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PLANNING FOR CONCENTRATED IMPLEMENTATION OF HIGHWAY SAFETY COUNTERMEASURES

PHASE I REPORT

Volume 1
Program Planning Considerations

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Prepared by

HIGHWAY SAFETY RESEARCH INSTITUTE
Institute of Science and Technology
The University of Michigan
Ann Arbor, Michigan 48105

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16. Abstract

At present there is a recognized need to improve the basis on which resource committments to highway safety activities will be made in future years. The goal of the present study is to formulate detailed plans for experimental programs that will determine the impact of selected safety countermeasures on highway safety. This report contains a consideration of the factors that we have found to be important in the design of such programs.

From a discussion of the general highway traffic system, six program areas are defined. For each program area, there is a discussion of candidate countermeasures and selection criteria; measurements of effectiveness; and control, resource, and data requirements. Considerations involved in the choice of a suitable site for each program are also stressed.

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PREFACE

This document is the first volume of a two volume report covering the six month Phase I effort of a one year program. The present volume contains the main discussion of results from the study. Volume 2 of this report contains a bibliography of documents pertinent to countermeasure development in each of the sixteen standard areas.

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1.0 Introduction

In response to the Highway Safety Act of 1966, the National Highway Safety Bureau promulgated a set of Highway Safety Program Standards to provide guidelines by which individual states could plan and execute comprehensive highway safety programs. As these programs were put into operation across the country, a need for some rational means of apportioning the available resources in a manner that would produce an optimal increase in safety benefits became increasingly apparent.

Now it is not a difficult task for even an untrained person to list a sizeable number of reasonable approaches to reduce accidents. It is even likely that a consensus of opinion will exist on many of these approaches lending to them a further degree of acceptance. What is difficult to produce of course is a demonstration that even the most carefully researched approaches, such as those specified in the standards, do in fact result in a significant decrease in the number of accidents or in other indicators of danger.

No reflection on the quality of the standards themselves is intended by this observation since they represent a consensus of opinion based on many observations and long experience. What is indicated, however, is that traffic system complexity, considered as a physical-psychological unity, is not fully appreciated. Many experiments are confounded by the occurrence of factors that were not anticipated in the design. Others founder on purely political grounds that are unrelated to the experiment. With this background, our program goal is clear: define a set of programs that will measure the utility of important countermeasures as a function of their level of application, and will rank the relative utility of the various countermeasure schemes in achieving some overall safety benefit (such as total number of accidents). Our approach toward achieving this goal is discussed in the remainder of this section.

One of the early tasks of this program was the collection and review of documents pertinent to the sixteen standard areas. The resulting report bibliography constitutes a portion of the resource collection required to establish an information base on the state of the art in highway safety countermeasure development.

The report bibliography contains about one thousand entries that are grouped by standard area. Contained in this collection are general discussions of the problems and attitudes common to the standard area, reports on current and proposed countermeasures, evaluations of pertinent methodologies, and presentations of factual data on actual programs. This bibliography has been reviewed by HSRI staff members as background information for our program development task.

A complete listing of the bibliography is presented in Vol, 2 of this report. Several delimiting considerations that are applicable should be noted here:

First, the bibliography was prepared from HSRI Library catalogs. The HSRI Library, a divisional library of The University of Michigan was established in July, 1966, to serve the specialized needs of the HSRI staff. Approximately 15,000 cataloged documents are on file and more than 250 periodicals are received. Documents include books, pamphlets, technical reports, journal articles, preprints, speech drafts or anything that can be stored on paper, microfilm, or microfiche. Thus, each document listed in Volume 2 is on file in our library; but more importantly, only those documents on file are contained in the bibliography. For this reason, some important contributions to the field may not be represented.

Second, the bibliography is not intended to be exhaustive even of the information contained in the HSRI Library. Documents that are listed represent only those that were felt by the compiler to be useful and pertinent to each standard area.

In view of the extensive character of the HSRI Library and the experience of the contributing staff, however, the resulting bibliography is felt to be a useful indication of the state of the art in highway safety in each of the standard areas.

The literature review only indicates what has been done. To determine what needs to be done, a general model of the traffic safety system was formulated to preserve the systems nature of the problem at hand and to help identify critical groupings and linkages. From this model we were able to identify six action areas that involved groupings of the safety standards and that could be identified with realizable program areas. Thus, it was concluded that six program types (not six programs) would provide a natural way of grouping the traffic system into tractable measurement areas.

The modelling effort -- which is important to understanding the workings and implications of a complex system -- was continued at the program level area to define and clarify system operation. This model provides a framework within which it is possible to determine the possible effects of each countermeasure candidate. Such a clarification of cause and effect permits one to select optimum points in the system to apply countermeasures and to monitor their effectiveness. With the measure of effectiveness in hand a good model also indicates the relationship between the measured intermediate criteria and the desired overall safety benefit.

Finally, considerations involved in siting a demonstration program have received extensive attention. While site location considerations are not a part of the "technical" program plan, they are so closely related to the suceessful operation and completion of a program that they must be considered highly significant. We have gathered a variety of information relative to the siting problems through visits, phone conversations, literature search and personal experience so that a sensible choice may be made.

It should be emphasized here that present report covers the first phase of the contracted studies and is intended to be a presentation of the considerations involved in designing experimental countermeasures demonstration programs. The program plans and site selections that are presented below must consequently be considered as only tentative. Phase II of the program will be devoted to constructing Operational Plans based on the Phase I research.

2.0 The General Traffic Safety System Model

In order to provide a historical background and systematic rationale for our selection of program areas, a generalized model that relates pertinent aspects of the highway traffic safety system is presented here. From this general model, it appears desirable from a functional point of view to delineate sub-models, each sub-model corresponding to the aggregation of a number of standard areas. These system components have the additional advantage that they provide a homogeneity of countermeasure evaluation schemes that leads naturally to their identification with desired program areas.

2.1 Sub-System Definition

The general traffic safety model is shown diagramatically in Fig. 2-1. As a point of origin for our discussion, we begin with a traffic event. Typical examples of these events are accidents, violations, or arrests as well as administrative functions such as title transfers, driver license examinations, or court actions. Regardless of its nature, we assume that each event generates two possible sequences that are differentiated by the time scale in which they operate. Short term operations are shown to the right in Fig. 2-1.and represent the immediate consequences of the event: i.e., a detection is made and some action results (in the case of crashes, for example, the police come, emergency medical service arrives, a two truck removes the damaged vehicles, etc). Such activities are grouped together into what we shall call a SYSTEM RESTORATION MODEL.

Apart from the immediate consequences of the event, there are a number of longer term operations that may function over extended periods of time: these processes are shown to the left of the event in Figure 2-1. For purposes of discussion let us suppose that our

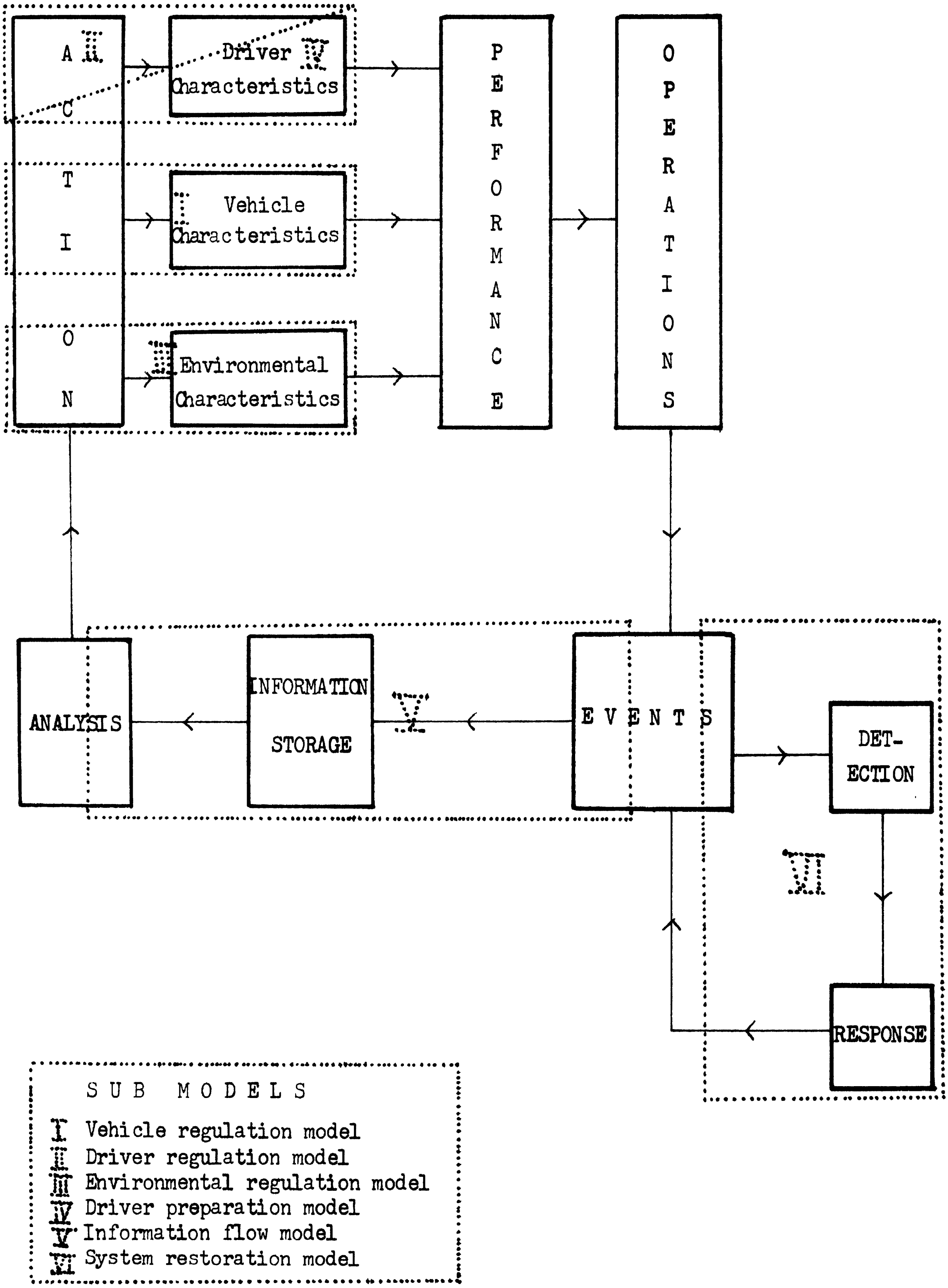

Figure 2-1. Conceptual view of the highway traffic safety system.

event was an accident. Following investigation by a policeman or other official, a report of this accident will be sent to the central information point for storage. Subsequently that report (together with many others) will be analyzed by some person or agency. There are many potential users for this information -- an insurance company that bases the premium for each individual on his accident experience and the experience of "similar" persons; a department of motor vehicles that maintains a point system for identifying and treating problem drivers; or a highway department research section that is seeking information from accident data to identify highway design problems. Analysis output consequently consists of processed information that can be distributed to action agencies where appropriate traffic system modifications may be instigated. For modelling purposes, we will consider the links from initial report generation to the performance of some degree of analysis and final reporting as the defining operations of an INFORMATION FLOW MODEL.

The analyzed data output of the information flow subsystem is shown as an ACTION activity input in Fig. 2-1. Actions may result from this formal or informal information that produce a change (or at least an attempt at change) in the characteristics of an appropriate system component. These actions may be categorized by the nature of the traffic system component they seek to correct -- driver, vehicle, or road. In general then, any action program tries to induce a change in some part of the traffic system. Following this change a subsequent alteration of the affected part's operating performance can be expected. Ultimately of course, a modification of the system's accident production potential is desired.

In the present discussion, action programs have defined inputs consisting of analyzed event reports data; and outputs that act on people, vehicles, or roads. With the recognition that drivers represent the most important part of the system, we have identified four action models: They are 1) <u>THE DRIVER PREPARATION MODEL</u>, 2) <u>THE DRIVER REGULATION MODEL</u>, 3) <u>THE VEHICLE REGULATION MODEL</u>, and finally, 4) <u>THE ENVIRONMENT REGULATION MODEL</u>.

2.2 Development of Program Areas

A decomposition of the general traffic safety model into the six submodels described above provides a convenient, satisfying way of classifying the overall operation of the safety system into action areas that have consistent internal goals as well as minimum functional overlap with each other. Each of the action areas corresponds to the tasks and events normally associated with a number of Highway Safety Program Standards. For example, our driver preparation model involves most of the requirements of the Driver Licensing and Driver Education Standards. Some of the standard areas are so broad in scope, however, that their effect is evident in a number of action areas. The Police Traffic Services standard is a prime example of this, since police action is vitally intertwined in all parts of the traffic system.

The fact that the general traffic model can be conveniently broken up into a minimally interacting set of submodels does not indicate, however, that these submodels should (or could) form the basis for a set of implementable measurement programs. But for reasons given below this is in fact our contention.

It was suggested earlier that division of the general traffic safety system into the subsystems outlined above results in a number of submodels that display a reasonable unity of goals and methods. On further consideration of these submodels, it is evident that the countermeasures peculiar to each action area imply a corresponding unity of measurement types for their proper evaluation. For example, in a driver regulation program the intermediate criteria used to evaluate the potential effect of a given countermeasure would in all likelihood be a subjective measure to determine the role of regulation in effecting a change in driver behavior. In contrast, a vehicle regulation program would employ objective measures to quantitatively evaluate the effect of regulation on vehicle behavior.

Consequently, we propose that six program types be implemented as carriers for countermeasure evaluation. To reiterate, these programs are in the areas of:

1) Information Flow
2) Driver Preparation (Highway User Preparation)
3) Driver Regulation (People Regulation)
4) Vehicle Regulation
5) Environment Regulation (Highway Regulation)
6) System Restoration

The use of "types" is emphasized here because the need for control groups and multiple level studies will certainly result in more than six actual programs. For each of these program areas we would like to propose an experiment that would permit measurement of several levels of performance along with their output in some useful, measurable terms. A brief summary of each program area is presented below.

Information Flow

This program area is concerned with the flow of traffic safety data: namely driver, vehicle, highway and accident records.

The primary emphasis in the data flow program is to maximize the utilization of traffic records systems by the local user or highway safety practitioner. The users fall into the other five program areas covered by this report; thus, the data flow program is an integral part of each of the other programs and should be considered as such in the implementation of the other programs.

We visualize a multi-level experiment in which the principal emphasis is on the utilization of existing information banks. There are many states that have spent a large amount of money building a capability to store and process traffic accident and ancillary information but have spent little developing a capability to use such information. For example, we estimate that Michigan uses about 200 man years of effort per year acquiring and storing accident information, but a miniscule amount on the direct analysis of such information for anything other than public relations or national safety council statistics programs. We propose to take several jurisdictions (within several states, depending upon how much money can be devoted to this)and to treat each at a different level of sophistication with regard to output effort. The lowest level would be nothing more than what is currently done (e.g. NSC summaries); the next level might be to have the state highway department perform analyses with respect to its own personnel assignment, etc., a third level might be all of level two plus a modest effort in special studies on, say, small cars, motorcycles, young drivers, drinking, etc. (perhaps using bi-level reporting etc); and finally the full treatment would include all the above tasks plus a large effort aimed at analysis of local problems (working directly with city traffic engineers, city police officials, etc.). Measurement of effectiveness for this process cannot be a direct measure of accident reduction (although these data banks would serve to evaluate some other things which are going on), but would rather be a usage criteria: measurement of information flow quality through the system and an evaluation of what users do with the data by the application methodology used in library user studies.

The secondary emphasis of the data flow program is the development of statewide exposure measures as a basis for computing accident rates. Valid accident rates are essential for the identification of problem areas and for evaluation of countermeasures adopted to relieve the problems. The comprehensive exposure survey would be based on methodology developed by HSRI for the NHSB.

Highway User Preparation

This is potentially the most long term evaluation problem we must deal with. We have concluded that the customary manipulation of methods and equipment should be secondary to the introduction of new content into both instructional courses (ranging from pre-school to driver improvement) and driver license examinations. We need to know how much effort is required for instruction and examining to go beyond "skills and drills" to a more sophisticated concept of highway user tasks in behavior-decision terms. We propose three levels of effort for driver preparation: at the lowest level, literature on new content would be distributed to driver education and driver improvement specialists; at the second level, the specialists would receive in-service training and other support; the highest level would consist of a comprehensive program of in-service training, public information, and other support to change instructional content and to integrate it more satisfactorily with driver examining. Considerable emphasis in the latter is placed on the "diagnostic" concept described recently by Miller and Dimling (Ref 4-2). Three levels of effort are also proposed for the pre-driver in order to compare school courses with some innovative television techniques. To evaluate instruction, we need to look at sub-task behavior (e.g. perceptual performance), operational behavior in both test and unobtrusive situations, and qualitative measures of accident/violation experience; driver examining should be evaluated on its diagnostic utility and its role in encouraging self-improvement. Finally we should examine the public acceptance of each level of change.

Driver Regulation

The driver regulation area includes the Police Traffic Services, Codes and Laws, Courts, and Alcohol standards. Because of the nature of the highway safety problem in historical terms and due to the desires of several governmental agencies, this area will most likely be the largest in effort and money as well as the longest in time. As a result, two inter-related sets of 10 experiments each have been proposed. Sites ranging in population from 75,000 to 250,000 are suggested as feasible for efficient experiments. Cost estimates range from $25K to $2.0M per year per program depending upon the breadth of the program. Time estimates range from 3 to 7 years as minima for valid and reliable data, again depending upon the nature of the specific program. Programs which jointly maximize scientific information and positive social change are offered by the utilization of innovative techniques of experimentation (e.g., quasi-experimental design), analysis (e.g., multivariate analysis of variance), program insertion (non-obtrusive designs and measures) and pre-, post- and during contractural relationships with the contractors (e.g. allowing innovative use of funds within countermeasure guidelines, in-house measuring agents where possible, etc.). Rather than assessing the efficacy of a limited subset of possible "innovative" countermeasures, the overall experimental design asks the questions of cost vs. benefit and relative efficacy for conceptual areas of people regulation countermeasures, utilizing the more traditional techniques of people regulation. The experimental design is structured such that both additive and multiplicative effects of adding countermeasure efforts to ongoing people regulation programs can be separated and assessed. The idea of extensive measurement, using more intermediate criteria, especially behavioral and decision making parameters, is suggested as the primary need for effective evaluation of any of these programs. Possibilities for utilizing existing programs (e.g., alcohol, ASAP) is discussed and considered as a possibility for cost minimization. Finally, the usefulness of the complete establishment and utilization of all relevant relationships is emphasized as a requirement for efficacious programs. The failure to consider the gamut of political/ social considerations as well as scientific needs will produce at best illusory experience.

Vehicle Regulation

This program essentially is vehicle inspection. Other countermeasures in the area include affecting owner repair practice and possibly influencing component failure time parameters. In this program two questions need be answered. First, "Does more or better inspection improve the mechanical condition of the vehicle population?" Second, "Does improved mechanical condition reduce the frequency or severity of accidents?" We suggest five basic programs in the area; 1) doing nothing for control, 2) a simple spot check program, 3) a "voluntary" self-inspection program coupled with spot checks, intensified law enforcement, and a possible call-in audit approach, 4) an annual standard inspection such as are used in several states, and 5) a highly intensive diagnostic inspection system. The primary measure of effectiveness is the change in the frequency of outage for various vehicle components among the various systems. This measure would be obtained through a combination of spot checks, analysis of inspection statistics, and a diagnostic sample of vehicles in the population. Secondary measures of effectiveness include survey s of owner repair practices, checks on the effectiveness of recall campaigns, and examination of the effect of, yet to be announced, used motor vehicle safety standards. An ambitious program would also include diagnostic examination for defects of a cross section of both accident and non-accident involved vehicles to determine the relative over involvement, if any, of vehicles displaying particular types of defects.

Ideally the programs should be located in geographically separate areas of the same state to control as much as possible for such extraneous factors as climate, geography, and social-economic differences. The currently approved experimental program in Tennessee serves as a prototype for this approach.

Environment Regulation (or Highway Regulation)

While this area derives from three standards(highway geometrics, signs and signals, and pedestrian safety) we have emphasized the signs and signals area for a proposed experiment. This is because there is already a great deal of effort in highway engineering from a safety point of view, much of it with competent evaluation. The Highway Research Board, as well as other agencies, have encouraged reporting of such work. While the quality of the evaluation varies, it would be better to encourage the present work than to compete with it.

A different argument exists for the pedestrian area. There is not much doubt about the kinds of pedestrian protection efforts which are of value--training (particularly for youngsters), police patrols, crossing guards, a variety of signalling systems, and, in heavy traffic situations, grade separation. While a pedestrian safety activity may be of value in some other experimental area (say people preparation or people regulation) there does not seem to be much value in it here.

The signing and signalling area has definite possibilities, however. Existing standards for signing are not followed, even in new construction. And in older areas signing is often quite poor. The Blatnik committee movies (Ref 2-2) indicated directly the kinds of maneuver errors committed by drivers who were confused by signing on freeways. We have suggested a resigning program for four large city beltways: One to come up to the minimum FHWA standard, the second to come up to the maximum standard, and the third to exceed the standard by innovation; a fourth area would be held as a control. The experiment could be conducted reasonably quickly, and an immediate measure of effectiveness in terms of conflict or error measures could be accomplished within months. A year or two of accident data would also be useful.

A second signalling and signing experiment is proposed--this one to modify the signs in a small to medium size city (say 50,000 to 100,000 population) to assist visitors in finding their way into and through the urban area. This size city was recommended as a compromise between the existence of a problem and cost, and should be large enough to demonstrate the value of improved route signing. Measures of effectiveness would include observation of traffic, interviews of travelers, and specialized accident reporting (i.e. a supplementary accident report collected on out of city visitors). This program would take longer for measurement than the beltway change described above, but two years of accident data supplemented by occasional direct measurements should provide adequate information.

System Restoration

We have proposed to locate system restoration experimental programs in county-size areas (several hundred thousand people in a thousand square miles). The site should have at least one moderate-sized city, and some hospital facilities. And, as necessary for all programs, it should have a problem which is susceptible to improvement.

There should be four sites: One for a control in which measurement but no intentional change would be made at least during the first years. The second would be brought up to the NHTSA minimum standard with respect to training and equipment. The third would be brought up to the NHTSA maximum standard--using the recommended ambulance attendant training course, and the recommended vehicle, as well as increased training for dispatchers and cleanup personnel. This level should also have a strong central planning and coordinating activity. The fourth should exceed the third--particularly in innovative measures. The use of returning medical corpsman as attendants, helicopters (where they can be predicted to have value) etc. are recommended.

In each case the principal measures will be time (the service times individually and collectively) and adequacy of treatment (as judged by medical personnel). There should be an attempt to measure morbidity and mortality, although it is recognized that this will be difficult in any short term experiment. A county of the size designated above, might expect, for example, to have 50 to 75 traffic fatalities per year, but the deviation of the actual number from the mean is likely to be large. Primarily for this reason the careful study of individual cases is in order.

Some pertinent aspects of these proposed programs are presented in condensed form in Table 2-1 for summary purposes.

2.3 Program Planning Criteria

As stated above then, our conclusion is that six types of demonstration programs should be implemented to provide a comprehensive evaluation of highway safety countermeasures.

The demonstration programs must be designed to provide answers in two areas of uncertainity:

1) Which standard areas provide the best opportunities for highway safety improvement?
2) What countermeasures in each program area are most desirable for highway safety improvement?

The supposition that an answer to these general questions does in fact exist also implies a means for rating each program and countermeasure type in terms of effectiveness.

Our approach to answering the general questions posed above is to consider that each program type that is implemented will be designed to provide a measure of UTILITY as a function of LEVEL OF APPLICATION. To take a simple quantifiable example, we might rate a water chlorination system by its utility (in terms of the number of bacteria killed per unit volume of water) as a function of the level of application (gms of chlorine per unit volume of water). Such a measurement would provide information on critical features of the relationship between bacteria and chlorine, as indicated in Figure 2-2. That is, very small application levels would not provide a lethal dosage and little effect(or change in utility) would be noticed. When dosage is increased to the point where some effect is noticed, a critical Minimum Application Level is defined. Conversely, when the dosage level is very large, a saturation effect is obtained and a critical Maximum Application Level can be defined. Knowledge of the two application levels serves to define the useful operating region for this type of system.

Program / Characteristic	Information Flow	Highway User Preparation	Driver Regulation	Vehicle Regulation	Environment Regulation	System Restoration
Governmental Unit	State	City with State Participation	Small to Medium City	State or Medium County	Large City	County
Affected Population		5000-6000	75-200K Residents 35-100K Drivers + Transients	10^5 vehicles	0.5-1 x 10^6 Residents + Traveling Motorists	200,000 Residents in each area
Number of Experiments	4	6	10 ~ 20	5	2-4	4
Duration	2-4 yrs.	4-5 yrs.	2-7 yrs.	3-5 yrs.	1 year	2-4 yrs.
Cost	200-900 K$	550K$ First Year 270K$ Following Years	25K$-2M$/yr.	100-400K$ per jurisdiction per year	1M$	4M$
Possible Sites	NY, Ohio, Calif., Fla., Ill., Ind., Penn. Conn., La., Mich. Tenn. Ga. Mass., N.J.	States with good relationship between schools and DMV	To Be Determined	Ohio, Fla., Tenn., Mich., Ill., Calif., Wisc., Ind.	To Be Determined	To Be Determined
Experimental Measures	Data Flow Quantity Quality Data Utilization Critical Incidents Repeated Usage Penetration or Acceptance	Instructional Changes (1) Sub-Task Behavior (Perception, Prediction, Decision, Execution) (2) Operational Behavior (Critical Events, Violations, Accidents) (3) Student Acceptance Driver Exam Changes (1) Diagnostic Utility (2) Self-Improvement Action (3) Driver Acceptance	Behavior Decision Parameters: (1) Expectancy (2) Value Accident Rate Critical Event Index (1) Headway (2) Error (3) Conflict Enforcement Indices (1) Density (2) Randomness (3) Selectivity Organizational Effectiveness	Vehicle Condition Accident Rate	Driver Errors or Conflicts Accident Rate	Time to Treatment Time in Transit Morbidity Fatality Incidents Resulting from Debris

Table 2-1

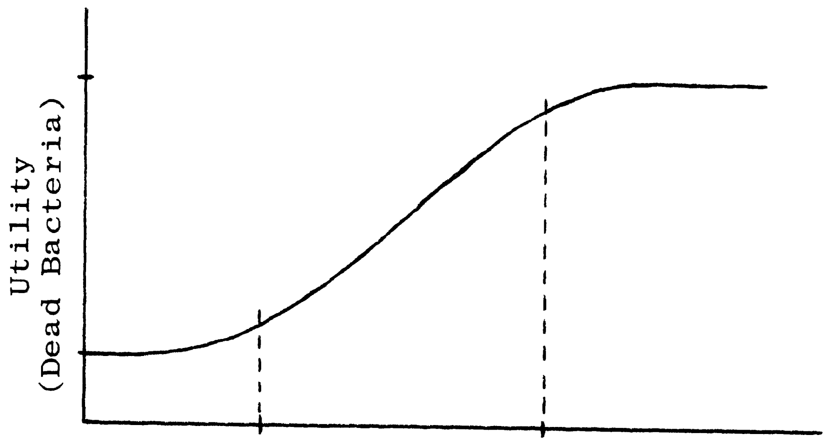

Figure 2-2. Typical Utility-Application Behavior

Such a one dimensional relationship between easily quantifiable utility and application measures is, unfortunately, not applicable to our problem; the general methodology, however is. Utility, in general, will be a multi-dimensional quantity that describes the many facets involved in the description of a tenuous quantity of this kind. Some dimensions of the utility variable will be straightforward, quantifiable components such as the number of persons driving without a license, the percentage of cars with defective brakes, or the number of moving violations. Other components, while not measurable may be ranked on some scale of importance while still other components are simply categorical in nature. Although we have talked only of the utility measure here, the same considerations apply to the Level of Application.

The important point to note here is that our desired relationship between Utility and Level of Application will be a complicated one. Now the maxima of multivariate functions are notoriously difficult to find and we do not have any high hopes of determining optimum levels of applications. What we do know how to find with properly defined measurements, however, are indications of the critical minimum and maximum application levels that could define the acceptable region of operation for a given program type.

In order to locate these critical points we propose using a number of separate test sites for each program area with the use of a different application level at each site. The initial measure of level of application will be simply the number of countermeasures that are employed in each demonstration. Thus, we may vary in complexity from a control site where no changes in the existing structure are made to a maximum effort level in which a significant number of selected countermeasures are employed. Because of secondary modifications in the traffic system brought about by the application of a primary countermeasure, the level of application in practice may differ from the assigned count of countermeasure types. For example, an increased conviction rate in the courts may result in a sympathetic increase in the number of violations issued by police who feel their efforts are being more adequately rewarded.

2.4 Countermeasure Categories

The Hall-Carlson report (Ref. 2-1) indicated that countermeasure programs could be divided into three general categories with respect to evaluation methodology. The first type is called "DIRECT COMPONENT CHANGE" program, and is typified by the installation of a left turn lane at an intersection where many rear-end accidents occur. Another direct component change (in the vehicle construction area) is the introduction of energy absorbing steering column. These direct changes can be evaluated sensibly by a direct measure of accident rate or injury rate respectively, since they are closely connected with the accident process.

The second type of program is called a "COUNTING" program. There are a number of such activities going on presently under "402" sponsorship. In the "codes and laws" area there are "COUNTING" activities such as simply determining how close a given state is to the Uniform Vehicle Code. This type of program can perhaps best be evaluated by an auditing process - i.e. was it done. Counting the traffic signals in a city, inventorying the ambulance capability of a county, etc. are reasonable programs (at least under some of the standards), but generally one can only measure whether or not they were done and perhaps discover whether they provided useful information for directing an action program.

The third kind of countermeasure is called an "INDIRECT COMPONENT CHANGE" program. This class constitutes the most common programs, and is exemplified by the addition of a new simulator to a driver education program within a jurisdiction, or the installation of VASCAR in state police cruisers. In these cases the intended effect of the change is usually to alter the characteristics of the driver, the vehicle, or the road as discussed above.

In general there is a spectrum of possible measurements that may be made in connection with any action program. Often some direct effect can be measured, but ultimately it is quite desirable to relate the countermeasure to the overall accident rate. A choice between the two measurement approaches is usually difficult to make. The ultimate goal of any system modification is, of course, the reduction of accidents: this statistic, however, is very difficult to relate positively to the countermeasure. On the other hand, the use of indirect criteria offers the possibility of finding a well understood relationship between countermeasure and measurement statistic; but the relationship between the measured output and the overall accident rate may be obscure at best. Our hypothesis is that the appropriate measure can only be devised by a careful modelling of the problem so as to understand the chain of relationships shown in Figure 2-1.

2.5 Countermeasure Candidates and Their Selection

Potentially then, a huge number of potential countermeasures exist if one counts each specific application. It is consequently of little use or value to simply list all the possible things that could be tried to improve traffic safety. Recognizing this, it has seemed to us much more sensible to determine those countermeasure types that have received a broad base of support in the traffic safety community and have demonstrated some potential for success. Our source of this information has been the bibliography included in Volume 2, the computer data file of 402 programs described in the Appendix, a knowledge of exisitng 403 demonstration programs, talks with NHSB regional directors, and our contacts with other knowledgeable parties. To this list we have added some countermeasures of our own that seem appropriate to a particular program area. Having gathered a list of countermeasures by this procedure, further selection is necessary to choose those candidates that would do best in a program of the type we desire. Some further criteria that we have used for selection are described below.

An important criteria for the long term application of a specific countermeasure is the degree of acceptance that the measure generates among the motoring public. It is true that most highway safety actions are regulatory in nature since they seek to bring about a behavior pattern that is understood by everyone using the system. Man's basic freedom of spirit does not take kindly to regulation, however, and at best conditions are accepted as necessary facts of life. Within the accepted framework of regulation, then, it seems best in the long run to avoid those measures which the population at large feels are unduly repressive. As an example, the significant reduction of speed limits on a given highway might reduce accidents in the immediate locale but could have long term detrimental effects in diverse areas as a result of ill will generated by people who use the highway and feel with some cause that the speed limit is unreasonable. In summary, the entire subject of regulation must be handled carefully as a result of man's basic freedom of action and as a result of the individual or community power gained through the regulation of others.

Another criterion involves the degree of change represented by the countermeasure. Here we have the important balance between what could be done and what seems best to do (relative to what has been done) and what resources are available to accomplish the charge. In certain areas--driver preparation, for instance--it is felt that what has been done is inadequate in many respects to achieve the desired objective: consequently some significant changes have been proposed. This recognized need for change must be balanced against the resources available (manpower, money, facilities, etc). to accomplish the change and against its relative priority among other countermeasure approaches.

Further, if the countermeasure is to have national applicability its large scale effectiveness must be considered. Certain measures may be tailor-fitted to specific locales but are not applicable in general on a country wide basis.

The timing of a specific countermeasure may also be critically important if recognition of its value is to be obtained. This statement simply implies a recognition that ideas have their own natural "time" and that it is little use to preach puritanism during a period of liberal tendencies.

Finally there is the practical, experimental design problem of selecting countermeasures that lend themselves to definite measures of enforcement level and to suitable intermediate criteria measures of their effect on the system. Since many, many programs in the past have failed to demonstrate any utility for the countermeasures under evaluation, this consideration is critical. That is, a demonstrated capability for a "less desirable" countermeasure seems to be more significant than the undemonstrated capability of a "better" one.

While we believe firmly in this view as a research organization, it is not the considered opinion of the highway safety community in general. In a great many instances there is strong feeling that certain concepts are useful and that everyone knows they are useful. In such cases we feel that these programs should certainly be funded.

Rather than promoting these programs as an honest, hypothesis approach to the problem, however, an ineffective evaluation effort is appended to add an aura of scientific endeavor. The net result is a consumption of tax dollars and the generation of a skeptical attitude about the validity of scientific analysis. Our aim consequently is to design programs that will yield results commendable to evaluation at the expense of more "obviously" desirable programs.

2.6 Experimental Design and Measurement

There appear to be at least two major considerations with respect to the desired outcomes of experimental countermeasure programs, positive change and experimental evidence. Positive change of course involves a good deal of value judgment, but most can agree that reducing the negative aspects of highway transportation (death, accidents, conflicts, etc.) is desirable. A more detailed discussion concerning the why and how of positive change and type of definable and perceptual change are presented later in this report (C.F. See 5). Experimental evidence, the prime requisite of SCOPE, requires some definition with regard to demands and resources of such an effort. A malady common to research in highway safety, and several other non-physical sciences as well, is the attempt to mimic the apparent success of the physical sciences by applying the hypothetico-deductive model of research to complex (biological, psychological, social and physical) ill-defined systems such as the highway safety system.

Though one can admire the zeal of such an application, the widespread disillustionment and cynicism concerning the apparent lack of success with the strict Fisherian or agricultural (Field "A" vs. Field "B" where A received fertilizer and B received none) type of experimental/statistical approach to highway safety research demands some more effective approach for extracting information from such research. This document proposes experimental design and measurement as the state-of-the-art approach to verifying the efficacy of highway safety countermeasures. This report also is predicated on the belief that an experimental design with some known degree of design and control is better that the traditionalist approach of a strict experiment vs. no experiment at all. If one is to accomplish the goal that SCOPE wishes to attain then such a nihilistic approach must be supplanted by a careful compromise which maximizes positive outcomes and minimizes contaminating interferences given the resource constraints.

That is to say, given the range of possible countermeasure programs, were a fully experimental approach the only way to accomplish SCOPE requirements, there would exist vitually no feasible opportunities for executing such experiments in the present highway safety system. The alternatives then are to either abandon SCOPE and continue in our ways <u>or</u> to take advantage of certain components of the on-going highway safety system, insert some degree of control, techniques of measurement and sampling, and execute a quasi-experiment, where we may not have a fully controlled and/or randomized design but we can measure and interpret the effects of those elements over which we have no control. This is the method of quasi-experimental design. These techniques are more fully explicated in Ref 5-7 and the reader is urged to consult this reference.

An illustration of the quasi-experimental method in highway safety would be the utilization of a "natural" phenomenon such as the current state of affairs in Tennessee with respect to motor vehicle inspection. Currently, at least three different forms of vehicle inspection exist: (1) Semi-annual (Memphis), (2) Annual (Chattanooga) and (3) Knoxville has just discontinued inspection. By employing some extensive type of measurement and sample selection, the state of affairs in Tennessee can be paralayed into a quasi-experimental design. History and testing effects must be measured and/or controlled where possible, but in any case Tennessee can allow the experimental assessment of relative efficacy of several levels of motor vehicle inspection via the quasi-experimental method. Section 6 of the report outlines the details of such an effort. There is no reason why this method cannot be utilized in the other countermeasure areas.

A trade-off then exists between strength of control or design and strength or depth of measurement. What we cannot control we must measure. Consequently current state-of-the-art statistical methods such as randomized blocks analysis of variance and multivariate analysis of variance and covariance permit a type of after-the-fact or post hoc "control" or adjustment where control is not possible on an experimental basis. In any case, it would be nihilistic to argue that such an approach accomplishes less than no experimental evaluation at all, which indeed would probably be the other choice.

The above argument then points toward more extensive measurement and the utilization of more intermediate criteria (as opposed to final criteria such as accident and injury indices) in the highway safety causal chain of events (Ref 2-3). At least three additional justifications for such extensive measurement can be provided. First, simply the fact that intermediate criteria are generally more frequently occurring than, say accidents, such a richer measure produces more reliable evidence of change. Statistically, a power function explicates, amongst other things, the fact that by increasing sample size (e.g. by increasing the number of measurements by using intermediate criteria) we can increase power and thus the likelihood of detecting change in an experimental system.

The power curves below (fig. 2-3) illustrate the relative advantage of intermediate criteria over ultimate criteria. The curve to the right depicts a typical curve for the likelihood of detecting a significant effect using an ultimate criterion as the detector.

Simply, a power curve or function represents the likelihood of detecting a significant effect from a change in the arithmetic mean of some criterion (e.g. average accident rate per person per year) given a certain confidence level (alpha), a certain sample size (n) and a certain variability (sigma) for that sample. In this case, the criterion typified consists of a standard deviation of .25 a sample size of 1000, a confidence level of 99% and changes in the mean likely for means in the neighborhood of .05. An example of such data would be the Michigan Driver Profile of

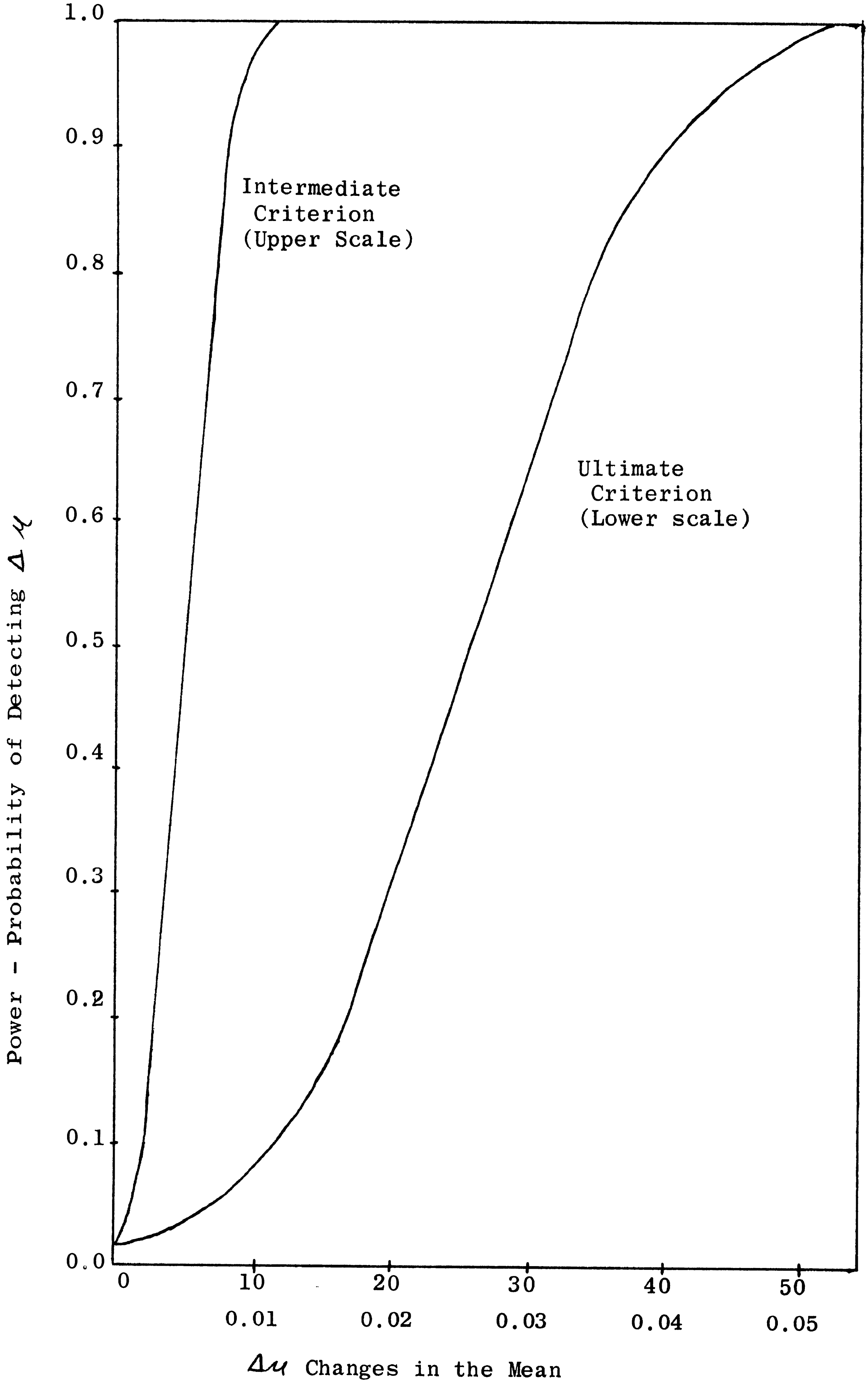

Figure 2-3 Two Sample Power Functions

approximately 1000 drivers over a seven year period (1961-1967)* with a mean of about .071 accidents per driver per year and a standard deviation of about .26. Generally, accident data of this sort has an average of about .07 and a standard deviation of about three times that number. The coefficient of variation C, equal to the standard deviation S divided by the mean m (i.e. C = S/m) is useful in describing these data. For ultimate criteria such as the above, C equals approximately 3 (i.e. the S is three times the mean). As we approach more intermediate criteria which are less open to contaminating extraneous factors, C approaches 1, which implies less variability, therefore more "control" in the general sense. If we look at this curve (to the right) we can see that with a sample size of 1000, we would have to have a difference as large as .04 (more than 1/2 of the mean) in order to have a 90% chance of detecting a significant effect. From a different point of view, we would have to have at least a sample of 1000 in order to have a probability of detecting a .04 change in the mean. This is certainly a substantial change and it is doubtful if such a change could be effected. Another way of overcoming this is to increase sample size; the problem then becomes one of increasing cost and time, two undesirable facets of our proposed set of experiments. Another alternative, as mentioned earlier, is to detect changes with more responsive criteria, intermediate measurements. From our power curves, we can see that using a intermediate criterion (e.g. driver errors or conflicts per driver per year) will give us a more powerful detector of significant change. From the left hand curve, we can see that with a sample of still only a 1000, a 99% confidence level, and a standard deviation of 50, we can detect a difference as large as 8.0 in the mean of our criterion with a probability of .90. Here the coefficient of variability would be approximately 1, so we would be dealing with a criterion with a mean of 50.0 and a standard deviation of 50.0, which would be in the range of

*Little, J.W., HSRI, April 1968.

data such as driver errors, etc. In general, we can see that the steeper curve, the one on the left, represents the most powerful criterion, the one most likely to detect a smaller change in the mean. A great advantage of such a criterion is that unlike the limited accident rate criterion which is bounded by its relative scarcity, the intermediate type of criterion is relatively unbounded, cheaper to obtain because of its relative abundance, more likely to occur and thus more responsive as a detector of change, and if we take more of such measures, increases the likelihood of detecting smaller changes. Thus, we are saying that <u>in addition to</u> the less powerful ultimate criteria, we should use an abundance of intermediate criteria in order to (1) detect significant changes more quickly and (2) establish the entire causal chain between the intermediate criteria and the ultimate criteria according to our model.

An added responsibility of such an approach is the requirement that we must then connect all of the criteria through some causal chain model to the final accident criteria in order to justify the usefulness of our intermediate criteria as predictors. Another practical consequence of utilizing intermediate criteria is the increase in responsiveness of our measurement by decreasing the amount of time needed to sample enough data to detect change. This again is obvious from power curves. The need for more responsive criteria for shorter experiments is obvious from the dynamic rate of change of our current social and transportation system and consequently the probability of uncontrolled variance in quasi-experimental designs. A second justification of the intermediate criterion approach is that intermediate criteria tend to be less confounded by extraneous factors and thus contaminance than do final criteria. Simply, we have more control over intermediate criteria, they are more common and thus easier to measure. Again, the fact that they are "cleaner" measures makes them more reliable and more valid as change criteria.

Third, and finally, intermediate criteria permit the application of the more realistic multiple causation model to the system. Through the utilization of such techniques as mutlivariate analysis of variance we can look at both the aggregate effects of the independent or manipulated variables upon all of the dependent measures (intermediate criteria), controlling for their interdependency, and the effects upon each of the variables in isolation. Also, by using strength statistics* we can assess the efficacy of all of the criteria as change detectors.

It is with the above techniques that the science of highway safety can "come of age" and operate more sensitively to the demands placed upon it by both scientists and lay persons as well as by the social-political agents wanting observable indicators of success and failure. Most non-physical sciences are beginning to recognize the need to tailor models of experimentation and analysis to the system under observation. It is time for highway safety to realize the complexity of its system and to apply more responsive techniques for analyzing these complexities.

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*Eta, omega-squared and several other strength of relationship statistics exist for such purposes. These statistics are not only well documented and defined (2.4) but most recent computer programs include these with significance tests.

2.7 Data Requirements

In our tentative program designs, it will be noted that we have placed a minimum emphasis on the use of mass accident data as a measure of effectiveness in the evaluation of program utility. This reflects our opinion that such data will not have a great deal of value for this purpose due largely to the fact that normal accident data does not accurately reflect the intermediate criteria that we feel must be evaluated in order to understand the complex behaviors associated with many proposed countermeasures.

In general, then our program designs indicate a need for specialized, detailed data taking activities such as surveys, traffic courts, specialized observations of driver behavior, etc. These data activities will be tailored to the individual program and individual countermeasures to give a comprehensive picture of the many types of actions that might result from a given countermeasure application.

These comments should not be misconstrued so as to indicate that mass accident statistics are useless. Such data is very useful in providing indications of trouble areas where countermeasure activity may be helpful and in pinpointing other causative factors. In this light, the presently existing mass accident data will continue to provide a huge amount of background data for any experimental program, and in certain instances direct measures of countermeasure effectiveness. The problem of mass data usage is discussed in detail in Section 3.0. But the need for additional data taking activities is quite clear.

3.0 Information Flow Program

This program area is concerned with the flow (collection, preparation, storage, retrieval, analysis, dissemination and utilization) of traffic safety data: namely driver, vehicle, highway, and accident records. Countermeasures to effect changes in public attitudes through the mass media or selectively disseminate driver education programs tailor made to an individual communities' needs, for example, are considered as parts of other program areas. Data flow systems are an integral part of many of the standards. Thus, the data flow program cuts across and is in reality a subportion of each of the other program areas covered in this report. This inter-relationship is discussed in more detail in the following sections.

The primary emphasis in the data flow program is to maximize the utilization of traffic records systems by the local user or highway safety practitioner.

The users of data fall into the other five program areas covered in this report. The data flow program is an integral part of each of the other programs and should be considered as such in the implementation of the other programs.

The experimental program calls for the selection of a state with an existing automated records system. A comprehensive user study will be conducted to determine the mix of data services required. The data flow program implemented for each locality/ county will be one of four levels ranging from no change to a full range of services. Follow-up user surveys will be conducted to study data flow and utilization at each program level. A utility curve will then be developed to relate funding level to extent of data utilization.

The secondary emphasis of the data flow program is the development of statewide exposure measures as a basis for computing accident rates. Valid accident rates are essential as measures of effectiveness, for identification of problem areas, and for evaluation of countermeasures adopted to relieve the problems. To our knowledge, a statewide exposure study has not previously been conducted by any state.

Four standards are directly involved here. First, and central to information flow is the traffic records standard (number 10). Besides accident data this standard embraces driver records, vehicle data and highway data.

The second standard is the identification and surveillance of accident locations. Standard number nine deals primarily with the Bureau of Public Roads and the state highway departments, but has a direct interface with the traffic records standard.

The third standard is motor vehicle registration (2) which involves the accurate and timely collection, recording, retrieval, and presentation of motor vehicle data for enforcement and analysis purposes.

The fourth standard is accident investigation. While this is not yet one of the announced standards we are considering it in its preliminary form for the purposes of this project.

These are the four standards encompassed by the information flow model and program area, in that information collection, processing, and dissemination are central to all of them. To a lesser degree many of the other standards involve some information flow aspects, namely-periodic motor vehicle inspection, driver licensing, traffic courts, alcohol, pedestrian safety, and police traffic servcies. Thus, in an operational sense, information flow is pertinent to many of the standards. This can also be seen in a brief list of highway safety related traffic records.

Traffic Records

Driver Records
- Education
- Licensing
- Violations
- Sanctions
- Financial Responsibility

Vehicle Records
- Registration
- Inspection
- Stolen

Highway Records
- Fixtures Inventory

Accident Records
- Police Reports
- Operator's Reports
- Multi-Disciplinary Accident Investigations (MDAI)

A short overview of 402 projects in the traffic records standard will illustrate current activities. Of the some 4200 projects on file (see Appendix), 248 projects involved the traffic records standard and totaled over $37 million in federal matching funds. As could be expected, many are statewide study prototypes that have recently been implemented. The majority of these programs are being implemented by highway or public road agencies. It is interesting to note the number of projects in large metropolitan areas.

Table 3-1 shows a breakdown of the 402 projects by several variables of interest.

