Armrests for t...
- Enactment by ... lation requiring all ... least 40 hours of ... two hours are ... ...tory ...

ELMIRA, N. Y.
STAR-GAZETTE
D. 50,500

MAR 2 1978

Trucker killed nea...

NEWFIELD — A 41-year-old Ohio man was killed early Wednesday near this Tompkins County community after the brakes on his tractor trailer failed, authorities said.

"It's one of the worst accidents I've seen in 19 years," one sheriff's deputy said.

Deputies said Edgar M. Brooks of Girard, Ohio, was killed about 1 a.m. when ... Rt. 13 ...

MIDDLETOWN, CO...
PRESS
D. 20,000

MAR 17 1978

School Bus, Car Accident Injures Five

Police said five persons were injured yesterday afternoon when a school bus collided with a car at the intersection of Washington and High streets.

Police said there were no school children in the bus when the accident occurred.

Police said the bus driver, Rena A. Doyle, 19, of 190 Shunpike Road, Cromwell, was making a right turn onto High Street from the eastbound lane of Washington Street when the brakes on the bus failed.

Police said the bus began to slide and struck an automobile operated by Sharon G. Klick, 29, of 33 Inverness Lane.

Ms. Doyle, Ms. Klick, and three passengers in the Klick vehicle, Gregory Klick, 2, Emma Klick, 4, and Joan Cassyd, age 4 months, all were treated at Middlesex Memorial Hospital and released following the accident.

Ms. Doyle received a written warning for defective brakes. Although the bus is owned by the City of Middletown, state law dictates that the driver of any vehicle is responsible for the condition of the vehicle.

Newsday Photo

GLOVERSVILLE, N. Y.
LEADER-HERALD
D. 14,500

FEB 27 1978

2 Ticketed in County Mishaps

One persons received minor injuries and two tickets were issued in weekend accidents investigated by the Fulton County sheriff's department.

Gary E. Barnes, 26, of Stratford sustained minor head and chest injuries after hitting a parked car at 6:30 Saturday night in the Town of Stratford. He did not require immediate medical attention.

The accident occurred on Route 29-A, two tenths of a mile west of Avery Road.

A car owned by William W. Day of Stratford was parked disabled on the shoulder of the highway, facing west, when Barnes, also traveling west, struck the car from the rear.

Day was issued a ticket on a charge of not having any insurance by Deputy R. A. Gisondi, who investigated.

A ticket for failure to keep right was issued after a 1-car accident at 12:15 yesterday morning in the Town of Johnstown on East Fulton Street Extension, 200 feet east of Route 30-A.

Laurie J. Abel of Perth RD 1 was issued the ticket.

According to the report, she was heading east on East Fulton Street Extension and reportedly said the gas pedal stuck, causing the vehicle to go out of control, crossing to the north side of the highway skidding 185 feet before coming to rest against a utility pole.

Deputy E. C. Bucknell investigated.

Jamestown Post-Journal
JAMESTOWN, N. Y.
D. ...

FEB 15 1978

Still Critical

Anna Foster, 56, of Kennedy was still listed in critical condition in the intensive care unit of WCA Hospital this morning as the result of a two-car car accident Monday.

A broken steering mechanism caused the vehicle Mrs. Foster and her husband were riding in to collide with a parked car on Route 62 south of Grubb Hill Road, police said.

Andrew Foster, her husband, was discharged from the hospital after treatment for a head injury and a laceration of the right hand.

Vineland Times Journal
VINELAND, N. J.
D. 17,139

FEB 25 1978

Truck Crushes Expressway Toll Collector

1541a

PLEASANTVILLE — An Atlantic City Expressway toll collector was fatally injured yesterday afternoon after being hit and dragged by an 18-wheel tractor-trailer apparently experiencing brake failure.

Charles A. Young, 61, of 108 ...tic ave., Atlantic City, was ...ed dead on arrival at ...City Medical Center, ac... to police. Police said ...'s body was totally crushed ...being dragged 260 feet and ...d beneath the tractor-...ler, and that he died instantly.

Young had been crossing the ...nes toward the office of the Pleasantville Toll Plaza after being relieved of his duties around ...p.m. when he was struck by ...17,000 pound rig driven by ...mes H. Steck, 21, of ...iladelphia, according to police.

The truck, owned by Marsh Crap Trap Co. of Trenton, was traveling east approaching the plaza when it suffered brake failure, police said. According to police, investigation revealed that the driver had attempted to stop before hitting the toll collector.

Police said Young was friendly ...drivers of the ex... ...d to hand out ...

The Sunday Star-Ledger
NEWARK, N. J.
SUN. 560,261

FEB 2 6 1978

MAR 7 1978

Truck defective

State Police said yesterday a preliminary investigation revealed a wheel brake cylinder was defective on a truck that struck five and killed a toll collector on the Atlantic City Expressway in Pleasantville.

Charles Young, 61, of Atlantic City, was finishing his day shift at 3:30 p.m. and walking to ...a office ...k by the ...-year-old James Steck of Philadelphia, police said.

He was pronounced dead on arrival at Atlantic City Medical Center.

Steck told police he applied the brakes but they did not work.

He was released pending further investigation.

Police said they impounded the truck, which is owned by Marsh's Crab Trap of Trenton, to test it.

LOCK HAVEN, PA
EXPRESS
D. 10,500

LEBANON, PA.
NEWS
D. 26,500

MAR 4 1978

Car On Fire

7541A

Men and equipment fr... the Ebenezer Fire Co. ...sponded to the Bill Plottenbe...er residence, Lebanon RD... Friday, when a small electri... fire broke out in a car in... Plottenberger driveway. ... fire was put out and dama... was listed at $20.

OLEAN, N. Y.
TIMES HERALD
D. 21,000

FEB 1 4 1978

Woman Critical In Two-Vehicle Crash

POLAND — Anna Foster 682 Main St., Kennedy, N.Y., was critically injured when the car her husband was driving slammed into a pickup truck parked off Rt. 62 in the Town of Poland, Monday, according to Falconer-based State Police.

Andrew Foster, 71, of the same address, was headed north on Rt. 62 at 5:30 p.m. Monday when he lost control of the vehicle following failure of a steering mechanism. The car ...n off the right shoulder of the ... State Police, ...up truck. ...assenger, ...ospital in ...sible skull ...l injuries. ...ical condi- ...ated there

The Hartford Courant
HARTFORD, CONN.
D. 170,459 SUN. 219,365

MAR 2 1978

...Ian Rescued ...fter Truck ...raps His Leg

7541A

By KRISTI VAUGHAN

NEW LONDON — A 42-...ar-old Bridgeport man ...orking on a city sewer pro-...t narrowly missed spend-... the night with his foot ...ight by a dump truck be-...use a 14-year-old New ...ndon youth heard the ...n's cries for help and ran ...is aid.

...ohn Hickey was knocking ...a friend's back door Wed-...day when he heard what ... believed was a whistle. ...en I listened and it was a ...calling for help so I ran ...ss the railroad tracks ... saw him pinned where ... back of the dump truck ...

...the Ocean ...tation and ...while men ...e station ... James Sul-... pulled free ...er from his ...rke Sewer ... of Bridge-... back of the ... police said ... trapped for ...utes and was ...jured. He was ...eleased from ...d Memorial

...been taking ... of fill to the ... had gone to ...nctioning cyl...e truck's body ...k of the truck ...ng to its hori...n, pinning hi... the body an...

...co-workers sai...ey, a Couran... not heard th... Sullivan migh...vived the nigh...s on a privat...

Watertown Daily Times
WATERTOWN, N. Y.
D. 43,427

FEB 2 2 1978

Fire Starts In Auto Ceiling

7541A

J. Harry Gerrish, State Street Road, was driving at Sherman and Mullin Streets Tuesday afternoon when fire sudde... out in the ceiling burning some of ...rish's hair.

City firemen ... fast."

He suffered minor burns to his hands, and declined treatment ...

ST. MARY'S, PA.
PRESS
D. 4,500

FEB 2 2 1978

Little Damage In Car Fire

7541A

Crystal Fire Department members were called out at 10:48 this morning for a car fire at 355 North Michael Street.

According to a report issued by Dale Bille, first assistant Chief, David Perschka drove his 1973 coupe from Ridgway and parked it in the garage behind his home. His wife went to the garage to get something out of the auto and noticed smoke coming from the car.

When firemen arrived on the scene the fire was already extinguished.

DAMAGED MARKET — ...p truck, driven by Da... ...lshans of Jersey Sh... ...lled into Clark's Market, ..., just west of Avis, at a... ...5 a.m. Monday and cra...

ALTOONA, PA.
MIRROR
D. 34,500

FEB 2 4 1978

3-Car Crash Results When...

7541

The left rear ... apparently fell ... traveling south ... causing a three... near Alto-Reste Bu... ...legheny Township, ... Thursday. State police came off...

TUPPER LAKE, N. Y.
FREE PRESS & HERALD
W. 3,500

FEB 2 2 1978

Oil truck loses ...ark St.

... when ... water ...ws ex-... the ...rigin-... light, ... the ... short

...ded with bottled ...some excitement ...ursday when its ...akes failed as it ... descending Park ... hill toward the uptown business ...strict.

Arlen Lamica, the driver, applied ... brakes approaching McLaughlin St. ...ersection. They failed to respond, and ... speed he pulled to ... Faye's Grill, and ...aded vehicle into ...ght feet high near ...

... jumped the snow ...d gas tanks flying ...ll four wheels in ... vacant lot east of ...e wheels caught ...akes, and Tupper ...d pumped water ... douse the blaze.

WARREN, PA.
TIMES AND OBSERVER
D. 12,500

FEB 2 8 1978

...'s Off ...ph Twp.

7541A

...t. A PennDOT plow truck driven by ... Turner, 31, of Tidioute, traveling east ... on Hill at 4:30 p.m. Monday, was ...-ut of control when the mechanism ...e plow in the "up" position broke, ... the plow to the roadway. The truck ...ew 1978 GMC truck in the westbound ...n by Paul W. Morris, RD 1, Tidioute, ...ng the westbound vehicle. Damage ... to the truck. Morris displayed signs ...njuries. Police said the plow-drop was ...echanical defect.

ELMIRA, N. Y.
STAR-GAZETTE
D. 50,500

MAR 2 1978

Trucker killed near Newfield

accident truck 7541A

NEWFIELD — A 41-year-old Ohio man was killed early Wednesday near this Tompkins County community after the brakes on his tractor trailer failed, authorities said.

"It's one of the worst accidents I've seen in 19 years," one sheriff's deputy said.

Deputies said Edgar M. Brooks of Girard, Ohio, was killed about 1 a.m. when his tractor trailer lost its brakes on Rt. 13.

They said the truck, loaded with aluminum, skidded and struck two utility poles before overturning and crushing Brooks who had been ejected.

The truck was owned by Ohio Fast Freight, Inc.

The truck lost its brakes on Newfield hill, at Rts. 34, 96 and 13.

identification of the vehicle by telephone. In the case of the defective dome light wiring in New York, a call was placed to Watertown. In this case the inside roof of the car had overheated and caught fire, causing the driver's hair to ignite. Officials in Watertown were most receptive to "outside" inquiries, and the people talked to remembered this newsworthy item well. The fire department searched their records, and reported that this vehicle was a 1968 Chevrolet station wagon.

Three weeks of clippings from these newspapers in four states yielded 17 separate stories, a sample of which are shown in the figure. In order for this information to be useful to ODI some followup by telephone or mail would be required. If the willingness to provide information by phone is universal, this would seem to be the best, and nationwide might provide more than a hundred reports per month. Of the clippings received during this pilot test, most involved accidents, and most identified the defect with enough detail to classify it into the ODI computer file. But none of them identified the vehicle adequately, and this could evidently only be done by the sort of followup described.

A table of defect types for the clippings received during the pilot survey is shown as Table 7. The two hydraulic control failures occurred on trucks--one a dump truck in which the lift mechanism failed and trapped the operator, and the other a plow in which the lift failed, causing a two-vehicle crash. Brakes were the most common fault, with electrical fires second.

A professional clipping service is a relatively inexpensive technique for keeping informed about news of vehicle defects and their consequences. The service used in the pilot study cost $35.00 for the first state, and an additional $5.00 for each subsequent state, plus a charge of twenty-eight cents for each clipping. Coverage of all the

Table 7

Defects Reported by
Newspaper Clipping Service

Type of Defect	Number Reported
Brakes	6
Electrical Fire	3
Steering	2
Hydraulic Control	2
Stuck Accelerator	1
Wheel Fell Off	1

forty-eight contiguous states, assuming that there would be two hundred clippings per month, would cost less than $350 per month. Even though the news articles do not contain very detailed vehicle make and model identification, they do usually identify the type of vehicle and the type of defective component. It is suggested that a small file of clippings, maintained either manually or in a convenient computer form, would keep ODI informed of the frequency of various kinds of problems associated with accidents. Telephone followup to determine specific make and model data would then permit such data to be entered into the complaint letter files.

SECTION 8

IN-DEPTH ACCIDENT INVESTIGATIONS AS A SOURCE

The Federal government, mainly under the direction of the Department of Transportation, has for many years sponsored in-depth accident investigation studies. The earliest of these projects were known as Multi-Disciplinary Accident Investigations (MDAI), and they are still going on in many areas of the country. While the cases collected are best described as a sample of convenience, the data have been useful particularly in understanding injury mechanisms. The detail of information and the quality of the data are higher in this data base than anywhere else in the accident investigation literature.

The MDAI data file, which currently contains about 15,000 cases, is biased toward severe accidents. Selection criteria have often been left to the interests of the professional teams involved in the work. In past years several teams concentrated on vehicle defects, but their output was small. For the most part vehicles investigated have been rather new and only a limited number of defects in accidents have been reported. MDAI teams generally have sufficient expertise in vehicle engineering to investigate and report on observed defects, but with the small number of accidents fully investigated the total number of defects reported has been small. Indeed, table 1 lists only 22 entries in the ODI file attributed to MDAI, with another 29 attributed to the Indiana University studies which concentrated on vehicle defects for a long period.

Many years of planning have led NHTSA to the point of being able to implement the National Accident Sampling System (NASS). This system, when it is fully operational, will provide DOT with nationwide estimates of accident rates and trends. Between 35 and 65 teams of professional investigators will be in the field collecting accident cases according to a rigidly enforced probability sampling plan, in an attempt to acquire the most accurate and comprehensive set of data possible. These teams relating specifically to defects would provide a rapid indication of the extent of any possible problems on a national scale. Even though the NASS will not be fully operational for a number of years, preliminary data may be a good indicator of the eventual efficacy of this method of data acquisition for ODI's decision-making responsibilities.

Again the number of vehicle defect-caused accidents reported through the NASS may be expected to be quite small. With a total of perhaps 15,000 vehicles investigated per year each team may identify only a few cases of interest, although it is suggested that their output could be improved by taking some of the actions listed below.

The National Crash Severity Study (NCSS) has been in place and collecting data for over a year. This system is not a national probability sample, but is rather described as a "purposive" sample designed to reasonably represent the major geographic, demographic, and climatic variables of the forty-eight contiguous states. While the major purpose of the NCSS is to collect data relevant to a study of the relationship between crash severity and injury production, acknowledgment has already been made within the program of the importance of vehicle defects. A special defect form has been distributed to each of the seven teams with instructions as to its use. There is an obligation on the part of each team to report any safety-related defects that are found in the course of its investigations to the Office of Standards Performance at NHTSA. Neither the quality of the data nor the degree of compliance of the teams can be estimated at this time, but this source of information can be viewed as a potentially valuable one for establishing an emerging pattern of defects that might otherwise go unnoticed.

While in-depth teams have occasionally provided defect reports, they have little emphasis on this subject in either their training courses or in their communications from NHTSA. A standard defect report form has been provided (in NCSS and presumably in NASS), but except for that findings seem to be the result of chance.

Some specific actions to improve this situation are suggested:

1. Make a periodically updated listing and description of past and present defect investigations--the same sort of documentation used by the Hotline operators--and make this available to the field accident investigation teams.

2. Include several hours in the in-depth training courses on the subject of defect identification, preferably with the guidance of, or direct participation of, ODI personnel.

3. As the recalled vehicle list becomes available in on-line computer form, and as the NASS teams acquire computer terminal capability, provide the teams with access to this data so that each vehicle can be checked at the time of the investigation. This action is likely to be more useful to the investigators in their interviews, but feedback relative to the effectiveness of recalls should be of interest to ODI.

4. Provide a telephone communication contact within ODI for accident investigation teams--either for reporting, or for seeking advice in connection with an investigation. The present paper reporting system discourages full communication between the field teams and the ODI as a user.

The in-depth accident investigation activities sponsored by NHTSA represent a resource for ODI which has the potential for providing detailed reports on new findings of defects, or supportive information for active investigations. It can be more productive than it has been in the past, in part because the newer investigation programs will have broader coverage, and in part if more training and encouragement and communications are provided.

SECTION 9

ANALYTIC METHODS

The present ODI defect file contains a variety of information about vehicle (and other component) defects in a data management system which allows convenient retrieval of subsets identified by the user. The data management system in use, however, is not intended for statistical analysis, and it would be necessary to modify it, or to transfer portions of that data to other systems to produce such a capability. One of the most widely available analysis packages for processing survey data is the SPSS (Statistical Package for the Social Sciences) system, and this section of the report describes procedures for converting the defect file data into that form, complementing it with exposure data (from the vehicle registration rolls or production information), and calculating and displaying such dependent variables as "reported defects per registered vehicle in the population" in such as way as to permit quicker and easier identification of potential problem areas.

A set of police-reported accident data from the state of Washington, and the NHTSA-generated FARS data are used to demonstrate this technique. The FARS data, as it has been reformatted for this demonstration, should be useful immediately in the defect identification process, particularly for fire involvement cases. Procedures necessary to apply the techniques described here to the existing Office of Defects Information files are discussed.

Background

The present ODI complaint letter file contains data from many sources--letters from owners about specific parts failures or deficiencies, reports of accidents or injuries involving defects, and information about failed parts reported by repair agencies.

One criticism of the present ODI operation has been that exposure has not been properly taken into account. Whether it is more dangerous for the American public to have a 0.01% defect in a high production domestic car than a 10% defect in a low volume foreign import is debatable, but it would be desirable for a defect analysis technique to be capable of identifying and quantifying either kind of problem.

The R. L. Polk vehicle registration data on vehicle make/model has recently become available in a more detailed form. This data, taken from state registration rolls, does not adequately represent the newest cars, and would have to be supplemented by other (say, production) data to be up-to-date with the ODI complaint files.

One would like to be able to identify defects and to order these by some safety criticality measure. For example, if there is evidence that a component catches fire hours after a vehicle has been parked in a garage, and has been responsible for burning down a number of garages, one might wish to weight such evidence more strongly than that of a light switch which fails only when one attempt to turn it on. Similarly, one might weight "defect" involvement in fatal accidents more than a "complaint letter." A data processing system should permit an analyst to assign weights to different data sources or different kinds of defects.

One would like to calculate rates--i.e., the number of defects per registered vehicle--by make, model, or by various logical groupings, such as "all GM Intermediate bodies," "Mavericks and Comets" together (for years when they were essentially the same car), or all cars with wheelbase between 112 and 116 inches. Some such questions would require a degree of detail in the exposure data which is not readily available at present, but these sorts of groupings should strengthen the capability to discover defects associated with production or design problems.

Approach

The existing data (both the defect information and the exposure information) will be described with respect to content and form. Then a sequence of steps will be described for putting that data into a form for analysis as described above. Next the analysis technique will be demonstrated using the Washington and FARS data as surrogates for the ODI complaint letter file.

For operation with the present ODI data files, coding must be made consistent between those and the exposure data, i.e., both the defect data and the exposure data would have to identify vehicles (components) in the same way. Both the present Kappa coding system and the R.L. Polk registration system derive from Vehicle Identification Number (VIN) records, and identify vehicles in terms of marketing make and model names. The ODI system uses a ten digit code, with the digits (from left to right) indicating in Table 8:

Table 8

ODI Vehicle Coding

DIGIT	Meaning
1 & 2	Country of Manufacture
3 & 4	Company, Corporation, or Manufacturer
5 & 6	Corporate division, "Make"
7 & 8	Model
9 & 10	Sub-model

For example, the five 2-digit code groups might indicate (1) U.S.A., (2) General Motors, (3) Buick, (4) Century, (5) Special. In addition, vehicle model year would be represented by a 2-digit code, and a vehicle type variable identifies busses, chassis cabs, motorcycles, passenger vehicles, etc., with a 2-digit code (although this is presently an alphanumeric code). Also coded, at least occasionally, are body style, wheelbase, horsepower, number of cylinders, carburetion (e.g., 2-bbl., 4-bbl.), power steering, automatic transmission, air conditioner, speed control, and the identification of a "two-stage" vehicle.

By comparison, the present R.L. Polk files allow most of these factors to be identified (presently in a different coding system), although it seems doubtful that air conditioning, transmission, power brakes, power steering, or speed control could be determined.

Defective components are coded in the ODI files by an eight-digit code representing about 15 major categories and numerous sub- and sub-sub categories. It would be possible to transfer all of this data to an analysis file, establishing counts of defects of each type for each unique vehicle category, but it would be more practical (and perhaps equally useful) to group the defects into larger categories. The present ODI code lends itself to such recategorization, and a possible list of 30 classes is shown in the table below. (Table 9). Defects are coded in the ODI files by 15 major categories and numerous sub- and sub-sub categories using an eight-digit code. Using the higher level identifiers one could define the major components of a vehicle.

In order to demonstrate the concept discussed above, a set of existing (accident) data which provides a moderately detailed breakdown of vehicle make and model, and a number of "defect" identifications in connection with accidents are used. Data from the state of Washington are coded into six vehicle identification variables--Country of Origin, Manufacturing Corporation or Company, Division (or Make of Car), Body Size, and Model year. An SPSS file has been formed which includes one case for each unique combination

Table 9

Suggested Grouping of Components

Item	Codes
Steering	010 to 015
Suspension	020 to 025
Wheels	026
Tires	027
Service Brakes	030 to 036
Parking Brakes	040 to 042
Engine	050 to 051
Cooling System	052
Fuel Systems	061
Carburetion	062
Fuel Injection	063
Throttle linkage	064
Emission control	065
Exhaust system	066
Power train	070 to 074
Electrical	080 to 085
Lights	090 to 094
Horns	095
Light concealment	096
Glass	100 to 101
Mirrors	102
Wipers/Washers	103
Heater/Air conditioning	110 to 119
Passive rest.	121
Active rest.	122
Anchors/seats	123
Inst. panel	124
Structure	130 to 138
Equipment	150 to 159

of the above variables which is present in the data, followed by a series of counter variables indicating (1) the total number of vehicles in that class, and (2) through (12) the numbers of brake, headlight, rear light, worn tire, blowout, wheel falling off, steering, power train, glare, no lights, others, no defects, and unknowns.

The file may be used with conventional SPSS program packages, and with appropriate "Select If" and "Weight" statements can produce a variety of output appropriate to detection of trends of peaks in the data. Several examples of such output are given in the following paragraphs.

File Structure and Sample Outputs

The SPSS file structure used in this example is shown in Appendix D. Variable labels, value labels, missing data values, etc. have been assigned. This sort of file may be used with one of the "counter" variables as a weighting factor, so that the numbers produced by the run represent such total quantities as "total number of vehicles (of a given class) in the population," "total number of vehicles (of a given class) with brake defects noted," etc. In addition, using the facility of SPSS, it is easy to construct new variables--e.g., adding all the different kinds of defects together, or making a weighted combination of defects (so that, for example, more important entries would count more heavily in the result). One such weighting might be to assign fatal accident defect reports, say, 25 times the weight of a "complaint letter"; or to assign fire reports a higher weighting than non-fire reports. The Washington digital file does not contain all of the identifying variables present in the ODI/Polk data, but the analytic methods will be demonstrated with the available variables.

Two-way Tabulations

This SPSS run produced three tables, all limited to Chrysler products. (Numbers following refer to the tables)

10. Make by body type, weighted by the number of vehicles in the total file.

11. Make by body type, weighted by the number of with defective brakes.

12. Make by body type, weighted by the number of with tires worn.

Additional tables may be prepared from ratios of the values within the cells, and two of these are shown:

13. Make by body type, proportion of vehicles with defective brakes.

14. Make by body type, proportion of vehicles with tires worn.

Table 10

Number of Chrysler Cars in Accidents in Washington by Body Size

Make	Inter-mediate	Standard	Specialty Pony	Compact	Total
Chrysler	0	250	0	0	250
Dodge .	297	203	127	407	1034
Plymouth	335	412	82	403	1232
Total .	632	865	209	810	2516

Table 11

Number of "defective brake" Chrysler Cars in Accidents in Washington Make by Body Size

Make	Inter-mediate	Standard	Specialty Pony	Compact	Total
Chrysler	0	1	0	0	1
Dodge .	3	1	0	3	7
Plymouth	2	4	1	2	9
Total .	5	6	1	5	17

Table 12

Number of Chrysler Cars in "Tire Worn" Accidents in Washington Make by Body Size

Make	Inter-mediate	Standard	Specialty Pony	Compact	Total
Chrysler	0	6	0	0	6
Dodge .	8	6	9	8	31
Plymouth	17	10	1	7	35
Total .	25	22	10	15	72

Table 13

Proportion of Chrysler Cars with Brake Defects in Accidents Make by Body Size

Make	Inter-mediate	Standard	Specialty Pony	Compact	Total
Chrysler	0	.004	0	0	.004
Dodge .	.01	.005	0	.007	.0067
Plymouth	.006	.01	.012	.012	.0073
Total .	.0079	.0069	.0048	.0062	.0068

Another Computer Approach

The two-way tables are not very convenient, since they require computation external to the SPSS system to develop ratios. The SPSS BREAKDOWN program divides the data into

Table 14

Proportion of Chrysler Cars with "Tire Worn" Accidents by Body Size

Make	Intermediate	Standard	Specialty Pony	Compact	Total
Chrysler	0	.024	0	0	.024
Dodge .	.027	.030	.071	.020	.030
Plymouth	.051	.024	.012	.017	.028
Total .	.040	.025	.048	.019	.029

groups more conveniently. In BREAKDOWN the analyst may specify a dependent variable (e.g., the number of defective vehicles), and a sequence of independent variables. The result is a display of values of the dependent variable for successive subsets in the order prescribed.

An additional capability is SPSS is the fairly easy computation of a new variable as any function of existing variables. Given that the data are recorded as counts for individual defects, one may sum these over any desired grouping (say, create a new variable which is the sum of different kinds of defects), or weight the data so as to give increased importance to particular defects. For example, if the defect data set consisted of (1) complaint reports, (2) injury accidents involving defects, and (3) fatal accidents involving defects, one could define a new dependent variable which was a weighted combination of these three kinds of entries.

Tables 15, 16, and 17 show the result of applying the BREAKDOWN program to the Washington data. In table 15, the dependent variable (titled "SUM" in the table) is the total number of vehicles manufactured by Ford, subsequently broken down by manufacturing division (Ford and Lincoln-Mercury) and then by Body Type. The following table shows the value of the dependent variable "NEWVAR" for each of the sub-groups. This may be thought of (the "SUM" column) as the number of vehicles exhibiting a defect, although in this case the number represents a weighted sum of several defects. This is done simply to demonstrate that SPSS provides the flexibility to create a variable representing such a weighted combination.[1]

Ratios of the "SUM" values in the second table to those in the first may be computed to determine which sub-groups are high or low with respect to this particular variable. A program has been written to calculate the ratio given the BREAKDOWN tables as input, but it will be shown in connection with the FARS data to follow. In addition to computing the ratio, the program computes and displays the statistical significance of the difference between the value of the dependent variable for the subgroup and the same value for the total group.

Application to the FARS data

The FARS data for 1977 was converted into a form similar to that of the Washington data. Vehicle make and model identification in FARS is in several forms, and the form not derived from the VIN has been used as it is somewhat more complete. Variables identifying make, model, body type, model year, weight, and wheelbase are coded, and counter variables are derived for a vehicles in the file, and for those with fires, and each of the several categories of defects. Appendix E details the SPSS file structure, and this is a simple transformation of variables from the FARS file.

---

[1] In SPSS this is done by writing the FORTRAN statement:
NEWVAR=BRAKES+5*STEERING+25*WHEELOFF

\>
\>FILE DEFECT (CREATION DATE = 01/20/78)

\>- - - - - - - - - - - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - - - - -

\>CRITERION VARIABLE TOTALVEH INVENTORY OF VEHICLES IN CATEGORY
\> BROKEN DOWN BY DIVISION MANUFACTURING DIVISION
\> BY BODYTYPE BODY TYPE

\>- -

>VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
>FOR ENTIRE POPULATION			4361.0000	7.0339	13.4694	181.4253	(620)
>							
>DIVISION	121.	FORD	3705.0000	8.3258	15.5031	240.3463	(445)
> BODYTYPE	1.	INTERMEDIATE	587.0000	6.0515	7.1039	50.4661	(97)
> BODYTYPE	2.	STANDARD	1114.0000	9.4407	12.9017	166.4537	(118)
> BODYTYPE	5.	PERSONAL LUXURY	159.0000	4.0769	4.0548	16.4413	(39)
> BODYTYPE	6.	SPECIALTY PONY	760.0000	12.6667	26.5596	705.4124	(60)
> BODYTYPE	8.	COMPACT	452.0000	7.2903	13.9911	195.7504	(62)
> BODYTYPE	12.	PICKUP	79.0000	9.8750	11.4447	130.9821	(8)
> BODYTYPE	14.	UTILITY	32.0000	1.7778	1.2154	1.4771	(18)
> BODYTYPE	17.	PICKUP CAR	15.0000	1.5000	0.9718	0.9444	(10)
> BODYTYPE	18.	SUBCOMPACT MINI	507.0000	15.3636	26.1113	681.8011	(33)
>							
>DIVISION	122.	LINCOLN MERCURY	656.0000	3.7486	4.1224	16.9939	(175)
> BODYTYPE	1.	INTERMEDIATE	111.0000	3.8276	2.9285	8.5764	(29)
> BODYTYPE	2.	STANDARD	217.0000	3.6780	3.6172	13.0842	(59)
> BODYTYPE	3.	LUXURY SEDAN	95.0000	2.6389	2.1534	4.6373	(36)
> BODYTYPE	5.	PERSONAL LUXURY	3.0000	1.0000	0.0	0.0	(3)
> BODYTYPE	6.	SPECIALTY PONY	134.0000	7.0526	8.5341	72.8304	(19)
> BODYTYPE	7.	GRAND PRIX	14.0000	3.5000	3.7859	14.3333	(4)
> BODYTYPE	8.	COMPACT	79.0000	3.2917	2.6454	6.9982	(24)
> BODYTYPE	18.	SUBCOMPACT MINI	3.0000	3.0000	0.0	0.0	(1)

\> TOTAL CASES = 906
\>MISSING CASES = 286 OR 31.6 PCT.
#

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>

>FILE NONAME (CREATION DATE = 03/23/78)

>- - - - - - - - - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - - - -

>CRITERION VARIABLE FIRES / NO.VEHS

> BROKEN DOWN BY MAKE MAKE OF VEHICLE

> BY WHLBASE BRACKETED WHEELBASE OF VEHICLE - VIN

>- -

>VARIABLE	CODE	VALUE LABEL	TOTAL SUM	NUMBER DEFECT	% DEFECT	SIG. LEVEL
>FOR ENTIRE POPULATION			35783	857.0000	2.39	0.0000
>						
>MAKE	1.	CHEVROLET	10658	263.0000	2.46	0.7210
> WHLBASE	1.	80-93 MINI	3	0.0	.00	****
> WHLBASE	2.	94-101 SUBCOMP	658	22.0000	3.34	0.9460
> WHLBASE	3.	102-111 COMPACT	1370	25.0000	1.82	0.0796
> WHLBASE	4.	112-118 INTERMEDIATE	1461	40.0000	2.73	0.8091
> WHLBASE	5.	119-125 FULL SIZE	1559	23.0000	1.47	0.0076
> WHLBASE	6.	126+	22	0.0	.00	****
> WHLBASE	7.	UNKNOWN WHEELBASE	5585	153.0000	2.73	0.9668
>						
>MAKE	2.	FORD	9516	248.0000	2.60	0.9422
> WHLBASE	1.	80-93 MINI	2	0.0	.00	****
> WHLBASE	2.	94-101 SUBCOMP	727	19.0000	2.61	0.6516
> WHLBASE	3.	102-111 COMPACT	1027	30.0000	2.92	0.8681
> WHLBASE	4.	112-118 INTERMEDIATE	859	25.0000	2.91	0.8411
> WHLBASE	5.	119-125 FULL SIZE	1448	39.0000	2.69	0.7758
> WHLBASE	6.	126+	3	0.0	.00	****
> WHLBASE	7.	UNKNOWN WHEELBASE	5450	135.0000	2.47	0.6667
>						
>MAKE	3.	PONTIAC	2431	63.0000	2.59	0.7443
> WHLBASE	2.	94-101 SUBCOMP	45	4.0000	8.88	****
> WHLBASE	3.	102-111 COMPACT	379	16.0000	4.22	0.9902
> WHLBASE	4.	112-118 INTERMEDIATE	796	21.0000	2.63	0.6752
> WHLBASE	5.	119-125 FULL SIZE	506	11.0000	2.17	0.3715
> WHLBASE	6.	126+	73	2.0000	2.73	****
> WHLBASE	7.	UNKNOWN WHEELBASE	632	9.0000	1.42	0.0534
>						
>MAKE	4.	BUICK	1617	26.0000	1.60	0.0169
> WHLBASE	2.	94-101 SUBCOMP	27	2.0000	7.40	****
> WHLBASE	3.	102-111 COMPACT	61	1.0000	1.63	****
> WHLBASE	4.	112-118 INTERMEDIATE	428	8.0000	1.86	0.2370
> WHLBASE	5.	119-125 FULL SIZE	410	8.0000	1.95	0.2770
> WHLBASE	6.	126+	253	1.0000	.39	****
> WHLBASE	7.	UNKNOWN WHEELBASE	438	6.0000	1.36	0.0789
>						
>MAKE	5.	PLYMOUTH	2087	32.0000	1.53	0.0041
> WHLBASE	1.	80-93 MINI	13	0.0	.00	****
> WHLBASE	2.	94-101 SUBCOMP	2	0.0	.00	****
> WHLBASE	3.	102-111 COMPACT	524	6.0000	1.14	0.0294
> WHLBASE	4.	112-118 INTERMEDIATE	398	8.0000	2.01	0.3065

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>FILE DEFECT (CREATION DATE = 01/20/78)

>- - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - -

>CRITERION VARIABLE NEWVAR
> BROKEN DOWN BY DIVISION MANUFACTURING DIVISION
> BY BODYTYPE BODY TYPE

>VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
>FOR ENTIRE POPULATION			69.0000	0.1113	0.5703	0.3252	(620)
>DIVISION	121.	FORD	59.0000	0.1326	0.6562	0.4306	(445)
> BODYTYPE	1.	INTERMEDIATE	9.0000	0.0928	0.5417	0.2934	(97)
> BODYTYPE	2.	STANDARD	23.0000	0.1949	0.8698	0.7566	(118)
> BODYTYPE	5.	PERSONAL LUXURY	3.0000	0.0769	0.2700	0.0729	(39)
> BODYTYPE	6.	SPECIALTY PONY	10.0000	0.1667	0.5262	0.2768	(60)
> BODYTYPE	8.	COMPACT	4.0000	0.0645	0.3068	0.0941	(62)
> BODYTYPE	12.	PICKUP	0.0	0.0	0.0	0.0	(8)
> BODYTYPE	14.	UTILITY	10.0000	0.5556	1.6169	2.6144	(18)
> BODYTYPE	17.	PICKUP CAR	0.0	0.0	0.0	0.0	(10)
> BODYTYPE	18.	SUBCOMPACT MINI	0.0	0.0	0.0	0.0	(33)
>DIVISION	122.	LINCOLN MERCURY	10.0000	0.0571	0.2328	0.0542	(175)
> BODYTYPE	1.	INTERMEDIATE	1.0000	0.0345	0.1857	0.0345	(29)
> BODYTYPE	2.	STANDARD	4.0000	0.0678	0.2536	0.0643	(59)
> BODYTYPE	3.	LUXURY SEDAN	2.0000	0.0556	0.2323	0.0540	(36)
> BODYTYPE	5.	PERSONAL LUXURY	0.0	0.0	0.0	0.0	(3)
> BODYTYPE	6.	SPECIALTY PONY	1.0000	0.0526	0.2294	0.0526	(19)
> BODYTYPE	7.	GRAND PRIX	0.0	0.0	0.0	0.0	(4)
> BODYTYPE	8.	COMPACT	2.0000	0.0833	0.2823	0.0797	(24)
> BODYTYPE	18.	SUBCOMPACT MINI	0.0	0.0	0.0	0.0	(1)

> TOTAL CASES = 906
>MISSING CASES = 286 OR 31.6 PCT.
#

This page reserved for Table 17

The tables presented here concern the incidence of fires in vehicles involved in fatal accidents. Intermediate tabulations, similar to those above, may be prepared. But the final table (shown as Table 18) contains all of the pertinent information. In this table the breakdown has started with Make (e.g., Chevrolet, Ford, Pontiac, etc.), and is then followed by wheelbase arranged in groups identified with compact, intermediate, full-size bodies. The column headed "Total Sum" tabulates all of the vehicles of each class involved in fatal crashes. The column headed "Number Defect" tabulates those vehicles which sustained fires. The "% defect" column represents the ratio of these two.