3.1 Data Flow Subsystem

3.1.1 State Traffic Safety Data Flow

A simplified model of state level traffic records data flow is shown in figure 3-1. Typically the bulk of data is stored at

TABLE 3-1 TRAFFIC RECORDS PROJECTS

Novelness (departure from existing conditions)		Implementation	
1. Continue existing functions	42	1. Normal program unaffected	74
2. Continue previous 402 projects	2	2. Feasibility study	1
3. Expand/Improve existing program	42	3. Survey/Data collection	15
4. Revise to automated existing program	7	4. Recommendations/plans plans	6
5. Manual to automated operations	36	5. Prototype implemented	94
6. Study/Implement new program	65	6. Evaluation/analysis	8

Geographic Coverage		Implementing Organization	
I. Statewide, implied	79	1. Diffuse	26
2. Less than statewide, implied	27	2. Vehicle Regulation	3
3. Statewide specified	25	3. Driver Licensing	3
4. County-wide	13	4. Highway Department	135
5. Metropolitan (50,000 + population	34	5. Police	14
6. Local (town, village)	16	6. Courts	1
7. State-County	2	7. Education	1
8. County-City, or County Local	4	8. Research	4
		9. Vehicle Inspection	2

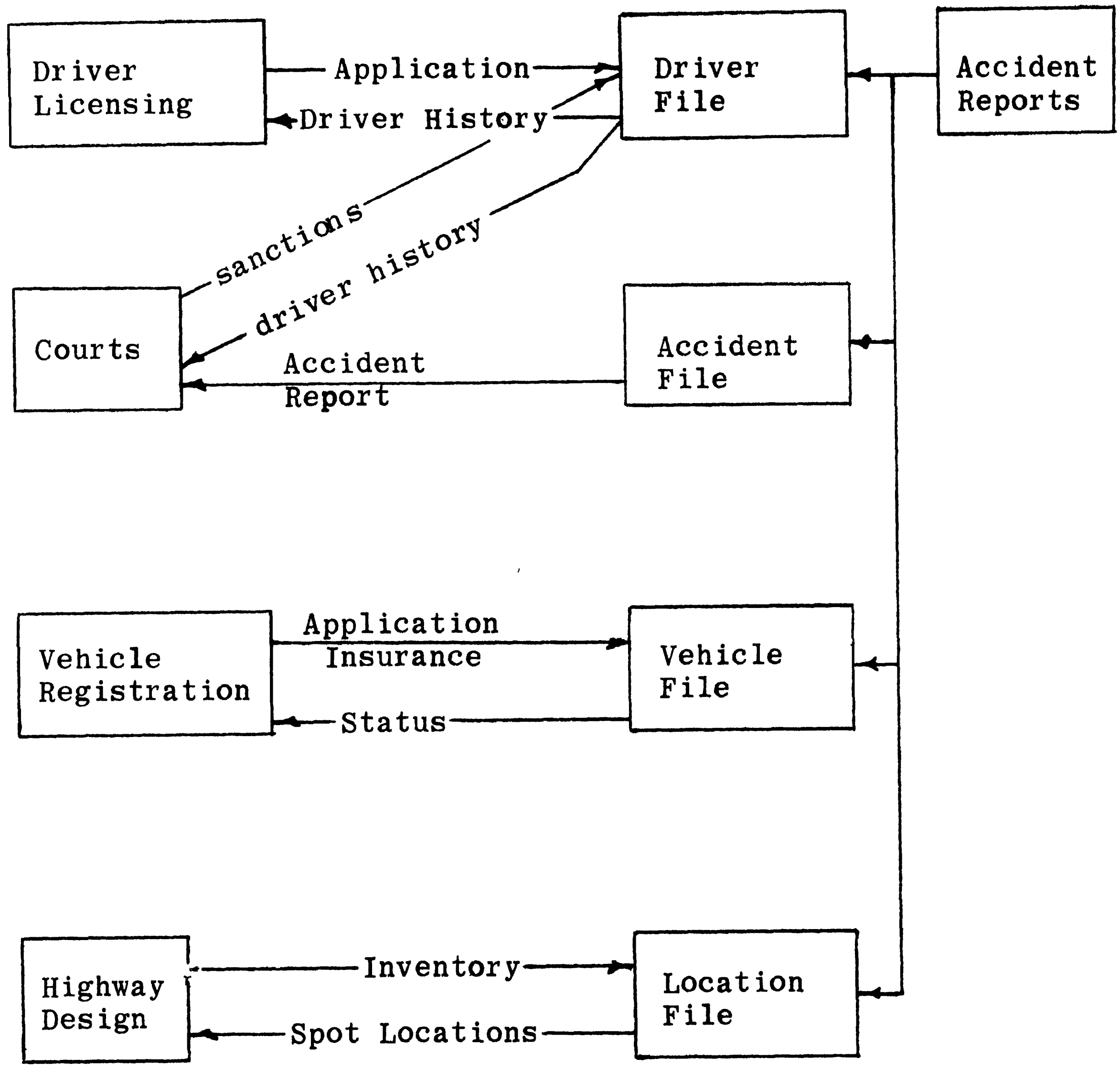


Figure 3-1 State Traffic Records Data Flow

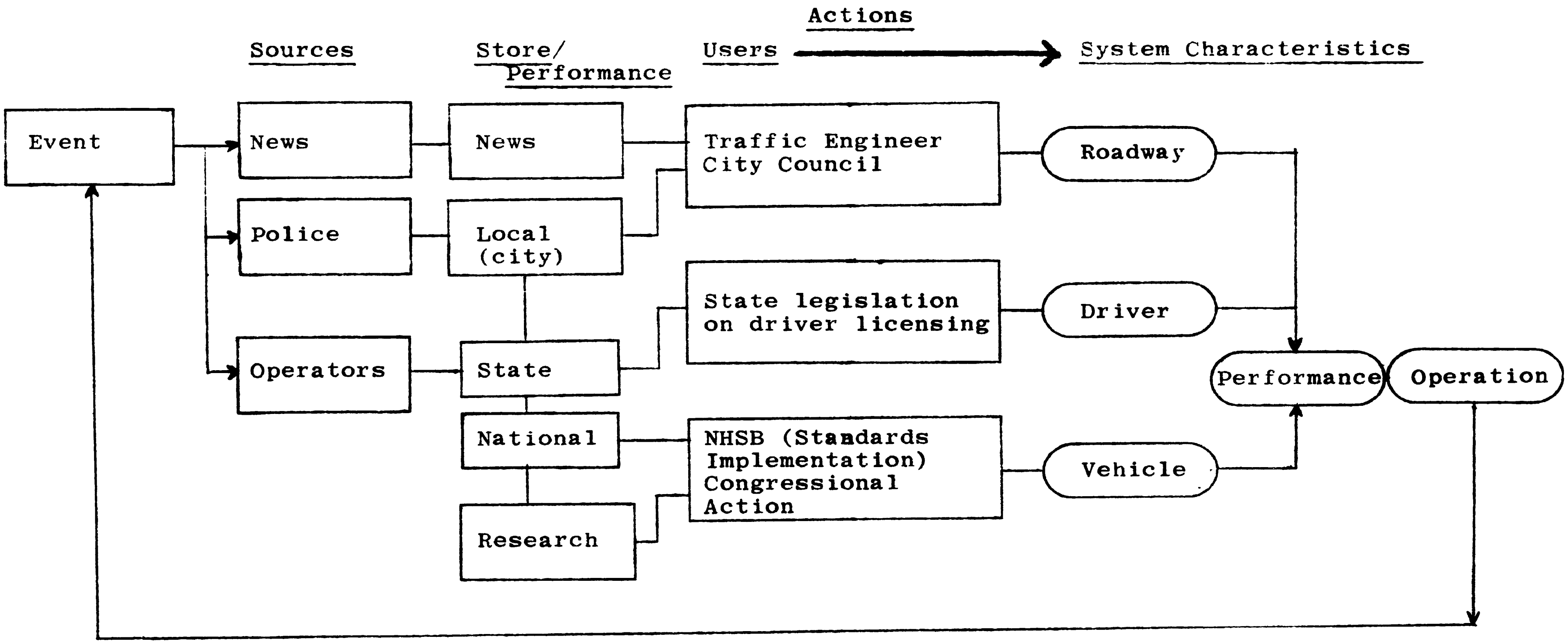
the state level in four separate files: 1) Driver, 2) Vehicle, 3) Highway location and 4) Accident files. The driver, vehicle, and highway files are strongly related to both their data sources and users. Existing records system followed the evolutionary development of motor vehicle departments as well as highway and state patrols. They assist these departments in the control of operators and vehicles, and associated revenue collecting functions. True accident files that relate all three accident features (human, vehicle, environment) are fairly rare. The information contained on accident reports is often fragmented in several files.

3.1.2. Accident Data Flow Model

Because of the broader interest in accident records, an accident data flow model is presented (Figure 3-2), that considers the full range of accident investigation and data processing activities implicit in the General Traffic System Model (Section 2.0). The other traffic records systems involve fewer sources, files, and users, so they tend to follow a similar but simpler diagram. The diagram is analogous to that of a library system, where the operational goal is to get the right information to the right person at the right time, by the judicious acquisition, processing, organization, and storage of information and the provision of user/parton services. Successfully meeting this goal will tend to improve the highway safety practitioner's decisions to change conditions in the traffic system.

The information flow diagram follows the same pattern as the general countermeasures model presented earlier but amplifies the linkages between the event (collision) and the action (countermeasure). Typically, following the detection of an event (collision), two reports are prepared: police report and local news account. The

Figure 3-2 Accident Data Flow Diagram



police report may be filed locally and plotted on a pin map to spot high accident locations. We hypothesize that the local traffic engineer might install a left turn lane and a new traffic signal as a result of pressure from a newspaper account of an accident involving the wife of a city father and/or because of the high incidence of accidents at the intersection noted on the pin map. This action will hopefully reduce the frequency of accidents at the improved intersection.

Local accident records may also be compiled at a state level and summarized at a national level. Thus, many other examples of information flow could be described. All involve the recording of information from a variety of sources into storage/analysis centers that disseminate processed information to decision makers who in turn initiate countermeasures.

Clearly the network can be expanded to include other data sources (coroners, medical examiners) and a more exhaustive list of users (e.g. traffic courts, vehicle designers). By removing the individual network branches the feedback or closed circuit nature of the generalized data flow model (Figure 3-3) can be seen. A significantly close association exists between data consumers and data suppliers in that, very often, they are the same people or organizations.

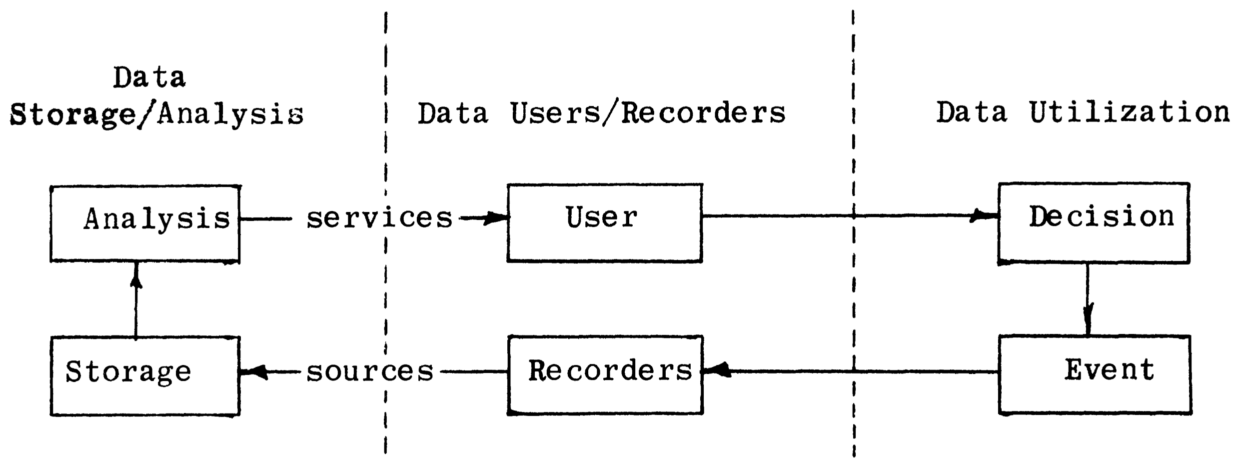


Figure 3-3. Generalized Data Flow Model

3.1.3. Relationship of Data Services/Supply to Countermeasure Program Areas

As noted earlier, the data flow program is a subportion of all the other programs. Thus, it is reasonable to categorize data users according to the program areas. Each user group is often a source of information as well as a user of data services. Table 3-2 is a listing of potential data services and data supplies organized by program area. The last two user groups are not directly covered by the Highway Safety Program Standards but play an integral part in the data flow.

3.2 Countermeasure Description: Data Utilization

A considerable amount of resources have been devoted to the establishment of state traffic record systems. The development of uniform accident reporting schemes and the automation of central records systems have received particular attention to-date. It is the primary objective of the experimental demonstration program described here to focus on the utilization of traffic records systems in satisfying the needs of users; in particular the local highway safety practitioner. While the centralization of traffic records files at state level is effective, the utilization of this information to improve the decisions made by practitioners (to change the highway-vehicle-driver system) would be most effective at the local level. Local and State planning and evaluation of countermeasures are ultimately determined on the basis of accident rates. These rates must be based on comprehensive driving exposure data, in terms of annual highway travel by classes of drivers, vehicles, roads, and natural environments.

While the need for 'knowing how we are doing' makes the implementation of a strong records system imperative, the drive towards implementation can be so strong that large sums of money are spent designing or attempting to design systems in hypothetical situations for undetermined people with unknown needs. It is not hard for theorists and promoters to ignore the user. Many effective action programs have been conducted to term accident investigators, implement uniform accident reporting forms, and develop sophisticated traffic records files. Likewise several innovative analytical tools have been developed to assist the practitioner in the application of information in file. The use of these tools are indirect countermeasures. Their description and the selection process for matching them with user needs follows.

A recognition of the importance of local government participation is noted in the introduction to Chapter VII of the Traffic Records Program Manual.

> "Since the responsibility for the same operation of a major portion of the nation's roadways is in the hands of local government, the Highway Safety Standards issued by the Federal Government and transmitted to the States ultimately are applied to a great extent, at the local level. Local agencies, through participation in a State traffic records program, should experience an improved understanding of their highway safety problems by studying the problems and solutions of other communities in the state."

Local participation provides an opportunity for the State and local governments to pool their experience and data for their mutual advantage, and opens the possibility for local agencies to share the benefits of electronic data processing equipment for statistical analysis.

A fully implemented data flow program would entail the establishment of local highway safety teams representing all aspects of the problem. Virginia and Wisconsin have both passed legislation requiring the establishment of county level teams. Dan Schultz described the Wisconsin Accident Review Committes to the 1969

National Safety Congress (Ref. 3-1). A three man committee in each county (the county highway commissioner, a law enforcement representative, and a director of highway safety promotion), at least quarterly, review a location map of a years accidents and make recommendations to the appropriate organizations. For instance, an overly represented rural intersection may call for the stop sign installation by the highway department and increased law enforcement because the local tavern is located at the intersection. The use of the spot map alone was found to be not fully sufficient as it did not show the type of accidents, time of day, or traffic movement. The establishment of location files of accident reports has improved the situation.

Local accident problems are best studied at the local level. The compilation of spot maps and location files on the local level stimulates more interest locally than if spoon fed from a central state file. In fact, if set up by the local law enforcement agency, they will then discover for themselves any weakness or lacking data on their own accident reports. Beyond the utilization of traffic records, the establishment of a local team provides John Q. Driver the opportunity to comment on near-misses, minor accidents, and dangerous situations. Both these actions were successful in the Wisconsin team experiences.

Several other states have also considered local participation. California, Florida, Hawaii, Idaho, Illinois, Michigan, Montana, Missouri, New York and Oregon have all used 402 projects to assist local jurisdictions and coordinate city-county-state level records activity. One of the broadest countermeasures programs at the county level is that of Bruce Madsen's of Oakland County, Michigan. His testimony before the Subcommittee of Roads of the Senate Committee on Public Works noted the value of local data utilization:

> "A substantial increase in traffic accidents and fatalities--such as that which we experiences--has,

many times in many places, resulted in an aroused, concerned public. All too often, hastily established organizations have emerged to deal with the problem. As a result, the programs and solutions that are developed are frequently based upon little or no knowledge of the real traffic problems and needs.

"We wanted to make certain that we wouldn't make the same mistake that some other counties made in dealing with this problem, so we set out, in what has been described by traffic authorities as a unique approach, to identify Oakland County' specific traffic problems as a prelude to program development."

While local participation is the primary goal of the data flow program certain countermeasures require a statewide approach. A mission orientated program must cover a broad enough area to encompass a relatively homogeneous or stable group. Driver regulation requires statewide control because an individual's high mobility makes the problem external to local agencies. Although the local policeman may issue a violation only a statewide records system will be able to provide a traffic court judge with driver histories to assist in setting appropriate sanctions.

Clearly many other programs, such as vehicle regulation must be coordinated at the state level. One such program is a statewide exposure and driver survey for use in planning and administration. A state exposure survey would provide the basis for determining true accident rates. The same survey can also provide information on driver attitudes and demography which would be of value in alcohol programs or the driver regulation program presented in Section 5.

A comprehensive exposure study on a statewide level has never been conducted before, yet is essential in the determination of accident rates. Accident rates have accident counts as a numerator and some measure of exposure as denominator. Often the annual mileage is used as an exposure measure. A comprehensive exposure survey would provide an accurate measure of annual highway travel by classes of driver, vehicles, roads, and natural environments and cross classifications of these elements. The full picture of exposure considerations will be found in Ref. 3-2 .

The consideration of young drivers on rural freeways provides an example of the role of exposure data in countermeasure evaluation. It is in general well established that young drivers are over involved in accidents and that there are fewer accidents per mile travelled on rural freeway than on city streets. But what about young drivers on rural freeways and city streets? Is it possible that the new driver trained primarily on city streets is particularly prone to accidents on rural freeways? With adequate exposure information the relative involvement of young drivers on city streets and rural freeways can be determined and/or the accident rate of young drivers can be compared with other drivers on rural freeways. This analysis would point towards the need for a specific countermeasure and the subsequent evaluation of the countermeasure effectiveness.

Exposure measures can be direct, indirect or induced. A potentially good indirect measure is resident population (one to one with vehicle registration) although population is relatively insensitive to short range change. In some situations such as selective enforcement raw accident counts may suffice fairly well.

While conducting an exposure survey it would be fairly reasonable to collect other information on, say, trip origins and destinations, family car use patterns, driving habits, attitudes, and knowledge. The exact nature of the survey questions would be determined by the content of the other program areas.

The following two sections outline specific data utilization countermeasures and a selection criteria for determining an effective mixture of measures.

3.2.1. Selection Criteria: User Study

The managers of information systems and libraries have always had a need to evaluate their system functions in the light of his objectives. The acquisition, processing, and retrieval of information is evaluated in terms of the user-system interface and the ultimate utilization of information is considered. There exists a fairly large body of experience in the literature upon which to base a study of traffic records system users. This literature has been reviewed and synthesized in References 3-3 through 3-12.

Why study the individual user so closely? The individual has learned from experience the channels through which he has the highest probability of obtaining useful information and will tend to select those channels whenever a choice is involved. Therefore, an information service has to demonstrate by actual performance that it provides a more profitable channel. The individuals judgement will prevail rather than that of managements. Again, this behavior pattern underscores the need for local participation and utilization of traffic records.

A preliminary task in the data flow program will be to determine who the users are, what the data needs are, and what the current sources and utilizations of data are. The results of this study will assist in determining a good mix of services to provide. Follow-up user surveys will be conducted in order to further adopt the program to user requirements and evaluate the effectiveness of the program. Specific measures of evaluation are discussed in Section 3.3. The remainder of this section is concerned with the user study methodology.

Realistically, user studies do not provide an exacting basis for design. While the study methodology is not well developed, the study results do provide fruitful insights that serve as guidelines for planning. Four questions need answers.

1. Who are the potential users?
2. What are their information and data needs?
3. Which of these needs should be fulfilled?
4. Where are their present sources and utilization of data?

The initial effort is in defining the spectrum of users (people and organizations) within the state and their functions. With this outline as a guide, the number of users in each category can be determined in order to get an idea of the size and nature of the 'market' for services. Next we attempt to define the needs of users by now classically defined approaches; the direct and indirect methods. The direct method is to question users the indirect method consists of observing actual request activity.

The most effective direct method is the semi-structured, in depth interview. Mailed questionnaires and rigidly structured forms restrict full exploration of users needs by forcing him to pick from a list. He may not realize the full potential of what could be provided. Open conversation makes it possible to inquire what the respondent does with information, what the consequences of late information arrival are, and where he looks for information. The method is limited in that the respondent cannot easily define a need which he has never experienced (such as a computer-access terminal), but such a limitation can often be overcome by the opportunity to discuss the problem in some detail.

A clear distinction needs to be made between user opinion and actual experience. His lack of experience limits the value of his opinion. The critical incident technique can provide more objective results. The respondent is questioned on his most recent experience, according to an outline:

1. The user - who is he, what does he do.
2. His most recent task/job.
3. His utilization of data services.
4. His search for data related to his most recent task.

The satisfaction of all users needs is clearly restricted by technical, socio-political, and economic complications. The value of each requirement must be determined and weighted by the relative importance of each requirement in order to begin analysis of services to be provided. Follow-up user studies will then consider the measure of agreement between performance and requirements. To aid analysis, the number of requirements will be restricted to from ten to twelve categories. A preliminary list would include:

1. Delay in receiving product.
2. Portion of relevant material overlooked, in terms of time spent looking elsewhere.
3. Form of product.
4. Effort of user to communicate with system.
5. Portion of irrelevant material provided.
6. Currency of data provided.
7. Adequacy of file or sample size in providing a significant answer.

A more detailed study of how the user supplies what he receives could be determined through the more sophisticated gaming techniques. A sample of users are grouped and placed in a game situation, where they are given a sample problem or job. Each group would receive different amounts of data.

3.2.2. <u>Listing and Description of Candidate Countermeasures</u>.

There are as many specific data countermeasures as there are types of users. A fairly comprehensive tabulation of data services is given in Table 3-2. An exhaustive discussion of each would be too lengthy. Each of the following topics has been explored by the HSRI staff and any omitted items do not preclude their potential value to the data flow program. The list is in four sections:

A. Data Collection
B. Files (updating, structure, medium)
C. Retrieval/ Dissemination
D. Analysis/ Utilization

Table 3-2 Relationship of Data Services/Supply to Program areas.

Data Services →		Program Areas →	Data Supply**
Item History	Aggregate Summary	Data Users/Sources	

Driver Preparation

Item History	Aggregate Summary	Program Areas	Data Supply
General		Alcohol*	
General		Motorcycle Safety* (preparation)	D-Motorcycle license
General		Pedestrian Safety* (preparation)	
General		Driver Education	D-Pass/fail preparation
General, Driver Record		Driver Rehabilitation	D-Pass/fail rehabilitation
Driver Record		Driver Licensing	D-Identification, denials, medical history, warnings

Driver Regulation

Item History	Aggregate Summary	Program Areas	Data Supply
Stolen vehicle	Manpower	Police Traffic Services*	D-Violations, Arrests
Criminal record	Deployment		A-Police Report
Driver history		Codes, Laws, Courts	D-Convictions Suspensions, Revocations, Negligence
Financial responsibility			
Driver Record	Selective Enforcement	Alcohol*	D-BA level test results

Vehicle Regulation

Item History	Aggregate Summary	Program Areas	Data Supply
Vehicle History		Vehicle Inspection	V-Defects, Mileage
Vehicle History		Vehicle Registration	D-Financial responsibility
			V-Identification, owner
Vehicle History		Motorcycle Safety* (Regulation, Inspection)	V-Motorcycle identification, defects, mileage
Vehicle History		Police Traffic Services*	V-Mechanical violation, stolen Accident Damage

Environment Regulation

Item History	Aggregate Summary	Program Areas	Data Supply
		Highway Design	H-Features Inventory
		Traffic Control Devices*	H-Device Inventory
		Pedestrian Safety* (devices)	
Collision Diagram	Locations Tabulations	Identification and Surveillance of Accident Locations*	H-Mileposting

System Restoration

Item History	Aggregate Summary	Program Areas	Data Supply
Manpower deployment		Emergency Medical Care	A-Post accident service provided
Manpower deployment		Debris Removal/Clean Up	A-Post accident service provided

Data Flow

Item History	Aggregate Summary	Program Areas	Data Supply
		Vehicle Registration*	V-Vehicle File
		Identification and Surveillance of Accident Locations*	H-Highway File
		Traffic Records	A-Accident File
		Driver Licensing	D-Driver File

Society

Item History	Aggregate Summary	Program Areas	Data Supply
		Corporate Bodies	
	Vehicle Performance	Automotive Industry	V-Recall defects
Driver History, Accident Report	Actuary	Insurance Companies	D-Identification, Insurance Coverage
	General	Safety Service Organizations	
Special	Special	Research Institutions	
	Involvement	Motor Fleets	A-Fleet reports
	General	Legislatures	
	General	Mass Media/Public Information	A-News report

Individuals

Item History	Aggregate Summary	Program Areas	Data Supply
Accident Report		Operators	A-Operator's report
Driver History		Medical Doctors/Physician	D-Medical condition
Accident Report		Lawyers	

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* Standards in more than one program area

** D = Driver data H = Highway data
V = Vehicle data A = Accident data

A. Data Collection

Multi-Level Data System

Data may be collected at three levels: (1) accident frequency data and operational data for state agencies may be collected by police on all accidents, using a brief report form; (2) data concerning specific research study efforts may be obtained by technicians or specially trained police officers; and (3) detailed data may be obtained by multi-disciplinary teams through intensive accident investigation. Any of these levels may be attempted independently, although all three ultimately are integrated.

Source Data Collection

There are several new techniques for entering data directly into computer storage without the additional step of keying the information onto cards or magnetic tape. The techniques range from optical character reading of the original accident report into storage, to direct interactive transmission of data from the accident scene into computer storage, with the computer performing consistency checks on the data and requesting retransmission of erroneous data. Any of these techniques will improve the error rates and timeliness of a traffic records system.

Uniform Reporting

Accidents are still reported by many sources, of various accuracies and reporting levels. While the local participation program will tend to improve the reporting, other means of promoting uniform reporting should be used as well. The operator's report should be compared with the police report as early as possible. Training in accident investigation should be provided on a wide basis.

B. Files

The capacity and processing per dollar of modern computers has increased to the point that sophisticated file structures can be used that permit both on-line retrieval and updating of files. These techniques have been applied to the identification of stolen vehicles and "bad" drivers, but can be expanded to other applications.

Accident data files are fragmented in most states. Driver, vehicle, and highway files are normally maintained but are not integrated for full utilization in the analysis of accident patterns. Much can be done in the areas of file compatibility, linking, and integration. Welfare and criminal files might be linked to driver files to promote fair adjudication of the alcoholic driver.

File procedures can be improved to increase data validity and timeliness. Quality control should be built into file building procedures.

Photographic files of highway and accident locations have been developed by three states. Microfilmed records are used for backup in several state computerized record systems.

C. Retrieval/ Dissemination

The Traffic Records Standard calls for rapid audio or visual response upon receipt at the records station of any priority request for status of driver license validity or status of vehicle possession authorization, where rapid response is defined as no more than one minute for turnaround time or less, if possible.

This requirement can be met through the use of remote computer terminals of the teletype, cathoderay tube, or audio response type. The potential also exists for rapid access to other individual histories. Through teleprocessing, special, local team studies could be handled on a large central computer and the results returned to the remote processor.

A recent advertisement* for data terminals provides an example of the possibilities. The "data terminal system gives instant access to traffic ticket records of 1,800,000 drivers... provides the data entry and retrieval system for the Motor Vehicle Department of one of the most populous states. The present headquarters' system is being expanded, ... and will be remoted to seven regional offices...Some are located right on the judges' benches in municipal courts, for use after trial and before sentencing to determine the violator's past driving record."

D. Analysis/ Utilization

Accident analysis can be conducted on a single item basis or on an aggregate basis. Single item analysis would include one driver's complete history, a vehicle's condition, or the pattern of accidents at one highway location. Aggregate analysis looks at large subsets of the data or the entire data base simultaneously. Both kinds of analysis capabilities are needed.

Many analysis tools exist under a variety of names.

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* Bunker-Ramo Series 2200 CRT terminals, <u>Datamation</u>, January 15, 1971, pg.5.(see Figure 3-4)

This Bunker-Ramo data terminal
system gives instant access to traffic
ticket records of 1,800,000 drivers.

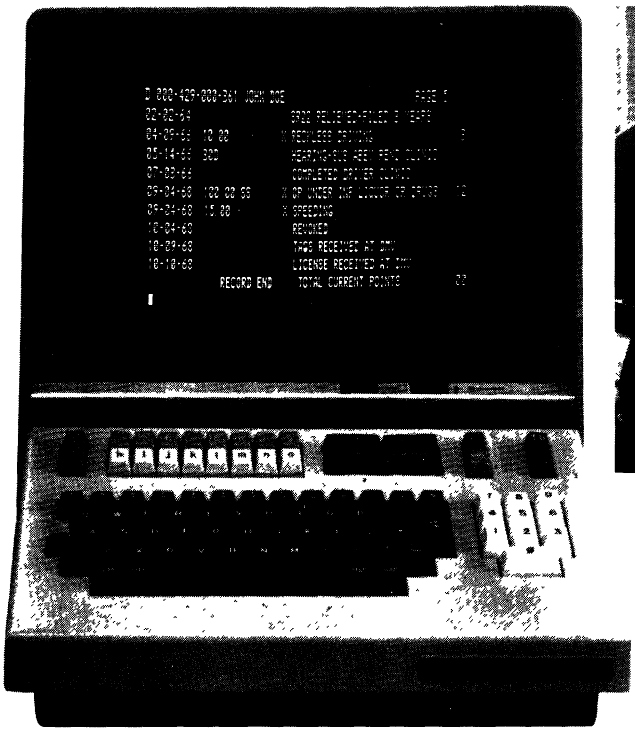

FIGURE 3.4 Cathode Ray Tube Data Terminal

Monthly Summaries

Typical state monthly accident summaries provide distributions of observed frequencies of single variables or parameters. These univariate distributions do display interactions with other variables. Tabulation of total counts is not as informative as percentages or accident rates based on measures of exposure.

Some of these tabulations tend to produce repetitive conclusions month after month and provide no increased knowledge. The need exists for statewide exposure data, bivariate analysis or cross-tabulations, more meaningful variables, exception reporting that points to unusual situations, and tailor-made reports for each user's application and territory.

Forecasting

Implicit in all operational decisions directed towards the accident problem is some estimate of accident expectation, regardless of whether or not the estimate is explicitly identified. Control chart theory and trend analysis forecast accidents within confidence bands. In trend analysis one can break out the individual frequency components through a powerspectra analysis in order to better forecast accidents by accounting for seasons, long range trends, etc. This analysis is inherent in both selective law enforcement and spot improvement programs.

Resource Allocation

Short term distributions of accidents can be used in conducting selective enforcement programs and in determining the optimum positions or stations for ambulance and emergency crews in order to minimize response time. Longer distributions can aid in decisions to make major changes in the traffic system, e.g., construction of a left turn lane.

Selective Enforcement

Engineering and education are costly and take a long time to implement--relative to changes in traffic law enforcement --which is flexible and rapidly brought into action. Selective enforcement is enforcement which is proportional to traffic accident rates with respect to time, place, and type of violation. Comparative summaries that generate interest in "how we are doing" and accident rate analysis to determine optimum manpower deployment are called for. (Ref. 3-13)

Identification of Accident Locations

Three types of location methods exist: (1) the route number-accumulated mileage system, (2) the modal system, and (3) the coordinate system. While the mileage system is in common usage, the modal system shows great potential. Specific areas of improvement are in determining the geometric characteristics of collision paths and collision path lengths, the correlation of accident location data and road inventory records, and traffic volume data would also assist in analysis. Existing state trunk line location schemes should be expanded to cover all state roadways.

The computer can aid in spotting high accident locations by noting and/or ranking accidents, i.e., a "hit parade." Many criteria exist for identifying problem locations, e.g., accident count/frequency, accident rate per vehicle mile traveled, clusters of densities of at least X accidents in Y feet, and improbable rates above the average for the route.

Collision Diagrams

The history of a individual highway location is often portrayed on a collision diagram (Ref 3-14), which by its simplest definition, is merely a graphic representation of accident experience at, say, an intersection, by type of accident and severity. A straight collision diagram is distinguished as a 'strip map' that covers an area of highway of up to several miles. The graphic representation is prepared in order to determine accident patterns, e.g., rear end, left turn. Following corrective action, another diagram is prepared for a 'before and after' study. The collision diagrams can be prepared with the assistance of the computer in pre-processing the data or mechanical plotters can prepare diagrams directly under computer control.

Spot Improvement Significance Measures

Before and after accident rate percentages should be lower by design--not chance. Conservative Chi-Square tests can be made for the statistical significance of any rate reductions. Certain data collection controls need to be imposed: (1) valid exposure (vehicle-miles) is needed before and after (2) traffic volumes and composition of traffic volumes should not change significantly (3) corrections should be made for existing trends and (4) more than 50 accidents should be included in the analysis.

Measures of Effectiveness

The Traffic Records Program Manual (Ref 3-15) notes that "the effectiveness of the traffic records program is its ability to produce the information needed to support decisions for effective management of the total traffic program". The manual suggested five groups of questions for use in evaluating a system:

1. Source data collection (What data?, By whom?)
2. File updating (Procedures?, Backup?, Timeliness?)
3. Information storage (File structures?, Storage media?)
4. Information retrieval (Flexible?, Timely?, Format?)
5. Information use (Essential?, Ease of interpretation?)

More quantitative measures of effectiveness can be measured in terms of metering the flow of data through the records system and from the data utilization point of view, i.e., is the information effectively assisting the decision maker. The acceptance and utilization of services is dependent upon the quality of the services and level of promotion and training provided the user. Both aspects must be considered in measuring the total effectiveness of the data program.

3.3.1 Measures of Information Flow

The flow of information through the system can be measured in terms of quantity and quality (or goodness). Quantity is a function of the number of parameters or variables, V, recorded and the number of reports, R.

$$Q = f(V,R)$$

How "good" the information is, is a function of several parameters C_i, which can be combined with weighting factors, w_i, that are dependent on the relative importance of each parameter. A list of some pertinent measures follows.

$$G = \prod_{i=1}^{n} w_i C_i$$

where C_i = Currency (timeliness)
Cost
Consistency
Completeness (e.g., missing information)
Correctness (misinformation)
Compatibility (mismatch)

Quantitative measures are being refined for each parameter. For example, consider compatibility as the degree of mismatch. It can be conceptualized as a function of the number of information items needed/required vs. the number provided or available. The degree of compatibility can be computed as number of items both needed <u>and</u> provided (logical intersection) divided by the number of items either needed <u>or</u> provided (logical union). Thus if a user is provided five items and he only needed three of them the degree of compatibility would be three fifths.

$$\text{Compatibility} = \frac{\text{needed and provided}}{\text{needed or provided}}$$

The flow parameters can be measured at several points in order to detect weak points in the flow and test the effectiveness of system improvements. The degree and sophistication of the data processing analysis can also be established against an ordinal scale of benchwork capabilities.

3.3.2 Measures of Data Utilization

Countermeasures are initiated and implemented as a result of decision making. The nature of these decisions is determined by the flow (or lack of flow) of information to the decision maker, i.e., we presume that all decision making is based on input information. Thus, the interface between the information system and the user/decision maker is critical*

User acceptance levels:

- quality transmission
- informative/semantic understanding
- influence/affective

The degree of penetration or acceptance of information by the user can be considered as three levels. At the first level we determine whether the information got there and in readable form. At the second level we look at how relevant and informative was the information. Did the user understand and believe it? At the third level, in what, if any, way did the information influence his actions?

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* This model is intended to be quite general. It is possible that the information used by a decision maker might come principally from a newspaper article, or from political pressure (say by telephone) or from an analysis or accident data performed by an engineer of the state highway department. While it seems possible that more professional analysis may lead to more appropriate decisions, it is likely true that many decisions are made as the result of public pressure and are based on less than complete information. We intend to treat the information flow relationships involved here to evaluate the effectiveness of the more sophisticated processing and analysis techniques.

These questions have frequently been raised by librarians in determining how best to package their information products, and their experience in answering these questions is useful in studying the traffic records system. Quite a wide range of study techniques can be applied. Objective measures can be developed for surveys of users. For instance, accounts of critical incidents can be noted or a record can be kept of repeated queries by individual users as a measure of user acceptance. An in depth study of the decision making process is possible through the use of multi-dimensional scaling techniques. The methodology for conducting an information system evaluation study is discussed in Section 3.2.1.

3.4 Controls and Data Requirements

Three program levels are anticipated, plus a control level. Each county in the selected states would be at one of four levels. The control counties would continue to receive the same information services as before. The users will be surveyed before and during the program in order to detect any changes or trends. The data flow program will be implemented at various preset funding levels; say, three levels. The initial user survey sets the stage for services to be provided and follow-up user studies serve as feedback to further adapt the system to users needs and to evaluate overall improvements in data flow and utilization. A minimum program might involve adding statistical analysis tools to the state records system and promoting their use. A medium level could provide an optimum mix of push (e.g., monthly tabulations) and pull (e.g., special request studies) services on a more aggressive basis. A full fledged program would entail the above services plus the implementation of a local data records system that is fully integrated with the state level system. These programs are discussed in Section 3.2. The control of program level in the individual localities will open the possibility of determining a program level utility curve that will trade off utility with funding level.

There are many different services that can be provided from a traffic records system. The precise mix of individual data services can not be preset, and will be expected to assume a maximum utility mix within the set levels of effort. On the other hand the amount of effort spent promoting the services and training potential users must be considered separately from the effort spent in providing the services. Product marketing and product quality must be kept in a reasonable relationship for a successful program.

Following the state selection and initial user needs study, local communities (counties/cities) will be asked to bid in competition for local data services. Several programs at each funding level would be selected according to the criteria in prior discussions. Each six months following implementation a evaluation and program review will be conducted. This review will serve as an adaptive feedback in refining the data services to the users needs.

Data requirements, in this context, refer to evaluation statistics. Evaluation methodology and measures are covered by Section 3.2.1 and 3.3 respectively. Data collection will be required on a 'before and during' basis, i.e., the initial and follow-up user studies.

The proposed driving-exposure survey plan would require a random sample of at least 2,000 licensed drivers. Each subject would complete a one-day trip record on a date selected randomly from 28 possibilities. Variables recorded, in addition to trip mileage, would include driver age and sex, vehicle type, and model year, roadway type, and time of day (daylight vs. darkness). A full discussion of exposure survey methodology is included in Ref. 3-16.

3.5 Resource Requirements

The level of resources required for the implementation of a particular information utilization countermeasure program will be dependent upon site selection, results of the users study, and experimental design controls. The selection of a state with a relatively unsophisticated traffic records system would require more resources to initialize an information C/M. The results of the users' needs study may uncover a data analysis requirement not available in the existing state traffic records system.

The level of resources available will also be controlled as part of the experimental design. The previous section discussed the control of resources in order to relate payoff and program level.

The lowest level of implementation would require a state-central staff of six, consisting of a manager, one clerical/secretarial, and four staff with a even representation of computer programming and statistical/data analysis experience. This staff with support funds (e.g., computer time) is estimated to cost between $120,000 and $200,000 per year.

The highest level of implementation within one state would require a central staff of sixteen (including six field representatives) and support of local or county traffic records systems. This program is estimated to cost between $400,000 and $500,000 per year, plus $100,000 for each local records system established.

Initial implementation costs for software development are estimated at $100,000 over the first two years. Evaluation and user studies over the duration of the program will be at the same funding level.

The proposed exposure survey is 18 months in duration and will cost between $50,000 and $60,000.

3.6 Program Site Selection

Three criteria exists for site selection:

1. Need
2. Size
3. Hospitality

The need for a data program must exist. If there is no recognizable problem, no utility will result from the program. On the other hand the selection of a completely virgin site would not permit a timely completion of the program. Thus, the paradigm would have a sophisticated computer-based real-time traffic records system but no existing data utilization activities.

Size of the site must be large enough to insure the validity of the evaluation results, but small enough to be within the bounds of practicality. Clearly the data flow program must be based at the state level (with the selective involvement of local jurisdictions) because existing traffic record systems are centralized at the state level.

Hospitality will obviously be dependent on social-political climate as well as technical capabilities relative to the countermeasure goals. Clearly the political jurisdiction must want to implement a data flow program for it to be successful. Technical capabilities in the sophistication of the existing traffic records.

Are data files well structured, interlinked, accurate, automated, and timely? What is the accident reporting level` some states only reach the 30% level) and how badly fragmented (split into different files, portions not coded) is the accident data?

Besides the technical sophistication of a states' record system, consideration will be given to the competence of personnel, particularly in the area of evaluation techniques.

While site selection factors will be considered in more detail during the second phase of this contract (see discussion in Section 9), some insight can be gained by reviewing 402 projects (see description in the Appendix). 438 projects in standard areas 2 (Motor Vehicle Registration), 9 (Identification and Surveillance of Accident Locations), and 10 (Traffic Records), as well as information projects in the following analysis. Three measures are considered:

1. Percentage of Funds within State
   Percent of funds spent on information projects in each state relative to all funds spent in state. This gives a rough measure of the state's "interest" in information projects by removing the bias of total state funding (and thus reducing the population bias).

2. Percentage of Information Project Funds
   Percentage of funds spent on information projects in each state relative to all funds spent on information projects ($50.7 million). This gives a rough measure of the states "sophistication", by showing directly who has spent more on information projects.

3. Percentage of Numbers of Information Projects
   Percentage of number of information projects in each state relative to total number of information projects (438). Besides being a measure of activity in the area, the number of projects in a state is a rough measure of the "breadth" of states program, both in terms of the number of different applications and the involvement of local communities or counties.

Clearly, there are other more exacting measures for state selection, but these three provide an initial look at the problem. Table 3-3 displays the top 20 states by each of the three criteria. Ten states are common to all three lists, and seven states were represented twice. Ohio, Vermont, Indiana and Hawaii were high in interest, i.e., percentage of information project funds within the state. Ohio, New York, California, and Pennsylvania were on top with the largest amount of information project funds, which is not too surprising when considering their large populations. California, Illinois, New York, and Michigan had broad programs as determined by the relative number of projects in each state.

Two maps have been prepared to display the geographic distribution of information programs according to the first two criteria. Fig. 3-5 is distributed according to the percentage of funds within states. Fig. 3-6 is by the proportion of the total amount of information funds. The percentage ranges associate with each map symbol are as follows:

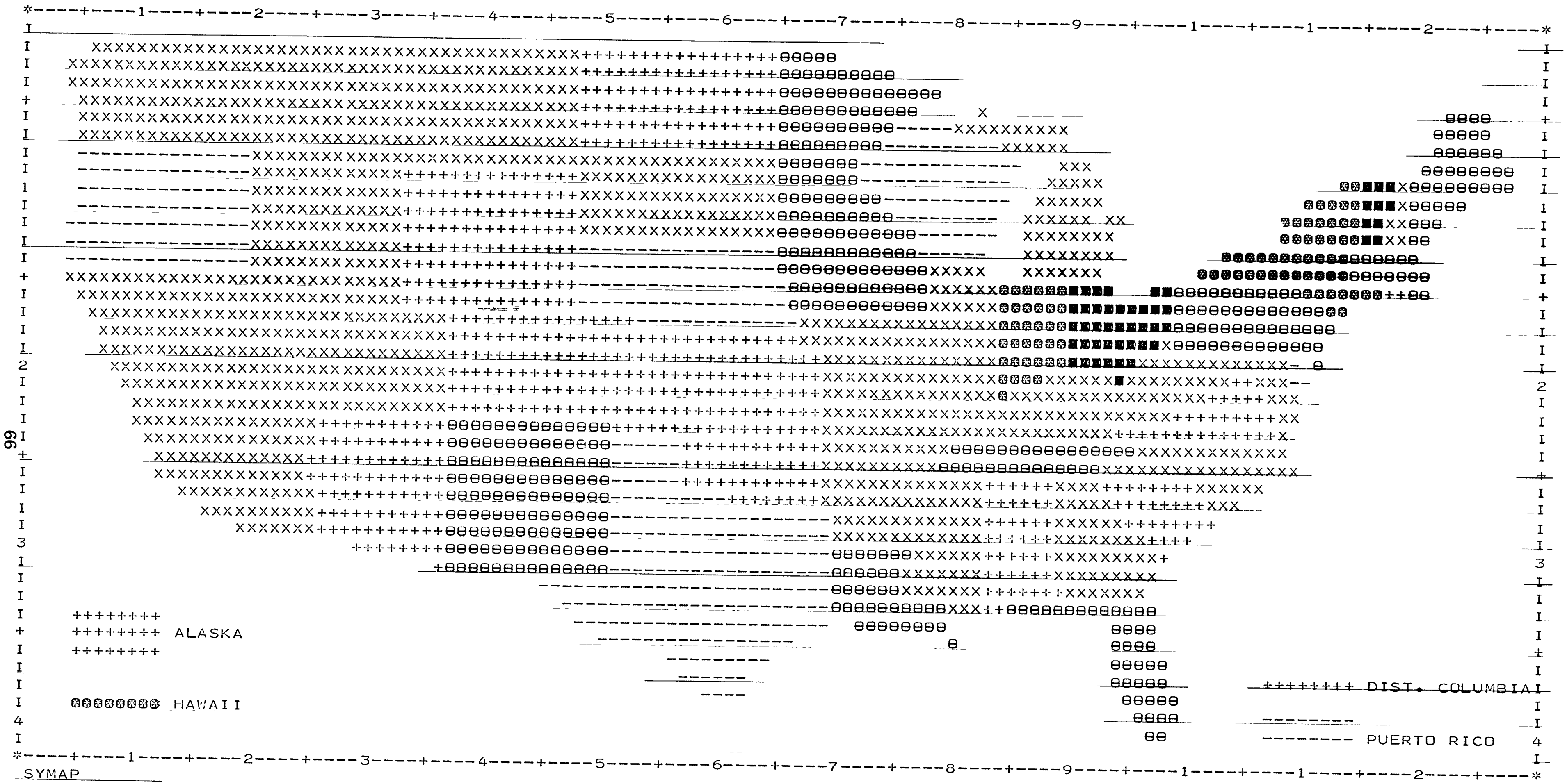
Symbol	% within state	Information Funds (thousands $)
O,X,V	51 - 70%	$ 5,000 - 4,000
O,*	41 - 50%	$ 2,000 - 4,999
O,-	31 - 40%	$ 1,000 - 2,999
X	21 - 30%	$ 500 - 999
+	11 - 20%	$ 100 - 499
-	0 - 10%	$ 0 - 99

A grouping of the states can be determined through a combination of the criteria: by summing the ranks (Table 3-4) or by summing the proportional percentages (Table 3-5). Weighting factors could also be applied to each criteria before combination, but the measures are crude enough to undermine the value of more sophisticated approaches.

TABLE 3-3

STATES RANKED BY INDIVIDUAL CRITERIA

Percent Funds within State			Percentage of Information Funds			Percentage of Information Projects		
Rank	State	%	Rank	State	%	Rank	State	%
1	Ohio	67%	1	Ohio	13.24%	1	Calif.	11.6%
2	Vermont	54.	2	N.Y.	13.21	2	Ill.	7.1
3	Indiana	47.	3	Calif.	8.42	3	N.Y.	5.2
4	Hawaii	40.4	4	Penn.	6.59	4	Mich.	4.3
5	Conn.	40.0	5	Indiana	4.78	5	Wash.	3.4
6	New York	39.9	6	Ill.	4.19	6	Florida	3.2
7	La.	38.4	7	Mich.	3.50	7	Wisc.	3.0
8	Tenn.	38.1	8	Florida	3.41	8	Conn.	2.7
9	Florida	36.	9	Mass.	3.32	8	Georgia	2.7
10	Penn.	35.5	10	N.J.	3.14	8	La.	2.7
11	Minn.	34.9	11	Tenn.	2.68	8	Va.	2.7
12	Mass.	34.	12	Minn.	2.55	9	Ohio	2.5
13	Maine	31.	13	La.	2.30	9	Tenn.	2.5
14	N.J.	30.	14	Georgia	2.12	10	Idaho	2.3
15	Miss.	29.	15	N.C.	1.96	10	N.J.	2.3
16	Utah	27.8	16	Conn.	1.82	11	Colorado	2.0
17	Georgia	27.6	16	Texas	1.82	11	Maine	2.0
18	Calif.	27.2	17	Iowa	1.77	11	P. R.	2.0
19	Illinois	27.1	18	Mou.	1.67	12	Miss.	1.8
20	Montana	26.8	19	Kent.	1.61	12	Utah	1.8



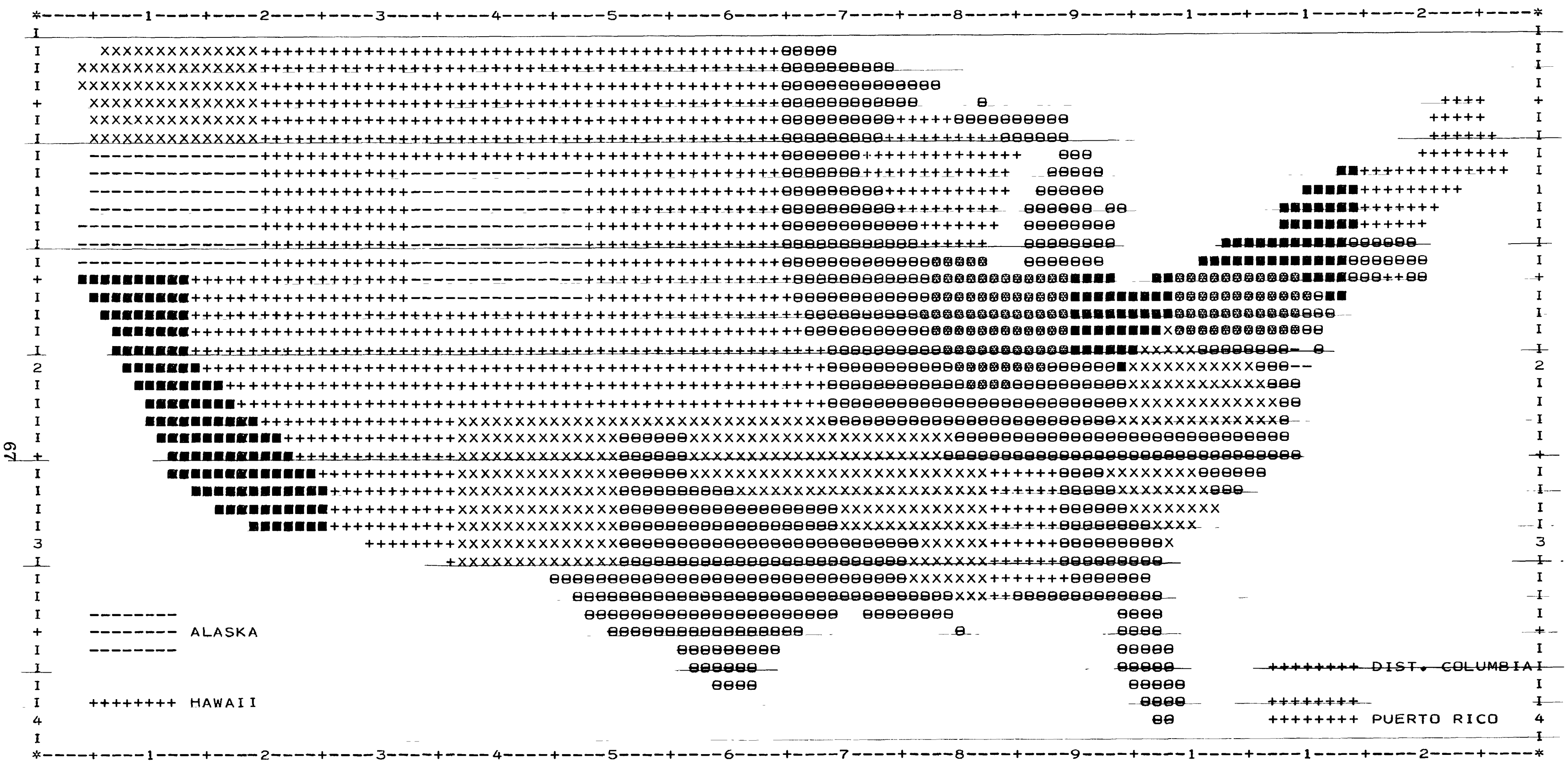
TIME = 0.0

PERCENTAGE OF FUNDS FOR

INFORMATION PROGRAMS WITHIN EACH STATE

(STANDARD AREAS 2, 9, 10)

Fig. 3-5



SYMAP

TIME = 0.0

PERCENTAGE OF TOTAL FUNDS

INFORMATION PROGRAMS

(STANDARD AREAS 2, 9, 10)

Fig. 3-6

Looking at the results of both combinations of criteria (Table 3-6), the top fourteen states can be rated in four groups.

1. New York, Ohio, California
2. Florida, Illinois, Indiana, Pennsylvania
3. Connecticut, Louisiana, Michigan, Tennessee
4. Georgia, Massachusetts, New Jersey

The Westinghouse Electric Corporation, in their March 1970 Supplementary Report to the NHSB on the current status of the States relative to the implementation of a NHSB Information and Data System, ranked the states for primary consideration for integration into a National System. Their check rated list included seven states: California, New York, Texas, Pennsylvania, Ohio, Illinois, and Michigan. This group represents over 43% of the registered vehicles and 45% of the licensed drivers in the nation. They also have well advanced traffic record systems. The Westinghouse selection criteria was purposely aimed at large states in order to have a large population represented in a National System. For the purpose of the data flow program small states with an advanced traffic records system will be considered, and, in fact, have certain advantages.

This analysis does not resolve the site selection problem, but does indicate which states should be considered as strong candidates during the second phase of the project. A full consideration of the experimental setting is presented in Section 9 of this report.

TABLE 3-4

STATES RANKED BY SUM OF RANKS

State	Rank Sum	Individual Rank		
		% within State	% of Funds	% of Projects
New York	11	2	6	3
Ohio	11	1	1	9
Indiana	21	5	3	13
California	22	3	18	1
Florida	23	8	9	6
Illinois	27	6	19	2
Louisiana	28	13	7	8
Penn.	28	4	10	14
Tennessee	28	11	8	9
Connecticut	29	16	5	8
Michigan	32	7	21	4
New Jersey	34	10	14	10
Mass.	35	9	12	14
Georgia	39	14	17	8

TABLE 3-5

STATES RANKED BY SUM OF PERCENTAGES

State	Percentage Sum	Proportional Percentages		
		% within State	% of Funds	% of Projects
California	22.2	8.4	2.2	11.6
New York	21.6	13.2	3.2	5.2
Ohio	21.0	13.2	5.3	2.5
Illinois	13.4	4.2	2.1	7.1
Penn.	10.8	6.6	2.8	1.4
Indiana	10.1	4.8	3.7	1.6
Michigan	9.8	3.5	2.0	4.3
Florida	9.5	3.4	2.9	3.2
Tennessee	8.2	2.7	3.0	2.5
Louisiana	8.0	2.3	3.0	2.7
New Jersey	7.8	3.1	2.4	2.3
Connecticut	7.7	1.8	3.2	2.7
Mass.	7.4	3.3	2.7	1.4
Georgia	7.0	2.1	2.2	2.7

TABLE 3-6

TOP FOURTEEN STATES RANKED BY:

Sum of Ranks		Sum of Percentages	
Sum	State	State	Sum
11	NY	CALIF	22.2
11	OHIO	NY	21.6
21	IND	OHIO	21.0
22	CALIF	ILL	13.4
23	FLA	PENN	10.8
27	ILL	IND	10.1
28	PENN	MICH	9.8
28	TENN	FLA	9.5
28	LA	TENN	8.2
29	CONN	LA	8.0
32	MICH	NJ	7.8
34	NJ	CONN	7.7
35	MASS	MASS	7.4
39	GA	GA	7.0

4.0 Highway User Preparation

Highway user preparation encompasses all those programs which are concerned with raising through some educational effort the performance level of individual vehicle operators, passengers and pedestrians. A distinction may be made between:

> activities designed to initiate people into new active highway-user roles, such as driver education and initial driver examination, and:
>
> activities designed to upgrade the performance of people in existing roles, such as driver improvement and periodic driver re-examination.

In terms of the H.S.P. Standards, this area covers everything related to instructing, and measuring the performance of, individual highway users in the Motorcycle, Driver Education, Driver Licensing and Pedestrian Safety Standards.

4.1 Subsystem Model Description

Diagram 4-1 places the status quo of highway user preparation in the context of the global traffic system model. Comparatively little is done to prepare pedestrians, passengers and bicylists* and for simplicity they are omitted from this diagram.