This table represents only passenger cars in the FARS file, and the first row indicates that of 35,783 cars, 857 had fires--2.39% of the total. The last column of the table, headed "Sig. Level," indicates whether a defined sub-group is significantly higher or lower in fire incidence than the value of the entire population. The significance level has been calculated by one of two methods, depending on the sub-group size. When the sub-group is large, a normal approximation has been used to obtain the significance level; when the sub-group is small, the exact probability has been computed. Finally, for those cases with a very small number of vehicle in the population, and no fires, neither tests provides a useful result, and the notation "****" has been entered in the Significance column.[2]

The interpretation of the "Significance Level" column is as follows: values greater than 0.9 indicate that these groups have a higher than average fire involvement at a significance level of 0.1 or less. Similarly, values between 0.0 and 0.1 indicate that the groups have less fire

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[2] The FORTRAN program used to develop this output from the SPSS BREAKDOWN printout is given in Appendix G.

>

>FILE DEFECT (CREATION DATE = 01/20/78)

>- - - - - - - - - - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - -

>CRITERION VARIABLE NEWVAR / TOTALVEH

> BROKEN DOWN BY DIVISION MANUFACTURING DIVISION

> BY BODYTYPE BODY TYPE

>- -

>VARIABLE	CODE	VALUE LABEL	TOTAL SUM	NUMBER DEFECT	% DEFECT
>FOR ENTIRE POPULATION			4361	69.0000	1.58
>					
>DIVISION	121.	FORD	3705	59.0000	1.59
> BODYTYPE	1.	INTERMEDIATE	587	9.0000	1.53
> BODYTYPE	2.	STANDARD	1114	23.0000	2.06
> BODYTYPE	5.	PERSONAL LUXURY	159	3.0000	1.88
> BODYTYPE	6.	SPECIALTY PONY	760	10.0000	1.31
> BODYTYPE	8.	COMPACT	452	4.0000	.88
> BODYTYPE	12.	PICKUP	79	0.0	.00
> BODYTYPE	14.	UTILITY	32	10.0000	31.25
> BODYTYPE	17.	PICKUP CAR	15	0.0	.00
> BODYTYPE	18.	SUBCOMPACT MINI	507	0.0	.00
>					
>DIVISION	122.	LINCOLN MERCURY	656	10.0000	1.52
> BODYTYPE	1.	INTERMEDIATE	111	1.0000	.90
> BODYTYPE	2.	STANDARD	217	4.0000	1.84
> BODYTYPE	3.	LUXURY SEDAN	95	2.0000	2.10
> BODYTYPE	5.	PERSONAL LUXURY	3	0.0	.00
> BODYTYPE	6.	SPECIALTY PONY	134	1.0000	.74
> BODYTYPE	7.	GRAND PRIX	14	0.0	.00
> BODYTYPE	8.	COMPACT	79	2.0000	2.53
> BODYTYPE	18.	SUBCOMPACT MINI	3	0.0	.00

> TOTAL CASES = 906

>MISSING CASES = 286 OR 31.6 PCT.

>

#

This page reserved for Table 18.

involvement than average with a significance level of 0.1 or less. The over- or under-representation significance depends both on the number of vehicles in the subset and their deviation from the grand mean. Thus, Chevrolets of unknown wheelbase, with 2.73% involvement, are significantly higher in fire incidence than the mean partly because there are so many of them. The 1461 intermediate Chevrolets, although they have the same "%fire" value, are not identified as significantly high. Simple inspection of the last column reveals that Plymouths are significantly under-represented, as are Buicks, Oldsmobiles, Cadillacs, and AMC cars; Dodges and Fords are overrepresented; and the remainder relatively neutral.

With the level of detail currently available in the FARS data, one may take these findings only as an indication that further study might prove worthwhile. It would be possible to further subdivide the fire data by type of collision, for example, and perhaps some insight into fires involving rear-struck vs. front-struck cars would result. But a better solution would seem to be to add this sort of detail in the FARS coding,and to tailor that to the needs of ODI.

What Should be Done

The point of the analysis procedures described in this chapter has been to demonstrate that a packaged analysis system such as SPSS can be used with a combination of defect and exposure files to produce output identifying vehicles with higher than normal "defect" experience. The method used in both the Washington and FARS files could be extended to the current ODI files in combination with the Polk exposure data. This would require a number of actions, but they are quite straightforward. They include:

1. Deciding on a consistent code for vehicle make and model, engine, body, etc. between the present Polk codes and the present ODI (Kappa) codes. If the data are actually to reside in SPSS form, it may be

best to translate both Polk and Kappa codes into a new form most appropriate for SPSS. In any case, this is likely to be a simple transformation which can be performed almost entirely by computer.

2. Acquiring population data for recently produced vehicles (i.e., those not in the Polk registration-derived data), and encoding that in the same form as above.

3. Choosing an arrangement (recoding) of the defect data to be placed in the analysis file. One possible arrangement has been shown above, but some thought should be given by the users in ODI as to what level of detail they want. Again, this transformation is going to be almost entirely done by computer, and choices made at this point are not necessarily permanent or final; but a candidate set should be chosen.

4. Merging the defect and Polk data sets into a common form.

5. Deciding whether SPSS is the most appropriate working system, and if so, lay out and build an SPSS file.

6. Writing necessary programs to permit useful "rate" outputs from the SPSS files.

7. Reviewing the output and trying additional presentations of data.

There are a few possible pitfalls to look out for. The sample data used here do not permit a zero denominator, since both the defect and non-defect cases together constitute the denominator. This same procedure would probably be best for an operating system. It is not clear that SPSS will handle the cell sizes implied by a census of registered vehicles in the U.S., and it may be necessary to divide population data by one or more factors of ten. And any operating system should make it easy to modify and/or update the data--choosing different arrangements of defect variables, etc.

This sort of computer based system for identification of higher-than-desired frequencies of defective components should provide a capability to the Office of Defects

Investigation to scan its complaint and defect files periodically and to print out variations from the norm. The computer-based system will not, in general, perform the engineering analysis necessary to fully identify defect mechanisms; but it should serve as an indicator of which subjects deserve further study.

SECTION 10

CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations derive mainly from sections 4 through 9 of this report, and there are many detailed procedural recommendations made in those sections. In this final section a summary of recommendations and conclusions is presented.

In November of 1976 the National Motor Vehicle Safety Advisory Council submitted a report to the NHTSA administrator concerning Safety Defect Recall Campaigns.[3] A principal conclusions of that study was given as, "The Council believes there is a critical need to develop more significant data and more comprehensive data sources". Table 1 of the present report shows the list of sources used today, along with the frequencies of inputs from them. While there are 41 sources listed, only a few of these contribute data in large numbers. In this study we have sought data sources which would either cover large populations (with a small but finite probability of finding defects) or small populations with a high probability of cases of interest. The new sources suggested herein are believed to be practical, and implementable into the ODI information processing system.

The present ODI data processing system has the capacity to handle additional inputs, but it does not have the capability to perform statistical analyses directly. This report recommends the development of analytic capabilities, and of associated computer activities. If the present ODI data processing system is reaching the limits of capacity, thought should be given to developing a new system with capability for both retrieval and analysis.

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[3] "Safety Defect Recall Campaigns--A Report Submitted to the Secretary of Transportation by the National Motor Vehicle Safety Advisory Council" DOT-HS-802 111, November 1976.

The Fatal Accident Reporting System

Present coding of defects in the FARS program is inconsistent from state to state, and often not even in accord with the written rules. Operations within the FARS system should be modified to establish codes and code usage of direct interest to ODI.

Both to minimize delays and to get more complete data, arrangements should be made to submit fatal accident defect cases of potential interest directly from the state coding personnel (or even from police officers) to the NHTSA Hotline or by mail to ODI. There is often data available to these coders which would be of direct interest to ODI personnel, but which does not appear in the restrictive digital codes.

Coding of fire information in the fatal accident files should be made more detailed. At present it is not possible to separate engine fires, electrical fires, fuel tank fires, etc., but these divisions should be of interest in defect determination.

The present FARS data should be submitted to analyses similar to those shown in Section 9 of this report. This sort of analysis activity should identify coding shortcomings, and ultimately feed back to make the file more useful. But if the file is not analyzed extensively and by many different users such feedback will be a long time coming.

Court Records

Relatively recent changes in the law regarding warranty and strict liability have resulted in an increased number and broader scope of products liability suits against manufacturers over the past decade. The individual products liability suit is usually accompanied by intensive investigation, and with increasing caseload has come increasing sophistication in the form of detailed technical material and legal methodology. Records of such cases essentially are in the public domain from the time they are filed, and thus the court records of the country may serve as a resource with a high content of information pertinent to the interests of ODI.

Before implementing a system to acquire data from this source, it would be appropriate to conduct a pilot study. This might be done by searching court records of a dozen large east coast cities, for the purpose of establishing information as to the volume of cases handled by these courts, what types of products are alleged to be defective, and what classes of defendants in addition to the major domestic auto manufacturers should be included in a working system, (e.g., suppliers, parts manufacturers, two-stage vehicle manufacturers, and suppliers and manufacturers brought in as third-party defendants).

Assuming that the results of such a pilot study were positive, the next step would be to design an active data acquisition system, accompanied by either a place for such data in the current ODI files, or a parallel separate file structure for recording court data.

Fire Department Records

Fire department records are of potential value to ODI because they contain information about vehicle fire problems not associated with crashes. City, state, and national compilations of fire incident information identify ignition source, type of material burned, extent of damage, injuries, and many other factors not available in police data. Where vehicle design has been a factor in fire causation, analysis of such data has the potential to identify the problem.

Mass fire data from one or more states could be used immediately for analysis, subject to the limitations that vehicle identification is often not as detailed as ODI would prefer. Nevertheless, large groups of vehicles (say by model year and manufacturing division) can be isolated and evaluated. Data is likely to be more complete at the state level than at the national level at present, although the National Fire Prevention and Control Administration is encouraging state participation in a uniform reporting system which ultimately should lead to better national data.

A possibly more productive source of fire incident data, particularly from the standpoint of detailed vehicle identification, is to get reports directly from the source--i.e., from the fire fighters or at least the department which covered a particular fire. Three approaches to getting information from this source are discussed in Section 6--a continuing survey of fire departments in a few major cities, the addition of a fire data acquisition capability to the NASS system, and a special sampling system to collect national data on vehicular fires. The latter suggestion would be of interest mainly if the National Fire Prevention and Control Administration develops that sort of capability. A recent MITRE Corporation study has proposed that.[4]

Clipping Service

A newspaper clipping service concentrating on news involving accidents and defects can produce many items of interest. Such news tends to occur in small towns, and has the disadvantage of lack of detail--particularly concerning vehicle makes and models. Nevertheless, with modest followup, a continuing input of information could be developed at little cost.

NHTSA should subscribe to such a service, and should

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[4] "Feasibility Study of a Nationwide Fire Hotline,", by S. M. Halpern, C. A. Hauer, and S. Polk, The MITRE Corporation, January, 1977.

maintain at least a hard-copy file of the resultant information. If the volume of information turns out to be as large or larger than that predicted by this study, it would be appropriate to develop a computer file of this information, and to add the necessary followup to better identify needed details.

In Depth Accident Investigation

The NHTSA-sponsored in-depth accident investigation activities are already considered a resource for ODI, but with the increasing volume of vehicles handled in that system should be of more value in the future. The accident investigation system will be of most value, however, if positive actions are taken within NHTSA to stimulate reports of interest.

Actions suggested in this report include (1) furnishing the field units with written information about defect and recall cases, (2) getting ODI participation in the training of the field teams, (3) as the NASS teams get computer terminal equipment, encouraging their access to ODI lists of recalled vehicles, and (4) establishing a mechanism for telephone contact between field teams and ODI for the purpose of reporting or for seeking advice--a sort of technical Hotline for professionals.

Analytic Methods

There are many sources of defect information, including the present files maintained by ODI. Up to the present there has been little effort to apply statistical analysis techniques to the data in seeking areas of potential interest.

In this report several new data sets have been discussed, and the use of standard packaged analysis tools to analyze them has been demonstrated. Analysis should be an integral part of any data collection system, and any consideration of redoing the ODI files should include planning for analysis. For the present, however, analysis activities might best proceed toward incorporating the R.L. Polk or other exposure information into a defect file, and developing the capability to list out high and low defect rates for various vehicle categories.

- Analytic activities for the new sources suggested in this report could be a modified fatal accident file which permits the sort of displays shown in section 9. Procedures for the analysis of the court records, the fire data, in-depth accident investigations, and the clipping service should be developed along with any decision to incorporate such data into the ODI system.

APPENDICES

APPENDIX A
Tables of FARS Fires and Defects in Michigan

Summary of Michigan FARS Defect-Related Fatal Crashes

BRAKES	
Mentioned no brakes or brake fluid	5
Investigated and worn out	2
STEERING	
Stuck Throttle	2
Mentioned as having no capability	6
TIRES	
Mixed Tires	2
Bald	5
Blow out	9
Rim or wheel came off	1
FIRES	
Prior to impact	1
Upon frontal impact	20
Rollover	2
Rear-ended by vehicle	6
Rear-ended another vehicle/ and caught fire	2

Three crashes involved snowmobiles. Several other miscellaneous defects are listed as follows:

Moisture caused brakes to freeze	1
Misdirected headlights (killed pedestrian)	1
Carbon monoxide poisoning (home-made house trailer)	1
Hood flew up (no visibility)	1
Faulty door latch (passenger fell out)	1
Trailer came loose, killed pedestrian	1
Truck trailer loosened & killed another driver	1
Worn out shocks	1
Propane truck exploded on impact causing seven vehicles to catch on fire - each of the 7 are coded as fires	1

1976 Michigan FARS Defect-Related Crashes

	FARS Case #	Date of Crash	Alcohol related or BAC	# of Fatals	Vehicle Type	Year	Make	Defect Listed	Results of Mechanical Investigation
1.	23	1/11/76		1	Snowmobile	71	Johnson	Brakes	Totally worn out
2.	52	1/22/76	yes, no BAC	1	Snowmobile (parked car not mentioned)	72		Fire	No mention but hit a parked car at the gas tank (reckless)
3.	163	2/25/76		1	Chev. Carryall	71	Chev.	Tires	Mix of snow & belted radial (hit slippery water)
4.	168	2/25/76	.170	1	Full size	73	Pontiac	Fire	No reason, still open
5.	178	2/27/76	.070	1	Pick-up	66	GMC	Tires	Bald - blow out
6.	207	3/12/76	.240	1	Full size	70	Amer. Motors	Hood flew up	Hit guard rail
7.	209	3/12/76	.100	Veh.1 - 3 Veh.2 - 2	full size Interim	69 69	Ford Olds	Fire	Unknown
8.	222	3/14/76	.130	1	Interim	67	Plymouth	Faulty latch mech. on door	Prior damaged door - it opened and she fell out
9.	225	3/18/76		1	Compact	73	Chev.	Tires	No tread
10.	226	3/14/76	.110 Dr	1	Full size	71	AMC	Fire	Killed pedestrian mis-coded (coding error)
11.	235	3/20/76	.110	1	(Corvette) Sports car Full size	75 65	Chev. Buick	--- Fire	 Struck in rear-burst into flames
12.	237	3/22/76		1 1	Diesel Semi	63 66	IH GMC	Tires	Bald - blow out

13.	243	3/26/76	.150	1	Full size	69	Chev.	Tires	Bald - blow out
14.	260	3/24/76		1	Full size	68	Pont.	Fire	upon rollover
15.	297	3/31/76	.18	1	Full	61	Chev.	Fire	from struck gas tank
16.	320	4/8/76	.13	1	Full	65	Unk.	Tires	Bald
17.	325	4/10/76	.27	1	Full	70	Ford	Fire Tires	Burst into flames on impact Different brands
18.	362	4/17/76		1	Dump	72	Dodge	Trailer Hitch	Trailer came loose and killed other driver
19.	412	4/29/76		1		64	Chev.	Tire	Blow out
20.	428	4/23/76		1 1	Stake Truck Pick-up	66 76	Chev. Chev.	Fire in vehicle #2 upon impact	
21.	520	5/29/76	Yes, no test	1	Full	67	Ford	Fire & explosion	Witnesses say smoke from car prior to impact
22.	541	5/30/76	.03	1	Pickup	55	Chev.	Stuck Throttle	Appears to be defect
23.	550	5/31/76		2	pickup	70	Ford	Tire & rim came off while travelling	One of 8 bolts was broken
24.	553	5/18/76		1	Full	71	Ford	Tire	Speed 100 mph tire blew out
25.	563	5/22/76	.21	1	Int.	63	Ply.	Fire	Coding error
26.	574	5/18/76	.29	1	Compact	74	Ford	Fire & explosion	On impact, rear-ended
27.	601	6/6/76	.15	2	Int.	69	Chev.	Fire	Frontal impact caught fire when hit tree
28.	688	6/13/76		1	Full	73	Ford	Fire	Engine compart on impact.
29.	713	6/26/76		1	Massey Ferguson Tractor			Brakes	No brakes
30.	728	7/4/76		1	Interim.	68	Dodge	Fire	Upon rollover

31.	736	7/5/76	.26	1	Compact	66	Volks.	Fire	upon impact with other veh.
32.	754	7/10/76		1	Compact	76	Pont.	Trailer-Hitch loosened	trailer loose, killed pedestrian. No defect - loosened as veh. hit bump!!
33.	768	7/12/76	.21	1	Full	75	Olds	Fire	Engine compartment on impact with wall
34.	812	7/19/76	.22	1	Full	68	Cadillac	Fire	Miscoded
35.	822	7/23/76	.15	1	Full	67	Ford	Fire	Upon frontal impact
36.	834	7/25/76		1	Sports car	69	Chev.	Tire	Flat tire
37.	851	7/25/76		1	Full	68	Chev.	Fire	On impact
38.	873	7/29/76		1	Full	65	Ply.	Fire	Upon impact
39.	874	7/31/76		1	Semi	72	GMC	Tire	Blow out
40.	887	6/22/76		1	Pickup	65	GMC	Brakes	Loss of brake fluid
41.	968	8/16/76		1	Tanker	74	Int'l.	Fire	Upon impact
42.	978	8/17/76		1	Full	69	Chev.	Brake	Driver stated brakes failed
43.	984	8/19/76		1	Inter.	75	Chev.	Fire	on impact with tree
44.	1003	8/21/76		1	Int.	74	Chev.	Worn out shocks	
45.	1034	8/19/76		1	Propane tanker	76	Int.	Exploded	Caused fire, caught 7 other cars on fire (all other veh. coded fire)
46.	1035	8/25/76		1	Motorcycle	76	Norton	Fence	Caught fire on impact
47.	1047	5/26/76		1	Full	75	AMC	Steering	stated by driver (no follow up)
48.	1069	8/28/76		2	Int.	69	Chev.	Rear tire wobbling	UD-10 states, being checked out, no further documentation
49.	1091	8/10/76		1	Pickup	69	Dodge	Brakes	Stated by passenger

50.	1094	7/8/76		1	Semi	72	Kenworth	Tire Fire	Flat On impact with tree
51.	1195	9/19/76		2	Carryall	69	Chev.	Exploded	on impact with guardrail
52.	1239	9/27/76		1	Full	65	AMC	Brakes	Couldn't stop (no other comment)
53.	1293	10/2/76	.06	1	Inter.	70	Ply.	Fire	On impact with guardrail
54.	1355	10/4/76		1 Ped.	Full	65	Chev.	Brake	Failure, no other comment
55.	1409	10/29/76		1	Compact	74	Foreign	Fire	Rear-ended and caught fire
56.	1429	11/6/76	.10	1	Pickup	76	Ford	Shimmy in front end	No other comment. Shimmy caused it to leave road. Police marked veh. defect
57.	1493	11/19/76		2	Sports	71	Ply.	Fire	Vehicle broke apart & rear burst into flames
58.	1495	11/14/76	.23	1 Ped.	Full	68	AMC	Lights	Didn't shine on Ped. Mis-directed
59.	1535	11/27/76	.23	2	Pickup	76	Chev.	Fire	on impact
60.	1536	11/29/76		2	Semi	75	Reo	Brakes	Moisture in lines caused brakes to freeze at 10°, hit by car with 2 occupants who were killed
61.	1624	12/18/76		1	Pickup	70	Ford	Steering	Possible defect, ran off road car too damaged to tell
62.	1678	12/15/76		1	Inter.	75	Ply.	Fire on Impact	Actually lost control <u>first</u>
63.	1684	12/18/76	.23	1	Pickup or panel	61	Inter.	Tire or steering & fire on impact	Out of control
64.	1700	10/16/76		1	Motor home	69	Chevy truck body	CO poison-ing	Tail pipe didn't clear frame home made job.

APPENDIX B
Tables of FARS Defects in Ohio

OHIO DATA

FARS #	Date of Crash	Number Killed Which Vehicle	# of Vehicle	Year	Make	Veh. Model	Defect listed on Police Report	Description of crash and/or Comments	Result
0004	1-1-76	1	2	75	Chev.	Blazer (coded Unk.)	Tires	Hit parked car	only tires checked on report
0006	1-2-76	1 0	2	68 63	Mercury Plymouth	Montego Valiant	Brakes Brakes	Head-on	Sheriff's Dept. checked brakes on both vehicles (apparently because nobody used them?)
0007	1-10-76	1 0	2	67 75	Olds Chev.	Cutlass Pickup	Tires ----	Head-on	Went out of control crossed center line
0016	1-6-76	1	1	74	coded Unk. International Transtar Tractor	Semi	Tires	Driver lost control on ramp	
0034	1-5-76	1 0	2	69 70	Chev. Pontiac	Nova Catalina	Tires & Suspension	Tires & shocks checked	Police checked excessive speed as cause
0035	1-6-76	1 0	2	71 63	Chevy Dodge	Impala Dart	Tires Tires	Police checked both for tires (head-on)	No further mention
0060	1-22-76	1 0	2	63 66	Plymouth Coded Unk. (White)	Fury Semi	Tires ---	# 1 rearended #2	Tires poor on # 1 noted
0067	1-28-76	0 1	2	66 76 (coded 66)	Dodge Ford	Charger (coded unk)	Brakes ---	Recklessness - brakes as cause	Box checked by police (can't see why) (no further explanation)
0069	1-17-76	1	1	66	Ford	Torino	Tires	Right front tire smooth	Hit post
0075	1-28-76	6(2) + (4)	1	70 (coded)	Pontiac (but really a 74 Dodge Challenger)		Tires	Vehicle hit house & went thru it. Killed 4 occ. of house + driver and passenger of vehicle	

0077	1-20-76	1	1	68	Pontiac	LeMans	Tires (box checked by police)	No other mention	Hit Tree
0084	1-29-76	0	2	72	Lincoln	Continental	-0-		
		1		(65 coded Buick Unknown) but really 69 Pontiac LeMans			Tires	Lost control - hit head-on	
0090	1-29-76	1	3	64	Buick	Electra		# 3 pulling #2	
				71	(coded Unk. but White)	Semi	Signal lights	#1 hit rear of #2 killing driver of #1	
				71	White (coded Unk.)	Semi			
0094	1-30-76	1	2	73	Olds	Vista Cruiser	---		
		0		72	GMC	Astro	Brakes	Lost control, jack-knifed, slid left of center, struck Olds	
0095	1-31-76	0	2	74	Chevy	Impala	---		
		2		70	Buick	Skylark	Tires	Head-on left of center	
0103	1-17-76	1	1	66	Mercury	Montego	Brakes	Brakes grabbed when applied then went out of control	
0113	1-29-76	1	3	63	Amer.	Rambler		#1 hit 2	
		0		73	Chev.	2-door ?		#2 hit 3	
		0		72	Cadillac (improperly coded as Oldsmobile)	Calais	Tires	Blow out	
0116	2-2-76	1	1	66 (coded as 62)	Ford	Galaxie (coded as Unknown)	Tires	Right front lost control	
0128	2-9-76	0	2	70	Pontiac	Catalina	Tires	Front tires smooth - left of center struck # 2 head-on	
		1		70	Ford	LTD			
0136	2-10-76	1	2	66	VW	Beetle			
		0		66	White Truck & Trailer (coded unknown)		Lights	no lights on or safety equipment lit - beetle hit and went under	
0137	2-12-76	1	2	68	(coded as Ford really Fiat)		Tires	Lost control - crossed center line only TIRE box checked by police	
		0		69	Chev.	Nova			

0143	2-13-76	0	2	70	Ford	(coded Unk.) Ranger	Tires	Intersection collision - can't see why tires are checked by police as defect (no mention)
		1		68	AMC	Ambassador		
0156	2-14-76	1	1	(Coded as 74 Dodge actually 64	Chevy	Impala	Tires	Lost control on ice, Tires box checked by police
0184	2-15-76	1	1	Unknown	dunebuggy	Go-cart	Brakes	2 vehicles but coded only as one since truck was parked. Driver lost control & rammed the truck. Brakes box checked by police
0185	2-22-76	1	1	69	Mercury	Montego	Tires	RR tire smooth inside. struck by a <u>train</u>
0189	2-21-76	1	1	68	Chev.	Impala	Tires	Lost control - hit tree
0190	2-21-76	0	1	65	Buick	LeSabre	Tires	Too fast hit 6 year old
				(miscoded as unknown Chrysler)				
		1	Pedestrian					
0210	3-6-76	1	1	70	Plymouth	Satellite	Exhaust System	No muffler
0220	3-3-76	1	1	67	Chev.	Nova	Tires	No mention - lost control & flipped over
0226	3-7-76	0	2	73	Ford	Torino	Tires & brakes	
		0		65	Pontiac	Catalina		
				(64 Chev. was parked - not counted)				
		8 pedestrians						Struck by Vehicle #1. Passengers of 9 vehicle caravan that had stopped. All pedestrians were standing in road.
		This was a weird crash. All members of caravan HBD. Tires on striking vehicle smooth and RF inboard and outboard pads worn into rivets. Brake cylinders - DRY. They <u>inspected</u> the vehicle						
0234	3-9-76	2	1	68	Buick	Skylark	Tires	The word "rear" is next to tire box lost control & hit tree HBD .21%
0240	3-8-76	1	1	69	Brockway (coded unknown)	Tractor- Trlr.	Tires	Defective LF tire caused crash - hit a tree

0242	2-26-76	1	1	57	Chev.	Tanker	Brakes	Brakes failed - caused rollover
0250	3-1-76	1	1	67	Pontiac	Executive	Tires	Struck embankment - nothing about tires
0254	3-16-76	1 0	2	74 72	Chevy Brockway	Vega Tractor	Tires	"front" inserted - lists speed too fast for conditions (Head-on)
0259	3-19-76		1	72 71	Plymouth (Coded, but really Ford	Unk. Galaxy	Tires	(both front) failed to negotiate a curve
0296	3-30-76	0 1 pedestrian killed	1	56	Chev.	Bel Air	Brakes	Brakes all the way to the floor
0299	3-29-76	1	1	74 (68 Straight Box Trailer)	Ford	Tractor	Tires	Tire blew out - rollover after losing control
0304	4-4-76	1	1	70	Dodge	Charger	Tires	No comment hit guard rail
0326	3-24-76	1 0 0	3	68 64 64	Chevy Ford Olds	Pickup Starfire	 Trailer hitch Brakes & steering	#2 towing #3 - chain broke - slammed #3 into #1
	Vehicle #2 yr. 63 Chev. Impala improperly coded as 64 Ford)							
0329	4-2-76	(on fire data listing)						
0332	3-13-76	1	1	66	Ford	Mustang	Tires	Lost control on slippery road
0337	4-3-76	1	1	72	Kawasaki	Motorcycle	Tires	Front tire badly worn - lost control on curve
0349	4-12-76	1	1	58	Int. loadstar dump truck		Doors	Left door came open - (driver fell out on curve and was run over)
0350	4-13-76	1	1	73	Mack	Tractor-Trailer	Trailer hitch	Load shifted breaking chain that was holding load - truck flipped and hit a tree
0353	4-16-76	1	1	68	Ford	Wagon	Suspension	Lost rt. rear wheel. Rt. rear axle was sheared off at backing plate - rollover
0358	4-14-76	4	1	68	Pontiac	Bonneville	Tires	lost control - speed too fast
0359	4-15-76	1	1	70	Ford	Maverick	Tires	LF lost control too fast

0367	4-24-76	1 0	2	73 69	AMC Buick	Gremlin Skylark	--- Brakes	Failed to stop at intersection	
				(coded but really 70 Olds Cutlass)					
0380	4-15-76	2 0	2	67 72	AMC Ford	Rambler Tractor/Trlr.	Tires	Pulled into #2's path (the left rear and right front tire on #1 were bald)	
0384	4-14-76	0 1	2	68 76	Chrysler BMW	Town & Country Motorcycle	Tires	Speeding - crossed centerline killed the cyclist (drunk BAC .23 of Veh. #1)	
				(coded as unknown motorcycle)					
0398	4-8-76	1	1	69	Opel	Kadette	Tires	Ran off road - overturned, left rear tire no tread	
0401	4-19-76	1 0	2	66 69	Dodge Chevy	Dart Impala	Tires Tires	Stated see UH-2 for tire defect report. #1 skidded across center line. Reviewed UH-2 schematic of scene stating: Dodge RF WARE Bars LF smooth. Chevy - RF tire Smooth	
					(dry & Daylight at a curve)				
0404	4-21-76	0 1 0	3	74 71 73	Chev. Dodge Ford	Bel Air Dart Maverick	Tires	#1 hit #2 into #2 no mention of tires	
0428	5-2-76	1 0	2	69 76	Dodge Cevh.	Comet Pickup Truck	Tires	RF tire # sliding, was hit by #2	
0432	5-7-76	0 1 pedestrian	1	72	Chev.	Impala	Signal lights	Police report states: "Other" - transmission Veh. #1 was backing out of a drive - struck pedestrian and across street into a building	
0436	4-22-76	0 1	2	72 65	GMC Chev.	Astro Nova	Signla lights	Possible left turn signal defective - #1 went to pass #2. #2 turned left	
0427	4-27-76	1	1	72	Plymouth	Valiant	Tires	Lost control	Hit ditch
0449	5-5-76	1	2	73 74	Chev. Chev.	Chevelle Caprice	Tires	Thru red light	
0457	4-29-76	0 1 pedestrian	1	55	Chev.		Tires, brakes, horn	No mention	Struck pedestrian

0461	5-5-76	0	2	73	Chev.	Monte Carlo		Head-on	
		1		66	Rambler	Classic	Tires		
0464	5-7-76	0	2	67	AMC	Rebel	Tires	Drove left of center	
		1		71	Ford	Pinto	Tires	Head-on	
0465	5-8-76	1	1	71	Plymouth	Roadrunner	Tires	Lost control	Rollover
0479	5-15-76	1	1	71	VW	Beetle	Tires	Ran off road right side	
0482	5-16-76	1	1	67	Ford	Mustang	Body	Passenger fell thru hole in floor board	
0490	4-24-76	1	1	73	Toyota	Corolla	Tires	Lost control (both rear tires smooth) Officer feels cause of crash is inattention & oversteer	Struck median - rollover
0499	5-3-76	0	2	66	Olds	F-85	Tires	High speed & reckless	
		1		72	Ford	Torino			
0507	5-24-76	0	2	73 (coded 74)	Int.	Tractor-Trlr Truck			
		1		69	Ford	LTD	Tires	Failure to yield	
0511	5-13-76	1	2	69	Int.	Transtar			
		0		70	Int.	Transtar	Trailer hitch	Overloaded truck causes 5th wheel to come down. Wheel hold & tie chain	
0512	5-17-76	1	1	66	Chev	Pickup	Tires	Lost control on curve -- too fast for conditions	
0515	5-3-76	1	1	68	Pontiac	LeMans	Tires	Speed too fast	Hit post
0530	5-21-76	1	2	68	Mercury	Cougar	Tires	Head on - loss of control	
		0		62	Chev.	Impala	Tires & brakes not coded		
0545	5-10-76	1	1	72	Toyota	Celica	Tires	left road hit fire hydrant	
0553	5-29-76	1	1	69	Ford	Van	Tires	Off at side into ditch	

0572	6-1-76	0 1	2	75 74	Mercury Opel	Marquis Manta	Tires	Left of center	Hit #2
0595	5-27-76	1	1	67	Chev	Camaro	Tires	Left of center	Hit bridge support
0622	6-5-76	1	1	73	Chev.	Olson Van	Tires (rear)	Left of center	Rollover - body separated from chassis (should be coded
0625	6-10-76	1	1	63	VW	Beetle	Tires (rear)	Off right side of road	
0640	6-9-76	0 1	2	72 70	IHC Suzuki	Bus Motorcycle	--- Brakes	Cycle ran into rear of parked bus	
0655	6-10-76	0 1	2	73 66	Chev Pontiac	Caprice Bonneville	---- Brakes	Brakes failed	Hit #1 then a House
0660	6-12-76	2	3	73 73 76	Suzuki Mercury Ford	Bike Monterey Mustang II	--- Brakes	driver claimed brakes failed -	actually speeding
0673	6-11-76	1	1	71	Plymouth	Duster	Other lights & tires	Speeding	Hit gravel (defects never mentioned) (this never coded)
0674	6-12-76	1	1	67	Coded Pontiac actually Mercury	Cougar	Tires	Speeding - DUIL	
0683	5-29-76	1	1	65	Chev.	Chevelle	Suspension	"FRAME" is written next to "other" box - no mention made	Excessive speed the cause
0685	6-10-76	2	1	74	Int.	Trac/Trlr	Tires	Right front tire shredded	Loss of control
0688	6-19-76	1	1	68	Dodge	Super B	Tires	Front smooth	Loss of Control
0690	6-23-76	1	1	74	GMC	Tractor/Trlr	Tires	Tires on trailer checked (box)	