At present, having learned to drive in some way, novice drivers** enter the traffic system via a driver license examination which is almost universally regarded as a screen against imcompetence. Of the few who are screened out, only a much smaller number receive specialist help to upgrade their performance. Once having entered the system, most drivers have little or no contact with the preparation subsystem. Those who make contact may do so in one of three ways: a) they may live in one of the few states which require

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* For example, of all 402 projects FY68 through FY79, only 4 or 5 were for bicycle safety, and only 32 for pedestrian safety, against more than 600 for driver education.

** Throughout Section 4, the term "driver" is intended to include motorcyclists.

Diagram 4-1 THE EXISTING HIGHWAY USER PREPARATION SYSTEM

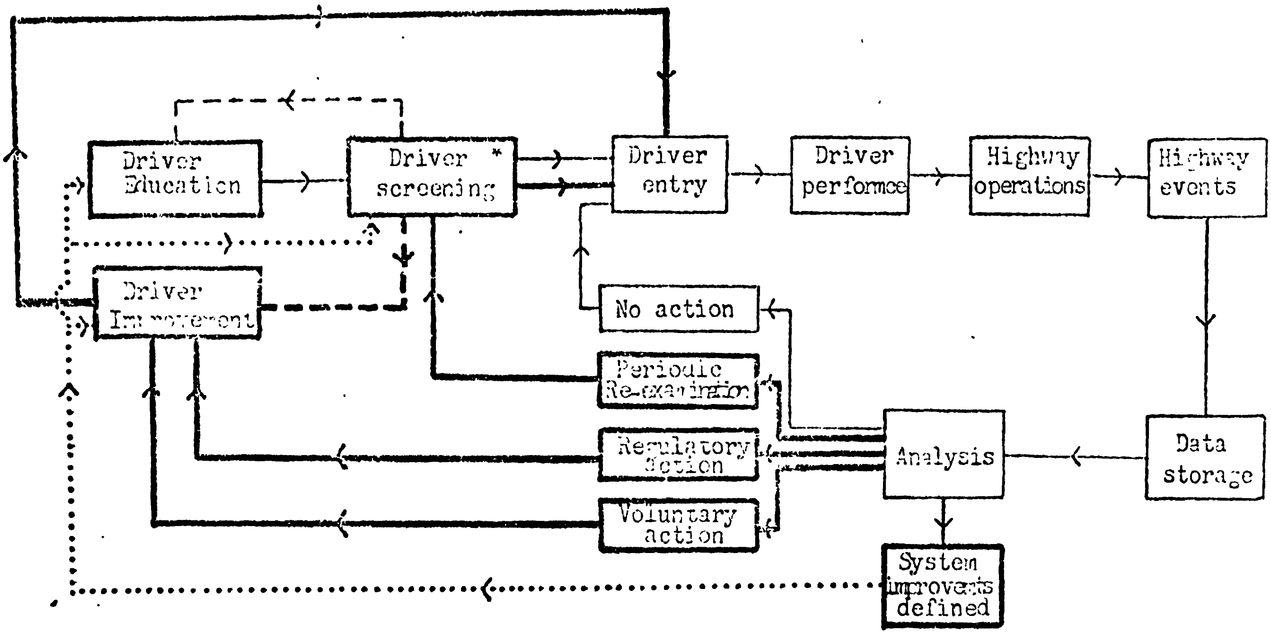
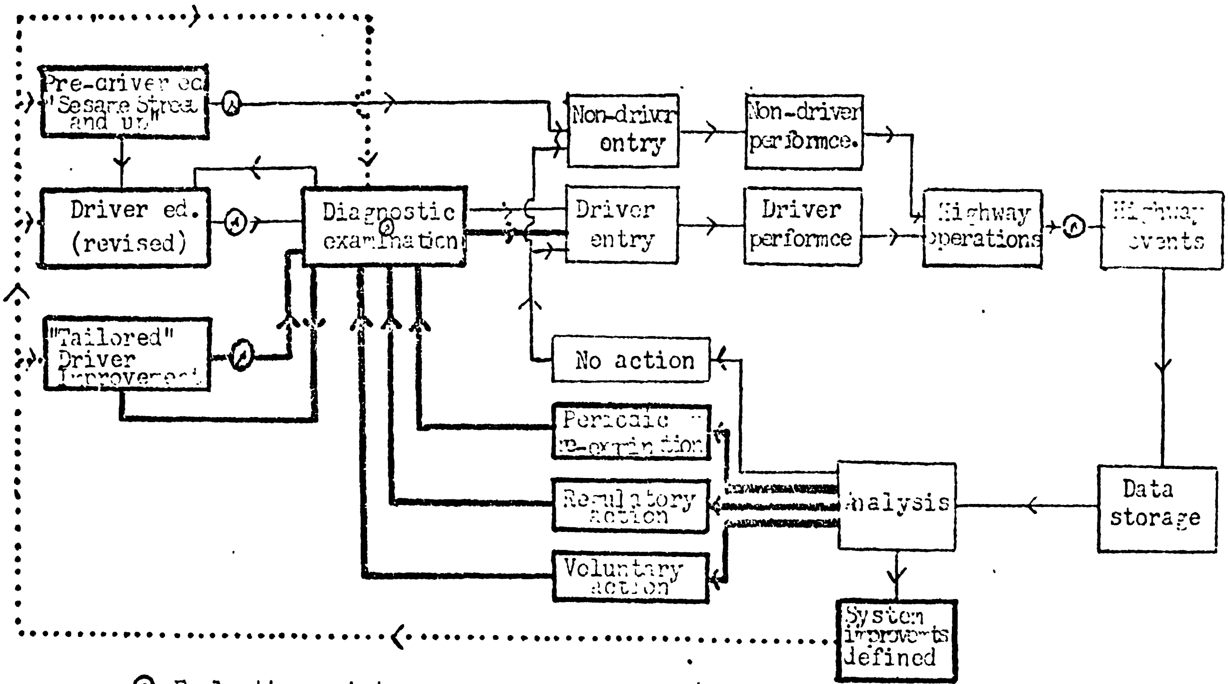


Diagram 4-2 AN ALTERNATIVE HIGHWAY USER PREPARATION SYSTEM



Ⓐ Evaluation point
* Medical factors omitted
——>—— Normal progression of driver through education/licensing system
– – –>– – "Weak link" in above
━━>━━ Normal progression of driver through re-examination/improvement system
━ ━ > ━ "Weak link" in above
.....)... Normal flow of information on system improvement needs

periodic re-examination of knowledge and/or performance,* b) they may be referred to a driver improvement program after accumulating a bad driving record; c) they may voluntarily attend a defensive driving course or the like. The general driving public are also subject in a non-uniform manner to the driver improvement efforts of traffic safety propagandists.

There are a number of problems with the status quo:

> Driver license examinations have not been are not able to screen out any but the grossly incompetent. (Goldstein, 1963 (Ref. 4-1); Miller and Dimling, 1969 (Ref. 4-2),
>
> Driver education reflects the driver license examination to the extent that teachers may share with the general driving public the very limited concept of the driving task which is implicit in the content of most examinations, namely adherence to a set of rules and laws and the skill to perform maneuvers. Many commercial driving schools and some high schools mold their courses around their state's examination. Thus there is considerable inertia to be overcome by the concept of driving as more of a thinking/decision-making activity. The literature suggests that this concept is the key to improved instruction. Nevertheless, there remains the further difficulty that Carlson and Klein (Ref. 4-3) and others have shown that the attitudinal area (or "life-style") may be more influential than instruction on driving behavior. Yet admonition is virtually the only technique which is used to attempt to modify attitudes. We may not be able to affect life-style in 30 or 40 hours at age 15 or 16, but there probably is much more which could be done as the

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* A much smaller number than those which re-examine eyesight or just require an appearance.

child develops his first highway-user roles as pedestrian, passenger and bicyclist at a much earlier age. Thus countermeasures against child traffic accidents may also ease the future driver education task.

Driver improvement efforts in this area tend to reinforce the limited conception of driving discussed above. Much of what exists is of the single treatment type (eg. driver safety classes), whereas the consensus of D.I. research is that treatment should be "tailored" to individual needs. The extreme example of the single treatment approach is the automatic return of a license after a period of suspension on the (dubious) assumption that enforced withdrawal from the highway system will lead to more proficient driving.

4.2 Countermeasure Descriptions

4.2.1 Selection Criteria

Expert opinion was sought nationally, and the literture as well as "402" project overviews and case histories were reviewed, to obtain and evaluate candidate countermeasures. As little empirical evidence exists of the relative value of past efforts in "preparation", it was necessary to proceed on the assumption that the greatest payoff would result from:

a) Identifying the areas of activity with the greatest discrepancy between existing practice and what experts regard as the "best we know", and:

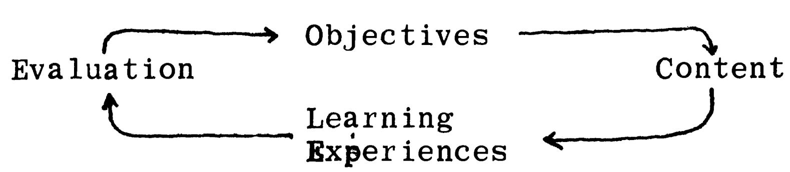
b) Having identified these areas, specifying the type and level of change which is appropriate given the constraints which would be expected in potential sites: these constraints are more than the practical limitations of manpower and facilities; they include the social and political frames of reference both of the practitioners (teachers, driver improvement specialists, driver license examiners, and broadcasters), and of the user groups (drivers, bicylists, passengers, pedestrians) whose characteristics we wish to change. In essence, this is to question the timeliness of a proposed change.

Thus far we have identified four components of the traffic safety system within which countermeasure effort could be made to improve highway user preparation. They comprise three areas of instruction (those for "pre- or non-drivers", novice drivers and experienced drivers), and one area of motor vehicle administration (driver license examination). An analysis of the status quo suggested that countermeasures incorporating the "best we know" will involve not only changes to these components, but also to the manner in which the components interact.

The major alternatives for improving the instructional areas and driver examining are to make changes to one or more of the following:

a) Organizational structure and time allocation
b) Objectives
c) Content
d) Success criteria (how much progress towards objectives is acceptable)
e) Methods and equipment
f) Manpower recruitment and preparation
g) Record keeping

While these are interdependent, they suggest a variety of "pressure-points" for countermeasure effort. Our investigations lead us to believe that we should focus on objectives, content, and success criteria, on the grounds that they have the greatest room for improvement, are the most timely, and offer good opportunities for developing a better integrated "preparation system". The primary thrust would be to change these three; changes to the others would follow as necessary. Support for this choice was considerable when the whole range of highway safety instructional programs was analyzed as a broad curriculum development problem. Most models of curriculum development focus upon four components:



Too much of highway safety instruction has been trapped in a vicious circle of vague but emotionally appealing accident-prevention objectives, content which is characterized by admonition and drills, unchallenging learning experiences, and little or no evaluation. Such a curriculum has little hope of self-renewal. The standard answer has been to try to improve learning activities (which is where much of the "402" effort has been placed*) with changes in format or additional equipment. If content changes occurred it was, in many cases, almost incidental. Fortunately, recent effort has led to much more specific (behavioral) objectives which both fit accident prevention needs, and which meet the criteria upon which the formal educational system decides whether an area is the legitimate concern of the schools. This has led in turn to a substantial amount of curriculum content which has yet to be widely introduced. There is a need to demonstrate the advantages (and limitations) of this content, not only in terms of outcomes, but as it relates to modern educational approaches; in particular, under the philosophy that education should, as R, S. Peters and others contend, pursue "reality", we have open to us "discovery learning". Under this approach, traffic educators can better justify such innovations as the simulation of critical maneuvers (for example in the use of skid pans).

4.2.2 Listing and Description of Countermeasures: An overview of changes to improve the integration of the highway user preparation system.

There is wide agreement among the experts we consulted that driver license examination and driving instruction should relate

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* In fact, in FY68 through FY70, there were only 20 programs in the general area of curriculum content development; this included all the driver education, motorcycle, bicycle and pedestrian curriculum guides, school bus manuals, and driver license handbooks and manuals (see Table 4-1).

Table 4-1

	YEAR	STATE	NHS PROGRAM STANDARD	NHSB PROJECT NUMBER	TOTAL PROJECT COST THOUSANDS OF DOLLARS	AUTHORIZED FEDERAL FUNDS THOUSANDS OF DOLLARS	
1	68	ARK	DE	002	00001	00001	MANUAL & CURRICULUM GUIDE FOR DRIVER EDUCATION TEACHERS
2	70	COLO	DE	002	00008	00004	DEVELOP CURRICULUM GUIDE COMMERCIAL DRIV ED SCH
3	69	DEL	DL	001	00202	00045	MOTOR VEHICLE DEPT FOR ADDITIONAL DRIVER MANUALS
4	68	DEL	PS	001	00001	00001	DEPT OF PUBLIC INSTRUCTION FOR PRINTING OF TEACHERS' GUIDE
5	69	FLA	DL	001	00034	00034	DRIVER HANDBOOK REPRODUCTION
6	68	IOWA	DE	002	00040	00020	DEVEL PUBLISH IMPLEMENT CURRICULUM GUIDE FOR PUBLIC SCHOOLS
7	69	IOWA	DL	001	00091	00045	DEVELOP & PUBLISH A DRIVER LICENSE MANUAL PUBLIC DISTRIB
8	70	KEN	PS	002	00005	00002	DEVELOP & PRINT PEDESTRIAN SAFETY EDUCATIONAL CURRICULUM
9	70	MOU	DE	001	00003	00001	DEV & PUB ST CYCLE SFTY GUIDE SUPPLEMENT CURRICULUM GUIDE
10	70	MOL	PS	001	00006	00003	DEVEL & PUB PED SFTY GUIDE SUPPLEMENT DE CURRICULUM GUIDE
11	69	NEV	DE	001	00003	00002	DEVEL UNIFORM INSTRUCT MAT COURSES IN TRAIN SCH BUS DRIVERS
12	69	OHIO	DE	004	00010	00010	DEPT OF EDUCATION DEVELOP CURRICULUM GUIDE FOR TEACHING DE
13	69	OHIO	PS	001	00011	00011	ED DEPT PROVIDE TEACHING GUIDE IMPROVE & EXPAND PED ED PROG
14	69	OHIO	PS	001	00033	00000	IMPROVE & EXPAND PEDESTRIAN EDUCATION PROGRAM-STATE
15	68	OKLA	DE	002	00036	00018	STATE ADMINISTRATION & DEVELOPMENT OF TEACHING GUIDE
16	70	PENN	DE	013	00007	00003	PENNSYLVANIA DEPT OF EDUCATION DEVELOP CURRICULUM GUIDE
17	68	SC	DE	003	00014	00007	MANUAL PUBLICATION - DE TEACHERS GUIDE - STATE
18	68	TENN	DL	001	00010	00010	STATE SAFETY DEPT $13,581 FOR REVISION OF EXAMINER'S MANUAL
19	68	TENN	DL	002	00030	00030	ST SAFETY DEPT $31,754 FOR ISSUANCE OF NEW DRIVER'S MANUAL
20	68	VER	DE	001	00003	00001	DEVELOP BUS DRIVERS MANUAL TESTING & CERTIFYING BUS DRIVERS

ALL INPUT DATA HAVE BEEN PROCESSED

NCASES= 20

ALL "402" PROJECTS IN DRIVER EDUCATION, DRIVER LICENSING, AND PEDESTRIAN SAFETY INVOLVING THE PREPARATION OF CURRICULUM GUIDES AND INSTRUCTIONAL MATERIALS

NOTE: There have been no projects under the Motorcycle Safety Standard to each other much more than at present. It seems that to achieve this, the focus in driver examining* should shift from attempts to screen out all of the bad drivers to Miller and Dimling's concept of a diagnosis of a driver's strengths and weaknesses (op cit, Ref. 4-2). This is the key to a number of possible modifications to the preparation system. Diagram 4-2 shows how a diagnostic examination could be employed as a pretest/posttest for "tailored" improvement activities which drivers undergo, as before, following official or voluntary action, in addition to its function as a much more meaningful test to follow (improved) driver education.

Thus, for drivers, content changes in examining would permit a range of tests to be designed to correspond to changes in instructional content - at the "initiation" and at the "improvement" level. Necessary changes in success criteria would mean superseding the concept of passing a single threshold of competency with that of attaining several levels of conditional approval; in practical terms this means that while denials would still be possible, restricted licensing would be extended for both the novice and the experienced driver, and that the nature of the restrictions would relate as far as possible to the diagnosed weaknesses.

For non-drivers, the assumption is made that countermeasure effort should be directed towards children, and from a very early age-probably as soon as they can understand a television program. Diagram 4-2 shows this effort collectively as "pre-driver education". The "diagnostic" concept, which can be applied in much more detailed tests in driver education than would be practicable for driver licensing, may also be applied to the development of evaluation methods as an integral part of programs aimed at the child

* Note that this refers to the performance/knowledge components of driver examining. Screening on medical factors is an additional countermeasure area which has not been fully explored at this time.

accident program.

<u>An overview of changes to the components of the highway user preparation system</u>

In selecting an orderly set of changes to the four major components (the three instructional areas and driver examining), the approach has been to define the instructional changes first, on the grounds that the changes in driver examining will necessarily correspond to the success criteria which are developed together with the objectives and content of the two driver instruction components. Also, while at this stage changes to objectives/content and success criteria are being considered under the general heading of driver, bicycle and pedestrian instruction, ten eventual "target groups" of highway users have been defined. The following table lists for each group the instructional activity within which the changes can be applied:

A. Experienced Drivers:

1. General driving public:	Locally oriented TV/Radio driver re-education, and network programs of the "National Driving Test" variety. Public information on changes to driver examining and improvement procedures.
2. Voluntary driver improvement participant:	Clinic or center giving individualized instruction following diagnostic pre-test.
3. Periodic re-examinee:	Diagnostic examination, with referral if necessary to individualized instruction.
4. Violation repeater:	Diagnostic pre-test, "tailored" instruction/treatment, and diagnostic post-test. Also extend use of restricted licensing in re-education efforts.

B. Novice Drivers

1. Novice motorcyclists:	Youth oriented course (public

	schools involved), and diagnostic license examination.
2. Teenage novice motorists:	High school course and diagnostic license exam. Good possibilities for "probationary" licensing linked to programs for high school students who have been driving for some time (e.g. small group "trigger film" sessions).
3. Adult novice motorists:	Possible cooperation with commercial driving schools, especially if it helped them adjust to the same diagnostic examination as B. 2.
C. Pre-drivers	
1. Pedestrians/passengers:	TV campaign for the very young ("Sesame Street" approach) plus course material for nursery, day care and elementary schools.
2. Bicyclists:	Bicycle course and other instructional materials for upper elementary grades. Other possibilites include TV programs and club activities.
3. Other:	Instructional materials of the "Understanding the Mobile Society" variety for all grades but especially the Junior High. A major focus would be the tradeoff between the use of automobiles and other forms of (especially mass) transportation.

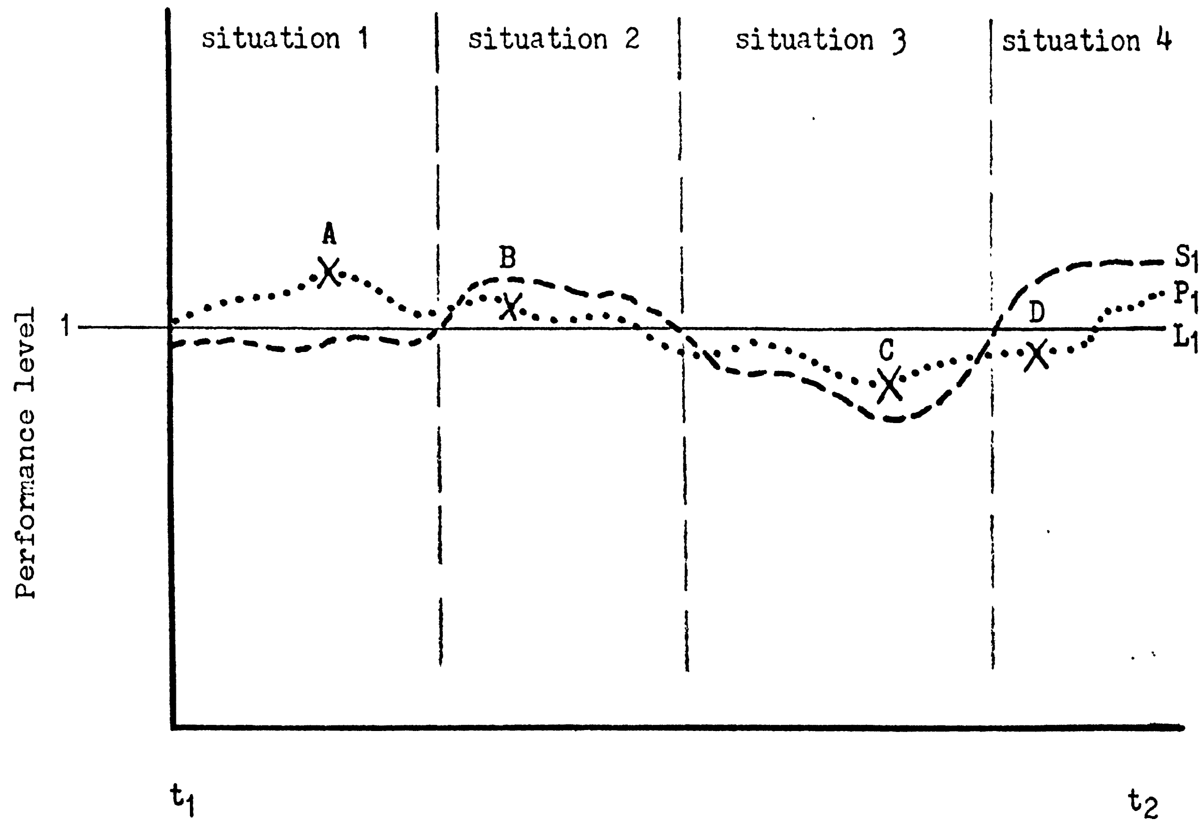
<u>The nature of suggested changes to objectives/content and success criteria.</u>

Priority was given in Phase One to considering alternative objectives and developing a model for changing instructional content for drivers, bicyclists and pedestrians. As promising improvements which have been tried or suggested in various parts of the country were considered, it became obvious that most of them were centered around a similar theme: an attempt was being made to treat the behavior of people in traffic as a thinking-decision-making activity rather than as some level of adherence to rules and regulations. For the driver groups, it was reasonable to ask what it is that driver preparation can do which is beyond the scope of driver regulation. Even if we can assume that driver regulation is more or less successful in obtaining compliance to traffic laws, we cannot regard this as the complete solution to unsafe driving because a legal act may or may not be safe. Legal behavior, though normally necessary for safe performance, is frequently insufficient to avoid collisions. A simple graphical model of this is shown in diagram 4-3.

It has already been discussed that safe performance is popularly envisaged as a combination of physical skill and legal behavior. Yet the law connot prescribe more than the minimal safe performance which results from obeying speed limits, rights of way and the like. That the law cannot possibly be objective about precise driver actions in highly variable situations is evidenced by its tendency to relate its sanctions to the fortuitous consequences of unsafe behavior rather than to the behavior itself. Thus it is towards the area of the legal, unsafe act (B) that driver instruction should direct much of its efforts. Specifically, it needs to shift its main emphasis from handling skills and rules of the road to driving as a perception-prediction-decision-making process. Note that this is not suggesting the elimination of the former; indeed, this approach should make traffic rules more comprehensible. The overall objective is to narrow the gap between the subjective and objective probability that a driver's action will lead to an irreversible collision situation, as well as the gap between the subjective and objective value of taking risks.

Diagram 4-3

MODEL OF SAFE/UNSAFE AND LEGAL/ILLEGAL DRIVING BEHAVIOR



WHERE:

S = sufficient safe performance level, and $S_1 = \frac{S}{L}$ (— —)

P = a driver's actual performance level, and $P_1 = \frac{P}{L}$ (.......)

L = legal performance level, and $L_1 = \frac{L}{L} = 1$ (———)

DRIVING ACTS AT THE POINTS INDICATED MAY BE CLASSIFIED:

	Safe	Unsafe
Legal	A	B
Illegal	C	D

EXPLANATION:
The diagram plots the progress of a driver through four highway/traffic situations which demand different performance levels for safe operation (S). Legal performance level (L) recognizes the changes in situation, but because it changes abruptly, all three curves are normalized on (L) for clarity. The driver's response (P) in the four situations cover all possibilities in the matrix on the left.

In diagram 4-3, sufficient safe performance level (S) would be a function of the objective probabilities and values connected with his actions, and the driver's actual performance level (D) would be a function of the subjective probalities andvalues.

Suitable curriculum content is becoming available from a number of sources. The National Highway Safety Bureau have a number of current "403" contracts in this area, such as the HumRRO driving task analysis and A.I.R.'s work with instructional aids. HUFSaM, and A.S.F. before them, have done substantial driver education curriculum development work, and have been active in disseminating it to teacher educators. Illinois State University have been much involved, particularly in the area of perception. Developmental work is continuing in the states of Washington, Michigan, Florida, Missouri and others. Collectively, this has become known amongst driver educators as the "new curriculum movement." A countermeasure program should perform the crucial role of pulling together the good results of many of these efforts, designing a model implementation of the new content, not just in the public schools but in the various driver instruction and improvement areas, and providing an adequate evaluation methodology.

An important part of the model implementation is new success criteria. A simple pass/fail system is unhelpful where much experiential learning takes place over a long period of time, and we have good reason to believe that learning to drive is of this nature. Many of the instructional aids available and being developed are partially or wholly usable for testing purposes within courses; from these and other sources, diagnostic examinations can be built. Some such items have already been tried in driver license examinations, notably in the State of Washington, whose recent evaluation of the experiment offers support for the general approach being suggested here.* The diagnostic examination could in turn

*In "An Evaluation of Washington's Automated Driver Knowledge Examination", it is stated: ".... It was concluded from this evaluation that, while of considerable diagnostic value (understanding why bad and good record drivers answer certain items consistently differently is valuable for driver improvement purposes), rules of the road knowledge could not be used as an indicator of good driving performance, and is at best a necessary, but not sufficient condition for good driving. (July 1970) identify a number of alternative areas of content for driver improvement; perhaps four or five alternative treatments should be available, including individual and group counselling.

The approach for the pre-driver is essentially similar to that for the driver; the aim is to get at subjective judgment of risk and the values attached to it. While the driving task is considerably more complex, children have to deal with the same types of problems as a driver handles--time-space judgments, predictions of the behavior of other road users, and the like. Just how ill-equipped they are to handle these problems has been demonstrated by Sandels (Ref.4-4). We need to start very early with pedestrians to try to give them some basic concepts of traffic. We may be able to use the "Sesame Street" approach to affect value-judgments; this has some interesting possibilities: can we, for example, have young children pressure their parents into using seat belts by borrowing the techniques of breakfast cereal marketing? On a more individual basis, we can reach the very young in nursery and day-care schools and the early elementary grades. Ways of teaching them to cross roads are being explored in a number of places at this time: at the Road Research Laboratory and the University of Nottingham in England, at Uppsala in Sweden, and within the safety education program of the Office of Public Instruction in Illinois, where their elementary specialist (Donald La Fond) is using with apparent success a method he calls "situational decision-making." Finally, this area is ideally suited to educational games.

The area of bicycle programs holds more promise than is often realized. For most children, the bicycle provides their first active involvement with traffic, and it is an ideal time to work with concept that the rules of the road are "necessary but not sufficient." The bicycle is also a valuable source of intermediate experience in "learning to adjust to being mechanized." There is a significant accident problem which warrants more attention--550 children between 5 and 14 were killed on bicycles in 1969. Unfortunately, the content of bicycle programs is not so well developed, nor is it the subject of as much interest, as some of the other areas; however, useful work has been done in England, Ontario and Illinois. Some of the greatest potentiality is in the area of teaching visual awareness. Altogether, some further investigation is needed before specifying a program; there is a good case for developing a new special course together with some material which could be integrated into school work at other times.

There is excellent potential for upgrading the various components of the highway user preparation system through the introduction of new objectives, content and success criteria. The role of the countermeasure program is to ensure that this is done as quickly as possible and in a cohesive manner.

4.3: Measures of Effectiveness

Three levels of criteria will be employed: short-term, intermediate, and long-term. The preparation area affects the system less directly than most, and therefore short-term criteria become relatively important. Wherever possible, control groups will be used, and a balance will be sought between the intensive evaluation of small samples, and the collection (mainly through survey techniques) of limited data from large samples.

4.3.1: Short Term Evaluation

These measures will be applied during and immediately after countermeasure programs.

Short-term Evaluation of Changes to Instruction

Essentially this means testing instructional courses in some detail in terms of their own (usually behavioral) objectives. It is from this level that the diagnostic examination is assembled, including a concise version for driver licensing. To be able to do this, it is necessary to build an analytical model of the sub-tasks involved in the behavior being considered, and to establish criteria for each of the sub-tasks. Clearly, this could be done in very great detail, but comparatively simple models are quite useful. For example, we could take R. B. Miller's (Ref. 4-5) analysis in which he defined four stages:
identify, predict, decide, and execute; adding the dimension of the two level interaction (driver with vehicle, and driver + vehicle with highway + traffic environment) we arrive at the model in diagram 4-4. The model was used here to generate a criterion (though not the <u>only</u> criterion) for each stage and for both levels of interaction; these are listed in the diagram, and together encompass most of the short-term criterion variables suggested in recent driver education evaluation methodology studies.

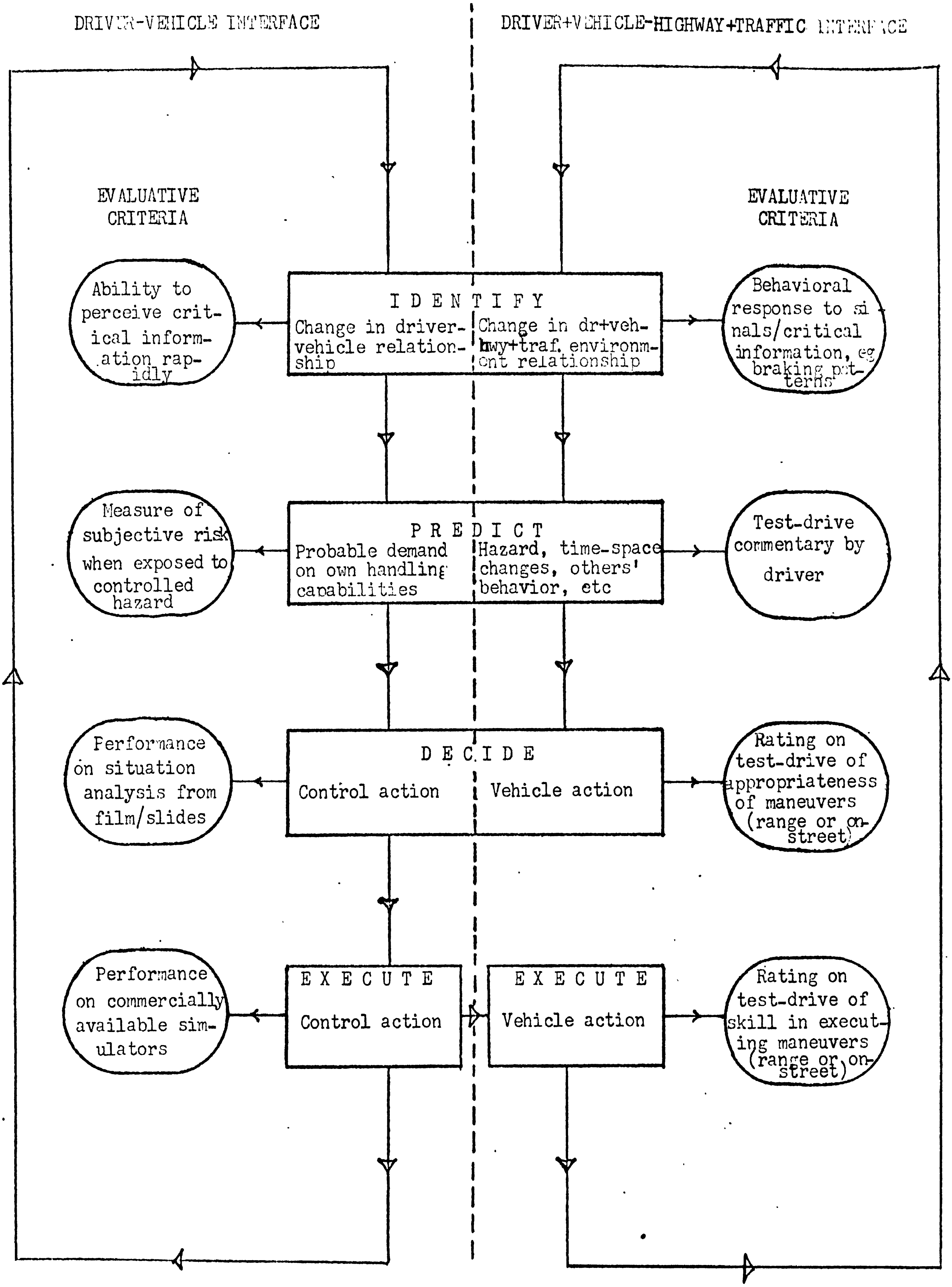


DIAGRAM 4-4: MODEL FOR SHORT-TERM EVALUATION OF DRIVER PERFORMANCE

Some promising instruments which have become available only recently require further experimentation, some of which could be carried out during the pilot implementation phase which is suggested in Section 4.4.3.

At present, a test made up of such criteria would be useful primarily to evaluate course-effectiveness and to diagnose weaknesses in individual performance. However, attempts should be made to validate it against intermediate and long-term criteria. Ideally, some mathematical model should be developed; for example, if I,P,D and E represent some measure of performance at Miller's four stages, then we might hypothesize that:

$$p\ (X/I,P,D,E) = \alpha\,(I) \cdot \beta\,(P) \cdot \zeta\,(D)\ \gamma\,(E)$$

where: X = safe driving, and α, β, ζ and γ are constants.

Conceptually, a multiplicative model of this type for predicting safe driving may be conjunctive in nature; that is, level of performance at each stage (I,P,D, and E) may have to exceed certain thresholds for driving to be safe.

Some of the more interesting possibilities with the use of behavioral objectives for evaluating instructional changes, especially in the younger age groups, are in the realm of role-playing/decision-making games and other simulation-based approaches.

Finally, the evaluation of instructional changes will include some direct tests of knowledge and attitudes, as well as some measures of the way changes are received by highway users. In the school courses, the latter will include some student evaluation of teaching, content, and the fairness of success-criteria. More subtle measures will be necessary for the driver improvement programs. For radio and TV efforts (except those pinpointing specific dangers in local highways) a survey of viewer reaction is probably the only feasible source of evaluation.

Short-term evaluation of changes to driver examining

Primarily, this will involve a measure of the quality and quantity of identified weaknesses in knowledge and performance. Here, too, drivers' reactions to the administration, content and parity of the changed examination will be sought.

4.3.2: Intermediate Evaluation

These measures will be applied at any time following countermeasure programs up to a year or more later. Considerable improvements are needed to evaluation methodology at this level. Some innovative techniques are being sought. An importance source is the Federal contract at Michigan State University to develop an intermediate driver performance instrument.

Intermediate Evaluation of Changes to Instruction

Techniques to be used fall into two groups. Firstly, the traditional approach of re-applying the criteria which were used in the short-term evaluation to establish the stability or latency of any differences between experimental and control groups. There are practical limitations on this approach with the driver groups: as the performance instruments are somewhat expensive to administer, it will be necessary to use fairly small samples. Also, it is desirable that the experimenter is as unobtrusive as possible when evaluating performance, and it is extremely difficult to achieve this except for very biased samples (e.g., taxicab drivers). There are some techniques, however, for looking at the knowledge and attitudes as well as the performance of comparatively large unbiased samples, using recent developments in survey research, such as those discussed in the Driver Regulation sections of this and the Interim Phase I Report.

The second group of techniques are for the observation of the on-street behavior of highway user groups. In terms of the global traffic safety system model, this is evaluation at the "operations" stage, beyond the point of individual performance testing. Once again, the pre-drivers present fewer problems: it is not difficult to observe pedestrian or bicyclist behavior in the neighborhood of a school in which, some time earlier, instruction was given. The difficulty with drivers is identifying, at some highway location, a satisfactory sample of the relatively small number who have been exposed to the instructional courses; also, it is not reasonable to assume that all of the remaining drivers are satisfactory control subjects. The most promising solution is to site some of the instructional changes in comparatively isolated towns and cities to increase the likelihood of observing those drivers who have been involved. Observational techniques include electronic devices which have been developed to detect and identify violators (to look at gross driving errors), and human observers (to look at judgmental errors and conflicts in more detail); positive identification of the driver is a problem with the latter technique.

Intermediate evaluation of changes to driver examining

This will be in the form of a follow-up study to determine to what extent drivers have taken steps to overcome weaknesses identified by the various diagnostic examinations. Some data will be available from the records of driver improvement activities, both voluntary and required. A survey will be needed to complete the picture.

4.3.3: Long Term Evaluation

Long term evaluation of changes to instruction

In the driver groups, an opportunity to re-apply short-term performance criteria will be provided as a matter of course if periodic re-examination is incorporated in the overall program design. In addition, it would be desirable to test in much greater detail than would be practicable for a periodic re-examination a small sample of drivers after two or three years. For all groups, accident and violation data will be analyzed; qualitative measures, such as culpability in accidents, may be more meaningful than overall rates. It will be difficult to use accident and violation criteria until 2-3 years have elapsed for the driver groups, somewhat less for the pre-drivers. Uses of "near-miss" data are being examined.

Long-term evaluation of changes to driver examining

Ultimately we want to know if a diagnostic examination leads to an upgrading of individual performance. However, the diagnostic examination cannot be evaluated apart from the driver education and improvement system into which it is integrated. Nevertheless, a study can and will be made of any patterns of response to the diagnostic examinations which consistently distinguish between those who (despite re-education efforts) have poor subsequent driving records and those who do not.

4.4: Experimental Design

As with the other sub-systems, highway-user preparation programs will be developed at several levels of activity. Eight "sites"* will be needed to accommodate three levels of countermeasure effort and one no-action control for the pre-driver groups, and all the driver groups, respectively.

4.4.1: Outline Plan for Varying Countermeasure Effort

The maximal effort will consist of those programs listed in section 4.4.2. The minimal and intermediate levels of effort will consist of the following:

GROUP:	MINIMAL EFFORT:	INTERMEDIATE EFFORT:
Pre-drivers	TV programs only	School courses only
Driver groups	Supply of new course materials only to driver education teachers and driver improvement personnel	Radio/TV programs; changes to high school driver education and the classroom type of driver improvement using in-service training of personnel, including an introduction to non-directed discussion techniques.

*Each "site" may consist of several localities (see 4.4.2)

4.4.2: Controls and Data Requirements

It will be necessary to control a number of variables either in selecting the experimental and control populations or in analyzing the data. Because of informal contact between course participants and others, it is not practicable to select control groups or vary the level of effort within single schools for pre-drivers and novice drivers, and possibly even cities for experienced drivers. This makes it difficult to select sites which are comparable on geographical and socio-economic variables, and on the quality of instructional and examining facilities. A careful selection of localities will have to be made using the stratified-cluster technique.

Within selected populations, data should be collected on the range of individual differences on biographical variables and personality characteristics. In the driver education courses it is essential to randomize on the much-discussed variable of "initial student interest and motivation", probably by making it a required course.

4.4.3: Resource Requirements

Size

A fairly large experimental population is desirable, given that the probabilities of different amounts of change resulting from countermeasures are difficult to predict in this area; to be sure of statistical significance with small samples, that prediction has to be made with some accuracy. In practical terms, this means "matched sets" of local school districts who are willing to cooperate, and which, to facilitate coordinated planning, should probably be in a single state.

However, it will not be possible to operate at this scale immediately. It has become increasingly clear that for the highway user preparation area to succeed, a pilot phase of at least nine months will be needed. There are a number of reasons for this. Firstly, it is essential that teachers and driving examiners should receive special in-service training for the "maximal" and "intermediate" level programs. This could be very conveniently integrated with the latter stages of an experimental/developmental program in a very few schools and driver examining stations, staffed by people with special expertise. This is in effect to provide a "mini" demonstration of changes and evaluation methodology on which the much wider implementation could be modeled, but it also provides the opportunity to prove on a small scale some of the more recent curriculum content and driver examining innovations. Similarly, work could be completed on some of the evaluation instruments which need refining before they are used in countermeasure projects. Further, the pilot phase would give much needed time to coordinate the various sites, to prepare the written course materials for the "minimal" programs, to develop the TV and radio programs, and, most importantly, to conduct a public information campaign in the "maximal" sites to explain the changes to driver examining and driver improvement. Finally, it would permit the gathering of base-line data in all of the experimental sites for before and after studies.

Approximately one year from the original starting date, the highway user preparation program would be fully implemented at the three levels of effort on a fully planned basis. Ideally, the full program should run for at least three years, following which the steering group would prepare and submit its final evaluation.

Level of funding

Because this entire plan is almost entirely directed towards changing existing functions rather than introducing new capabilities, the level of funding required is not excessive. The greatest expenditure is needed to maintain a steering and evaluation group, who because of the complexities involved, should have substantial expertise in evaluation methodologies. Adequate funds are needed in the first year to attract outstanding teachers, driver examiners and driver improvement specialists for the pilot phase, and to support the in-service training courses. The remainder of the funds will be needed for the TV/radio and other informational efforts, some additional staff and equipment at the local level, and for the development and distribution of instructional materials.

5.0 Driver Regulation Countermeasures

At least four major sources of structure and information can be useful towards the creation of a heuristic for designing and evaluating the effectiveness of countermeasures in the area of driver regulation:

1) behavioral decision theory;
2) the HSRI event oriented causal chain model (the general traffic system model, 2.0);
3) the Traveler's reports on Police Traffic Services, especially as reviewed by O'Day (1970); and
4) the HSRI file of existing "402" countermeasures.

One of the major thrusts of the SCOPE program is not only to design countermeasures that work, but to be able to describe both <u>why</u> they work and <u>how well</u> they work. It seems, then, that what is needed is a concentrated measurement effort which provides clues to the <u>necessary</u> and <u>sufficient</u> conditions for countermeasures to reliably repeat their effects (the why of it) and to provide some sort of cost/effectiveness or cost/benefit (the how well of it) analysis of the countermeasures. That is to say that the cost/benefit analysis of a specific countermeasure should tell us something about the payoff for specific countermeasure investments. One way of conceptualizing this direction of the effort is to visualize a utility vs. cost curve for a stratified incremental program of countermeasures in any area:

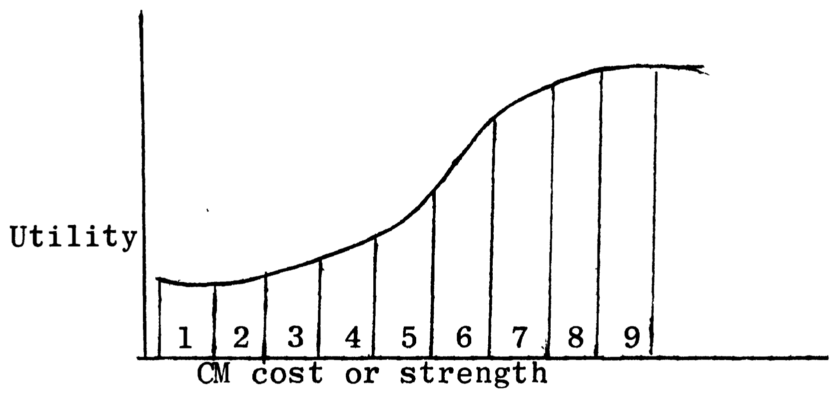


Figure 5-1 Countermeasure Cost/Benefit Curve

Each bar of this graph can be thought of as a specific countermeasure program having a certain cost or strength and a certain payoff or utility. Thus, each of the vertical bars represents a discrete countermeasure program where the number of any program, m, and any other program, n, imply that for $m > n$ the level of effort, strength or cost for program m is greater than that for program n. Here we might also conceive of program n being a subset of program m. This idea will be expanded later. Admittedly we are begging the question of measurement of these things (cost, effort, utility, etc.) but this will be discussed as part of this paper. Crudely speaking, we could simply tally the cost in dollars of a program in some city and map it against the payoff in (e.g.) accident reduction for a control city or area (or itself at an earlier date) which did not spend X dollars on the countermeasure. Clearly, this illustratory example is insufficient to reliably establish a cost/benefit curve and the previously discussed techniques of measuring intermediate criteria must be attempted. These criteria and their measurement counterparts in terms of recent survey research techniques are more fully discussed in the interim phase I report predecessor paper. There is, however, no need to stop here, for techniques of multidimensional and non-metric scaling from mathematical psychology viz a viz Coombs, Shepard, Kruskal, Guttman, Lingoes, etc. can provide much more sophistication in the way of measuring cost and benefit or utility. First of all, it is naive to think that some unidimensional scale like dollars can effectively measure the change input or output of a program when so many important human factors abound (e.g. attitude changes, behavioral changes and other non-tangibles) which all have value. Secondly, it is just as naive to believe that we can garner metric scales (again e.g. dollars) to measure all of the phenomena involved--a wealth of measurement exists at the non-metric level which can provide much more depth to the measurement process. In any case, it is suggested that advanced techniques of scaling be employed, such as non-metric and multidimensional methods, to develop more sensitive scales of measurement. Once a thorough scaling of the cost/benefit phenomena are performed, then the task of identifying the relationship between the two, as in our figure (Fig. 5-1), with all its inflection points, trends, etc. can be reasonably carried out. It is with these sorts of analyses and the gut-level feelings (e.g. "community opinion," "feeling of the (police) force", etc.) that most of the evaluation of the SCOPE programs can be conducted. If in fact a maximal gain is acquired from some countermeasure and the analyses reveal it, a good public relations (PR) effort should produce the positive gut-level output. The effect can be reversed by insuring at least a modicum of success of any program by providing a strong PR effort and the resulting support from the community, police force, etc. which would be reflected in these gut-level feelings. If SCOPE is to be successful both in the eye of the public and as a scientific endeavor, a great deal of money, time and effort should be spent on the public relations aspect of the program. Thus, all of the relationships between all of the institutions and agencies involved in the respective SCOPE efforts must be clearly defined, and established where non-existant, and relationships at the level of communications, operations and administration should be defined and maximized with respect to the task requirements. Figure 5-2 below outlines the matrix of most of these relationships.

	Public	Local Police	County Police	State Police	Local Safety Rep.	State Safety Rep.	Regional H.S.B.	Federal H.S.B.	Local Evaluator	Global Evaluator	Courts
Public											
Local Police											
County Police											
State Police											
Local Safety Rep.											
State Safety Rep.											
Regional H.S.B.											
Federal H.S.B.											
Local Evaluator											
Global Evaluator											
Courts											

Task-Relationship Matrix

Figure 5-2

Each of these relationships should be treated and carefully established. Failure to consider the matrix of task relationships could be disastrous especially in the area of driver regulation where the "government" is ostensibly taking some action with respect to individuals and their behavior. The traditional failure of federally funded programmatic social innovation to consider the gamut of social and political factors has produced a harvest of bitter fruit with respect to many concerned scientists, the public, the federal government, local and state agencies, etc. Even the most non-obtrusive programs will produce negative consequences where the experimental control of human behavior is concerned. The social psychologists' concern with "reactance motivation," the negative over-reaction aroused as a result of some over obtrusive manipulation, attests to the pervasiveness of this phenomenon. Thus, when we say public relations, the acronym PR should assume a much broader meaning than that of the glossy Madison Avenue approach.

From an experimental point of view, a PR effort at the national level would mute the strong Hawthorne or halo effect possible in SCOPE areas <u>not</u> present in control or comparison areas by raising public interest to such a high level <u>overall</u> that the relative Hawthorne effect from any SCOPE program would be minimal with respect to the overall effect. In general, the Hawthorne effect should be more fully explored in the area of highway safety.

With respect to the driver regulation area, a major focus of measurement would be driver behavior. Rather than using only the standard set of behavioral measures (e.g. number of arrests, accidents, etc.) a more uniform and extensive approach to measuring driver behavior would be preferable. Hopefully, any countermeasure program, especially in the area of driver regulation, will alter both behavior and the decision making processes of drivers. In fact, if we can accept the psychologist's three dimensional model of an attitude, if we are to change attitudes toward driving, we must consider 1) cognitive or decision making components, 2) affective or emotional components and 3) the conative (or behavioral tendencies) components of the attitude. As an example of how these three components can act independently, people may believe (cognitive) that speeding is dangerous, may fear (affective) the negative outcomes and yet will tend to go ahead and speed (conative). Nevertheless, for practical purposes, we should consider the rational model of man which says a man most often behaves as he believes is best. If we were to accept an irrational model, the inherent lack of a reliable relationship between attitudinal components would disallow any possibility of constructing a usable and repeatable countermeasure to regulate driver behavior. The rational model then gives us at least a workable approach to the evaluation of countermeasures.

One area of theory and research that deals with this problem is that of behavioral decision theory. Ward Edwards (Ref. 5-5, 5-6) has two good surveys of behavioral decision theory in the area of psychology. Edwards (Ref. 5-4) also has a discussion of behavioral decision theory applied to the area of driver behavior. The reader is urged to read this last reference for a full survey of the application of behavioral decision theory to driver behavior.

We can begin a brief review of behavioral decision theory (BDT) by assuming that just as people (in general) process information, make decisions under risky conditions and behave accordingly, so do people as drivers of automobiles. If we can assume that these basic processes do not vary substantially from car to office or home or anywhere humans go, then we have a body of theory and research that can be valuable to the study of driver behavior. For heuristic purposes at least we shall assume so.

Basically, BDT tells us that given N possible courses of action, each course of action i having a probability P_i and a value V_i attached to it, a rational man will choose that course of action i whose product $P_i \times V_i$ is greater than that for any other course of action $\neq i$. That is to say, if we have several choices of behavior, each having an expectancy or probability of occurence and each having a value or utility, if we multiply the expectancy by the value for each behavior (thus forming an "expected value" for each), the behavior with the highest expected value (EV) will most likely be selected. If we then focus upon the dynamics of an unsafe or illegal driving act as opposed to a safe or legal one, a driver can be described as a decision maker who samples discrete bits of information and makes discrete decisions within a spectrum of continuous information from a continuum of events. Within each of these discrete information-processing/decision-making events we can consider a driver to possess a set of rules as to what is a safe or unsafe and a legal or illegal driving act within certain variable limits. The safe/unsafe dynamic would most likely operate against some expectancy and valuation of an accident while the legal/illegal dynamic would operate in a more diverse domain, consisting of expectancies and valuations about detection, incarceration, punishment, etc. One possible model for clarifying the sequence of decisions that drivers may make concerning safeness and legality would be the HSRI event-oriented chain model (see section 2.0). Here the detection, response, information storage, analysis and action phases would most likely relate to the legality function while the safeness function would probably relate most to driver characteristics, performance and (vehicle) operation. In any case, a viable method for determining these subjective scales of judgement would be through the application of behavioral decision theory.

We might consider a few general examples of how BDT in conjunction with the HSRI event-oriented chain model might allow more specific measurement of driver behavior. For example, let us consider a discrete information-processing/decision-making event as an event in our general chain model. Let us further assume that a driver simulates something like our model in his decision making process in a sequential fashion. That is, using safety and legality as desiderata a driver gains information about an event and processes it under the rules of BDT. For example, perhaps he notices his speed is in excess of the speed limit. He now processes that information by assessing the expected value of detection (of his excess speed). His behaviors generally call for decreasing, maintaining or increasing speed. Depending upon a complex of factors including his speed, his excess of speed over the limit, road and vehicle conditions, enforcement, etc. the driver will pursue the one of the three behaviors which has the highest EV. Thus, slowing down may have a low expectancy of detection and a low negative value associated with detection at that slower speed, while a maintained speed might have a low to moderate expectancy of detection and a moderate negative value, and speeding up might produce a moderate to high expectancy of detection and a high negative value from detection. Note that if he either has a very low expectancy of detection or a very low negative value associated with detection, this decision rule will not affect his behavior since the EV will be low and relatively equal for all choices and it matters not how much he speeds. Likewise, the same decision processes would apply with respect to response (enforcement), information storage (ticket or summons), analysis (court/legal system) and action (adjudication) components of our chain model. Some interesting predictions can now be made. A driver whose EV is very low (i.e. either or both his expectancy and valuation of a consequence of his action are very low) with respect to all of the components of the legality judgement simulated in the chain model, will not alter his behavior on the basis of anything in that judgement process. More substantively, if he doesn't believe he will be detected or value the loss of being detected very highly (or both), a driver will not change his behavior (speeding, e.g.) accordingly. Likewise, if he doesn't expect or value the enforcement, or the ticket, or the court/legal system or the adjudication (jail, fine, etc.), he will not be affected by these considerations. A more crucial interpretation is that a driver need only break this chain at any one point by not expecting or negatively valuing an action, and the entire effect of that system is nullified. Thus, it appears that in order for this part of the system to work, none of the five areas are sufficient to alter behavior but all are necessary. Under the assumption of this model it is then no wonder that "only one research study (Operation 101) on the relationship of police traffic services to highway safety was found that showed a statistically significant reduction of accidents and a sufficient control of other factors that influence accidents," (Travelers, 1970) It is also not surprising that narrow thrust programs in single areas (e.g. just "crackdowns," or just court improvements, etc.) as opposed to broad comprehensive efforts (which are rare) usually fail to dent gross accident data, especially under the tenets of this model. In spite of these dim predictions and consequences, some basic features of BDT which are demonstrated in "real-life" situations can be useful and effective in a countermeasure program.