0697	6-25-76	1	1	64	Olds	88	Tires	Excessive speed	
0701	6-23-76	1	2	74	Olds	Omega	---	Left of center - DUIL	
		0		69	Pontiac	Catalina	Tires		
0703	6-25-76	1	1	66	Chev.	Impala	Tires	Excessive speed & recklessness	
0710	6-16-76	1	2	71	Plymouth	Cricket	---		
				69	Pontiac	Custom	Tires	Lost control - left of center	Head-on
0727	5-29-76	1	1	68	GMC	Van	Tires	Excessive speed	Rollover
0728	6-12-76	1	1	69	Chrysler	Newport	Tires	Mixed tires - ran thru "Road Closed" sign	
0735	7-2-76	0	4	70	Chrysler	Town & Cntry	Tires		
		0		72	Ford	Gran Torino	----		
		0		69	Mack	Truck	Brakes		
		1		74	Ford	Econoline Van	---		
			(brakes for veh. 3 miscoded) - tires never mentioned						
0747	7-3-76	1	1	54	Harley no "baffles"	Motorcycle (not coded)	Brakes	No front brakes	Cause of crash was speed
0749	7-4-76	1	1	76	Citicar	Van	Tires	Its rear tire blew out	
0765	6-2-76	1	2	65	Chev	Corvair	Brakes	Brakes rusted out	Rear-ended Veh. #2
				75	Plymouth	Fury	---		
0774	7-13-76	2	1	66	Chrysler	Newport	Tires	All drunk lost control	Hit a tree
0795	7-12-76	1	1	64	Olds	98	Tires	Left of center	Hit bridge
0809	7-7-76	1	4	72	Olds	Cutlass	----	Ran stop sign	
				74	Chev.	Stake Truck	----		
				67	Chev.	Impala	Tires		
				66	Plymouth	Unknown	----		
0811	7-9-76	0	2	71	Chev.	Vega	Tires		
		1		74	Ford	LTD	----	#2 failed to stop at sign	

0812	7-9-76	0 4	2	75 65	Mercury Chevy	Marquis Bel Air	---- Brakes	#2 failed to stop	Brake line found to leak fluid after crash
0824	6-6-76	1	1	71	Pontiac	LeMans	Tires	Lost control - speed DUIL	
0840	7-11-76	1 0	2	71 72	Chev. Ford	Nova Country Squire	Tires	Towing a camper - wheel came off causing rollover	
0842	7-12-76	1 0	2	70 72	Ford VW	Pickup Type 3	---- Tires	Front worn	Head-on
0845	7-16-76	0 1 pedestrian	1	73	Ford	Tractor	Tires	Speeding - crossed center line	Hit pedestrian & building & RR Track sign
0852	7-21-76	0 1 pedestrian	1	66	Chev	Bel Air	Brakes	Child darted out - brakes failed (used emergency brake)	
0862	7-14-76	1	1	66	VW	Beetle	Tires	Speeding	Hit pole
0863	7-16-76	0 1	2	71 70	Olds Pontiac	98 Trans Am	Tires ----	Speeding - left of center (out of control)	
0866	7-18-76	0 1 pedestrian	1	69	Mercury	Cougar	Tires	All 4 bad - left rear bald	
0870	7-19-76	0 1	2	73 67	Dodge Chev.	Dart Chevelle	Tires Tires	Failed to yield	
0873	7-22-76	1 pedestrian	1	65	Mercury	Park lane	Tires	Tires checked - no other mention Car hit 2 pedestrians (K=1)	
0882	7-23-76	2 {1 1 bicyclist killed	1	74	Chev.	El Camino	Lights Lights	Right high beam not working No lights on bike	
0883	7-26-76	3 0	2	65 69	Mercury Mercury	Unknown Cougar	Brakes ----	Brakes failed	
0901	7-25-76	1 0	2	70 75	Honda Ford	Cycle Torino	---- Tires	Turned into Veh #2 path	
0907	8-1-76	1	1	73	Honda	Motorcycle	Tires	Back tire bald - inattention is	Cause of crash - 4 children ejected

0908	8-1-76	1	1	66	Chev	Nova	Tires	Tire blew out	
0911	8-2-76	1	1	71	Dodge	Dart	Tires	Speeding & road defect (hit hole in road)	
0924	7-29-76	1	1	71	Dodge	Dart	Tires	Speeding	Hit pole
0928	7-31-76	1	1	75	Honda	Cycle	Horn	Speeding	Passenger hit pole
0937	7-26-76	1	2	69	Opel	Wagon	Tires	Left of Center	Head-on
		0		69	Chrysler	Unk.	Tires		
0948	8-5-76	1	1	73	Plymouth	Duster	Tires	Excessive Speed	Hit 12 trees
0959	8-12-76	0	2	74	GMC	Truck	---		
		1		69	Chevy	Nomad	Tires	Failed to yield	
0960	8-13-76	1	1	73	Ford	Pickup	Tires	Police check ball joints & wheel bearings (cause) high speed	
0961	8-13-76	1	2	70	Olds	98	tires		
		0		73	GMC	Tractor	---	Failed to yield - Veh. #1 struck Veh. #2 went under	
0976	8-14-76	1	3	73	Kawasaki	Motorcycle	000	Speed too fast	
		0		67	Chevy	Biscayne	Tires	Failed to yield	
		0		67	Mercedes	250 SE	---		
0986	8-18-76	0	1	66	Ford	Mustang	Brakes	Speeding - left scene	
		1 pedestrian							
0988	8-21-76	1	2	69	Yamaha	Motorcycle	----		
		0		70	Ford	Maverick	tires	Following too close - DUIL	
1006	8-6-76	0	2	71	Ford	Custom	Tires	Left of center - head-on	
		1		62	AMC	Classic	----		
1010	8-13-76	1	1	71	Chev.	Kingswood	Tires	Right rear door opened - passenger fell out (not coded)	
1039	8-28-76	1	1	66	Chev.	Bel Air	Tires	Speeding - curve	

1040	8-29-76	2	2	73	Triumph	Spitfire	---	Left of center	
		0		70	Chevy	Pickup	Tires	(low pressure)	
1043	8-2-76	1	1	73	Dodge	Dart	Tires & brakes	Police state "shocks" speeding is cause	
1052	8-24-76	0	2	66	Mack	R-600	Tires	Rt. front mostly smooth	
		1		72	Chevy	Impala	----	Turned in front of Veh. #1	
1058	8-13-76	2	1	74	Jeep (miscoded)		Tires	Reckless & speeding	
1059	8-22-76	1	1	66	Ford	LTD	Tires	Speeding	Ran-off-road
1067	8-29-76	1	1	67	VW	Unk.	Tires	Went off roadway	
1072	9-1-76	1	1	66	Dodge	Dart	Tires	Speed - 3 tires bald -	Hit parked car
1074	9-1-76	1	2	72	Plymouth	Fury III	Tires }	Failed to stop at sign	
		0		68	Buick	Electra	Tires }		
1079	9-3-76	1	3	72	Plymouth	Duster	----		
		0		69	Mercury	Montego	Tires	Ran-off-road (speed)	Hit Veh. #1 head-on
		0		71	Olds	Delta 88	----	#3 hit by flying glass	
1089	9-4-76	1	1	68	Dodge	Monaco	Tires	Speeding	Hit pole
1107	9-10-76	1	1	56	Chevy	Pickup	Tires	Speeding - rear tires smooth	
1111	9-12-76	1	1	71	Ford	Country Sq.	Tires	Speeding	Hit guardrail
1119	9-6-76	1	1	70	Plymouth	Barracuda	Power Train	Speeding, inexperience, rear sway bars disconnected to allow owner of vehicle to raise rear of vehicle	
1124	9-9-76	0	3	74	Ford	F700	----		
		2		73	Buick	Century	----	Speeding struck Veh. #1 to avoid Veh. #3 stopped to pick up kids	
		0		68	Dodge	School bus	Lights	Brake lights	

1131	9-15-76	0 1	2	75 67	Ford Ford	Straight Trk. Pickup	Tires Tires	Speeding & hauling pipe Trailer broke loose not coded	
1132	9-16-76	1 0 0	3	74 66 74	Ford Mercury Chevy	Maverick Comet Laguna	--- Tires ---	Speeding left of center	
1143	9-4-76	1	1	71	Dodge	Demon	Tires	Bald - speeding	Vehicle broke in half on impact with utility pole
1144	9-10-76	1 0	2	67 70	Plymouth Chev.	Belvedere Impala	Tires	Left of center - DUIL Veh. #1	
1146	9-12-76	1	1	70	Intern.	Tractor/Trlr	Tires	Right front tire blew out	Over guardrail - driver atn.
1149	9-18-76	1	1	70	Dodge	Charger	Tires	Ran off road right side	Hit pole
1161	9-9-76 coded	0 1 should be 2	2	72 70	Mack Ford	Diesel Econoline bus (school)	Tires ----	Air leak on right hose connection from tractor to trailer (not coded) also right rear inside dual missing - truck hit school bus unloading passengers	
1168	9-19-76	1 0	2 0	71 66	Ford Olds	Maverick 4-4-2	Tires ---	#2 went left of center	Head-on crash
1169	9-19-76	0 1	2	72 73	Plymouth Harley-Davidson	Satellite Motorcycle	---- Headlights	Stolen cycle without lighted headlight @ 2:35 a.m. drove into path of truck	
1172	see Fire list								
1177	9-24-76	1	1	74	Kenworth	Tractor/Trlr	Tires	RF tire blew out	Lost control - hit fence
1191	9-6-76	1	1	coded 71 should be 69	Ford	Mustang	Steering	Steering malfunctioned making a turn - hit parked car - DUIL	
1200	9-19-76	1	1	75	Plymouth	Roadrunner	Tires	Speeding - ran off road	
1204	9-25-76	1 0	2	74 70	Plymouth Chev.	Duster Impala	Tires Tires	Didn't stop for stop sign	

1207	9-26-76	0	3	66	Ford	T-bird	Tires	#1 of rt side back into #2,	
		1		66	Chrysler	Imperial	Tires	#2 pushed into #3	
		0		73	Olds	Cutlass	Steering	(no mention of defects listed) except for police boxes checked	
1221	9-24-76	1	1	67	Ford	Fairlane	Tires	Speeding	Lost control off left into ditch
1229	6-10-76	1	1	68	VW	Unk.	Tires	Off to left of center on curve	Lost control
1231	9-24-76	0	3	74	Plymouth	Satellite	---		
		0		66	Dodge	Polara	Steering	Steering gear broke, #3 tried to help #2. #1 speeding crashed into #2 and #3, killed driver of #3 who was standing outside	
		1		65	Chev.	Corvair	---		
1236	9-30-76	0	2	74	Buick	Century	---		
		1		64	Chevy	Corvair	Steering	(improperly coded - should be lights)	#2 DUIL hit #1 head-on
1253	10-7-76	1	1	70	Chevy	Impala	Tires	Speeding, left of center	Rollover
1264	10-10-76	1	2	70	Chev.	Nova	Tires	Failure to yield	
		0		70	Chev.	Impala	---		
1275	10-5-76	1	2	76	Kawasaki	Motorcycle	Tires	#1 speeding, leaning to right hit his head on truck	
		0		75	Ford	Step Van Truck	----		
1279	10-9-76	2	3	72	AMC	SST	Tires	#1 speeding	Lost control - into path of #2 and #3
		0		70	Chev	Malibu	----		
		0		76	Olds	88	---		
	(2 coded as Pontiac)								
1280	10-12-76	1	1	69	White	Truck	Tires	Right front tire blew out	Off to right, hit guardrail
1288	10-17-76	1	1	64	Ford	Galaxie	Tires	Tie rod broken	Lost control
1299	10-15-76	0	2	67	Mercury	Cougar	----	#1 backing up on a ramp, #2 hit #1 in rear (#2 had no brake lights)	
		1		66	VW	130	Other lights		

1308	10-23-76	1	1	70	Ford	LTD	Tires	Speeding	Ran off road
1310	10-24-76	1	1	70 (coded as 67)	Pontiac	Catalina	Tires	Speeding - DUIL .15	Failed to neg.curve
1317	10-23-76	0	2	67	Plymouth	Fury	Tires	Speeding - DUIL	Drove left of center
		1		73	Lincoln	Continental	----		Head-on
1332	10-30-76	0	4	68	Dodge	Tractor	Trailer hitch	Trailer came loose - investi-	
		1		73	Chev.	Pickup	----	gation showed safety catch was	
		0		70	Ford	LTD	----	broken. Veh. #2 hit loose trailer	
		0		75	Buick	Skylark		and was struck by Veh. #3. Veh. #4	
		(#2 coded as a '74 incorrect)						hit Veh. #3	
1335	9-14-76	2	1	70	Homemade	Unknown	Tires & brakes	Recklessness	Lost control - fell apart - hit trees - emergency brake was on
1343	10-21-76	1	2	67	Dodge	Coronet	Tires	Speeding	Lost control,
		0		73	Chevy	Impala	----	Had been drinking	Hit a pole
1349	10-26-76	0	2	70	Brockway	Truck	----	Brakes failed to stop VW at	
		1		65	VW	Sedan	Brakes	stop sign - hit truck	
1352	10-28-76	1	1	64	Chev.	Impala	Tires	Speeding	Lost control
1364	10-16-76	1	1	72	Ford	Gran Torino	Tires	BAC .21, speeding failed to negotiate curve	
1370	11-01-76	1	1	64	AMC	Rambler	Tires	Speeding	Ran off road, hit guardrail
1372	11-3-76	1	1	69 (coded as 1970 Chevrolet)	Toyota	Corolla	Suspension	Speeding, DWI	Bottomed out 9 times, before going off road. (bad shocks)
1375	11-4-76	0	3	75	Transstar	Dump truck	----	#2 passing #1 on right, #1 started to change lanes,	
		1		76	Chev.	Malibu	Tires	#2 hit #1 lost control, went across median hit #3	
		1		71	Chev.	Impala	Unknown	Head on	
		#2 coded as '73 Chev. unknown model (changed to Corvette)							

1380	11-6-76	1	1	73	Chevy	Impala	Tires	Lady got out to look at flat tire, car rolled backwards over her	
1381	11-6-76	1	1 (coded as '68)	69	Olds (coded as brakes - should be Tires)	Cutlass	Brakes	3 bald tires - missed curve Too fast DWI	Hit pole
1394	11-13-76	0 2	2	63 64	Mercury Olds	Comet ?	---- Tires	#2 ran stop sign into #1 path (3 bald)	
1404	11-3-76	1 0	2	69 69	Chev. Cadillac	Pickup deVille	Other - lights Tires	#1 went left of center	Head-on
1409	11-8-76	0 1	2 (#1 coded as a '69)	70 70	Buick VW	Skylark Bug	Tires ---	#2 ran stop sign - hit by #1	
1413	11-11-76	1	1	69	Ford	Custom	Tires	Excessive speed (front tires smooth)	Hit a pole
1416	11-14-76	1	1	70	Plymouth	Duster	Brakes	Accelerator stuck	Hit a pole
1439	11-17-76	1	1	63	Chev.	Pickup	Tires	Fell asleep at wheel	
1440	11-19-76	1	1 (coded as 1959 American Motors)	72	Chev.	Rally Nova	Tires	(front tire worn out) - speeding - failed to neg. curve	
1441	11-20-76	0 1 pedestrian	1	71	Chev.	Impala	Tires & headlights	DUIL - hit 2 pedestrians - killed one	
1451	11-20-76	2	2	65 68	Chev. Chev.	Malibu Impala	Tires ----	Unit #1 partial stop pulled into #2 path	
1455	11-18-76	0 1 0	3	68 73 70	Chrysler Buick Ford	Newport LeSabre Country Sedan	---- ---- Brakes	#3 hit #1 in rear, bounced & hit #2 head-on speed of #3 too fast	
1463	11-26-76	1	1	66	Chev.	Corvair	Tires	Lost control - speeding & drinking	
1470	11-5-76	1 0	2	68 65	Plymouth Mack	Barracuda Dump truck	Tires ----	#1 drove wrong way	Head-on

1476	11-13-76	1	2	70 73	Mercury Pontiac	Monterey Ventura	Tires ----	#2 went left of center	Head-on
		#2 coded as '71 Ford							
1508	12-1-76	0 0 1	3	62 73 72	Studebaker Kenworth Ford	Lark Tractor/Trlr ?	Tires ---- Tires	#1 about to make a left - #2 didn't slow down - hit #2 in rear - veered left and was hit by #3. #2 excessive speed	
		(vehicle #1 coded as '65 Chevrolet							
1513	12-2-76	0 1	2	75 73	Chev Ford	Cheyenne PU Mustang II	---- Tires	#2 trying to pass #1 who was going to turn left. Excessive speed of #2	
1516	12-4-76	1	1	73	Ford	Semi-tractor trailer	Tires	Left fron tire blew	Rollover and down embankment
1523	12-6-76	1	1	70	Ford	Mustang	Tires	Lost control on icy road	Hit pole
1546	12-16-76	1	1	73	Ford	Bronco	Brakes	Lost control BAC .25	Hit embankment
1556	12-16-76	0 1	2	69 63	Oliver Dodge	Tractor (farm) Polara	Signal lights Unknown	Dark, no lights - tractor with no lights on rear-ended by Veh. #2	
1557	12-16-76	2	1	66	Chev.	El Camino	Brakes	Reckless	Hit a pole
1559	12-17-76	1	1	71	Ford	Galaxie	Brakes	Speeding,lost control	Hit a tree
1563	12-19-76	1	1	62	Inter.	Truck	Tires	Drove off road	Rolled over
1565	12-20-76	0 1	2	70 66	Ford Olds	Galaxie 88	---- Tires	#2 lost control on icy road, slid and was hit by #1 broadside	
1583	12-11-76	0 0 1	3	70 70 73	Chev Chev Ford	Kingswood Camaro Mustang Mach II	Unknown Power train ----	#2 lost electrical power and was disabled. #3 helping #2. #1 came along, hit both	
1607	12-30-76	1	1	65	Chrysler	Newport	Brakes	Off right side, hit a tree DWI (unable to determine brake failure)	
1622	12-27-76	1	1	75	Ford	Maverick	Tires	stated by police - speeding - actue ethyl alcohol intoxication	
		(intoxicated incorrectly reported)							