Further elucidation of BDT reveals that there are basically at least four different models of BDT. The following figure makes this most clear.

		Probability: Objective	Probability: Subjective
cost/gain	Objective (value)	EV	SEV
	Subjective (utility)	EU	SEU

Figure 5-3 Four Behavioral Decision Theories

Each cell represents a separate theory as a function of two dichotomous variables: probability and cost/gain. Each of these can be thought of as having both a subjective and an objective part. Where we have both objective probability and objective cost/gain (value) we have expected value (EV) theory which says a person selects the behavior which has the highest EV or product of expectancy and value. Here the expectancy consists of the objective features of the probability of occurrence of an event and value consists of the objective features of cost/gain for that event. SEU however utilizes the subjective components of expectancy (subjective expectancy) and cost/gain (utility) for prediction, saying that the behavior with the highest SEU will be selected from all the choices. SEV (subjective expected value), and EU (expected utility) theory are simply combinations of the objective and subjective parts of cost/gain and probability. Thus, we have at least four models to work with.

To illustrate some differences let us examine a situation. If our driver is speeding at a certain time and point, the objective probability of being detected might be one in 500 while subjectively he may perceive and estimate the probability (subjective probability) to be one in 1000. In terms of the cost/gain of this, the actual loss in time or money (value) might be $5.00 on the average, while subjectively (utility) he may perceive this to be much higher, say $20.00 if we had to put a cost in dollars on it. Thus the EV here would be .002 x $10 or .02, the EU, .08, SEV, .01 and the SEU, .02. The intriguing thing here is that rarely does each theory predict the same outcome because of the uncertainties associated with the differences between objective and subjective probabilities and cost/gain. Perhaps this is best illustrated by mentioning some common truisms. It is well known that although the laws and enforcement on drunk driving are strict in the U.S. (objective components) most people believe (subjective) that they won't get caught and if they are caught the consequences won't really be so severe. In Scandinavia on the other hand, most "everyone" believes (even American visitors) that drunken driving will be detected and severely punished (subjective) while in fact things (laws, courts and police) aren't that severe (objective). Thus we can see a capriciousness about the subjective interpretations of objective probabilities and values connected with the traffic enforcement process.

We might then say that while most police departments, enforcement programs, etc. behave on the basis of EV theory, most drivers probably behave on the basis of SEU theory. In any case, people and programs should be investigated to see which if any of these models they most follow and if so, why? From this, research countermeasures can be designed on the basis of maximizing behavioral change from a more programmatic point of view. A final illustration of this effect would be the effectiveness of fines based on the ability to pay. For example, if everyone has the same subjective probability of getting fined or jailed as the result of speeding, but the fact that most likely the loss to very wealthy people of say $25 (utility) from a fine is less than that to people of lesser means, implies that on the basis of SEU theory, the poor man is most likely to be affected by stiff fines. Fines based on income however should equivocate SEU and therefore behavior.

To summarize then, several instances must be examined using these heuristics or paradigms. First we must consider the unsafe/illegal act under both objective and subjective models, and consider the relations between critical components. Here by critical components we mean both those elements that are ostensibly negative (acts, e.g. that endanger life and property) as well as those that are simply perceived as negative. More basically, we should investigate why there exists no necessary monotonic relationship between objective enforcement methods and subjective assessments of these policies. Pictorially,

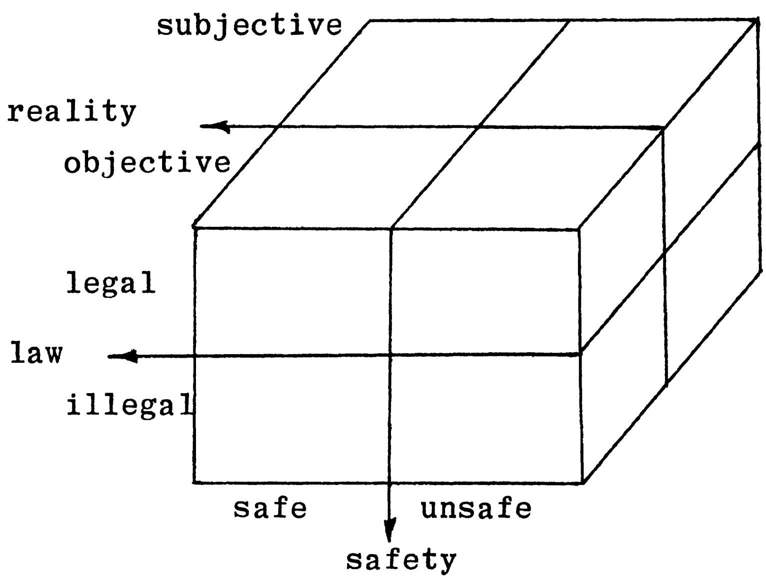


Figure 5-4 Relationship between safety/legality and the perception of acts

This matrix should be examined for both the usefulness of the four BDT models and for inherent relationships (or lack of same) between cells of the matrix. For example the two cells, safe-legal-objective and safe-legal-subjective are probably significantly positively related and would be what might be called veridical in that they represent a "true" assessment of a maximal situation. That is, people generally assess situations which are truely safe and legal as such. It would be interesting to examine any departures from this veridicality. More interesting e.g. might be the relationship between the unsafe-illegal-objective cell and the safe-legal-subjective cell. Why do some people assess unsafe/illegal acts as being safe/legal acts? More important than assessment here is the innovative uses of this paradigm. For example how do we achieve a condition as expressed in the truism about Scandinavia -- getting people to believe enforcement is more severe than it really is?

A possible innovative research/change method might be the employment of Skinner's method of successive approximation where the object of the program would be to maximize subjective estimates of loss and probabilities associated with undesirable outcomes, not knowing even one (possibly), ahead of time.

Another critical examination of our model would be to examine how drivers combine the EV or probabilities and costs from each step in the decision chain (multiple hurdles fashion, conjunctively, disjunctively, multiplicatively, how?) from detection through adjudication in making behavioral decisions in driving. This kind of examination can be carried out both at the survey level and at the individual experimental level. For example, survey questionnaires could be designed to look at changes in subjective estimates and decision rules as a function of objective changes in probabilities and values resulting from selective enforcement programs. The sequential chain in the enforcement process could be questioned here in order to examine the weak links where subjective estimates remain unaffected and unchanged. A wealth of survey and experimental techniques exist which can estimate the complexity of dynamics here. At the smaller, individual experimental level, techniques for changing subjective estimates and decision rules could be tested and examined using mass communication techniques. Utilization of phenomena that appear to have worked (but no one seems to know why) in such places as the Flint, Michigan, "402" selective enforcement program where "everyone believes" that there is a crackdown, can be reliably established for later utilization. More important cost/utility curves can be developed for assessing the relative worth of countermeasures designed to do such things as changing subjective estimates.

Now, in relation to the preceding remarks, how can we construct a programmatic spectrum of countermeasure efforts in order to jointly maximize their effectiveness in changing behavior, as scientific endeavors, and in the eyes of both the public and the people who truly provide the fiscal destiny of SCOPE? This does sound like a formidable task but it is felt that the preceding section offers several examples of guidelines, heuristics, procedures, models, criteria, etc. towards achieving these ends.

The experimental thrust of the SCOPE effort requires the unification of countermeasure programs along singular spectra. It is in this fashion that a global evaluation of the cost/benefit of the programs can be most clearly managed. More diverse additional scales of measurement may certainly be applied at the specific countermeasure level especially in the evaluation phases, but the design phase of a comprehensive programmatic experimental effort of the size that SCOPE needs requires some type of unidimensional model for cross-countermeasure comparison. Only through cross-comparison, both statistically and otherwise, can decisions be made as to the relative efficacy of any specific or general countermeasure efforts. For all of these reasons then, and reasons given in the previous section, the model which attempts to achieve a utility or cost/benefit curve (see Fig. 5-1) by relating countermeasure input (cost, effort, etc.) to output (benefit, dollars and time saved, etc.) is proferred as a reasonable guide for designing countermeasure programs. The problem then becomes one of extracting both the necessary and the best countermeasures from an extremely diverse set of existing innovative (and non-innovative), well executed countermeasures and several models and criteria for what is "best". Then the problem becomes that of embedding a subset of these countermeasures into an experimental paradigm which attempts to parametrically relate these to each other on some sort of cost/benefit basis. The first problem has been resolved by using the models and criteria of this paper and from the Interim Phase I Report to select prospective countermeasures from those compiled on the HSRI computer file of "402" programs, and other sources such as recent literature and visits to the HSB Regional Representatives. The second problem has been resolved by the construction of what might be called an additive heuristic for constructing an experimentally comparable spectrum of countermeasures. We shall describe the second resolution first.

The heuristic designed seems to maximize scientific output while minimizing the number of discrete countermeasure programs. The idea is this: construct the range of programs, from minimal to maximal efforts such that for any two contiguous programs, the one nearest the maximum program contains everything that the one nearest the minimum program contains <u>plus</u> a discrete quantum of countermeasure effort in addition. The figure below may elucidate the heuristic.

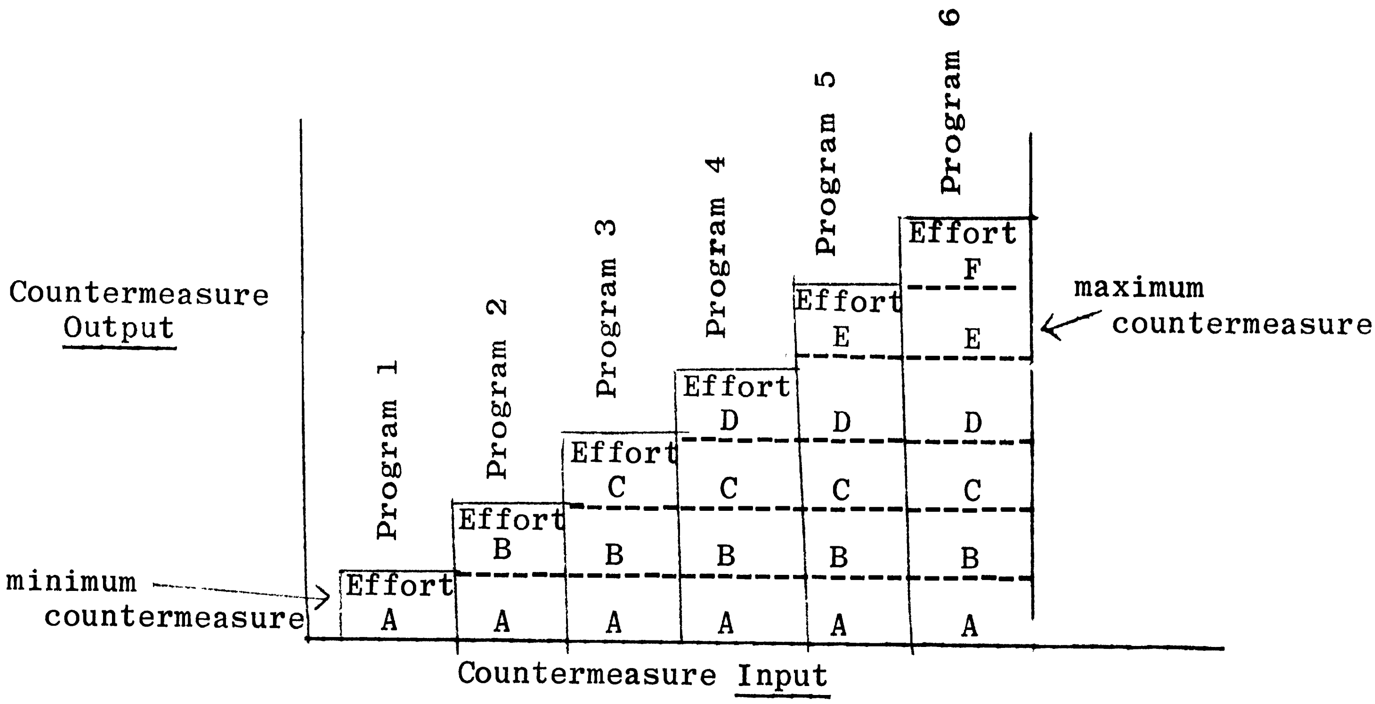


Figure 5-5 Incremental Countermeasure Spectrum

Note, for example, that program 5 contains everything in program 6, but that program 6 also contains effort F. Statistically then we could assess the differences between 5 and 6 and determine the effects of adding F to a countermeasure effort, especially on a cost/benefit basis. One undesirable loss in the trade-off between scientific maximization and program minimization is the fact that e.g. we would not know whether the effect from adding F is simply additive or is interactive with respect to any or all of the other programs or both. This does however seem like a relatively worthwhile loss with respect to the long range task. In any case, a plan for eliminating this problem will be offered later in this report. This might be called an experimental incremental modular approach to SCOPE, where experimental modules (countermeasures) are designed in incremental fashion so as to be comparable in an additive fashion. One advantage of this approach is that it embodies the SCOPE philosophy of providing a unified wide spectrum effort as opposed to a mixed bag of programs and a fractionated effort where comparability would be doubtful. Hopefully this will allow us to answer how well and why certain countermeasures work rather than just the answer to do they work? Thus, by operationalizing a continuum of efforts we can evaluate a more reliable array of results and establish a continuum of answers to such questions as "how well?" and cost/benefit.

A solution to the problem of proposing the specific countermeasures can now be presented. The interim phase I report presented the idea that the system of driver regulation embodies its relevant standard areas by encompassing police (traffic services) as the regulators (enforcers) of the system, codes and laws and courts as the regulations and their operators (judges) and alcohol as one small but important subset of the objects of regulation, (regulatees) human (driving) behavior. Using this concept, we can conceptualize our spectrum of driver regulation countermeasures, partially as a distance function between the regulation system at one end and the drivers regulated at the other. That is, referring to our figure 5-5 above, we could assume that as we move to a larger program (higher number) we are adding efforts which come closer to direct driver contact whereas efforts at the left or beginning are more distant from the driver in directness of contact and more concerned with internal features of the regulating system (e.g. allocation schemes of police manpower, selective enforcement, etc.). Another activity will help us concretize our countermeasure spectrum. From our search of the prose literature, talks with HSB representatives and searches of the HSRI computer file of "402" programs, there appear to be several discrete quanta which can help to classify and categorize most countermeasures in driver regulation into a few differentiated categories. The kinds of activities (purposely ordered) included in driver regulation programs seem to be: 1) measurement efforts where an ongoing PTS program is simply measured (usually at only a minimal level) for performance and effectiveness measures, 2) some sort of management scheme is overlaid on ongoing PTS program where things like manpower allocation and cost/benefit methods are used and innovative techniques of manpower usage are implemented, 3) training programs where present PTS manpower is trained for some advanced skills in e.g. behavioral science, management, etc. or in the use of some specific (e.g. electronic) tool, 4) manpower additions, like e.g. the Flint or California 101 program where more PTS manpower, either at or often above current training levels, is added to a PTS force, 5) equipment additions where major investments in electronic enforcement gear are made along with some minimal training effort, and implementation scheme, 6) procedural clarifications along the codes and laws dimension where streamlining, standardizing, and training occur mainly associated with optimizing usage and administration of codes and laws, as well as the implementation of new laws, 7) logistical improvements in the handling of court related problems where procedures and communications between PTS units and the courts are made more efficient, 8) media efforts, where increased communications between the public and the PTS programs are attempted and finally 9) social-individual oriented problems where commonly a system of direct contact aimed towards individual influence of problem (e.g. alcohol) drivers is implemented. Here again we can notice the directness of contact dimension between PTS and individual drivers going from nil to an extremely high level in 9. Now, we have a fairly well developed structural model into which we can embed several specific countermeasure programs.

It now becomes our job to disappoint any skeptical readers. Those readers who have been patiently awaiting a spectacularly innovative list of countermeasures one can implement tomorrow with fantastic results in (e.g.) accident reduction may expect to be disappointed. The reason for this manifold. First, it is somewhat counter to the philosophy and logic of this paper and general method to produce a set of innovative but highly divergent and therefore uncomparable countermeasures. In fact, there is an intrinsic contradiction between innovativeness and comparability which can often be a nemesis to projects such as this. Secondly, if a primary desire of highway safety is to establish some necessary and sufficient conditions for countermeasures to be effective, then the heretofore haphazard process of funding highly innovative and independent but parametrically and statistically unresolved experimental countermeasures must be altered. It is only through some interrelated experimental paradigm that relative effectiveness can be assessed and no matter how ostensibly successful some programs have appeared in the past, eventually the ultimate unanswerable question is posed asking if for the same money we coundn't have done x rather than y.

There is however no need to eliminate innovativeness at the independent variable end (of the countermeasure) we can and should be more innovative and thorough at the dependent variable or measurement end of the program (e.g. measuring behavioral and decision change variables in more detail). Large scale organizations typically will allow some degree of innovativeness at the input end (type of countermeasure) but tend to resist the dirtywork and details of innovativeness at the output end (measurement of innovative criteria). In any case, this paradigm does not prevent innovative countermeasures. It simply wishes to place them in perspective in relation to the total spectrum of countermeasures so that measures of relative effectiveness can be made. There are in fact several procedures at the Federal/logistical/fiscal end viz a viz innovative RFP procedures which could facilitate innovativeness within these programs. It is a contention of this model that innovative countermeasures developed at this end (not innovative techniques of measurement) will be more difficult to implement and evaluate than innovative countermeasures developed by prospective contractors given guidelines (e.g. our spectrum of incremental countermeasures) through some kind of amonetary competitive bidding scheme for types of countermeasures. It would indeed be wise to facilitate innovativeness at the contractor end since it appears that the most optimal PTS programs have been internally innovative rather than being procedurally accommodative toward externally developed countermeasures. Moreover, if programs are to be minimally obtrusive to local PTS agencies and their communities then self-generated countermeasures and procedures in general should be maximized. That is to say, these programs should not be pre-packaged but each contractor should be urged to be innovative within as minimal a set of logistical and methodological guidelines. Otherwise, if these programs are ineffective, it will be impossible to detect whether they were ineffective because of the organizational problems of the contractor or because of the inherent failure of the countermeasure. The failure to foster the spirit of internal organizational motivation or "commitment" due to the obtrusiveness of federal requirement will certainly spell doom for the effectiveness of such a large scale scientific effort.

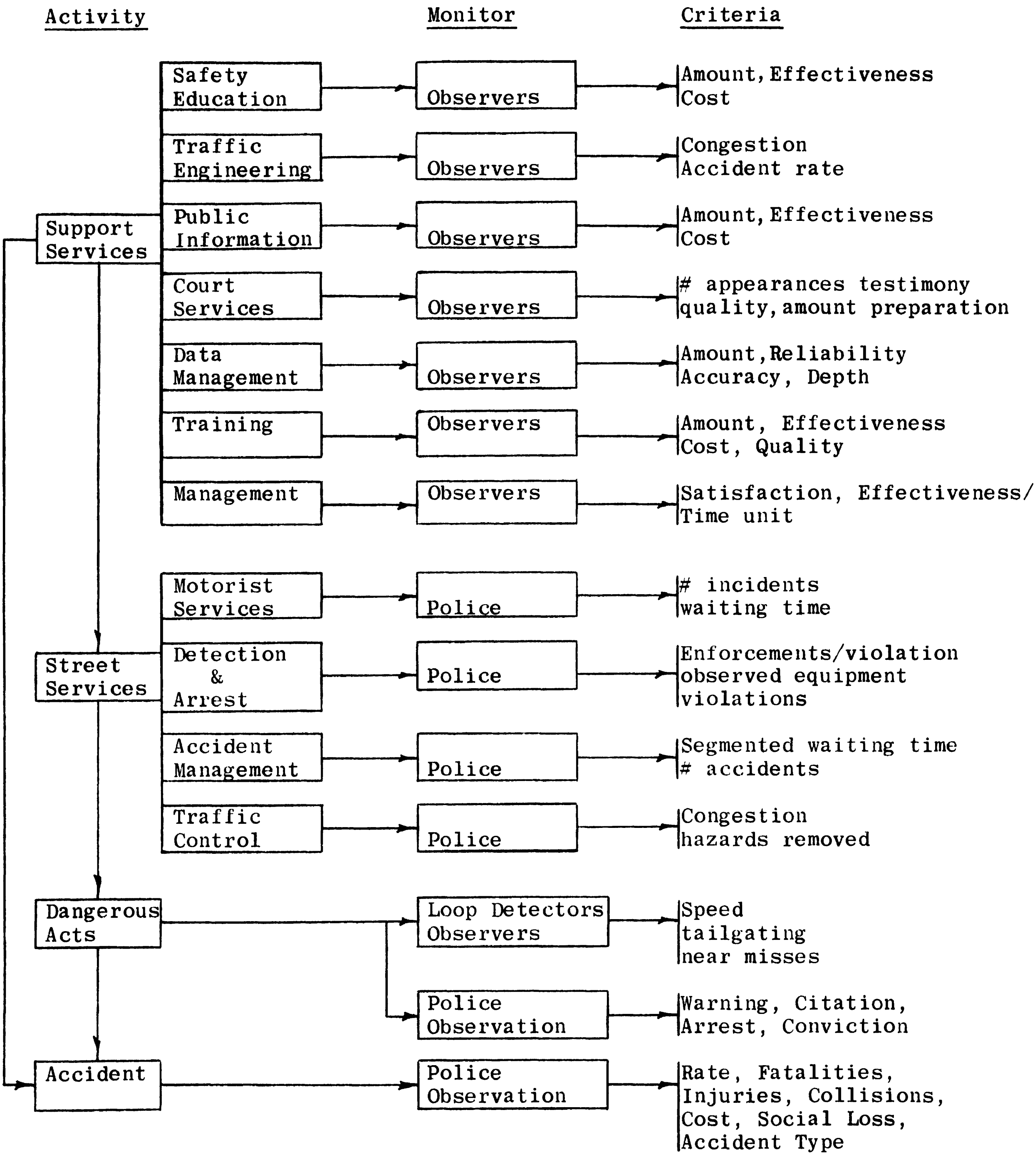
Here, then, are some more concrete suggestions for the dimensions of specific programs. There appear to be at least ten discrete steps in our countermeasure spectrum which generally follow our earlier listing of the nine traditional types of countermeasures. The ten programs should, according to our logic up to this point look something like these:

1) Measurement of a low or moderate level on-going PTS system. No manipulation should be attempted and a minimum of obtrusiveness should be employed. A suggested mechanism here would be to either train a present member of such a system or to insert a highly trained (e.g. policeman) member whose job would not appear to be that of measurement. The task would be to utilize a maximum amount of data with little or no disruption. An example of the types of extensive measurement possible in all of these programs is given below in figure 5-6.

Time: 3 yrs.
Size: Small to Medium City (75-150K)
Cost: 25-50K/year

2) Same as 1 except find a high-level PTS system to measure. Incidentally, the "level" of a PTS system refers to a number of things including any available measures of effectiveness, especially those not generated by the parent system, reputation, unusually low accident statistics, etc. Both 1 and 2 should be places where little or no Federal funding has occurred in PTS but the city for 2 should have a good reputation for PTS effectiveness. Reasons for 1 and 2 are to not only provide a baseline or zero-point for measurement but also to provide any clues to self-generated innovative techniques of driver regulation. Measurement facilities for both 1 and 2 should be local agencies for maximum effectiveness and yet minimum obtrusiveness. The Hawthorne effect must be guarded against in any case.

Time: 3 yrs.
Size: Small to Medium City (100-200K)
Cost: 25-50K/year



PTS Activity/Agent/Criterion Chart
Figure 5-6

3) A management countermeasure scheme where an on-going PTS service is optimized with respect to management properties such as leadership effectiveness, manpower allocation and utilization, job satisfaction, etc. This countermeasure in a sense asks the question "what can the most internally effective organization do for driver regulation?" Also, innovative assignment schemes such as selective enforcement, special units, etc. would fall under this category. Needless to say, 3 includes the measurement done under 1 and 2.

Time: 3-4 years
Size: 100-200K
Cost: 100-200K/year

4) Training countermeasure of the sort where a PTS system is "tooled up" for a broader system of driver regulation. This would include both on-site and remote training in behavioral science, statistics, measurement and computer methods, management science, law, electronic technology, etc. An ideal sort of thing here would be for the NHSB to have some people develop some self-contained self-instructional multi-media packages of instruction (e.g. video tape) in some of these skills at a moderate cost and test them as part of this countermeasure. Each package should not cost more than say 15-25K to develop, possibly less. Most of the cost here would be for "release-time" as opposed to the actual cost of the instruction. On site instruction would thus minimize cost and therefore a $150K bureau investment in say 5 to 10 package would net a large "release-time" savings.

Time: 1-3 years
Size: 100-200K
Cost: 100-250K/year

5) Manpower increases especially at the management level. This would include the addition of highly trained officers (e.g. in behavioral science, electronics, management science, education, etc.)

for both increased enforcement and other innovative applications. Again, using our additive scheme, 4 would include the features of 3, 2, and 1. This would be something like the Flint, Michigan, program mentioned earlier.

Time: 3-5 years
Size: 100-250K
Cost: 100-300K/year

6) Equipment additions countermeasures would consist more or less of the standardized equipment purchase (e.g. Vascar, videotape, breathalyzer) and training (as in 4). Here again 6 would include the features of 1 through 5.

Time: 3-5 years
Size: 100-250K
Cost: 100-350K/year

7) A procedural countermeasure in the adjudication process would include things like streamlining of PTS usage of the codes and laws, standardization of procedures relating to the codes and laws, training with respect to usage of both old and new codes and laws and innovative application of present code. Again, this would include 1 through 6.

Time: 3-5 years
Size: 100-250K
Cost: 150-400K/year

8) Logistical countermeasure efforts here would consist of procedural and communication streamlining in the handling of court related activities as well as the innovative use of and improvement of police/court relationships. This would include 1 through 7. Such things as special court units, punishment mechanisms, behavioral modification, etc. would be relevant here.

Time: 3-5 years
Size: 100-250K
Cost: 150-500K/year

9) Communications countermeasures would include especially things like relating PTS functions to the community at large using mass media techniques, public relations efforts through existing organizations, etc. Innovative techniques here might be things like regular TV feedback of bad intersections or things the police are doing, regular newspaper columns, etc.

Time: 3-5 years
Size: 100-250K
Cost: 200-600K

10) This last countermeasure would be what might be called a super countermeasure in that it includes everything before it but adding the effort on social-individual problems. Things like alcohol programs, sociopathic drivers (habitual speeders, etc.), problem drivers, etc. would be tackled here at a person to person or person to small group level. An ideal site here might be an ASAP city where SCOPE might take advantage of an ongoing alcohol activity. Innovative techniques such as a social problem driver unit might be usable here. Again, this massive program would include efforts 1 through 9.

Time: 4-7 years
Size: 100-250K
Cost: 400K-2.0M/year

We have now then more fully explicated our spectrum of countermeasures. A few comments should shed some more clarity on the program here. We again note the paucity of a mass of singularly innovative set of countermeasures. To repeat, it is the philosophy of this paper to <u>first</u> ascertain the effectiveness of traditional countermeasures using a more extended set of measurements and then to assess the usefulness of some so-called innovative countermeasures with the baselines established by the first effort. Another point in this program should be to take advantage of existing programs (e.g. ASAP) for economy purposes so long as they do not <u>endanger the</u>

effectiveness of the experimental aspects of the programs. Further, large programs may appear less obtrusive to the contractors if this technique is used. Also, cost of evaluation should be lessened if local agencies have already tooled up and had experience in this area. Another aspect that would be wise to consider here would be the use of local evaluation agencies whenever and wherever possible. This agency should act in conjunction with a global agency whose task it would be to coordinate uniformity and completeness among all of the SCOPE programs. Since the measurement effort would increase with program size, the global evaluation agency would have most consulting and contact with the largest programs. Such an agency would also serve to independently insure the effectiveness of the measurement effort in all of the programs, the critical and necessary feature of this proposed experimental effort. Finally, without sufficient data analysis and communication facilities both within the contracting organization's facilities and between the contractor and evaluators, an experiment of this size will be impossible. The reader is urged to consider the ideas offered in section 3 of this report under "Information Flow Program" for the details of this necessity.

In addition to the incremental modular proposal for ten experiments as just described, another set of at least 8 or possibly 10 experiments should be conducted. Although this is mentioned separately (mostly for fiscal reasons), it should be conducted simultaneously for experimental purposes. The experiment would be to conduct each one of the efforts added at each of the phases of the 10 experiments but in isolation. For example, in addition to the 10 incremental experiments, conduct a manpower increase only, an equipment addition only, etc. for each of the 10 efforts. This would be fairly easy to do (since it is what has usually been done under "402" monies) and can be done for about 30% of the total cost of the 10 additive experiments. For such minimal costs, the experimental advantages are great. Primarily, it will then be possible to determine whether any change in effectiveness or benefit from the addition of one quantum of effort was due to simply the additive effects of the program and/or to the interaction between the program and the others already existing. The usefulness from a cost/benefit point of view is enormous since it is most probable that it is a conjoint or interactive effect when existing PTS programs are increased or tooled up in some way.

The interim phase I report carefully explicates three models: police traffic services, courts and codes and laws, and alcohol. These detailed area reports can and should be used as guidelines in our suggested extended measurement process for the driver regulation area. Also, using the generalist tradition of this project, the area of driver regulation should really read "people" regulation since we are also concerned with non-driving behaviors as they affect the driving process. One extensive programmatic effort directed towards behavioral and decision making formation and change is suggested in the people preparation phase of this report. In one sense, the main distinction between the two models is that people preparation is oriented toward a population which is either not yet engaged in driving behaviors or has been temporarily removed from the road, while people regulation has to deal with on-road behaviors as a focal task. Because this distinction is merely useful in a formal sense, these two efforts will have many tasks and methods in common and as such should capitalize on each other to the advantage of SCOPE. The reader is referred to the people preparation description in this report (section 4) for a more complete discussion of these similar methods and approaches to the problem.

To summarize, several guidelines are suggested for maximizing SCOPE in the area of people regulation:

1. Distinguish between objective and subjective criteria and establish relationships between the two for all measures (e.g. visibility (subjective) vs. enforcement (objective)).
2. Extend and broaden measurement into more domains of driver regulation using (e.g.) the general traffic system model. Measuring things other than accident statistics such as driver errors, critical events, headway, traffic flow distribution statistics, police efficacy and efficiency measures, hardware and manpower utilization, etc. would be advantageous
3. Moving from macroscopic to more microscopic measures of human preformance using bayesian analysis, behavioral decision theory, signal detection theory and modern learning theory is suggested.
4. Using advanced techniques of scaling such as non-metric, multidimensional, and other recent developments of mathematical psychology in order to develop standardized techniques of measurement at the driver level.
5. Utilization of advanced statistical techniques such as multivariate analysis of variance, discriminant function analysis, path and cluster analysis, multivariate nonparametric analysis and other recent computational tools is suggested for analyzing the aforementioned spectrum of measures.
6. Application of more sophisticated techniques of survey research methodology such as cluster sampling, stratified random sampling, representative sampling and associated technological advances such as optical character recognition of questionnaires and telephone surveys should be utilized in order to minimize the cost of the abovementioned program of expanded measurement of behavior.
7. A twofold approach to change and measurement should be used, where for each large scale attempt at change and corresponding survey of results, there should be an analogous intensive fully experimental operation on a small group. This type of parallel operations

approach to countermeasures can ascertain with a fuller degree of certainty whether the countermeasure succeeded or failed because of the basic concept, or because of the level of intensity and/or operational problems.

8. There should be a complete implementation of techniques of quasi-experimental design (c.f. Ref. 5-7) in resolving the relative failure of traditional more rigid statistical/experimental approaches to answer any broad scale highway safety problems.
9. The use of repeated measure experimental design to capitalize on data and establish more reliability for findings should be advanced given the difficulty to construct fully controlled experimental designs.
10. A unified single dimensional programmatic approach to the entire set of experiments should be taken in order to be able to compare results across experiments and establish cost/benefit curves. For example, the incremental additive approach discussed in parallel with the isolated comparison unit method could achieve this end.
11. Non-obtrusive programs using non-obtrusive methods of measurement, both with respect to the agencies (e.g. police departments) and the people (drivers) involved should be utilized in order to maximize the effectiveness of the respective countermeasures.
12. Innovative scheme of bidding, RFP's, design competition, contractor guidelines, and fund allocation should be used in order to more fully utilize the resources of the prospective contractors. Such devices as proposal funding and limiting funds by area within each program so that a contractor can spend only up to x dollars on effort B, y dollars on effort C, etc. of his total program could, if employed correctly, maximize utilization of funds within efforts and help to establish cost/benefit guidelines more easily. This method in conjunction with a dynamic allocation scheme where a contractor need not spend the maximum allocation to effort B but may spend some of that money on effort C, so long as he does not spend below some minimum specified for effort B, would further maximize the contractor's capabilities. Finally, rapid feedback by evaluation agencies to the contractors of cost/benefit parameters could further maximize change.
13. Along the lines of the above suggestion, non-traditional approaches to experimentation and analysis such as sequential experiments using Bayesian analysis could answer the hypothesis without employing the traditional

isolation of results from the experimenters during the experiment.

14. Providing prospective and actual contractors with a "grab-bag" of detailed countermeasures applicable within their specific contract could also foster innovations and maximization of local capabilities.
15. The concept of having local evaluation agencies where possible, including internal agents such as policeman trained in experimental/statistical methods under the coordination and observation by a global evaluation agency (who will coordinate most of the SCOPE evaluation efforts) can help insure minimal obtrusiveness but maximum effectiveness in meeting contractual obligations.
16. A great deal of effort should go into complete explication and definition of the myriad of contractual and informal relationships (see fig. 5-2) between all people and agencies involved, wherever possible. This can range from personal introductions of members of staffs having working relationships to broad scale PR efforts. Much effort should go into legitimizing SCOPE in the eyes of police agencies, like e.g. IACP. One special mention is made of the PR effort in that the importance of ostensible success is usually crucial for both politico/social reasons as well as experimental reasons and therefore careful utilization of self-fulfilling prophecies, proselytizing, informing the public of the scientific value of the experiment, etc. can help to avoid negative socio/politico consequences due to non-significant or non-obvious but nevertheless valuable results. Caution should be taken not to enter into "guaranteed" non-productive political or social environments for experiments since the science of highway safety is still not strong enough to handle these additional burdens. In any case it would be good indeed to have more programs like the Flint, Michigan program.
17. Priorities should be placed on first examining traditional countermeasures from a cost/benefit point of view before venturing too far into an apparent endless stream of "innovative" countermeasures.
18. The driver should be examined as an information processor/decision maker having certain threshold and limits and any set of countermeasures should be examined from (e.g.) a cost/benefit view with respect to the driver's task. That is, we must ask such things as, "are we overlooking the driver's abilities with all of these programs and behavioral modifications?" We must utilize the capabilities of the driver but be careful not to overload them.

19. For fiscal reasons at least if it is not experimentally intrusive, ongoing safety programs should be utilized and SCOPE programs should be overlaid on these programs whenever possible.
20. Basic logical necessities should be examined regarding each SCOPE effort:
    a) causation vs. correlation - do we have necessary and sufficient conditions for X to cause Y?
    b) internal consistency - do we have stable measuring devices and how stable are they?
    c) reliability and validity - how repeatable and how "real" are our experimental effects?
21. Examinations of the decision making of drivers should be made in light of recent evidence showing the relative efficacy of positive rewards over negative. Can we structure positive reward systems instead of traditional cost systems and how would this affect performance? How well does deterrence and legal sanction with respect to changing driver behavior?
22. More detailed examinations of socially caused driving errors from the point of view of risk taking, sociopathic behavior and special social problems such as alcoholism, poverty, etc. should be carried out with intensive survey or interview methods. Driving must be rocognized as social behavior!

6.0 Vehicle Regulation

Vehicle Regulation comprises the set of traffic system actions that are directed specifically toward the vehicle in order to produce an improved safety measure at the information system output. Although this should properly consider design defects and new manufacturer produced safety modifications, our principal concern lies with the sixteen standard areas and consequently with the inspection, and in general, the regulation of vehicles that are currently in active use by the motoring public.

Thus our principal concern in vehicle regulation is the reduction of defective vehicle components in the population that contribute to the accident generation process. The hypothesis is that degraded component condition reduces vehicle performance which in turn enhances the probability that the vehicle will be involved in a crash. There exists a limited amount of scientific evidence which supports this hypothesis, but studies to date have suffered from a number of methodological and statistical problems which results in conclusions that are not fully substantiated. It is quite reasonable to assume that vehicles with bald tires or broken brake lines will be over-involved in accidents, but as yet no information exists on the degree of over-involvement. No one has predicted with precision what the effect on the accident rate will be of reducing the frequency of bald tires in a particular jurisdiction from 14% of the vehicles to 5% or the effect of reducing the frequency of broken brake lines from .1% to .001%.

Several standards apply to vehicle regulation. The principal directive comes from Standard Area One, Periodic Motor Vehicle Inspection, which requires that at a minimum every state conduct an annual inspection of all vehicles in its jurisdiction. Standards Area Three, Motor Cycle Safety, also involves vehicle regulation by prescribing certain specific features of inspection for motor cycles.

The proposed youth transportation safety standard would detail vehicle regulation activities pertaining specifically to school buses. School bus inspection currently is subsumed under Standard Area One.

In addition to the inspection-related standards, the vehicle-in-use program of NHSB influences strongly the vehicle regulation area. It can be expected that further standards (or modifications of existing ones) will be promulgated by the Highway Safety Bureau covering a wide scope of activities including minimum performance standards for the vehicle-in-use population, certification and performance standards for automobile maintenance personnel, and a system of owner records and information sources to assist the owner in proper maintenance practices.* Elements of the legal system also enter the vehicle regulation area through the enforcement of defective equipment regulations by the police and courts.

No detailed review of current inspection programs is presented. At latest count, some 33 states have motor vehicle inspection programs for all vehicles, and another seven operate random vehicle checks. The balance of states have either no inspection program or inspections for a limited class of vehicles only. The inspection programs differ among states in the number of components checked, the frequency of inspection, and the method of organizing inspections. The recently released report of Northern Research and Engineering Corporation contains an extensive discussion of the differing state programs, and this effort will not be duplicated. (Ref. 6-4).

Examination of the "402" projects discussed in chapter nine of this report indicates some 56 projects in the motor vehicle inspection area. Most of these projects are of a relatively small

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* Vehicle standards represent a separate NHSB activity distinct from the State Program Standards.

size and have centered on planning and implementation problems for specific states, training of inspection personnel and supervisors, and budget support for continuing PMVI programs. Three evaluation programs have been funded, two in North Carolina and one in New Jersey. The earlier North Carolina study (Ref. 6-5) contained a description of inspection statistics gathered from inspection reports and related failure rates for specific components to such items as vehicle mileage and age. The second North Carolina study (Ref. 6-6) attempted to relate incidence of accidents to recency of inspection as inspection was introduced in the state but failed to demonstrate any significant relation. No information has been received on the New Jersey evaluation.

Tennessee, the only state with an approved experimental program, has invested a large amount of funds in their projects. The program is continuing at present and no reports have yet been formally published. The current programs in the state include a semi-annual municipal inspection in Memphis, an annual municipal inspection in Chattanooga, and a recently abandoned municipal program in Knoxville. The evaluation program includes an examination of the inspection procedures used in the various city lanes, a survey of vehicle owners' attitudes toward inspection, a survey of garage owner's ideas concerning a state appointed inspection system, and a review of accident investigator's experience with and belief about defective vehicles in accidents. (Ref. 6-7). Tennessee may offer a prototype for the experimental program to be outlined below since it contains a variety of inspection systems, past, present, and potential, in relatively homogeneous but geographically isolated cities. Furthermore, a data base on inspection experience and a preliminary evaluation of the inspection program already exist.

In establishing vehicle regulation two major parameters are of concern to the decision maker: The first parameter is the minimum acceptable level of component performance. While a limited number of vehicle components such as lights and certain mechanical linkages, fail in a binary fashion (burning or out, solid or cracked), many items display a continuous degradation with age and mileage from their original performance levels. Inherent in any vehicle regulation scheme is a plan to establish tolerance limits for the particular components. In such a program, components which fall below these limits would fail inspection and replacement is required. The cost and effectiveness of a vehicle regulation program is quite sensitive to these tolerance levels. Establishment of low levels will lead to a quite economical program which may be easy to administer since only extreme cases need be sought; but such a program may not be effective in preventing accidents. For example a tire standard might require that tires shall not be showing cord on the tread surface or conversely require 6/32 of useable tread (a figure triple the current standard). The second parameter is the tolerable number of vehicles displaying out-of-specification components. In a given, fixed population, of course, the number of sub-standard vehicles will be a function of the acceptable level of component performance. Clearly, if the performance levels are increased suddenly, the number of out-of-specification vehicles will increase. The tolerable number of such vehicles therefore determines the severity of the inspection program necessary.

Due to the possibility of choosing enforcement (or acceptance) levels a number of possible regulatory approaches are possible with each yielding a distribution of vehicle defects. Figure 6-1, illustrates the concept nicely. The ordinate represents the proportion of the vehicle population exceeding a particular performance level while the abcissa represents level of performance. The curves, r_1, r_2,...,r_n, represent potential regulatory policies.

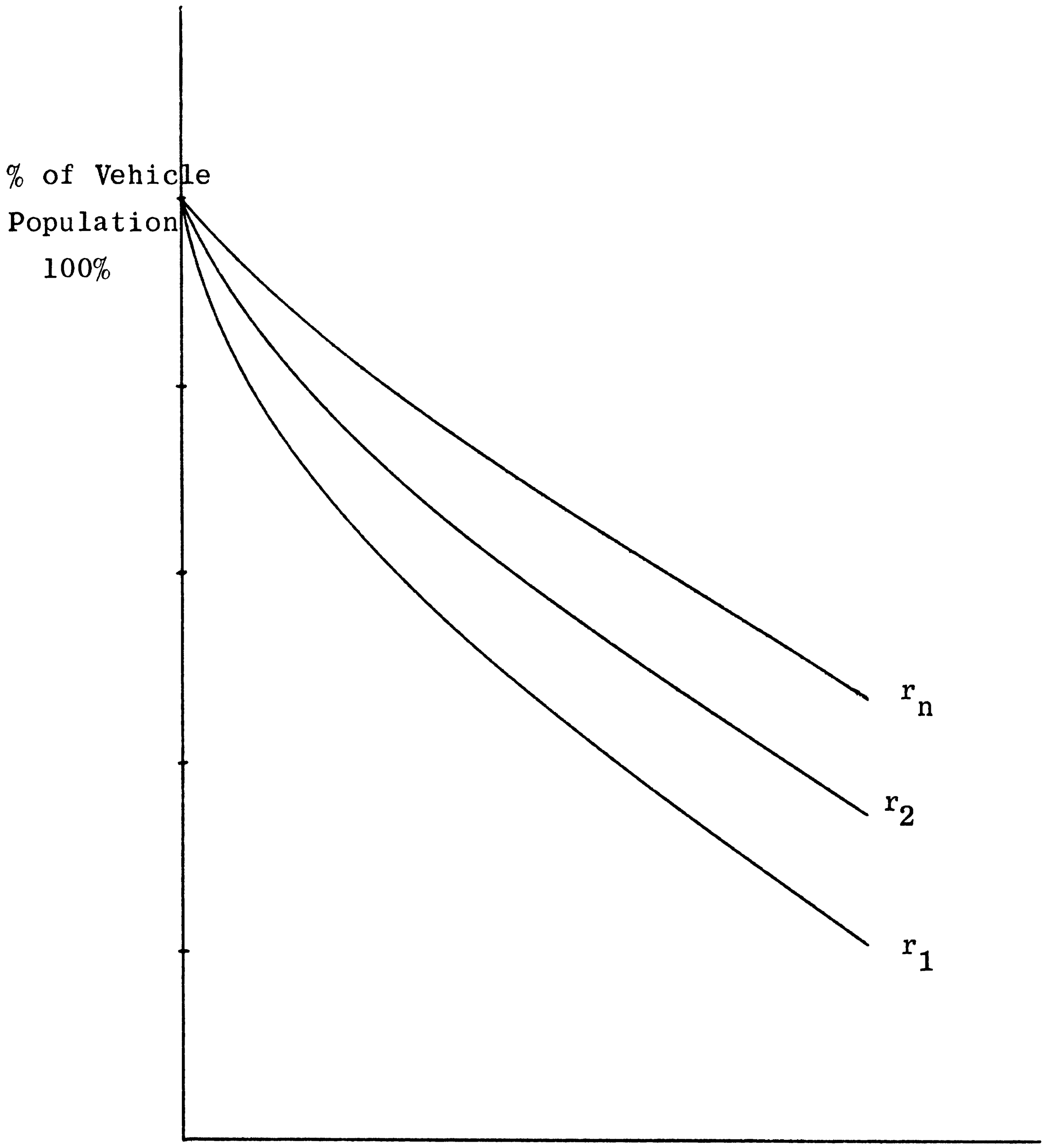

Figure 6-1

Interaction between levels of performance specified, regulatory policies followed and percent of vehicle population meeting specified performance standard.

In establishing vehicle-in-use regulation the decision-maker selects a performance level which he considers to be desirable and also establishes a regulatory policy to insure that a certain proportion of the vehicles meet that performance level.

Costs associated with the vehicle maintenance scheme may include higher initial investments in vehicles, more frequent and extensive repairs of component systems, increased levels of enforcement to insure compliance, and a greater investment of owner's time in complying with regulations. Such costs in all likelihood will increase with both the level of performance and the level of compliance demanded. None of these costs are easy to measure, and frequently some, particularly owner's time, are overlooked in designing vehicle regulation programs.

Benefits of a vehicle regulation program are even more difficult to assess. They may include improved vehicle life-time, reduced long-term maintenance problems, increased owner peace of mind, and reduction in accident frequency. This last benefit will be discussed in more detail below. Even the more mundane question of improved vehicle life-time has some serious problems in evaluating consumer time preferences. A 5% increase in the price of a vehicle to yield a 10% improvement in effective lifetime say from ten to eleven years, may not be viewed as worthwhile to the consumer who often currently values events three years in the future as being worth only 59% of their future value. (Discounting at 18% annual interest rate compounded monthly).

For more immediate purposes, the object of a vehicle regulation program might be to reduce the frequency of vehicles displaying defects. The defects would be defined on the basis of competent engineering judgement as to what level of degradation represented a level at which operation would become unsafe.

The ultimate goal of the vehicle regulation program would be the reduction in accident frequency associated with defective vehicles to the point at which additional gains in accident reduction no longer outweigh the additional costs of attaining increased vehicle performance. This corresponds to a critical point on the utility--application level curve discussed earlier.

6.1 Sub-System Model

In order to more clearly define the relationships between PMVI and accidents, we offer the conceptual vehicle regulation model shown in Figure 6-2. To develop a capability for predictively determining the effect of inspection on accident, injury, or fatality rates it is necessary to evaluate a series of unknowns. We must first determine how, and to what extent, vehicle inspection affects the mechanical condition of the operating car population; then, if mechanical condition is improved, we must determine how, and to what extent this improvement actually affects vehicle performance (man-machine interaction); and finally, if performance is improved, we must determine how and to what extent, that improvement affects the safety effectiveness measure.

Our model considers three major elements as determinants of the defect frequency. These elements are owner repair practices, component life-times as measured either in terms of miles driven or chronological time, and some form of motor vehicle inspection. The frequency of defects in turn influences vehicle performance which affects the accident generation process as shown in Fig. 6-2.

The frequency of defects can be easily summarized by the relationship shown in equation (6-1),

$$F_d = \frac{T_r - I}{T_r + T_f - I} \qquad (6\text{-}1)$$

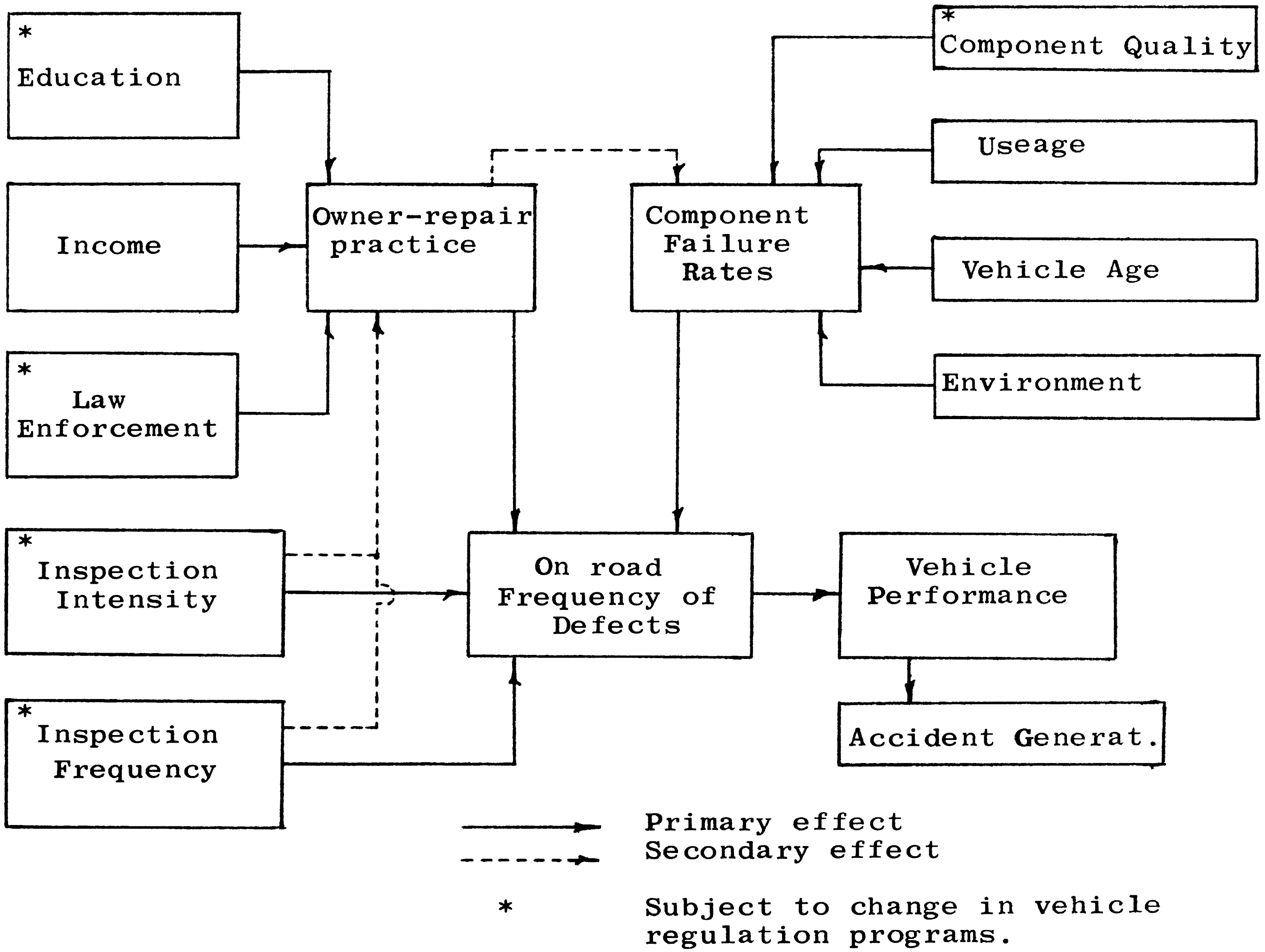

Figure 6-2
Vehicle regulation subsystem model.

where T_r is the owners mean time to repair a defect, T_f is the mean time to failure, and I is the expected reduction in time to repair due to inspection. Equation (6-1) represents a highly simplified version of the exact model (See Ref. 6-1). Vehicle regulation can affect each one of the variables in this relationship in a number of ways.

There are several inputs which determine the owner's repair practice. These include his level of income, his attitude toward vehicle performance with respect to safe operation, his level of information concerning vehicle defects, and his concern with law enforcement activity directed toward vehicle defects. The last two elements are in some ways outputs of the driver preparation and driver regulation sub-models respectively.

Mean time between failures is also subject to a number of inputs. These include vehicle age, environment, vehicle usage, and manufacturing quality. Manufacturing quality is subject to direct control by vehicle regulation through the establishment of minimum performance standards and establishment of minimum mean failure times.

The final input to the frequency of defects is the inspection program operation. This inspection program has two major parameters. Its frequency of inspection and its efficiency in detecting particular defects. The effectiveness of inspection in detecting and repairing defects depends also on the frequency of failure and the rapidity of owner repair. Evidence exists, and modeling suggests (as reported in the reference above), that inspection has little effect on those components which fail rarely and are fixed rapidly and has strong effect on those components which fail rapidly and are repaired slowly.

A few other interactions between owner practice, failure rate, and inspection have been hypothesized. First, that improved owner repair practice will improve component life-time through the value of preventative maintenance. A converse of this is that improved vehicle reliability might reduce owner's attentiveness to vehicle condition until some disastrous failure occurs. A third hypothesis is that some owner's may delay repairs until inspection time with the attitude that "I'm going to have to get this fixed then, so why do it now." Conversely, having been reassured that the vehicle is in passable condition, the owner may not be as attentive to defects after inspection and thereby increase his time to detect and repair defects. Little evidence to test these hypotheses exists but one recent study of owner maintenance practices lent some support to the later two. A certain number of individuals reported (2 - 18% for various components), that they repaired defects for state inspection, but not on their own initiative. Individuals living in inspection jurisdictions also displayed somewhat more limited knowledge of the classes and consequences of certain forms of degraded vehicle performance. (Ref. 6-2).

The links of the model from vehicle condition to vehicle performance and from performance to accident generation are poorly defined at present. A limited number of studies have been conducted on the effects of various component failures on brake performance, skid control, and tire durability. These studies have established certain tolerance limits for particular component parameters, but knowledge is far from complete in this area.

The connection between performance and accident generation is even less well known. Some studies have attempted to link the existence or non-existence of inspection to differences in accident fatality rates, but their statistical validity has been questioned by a number of authorities. Detailed accident investigations have yielded considerable evidence that particular defects lead to particular accidents, but have not systematically related the results to the frequency of similar defects in non accident involved vehicles.

6.2 Countermeasure Description

Specification of countermeasures in the vehicle regulation area centers on one primary problem: How to achieve the same results as can be expected of annual inspection of all motor vehicles by alternative means. This requirement currently appears to be a fixed feature of the highway safety plans and indeed is mandated by the National Highway Safety Act. Furthermore, inspection is an established program in a number of states, and continuing pressure is being applied to states which do not have an inspection program to adopt one. Any possible range of countermeasure activities in the vehicle regulation area may consequently be constrained by the inspection requirement.

If vehicle regulation is constrained to include annual inspections, a number of alternatives can be explored. First there are a number of differing administrative arrangements for conducting inspection centering on either state-run facilities or on state-appointed private garages. Current efforts by the Bureau are being made to determine the effectiveness of these alternate forms of inspection. Within the two forms further exploration, by study of existing systems, can be made to determine the effects of various levels of inspection intensity, number of components checked, specifications used, and inspection frequency. Planned future implementation in this area includes specification of standard performance criteria and inspection techniques for vehicles in use. These standard procedures could be compared with the results of inspections under current criteria to determine that the standard criteria are effective in further reducing defects in the vehicle population. Such measurement programs have been conducted with regard to particular aspects of inspection and continued measurement and evaluation could form the core of analysis of future implementations in the inspection area. In brief, the current program of the Bureau could be used as a guide for implementation and experimentation and with appropriate measurement techniques, the effectiveness of this program could be verified.

A number of alternative approaches do exist however, and a reasonable approach would be to consider these alternatives along with the improved standards as currently planned by the Bureau. Such programs might center on the improvement of owner repair practices through increased education and enhanced law enforcement of vehicle defect regulations. Requirements that the owner maintain vehicle logs or service records and that someone supply him with better consumer information may also improve owner repair practices. The effects of improved component reliability, as proposed by the Bureau, could be evaluated separately from the effects of inspection, and/or a program to improve owner maintenance practices. Ideally, the research would benefit if a number of alternative programs were operated in parallel, and the alternative programs were compared for relative effects while controlling on such factors as vehicle age, owner characteristics, mileage exposure, and environment.

Several alternatives exist for such a series of programs. These include 1) do nothing, 2) a limited voluntary inspection program such as has been proposed in Wisconsin with some rigorous random auditing of individual performance, 3) a random check lane program with perhaps two levels of intensity and probability of being checked, 4) a low intensity periodic program for all vehicles in a jurisdiction, 5) a high intensity periodic program, and 6) the full program as currently outlined by the Bureau. Some of the alternatives outlined above could be applied in some combination such as a type 2 program for periodic maintenance along with a type 6 program for regular inspection. There also exist possibilities for the combination of regular periodic inspections and a spot check program. Within each of these alternatives, measurements could be conducted on a before and after basis by examining the condition of vehicles over a period of several years to observe both short-term effects of the program and the longer term impact as vehicle owners adjusted to the new system on a permanent basis. The effort could be combined with a program to measure the effect of degraded vehicle component condition on accident involvement.

6.3 Measures of Effectiveness

Measurement can be conducted in three possible ways, and the ideal program would involve a combination of all three. The three alternatives are spot checks of vehicles on the road for defects, and/or observation of vehicles without stopping for certain visually obvious defects such as lights and glass defects, examination of inspection statistics themselves, and a diagnostic sampling of vehicles from the vehicle population. Each of these measurement techniques involves some problems and can yield valuable information.

Street checks of vehicles can provide a relatively inexpensive means of checking on the condition of many components. The sampling, if properly done, can in some sense be self adjusting for exposure since those vehicles which produce the greatest amount of mileage have the highest likelihood of being stopped by the spot check. One difficulty is that field operation may not provide either the necessary equipment or consistency of measurement available in a controlled garage. Furthermore, such measurements may be extremely sensitive to site selection. One HSRI project discovered a 100% variation (between 20% and 40% light outage) in vehicle defects between two observation points three miles apart on the same thoroughfare. (Ref. 6-3).

Use of inspection statistics, (in the case of a spot check program this would be the same as above) offers some potential for evaluating the effectiveness of inspection. When inspection is a required program, a comprehensive picture of the vehicle population's condition can be obtained on a regular basis, such programs do not have the problems of sampling biases that creep into other forms of measurement. However, inspection statistics must be used with caution since they do contain two possible sources of error. First they may reflect a fix-before-inspection phenomenon which masks the true condition of the vehicle during the service period. Second, there may be wide variations among different inspection facilities on the inspection criterion used and the severity of the inspection in detecting faults and forcing their repair. This may be true even with uniform inspection standards that are reasonably enforced upon the inspectors.

Sampling of the vehicle population along with diagnostic inspection of the vehicles selected represents the purest form of measurement. In this technique, a random sample of vehicles can be drawn from the vehicle registration rolls and the vehicles can then be located and inspected. This technique provides both uniformity of measurement and potentially unbiased data. Unfortunately securing co-operation of a large number of vehicle owners in the project may be time consuming and quite costly both in terms of man power necessary to secure participation and in necessary inducements to obtain a representative group of vehicle owners.

The relationship between vehicle regulation and accident reduction is the most difficult problem in the entire area. No simple solutions exist at present. Several studies which have been conducted indicate that particular types of vehicle defects contributed to particular types of accidents. On a slightly different scale, examinations of involvement rates have attempted to show that older vehicles are over involved in accidents. Unfortunately, these studies have floundered as a result of inadequate mileage exposure information. Investigations have been of limited scope due to the high expense of detailed accident studies, and these studies are constantly plagued with the often insolvable problem of reconstructing vehicle condition after an accident in which many of the vehicle sytems have been damaged severely. An adequate program to perform a correlation of vehicle defects with accident causation would involve not only detailed accident investigation, but also studies of the defects in vehicles of similar characteristics with respect to defects, make, age, and exposure to provide a comparative base of information. One useful approach in conjunction with evaluating the effects of a vehicle regulation program on mechanical condition would be to use the base data to identify particular problem classes of vehicles. The accident involvement of each class relative to the general vehicle population could then be investigated on an exposure adjusted basis. Statistical results could be verified by examining accidents involving that particular class of vehicles to confirm whether accident involved members of the group displayed the same general defect characteristics.

A final approach to measuring countermeasure effectiveness might be surveys of owner maintenance practices to see how the introduction or continuation of a particular program has changed their practices. This is an essential element since the success of any program to regulate vehicle performance depends to a large extent on the voluntary participation of vehicle owners. If a program has negative effects on voluntary maintenance, much of its effect will be vitiated. It is even theoretically possible that a poorly constructed program could have such a strong negative effect on owner practice that the frequency of defects in the population could increase. Hopefully though, the program will be constructed to enhance rather than detract from owner practices.

In measuring effectiveness of vehicle regulation, some distinction must be made between a laboratory and a social setting for experimentation. It is not profitable to solve certain engineering problems in a social context nor is it possible to solve social problems in a laboratory setting. Several problems involved in vehicle regulation are of an engineering nature. The links in the model involving vehicle component failure as a function of environment and useage are most tractable in a laboratory setting. Determining the effect of degraded component condition on vehicle performance also requires detailed controlled laboratory experimentation. Conversely, such elements as owner repair practice, the effects of inspection on repair practice, and the effects of altered vehicle performance on driver behavior may only be observable in a social setting. Determining the complex interactions among driver behavior, vehicle performance, and crash generation requires a complex combination of laboratory experimentation and field studies. Consequently in implementing the countermeasures, a complete effectiveness measurement program must contain both field studies and laboratory examination. If by the nature of countermeasure implementation i.e., governmental action programs, the direct measurement program is constrained to a field studies only then these field studies must be complemented by other research of the laboratory type or the measurements of effectiveness will be limited to determining changes in vehicle condition.

6.4 Site Selection Criteria

Specific site selection depends on a number of factors including the approach used for vehicle regulation. If the effectiveness evaluation is to center on pre-existent systems, then the problems of site selection are somewhat simplified since the locus of particular program types has already been fixed by policy differences among the various states. If the programs are to be innovative, the primary constraint is finding jurisdictions willing to experiment with a program that affects substantially virtually all of the motoring public. In all likelihood, the program will involve a mixture of examining "old" programs and of creating new ones.

In selecting sites, a strong preference should be given to areas which are homogeneous in environment and in the social and economic characteristics of the population. Climatic conditions and terrain have strong influence on the deterioration of vehicle components. Economic considerations greatly affect owner maintenance practice even within a given jurisdiction. Selection of sites from widely disparate areas consequently contaminate any results and makes comparisons of alternative programs extremely tenuous. Ideally one would like to apply different programs to randomly selected groups of vehicles within the same jurisdiction, but this would be subject to contamination effects from one program to another. Two reasonable compromises are possible. The first would be to implement different programs in geographically separate areas of the same state. The second would involve applying the differing programs to adjacent states within the same geographic region.

Specific selection criterion include finding a reasonably compact geographic area with a vehicle population large enough to provide a full range of make, age, and exposure characteristics. Such conditions might be met in an urban to semi-rural county with a vehicle population in the 100,000 - 200,000 range. Such an area is small enough to allow relatively close administrative control of the program to insure uniform practice and to minimize problems in communication and in gathering data. A second criterion is availability of historical data from previous vehicle regulation efforts for an area in which a program currently exists, or a willingness on the part of the local administrators to allow base line data to be gathered before full program implementation begins in an area where a new program is to be implemented. A third criterion is the willingness of state authorities to allow innovation or options on the local level. Two areas come to mind in this respect: namely, Ohio and Florida where vehicle regulation programs have been assigned to local governments for implementation. A fourth desirable item is the availability of diagnostic facilities in the community so that the necessary sampling and evaluation of vehicles may be conducted without incurring undue capital costs.

6.5 Implementation Problems

A number of problems are associated with implementation of the program. These include willingness of local authorities to participate, possible political problems associated with allowing deviations from national standards as currently required or proposed, the need to conduct the program over a long enough period so that transient effects of introduction are avoided, and the amount of resources needed to conduct the program.

Since a very large number of vehicles are affected by regulation programs, a fair amount of political controversy may be generated by the introduction or modification of a vehicle regulation program. Motor vehicle inspection has been, and continues to be, a source of public concern both in jurisdictions where it has been established and in those areas where it has been proposed but not yet implemented. Legislation will probably be required in almost every jurisdiction to modify current vehicle regulation practice. Securing the necessary legislation to implement an experimental program may be difficult.

Variation from the standard as established by the Bureau may have serious national policy implications in either direction or variation. If the Bureau were to allow non-standard programs with a lower level of activity for experimental purposes, those areas which are not exempted but were not overly enthusiastic with the standard might justifiably feel annoyed. Conversely political opposition might be generated if particular areas were induced to have a higher level of performance than required of the nation as a whole.

Any experimental program in this area needs to be of fairly long duration. Time is required for owners to adjust to the new system of required maintenance practice. Since some defects occur only at long intervals several checks may be required to discover and force the repair of a substantial number of these defects. Second if periodic programs are established, potentially large numbers of service establishments may be required to perform the inspection. If the program is not of a long duration, private service operators may be unwilling to invest the necessary funds without sufficient time to amortize their investment. The same holds true with respect to construction of public facilities. Finally to bring about any change in owner practice the public need be convinced that the program is of sufficiently long duration to interest them in complying. A period of three to five years seems to be appropriate in this regard.

Implementation decisions should also reflect the existing state of knowledge about the effects of vehicle inspection on component condition. A certain amount of measurement has already been made on this problem. Any implementation should involve a critical review of the previous work that has been done to adequately supplement that data to reflect appropriate local conditions.

In brief, implementation problems center on the fact that vehicle regulation probably affects more people, in a more costly way, and more frequently than any other of the countermeasure areas. Any program in this area will require the establishment of a substantial administrative and evaluation apparatus to produce results. Changes which are made are not of the subtle variety such as are found in altering the intensity of law enforcement or in upgrading driver records, but touch virtually every vehicle operator directly.

6.6 Data Requirements and Resource Demands

At this point little can be said about the data requirements in terms of specific numbers of vehicles to be checked and numbers of accidents to be investigated. The numbers will be quite large since for many components the frequency of occurrence may be low and the differences between pre and post experiment condition may be small (say for example between 5% and 3% outage frequency). Since there can exist great variation among makes, models, and ages of various vehicles a large sample may be required to adequately represent the entire population. Resource demands also depend on the nature of the programs selected. For a regular inspection, $10.00 per vehicle inspection is not an unreasonable total expense, although potentially a large portion of this cost will be carried by the vehicle owner. For sampling purposes, the expenses of contacting vehicle owners and securing the co-operation in addition to conducting the actual inspection could push the cost of sampling to $25.00 per vehicle or more. For accident investigation a two-man team probably can locate, inspect, and evaluate not much more than 1 vehicle per day. Again the data requirements and resource demands depend on the programs selected.

6.7 Conclusion

A number of possible forms of vehicle regulation have been suggested, These include no activity other than the usual enforcement of equipment laws, a voluntary program, a spot check program, and several forms of required inspection. A detailed measurement and evaluation program needs to accompany these programs. Implementation of these programs generates a number of problems both technical in terms of number of vehicles checked and the amount of checking done and political in terms of response to a major, potentially costly, effort. However, these implementation problems must be overcome and a wide range of alternatives examined in order to determine the most effective means of improving vehicle quality to reduce accidents.

7.0 Environment Regulation

Environment Regulation refers to that set of highway safety actions that are specifically directed toward modification of the roadway system. Standard areas of primary influence are the Highway Design, Construction and Maintenance standard (no. 12) and the Traffic Control Devices standard (no. 13). Certain aspects of the Pedestrian Safety standard (no. 14) dealing with the protection of pedestrians in the highway system are also pertinent.

7.1 Countermeasures Review

From a review of the applicable bibliography, a study of the current 402 funded programs, and discussions with traffic engineering personnel, we have derived a set of significant countermeasures. This material will be presented in three sections according to the appropriate standard area.

7.1.1 Pedestrian Safety Review

There are four principal activities in this area funded by 402 programs. They are 1) studies and/or implementations of new school crossings, 2) development of safety curriculums, mostly at the state level (and really more related to the driver education standard), 3) the construction of "safety towns"--actually, training aids in the form of model towns to train children as pedestrians, and 4) the establishment of school crossing guard facilities. From the pedestrian literature a few more activities show up: 1) there are a number of manuals for the design of pedestrian crossings (many from the AAA, and a few from traffic engineering sources), 2) discussions of the design of pedestrian malls or special pedestrian pathways for urban areas, 3) descriptions of special techniques such as zebra crossings, overheads and subways, talking traffic lights (often with evaluation write-ups), and 4) the organization and operation of school patrols.

The pedestrian standard suggests:

1) A continuing state-wide inventory of pedestrian-motor vehicle accidents to get a better identification of the problem.
2) State-wide procedures for improving the protection of pedestrians by the use of signs and signals, land-use planning, physical separation from vehicle pathways (overpasses, etc.) and judicious use of illumination.
3) Adequate education of drivers about the characteristics of pedestrians which make them susceptible to accidents.
4) Training of pedestrians of all ages, particularly children.
5) Protection of children in all areas.
6) Establishment and enforcement of traffic regulations to reduce pedestrian-vehicle conflicts.

A principal report on the pedestrian safety problem is expected to be released soon by NHSB, and it may add detail to the above.

7.1.2 Traffic Control Devices Review

In traffic control devices, the 402 programs are singularly uninteresting from the viewpoint of actual system modification. They are almost entirely surveys or inventories of existing sign and signal conditions in preparation for future improvements due to existing restrictions on hardware spending. The literature, on the other hand, describes a number of activities, and often contains a report indicating success in some particular location. These activities can be condensed into the following groups:

1) computer control of signals, and optimum timing
2) pedestrian crossings and signals
3) rumble strips and stripes
4) roadway delineation, edge marking, colored pavement
5) freeway merging control
6) symbolic signs
7) illumination of signs

The traffic control devices standard (4.4.13) can be summarized briefly as follows: Each state should 1) actively identify the needs for new or modified signing, 2) upgrade all existing traffic control devices to conform with appropriate standards, 3) where necessary, install new safety devices, 4) implement sign and signal inspection and repair programs, and 5) establish speed zones on expressways, major streets, and highways in accordance with good engineering practice. The purpose of this standard is "to assure the full and proper application of modern traffic engineering practice and uniform standards for traffic control devices in reducing the likelihood and severity of traffic accidents."

7.1.3 Highway Design Review

In the area of highway design, the 402 programs are again rather uninteresting, being primarily study or inventory activities. Some of the larger programs are a Nebraska study to correct the design of railroad crossings; another Nebraska program to inventory skid resistance characteristics of several pavement types; a North Dakota effort that developed an inventory system for roadway and bridge hazards; and California efforts in the correction of railroad crossing deficiencies.

The literature, on the other hand, is replete with ideas, including many reports of innovative operational experience. In addition to some emphasis in the general design literature itself on safety, there are reports concerning the specifics of guard rails, median barriers, breakaway signs, anti-glare fences, railroad grade crossings, bridge rails, and pavement characteristics (including grooving).

The standard requires that proper safety features be included in the design of new highways and residential areas so as to provide a safe environment for both pedestrians and motorists. A number of specific features are included: Roadway lighting should be provided or upgraded at certain locations. High skid resistance pavement should be used in new construction, and existing roads should be repaved where this may reduce accident rates. There should be special emphasis on safety when traffic is rerouted around construction zones. There should be a program for identification of rail-highway crossings and for elimination of hazards and dangerous crossings. Maintenance should be consistent with the design standards. Hazards in the road right of way should be identified and corrected. The following design and construction features should prevail: roadsides clear of obstacles, use of breakaway sign supports, protective devices for minimizing damage or injury at fixed objects, bridge railings designed to minimize impact severity, and guard rails installed where needed. The post crash program should include: signs to direct motorists to medical care, maintenance personnel trained for handling accidents, and provision for emergency access and egress to freeways for situations in which response time may be critical.

This is one of the more detailed standards, and in summary requires that good design and maintenance practices be used remembering that the safety of motorists and pedestrians is a prime consideration in all design choices.

7.2 Countermeasure Selection

From the review presented above, it is evident that there are a large number of countermeasures that are applicable to our Environment Regulation area. There are sufficiently many significant countermeasures, in fact, that it does not seem reasonable to incorporate all of them in a single experimental design.

The status of knowledge in the pedestrian safety field is good, and in addition is generally accepted by the public safety agencies over the years (most notably the AAA). Emphasis both in the literature and in active programs has been on protection for the elderly and for school children, problem identification, and training. The last two can be included under the identification and surveillance and education standards respectively. We believe that the general acceptance of the existing knowledge makes a controlled experiment in this field less useful than in others (see Ref. 7-1).

In the field of highway design, the situation is much different. There are many instances of inadequately designed roads and highways. Indeed, some new roads still are constructed with inherent major safety deficiencies such as rigid sign supports, improper bridge rails, and inadequate lighting. Yet the fault does not seem to lie in the non-acceptance of modern safety techniques so much as in slowness to revise programming, funding, and contracting procedures. In short this situation seems to need more of an education program based on present knowledge than a demonstration program to convince unbelievers.

Of course, new techniques for safety are being tried daily in the highway area and most of these ideas need to be properly evaluated to reveal their potential utility. But here, too, the requirement calls for more careful observation of current operations, better reporting, and broader implementation of the educational activities carried on by the Highway Research Board, AASHO, and other agencies.

Consider now the problems of signing and signalling. From a variety of possible experiments, we suggest one which we believe will permit a direct determination of sign system modernization results including increased understanding by the motoring public, and hopefully accident reduction. As discussed in section 2.0, direct component changes in the system are most susceptible to measurement in terms of accident reduction.

Sign changes fall into this category. The remainder of this section will discuss the general features of such a signing program.

7.3 The Experimental Program

For reasons discussed above we feel that the Environment Regulation area can be served best by a demonstration program in the signing area. The proposed programs would be restricted to sign modifications on beltways around several cities. These modifications will generally be directed toward achieving conformity with the standards but with some innovative features added.

Consider then a program to change the signing on approximately four beltway systems surrounding large cities. This choice is based on the following reasoning: Signs and signals are mostly useful to strangers. They are useful to local residents only when they are first installed.* Sign confusion has been demonstrated to exist--a particularly interesting set of observations was made by Walter May of Representative Blatnik's committee. He and his associates photographed maneuvers induced by misunderstood signs on high speed expressways. It was found that last minute lane changes, stopping and backing and other dangerous acts were rampant, and the assumption was made that these acts were correlated with inadequate presentation of information about the route structure.

A principal emphasis of the signs and signals standard is on high speed roads and their intersections. Beltways around many major cities carry much out of town traffic, and thus

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*One of the toughest problems is related to the "local strangers". These drivers not only are continually lost but because of their poor navigation skills and assumed familiarity with the area, they are likely to make many mistakes (because of erroneous preconceptions).

(at least where a problem currently exists) should be susceptible to improvement. Beltways may provide a suitable setting for an experiment because:

1. Strangers abound
2. There are many closely spaced choice points
3. There may be problems associated with orientation (north-south, etc.)
4. There are frequent junctions with main routes
5. There is usually heavy traffic volume

The conditions for a useful experiment are met if we have 1) a jurisdiction which has a problem, 2) a large enough area (i.e., enough intersections) to get statistically valid information on the effect of an improvement and 3) local people who are willing and interested in making a change and assisting in its evaluation.

Four beltways would ultimately be chosen, each satisfying the above conditions. This will require a survey, and some judgement on the part of the surveyor regarding the existence of a problem. Treatments would be as follows: One site would be retained as a control, at least for the first year of the experiment; the second would improve the beltway signing approximately to the minimum AASHO standard; the third would approximate the maximum AASHO standard; and the fourth would be encouraged to exceed the standard with innovations.

Selection of the areas to be tested should be by competition, inviting certain areas to submit designs. These would be reviewed, and choices made which provided the desired range of conformance with the standards. This procedure would at once provide the detailed design information, and insure that there was interest on the part of the controlling jurisdiction.

The point should be made that signing effectiveness should be a function not only of the size and color of the signs and lettering, but most surely of placement and number. All of these factors will, of course, depend on the local situation and it is clear that all signs on a given beltway would not be uniform. Special situations, such as left exits or dropped lanes, might require special treatment. Nevertheless, the several submitted designs could be analyzed by experienced traffic engineering personnel to predict their performance before initiation of the experiment.

The Highway Safety Program Manual, Volume 13, states that the most direct way of determining the effect of a highway safety program is by the reduction in number of accidents. We differ with that concept in the following way. The accident reduction may be a valuable measure of effectiveness, but it is not nearly as direct as the observation of changes in the traffic pattern. In this program area we believe that both are possible, but that significant traffic pattern changes can be determined in a matter of days, whereas accident reduction may require a year or more.

The general method of evaluation, then, will be to compare before and after accident rates at the selected intersections for about one year before and one year after the modification. Conflict measures, similar to those developed by Perkins and Harris, will be taken at the same intersections periodically in a period before installation of new signs, and the same measurements in the after period. Individual interchanges on a beltway will, of course, receive individual treatment--thus there will be the possibility of establishing control within a single beltway simply by holding one or more interchanges unmodified. We expect to calculate cost/benefit ratios based on average or actual costs of accidents reduced in the manner conventionally used in evaluating highway design changes. A typical beltway interchange in Ann Arbor has been observed to have 40 accidents per year. If this could be regarded as typical, a 20% reduction in accident rate in a 12 intersection beltway could be detected with some assurance in one year.

If a second approach can be made in the signing and signalling area, we suggest that the routing signs in an urban area might be updated. Again, the experiment requires a site which has a problem--i.e., one in which there is some evidence that inadequate signing contributes to the accident situation. A city which contains an objective frequented by both natives and out-of-towners (e.g. a hospital) would be desirable. Second, the area must be large enough to provide useful experimental results. And there must be a hospitable community ready to undergo change.

A cue may be taken from European cities in this field--in which signs indicating the direction of the inner-city, the freeway, etc. are both frequent and often color coded for easy interpretation. It seems likely that this sort of experiment should be carried out in a small to medium sized city (say 100,000 residents) because of total cost. But if the effort in this program area could be expanded this would be an appropriate experiment.

Measurement techniques would be somewhat different from those indicated for the beltway experiment. In particular we would use more interviews (e.g., with visitors at their destination) and probably special accident report notation to indicate whether the persons involved were familiar with the city and whether they had been confused by signing or the lack thereof.

A typical experiment could require 2 groups of unfamiliar subjects to find their way to the destination (before and after signing changes). Measures of their attention as well as their route and timing would be made.

8.0 System Restoration

The System Restoration program is primarily concerned with the immediate responses to an accident situation. In terms of standard areas, the Emergency Medical Services Standard (Number 11) and the Debris Hazard Control and Cleanup Standard (Number 16) are directly applicable. While the standards, and their supporting documents, go into considerable detail, we shall only summarize the major points here. Considered jointly these two standards require that states and local communities shall provide adequate systems for responding to highway injuries or to hazardous debris so as to minimize further injury or damage. Specific recommendations are summarized as:

1. The development of a comprehensive plan for the state or community to provide for handling emergency situations.
2. Adequate two-way communications.
3. An adequate notification system.
4. Adequate training for:
   - Medical attendants
   - Drivers
   - Rescue personnel
   - Dispatchers

The function of a properly operating restoration system is the timely and safe performance of actions necessary to return the highway system to its normal operating condition after an accident. This involves communication of the necessary facts to the appropriate agencies (ambulance, tow truck, etc.); dispatch of equipment; extraction of injured persons from the wreckage; first aid for the injured and speedy transportation to adequate medical facilities; regulation of traffic around the accident; safe handling of dangerous materials released in the accident; and finally, removal of wreckage and debris from the roadway to prevent future mishaps.

Surveillance and detection processes are performed in most communities by private citizens. The one communication channel available to essentially all citizens is provided by the telephone system. The dispatch facility, vehicle pool, and administration agency are included in this system since these components establish the dispatch protocol and the screening policy. They also dictate the distribution of - and allocation policy for - recovery vehicles.

The principal goal of the emergency medical system is to deliver the injured to a facility that can provide definitive care in a manner that maximizes the likelihood of a favorable prognosis with minimum morbidity. This concise statement is sufficient to identify the system emergency medical care characteristics responsible for ultimate performance. The time from onset of illness or injury to the initiation of treatment, and the quality of the treatment and care provided at the scene or in transit are the only factors through which the recovery system affects the condition of the patient. These are the two primary characteristics which constitute intermediate measures of the effectiveness of an emergency medical recovery system.

While the medical services act to return the injured person to health, debris hazard controls act to restore the highway to its normal condition. While medical services are always important to the injured, hazard control can potentially be important to large numbers of people. The incidence of vehicles carrying dangerous materials is quite high and proper handling of these materials is extremely important. A determination of the cost effectiveness of such procedures, while difficult, may be approached by analyzing mass accident data.

More detailed discussions of the subject can consider such items as optimal spatial allocation of vehicles to provide minimum response time, the use of particular communications techniques (such as telemetry of vital signs from ambulance to hospital) etc. Such specifics will not be dealt with further in a discussion of the standards, but will be considered in the experimental plans.

8.1 Emergency Medical and Debris Removal Countermeasure Programs

A review of the literature was conducted in the emergency medical and debris removal areas. The complete collection of materials is contained in Volume 2 of this report. A selection of this literature pertinent to either particular countermeasures or to general types of countermeasures is discussed below.

The EMS literature can be roughly divided into the following categories:

1. Organization and operation of hospital emergency departments.
2. Ambulance operations--including economic considerations, optimal allocation of ambulances in a community, and the technical aspects of operation (training and equipment).
3. Training of laymen for performance at accident sites.
4. Use of helicopters as emergency medical recovery vehicles.
5. Communication--for notification of accidents
   --for conversation or data transmissions between ambulance and hospital
6. Model ordinances for emergency medical systems.

In addition, a number of NHSB-sponsored programs have attempted to demonstrate one or more of the above countermeasures by implementing strong programs in cities, counties, or states.

In the debris removal/hazard control area, the literature is rather sparse. It can be divided for discussion purposes into:

1. Training for handling of spilled hazardous cargo.
2. Use of helicopters for debris removal from active roads.
3. Training police or others to handle traffic in connection with highway emergencies.

Finally, there is one major NHSB-sponsored study that has analyzed this problem in some detail and may result in suggestions for additional countermeasures. The report on this study has not as yet been published.

There have been a number of "402"-sponsored programs in the several states which could be classified as innovative and which serve as examples of useful countermeasure activities. Others are less innovative, but are reasonably new to the communities in which they were introduced. Following is a brief tabulation of several such programs in the EMS and Debris Removal areas that deserve further discussion:

State	Total $	Federal $	Description
Arizona	227 k	174 k	Develop EMS system statewide
Arkansas	530 k	220 k	Establish 4 county EMS programs and a state program
California	3,327 k	1,978 k	Develop means for early detection and removal of debris from freeways
Colorado	15 k	7 k	Develop advanced warning system for freeway driving conditions
Michigan	37 k	18 k	An emergency medical communication control system for Lenawee County
Minnesota	1,296 k	648 k	Purchase 91 ambulances and implement a statewide program
Nebraska	102 k	51 k	Establish a communication system in 12 areas for reporting crashes and dispatching emergency medical care
New Jersey	81 k	67 k	Establish an EMS data collection system
	162 k	57 k	Establish 2-way hospital-to-ambulance communication system in several counties
New York	418 k	418 k	Establish a statewide data collection system
Texas	462 k	231 k	Implement Texas overall EMS plan
Vermont	131 k	85 k	Plan a coordinated communications network and implement same
Wisconsin	6 k	6 k	Develop a manual for highway personnel at accident sites

The NHSB-sponsored "403" programs in the EMS field are extensive. While it was originally hoped that they would serve as models for improvements in other parts of the country, this goal has evidently not been wholly realized. In part this is because data from the several programs are seldom comparable.

These "403" programs did demonstrate a number of countermeasures, however: organization, training, communication, medical emergency equipment, and particularly the use of helicopters. But on the basis of data available it does not seem possible to compare the relative effectiveness of the several different approaches used--let alone to determine the absolute effectiveness in terms of cost-benefit.

Reviewing the elements of a restoration system program (as derived from the literature review, the "402" programs, and the several past and present demonstration programs), we come to the following conclusion: Much of the past work has been done in a few large cities--i.e. there have been demonstration programs in Detroit, New York, Los Angleles, Miami, and parallel programs sponsored by other agencies in Pittsburgh, Boston, and Philadelphia. These programs have considered training, the use of helicopters, the problems of ambulance spatial allocation in large cities, and communications. While the data from past programs are not always comparable, there are certainly some generalizations which can be made from the experimentation: Helicopters in large cities do not add much to the emergency medical capability, although they may add considerably to cost. Allocation is a problem which can be handled nicely by predictable analytical methods--in some cities it is a minor problem because of the large number of units available for ambulance service (e.g. Detroit and Philadelphia have used police station wagons as transporting vehicles for the injured). Equipment and training is more of an economic problem than anything else. There is a serious shortage of money in all of the large cities, and any major change program has to contend with this. In conclusion, it seems that past efforts have pointed the desirable direction for change in large cities--more professionalism, better assignment methods, and better equipment--and that further demonstration progams in this area would not be likely to change these conclusions. Unfortunately, there is not good cost/effectiveness information available from such studies, but again it seems unlikely that this can be obtained from further experimentation. To justify this conclusion, consider the following practical example of difficulties involved in the determination of cost.

In the Detroit emergency medical program experiments were conducted concerning communications, training, equipment, allocation, and helicopter usage. It was concluded that Detroit would be measurably better off if the ambulance service were moved from the Police Department (where it currently resides) to the Fire Department. The Fire Department already operates rescue squads which handle about 20% of the medical emergency calls (in addition to their normal fire attendant duties). The city's analyst calculated that the cost associated with transferring the emergency medical responsibilities to the Fire Department would be minor and that the city would be better served by firemen who had nothing to do at the scene of the accident other than to treat the injured. The Fire Department, on the other hand, calculated that they would require more than 100 new employees at a total cost of about $1,8000,000 per year. The fireman's union finally pointed out that the increased training requirements would justify higher pay for these individuals bringing the total cost to $4,000,000 per year. It is obvious that the actual cost is going to be much affected by political considerations and that it is next to impossible for exact determination to be made analytically.

Another group of demonstration emergency medical programs have been conducted at the state level (Arizona, Mississippi, Nebraska) and have generally emphasized helicopters. In addition, a number of states have conducted inventory programs to determine the status of their emergency medical (particularly ambulance system) capabilities. While there would seem to be value in controlled experiments at the state level, they would be quite expensive. Although the past and present demonstration programs have not brought forth a complete explanation of the restoration problem or its solutions at the state level, we conclude that future demonstration monies can be spent better at another level.

8.2 The Proposed Experimental Design

We propose that four separate restoration programs be instituted, all of them in areas of about county size. We intend to minimize if not eliminate the participation of helicopters--not because they have no place in the restoration system, but because we believe that they will be used enough in other programs to show their worth. Similarly we choose not to experiment with restoration programs in large cities, in part because there have been particular programs in New York, Detroit, Los Angeles, and Miami under past demonstration efforts, and in part because there seems to be greater potential for improvement in rural or semi-rural areas, and thus a better chance for useful measurements.

A particular choice of sites for this program area has not been made, but considerations for the choice are as follows:

1. An area large enough to permit statistically significant measurement of changes in the response or other service times associated with both the emergency medical and debris removal operations.
2. An area which has either a demonstrated or calculated restoration problem that is amenable to solution. This means that the present service times are larger than they should be, that the medical capability of the restoration system is primitive, and/or there are many accidents caused by previous accidents.
3. An area in which the social/political environment is conducive to change, and in which the participants are willing to determine or permit determination of measures of effectiveness.

The chosen level for restoration experimentation is a county with an area of the order of 1000 square miles, and a total population of 100,000 to 400,000, and at least one city of the order of 50,000 to 150,000. This would provide a setting in which there could well be deficiencies in communications, allocation, training, and ambulance equipment. Washtenaw County, in Michigan, could serve as a model for physical size and population density but is probably too far advanced in its service to serve as an experimental unit. Volz (ref. 8-1) has presented a solution to the allocation problem in such an area in a recent paper. Communications currently in force in this community include a centralized ambulance dispatching system and a private (radio) ambulance to hospital system. Training of ambulance attendants is accomplished through the auspices of the local (University) medical school. Most service in the county is provided by a single rather well-equipped commercial purveyor of ambulance services.

Although most of these changes have taken place over a period of only a few years--i.e. a transition from primarily funeral home service to the above described service-- there were essentially no careful measurements made of the effect of the changes. No one can tell, except by anecdote, whether the new service is faster, has a higher quality of medical care, or has indeed reduced morbidity or mortality in the area. The change is not obvious in either the total automobile accident data or in the number of fatal injuries per unit time. Service times of the new system have been measured, but can not be compared with the old system because no data on that exists.

Yet there is certainly an intuitive feeling among the participants in the system that the new system is "better" and worthwhile. It has been supported in part by tax monies, and the responsible officials have continued this support in the belief that it is worth it.

There is no assertion here that this county is near perfect--there are indeed several problem areas which deserve further attention: tenure of the medical attendants, agreement of several political subdivisions on support of the program, etc. But the major elements of a possible experimental program are there.

We propose, then, to conduct parallel operational experiments in different counties. Each succeeding experiment would constitute an increased level of sophistication in the restoration area, and the range would encompass everything from a rather backward program to a very forward one. The levels are displayed in Table 8-1.

Suppose that we could start with four areas, all in approximately the condition of level I--a ready to retire makeshift ambulance service with a minimal communications and medical equipment. For a period all areas would be left undisturbed to permit some before-experimentation measures to be taken, but ultimately we would want to change all of the areas except one in the direction of conforming to the NHSB standard. We propose three levels of improvement, shown in the chart as II, III, and IV. These might be considered the good, better, best approach, as the first is presumed to be responsive to the standard in a minimal way, and the latter probably exceeds it.

For each of four areas--training, equipment, planning, and detection/notification--general levels of achievement have been specified. As in other experimental areas, however, it is important to consider the interests of the community strongly in this matter and we suggest a competitive design approach. Detailed specification for the various levels will be prepared, and with the assistance of regional directors and state coordinators, discussions will be begun with particular communities regarding their interests in the program. We suggest that a paid planning activity might be in order for a number of chosen communities--followed by contract awards to those areas which come closest to satisfying the requirements of the experimental design.

Table 8-1

Area of Improvement		Level I (control)	Level II (good)	Level III (better)	Level IV (best)
TRAINING OF	Attendants (EM)	As is	Advanced Red Cross course	NHSB course (Ref. 8-2 & 8-3)	Paramedic course
	Dispatchers (EM & DHC)	As is	No change	Training (Ref. 8-4)	Advanced training (Ref. 8-4)
	Hwy personnel (DHC)	As is	No change	Training	Advanced training
	Drivers (EM & DHC)	As is	No change	Training	Advanced training
	General public	As is	No change	Red Cross course available	Red Cross course available plus course in high school driver ed. curriculum
EQUIPMENT	Ambulances Helicopters	As is	Conventional ambulance	NHSB recommended ambulances and equipment (Ref. 8-5)	Same as III
	Tow trucks, etc.	As is	No change	Ref. 8-4	Ref. 8-4
	Communications	As is (may be telephone to funeral home)	2-way radio	2-way radio with central coordination and dispatching	Same plus ambulance to hospital communication including cooperation of physicians
PLANNING	State/County	As is	Rudimentary	County-wide, active committee, manual allocation of resources	Same plus possible computer optimal allocation and including of emergency rooms in planning
DETECTION AND NOTIFICATION		As is	Telephone	Signing program to indicate location os medical facilities	Same plus possibility of central dispatch a la Santa Cruz county, heavy use of CRW, strong public information program

9.0 Experimental Setting

The choice of experimental test sites that are suitable for implementation of the six program types discussed earlier is a complex, many-faceted problem that we will investigate in some detail in this section. Our intent here is not to list a final choice of sites, but rather to present and discuss the various factors that we feel are important to such a selection and to review the sources of information we have used to obtain background information necessary for making a successful judgement. In reviewing the performance of many safety programs carried out in the past, a general feeling has developed among safety administrators that administrative organization, management capability, program "morale", and other personal, political, and organizational features of the government agency responsible for the program may be as important to ultimate success as the technical correctness of the plan or the nature of the countermeasures that are employed.

From a system point of view this is hardly surprising of course. Our notion of what constitutes the traffic system is simply expanding to include all important components. It is tempting to consider a large scale demonstration program (such as the type envisioned in this study) as the opportunity to perform a quantitative or well defined physical measurement on some part of the highway traffic system. If this system is assumed to be some sort of entity to itself with characteristics that are independent of the organizations responsible for their operation, then it might be possible to set down a well thought-out experimental plan that may be applied in any situation to uniformly yield the desired information.

Since people are involved in all phases of the traffic system, however, it is clear that well thought-out programs will succeed in one situation, do passably well in a second, and falter in a third. In fact, much the same comment can often be made for poorly thoughout programs. The differences in these experiments can often be traced to the motivation of the people involved in administering the program, to the management structure of the responsible agency, or to some other personal factor. Thus, in placing a site we feel strongly that political and organizational relationships must be taken fully into account and that the motivations of the people who will be involved in conducting the experiment be weighed carefully.

In the remainder of this section we will discuss the more important factors that must be considered and a discussion of the sources of information that we will use in defining test sites.

9.1 Governmental and Legal Relationships

Local and state level governmental units occur in many diverse forms and varieties. In order to evaluate how effectively a program will be admistered or how successful the project management will be in acheiving the cooperation of all necessary activities, it is necessary to investigate the important legal and administrative aspects of the local organization. For example, it is possible to negotiate in all good faith with a particular governmental agency that represents itself as the responsible agency for safety program management. However, unless this agency has the clearly defined authority and desire to authorize the deployment of actual resources, an experimental program may fail when indepependent service units (hospital, police force, motor vehicle department, etc.) pursue their own priority goals to the exclusion of the program and its objectives. In this example, the failure occurs because the real organizational structure and chain of command was not properly evaluated.

9.1.1 Administrative Considerations

As indicated by the above example, it is necessary to understand in some detail the administrative the administrative organization of the governmental unit under evaluation. Now this goal, like "Let's put a man on the moon by 1970" is somewhat easier to state that it is to accomplish. The major problem here seems to be the fact that the avowed organizational structure does not always correspond to the actual chain of command. By sheer force of personality, political maneuvering, or honest accomplishment an individual or agency may acheive a status of responsiblity for some action area. Chain of command is not often a clear-cut matter in complex organization structures, however, and this responsible agency may find itself like a rock in a stream with the water pouring freely around it. Our point here is simply that declared organization is only an indication of actual operating organization and that a full knowledge of the latter can usually be gained by observation of the system in action.

To pave the way for successful program operation, each area within the program requiring specific services from the community should be identified. Following this, a determination of the agency responsible for providing this service should be made. Unfortunately, it may develop that no responsible agency for this particular function exists. In such a situation an agency willing to accept the added responsibility must be found and charged with the proper authority, or a new agency must be formed. Finally, the persons and agencies comprising the chain of command responsible for authorizing and committing these services should be identified. To reiterate a point here, it is necessary in this analysis to differentiate between policy making, review, and analysis agencies on one hand and operational agencies on the other. Authorization for committment of resources should come from the highest authority necessary and should be realized by those further on down the chain of command.

The problem of commitment is important in view of the duration of the demonstration programs (on the order of five years) and the present unsettled nature of national and international affairs. For instance, in the police areas particularly a sharply escalating crime rate will place great pressures on the police commissioner to use all his available resources in a concerted enforcement campaign. Thus, police officers who are assigned to traffic services may actually spend much of their time in crime-fighting activities. No one would suggest that many traffic services are highest priority police activities so that this entire problem is open to debate.

In summary, what we are suggesting is that a rather careful study of administrative organization be made in potential test site areas to determine -- as a minimum -- who is responsible for successful operation of the program. The nature of the questions raised here indicates a close relationship to the 403 funded Demonstration County Programs being conducted in Oakland County, Michigan and Shelby County, Tennessee. The purpose of the countermeasures program is to synthesize operational program plans to demonstrate the effectiveness of selected countermeasures. The actual implementation of such plans, however, presupposes the existence of a community having necessary facilities and managerial experience to carry out the program. The development of such communities is the Demonstration County Program goal.

9.1.2 Legislative and Legal Considerations

The actual operation of a demonstration program is most sensitively dependent on the administrative branch of government, but the legal/legislative environment in the community effectively determines the nature of the program that may be carried on.

Each potential countermeasure in an experimental program involves the modification of an existing system or the introduction of a new one. If the modification involves a change in degree but not in principle, then the countermeasure would usually fall under existing laws and practices and could be implemented in most communitites with no legal complications. An example of this is an increase in the size of a police force. On the other hand the potential countermeasures could differ in principle from existing practice or could involve the introduction of a new principle. In this case there is a strong possibility that the technique would not be adequately defined by legislative action. Examples of this contingency concerns the right of police to stop and question people when no specific crime is suspected or the modification of traffic signs and other control devices whose nature is prescribed by law.

In designing the implementation of a given program then, two courses of action are possible: 1) Make sure that the countermeasures that are choosen for implementation are compatible with the laws of the community, or 2) determine if the necessary legislative backing for a specific countermeasure may be easily enacted.

It is expected that legal considerations will provide an effective control over the novelness of the techniques that are employed due simply to the lack of precedence.

9.2 Interpersonal Relationships

Since people are involved in all phases of the test programs, this topic conceivably comes to bear in all siteing criteria. However, we restrict the meaning here to a discussion of several pertinent topics.

9.2.1 Political Climate

We have discussed above the need for determining the administrative structure of the government agency responsible for managing the experimental program. How effectively this system operates for the well being of the public depends nevertheless on the political atmosphere that exists at the test locale.

A precise meaning of political climate is difficult to formulate. In our form of government the political party system is characterized by a natural set of checks and balances that tends to keep the party that is power honest. A considerable amount of variation exists in the operation of governmental systems, however, relative to the balance between effort needed to do the job required of the public official and the effort needed to maintain the political system. At one extreme, party considerations dominate public ones; at the other extreme the opposite is true. While it is unrealistic to expect unfailing dedication to public needs, it is also unrealistic to expect good cooperation in a community where the official's job next year depends on how much he has done for the political benefit of his party or his superiors and not how much he has done for the public. In analyzing the merits of a possible test site therfore, we feel that it is necessary to determine the degree of political involvement that various officials are subject to in the course of their duties.

In order to measure this involvement it is necessary to determine the status of personnel involved in the highway safety area: that is, are the important people elected, appointed, or are they civilian employees with some sort of career status? Does the entire safety staff change during election periods when key personnel (and hence policies) may undergo drastic changes?

Because the Governor's Safety Representative is an important part of the safety program operation, his (or her) political position can strongly affect the state's program. Important questions here are the nature of the relationsip between the Governor and Representative (close-friendly or distant-formal) and the rating of the representative as a working, directing member of the state safety force.

Political involvement is another factor that has crucial implications for the conduct of a long term program. A well-planned, well-organized study may effectively cease to function or at best suffer serious setback if key members of the team who are experienced in how things work are replaced in mid-stream by a large scale governmental turnover.

9.2.2 Group Pride

In the SCOPE-type programs under discussion in this report, one research oriented group is responsible for creating and developing programs plans which are then turned over to a second group for execution. This type of organization opens the door for conflict since the experiment goals and methodologies are not likely to have the full concurrence of those elected to carry them out.

Many programs in the social services area of the federal government have not done well in practice because the people which the program was supposed to help felt that their actual needs were subjugated to their supposed needs as viewed by the (distant) planners. It is tempting to consider convincing the program recipients that the ideas set forth by the planners are acutally their ideas and consequently deserve support. This is an even more flagrant demonstration of superiority, however, and in the long run is probably not a sound solution. The most plausible way of attacking the problem seems at present to be a straight-forward presentation of suggested methodologies, followed by a give-and-take bargaining session to achieve a final plan that can be actively supported by the group responsible for program execution.

To provide more information on this subject, a study of comparable experiences in the social services area has been instigated.

Hopefully the many successes and failures of programs in these fields will give us some insight into how or how not to cope with this situation when and if it arises.

9.3 Factual Considerations

In addition to the generally complex organizational and personal factors presented above there are a number of other characteristics of each site that are important in site selection. These characteristics are stable background features that describe the physical conditions and gross population statistics of the site.

A variety of demographic factors are useful: in particular we might think of total population, percentage distribution of population in urban and rural areas, number of registered vehicles, number of licensed drivers, number of miles of public roads, number of accidents per year, and the basic nature of the people (conservative, liberal, eager for change, etc.).

Geographic factors are also important. Here we think of the physical isolation of the area, the climate and the type of terrain that is generally prevalent.

9.4 Indications of Capability

Ability to perform the tasks set out in the job specification is one of the primary considerations involved in choosing a contractor -- this factor has also been one of our first considerations in choosing a test site. The question is: Do the necessary resources exist in the form of trained personnel and adequate facilities to perform the tasks required for the proper conduct and completion of the test program as well as a proper evaluation of the test results and formulation of sound, experimentally justifiable conclusions. More importantly, has the community been able to utilize these resources to carry out meaningful work in the highway safety area.

The most generally accepted method of obtaining this information is to look at past performance. In these days of rapid change, this information if not always up-to-date but is usually the best that is available. In later sections of this report some sources of this type of information are discussed.

9.4 Visits to NHSB Regional Directors

During the course of the Phase I effort on this program HSRI staff members personally visited the directors of the ten NHSB regional offices. The purpose of these visits was to familiarize the regional director with our countermeasures program, to acquaint him with our possible further action within his region, and, most important to this section, to gather information from the regional NHSB staff on working conditions within their region and possible favorable locations for our proposed demonstration porgrams.

In general these visits were highly informative in providing background information for each state in the region. The most useful information was found to be subjective and concerned the feelings of the regional director and his staff on political climate; local support of, and participation in, safety programs; status of the Governor's Safety Representative; possible evaluation facilities, and numerous other factors.

The information gathered from these visits was added to a central data file for each state.

9.5 Analysis of 402 Projects

From 1967 to the present, a considerable amount of money has been spent in the 402 matching funds projects to provide the states with an incentive for bringing their safety programs up to the minimum requirements set by the sixteen standards. Wtihout making a judgement as to whether this program has acheived its goal, it is possible to study the ways that the states have spent their matching funds money. Such data provides information on where the interests of each state lies and how much of its available resources were put into that particular area.

Early in the program we obtained a listing of 402 projects that was complete as of 30 June 1970. This listing contained certain financial and file information as well as a short descriptive phase giving the nature of the project. From this data we extracted other pertinent information and recorded the entire data bank on a computer-accesseble magnetic tape file. A complete description of the data file and the information available in it is presented in the Appendix. Because the data is directly available to a computer it can be analysed in a variety of ways.

As and introduction to the data, consider the priority implementation of 402 projects within each of the standard areas. To determine priority we have utilized four distinct measures. To indicate relative interest, the percentage of a state's total number of projects and authorized federal funding that was alloted to each standard area is evaluated. This measure is independent of the population and District of Columbia may outrank California or New York in this respect. To provide a measure that is sensitive to absolute committment we have also evaluated each state's percentage contribution to the total number of projects and total authorized funding within a standard area. In summary then, there are four measures

$$\text{RPP} = \frac{\text{No. of Projects in State and Standard}}{\text{Total No. of Projects in State}}$$

$$\text{APP} = \frac{\text{No. of Projects in State in Standard}}{\text{Total No. of Projects in Standard}}$$

$$\text{RFP} = \frac{\text{Authorized Funds in State and Standard}}{\text{Total Authorized Funds in State}}$$

One facet of the priority information is shown in Table 9-1. For each standard area, this table shows the state having the highest committment as determined by each of the four measurements defined above. Such a presentation of course shows only a fraction of the data available.

A novel way of presenting further information is available through a computer mapping program. This program produces a map of the Continental United States where each state is represented by a grey level that is a function of the variable being plotted. A series of these maps are shown in Figs. 9-1 through 9-17. Each map shows the data for a particular standard area. In each graph the map scale has been chosen to approximate a density that is proportional to the quantized logarithm of the Relative Funding Performance (RRP) variable. Such maps show at a glance where the high interest states are for each standard area. Additional programs have been written to provide histograms of the performance variables for each standard or state. Such data is very useful in determining where the interest in a given standard seems to lie and where the largest expenditures in each area have occured. Figs. 9-18 to 9-30 show these histograms for all 50 states as well as Puerto Rico and District of Columbia. Four states are presented on each page with the continental states in alphabetic order.

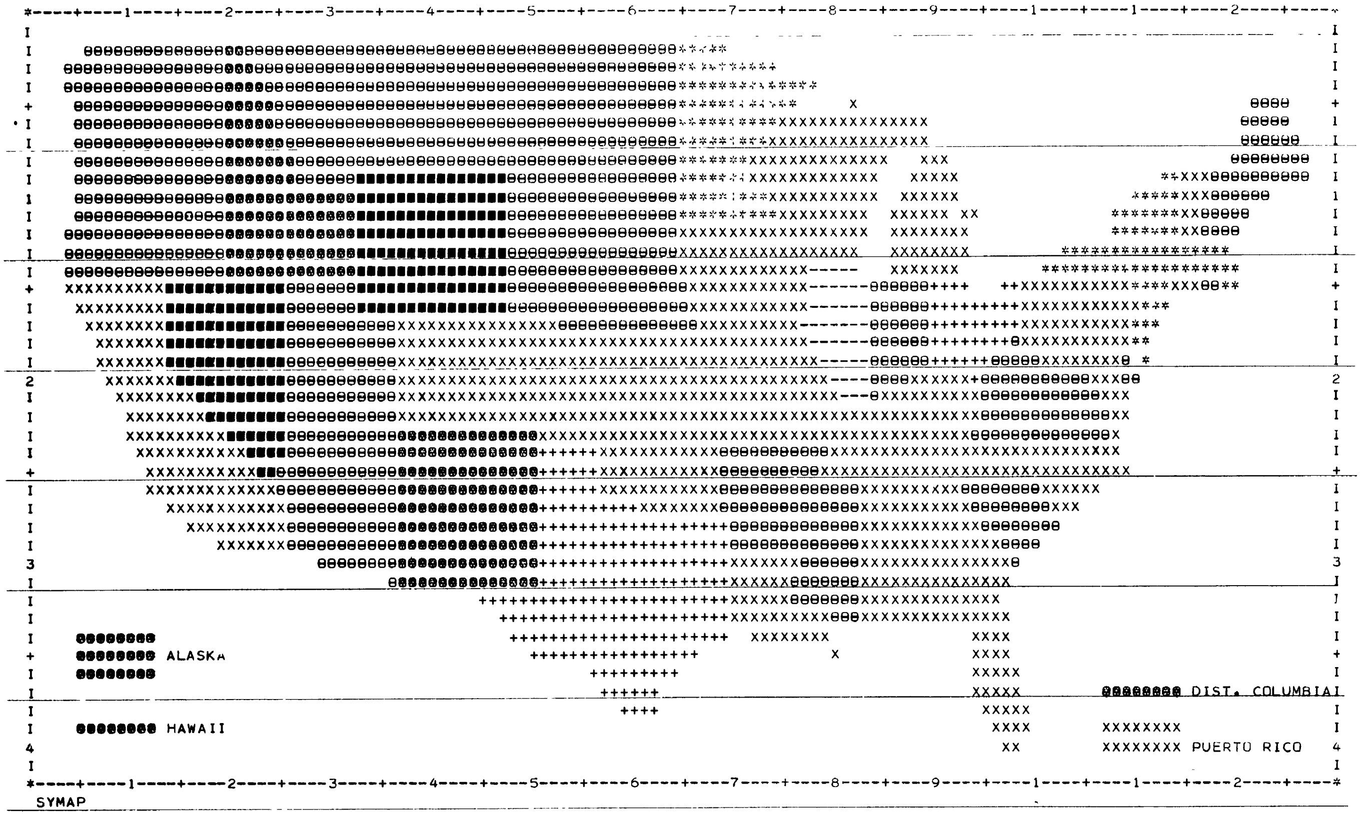
There are several other parameters coded into the computer file that have proved useful in our analysis of the 402 projects.