1626	12-31-76	0 1 pedestrian	1	76	Toyota	Celica	Wipers	Hit crossing guard - windshield dirty. No mention of wipers being defective - dirty windshield coded as wipers!
1628	11-25-76	1	1 (coded as '69)	68	Toyota	Corono	Tires	Reckless, excess speed Hit a tree
1629	12-4-76	2	2	70 74	Pontiac Ford	GTO Econo Van	Tires ----	Speeding BAC .27 loss control, Crossed center line
1630	12-8-76	0 0 1	3	72 71 72	Chev. Pontiac Olds	Kingwood LeMans 4-4-2	---- ---- Tires	#3 left of center, speeding hit #1, #2 hit #1 in rear, #3 hit guardrail also
1639	12-27-76	1	1	69	Ford	Mustang	Tires	Speeding, lost control on curve
1662	11-25-76	1	1 (Veh. #3 coded as a '69)	67	Ford	Galaxie	Tires	Left of center, speeding, tires bald
1664	9-23-76	0 1 0	3 (Veh. #3 coded as '69 Olds)	58 71 70	Ford Dodge Olds	Home made flat bed Polara 4-4-2	Trailer hitch ---- ----	Trailer hitch broke - trailer took off - Hit Veh. #2 Veh. #3 driverless, Veh. #2 because both Veh. #2 occupants had been ejected upon impact with trailer

APPENDIX C
Tables of FARS Fires in Ohio

OHIO FIRE DATA

FARS #	Date of Crash	# Killed	# of Vehicles	Year	Make	Veh. Model	Defect	Description
0070	1-21-76	0	2	74	Intern	Tractor/ Trailer	----	head-on, V2 turned over on left side, caught fire & burned
		3		74	Chev	Straight Truck	Fire	
0123	2-15-76	1	1	74	Merc	Unk	Fire	hit tree head-on--caught fire--occ burned up
0164	2-21-76	0	3	68	Chevy	Malibu	Fire	V1 speeding, rolled to left side, caught fire hit V2 & V3
		1		72	Dodge	Charger	----	
		0		73	Chry	Imperial	----	
0180	2-21-76	0	2	65	International		Fire	head-on--both burst into flames
		3		69	Chevy	Pickup C-10	Fire	
		(V#1 coded as '67)						
0252	3-19-76	1	1	66	Chev	Corvair	Fire	struck guardrail--caught fire as it rolled to right side
		(Coded as 66 Ford)						
0311	4-7-76	1	2	72	Ford	Torino	Fire	high speed V1 hit V2, burned
		0		69	Int	Truck	----	as its rear hit pole, fire broke out
0329	4-2-76	1	2	67	VW		Fire }	V1 left of center--head-on
		0		74	Olds	Cutlass	Tires }	V1 broke into fire
0344	4-15-76	0	3	62	Chevy	Belaire	----	19-yr-old V1 driver hit & run.
		1		73	Kawasaki	Motorcycle	Fire	didn't yield & hit 2 cycles.
		0		75	"	"	----	cycle V#2 caught fire & burned driver
0412	4-27-76	1	2	65	Ford	Mustang	Fire	V1 hit V2 in rear--went airborne, flipped end over end, burst into flames (driver killed)
		0		62	Chevy	Nova	----	
0447	5-10-76	1	1	71	Chevy	Impala	Fire	struck fence--engulfed in flames, gas can left floor--air heater lid off, lying on left side of motor.
0469	5-14-76	1	1	75	Harley-David	Motorcycle	Fire	cycle caught fire when struck pole
0474	5-3-76	0	2	66	White	Tractor/ Trailer	----	V2 left of center went under V1, burst into flames
		2		73	Unknown veh.		Fire	

FARS #	Date of Crash	# Killed	# of Vehicles	Year	Make	Veh. Model	Defect	Description
0481	5-14-76	1	1	65	Cadillac	Seville	Fire	roll-over on curve, caught fire
0500	5-09-76	2	1	69	Pont	Grand Prix	Fire	lost control, caught fire when hit guardrail
0524	5-20-76	1	1	71	Ford	Pinto	Fire	hit tree after losing control started on fire
0540	5-22-76	0	2	73	Lincoln	Continental	----	
		1		69	Norton	Motorcycle	Fire	motorcycle caught fire as it rolled over
0592	6-11-76	1	1	71	Pontiac	Catalina	Fire	hit pole, guardrail, another pole, overpass, then caught fire
0602	6-12-76	1	1	75	Yamaha	Motorcycle	Fire	developed fire--diverted driver's attention and he lost control
0630	6-11-76	1	1 (coded as a '72)	75	Ford	Torino	Fire	lost control, hit tree, rolled 5X then caught fire
0637	6-12-76	1	1	75	AMC	Jeep	Fire	hit poles & mail boxes. fire started at gear shift lever
0658	6-18-76	0	3	69	Ford	Truck	Brakes & Steering	V#2 gas tank ruptured on impact, causing veh to burst into flame. V3 caught fire from V2.
		2		70	Ford	LTD	Fire	
		1 (V2 coded as '69)		75	Chevy	Caprice	Fire	
0700	6-16-76	1	1	70	Ford	Galaxie	Fire	loss of control, flipped over, burst into flames
0782	7-09-76	1	3	72	Kawasaki	Motorcycle	Fire	V#2 turned & hit V1 head-on & started V1 on fire. V2 caught fire from V1. V3 then hit V2. (V3 driver son of V1 driver)
		0		68	Ply	Fury	Fire	
		0 (V3 coded as '75)		72	Kawasaki	Motorcycle	----	
0790	7-01-76	0	2	66	Int	Tractor/trailer	Fire	V2 left of center, hit V1 head-on. V1 caught fire after impact.
		1		75	Pont	LeMans	----	

0823	0823 5-21-76	2	1	52	Ford	Pick-up	Fire	Speeding--rolled over--spilled gasoline, caught fire
0877	7-01-76	1	2	66	Triumph		Fire	no mention of fire in V2
		0		75	Ford	Mustang	Fire	head-on--no mention how fire started V1
0898	7-28-76	1	1	69	GMC	Tractor/ trailer	Fire	after air-borne, veh burst into flames when hit wall
0921	7-20-76	1	2	67	Merc	Colony	Fire	V1 failed to stop at sign. V2 struck left rear of V1; V1 burst into flames & hit a pole
		0		72	GMC	Astro Tractor/trailer		
0934	8-06-76	0	2	73	Ford	Unk truck	Fire	head-on--V1 overturned & caught fire
		3		65	Olds	88	----	
0987	8-20-76	0	11	74	Peterbilt	cab over tractor	Fire & brakes	chain reaction
		0		73	Buick	Electra	----	V1 struck V2 left rear,
		1		70	Ford	Torino	Fire	then 2 hit 3, etc.
		0		72	Buick	Skylark	Fire	
		0		75	Olds	88	----	tractor turned on its side--
		3		76	Chevy	Monte Carlo	Fire	caught fire
		0		71	Dodge	Challenger	----	
		1		73	Chev	Caprice	----	
		3		75	Buick	--	----	
		0		68	VW	Bug	----	
		0		71	Ford	--		
		(V10 coded as '71)						
1130	9-13-76	1	2	75	Ford	Custom	Fire	V1 skidded into 2 & in minutes flames enveloped both
		0		70	Chev	Dump truck	Fire	
1170	9-20-76	0	2	76	Ford	Straight truck	Fire }	exploded on impact
		1		69	Olds	Cutlass	Fire	v1 rear-ended V2
1171	9-20-76	1	1	71	Diamond Reo	Tractor/trailer	Fire	overturned, caught fire
1262	10-10-76	1	1	76	Chevy	Nova	Fire	hit tree head-on, caught fire

1302	10-17-76	2 0	2	70 74	Ply Chevy	Roadrunner Unk	Fire ----	head-on--#1 rolled over & burned
1322	10-30-76	1 (parked veh)	2	70 68	Ford Pontiac	Mustang Bonneville	Fire	V1 hit parked car at gas tank; both went up in flames. V2 is not coded by FARS.
1324	10-10-76	1	1	69	AMC	Ambassador	Fire	fell asleep, hit abutment, burst into flames
1344	10-22-76	2	1	72	Ford	LTD	Fire	struck pole, burst into flames
1346	10-23-76	3 2	2	76 75	Olds Pont	Regal Catalina	---- Fire	#1 failed to stop at int. collided. V2 ended in a field on fire.
1355	10-29-76	2 (coded as 68 Chevrolet)	1	67	VW	Bug	Fire	flipped over & caught fire
1376	11-05-76	2 (Torino is not coded, as it is parked veh.)	1	65	Pont	GTO	Fire	hit parked 1974 Ford Torino in rear--both caught fire.
1389	11-13-76	1 0	2	70 72	Ford VW	Fairlane Beetle	Fire ----	head-on--V1 caught fire & burned
1419	11-15-76	4 0	2	68 76	Ply Ford	Fury Pinto	Fire	V1 hit V2 head-on, bounced, and its rear end hit pole when it burst into flames
1466	10-16-76	1	1	74	Dodge	Unk	Fire	Caught fire after it roller over 3 X.
1477	11-13-76	0 0 2	3	74 68 69	Dodge Chevy Ply	Sportsman Camaro Satellite	---- ---- Fire	V3 hit V1 then V2 then embankment & rolled on left side--caught on fire
1510	12-01-76	1 (coded as 1968)	1	73	Olds	Unk	Fire	broadside into pole--burst into flame
1545	12-16-76	1 (coded as 1973 other)	1	74	Diamond Reo	Truck/ trailer	Fire	struck embankment. no mention of fire except in autopsy (4th degree burns) BAC.18 of driver also--(passenger was killed)

APPENDIX D
Washington Accident Data--SPSS Structure

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 STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES
>
>FILE   DEFECT   (CREATION DATE = 01/20/78)

 DOCUMENTATION FOR SPSS FILE 'DEFECT  '

 LIST OF THE   1 SUBFILES COMPRISING THE FILE

>DEFECT   N= 5019

 DOCUMENTATION FOR THE   23 VARIABLES IN THE FILE 'DEFECT  '

>REL  VARIABLE  VARIABLE LABEL                                  MISSING PRT
 POS      NAME                                                   VALUES FMT


   1  SEQNUM                                                      NONE   0

>  2  SUBFILE                                                     NONE   A

   3  CASWGT                                                      NONE   4

>  4  COUNTRY   COUNTRY OF MANUFACTURE                              0.   0
                MISS           0. UNKNOWN
                               1. USA
>                              2. CANADA
                               4. ENGLAND
                               5. FRANCE
>                              6. GERMANY
                               7. ITALY
                               8. JAPAN
>                              9. SWEDEN

>  5  COMPANY   MANUFACTURING CORPORATION                           0.   0
>                             11. GENERAL MOTORS
>                             12. FORD
>                             13. CHRYSLER
>                             14. AMERICAN MOTORS
>                             15. OTHER  USA
>                             16. USA     TRUCK
>                             21. GM CANADA
>                             22. FORD CANADA
>                             41. GM VAUXHALL
>                             42. FORD ENGLAND
>                             43. CHRYSLER-UK
>                             45. LEYLAND
>                             46. HILLMAN
>                             48. ROVER
>                             53. CHRYSLER FRANCE
>                             55. CITROEN
>                             56. RENAULT
>                             57. PEUGEOT
>                             61. GM GERMANY
>                             62. FORD GERMANY
#
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 STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES
>

 DOCUMENTATION FOR THE   23 VARIABLES IN THE FILE 'DEFECT   '

>REL  VARIABLE  VARIABLE LABEL                                    MISSING PRT
 POS      NAME                                                      VALUES FMT


   5  COMPANY   CONT
                              65. MERCEDES BENZ
>                             66. VOLKSWAGEN
                              67. BMW
                              68. AUDI
                              75. ALFA ROMEO
>                             76. FIAT
                              77. FERRARI
                              83. CHRYSLER JAPAN
>                             85. TOYO
                              86. NISSAN
                              87. TOYOTA
>                             88. HONDA
>                             95. SAAB OR VOLVO

>  6  DIVISION  MANUFACTURING DIVISION                              0.    0
>                            111. BUICK
>                            112. CADILLAC
>                            113. CHEVROLET
>                            114. OLDSMOBILE
>                            115. PONTIAC
>                            116. GMC TRUCK
>                            121. FORD
>                            122. LINCOLN MERCURY
>                            131. CHRYSLER
>                            132. DODGE
>                            133. IMPERIAL
>                            134. PLYMOUTH
>                            135. DE SOTO
>                            141. AMERICAN MOTORS
>                            151. CHECKER
>                            152. KAISER- JEEP
>                            153. INTERNATIONAL
>                            154. STUDEBAKER
>                            162. DIAMOND REO
>                            164. KENWORTH
>                            165. MACK
>                            166. PETERBUILT
>                            167. WHITE
>                            213. CHEVROLET
>                            215. PONTIAC
>                            222. LINCOLN MERCURY
>                            419. VAUXHALL
>                            422. ENGLISH FORD
#
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 STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES
>

 DOCUMENTATION FOR THE   23 VARIABLES IN THE FILE 'DEFECT  '

>REL  VARIABLE  VARIABLE LABEL                                      MISSING PRT
 POS      NAME                                                        VALUES FMT


`  6  DIVISION  CONT
                             434. CRICKET
>                            451. AUSTIN
>                            452. AUSTIN  HEALY
                             453. MG
/                            454. MORRIS
>                            455. JAGUAR
                             456. TRIUMPH
                             461. HILLMAN
>                            463. SUNBEAM
>                            486. JENSEN
>                            488. LAND    ROVER
>                            531. SIMCA
>                            551. CITROEN
>                            561. RENAULT
>                            571. PEUGEOT
>                            618. OPEL
>                            622. CAPRI
>                            651. MERCEDES BENZ
>                            661. VOLKSWAGEN
>                            662. PORSCHE
>                            671. BMW
>                            681. AUDI
>                            751. ALFA ROMEO
>                            761. FIAT
>                            771. FERRARI
>                            832. COLT
>                            851. MAZDA
>                            861. DATSUN
>                            871. TOYOTA
>                            881. HONDA
>                            882. SUBARU
>                            883. SUZUKI
>                            951. SAAB
>                            952. VOLVO

>  7  BODYTYPE  BODY TYPE                                            0.    0
>               MISS           0. UNKNOWN
>                              1. INTERMEDIATE
>                              2. STANDARD
>                              3. LUXURY  SEDAN
>                              4. LIMOUSINE
>                              5. PERSONAL LUXURY
>                              6. SPECIALTY PONY
#
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 STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES
>

 DOCUMENTATION FOR THE   23 VARIABLES IN THE FILE 'DEFECT  '

>REL  VARIABLE  VARIABLE LABEL                                       MISSING PRT
 POS      NAME                                                        VALUES FMT


   7  BODYTYPE  CONT
                              7. GRAND PRIX
>                             8. COMPACT
>                             9. SUBCOMPACT
                             10. SUPERSPORT
                             11. SMALLVAN
>                            12. PICKUP
                             14. UTILITY
                             15. PANEL   TRUCK
>                            17. PICKUP  CAR
                             18. SUBCOMPACT MINI
                             19. EURO SPT CAR
>                            20. UNKNOWN BODY

   8  BODSTYLE  BODY STYLE                                               99.   0
                              1. COUPE
>                             2. HARDTOP
                              3. 2-DR HARDTOP
                              4. 4-DR HARDTOP
>                             5. SEDAN
                              6. 2-DR SEDAN
>                             7. 4-DR SEDAN
>                             8. STATION WAGON
>                             9. CONVERTIBLE
>                            12. ROADSTER
>                            14. AMBULANCE
>                            18. PANEL TRUCK
>                            19. CHASSIS  CAB
>                            20. DUMP TRUCK
>                            21. FLATBED
>                            23. STAKE OR RACK
>                            24. TANK    TRUCK
>                            25. TRACTOR TRAILER
>                            26. PICKUP
>                            29. CAMPER  PICKUP
>                            30. MOTOR  HOME
>                            32. FIRE    TRUCK
>                            33. GARBAGE TRUCK
>                            34. BUS
>                            35. CONSTRUCTION EQUIP
>                            36. FARM    EQUIP.
>                            37. OTHER TRUCK
>               MISS         99. UNKNOWN
#
```

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

DOCUMENTATION FOR THE 23 VARIABLES IN THE FILE 'DEFECT '

REL POS	VARIABLE NAME	VARIABLE LABEL	MISSING VALUES	PRT FMT
9	MODYEAR	YEAR OF MANUFACTURE	99.	0
10	TOTALVEH	INVENTORY OF VEHICLES IN CATEGORY	NONE	0
11	BRAKES	REPORTED BRAKE DEFECTS	NONE	0
12	HEADLITE	REPORTED HEADLIGHT DEFECTS	NONE	0
13	REARLITE	REPORTED REAR LIGHT DEFECTS	NONE	0
14	TIREWORN	REPORTED SMOOTH OR WORN TIRES	NONE	0
15	BLOWOUT	REPORTED TIRE PUNCTURE OR BLOWOUT	NONE	0
16	WHEELOFF		NONE	0
17	STEERING	REPORTED STEERING MECHANISM DEFECT	NONE	0
18	POWER		NONE	0
19	GLARE	REPORTED HEADLIGHT GLARE	NONE	0
20	NOLITES	LIGHTS OR REFLECTORS INSUFFICIENT	NONE	0
21	OTHERS		NONE	0
22	NODEFECT	NO DEFECTS REPORTED	NONE	0
23	UNKNOWN	MISSING DATA	NONE	0

APPENDIX E
FARS File--SPSS Structure

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

FILE NONAME (CREATION DATE = 04/04/78)

DOCUMENTATION FOR SPSS FILE 'NONAME '

LIST OF THE 1 SUBFILES COMPRISING THE FILE

NONAME N=16404

DOCUMENTATION FOR THE 28 VARIABLES IN THE FILE 'NONAME '

REL POS	VARIABLE NAME	VARIABLE LABEL	MISSING VALUES	PRT FMT
1	SEQNUM		NONE	0
2	SUBFILE		NONE	A
3	CASWGT		NONE	4
4	MAKE	MAKE OF VEHICLE	NONE	0

1. CHEVROLET
2. FORD
3. PONTIAC
4. BUICK
5. PLYMOUTH
6. OLDSMOBILE
7. DODGE
8. VOLKSWAGEN
9. MERCURY
10. CADILLAC
11. AMERICAN
12. CHRYSLER
13. LINCOLN
14. OPEL
15. DATSUN
16. TOYOTA
17. CAPRI
18. MAZDA
19. FIAT
20. VOLVO
21. AUDI
22. COLT
23. HONDA
24. PORSCHE
25. MG
26. SUBARU
27. ARROW
61. BMW
62. BSA
63. HARLEY-DAVIDSON
64. KAWASAKI

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

DOCUMENTATION FOR THE 28 VARIABLES IN THE FILE 'NONAME '

REL POS	VARIABLE NAME	VARIABLE LABEL	MISSING VALUES	PRT FMT
4	MAKE	CONT		
		65. NORTON		
		66. SUZUKI		
		67. TRIUMPH		
		68. YAMAHA		
		80. BROCKWAY		
		81. DIAMOND RED		
		82. FREIGHTLINER		
		83. FWD		
		84. GMC		
		85. INTERNATIONAL		
		86. KENWORTH		
		87. MACK		
		88. PETERBILT		
		89. WHITE		
		97. OTHER		
		99. UNKNOWN		
5	MODEL	MAKE-MODEL OF VEHICLE	NONE	0
		101. CHEVY NOVA		
		102. CHEVY CHEVELLE		
		103. CHEVY MONTE CARLO		
		104. CHEVY BISCAYNE		
		105. CHEVY BEL AIR		
		106. CHEVY IMPALA		
		107. CHEVY CAPRICE		
		108. CHEVY CAMARO		
		109. CHEVY CORVETTE		
		110. CHEVY CORVAIR		
		111. CHEVY VEGA		
		112. CHEVY EL CAMINO		
		113. CHEVY MONZA		
		114. CHEVY LAGUNA		
		115. CHEVY CHEVETTE		
		197. CHEVY UNKNOWN		
		199. CHEVY UNKNOWN		
		201. FORD FALCON		
		202. FORD MAVERICK		
		203. FORD TORINO		
		204. FORD GALAXIE		
		205. FORD LTD		
		206. FORD MUSTANG		
		207. FORD THUNDERBIRD		
		208. FORD CUSTOM 500		

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

DOCUMENTATION FOR THE 28 VARIABLES IN THE FILE 'NONAME '

REL POS	VARIABLE NAME	VARIABLE LABEL		MISSING VALUES	PRT FMT
5	MODEL	CONT			
			209. FORD XL		
			210. FORD PINTO		
			211. FORD RANCHERO		
			212. FORD FORS		
			213. FORD ELITE		
			214. FORD GRANADA		
			297. FORD UNKNOWN		
			299. FORD UNKNOWN		
			301. PONTIAC LE MANS		
			302. PONTIAC CATALINA		
			303. PONTIAC EXECUTIVE		
			304. PONTIAC BONNEVILLE		
			305. PONTIAC GRAND PRIX		
			306. PONTIAC FIREBIRD		
			307. PONTIAC GRANDVILLE		
			308. PONTIAC VENTURA		
			309. PONTIAC GRAND AM		
			310. PONTIAC ASTRE		
			311. PONTIAC SUNBIRD		
			312. PONTIAC GRAND LEMANS		
			397. PONTIAC UNKNOWN		
			399. PONTIAC UNKNOWN		
			401. BUICK SKYLARK-CENTUR		
			402. BUICK LESABRE		
			403. BUICK WILDCAT		
			404. BUICK ELECTRA		
			405. BUICK RIVIERA		
			406. BUICK SPORTSWAGON		
			407. BUICK LESABRE CUSTOM		
			408. BUICK ESTATE WAGON		
			409. BUICK APOLLO-SKYLARK		
			410. BUICK SKYHAWK		
			497. BUICK UNKNOWN		
			499. BUICK UNKNOWN		
			501. PLYM VALIANT		
			502. PLYM SATELLITE-FURY		
			503. PLYM FURY 1		
			504. PLYM GRAND FURY		
			505. PLYM GR FURY CUSTOM		
			506. PLYM GR FURY BROUGHA		
			507. PLYM BARRACUDA		
			508. PLYM VAL SCAMP		
			509. PLYM VAL DUSTER		

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

DOCUMENTATION FOR THE 28 VARIABLES IN THE FILE 'NONAME '

REL POS	VARIABLE NAME	VARIABLE LABEL	MISSING VALUES	PRT FMT
5	MODEL	CONT		
		510. PLYM VOLARE		
		597. PLYM UNKNOWN		
		599. PLYM UNKNOWN		
		601. OLDS CUTLLSS		
		602. OLDS DELTA-88		
		603. OLDS 98		
		604. OLDS TORONADO		
		605. OLDS DYNAMIC-DELMONT		
		606. OLDS JETSTAR-88		
		607. OLDS VISTA CRUISER		
		608. OLDS OMEGA		
		609. OLDS STARFIRE		
		697. OLDS UNKNOWN		
		699. OLDS UNKNOWN		
		701. DODGE DART		
		702. DODGE CORONET		
		703. DODGE POLARA		
		704. DODGE MONACO		
		705. DODGE CHALLENGER		
		706. DODGE CHARGER-CORONE		
		707. DODGE DART SPORT		
		708. DODGE DART SWINGER		
		709. DODGE ASPEN		
		797. DODGE UNKNOWN		
		799. DODGE UNKNOWN		
		801. VW KARMAN GHIA		
		802. VW BEETLE		
		803. VW DASHER		
		804. VW 411-412		
		805. VW COMMERCIAL		
		806. VW THING		
		807. VW RABBIT		
		808. VW SCIROCCO		
		897. VW UNKNOWN		
		899. VW UNKNOWN		
		901. MERCURY MONTEGO		
		902. MERCURY MONTEREY		
		903. MERC MONTEREY CUSTOM		
		904. MERCURY MARAUDER		
		905. MERCURY MARQUIS		
		906. MERCURY COUGAR		
		907. MERCURY COMET		
		908. MERCURY BROUGHAM		

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

DOCUMENTATION FOR THE 28 VARIABLES IN THE FILE 'NONAME '

REL POS	VARIABLE NAME	VARIABLE LABEL	MISSING VALUES	PRT FMT
5	MODEL	CONT		
		909. MERCURY MONARCH		
		910. MERCURY BOBCAT		
		997. MERCURY UNKNOWN		
		999. MERCURY UNKNOWN		
		1001. CADDY CALAIS		
		1002. CADDY DEVILLE		
		1003. CADDY BROUGHAM		
		1004. CADDY ELDORADO		
		1005. CADDY COMMERCIAL		
		1006. CADDY FLEETWOOD		
		1007. CADDY SEVILLE		
		1097. CADDY UNKNOWN		
		1099. CADDY UNKNOWN		
		1101. AMC GREMLIN		
		1102. AMC HORNET		
		1103. AMC MATADOR		
		1104. AMC AMBASSADOR		
		1105. AMC JAVELIN		
		1106. AMC AMX		
		1107. AMC RAMBLER-AMERICAN		
		1108. AMC PACER		
		1197. AMC UNKNOWN		
		1199. AMC UNKNOWN		
		1201. CHRYS NEWPORT		
		1202. CHRYS NEWPORT CUSTOM		
		1203. CHRYS 300		
		1204. CHRYS NEW YORKER		
		1205. CHRYS TOWN+COUNTRY		
		1206. CHRYS IMPERIAL		
		1207. CHRYS CORDOBA		
		1297. CHRYS UNKNOWN		
		1299. CHRYS UNKNOWN		
		1301. LINCOLN CONTINENTAL		
		1302. LINCOLN MARK 3		
		1303. LINCOLN MARK 4		
		1304. LINCOLN MARK 5		
		1397. LINCOLN UNKNOWN		
		1399. LINCOLN UNKNOWN		
		1401. OPEL KADETT-STANDARD		
		1402. OPEL GT		
		1403. OPEL 1900		
		1404. OPEL MANTA		
		1405. OPEL 2-DR COUPE		

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'OCUMENTATION FOR THE 28 VARIABLES IN THE FILE 'NONAME '

REL POS	VARIABLE NAME	VARIABLE LABEL	MISSING VALUES	PRT FMT
5	MODEL	CONT		
		1497. OPEL UNKNOWN		
		1499. OPEL UNKNOWN		
		1501. DATSUN 240,260,280Z		
		1502. DATSUN 1200		
		1503. DATSUN PL411		
		1504. DATSUN PL510		
		1505. DATSUN 1600		
		1506. DATSUN 2000		
		1507. DATSUN PL610		
		1508. DATSUN B210		
		1509. DATSUN PL710		
		1597. DATSUN UNKNOWN		
		1599. DATSUN UNKNOWN		
		1601. TOYOTA LAND CRUISER		
		1602. TOYOTA COROLLA		
		1603. TOYOTA CROWN		
		1604. TOYOTA CORONA		
		1605. TOYOTA MARK2		
		1606. TOYOTA CELICA		
		1607. TOYOTA CARINA		
		1697. TOYOTA UNKNOWN		
		1699. TOYOTA UNKNOWN		
		1701. CAPRI		
		1797. CAPRI		
		1799. CAPRI		
		1801. MAZDA 808-1600		
		1802. MAZDA RX2		
		1803. MAZDA RX3		
		1804. MAZDA RX4		
		1805. MAZDA COSMO COUPE		
		1806. MAZDA 808-1300		
		1897. MAZDA UNKNOWN		
		1899. MAZDA UNKNOWN		
		1901. FIAT 124		
		1902. FIAT 128		
		1903. FIAT 850		
		1904. FIAT 131		
		1997. FIAT UNKNOWN		
		1999. FIAT UNKNOWN		
		2001. VOLVO 140		
		2002. VOLVO 160		
		2003. VOLVO 1800		
		2004. VOLVO 240		

```
STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES


DOCUMENTATION FOR THE   28 VARIABLES IN THE FILE 'NONAME   '

REL  VARIABLE  VARIABLE LABEL                                    MISSING PRT
POS    NAME                                                       VALUES FMT


  5  MODEL     CONT
                          2005. VOLVO 260
                          2097. VOLVO UNKNOWN
                          2099. VOLVO UNKNOWN