The "novelness" of a project has been estimated in accordance with the levels indicated in the Appendix. This variable was intended to indicate the degree to which the project followed conventional techniques on one hand or attempted new and novel approaches

TABLE 9-1

Standard Area		Greatest Percentage of Projects in Standard		Greatest Percentage of Projects in State		Greatest Percentage of Funds* in Standard		Greatest Percentage of Funds* in State	
		State	Percent	State	Percent	State	Percent	State	Percent
0	P+A	NY	4.4	DC	35.7	CAL	6.1	NEV	39.6
1	PMVI	FLA	16.1	VER	13.9	NY	17.3	ARK	24.6
2	MVR	TENN	25.9	TENN	13.0	PENN	57.1	LA	28.1
4	DE	ILL	11.7	VIR	38.7	TEX	14.7	ALA	52.1
5	DL	NY	7.3	HAWI	33.3	NJ	12.2	WASH	27.0
6	C+L	ILL	27.5	LA MISS	5.6	MISS	27.8	MISS	5.9
7	TC	ARK MISS	11.1	ARK	12.9	CAL	33.1	MISS	9.7
8	ALC	ILL	24.8	ARIZ	34.8	GA	7.8	DC	16.8
9	IDAL	CAL	20.6	CAL	21.8	CAL	33.4	NC	14.1
10	TR	CAL	8.5	OHIO	23.8	OHIO	17.7	OHIO	65.7
11	EMS	MASS	10.0	VER	38.9	PENN	8.0	NEB	44.3
12	HDCM	CAL	20.5	CONN	7.9	CAL	47.0	ND	10.9
13	TCD	ILL	19.7	ORE	28.8	NY	28.1	ORE	15.1
14	PS	CAL	13.6	MD	14.0	CAL	38.7	MD	12.9
15	PTS	MASS	17.6	KEN	67.4	NY	9.8	NJ	46.6
16	DHC	WISC	50.0	WISC	4.3	CAL	75.3	CAL	13.5

*Federal Funds Authorized



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C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C PLANNING AND ADMINISTRATION, FY68 THRU FY70 (HSP STANDARD 4.4.0)

DATA VALUE EXTREMES ARE 0.0 39.61

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PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

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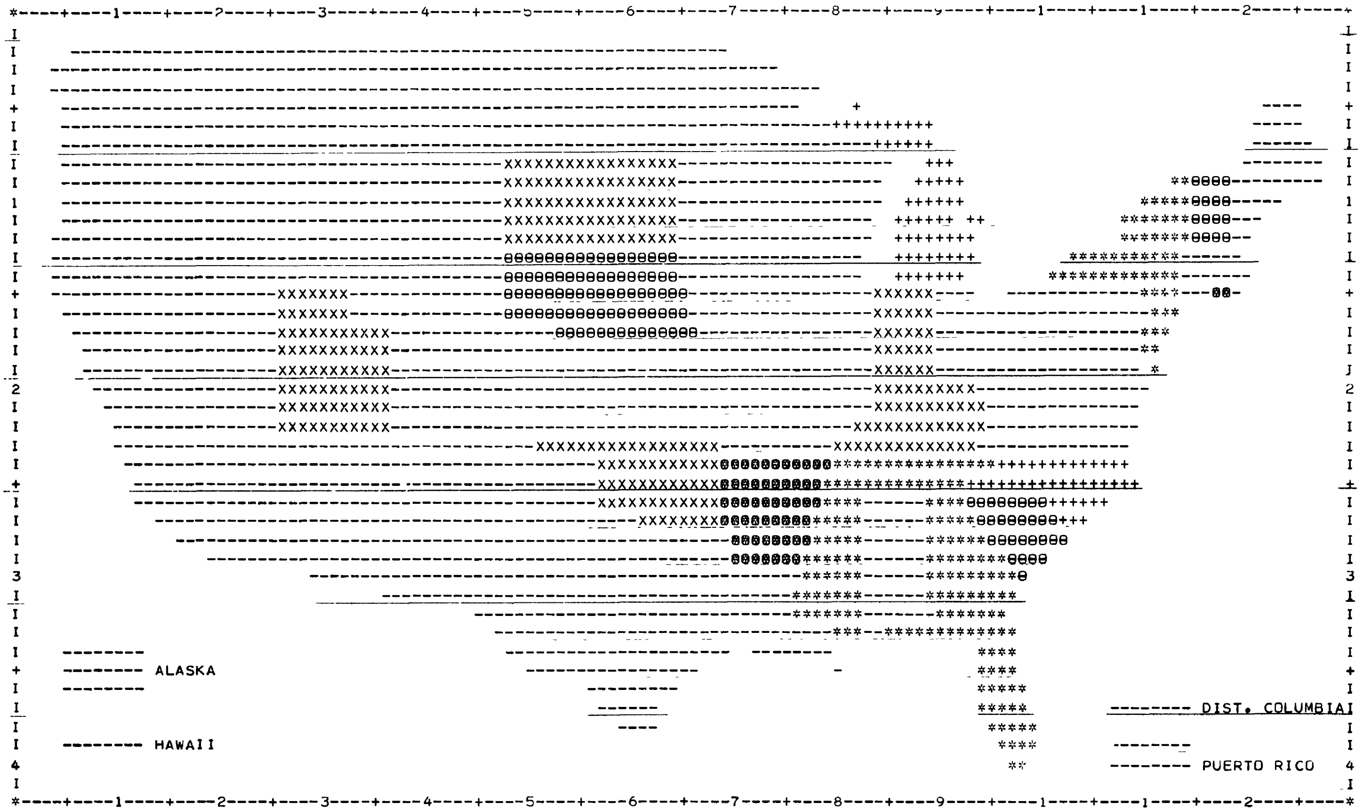

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C PERIODIC MOTOR VEHICLE INSPECTION, FY68 THRU FY70

C (HSP STANDARD 4.4.1)

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PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

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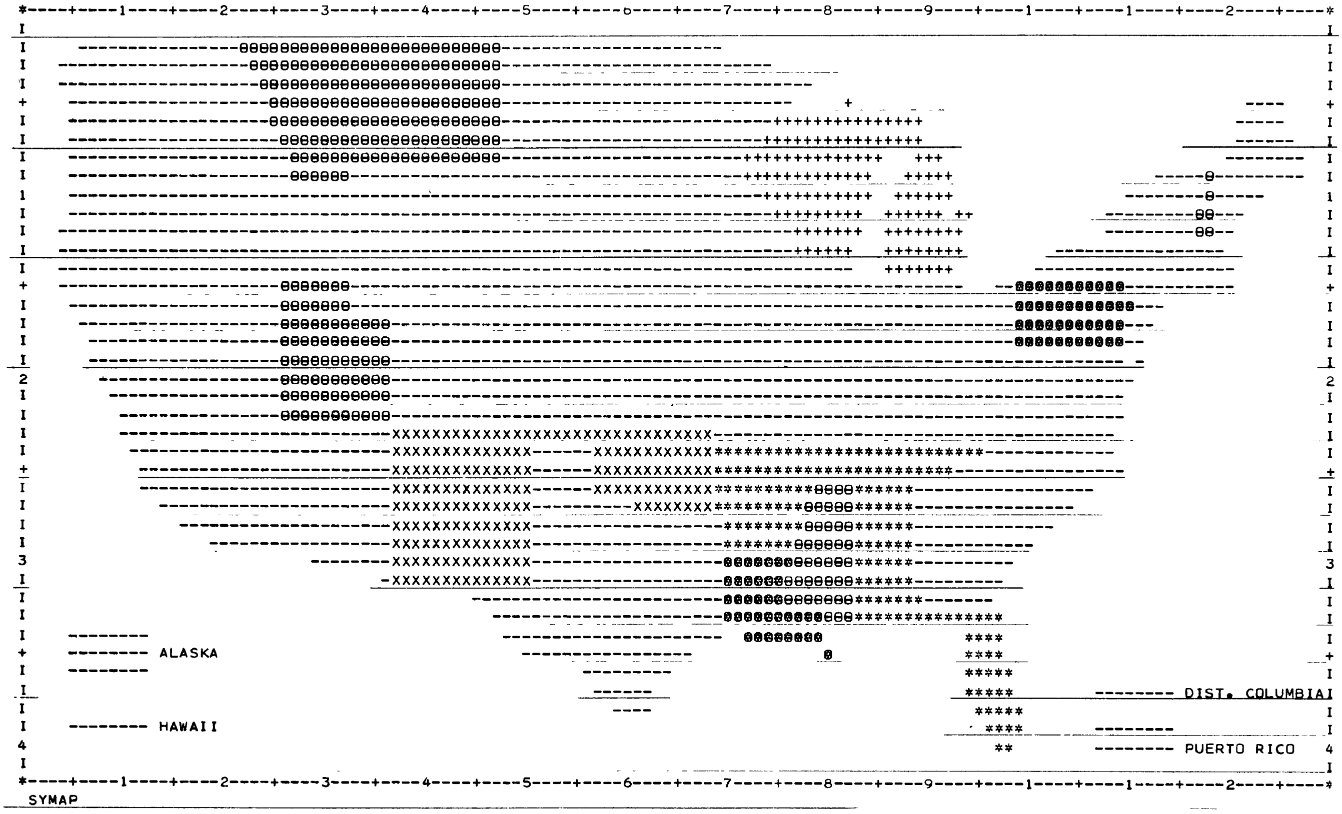

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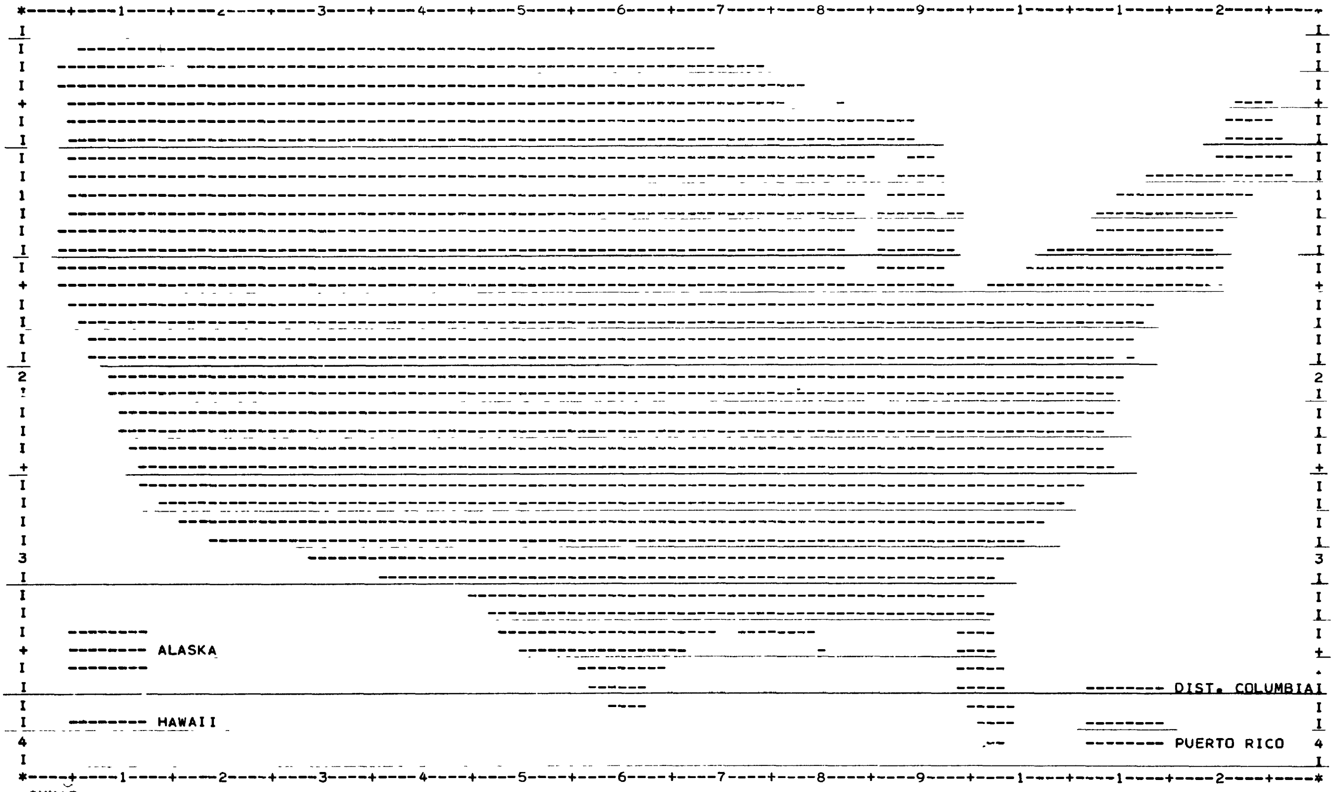

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PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

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      2                        I**3**I   IXX4XXI   I@@5@@I   I@@6@@I   I■■7■■I
      3                                  IXX4XXI   I@@5@@I   I@@6@@I   I■■7■■I
      4                                  IXX4XXI   I@@5@@I   I@@6@@I   I■■7■■I
      5                                            I@@5@@I   I@@6@@I   I■■7■■I
      6                                            I@@5@@I   I@@6@@I   I■■7■■I
      7                                            I@@5@@I   I@@6@@I   I■■7■■I
      8                                            I@@5@@I   I@@6@@I
      9                                            I@@5@@I   I@@6@@I
      0                                            I@@5@@I   I@@6@@I
      1                                            I@@5@@I   I@@6@@I
     12                                            I@@5@@I   I@@6@@I
     13                                            I@@5@@I   I@@6@@I
     14                                            I@@5@@I   I@@6@@I
     15                                            I@@5@@I   I@@6@@I
     16                                            I@@5@@I   I@@6@@I
     17                                            I@@5@@I   I@@6@@I
     18                                                      I@@6@@I
     19                                                      I@@6@@I
     20                                                      I@@6@@I
     21                                                      I@@6@@I
```

TIME = 0.0

SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C DRIVER LICENSING, FY68 THRU FY70 (HSP STANDARD 4.4.5)

DATA VALUE EXTREMES ARE 0.0 26.98

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL        1         2         3         4         5         6         7
          =================================================================
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
 SYMBOLS  ----1---- ++++2++++ ****3**** XXXX4XXXX 0000500000 00006000 ■■■■7■■■■
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
          =================================================================
 FREQ.       10         7         9         7        11         8         0
        1  I--1--I   I++2++I   I**3**I   IXX4XXI   I005001   I006001
        2  I--1--I   I++2++I   I**3**I   IXX4XXI   I005001   I006001
        3  I--1--I   I++2++I   I**3**I   IXX4XXI   I005001   I006001
        4  I--1--I   I++2++I   I**3**I   IXX4XXI   I005001   I006001
        5  I--1--I   I++2++I   I**3**I   IXX4XXI   I005001   I006001
        6  I--1--I   I++2++I   I**3**I   IXX4XXI   I005001   I006001
        7  I--1--I   I++2++I   I**3**I   IXX4XXI   I005001   I006001
        8  I--1--I             I**3**I             I005001   I006001
        9  I--1--I             I**3**I             I005001
       10  I--1--I                                 I005001
       11                                          I005001
```

TIME = 0.0

SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C CODES AND LAWS, FY68 THRU FY70 (HSP STANDARD 4.4.6)

DATA VALUE EXTREMES ARE 0.0 5.88

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL          1         2         3         4         5         6         7
           =================================================================
            --------- +++++++++ ********* XXXXXXXXX ΘΘΘΘΘΘΘΘΘ ΘΘΘΘΘΘΘΘΘ █████████
            --------- +++++++++ ********* XXXXXXXXX ΘΘΘΘΘΘΘΘΘ ΘΘΘΘΘΘΘΘΘ █████████
 SYMBOLS    ----1---- ++++2++++ ****3**** XXXX4XXXX ΘΘΘΘ5ΘΘΘΘ ΘΘΘΘ6ΘΘΘΘ ████7████
            --------- +++++++++ ********* XXXXXXXXX ΘΘΘΘΘΘΘΘΘ ΘΘΘΘΘΘΘΘΘ █████████
            --------- +++++++++ ********* XXXXXXXXX ΘΘΘΘΘΘΘΘΘ ΘΘΘΘΘΘΘΘΘ █████████
           =================================================================
 FREQ.         27        22         2         1         0         0         0
          1  I--1--I   I++2++I   I**3**I   IXX4XXI
          2  I--1--I   I++2++I   I**3**I
          3  I--1--I   I++2++I
          4  I--1--I   I++2++I
          5  I--1--I   I++2++I
          6  I--1--I   I++2++I
          7  I--1--I   I++2++I
          8  I--1--I   I++2++I
          9  I--1--I   I++2++I
         10  I--1--I   I++2++I
         11  I--1--I   I++2++I
         12  I--1--I   I++2++I
         13  I--1--I   I++2++I
         14  I--1--I   I++2++I
         15  I--1--I   I++2++I
         16  I--1--I   I++2++I
         17  I--1--I   I++2++I
         18  I--1--I   I++2++I
         19  I--1--I   I++2++I
         20  I--1--I   I++2++I
         21  I--1--I   I++2++I
         22  I--1--I   I++2++I
         23  I--1--I
         24  I--1--I
```

SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C TRAFFIC COURTS, FY68 THRU FY70 (HSP STANDARD 4.4.7)

DATA VALUE EXTREMES ARE 0.0 9.67

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

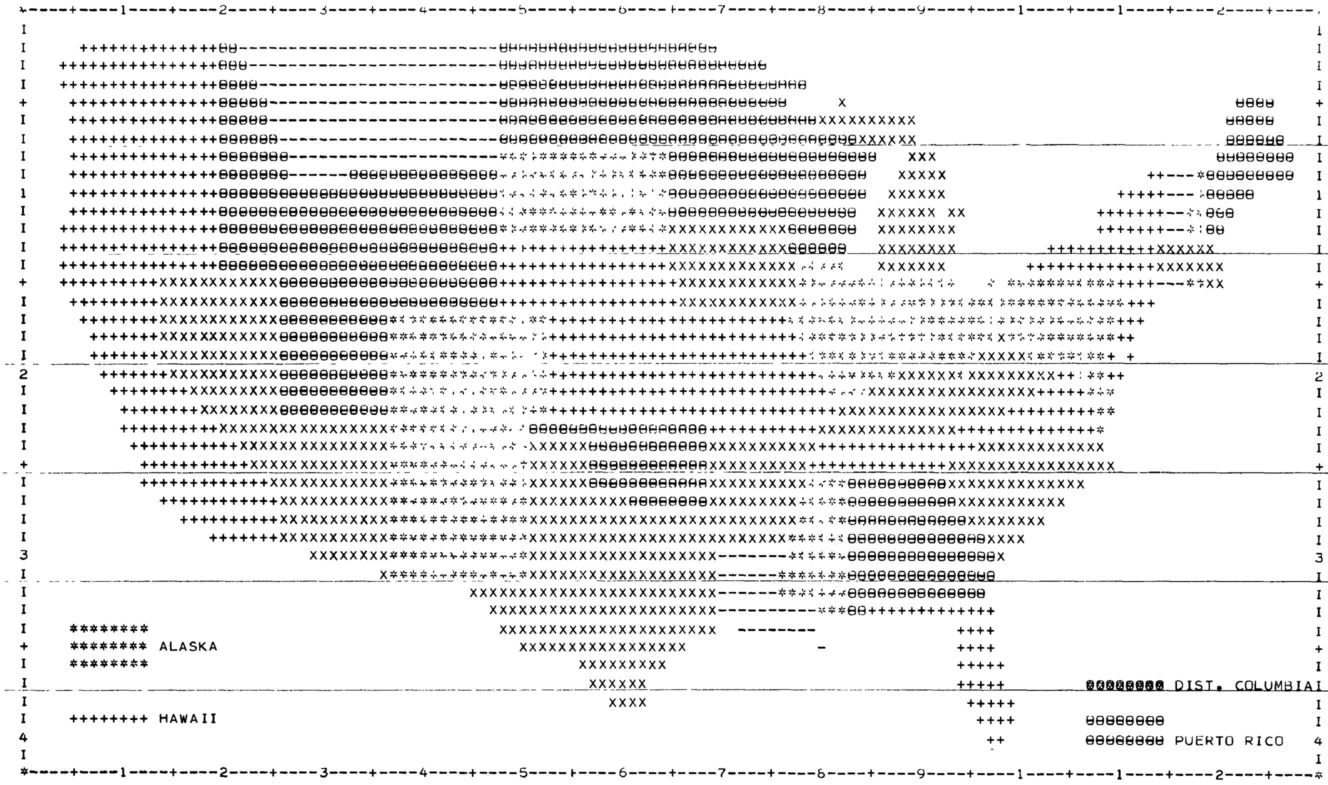
MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5	6	7
	---------	+++++++++	*********	XXXXXXXXX	000000000	000000000	■■■■■■■■■
	---------	+++++++++	*********	XXXXXXXXX	000000000	000000000	■■■■■■■■■
SYMBOLS	----1----	++++2++++	****3****	XXXX4XXXX	000050000	000060000	■■■■7■■■■
	---------	+++++++++	*********	XXXXXXXXX	000000000	000000000	■■■■■■■■■
	---------	+++++++++	*********	XXXXXXXXX	000000000	000000000	■■■■■■■■■
FREQ.	32	14	3	2	1	0	0
1	I--1--I	I++2++I	I**3**I	IXX4XXI	I00500I		
2	I--1--I	I++2++I	I**3**I	IXX4XXI			
3	I--1--I	I++2++I	I**3**I				
4	I--1--I	I++2++I					
5	I--1--I	I++2++I					
6	I--1--I	I++2++I					
7	I--1--I	I++2++I					
8	I--1--I	I++2++I					
9	I--1--I	I++2++I					
10	I--1--I	I++2++I					
11	I--1--I	I++2++I					
12	I--1--I	I++2++I					
13	I--1--I	I++2++I					
14	I--1--I	I++2++I					
15	I--1--I						
16	I--1--I						
17	I--1--I						
18	I--1--I						
19	I--1--I						
20	I--1--I						
21	I--1--I						
22	I--1--I						
23	I--1--I						
24	I--1--I						



SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C ALCOHOL IN RELATION TO HIGHWAY SAFETY, FY68 THRU FY70

C (HSP STANDARD 4.4.8)

DATA VALUE EXTREMES ARE 0.0 16.75

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
  LEVEL        1          2          3          4          5          6          7
           ==============================================================
           --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 █████████
           --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 █████████
  SYMBOLS  ----1---- ++++2++++ ****3**** XXXX4XXXX 0000500000 000060000 ████7████
           --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 █████████
           --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 █████████
           ==============================================================
  FREQ.        4          13         12         11         11         1          0
         1  I--1--I    I++2++I    I**3**I    IXX4XXI    I00500I    I00600I
         2  I--1--I    I++2++I    I**3**I    IXX4XXI    I00500I
         3  I--1--I    I++2++I    I**3**I    IXX4XXI    I00500I
         4  I--1--I    I++2++I    I**3**I    IXX4XXI    I00500I
         5             I++2++I    I**3**I    IXX4XXI    I00500I
         6             I++2++I    I**3**I    IXX4XXI    I00500I
         7             I++2++I    I**3**I    IXX4XXI    I00500I
         8             I++2++I    I**3**I    IXX4XXI    I00500I
         9             I++2++I    I**3**I    IXX4XXI    I00500I
        10             I++2++I    I**3**I    IXX4XXI    I00500I
        11             I++2++I    I**3**I    IXX4XXI    I00500I
        12             I++2++I    I**3**I
        13             I++2++I
```

TIME = 0.0

SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C IDENTIFICATION AND SURVEILLANCE OF ACCIDENT LOCATIONS

C FY68 THRU FY70 (HSP STANDARD 4.4.9)

DATA VALUE EXTREMES ARE 0.0 14.15

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

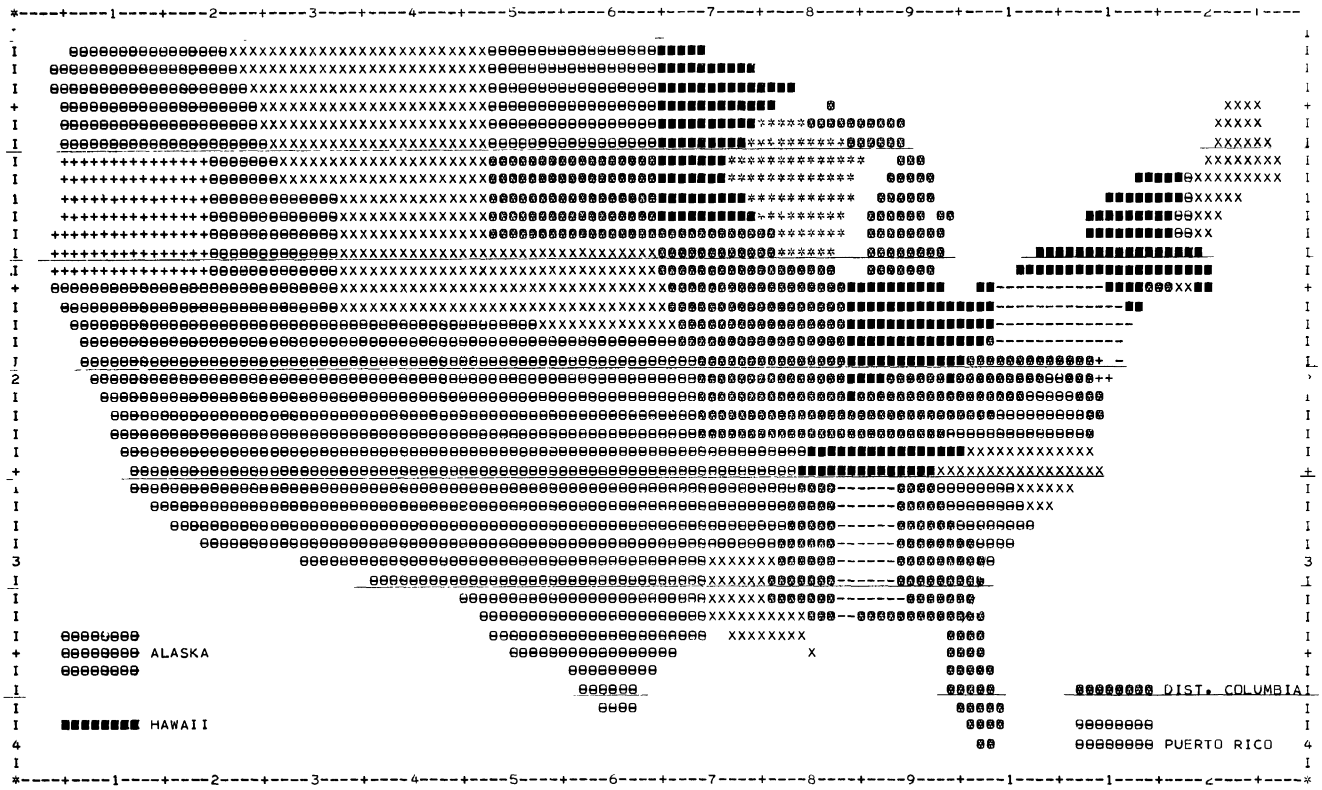
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
  LEVEL        1          2          3          4          5          6          7
          =================================================================
           ---------  +++++++++  *********  XXXXXXXXX  000000000  000000000  ■■■■■■■■■
           ---------  +++++++++  *********  XXXXXXXXX  000000000  000000000  ■■■■■■■■■
  SYMBOLS  ----1----  ++++2++++  ****3****  XXXX4XXXX  0000500000 0000600000 ■■■■7■■■■
           ---------  +++++++++  *********  XXXXXXXXX  000000000  000000000  ■■■■■■■■■
           ---------  +++++++++  *********  XXXXXXXXX  000000000  000000000  ■■■■■■■■■
          =================================================================
  FREQ.       17         14          8          8          5          0          0
          1  I--1--I    I++2++I    I**3**I    IXX4XXI    I005001
          2  I--1--I    I++2++I    I**3**I    IXX4XXI    I005001
          3  I--1--I    I++2++I    I**3**I    IXX4XXI    I005001
          4  I--1--I    I++2++I    I**3**I    IXX4XXI    I005001
          5  I--1--I    I++2++I    I**3**I    IXX4XXI    I005001
          6  I--1--I    I++2++I    I**3**I    IXX4XXI
          7  I--1--I    I++2++I    I**3**I    IXX4XXI
          8  I--1--I    I++2++I    I**3**I    IXX4XXI
          9  I--1--I    I++2++I
         10  I--1--I    I++2++I
         11  I--1--I    I++2++I
         12  I--1--I    I++2++I
         13  I--1--I    I++2++I
         14  I--1--I    I++2++I
         15  I--1--I
         16  I--1--I
         17  I--1--I
```

TIME = 0.0



SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C TRAFFIC RECORDS, FY68 THRU FY70 (HSP STANDARD 4.4.10)

DATA VALUE EXTREMES ARE 0.0 65.70

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

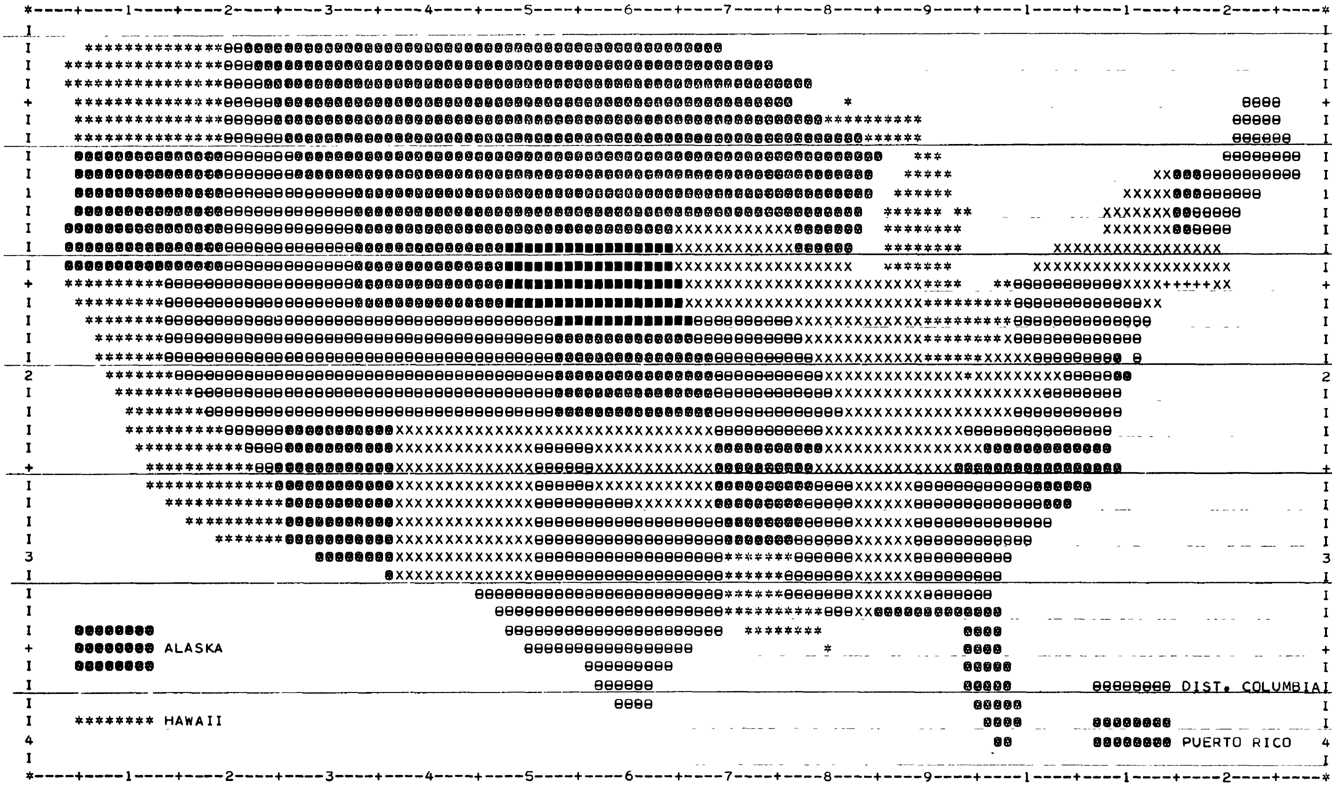
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL        1         2         3         4         5         6         7
         =================================================================
         --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 █████████
         --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 █████████
 SYMBOLS ----1---- ++++2++++ ****3**** XXXX4XXXX 000050000 000060000 ████7████
         --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 █████████
         --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 █████████
         =================================================================
 FREQ.        3         2         1         7        18        13         8
     1   I--1--I   I++2++I   I**3**I   IXX4XXI   I005001I  I006001I  I██7██I
     2   I--1--I   I++2++I             IXX4XXI   I005001I  I006001I  I██7██I
     3   I--1--I                       IXX4XXI   I005001I  I006001I  I██7██I
     4                                 IXX4XXI   I005001I  I006001I  I██7██I
     5                                 IXX4XXI   I005001I  I006001I  I██7██I
     6                                 IXX4XXI   I005001I  I006001I  I██7██I
     7                                 IXX4XXI   I005001I  I006001I  I██7██I
     8                                           I005001I  I006001I  I██7██I
     9                                           I005001I  I006001I
    10                                           I005001I  I006001I
    11                                           I005001I  I006001I
    12                                           I005001I  I006001I
    13                                           I005001I  I006001I
    14                                           I005001I
    15                                           I005001I
    16                                           I005001I
    17                                           I005001I
    18                                           I005001I
```

TIME = 0.0



SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C EMERGENCY MEDICAL SERVICES, FY68 THRU FY70 (HSP STANDARD 4.4.11)

DATA VALUE EXTREMES ARE 0.65 44.33

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

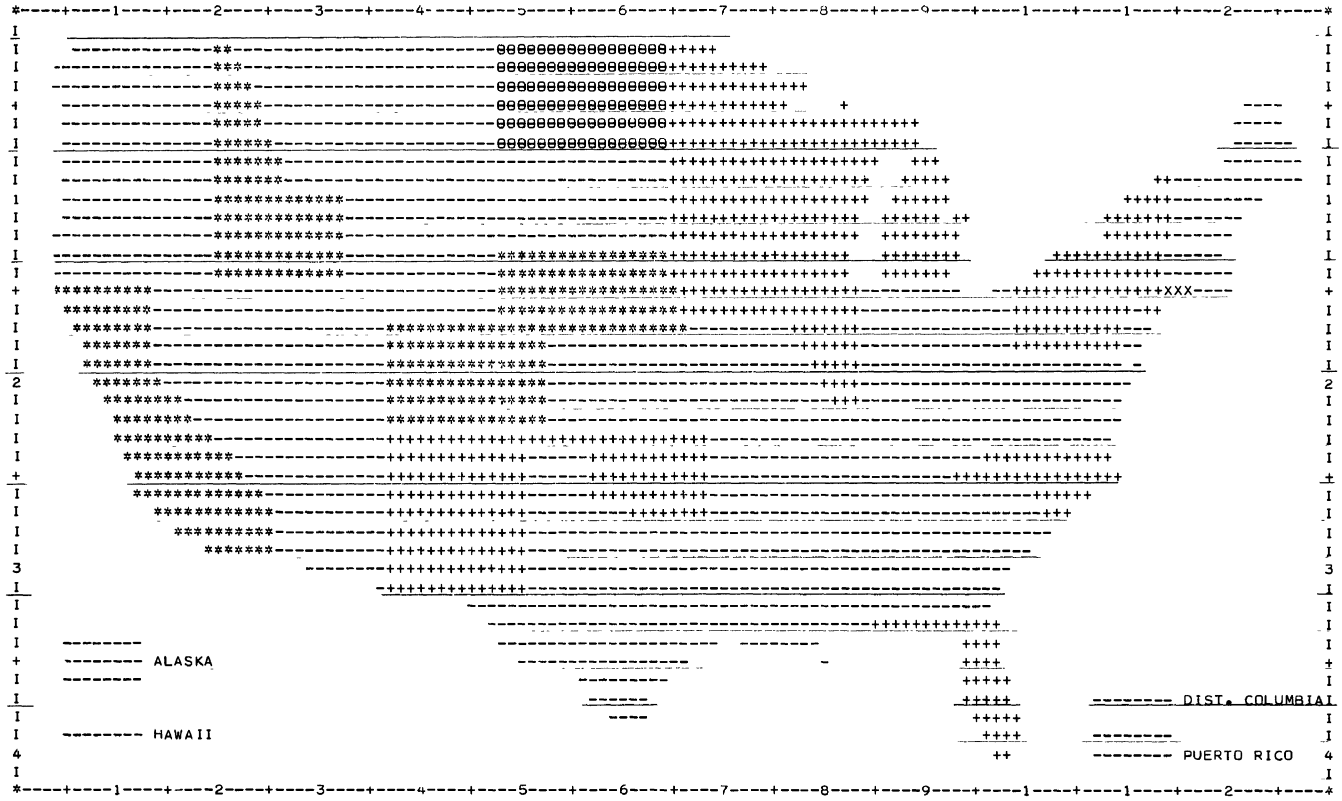
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL        1          2          3          4          5          6          7
          ==================================================================
          ---------  +++++++++  *********  XXXXXXXXX  @@@@@@@@@  @@@@@@@@@  █████████
          ---------  +++++++++  *********  XXXXXXXXX  @@@@@@@@@  @@@@@@@@@  █████████
 SYMBOLS  ----1----  ++++2++++  ****3****  XXXX4XXXX  @@@@5@@@@  @@@@6@@@@  ████7████
          ---------  +++++++++  *********  XXXXXXXXX  @@@@@@@@@  @@@@@@@@@  █████████
          ---------  +++++++++  *********  XXXXXXXXX  @@@@@@@@@  @@@@@@@@@  █████████
          ==================================================================
 FREQ.        0          2          6          11         16         16         1
       1              I++2++I    I**3**I    IXX4XXI    I@@5@@I    I@@6@@I    I██7██I
       2              I++2++I    I**3**I    IXX4XXI    I@@5@@I    I@@6@@I
       3                         I**3**I    IXX4XXI    I@@5@@I    I@@6@@I
       4                         I**3**I    IXX4XXI    I@@5@@I    I@@6@@I
       5                         I**3**I    IXX4XXI    I@@5@@I    I@@6@@I
       6                         I**3**I    IXX4XXI    I@@5@@I    I@@6@@I
       7                                    IXX4XXI    I@@5@@I    I@@6@@I
       8                                    IXX4XXI    I@@5@@I    I@@6@@I
       9                                    IXX4XXI    I@@5@@I    I@@6@@I
      10                                    IXX4XXI    I@@5@@I    I@@6@@I
      11                                    IXX4XXI    I@@5@@I    I@@6@@I
      12                                               I@@5@@I    I@@6@@I
      13                                               I@@5@@I    I@@6@@I
      14                                               I@@5@@I    I@@6@@I
      15                                               I@@5@@I    I@@6@@I
      16                                               I@@5@@I    I@@6@@I
```

TIME = 0.0



SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C HIGHWAY DESIGN, CONSTRUCTION AND MAINTENANCE, FY68 THRU FY70

C (HSP STANDARD 4.4.12)

DATA VALUE EXTREMES ARE 0.0 10.86

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL        1         2         3         4         5         6         7
         =================================================================
         --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
         --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
SYMBOLS  ----1---- ++++2++++ ****3**** XXXX4XXXX 000050000 000060000 ■■■■7■■■■
         --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
         --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
         =================================================================
FREQ.       35        11         4         1         1         0         0
       1  I--1--I   I++2++I   I**3**I   IXX4XXI   I005001
       2  I--1--I   I++2++I   I**3**I
       3  I--1--I   I++2++I   I**3**I
       4  I--1--I   I++2++I   I**3**I
       5  I--1--I   I++2++I
       6  I--1--I   I++2++I
       7  I--1--I   I++2++I
       8  I--1--I   I++2++I
       9  I--1--I   I++2++I
      10  I--1--I   I++2++I
      11  I--1--I   I++2++I
      12  I--1--I
      13  I--1--I
      14  I--1--I
      15  I--1--I
      16  I--1--I
      17  I--1--I
      18  I--1--I
      19  I--1--I
      20  I--1--I
      21  I--1--I
      22  I--1--I
      23  I--1--I
      24  I--1--I
```

SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C TRAFFIC CONTROL DEVICES, FY68 THRU FY70 (HSP STANDARD 4.4.13)

DATA VALUE EXTREMES ARE 0.0 15.10

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

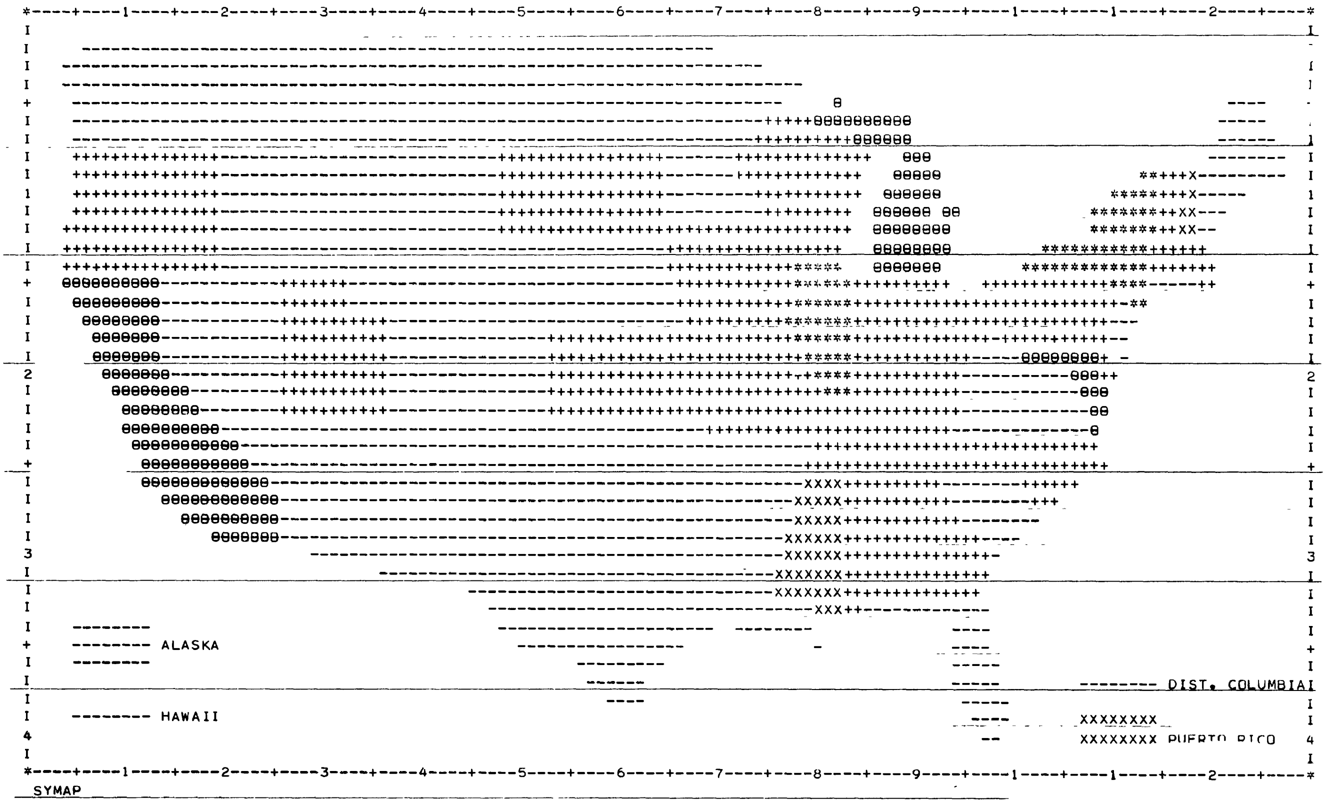
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
  LEVEL       1         2         3         4         5         6         7
          =================================================================
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
  SYMBOLS ----1---- ++++2++++ ****3**** XXXX4XXXX 00005000 0000600000 ■■■■7■■■■
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
          =================================================================
  FREQ.      18        22         2         8         2         0         0
        1  I--1--I   I++2++I   I**3**I   IXX4XXI   I005001
        2  I--1--I   I++2++I   I**3**I   IXX4XXI   I005001
        3  I--1--I   I++2++I             IXX4XXI
        4  I--1--I   I++2++I             IXX4XXI
        5  I--1--I   I++2++I             IXX4XXI
        6  I--1--I   I++2++I             IXX4XXI
        7  I--1--I   I++2++I             IXX4XXI
        8  I--1--I   I++2++I             IXX4XXI
        9  I--1--I   I++2++I
       10  I--1--I   I++2++I
       11  I--1--I   I++2++I
       12  I--1--I   I++2++I
       13  I--1--I   I++2++I
       14  I--1--I   I++2++I
       15  I--1--I   I++2++I
       16  I--1--I   I++2++I
       17  I--1--I   I++2++I
       18  I--1--I   I++2++I
       19            I++2++I
       20            I++2++I
       21            I++2++I
       22            I++2++I
```

TIME = 0.0



SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C PEDESTRIAN SAFETY, FY68 THRU FY70 (HSP STANDARD 4.4.14)

DATA VALUE EXTREMES ARE 0.0 12.90

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

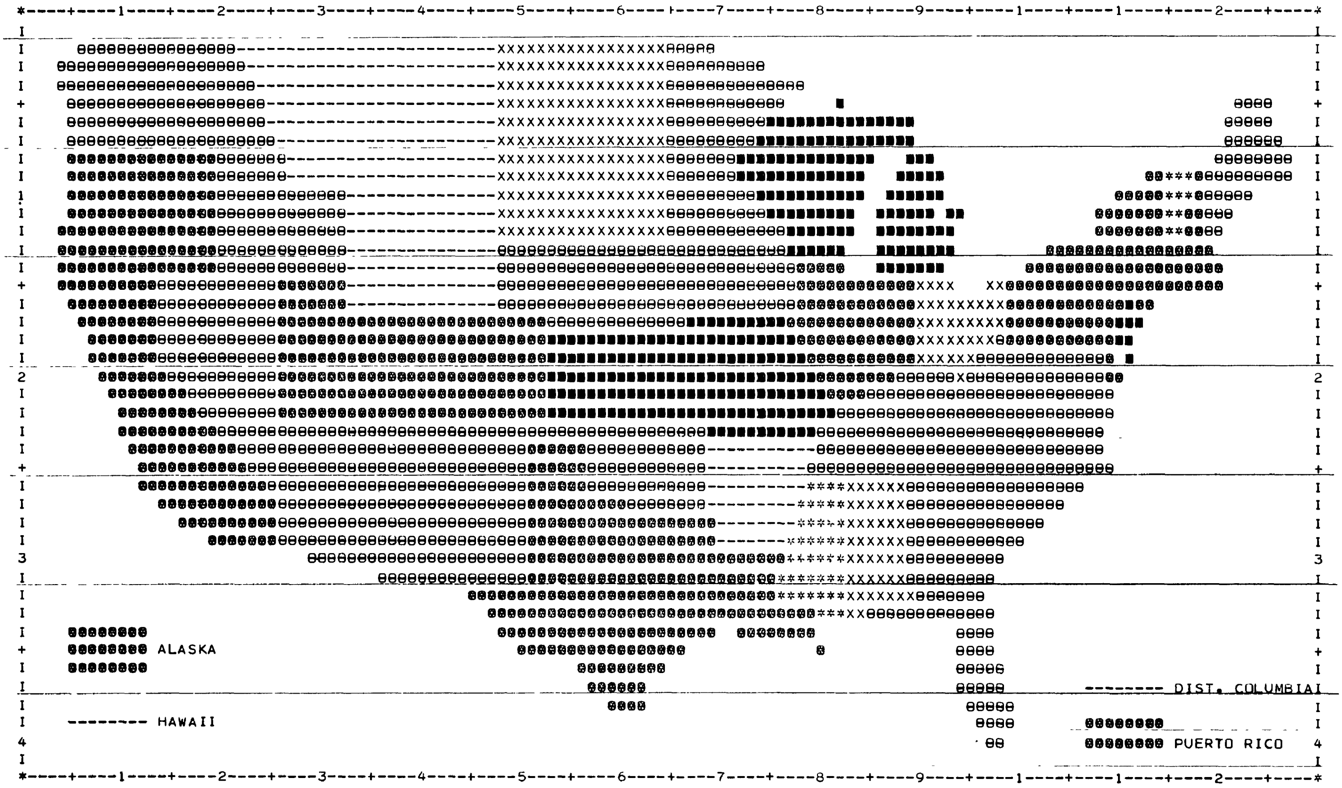
MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
LEVEL         1         2         3         4         5         6         7
          ===============================================================
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
SYMBOLS   ----1---- ++++2++++ ****3**** XXXX4XXXX 000050000 000060000 ■■■■7■■■■
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
          --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
          ===============================================================
FREQ.        26        18         2         3         3         0         0
       1  I--1--I   I++2++I   I**3**I   IXX4XXI   I00500I
       2  I--1--I   I++2++I   I**3**I   IXX4XXI   I00500I
       3  I--1--I   I++2++I             IXX4XXI   I00500I
       4  I--1--I   I++2++I
       5  I--1--I   I++2++I
       6  I--1--I   I++2++I
       7  I--1--I   I++2++I
       8  I--1--I   I++2++I
       9  I--1--I   I++2++I
      10  I--1--I   I++2++I
      11  I--1--I   I++2++I
      12  I--1--I   I++2++I
      13  I--1--I   I++2++I
      14  I--1--I   I++2++I
      15  I--1--I   I++2++I
      16  I--1--I   I++2++I
      17  I--1--I   I++2++I
      18  I--1--I   I++2++I
      19  I--1--I
      20  I--1--I
      21  I--1--I
      22  I--1--I
      23  I--1--I
      24  I--1--I
```



SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C POLICE TRAFFIC SERVICES, FY68 THRU FY70 (HSP STANDARD 4.4.15)

DATA VALUE EXTREMES ARE 0.0 46.57

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
 LEVEL        1          2          3          4          5          6          7
          =================================================================
          ---------  +++++++++  *********  XXXXXXXXX  @@@@@@@@@  @@@@@@@@@  ■■■■■■■■■
          ---------  +++++++++  *********  XXXXXXXXX  @@@@@@@@@  @@@@@@@@@  ■■■■■■■■■
 SYMBOLS  ----1----  ++++2++++  ****3****  XXXX4XXXX  @@@@5@@@@  @@@@6@@@@  ■■■■7■■■■
          ---------  +++++++++  *********  XXXXXXXXX  @@@@@@@@@  @@@@@@@@@  ■■■■■■■■■
          ---------  +++++++++  *********  XXXXXXXXX  @@@@@@@@@  @@@@@@@@@  ■■■■■■■■■
          =================================================================
 FREQ.        5          0          2          4         19         17          5
       1   I--1--I              I**3**I    IXX4XXI    I@@5@@I    I@@6@@I    I■■7■■I
       2   I--1--I              I**3**I    IXX4XXI    I@@5@@I    I@@6@@I    I■■7■■I
       3   I--1--I                         IXX4XXI    I@@5@@I    I@@6@@I    I■■7■■I
       4   I--1--I                         IXX4XXI    I@@5@@I    I@@6@@I    I■■7■■I
       5   I--1--I                                    I@@5@@I    I@@6@@I    I■■7■■I
       6                                              I@@5@@I    I@@6@@I
       7                                              I@@5@@I    I@@6@@I
       8                                              I@@5@@I    I@@6@@I
       9                                              I@@5@@I    I@@6@@I
      10                                              I@@5@@I    I@@6@@I
      11                                              I@@5@@I    I@@6@@I
      12                                              I@@5@@I    I@@6@@I
      13                                              I@@5@@I    I@@6@@I
      14                                              I@@5@@I    I@@6@@I
      15                                              I@@5@@I    I@@6@@I
      16                                              I@@5@@I    I@@6@@I
      17                                              I@@5@@I    I@@6@@I
      18                                              I@@5@@I
      19                                              I@@5@@I
```

TIME = 0.0

SYMAP

TIME = 0.0

C PERCENTAGE OF EACH STATE'S TOTAL AUTHORIZED FEDERAL "402" FUNDS FOR

C DEBRIS HAZARD CONTROL AND CLEANUP, FY68 THRU FY70,

C (HSP STANDARD 4.4.16)

DATA VALUE EXTREMES ARE 0.0 13.53

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	0.0	0.01	2.00	4.00	8.00	16.00	32.00
MAXIMUM	0.01	2.00	4.00	8.00	16.00	32.00	100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

0.01	1.99	2.00	4.00	8.00	16.00	68.00

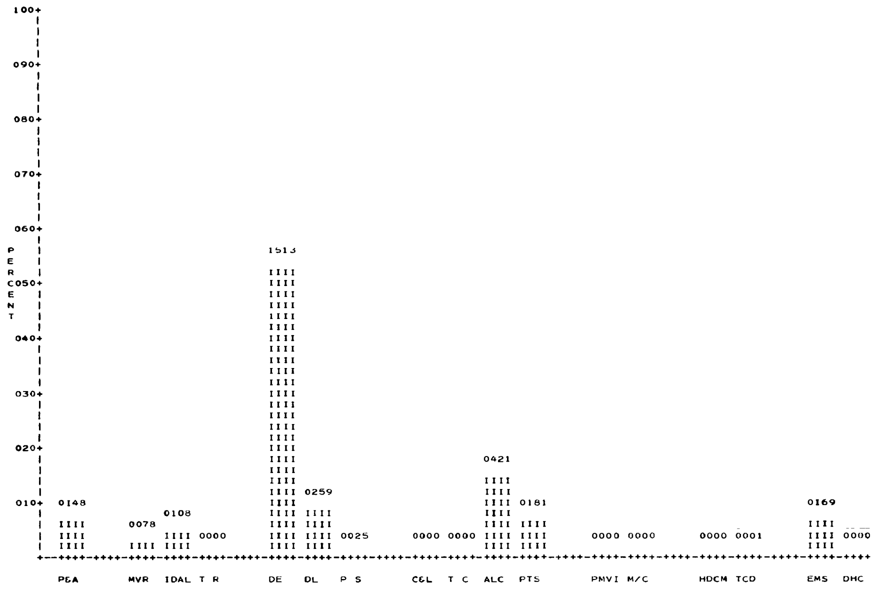
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