  6  BODTYPE   BODY TYPE OF VEHICLE                                 NONE   0
                             1. CONVERTIBLE
                             2. 2-DOOR
                             3. 4-DOOR
                             6. STATIONWAGON
                             7. JEEP TYPE
                             8. OTHER CAR
                             9. UNKNOWN CAR
                            15. MOTORCYCLE
                            16. MOPED
                            17. MINIBIKE
                            18. UNKNOWN MOTORCYCLE
                            25. SCHOOL BUS
                            26. CROSS COUNTRY
                            27. TRANSIT BUS
                            28. OTHER BUS
                            29. UNKNOWN BUS
                            35. SNOWMOBILE
                            36. FARM EQUIP
                            37. DUNE BUGGY
                            38. CONSTRUC EQUIP
                            39. EMERGENCY VEH
                            40. LIMOUSINE
                            41. MOTOR HOME
                            42. FIRE TRUCK
                            50. PICK-UP
                            51. VAN
                            52. CARRYALL
                            53. TRUCK 10-20
                            54. TRUCK 20-26
                            55. TRUCK >26
                            56. TRUCK GVW=UNK
                            57. TRACTOR-TRAILER
                            58. MULTI-TRAILER
                            59. TRACTOR ONLY
                            60. UNKNOWN TRUCK
                            99. UNKNOWN VEHICLE
                             0. UNKNOWN VEHICLE
```

:TATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

'OCUMENTATION FOR THE 28 VARIABLES IN THE FILE 'NONAME '

REL POS	VARIABLE NAME	VARIABLE LABEL	MISSING VALUES	PRT FMT
7	YEAR	MODEL YEAR OF VEHICLE	NONE	0
8	WEIGHT	BRACKETED WEIGHT OF VEHICLE - CODED 1. 500-1500 2. 1500-2500 3. 2500-3500 4. 3500-4500 5. 4500-5500 6. 5500-6500 7. 6500-10500 8. 10500-25500 9. 25500+ 10. UNKNOWN WEIGHT	NONE	0
9	WHLBASE	BRACKETED WHEELBASE OF VEHICLE - VIN 1. 80-93 MINI 2. 94-101 SUBCOMP 3. 102-111 COMPACT 4. 112-118 INTERMEDIATE 5. 119-125 FULL SIZE 6. 126+ 7. UNKNOWN WHEELBASE	NONE	0
10	NO.VEHS	COUNT OF VEHICLES OF UNIQUE TYPE	NONE	0
11	FIRES	NUMBER OF FIRES OR EXPLOSIONS	NONE	0
12	UNK1		NONE	0
13	TIRES	NUMBER OF TIRE OR WHEEL DEFECTS	NONE	0
14	BRAKES	NUMBER OF BRAKE SYSTEM DEFECTS	NONE	0
15	STEER	NUMBER OF STEERING SYSTEM DEFECTS	NONE	0
16	SUSPENS	NUMBER OF SUSPENSION SYSTEM DEFECTS	NONE	0
17	POWER	NUMBER OF POWER TRAIN DEFECTS	NONE	0
18	EXHAUST	NUMBER OF EXHAUST SYSTEM DEFECTS	NONE	0
19	HEADLTS	NUMBER OF HEADLIGHT DEFECTS	NONE	0

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

DOCUMENTATION FOR THE 28 VARIABLES IN THE FILE 'NONAME '

REL POS	VARIABLE NAME	VARIABLE LABEL	MISSING VALUES	PRT FMT
20	SIGLTS	NUMBER OF SIGNAL LIGHT DEFECTS	NONE	0
21	OTHLTS	NUMBER OF OTHER LIGHT DEFECTS	NONE	0
22	HORN	NUMBER OF HORN DEFECTS	NONE	0
23	MIRROR	NUMBER OF MIRROR DEFECTS	NONE	0
24	WIPERS	NUMBER OF WINDSHIELD WIPER DEFECTS	NONE	0
25	SEATING	NUMBER OF DRIVER SEATING-CONTROL DEFECTS	NONE	0
26	OTHER	NUMBER OF OTHER DEFECTS	NONE	0
27	HITCH	NUMBER OF TRAILER HITCH DEFECTS	NONE	0
28	UNK2		NONE	0

APPENDIX F
A Defect Inventory Model

FOR INTRA-UNIVERSITY CORRESPONDENCE

THE UNIVERSITY OF MICHIGAN
HIGHWAY SAFETY RESEARCH INSTITUTE

February 1, 1978

MEMO TO: File

FROM: T. Kim and R. Kaplan

SUBJECT: Predictive Model for Office of Defects Investigation

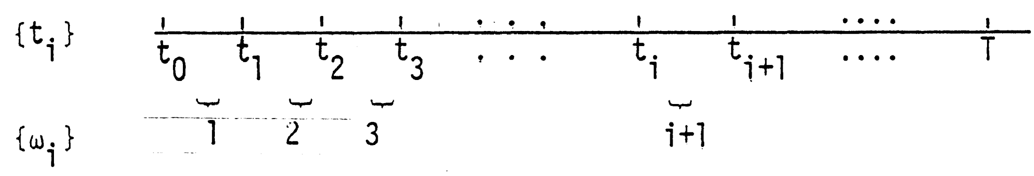
The NHTSA Office of Defects Investigation is responsible for the discovery of defective automobile components, recalling the vehicles for modification when the defect is safety related, and monitoring the recall process. Our contract with ODI is primarily concerned with identifying the communication channels by which the office is alerted to possible defect states. We think, however, that a natural extension of our analysis would be to model the defect process itself to provide the office with a policy-and-decision-making tool for its own managerial purposes. The initial outline for such a model follows.

A. Definitions and Assumptions

The time period for the analysis starts at t_0, the start of production for vehicle type j where

$$j = 1, 2, 1, \ldots, J$$

J being the total number of different types of vehicles under consideration. Time runs until T, the end of the planning horizon.



A unit time interval (UTI) is defined arbitrarily as one week, and the planning horizon may be, for example, 10 years, yielding T = 10 years = 520 UTI.

$\{t_i\}$ in the above figure is a sequence of time points where $t_0 < t_1 < t_2 < . . . < T$ and $UTI = t_i - t_{i-1} = t_{i+1} - t_i$ for all i where $i = 1,2,3, ..., T-1$

$\{\omega_i\}$ is the index of UTI where

$$\{\omega_i\} = \{\omega_1 \ \omega_2 \ \omega_3 \cdots \omega_T\}$$

$$\{ 1, 2, 3, ..., T \}$$

e.g. $t = \omega_5 =$ the 5th UTI = the 5th week

In addition to defining t_0 as the start of production, we define t_s as the time which production is stopped, and t_L as the guarantee time or the time lag before a component failure can occur.

$r(j,t)$ is the production rate of vehicle type j at time t, where $t \subset \{\omega_i\}$

$s(j,k_v)$ is the scrap rate of vehicle type j which has an age of k_v.

$$s(j,k_v) = 1 - \frac{\text{number of vehicle type j of age } k_v\text{+1 in use at t+1}}{\text{number of vehicle type j of age } k_v \text{ in use at t}}$$

which will be obtained from curve fitting or table look-up. Two assumptions are made in conjunction with the scrapping process:

1) Vehicles produced at time $t = \omega_i$ are exposed for scrapping after time t_i.
2) Vehicles produced at time $t = \omega_i$ are considered as one UTI old at time $t = t_{L+i}$ with $s(j,1)=0$.

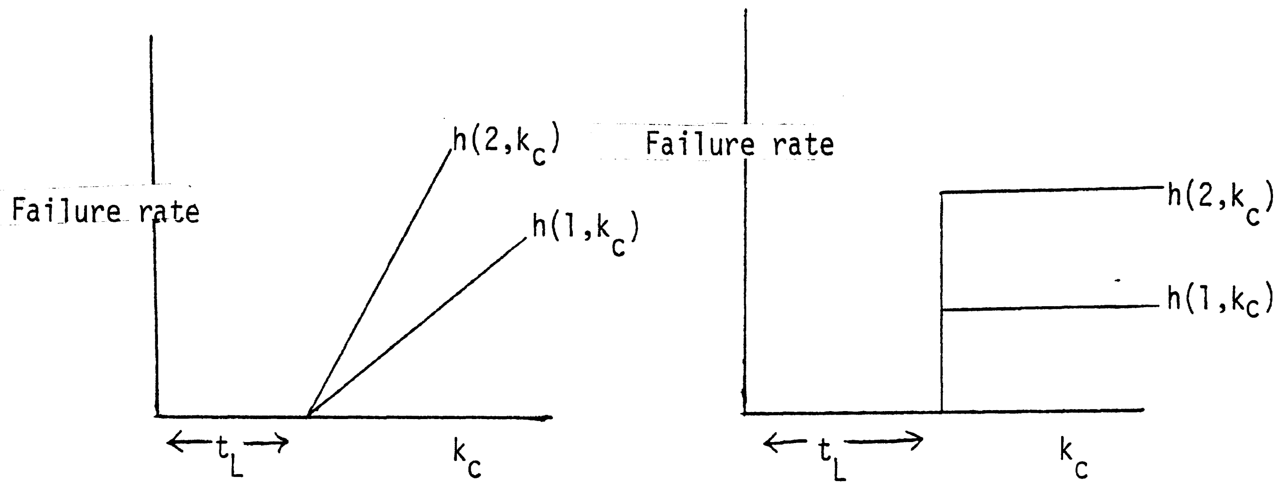
The component failure portion of this model assumes age-specific failure rate. That is, component failure depends on the age of the component, k_c, and is independent of the vehicle age, k_v.

Two types of failure will be allowed in the model;
Major: overhaul or replacement required, with k_c set to 0.
Minor: repair required, with k_c continuing

$h\ (i,k_c)$ = type i failure rate of component age k_c

$$i = \begin{cases} 1 \text{ for major failure} \\ 2 \text{ for minor failure} \end{cases}$$

The failure rates allowed are either increasing or constant (i.e., Poisson Failure process). Typical curves for these are shown below.



Increasing Failure Rate (IFR)   Constant Failure Rate (CFR)

One further assumption as an initial condition, is necessary before going into a discussion of the mathematical model. For a component failure occuring ω_i, the replacement/repair will be completed during ω_i. This will probably not hold if we consider components of the level of integration up to transmission or engine, but we are more likely to be dealing with parts at a much lower level of indenture, i.e., sub- or sub-sub-assemblies.

B. The mathematical model.

The first step in the computational process is to calculate $N(j,k_v,k_c,t)$, the total number of vehicles of type j of age k_v with a target component of age k_c which are exposed for failure at time t. That is, we want to compute the total inventory of vehicles on the road at any time by type, age, and target component age.

The following steps break down the computation and give: the total vehicle population at any time t, N(t), or by vehicle type, N(j,t), or or by vehicle age, N(k,kv,t).

$$N(j,k_v,t) = \sum_{k_c=1}^{k_v} N(j,k_v,k_c,t)$$

$$N(j,t) = \sum_{k_v=1}^{t} N(j,k_v,t)$$

$$= \sum_{k_v=1}^{t} \sum_{k_c=1}^{k_v} N(j,k_v,k_c,t)$$

$$N(t) = \sum_{j=1}^{J} \sum_{k_v=1}^{t} \sum_{k_c=1}^{k_v} N(j,k_v,k_c,t)$$

The mathematical task is to find an explicit expression for $N(j,k_v,k_c,t)$ for any t, $t \subset \{\omega\}$, and $k_v = 1,2,\ldots t$, $k_c = 1,2,\ldots k_v$, and $j \subset J$.

One possible approach to this task is to view the situation as a Markov Renewal Process. A single state consists of a specific age for both the vehicle and the target component and is expressed by (k_v,k_c). The diagram below shows the possible path analysis in the transition from one UTI to the next.

	(1,1)	(2,1)	(2,2)	(3,1)	(3,2)	(3,3)	(4,1)	(4,2)	(4,3)	(4,4
(1,1)		▱	▱							
(2,1)				▱	▱					
(2,2)				▱		▱				
(3,1)							▱	▱		
(3,2)							▱		▱	
(3,3)							▱		▱	▱
⋮										

Possible Transition Path Analysis with state of (K_v, k_c)

Two cases are of interest: 1) where $t \le t_s$, and 2) where $t_s < t \le T$.

where t_s is the time at which production stops.

In the first case

$$N(j,k_v,k_c,t) = \begin{cases} 0 & \text{if } k_v > t \\ N(j,k_v-1,k_c-1,t-1)*(1-S(j,k_v-1))*(1-h(1,k_c-1)) & \text{if } 1< k_v \le t \text{ and } 1< k_c \le k_v \\ \sum_{m=1}^{K_v-1} N(j,k_v-1,m,t-1)*h(1,m_L) & \text{if } 1< k_v \le t \text{ and } k_c = 1 \\ r(j,t-1) & \text{if } k_v=1 \text{ and } k_c=1 \end{cases}$$

The initial condition is specified by $N(j,1,1,1) = r(j,1)$.

Recursively for $1 < k_v < t$ and $1 < k_c \leq k_v$

$$N(j,k_v,k_c,t) = r(j,t-k_c) \prod_{m=1}^{k_v} (1-S(j,m)) \prod_{n=1}^{k_c} (1-h(1,n))$$

since $s(j,1)-h(1,1)=0$

For computational purposes we define

$$SH(j,k_v,k_c) = \prod_{m=1}^{k_v} (1-S(j,m)) \prod_{n=1}^{k_c} (1-h(1,n))$$

In this formulation, we note that

$SH(j,1,1) = 1$ and

$SH(j,k_v,k_c) = SH(j,k_v-1, k_c-1)*(1-S(j,k_v-1))*(1-h(1,k_c-1))$

Then, for $1 < k_v \leq t$ and $1 < k_c \leq k_v$

$N(j,k_v,k_c,t) = r(j,t-k_v)*SH(j,k_v,k_c)$

In the second case, where $t_s < t \leq T$, the effect of a recall is considered. The following three conditions are postulated in this formulation.

1) Production of the old component stops at t_s, and vehicles produced after t_s contain new components.
2) Any old components which fail, are replaced with new ones.
3) New components are "perfect", i.e., once replaced, are not subject to failure.

Since we no longer need to consider the age of the component after t_s (from 3 above), we may define $\overline{N}(j,k_v,t)$ as the total number of type j vehicles of age k_v which have been replaced with new components where $\overline{N}(j,k_v,t)=0$ when $t \le t_s$. We can also compute a combined failure rate $h(k_c)$ (using 2 above), so that

$$h(k_c) = \sum_i h(i,k_c).$$

Then $N(j,k_v,k_c,t)$

$$= \begin{cases} N(j,k_v-1,k_c-1,t-1)*(1-S(j,k_v-1))*(1-h(k_c-1)) & \text{if } t-t_s \le k_v \le t \\ & \text{and } t-t_s \le k_c \le k_v \\ 0 & \text{otherwise} \end{cases}$$

and $\overline{N}(j,k_v,t)$

$$= \begin{cases} \overline{N}(j,k_v-1,t-1)*(1-S(j,k_v-1)) + \sum_{m=1}^{k_v-1} N(j,k_v-1,m,t-1)*\, h(k_c-1) & \text{if } t-t_s \le k_v < T \\ 0 & \text{otherwise} \end{cases}$$

The total vehicle population at time t, when $t_s < t < T$ can be computed therefore by:

$$N(t) = \sum_j \left[\sum_{m=1}^{k_v} \sum_{n=1}^{k_c} N(j,m,n,t) + \sum_{m=1}^{k_v} \overline{N}(j,m,t) \right]$$

We wish now to calculate $M(i,j,k_v,k_c,t)$, the number of expected failures of type i, for vehicle type j of age k_v, with component age k_c at time t. In the case where $t \leq t_s$, (i.e., during time of production).

$$M(i,j,k_v,k_c,t) = N(j,k_v,k_c,t) * h(i,k_c)$$

and thus,

$$M(i,j,t) = \sum_{k_v-1}^{t} \sum_{k_c-1}^{k_v} M(i,j,k_v,k_c,t)$$

$$M(j,t) = \sum_{i} \sum_{k_v=1}^{t} \sum_{k_c=1}^{k_v} M(i,j,k_v,k_c,t)$$

$$M(t) = \sum_{i} \sum_{j=1}^{J} \sum_{k_v=1}^{t} \sum_{k_c=1}^{k_v} M(i,j,k_v,k_c,t)$$

where M(t) is the total of the expected failures in the vehicle population at time t. In the case where $t_s < t \leq T$, the formulation is identical except for the absence of the i component.

To calculate the number of expected failures for vehicle type j during any time period t_1 to t_2:

$$M(j,t_1,t_2) = \int_{t_1}^{t_2} M(j,t) \quad dt \text{ and}$$

$$M(t_1,t_2) = \sum_{j=1}^{J} M(j,t_1,t_2)$$ gives the total of the expected failures in the vehicle population.

C. The recall decision

The ultimate goal of the foregoing development is to provide assistance to the ODI in instituting and justifying recall campaigns. This model will provide an estimate of the number of defective items in the vehicle population and, based on an input of the failure rate or probability, will generate the failure distribution over time. The number of vehicles affected by a recall campaign beginning at time t_R can be calculated by:

$$M(j,t_R) = \sum_{k_v=1}^{t_R} \sum_{k_c=1}^{k_v} N(j,k_v,k_c,t_R)$$

when $t_R \leq t_s$.

Should $t_R > t_s$, we must modify this quantity by the experience occurring subsequent to the stop of production, given by

$$M(j,t_R) = \sum_{k_v=t_R-t_s}^{t_R} \sum_{k_c=t_R-t_s}^{k_v} N(j,k_v,k_c,t_R)$$

The total number of vehicles of all types included in a recall at time t_R can be computed by

$$M(t_R) = \sum_{j=1}^{J} M(j,t_R).$$

The effectiveness of a recall campaign can be measured by the response rate, R, the proportion of vehicles having the defective component repaired or replaced. The number of vehicles remaining on the road some period of time after the initation of the recall is computed as above, with the addition of the factor (1-R).

No attempt has been made in this discussion to account for the safety related costs of defective components. Naturally these are crucial to any decisions about recall actions, and the cost distribution for component failure is another necessary input to an eventual management system which will be useful to the Office of Defects Investigation.

APPENDIX G
The FORTRAN Program for Combining
Two BREAKDOWN Outputs

```
      C
        150 CALL MOVEC(55,IN(1),HEAD)
            CALL MOVEC(10,'TOTAL  SUM',HEAD(64))
            CALL MOVEC(13,'NUMBER DEFECT',HEAD(81))
            CALL MOVEC(8,'% DEFECT',HEAD(101))
            CALL MOVEC(10,'SIG. LEVEL',HEAD(115))
      C
            CALL WRITE(HEAD,LENH,0,LNUM,8)
      C
      C
      C
            IY=0
        200 CALL SETC(124,OUT,' ')
            CALL SETC(134,IN,' ')
            CALL READ(IN,LENIN,0,LNUM,7)
            IY=IY+1
      C
            IF ( LCOMC(1,'=',IN(16)) .EQ. 0 ) GO TO 300
      C
            IF ( K1(IY) .LT. 0 ) GO TO 210
      C
            CALL MOVEC(60,IN,OUT)
            CALL DECBIN(IN,63,6,KK)
            RKK=KK
            XKK=RKK/K1(IY)*100.
            IX1=XKK
            IX2=(XKK-IX1)*100
      C
            CALL MOVEC(6,SUMT(1,IY),OUT(66))
            CALL MOVEC(13,IN(61),OUT(79))
            CALL BTD(IX1,OUT(100),4,NDN,' ')
            CALL MOVEC(1,'.',OUT(104))
            CALL BTD(IX2,OUT(105),2,NDN,'0')
            IF ( IY .GT. 1 ) GO TO 205
            N=K1(1)
            P=RKK/N
            IDPROB=0
            GO TO 206
        205 NS=K1(IY)
            NDS=KK
            CALL DUMM(N,P,NS,NDS,DP,DPROB,IFISHR)
            IF(NDS.EQ.0.AND.DPROB.GT.0.5)GO TO 207
            IDPROB=DPROB*10000
        206 CALL MOVEC(2,'0.',OUT(117))
            CALL BTD(IDPROB,OUT(119),4,NDN,'0')
            GO TO 208
      C
        207 CALL SETC(4,OUT(119),'*')
      C
        208 CALL WRITE(OUT,LENOUT,0,LNUM,8)
            GO TO 200
      C
        210 IF (LCOMC(5,'CRITE',IN(2)) .EQ. 0 ) GO TO 251
            IF (LCOMC(5,'VARIA',IN(2)) .EQ. 0 ) GO TO 261
            CALL WRITE(IN,LENIN,0,LNUM,8)
            GO TO 200
      C
        251 CALL MOVEC(1,'/',IN(30))
            CALL MOVEC(8,TEMP1,IN(32))
            CALL WRITE(IN,LENH,0,LNUM,8)
```

```
          GO TO 200
C
      261 CALL WRITE(HEAD,LENH,0,LNUM,8)
          GO TO 200
C
C
      300 CALL WRITE(IN,LENIN,0,LNUM,8)
          CALL READ(IN,LENIN,0,LNUM,7)
          CALL WRITE(IN,LENIN,0,LNUM,8)
C
C
          WRITE(8,500)
      500 FORMAT('1')
C
          STOP
          END
          SUBROUTINE DUMM(N,P,NS,NDS,DP,DPROB,IFISHR)
          IFISHR=0
          DPROB=0.
          SIG=1.
          P1=P
          Q=1.-P1
          DNS=NS
          DDS=NDS
          DP=DDS/DNS
          HALF=DNS/2
          SAMP=P1*NS
          SND=NS-SAMP
          IF(SND.GT.7.AND.SAMP.GT.7)GO TO 30
          IFISHR=1
          IF(DDS.LE.HALF)GO TO 10
          SIG=-1.
          P1=Q
          Q=1.-Q
          NDS=NS-NDS
       10 PLOG=ALOG(P1)
          QLOG=ALOG(Q)
          IF(NDS.EQ.0)GO TO 20
          NP=1
          NP1=NS+1
          DO 50 I=1,NDS
          NP1=NP1-1
          NP=NP*NP1/I
          DP=PLOG*I+QLOG*(NS-I)
          DP=EXP(DP)
          AP=DP*NP
          DPROB=DPROB+AP
       50 CONTINUE
       20 TTP=QLOG*NS
          AP=EXP(TTP)
          DPROB=DPROB+AP
          IF(SIG.EQ.-1.)DPROB=1.-DPROB
          RETURN
       30 DIFF=DP-P
          VAR=P*Q
          VARN=N-NS
          VARN=VARN/N
          VARN=VARN*VAR/NS
          STAND=SQRT(VARN)
          Z=DIFF/STAND
```

```
      LOGICAL*1 IN(134),TEMP1(8),TEMP2(8),HEAD(124),OUT(124)
      LOGICAL*1 SUMT(6,500)
      INTEGER*2 LENIN,LENH,LENOUT
      DATA LENH/124/
      DATA LENOUT/124/
C
      DIMENSION K1(500)
C
      I=0
      IK=0

      CALL SETC(124,HEAD,' ')
      CALL SETC(124,OUT,' ')
C
C
   10 CALL SETC(134,IN,' ')
      CALL READ(IN,LENIN,0,LNUM,7)
      I=I+1
C
      IF ( LCOMC(5,'CRITE',IN(2)) .EQ. 0 ) CALL MOVEC(8,IN(23),TEMP1)
      IF ( LCOMC(8,'0FOR ENT',IN(1)) .NE. 0 ) GO TO 10
C
C
   50 IK=IK+1
      IF ( LCOMC(6,'      ',IN(63)) .EQ. 0 ) GO TO 60
      CALL MOVEC(6,IN(63),SUMT(1,IK))
      CALL DECBIN(IN,63,6,K1(IK))
C
   45 CALL SETC(134,IN,' ')
      CALL READ(IN,LENIN,0,LNUM,7)
      IF ( LCOMC(1,'=',IN(16)) .EQ. 0 ) GO TO 100
      GO TO 50
C
   60 K1(IK)=-1
      GO TO 45
C
C
  100 CALL READ(IN,LENIN,0,LNUM,7)
      IF ( LCOMC(3,'1ST',IN(1)) .NE. 0 ) GO TO 100
C
  110 CALL WRITE(IN,LENIN,0,LNUM,8)
C
      CALL SETC(134,IN,' ')
      CALL READ(IN,LENIN,0,LNUM,7)
      IF ( LCOMC(5,'CRITE',IN(2)) .EQ. 0 ) GO TO 120
      GO TO 110
C
  120 CALL MOVEC(8,IN(23),TEMP2)
      CALL SETC(101,IN(31),' ')
      CALL MOVEC(1,'/',IN(32))
      CALL MOVEC(8,TEMP1,IN(34))
  130 CALL WRITE(IN,LENH,0,LNUM,8)
C
  140 CALL SETC(134,IN,' ')
      CALL READ(IN,LENIN,0,LNUM,7)
      IF ( LCOMC(5,'0VARI',IN(1)) .EQ. 0 ) GO TO 150
      CALL WRITE(IN,LENIN,0,LNUM,8)
      GO TO 140
C
```

```
          CALL NORM(Z,DPROB)
          RETURN
          END
          SUBROUTINE NORM(Z,P)
C CONVERTS NORMAL DEVIATES TO HIT PROBABILITIES
C Z IS NORMAL DEVIATE
C P IS PROBABILITY YES(AREA BELOW CRITERION)
          X= ABS(Z)/1.41421
          PHI=1.0-1.0/((1.0+0.278393*X+.230389*X**2+.000972*X**3
         1    +.078108*X**4)**4)
          P= (PHI+1.0)/2.0
          IF(Z.GE.0.0) GO TO 1
          P=1.0-P
        1 RETURN
          END
ND OF FILE
```