```
  LEVEL          1         2         3         4         5         6         7
           =================================================================
            --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
            --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
  SYMBOLS   ----1---- ++++2++++ ****3**** XXXX4XXXX 000050000 000060000 ■■■■7■■■■
            --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
            --------- +++++++++ ********* XXXXXXXXX 000000000 000000000 ■■■■■■■■■
           =================================================================
  FREQ.         42         6         2         1         1         0         0
          1  I--1--I   I++2++I   I**3**I   IXX4XXI   I00500I
          2  I--1--I   I++2++I   I**3**I
          3  I--1--I   I++2++I
          4  I--1--I   I++2++I
          5  I--1--I   I++2++I
          6  I--1--I   I++2++I
          7  I--1--I
          8  I--1--I
          9  I--1--I
         10  I--1--I
         11  I--1--I
         12  I--1--I
         13  I--1--I
         14  I--1--I
         15  I--1--I
         16  I--1--I
         17  I--1--I
         18  I--1--I
         19  I--1--I
         20  I--1--I
         21  I--1--I
         22  I--1--I
         23  I--1--I
         24  I--1--I
```

* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

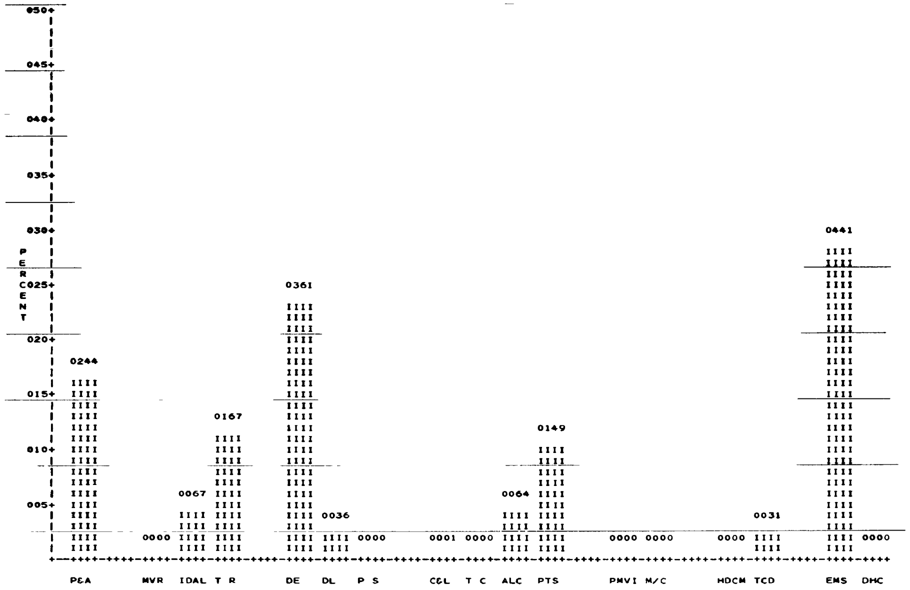
STATE ALA TOTAL FEDERAL FUNDS (THOUS$) $ 2903



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

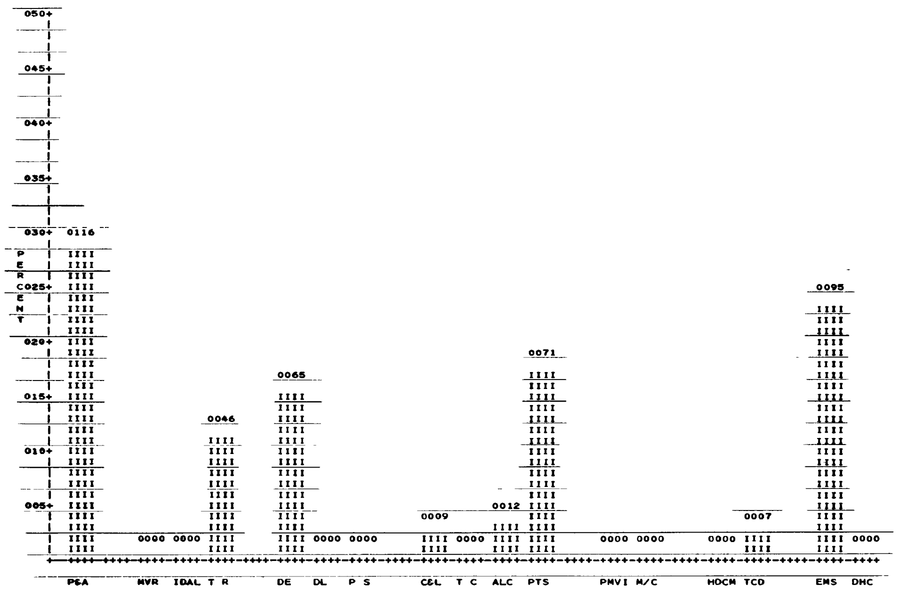
STATE: ARIZ TOTAL FEDERAL FUNDS (THOUS$) $ 1561



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

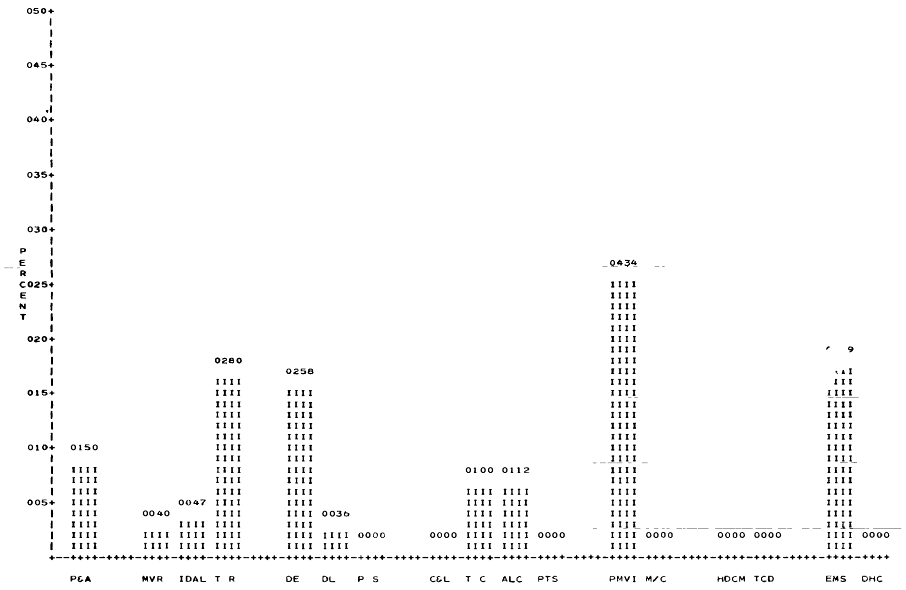
STATE: ALSK TOTAL FEDERAL FUNDS (THOUS$) $ 421



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

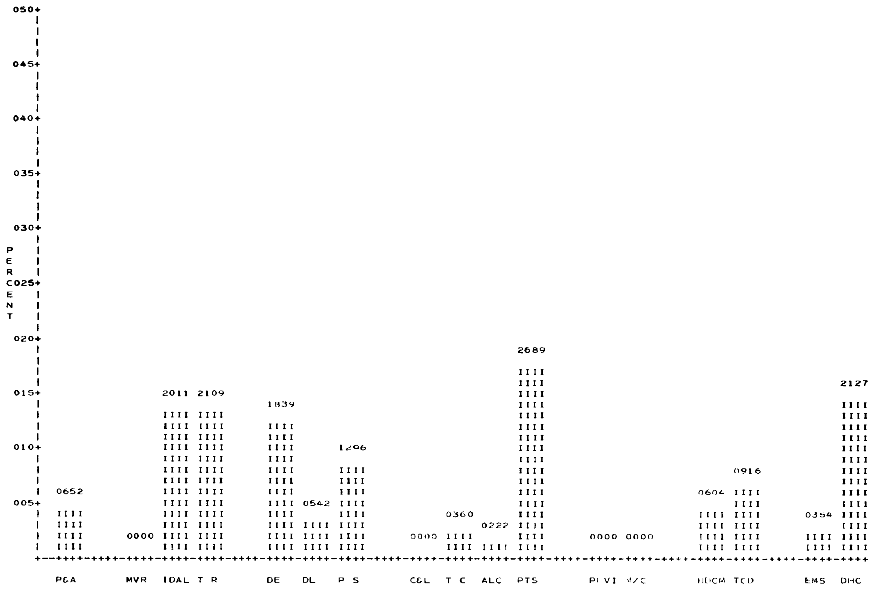
STATE ARK TOTAL FEDERAL FUNDS (THOUS$) $ 1766



* HSRI SYSTEMS - BAR GRAPH *

\- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

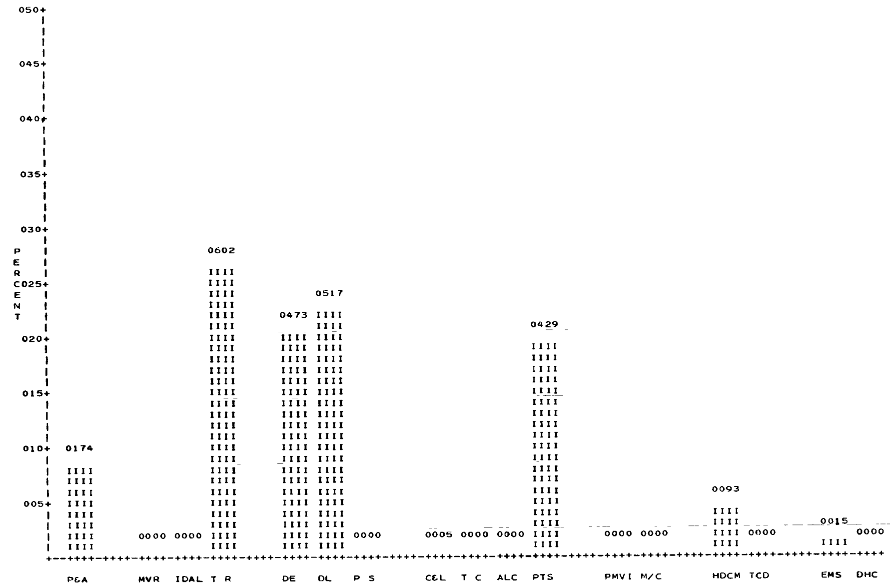
STATE: CAL TOTAL FEDERAL FUNDS (THOUS&) $ 15721



* HSRI SYSTEMS - BAR GRAPH *

\- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

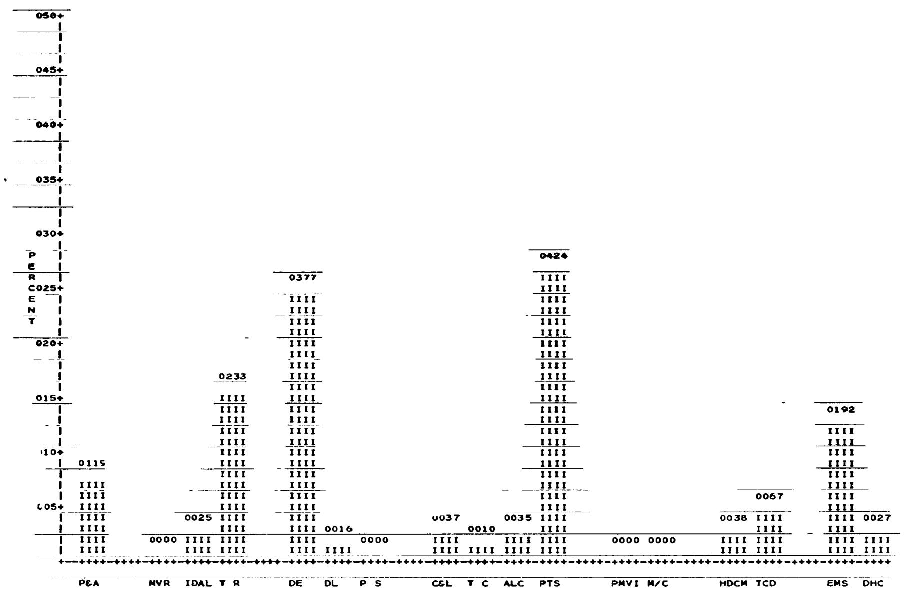
STATE CONN TOTAL FEDERAL FUNDS (THOUS&) $ 2308



* HSRI SYSTEMS - BAR GRAPH *

\- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

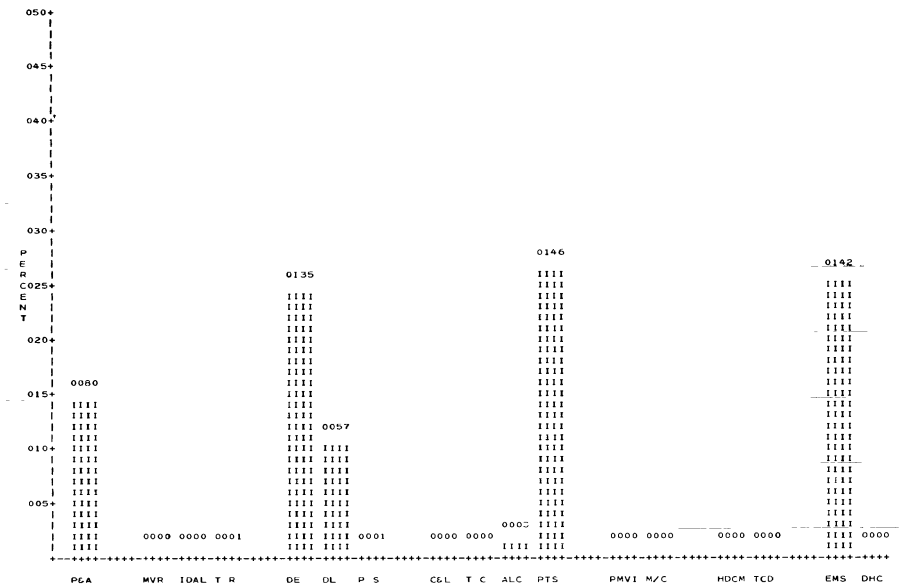
STATE: COLO TOTAL FEDERAL FUNDS (THOUS&) $ 1600



* HSRI SYSTEMS - BAR GRAPH *

\- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

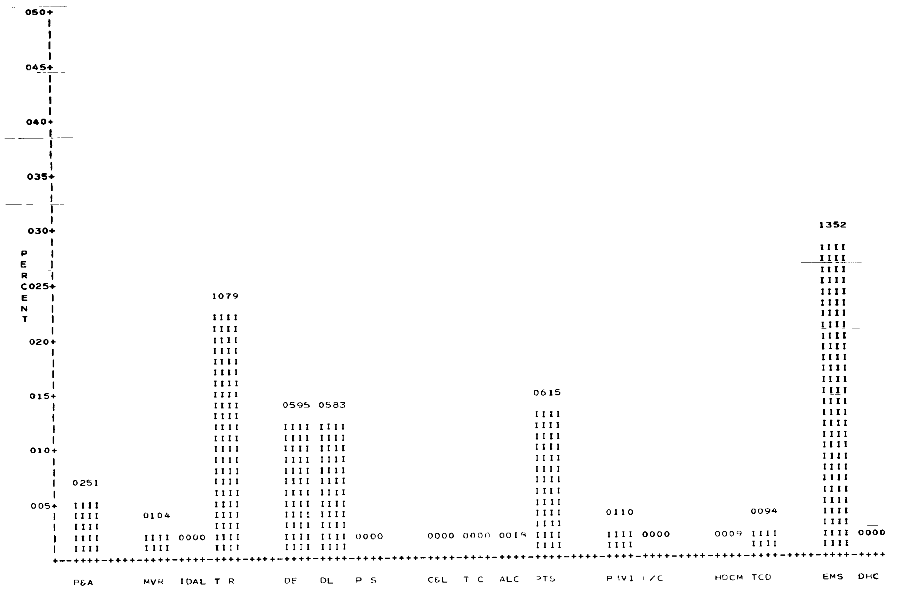
STATE DEL TOTAL FEDERAL FUNDS (THOUS&) 56



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

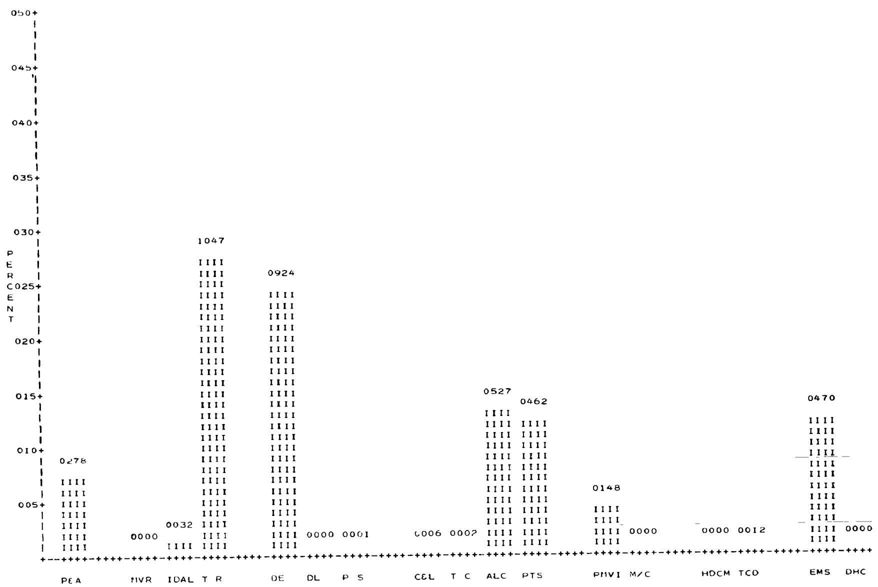
STATE: FLA TOTAL FEDERAL FUNDS (THOUS$) $ 4810



HSRI SYSTEMS - BAR GRAPH

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

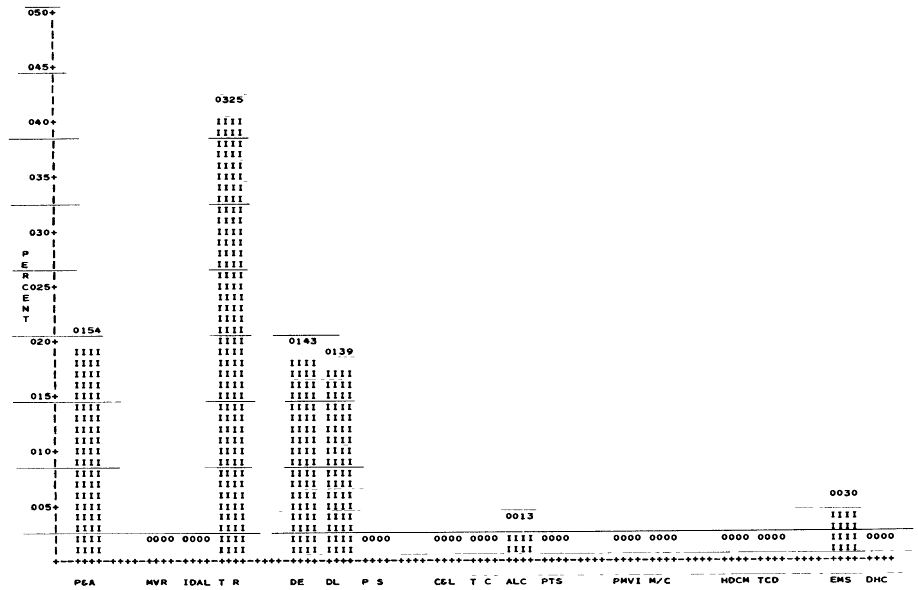
STATE: GA TOTAL FEDERAL FUNDS (THOUS$) $ [illegible]



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

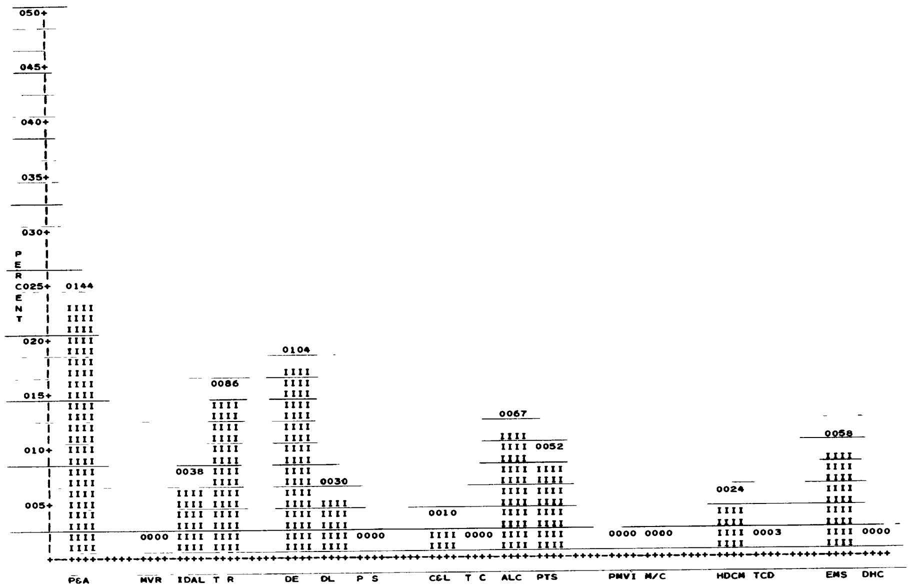
STATE: HAWI TOTAL FEDERAL FUNDS (THOUS$) $ 804



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

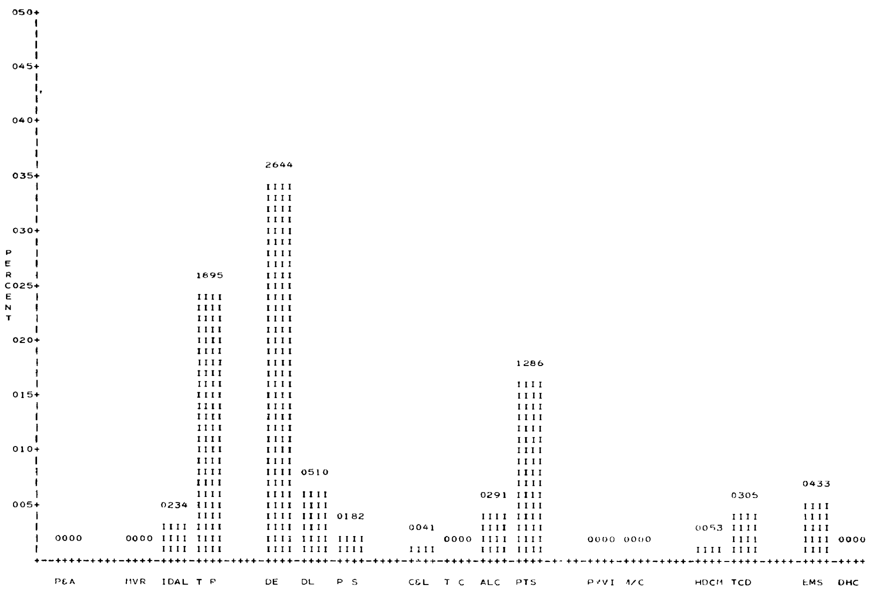
STATE: IDO TOTAL FEDERAL FUNDS (THOUS$) $ 616



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

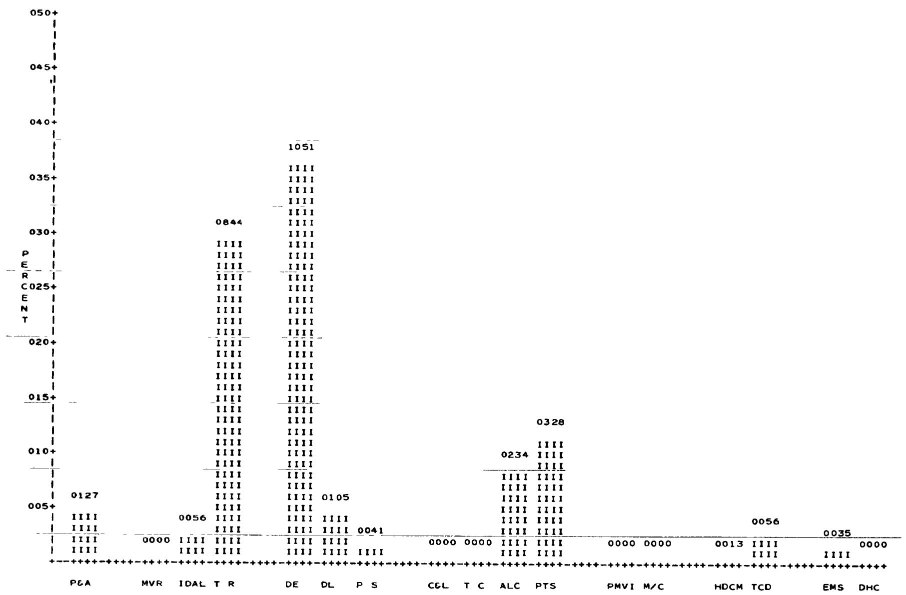
STATE: ILL TOTAL FEDERAL FUNDS (THOUS&) $ 7874



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

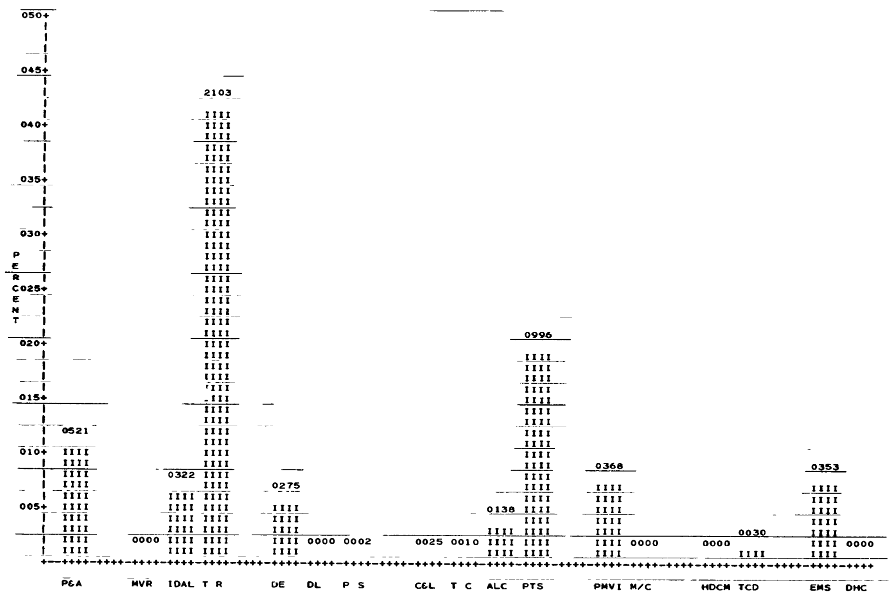
STATE: IOWA TOTAL FEDERAL FUNDS (THOUS&) $ 2890



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

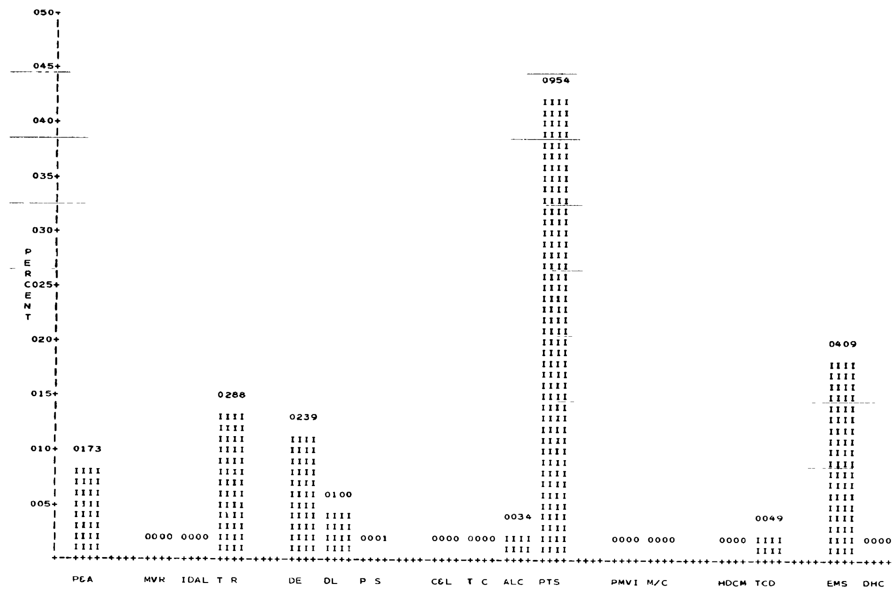
STATE: IND TOTAL FEDERAL FUNDS (THOUS&) $ 5143



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

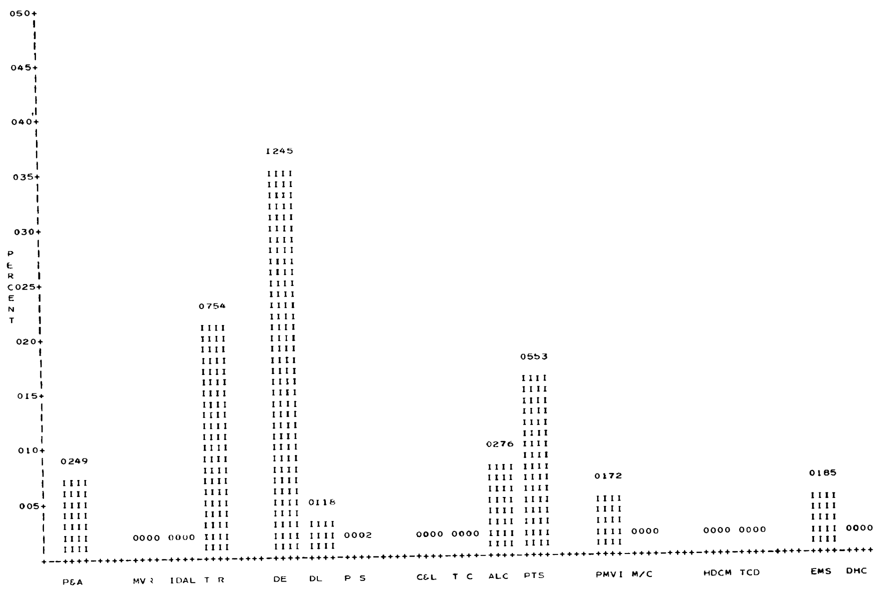
STATE: KAN TOTAL FEDERAL FUNDS (THOUS&) $ 2247



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

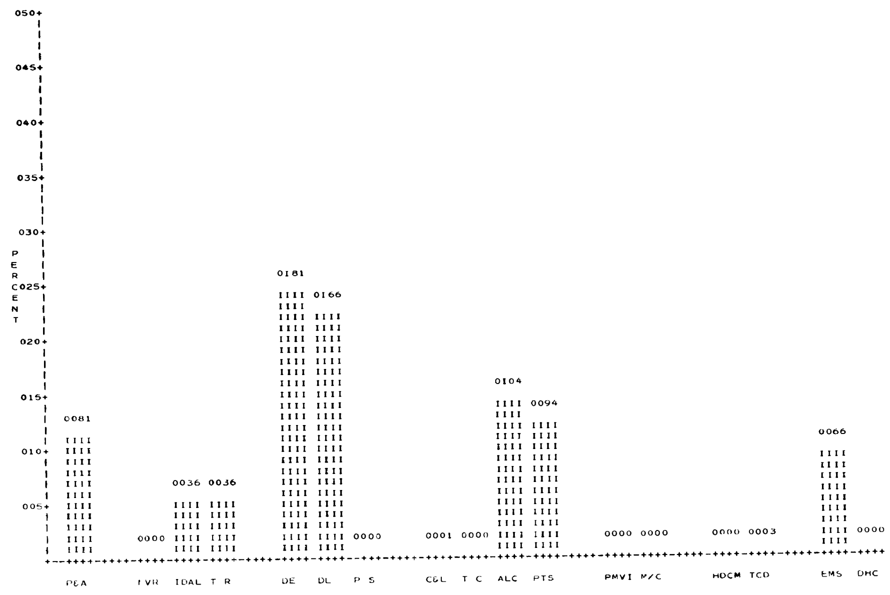
T TL PEN TOTAL FEDERAL FUNDS (THOUS$) $ 3554



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

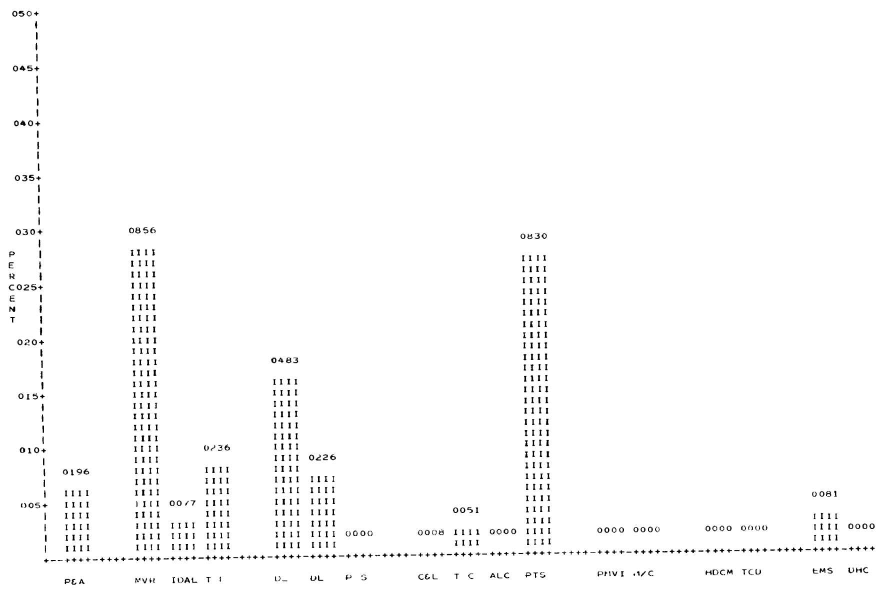
STATE: ME TOTAL FEDERAL FUNDS (THOUS$) $ 768



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

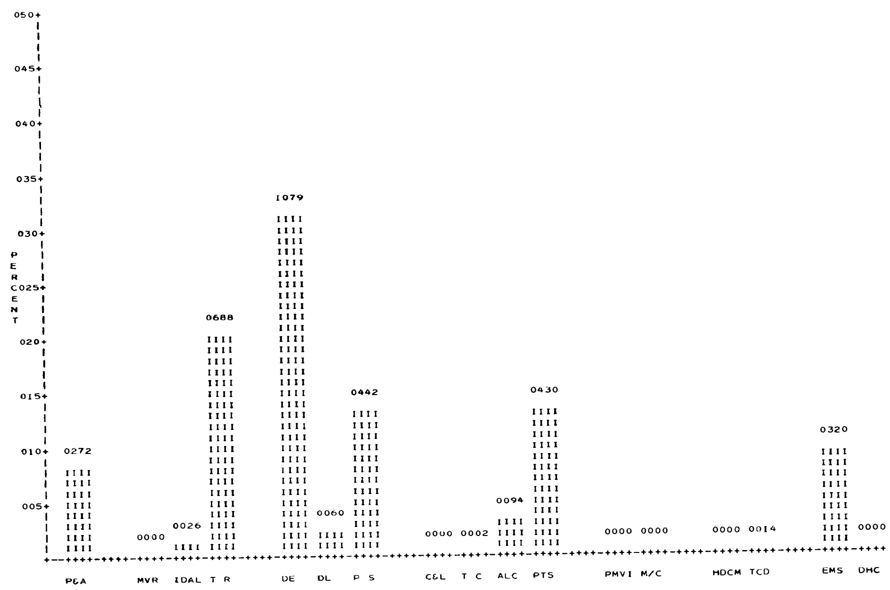
STATE. LA TOTAL FEDERAL FUNDS (THOUS$) $ 3044



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

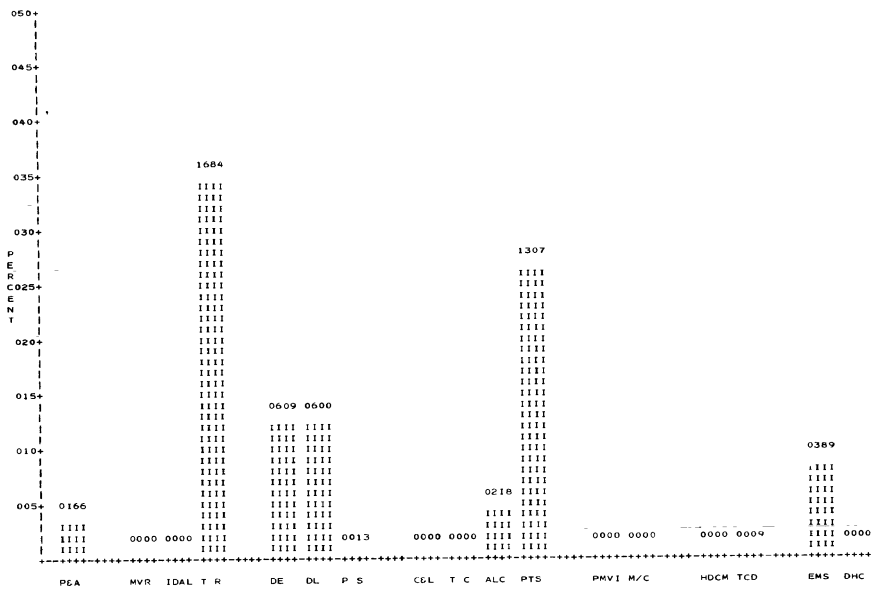
STATE MD TOTAL FEDERAL FUNDS (THOUS$) $ 3427



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

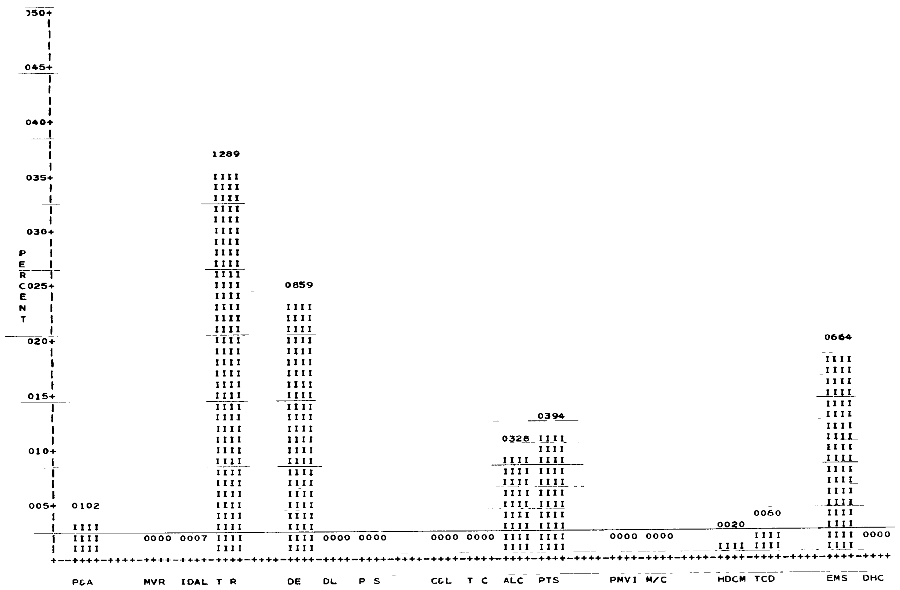
STATE MASS TOTAL FEDERAL FUNDS (THOUS$) $ 4995



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

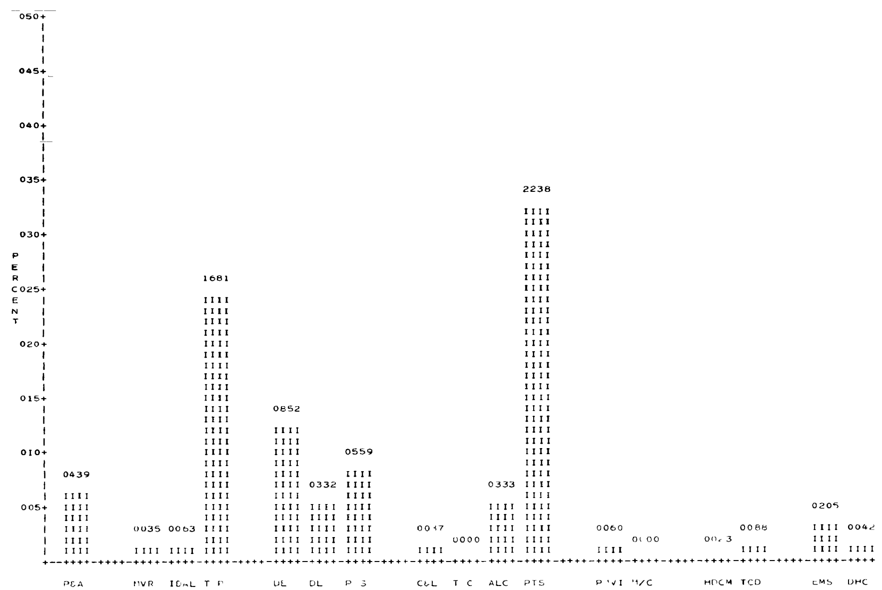
STATE: MINN TOTAL FEDERAL FUNDS (THOUS$) $ 3723



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

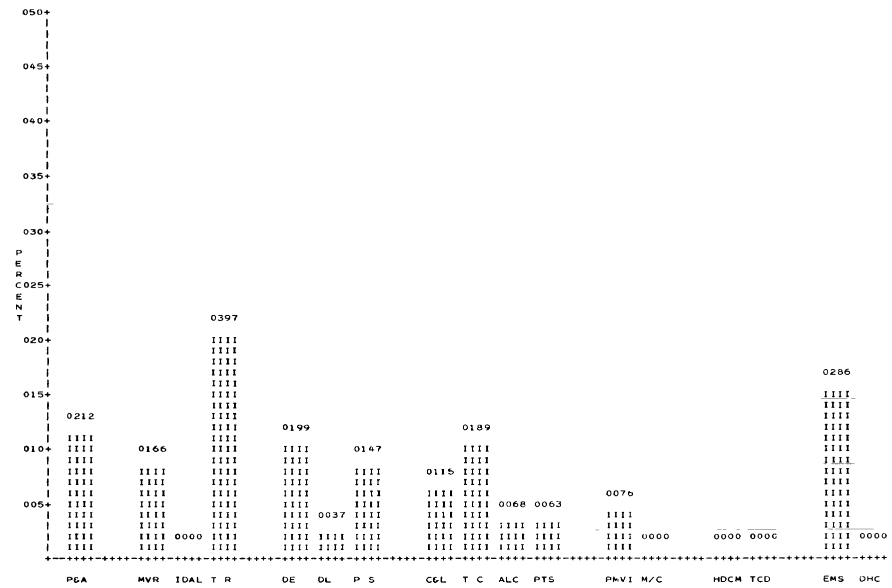
STATE MICH TOTAL FEDERAL FUNDS (THOUS$) $ 6987



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

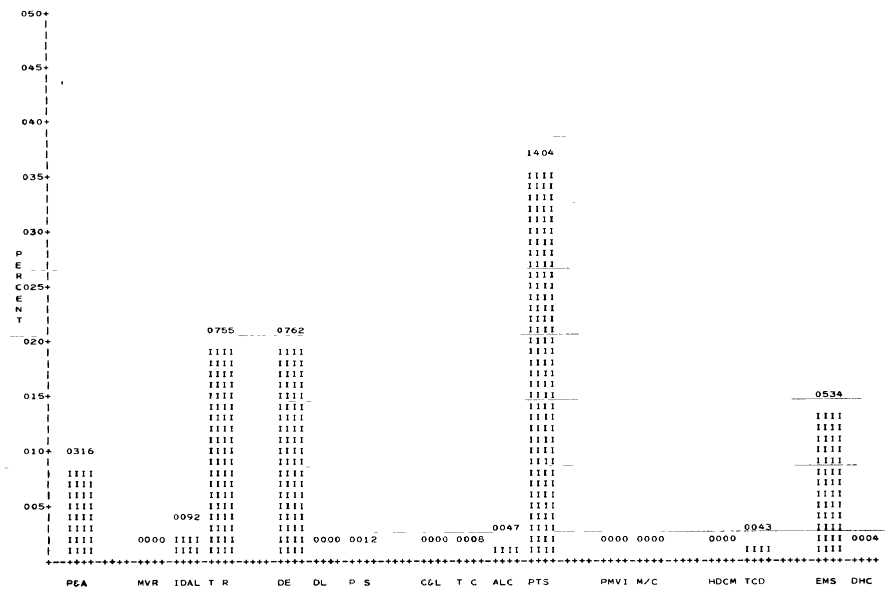
STATE: MISS TOTAL FEDERAL FUNDS (THOUS$) $ 1955



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

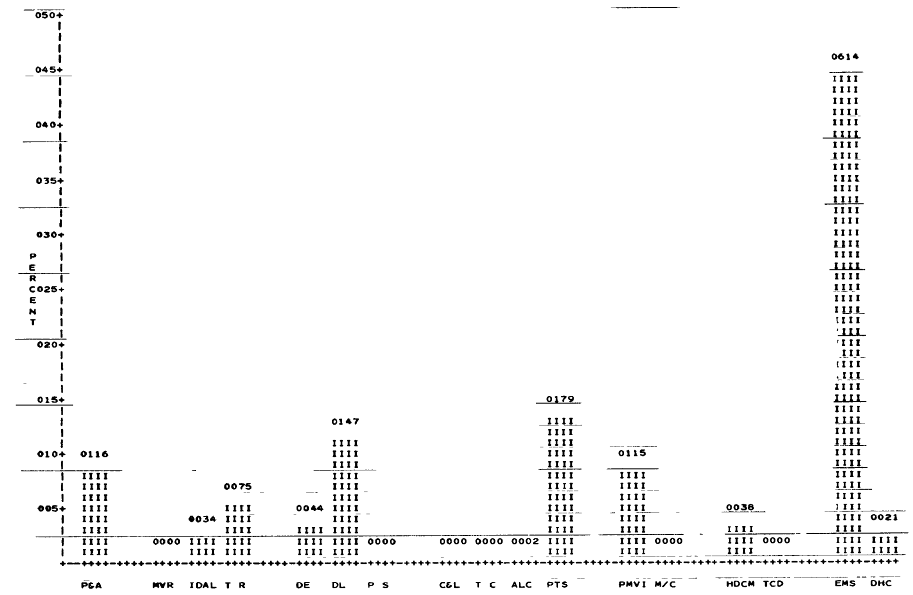
STATE MOU TOTAL FEDERAL FUNDS (THOUS&) $ 3477



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

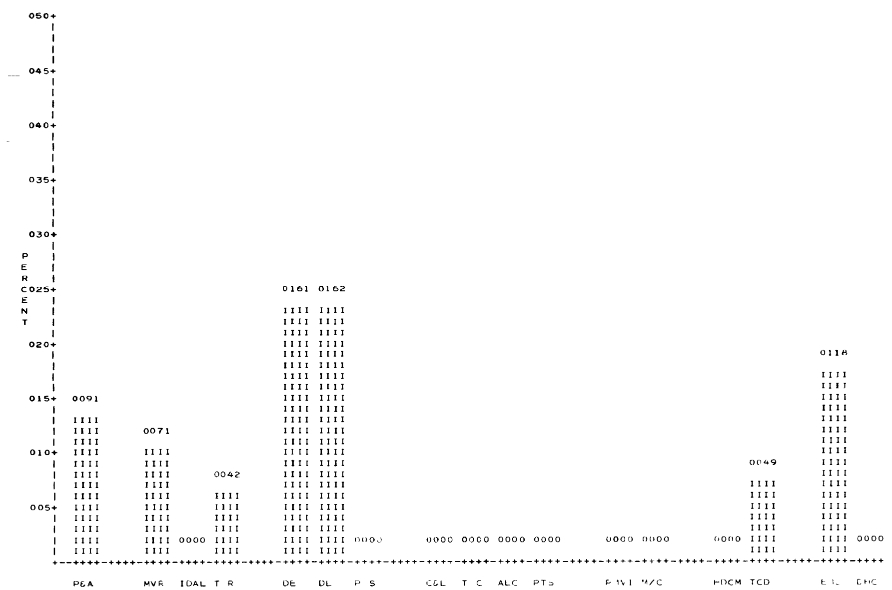
STATE: NEB TOTAL FEDERAL FUNDS (THOUS&) $ 1385



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

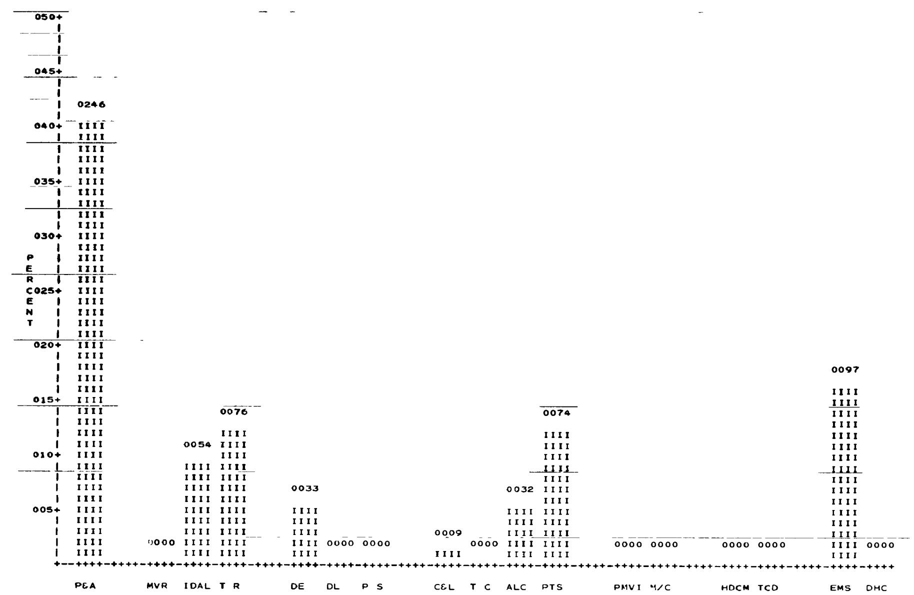
STATE MONT TOTAL FEDERAL FUNDS (THOUS&) $ 694



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

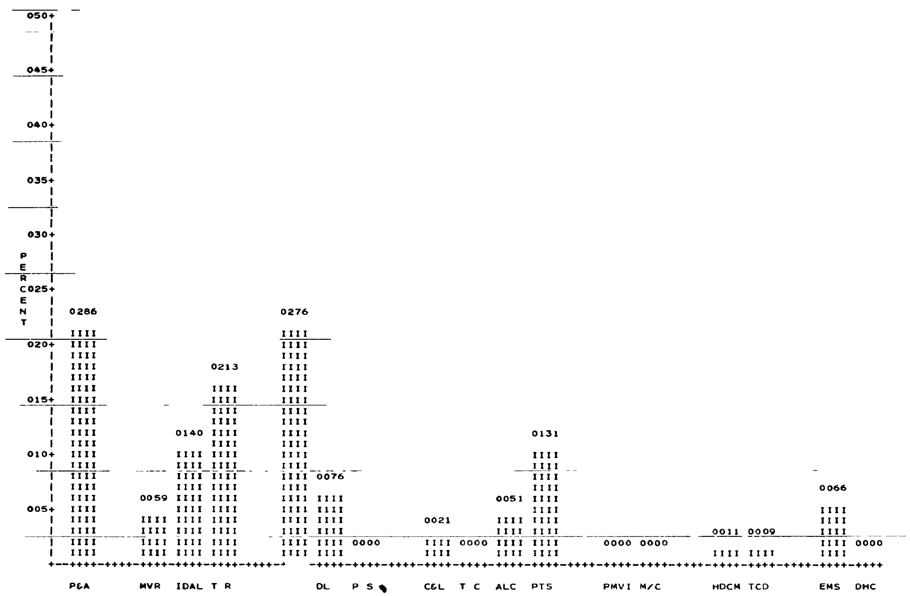
STATE: NEV TOTAL FEDERAL FUNDS (THOUS&) $ 621



* MSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

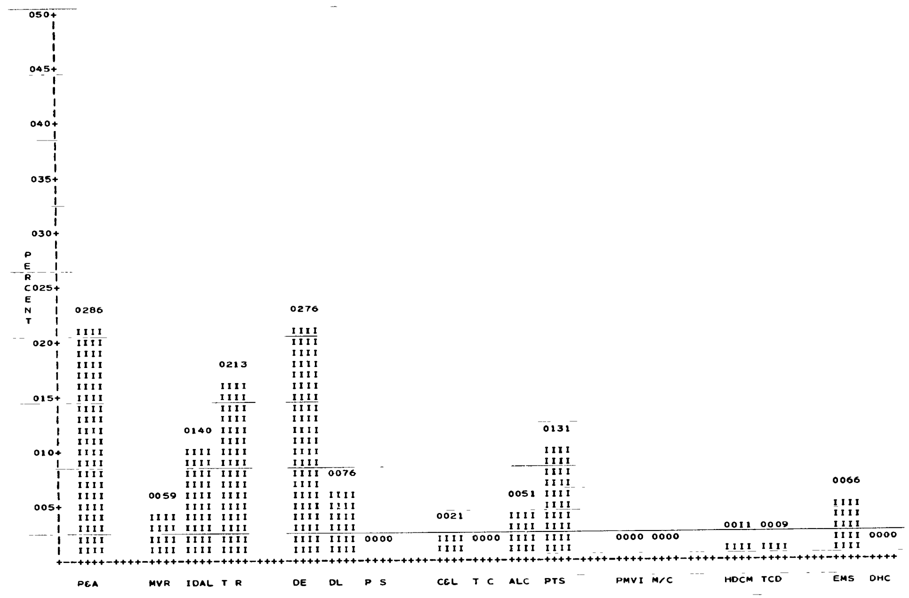
STATE: N M TOTAL FEDERAL FUNDS (THOUS$) $ 1339



* MSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

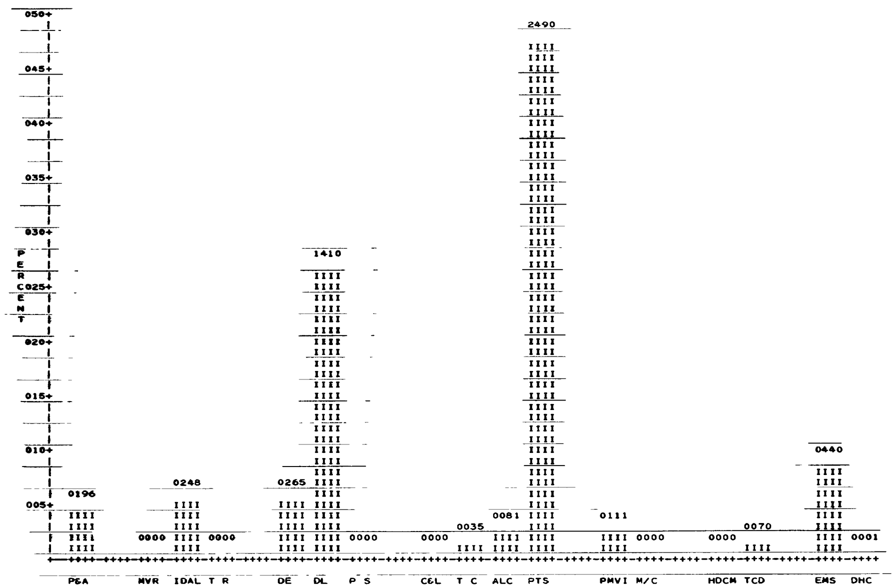
STATE: N M TOTAL FEDERAL FUNDS (THOUS$) $ 1339



* MSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

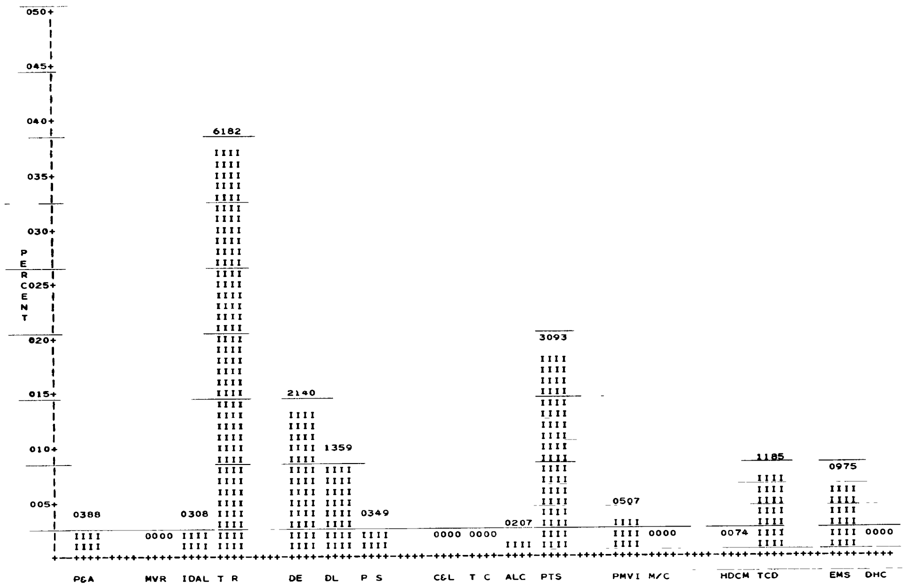
STATE: N J TOTAL FEDERAL FUNDS (THOUS$) $ 5347



* MSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

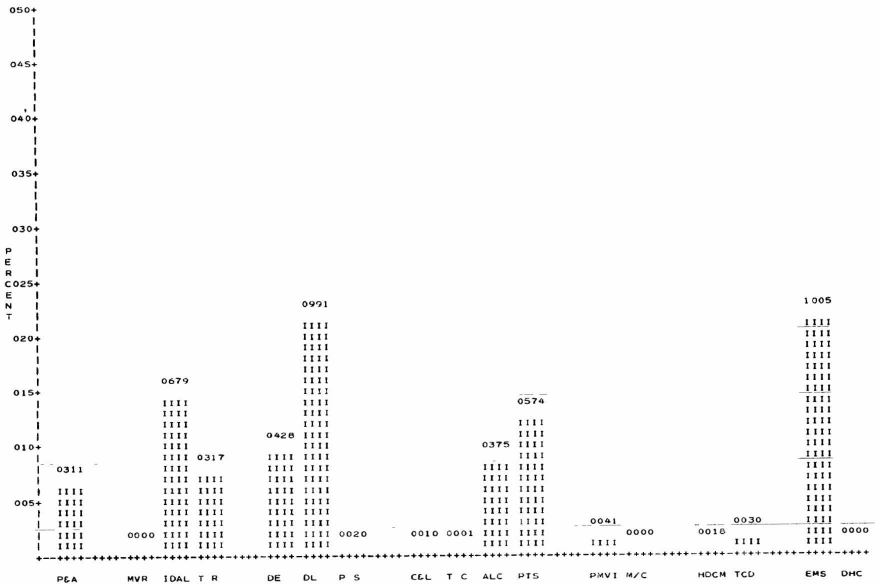
STATE: N Y TOTAL FEDERAL FUNDS (THOUS$) $ 16767



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

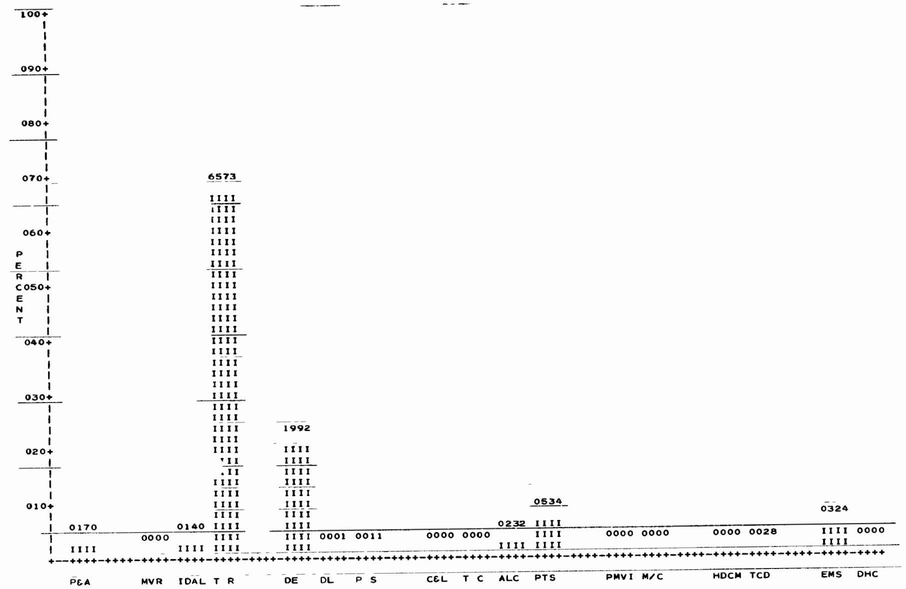
STATE: N C TOTAL FEDERAL FUNDS (THOUS$) $ 4800



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

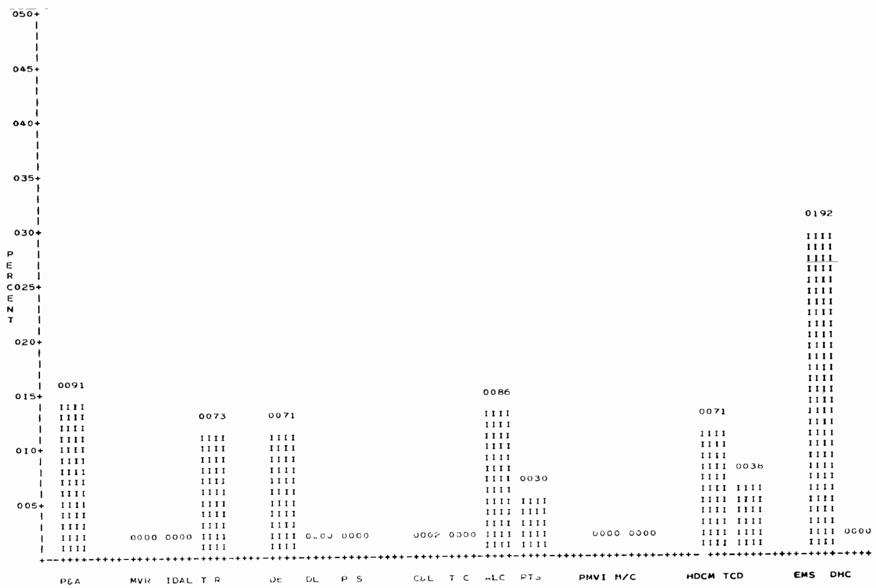
STATE: OHIO TOTAL FEDERAL FUNDS (THOUS$) $ 10005



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

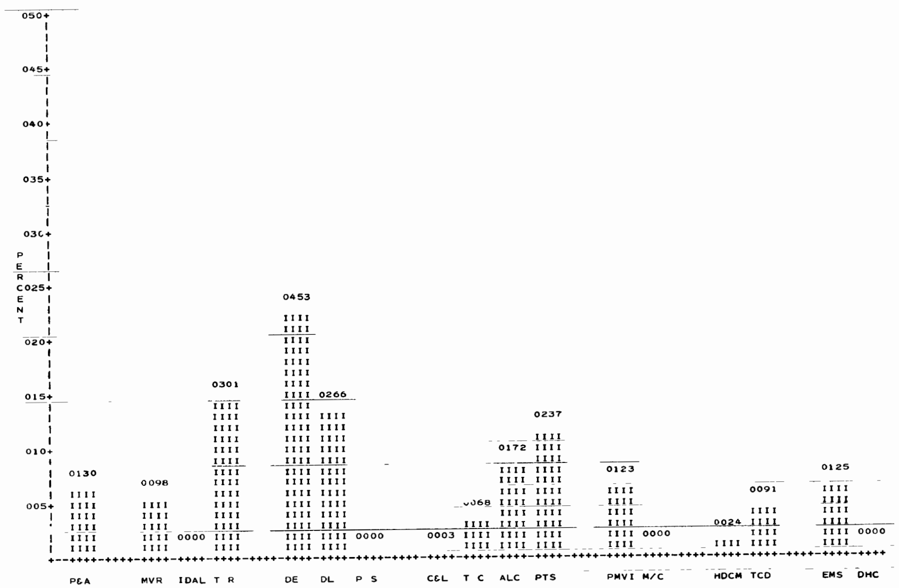
STATE N D TOTAL FEDERAL FUNDS (THOUS$) $ 654



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

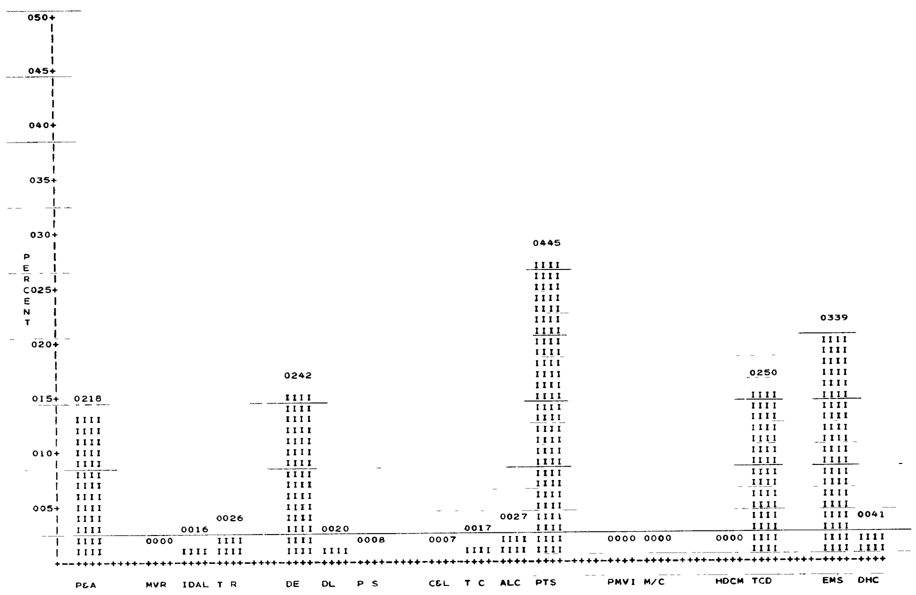
STATE OKLA TOTAL FEDERAL FUNDS (THOUS$) $ 2091



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

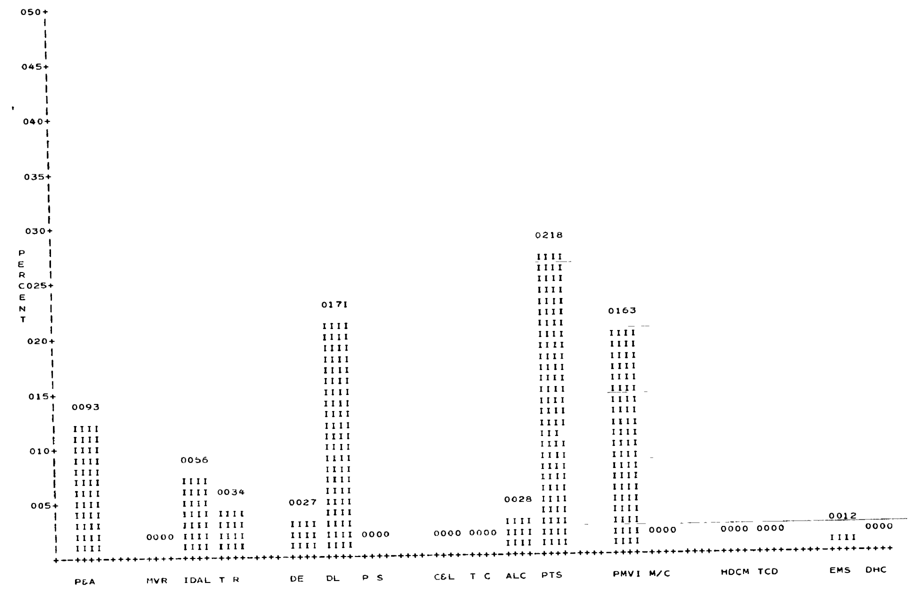
STATE: ORE TOTAL FEDERAL FUNDS (THOUS$) $ 1656



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

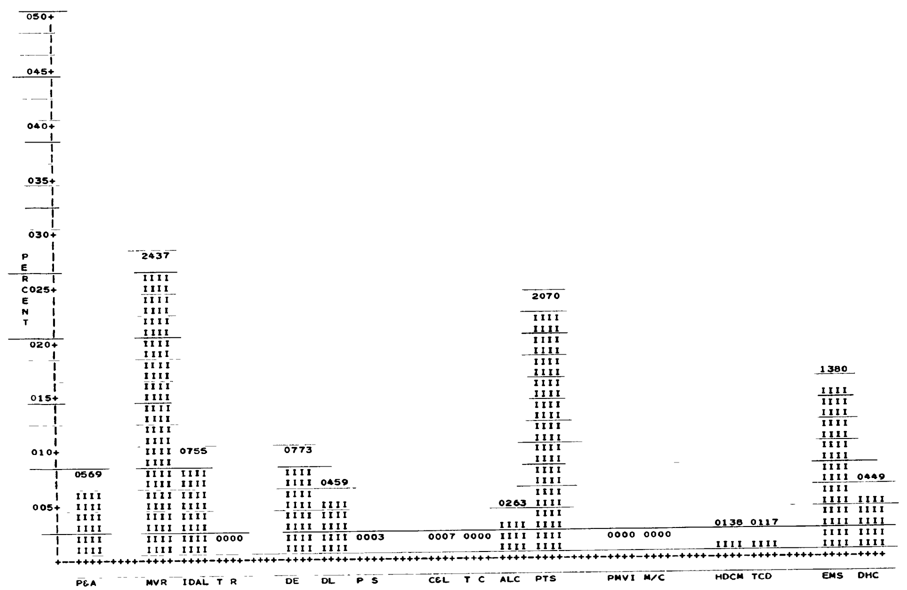
STATE R I TOTAL FEDERAL FUNDS (THOUS$) $ 802



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

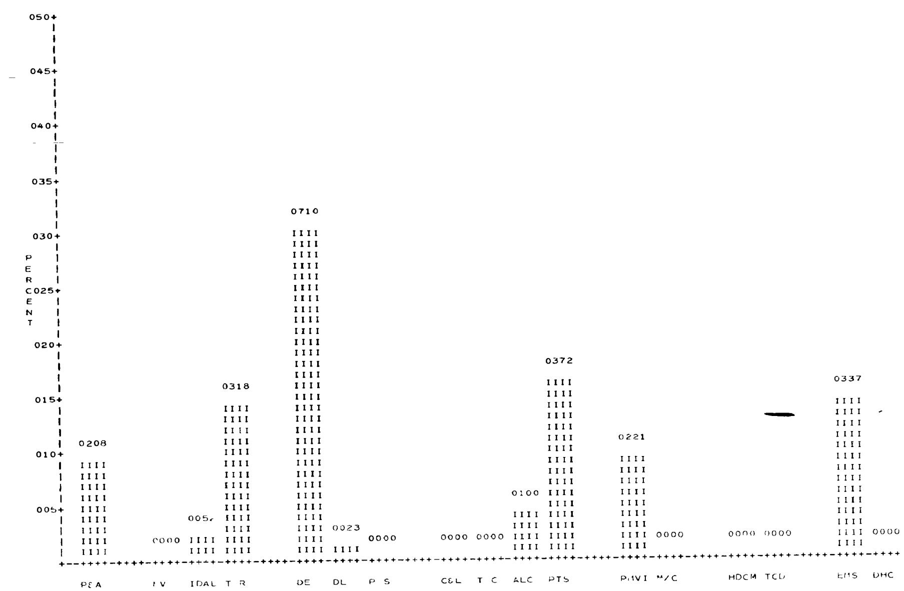
STATE: PENN TOTAL FEDERAL FUNDS (THOUS$) $ 9420

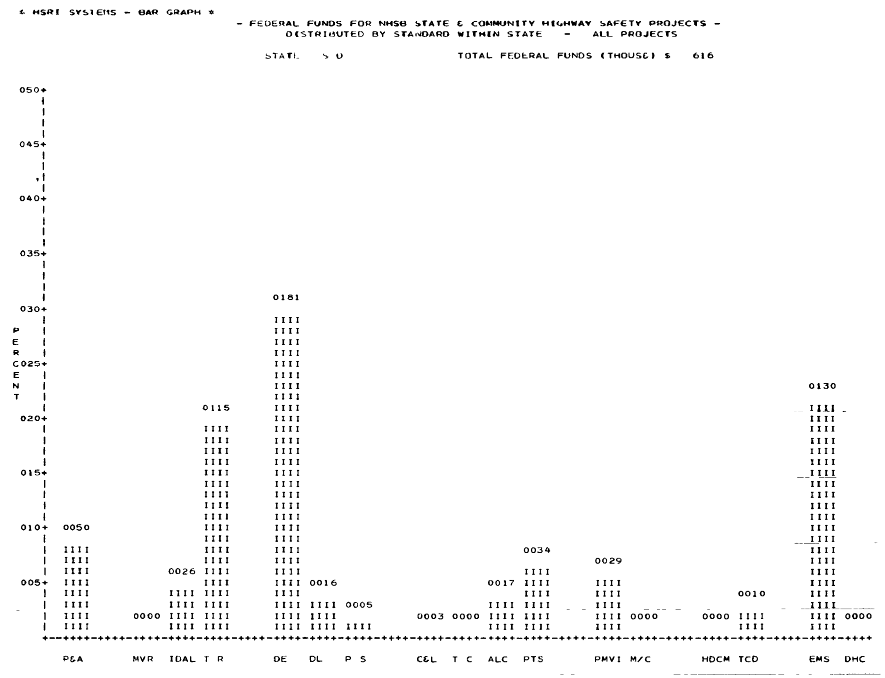


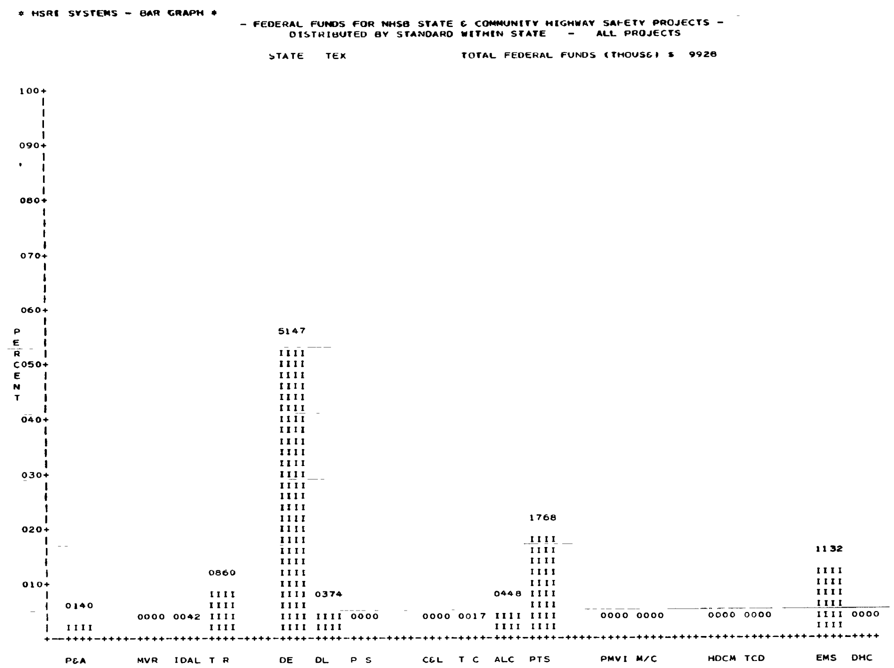
* HSRI SYSTEMS - BAR GRAPH *

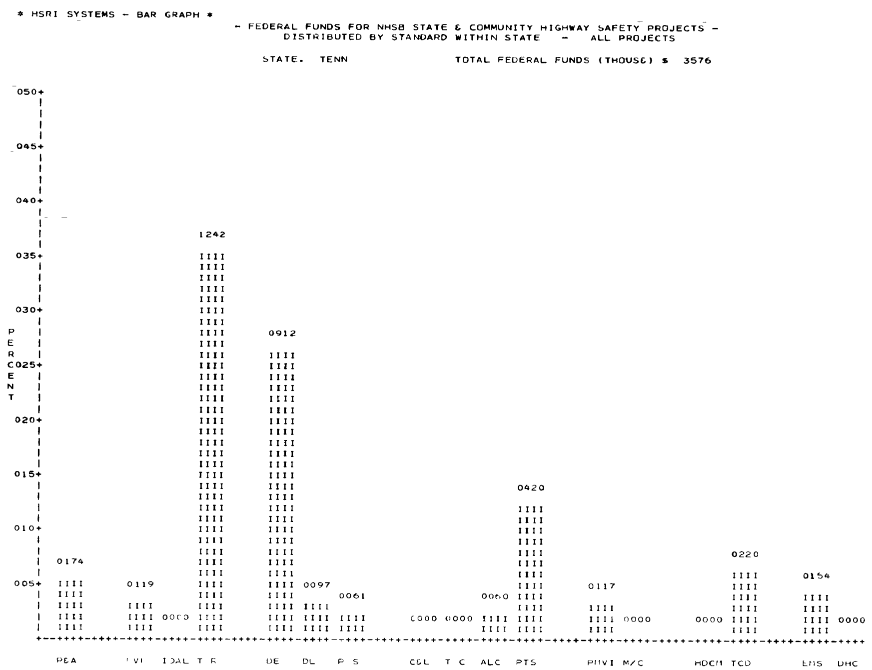
- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

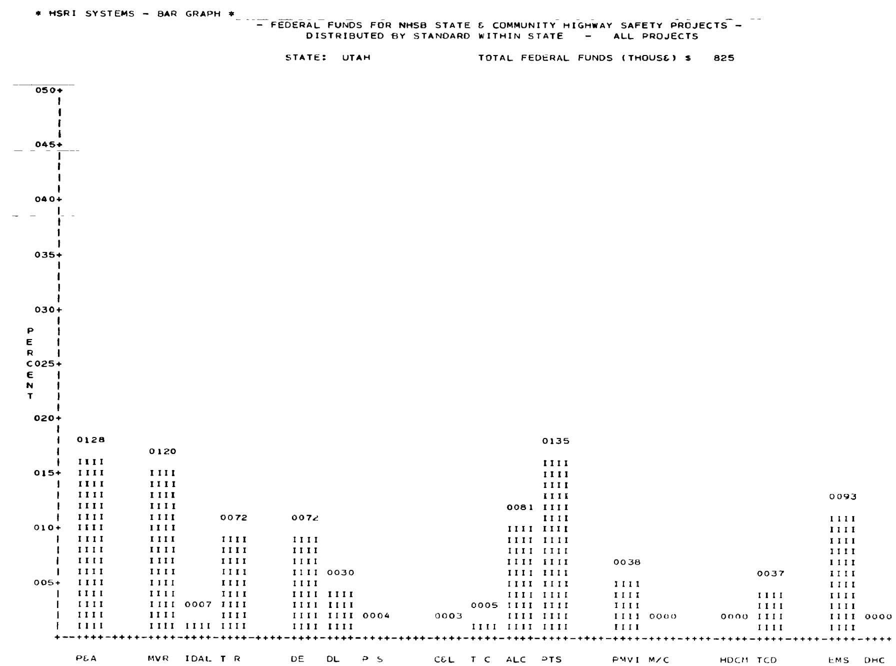
STATE S C TOTAL FEDERAL FUNDS (THOUS$) $ 2341




* HSRI SYSTEMS - BAR GRAPH *
- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS
STATE S D
TOTAL FEDERAL FUNDS (THOUS&) $ 616
PERCENT
050 045 040 035 030 025 020 015 010 005
0050 0000 0026 0115 0181 0016 0005 0003 0000 0017 0034 0029 0000 0000 0010 0130 0000
P&A MVR IDAL T R DE DL P S C&L T C ALC PTS PMVI M/C HDCM TCD EMS DHC


* HSRI SYSTEMS - BAR GRAPH *
- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS
STATE TEX
TOTAL FEDERAL FUNDS (THOUS&) $ 9928
PERCENT
100 090 080 070 060 050 040 030 020 010
0140 0000 0042 0860 5147 0374 0000 0000 0017 0448 1768 0000 0000 0000 0000 1132 0000
P&A MVR IDAL T R DE DL P S C&L T C ALC PTS PMVI M/C HDCM TCD EMS DHC

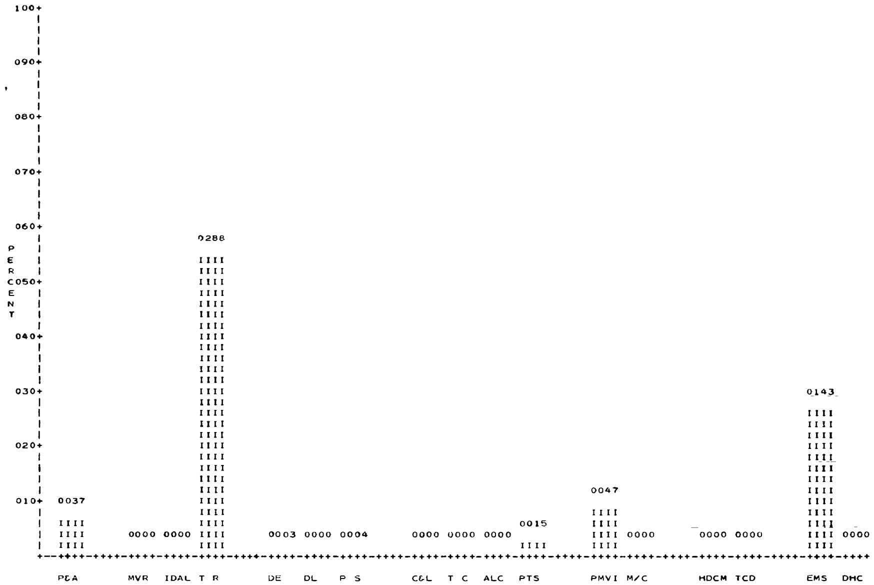

* HSRI SYSTEMS - BAR GRAPH *
- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS
STATE. TENN
TOTAL FEDERAL FUNDS (THOUS&) $ 3576
PERCENT
050 045 040 035 030 025 020 015 010 005
0174 0119 0000 1242 0912 0097 0061 0000 0000 0060 0420 0117 0000 0000 0220 0154 0000
P&A MVR IDAL T R DE DL P S C&L T C ALC PTS PMVI M/C HDCM TCD EMS DHC


* HSRI SYSTEMS - BAR GRAPH *
- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS
STATE: UTAH
TOTAL FEDERAL FUNDS (THOUS&) $ 825
PERCENT
050 045 040 035 030 025 020 015 010 005
0128 0120 0007 0072 0072 0030 0004 0003 0005 0081 0135 0038 0000 0000 0037 0093 0000
P&A MVR IDAL T R DE DL P S C&L T C ALC PTS PMVI M/C HDCM TCD EMS DHC

* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

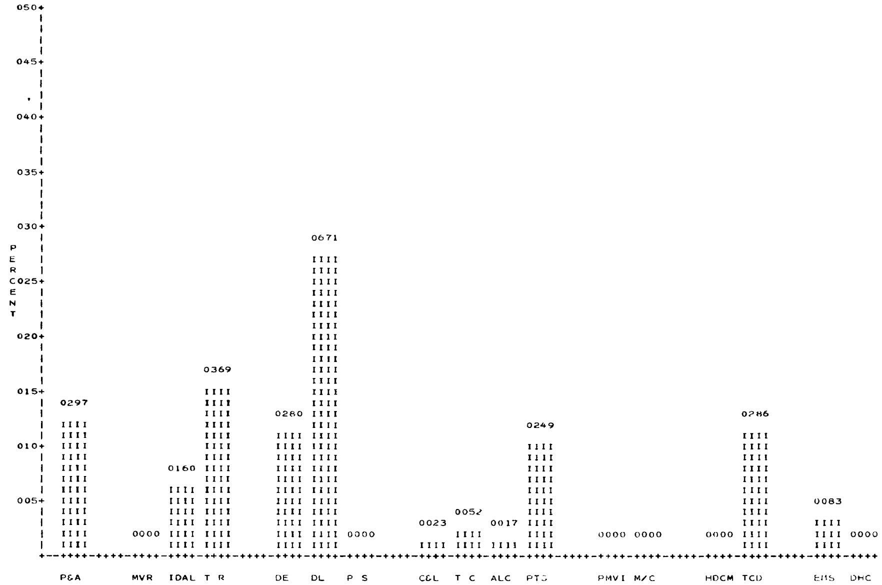
STATE VER TOTAL FEDERAL FUNDS (THOUS$) $ 537



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

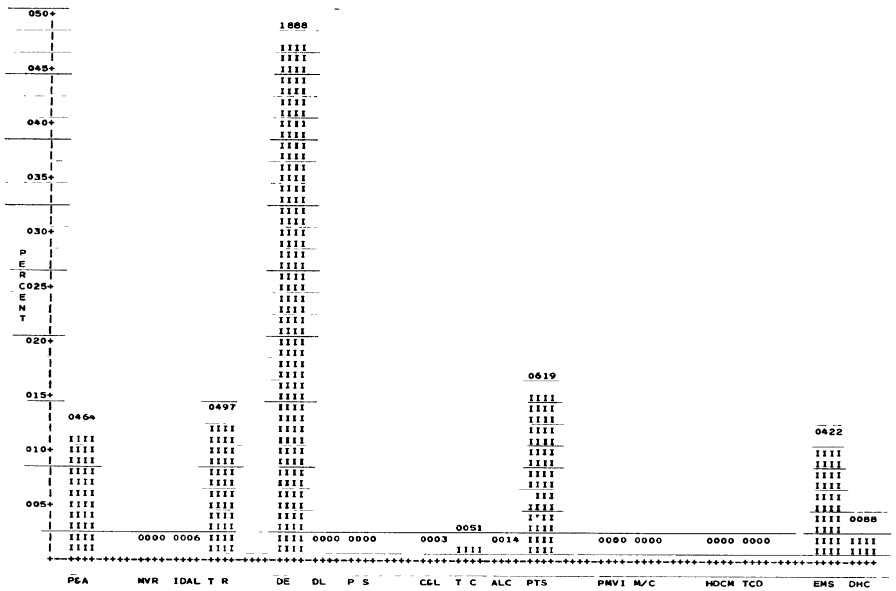
STATE: WASH TOTAL FEDERAL FUNDS (THOUS$) $ 2447



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

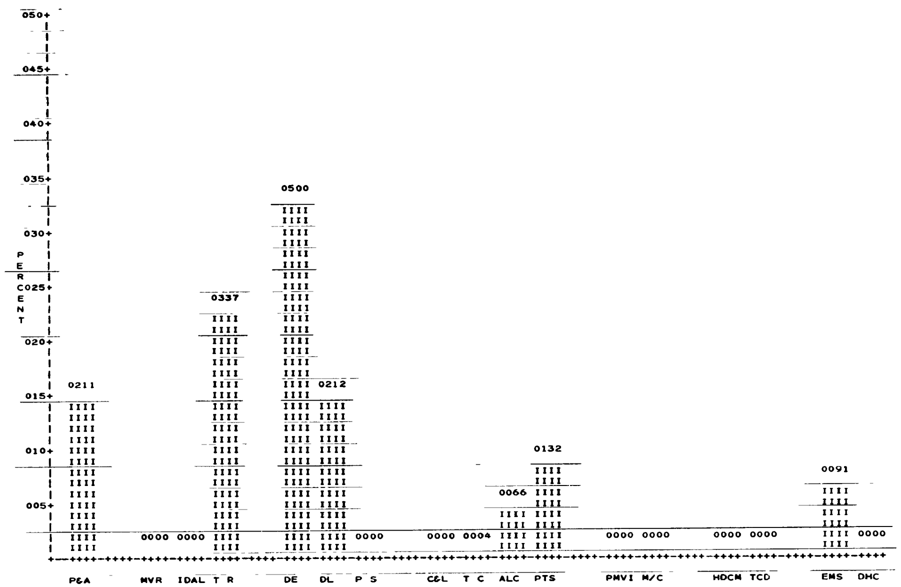
STATE: VIR TOTAL FEDERAL FUNDS (THOUS$) $ 4052



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

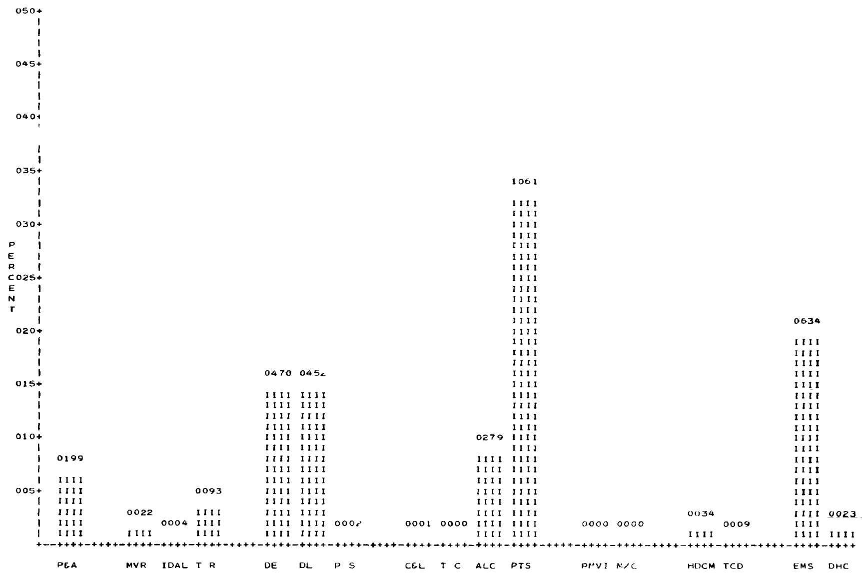
STATE: W V TOTAL FEDERAL FUNDS (THOUS$) $ 1553



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

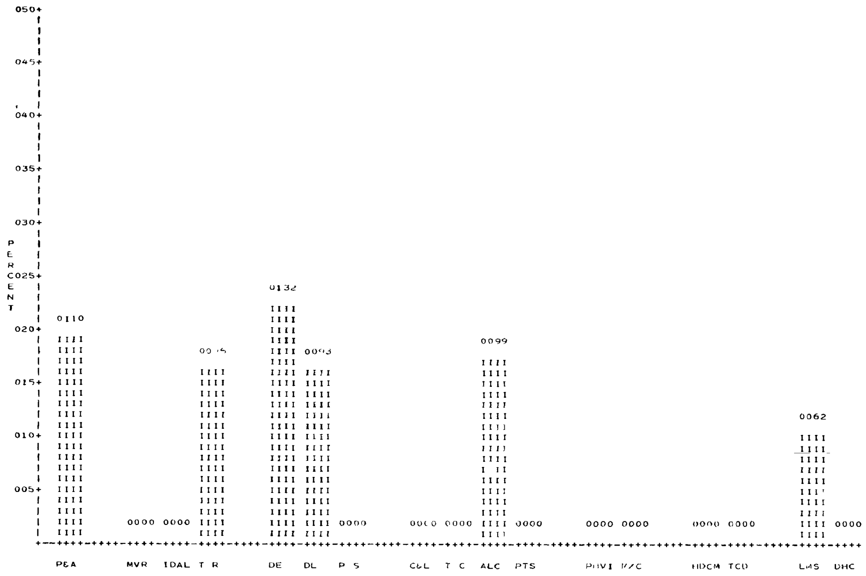
STATE: WISC TOTAL FEDERAL FUNDS (THOUS$) $ 3283



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

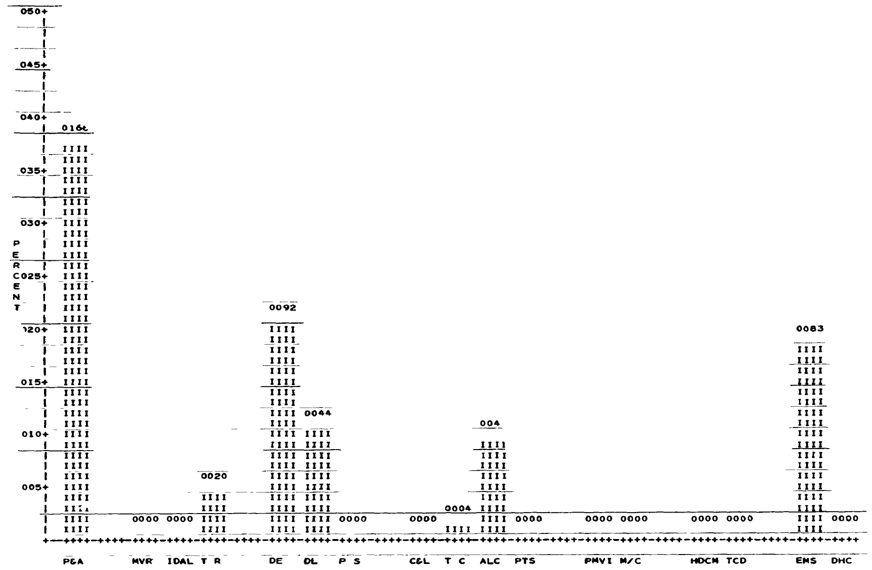
STATE: D C TOTAL FEDERAL FUNDS (THOUS$) $ 391



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

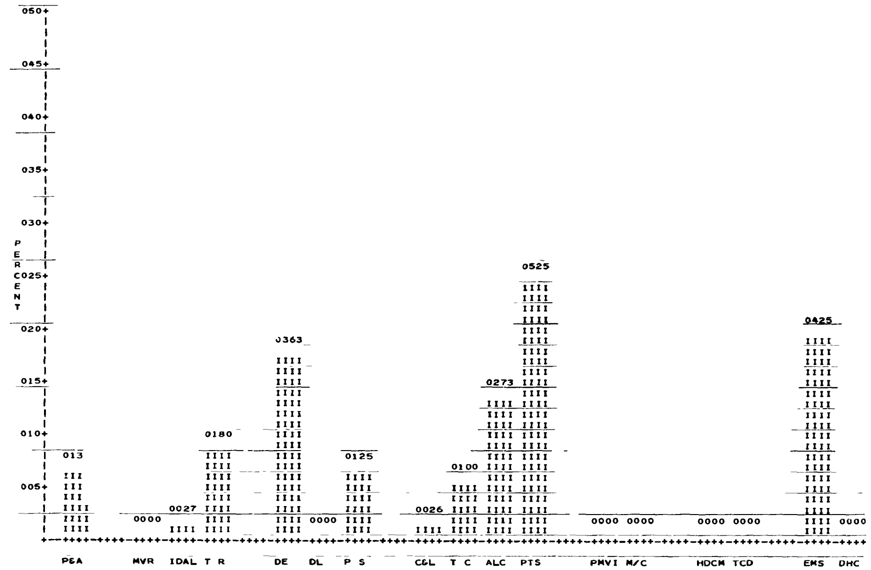
STATE: WYO TOTAL FEDERAL FUNDS (THOUS$) $ 450



* HSRI SYSTEMS - BAR GRAPH *

- FEDERAL FUNDS FOR NHSB STATE & COMMUNITY HIGHWAY SAFETY PROJECTS -
DISTRIBUTED BY STANDARD WITHIN STATE - ALL PROJECTS

STATE: P R TOTAL FEDERAL FUNDS (THOUS$) $ 2180



on the other. A novelness level of 6 for instance indicates a program to "study, develop or implement a new program, procedure, or system - provide a capability not previously present". By analyzing only those projects that have a novelness value of 6 therefore we may obtain printouts (i.e. tables, maps, histograms) of the type shown above with the additional provision that only innovative program are considered. Such an analysis has been used to identify possible sites where an innovative approach would be compatible.

Other variables discussed in the Appendix have been utilized to yield further insights into the deployment of 402 projects. However, a full discussion of the data is inappropriate here. Suffice it to say that our computerized file has permitted us to easily investigate many aspects of the 402 project deployment which we have found useful in our selection of possible experiment sites.

9.6 Relationship of Site to Program Type

Most of the factors that we have discussed in this section are concerns which would apply to the implementation of any program and consequently are not specific to any one of the six programs types that we have defined. There are definite relationships that exist between the nature of the proposed experiment and the site at which the experiment is conducted. These considerations tend to determine the governmental level (i.e. county, state, etc.) at which the program is operated.

A prime factor is the interaction of the experiment with the legal structure. For instance driver licensing is a matter handled at the state level and any modification of this function would have to be carried out at the state level. Police operations on the other hand are generally controlled by local ordinance so that porgrams involving the police could be conveniently carried out at the local level.

Similarly, an information flow study could conceivably be carried on at a variety of levels. However, access to large amounts of information and facilities to provide a meaningful statistical analysis of the data indicate to us that the program could best be carried on at the state level.

As a result of many considerations such as these, we have tnetatively selected the following governmental levels for our six program areas

Information Flow	-	State
Driver Preparation	-	Small City with State participation
Driver Regualtion	-	Small City
Vehicle Regulation	-	State
Highway Regulation	-	Large City
System Restoration	-	County

9.7 Data Collection for Site Selection

In order to provide a centralized source of siting information for the Phase II studies we have undertaken the categorization and filing of all information relevent to each state and area that has been surveyed. Two initial procedures have been put into operation at this time. First is the creation of a data-file on each state and second is the initiation of a 22 x 52 matrix graph which plots the important information about each state.

The data-file system on each state was created in order to have an organized concrete way of evaluating a state in a number of areas. Most information to date has been derived from visits to the directors of the federal regions by HSRI staff and some investigations of different source books on the states. As the project matures we hope to collect data about each state from Highway Safety personel, evaluation of projects (example: 402 and 403 projects,) and other projects of interest carried out by the different states in the last few years. Our hopes are to get the most complete collection of relevant data about each state that is possible. We are of course heavily concerned with the potential for future research work by the state staffs as well as past accomplishments.

Basically we have broken down the number of areas of concern into seven major categories:

1) Physical Factors: In this category we are trying to gather all data which might be relevent to a certain type of experimental analysis. We evaluate such factors as population characteristics (urban-rural, high-density-low-density), and geographical consideration such as number of highways and type. This type of data is useful, for example, if one wanted to do a split level design which called for relative isolation of the driving population in each treatment level. Hawaii with each island being a county might fit very well into this type of design.
2) Personnel Factors: Here we are concerned with evaluation of the expertise, power, and cooperativeness of the Governor's Representative and other important State Highway Safety figures which would be critical to project sucess. Also we evaluate the State Highway Safety staff to determine its size, experience, and competence in handling different types of research and demonstration projects.
3) Monetary Factors: This category covers such areas as recent state fiscal budgets (appropriated and spent), the amount of 402 funds spent and in what areas, amount and types of 403 projects done in recent years, evaluation of state projects and FHWA projects of interest.

4) Political Factors: Here we have a number of different areas of concern: 1. Is the state Highway Safety staff free from political intanglements and does the staff survive political changes in the state. 2. Is there generally popular support for Highway Safety spending and activities in the state; what specific areas are the public concern. 3. In what standard areas of Highway Safety has the state expressed interest. We are also concerned to some extent in the state's attitude toward involvement in federal projects which might cause friction in regards to local state autonomy.

5) Technical Factors: This category is broken down into two major areas: 1. We are concerned with management/administrative capabilities in regards to the quality of work and also the interior coordination and cooperation of the different Highway Safety departments found in each state. 2. We try to evaluate the state's research evaluation capabilities in term of the the facilities (both government and private), particular recognized people in the state, and also by reviewing the quality of past evaluation attempts by the state.

The second part of the data-file is a collection of information specifically related to each of the 6 areas of Highway Safety which were illustrated in the H.S.R.I. overall report.

Appendix

Computer File of 402 Projects

The National Highway Safety Bureau has funded over four thousand State and Community Highway Safety (Section 402) Projects encouraging adoption of the Highway Safety Program Standards. Since these projects originate at state and local levels, they tend to reflect indigenous interests and capabilities in the countermeasures area, and provide potentially valuable information about current programs and potential sites for new demonstration programs. One of the tasks of the present contract has been to develop a computer-based file of these projects that will facilitate analyses of current activities.

Information about existing 402 projects was provided by the NHSB in the form of voluminous computer printouts; one contained financial data while another gave a one-line description of each project. The state, standard area, and fiscal year of each project were also identified. The one-line descriptions were coded according to seven parameters chosen so as to aid in searching out projects having particular characteristics germane to countermeasure demonstrations. All of this information was keypunched and established as a standard Statistical Research System tape file. In this form information about NHSB 402 projects is readily available for analysis through standard S.R, system programs.

Table A-1 is the Dictionary for the completed file, and identifies twenty-nine variables used to describe each project. Much of this data is redundant, but had been incorporated in different forms so as to aid in running analysis programs and to simplify the interpretation of results.. There are essentially three classes of data: 1) identification (variables # 1 through #15), 2) financial (variables # 16 through # 21), and 3) descriptive (variables # 22 through # 29).

The identifying information consists of: state, standard area, fiscal year, and NHSB project number. Total project cost, federal funds authorized, and federal funds spent constitute the three pieces of financial data. The seven descriptive parameters are: 1) novelness - departure from existing conditions, 2) degree of implementation - position along the research/operational dimension, 3) hardware content, 4) type of implementing organization, 5) user group(s) toward which project oriented, 6) training aspects involved, and 7) geographical coverage of project. The specific categories and code values used are listed in the Code Book given in Table A-2. Coding of the descriptive paramenters was based upon the one-line description of each project which is also included in an abbreviated form as variable # 29. The effective date of this data as indicated on the NHSB printouts is July 30, 1970. Updating or additions to this file can be accomplished quite easily.

The file presently contains 4,254 cases. However, 414 cases (9.7%) pertain to existing projects submitted to the NHSB as a "soft match" for federal funds in other areas. Since these projects tend not to reflect new activities nor embrace federal commitments, they have been generally omited from analysis. Also, the printouts received from NHSB are current to different dates so there are 45 cases for which financial data are missing.

Analyses of this data tend to be of two kinds; either a display of some variable or set of variables across all of the data, or an examination of a selected subset of the data based upon a specific set of criteria. For example, questions about the level of funding for different standards in the several states are typical of the first type of analysis. An example of the second type might be to ask for a list of all novel projects in Driver Education at a local level not involving the purchase of equipment. The remainder of this appendix will describe some of the characteristics of this data derived from various analyses of the first type.

The first analysis task was to identify areas of greatest activity (both standard areas and states). For this univariate and bivariate frequency distributions were constructed of the number of projects in the various standards and states. In summary, this analysis showed that 31.4% (1336) of the projects are in the area of Police Traffic Services (standard #15), and that Illinois and Massachusetts each had close to 10% of the total number of projects (421 and 396, respectively). There are no projects in the area of Motorcycle Safety (standard #3) and the District of Columbia had the fewest number of projects - 14.

Although of interest, counts of the number of projects is a rather crude indicator of activity; an analysis of funding probably gives a more accurate indication of the level of effort involved. Both total project cost and federal funds authorized have been examined. Although the "402" projects are ostensibly matching fund grants, a "soft match" has been used in many cases, and a somewhat different picture emerges on a project-by-project basis depending upon which of these figures is used. For consistency federal funds authorized has generally been used. It is felt that they will tend to reflect more clearly the allocation choice of new monies from the fixed total authorization for each state. In general, total project costs are twice the value of federal funds authorized. Presumably, a comparison of federal funds authorized and federal funds spent would indicate the degree of completion; however, it appears that sometimes projects are terminated without spending the total authorization.

Based upon federal funds authorized the largest expenditures are in the area of Traffic Records (standard #10) with 21% (roughly $37,100,000) of the "402" federal funding to date. Driver Education (standard #4) and Police Traffic Services (standard #15) are a close second and third with 19.8% and 17.9% respectively. Although in terms of the number of projects they are ranked 5, 2, and 1, these three standards account for 58.7% of all federal funds authorized and 52.1% of all projects todate. New York, California, Ohio, Texas and Pennsylvania, in that order, are the five states with the largest values of federal funds authorized. Funding limitations have been established by Congress primarily on the basis of population so that one would expect the funding figures derived from the "402" file to be essentially a reflection of the size of each state. However, the "402" derived funding figures, and even their rank ordering, are only in rough agreement with statutory limitations. Vagaries of these funding figures have not been persued since the initial interest is in identifying areas of activity which is essentially comparative in nature.

The next analysis topic was an investigation of the distribution of funding for different standards within each state, and the relative involvement of the states in each of the standard areas. The results of these analyses are pictorially portrayed in the accompanying maps and bar graphs.

Seventeen computer-generated maps (one for each standard plus Planning and Administration) were prepared through a special map drawing program to display the percentage of each state's total authorized federal funds for the particular standard area concerned. The darker shadings indicate a higher percentage of state's funds for the standard involved. That is, the data displayed is a fraction, the numerator of which is the sum of federal funds authorized for projects within a particular standard area; and the denominator of which is the total value of federal funds authorized for all projects within that state. These maps, then, depict the relative emphasis that each state has placed upon a particular standard area. Data value extremes, the data range applying to each display level, and the frequency of data points within each display level are given below each map. A geometric variation in the range of values for each display level was selected in order to get a reasonably good spread of the data and to help single out data extremes. The same scaling factor is used on all maps to enable comparisons between different standards.

The accompanying bar graphs are based upon the same data used in constructing the maps; however, the protrayal is of the distribution of funds according to standards within states. There are 52 bargraphs (one for each state plus the District of Columbia and Puerto Rico.) The abbreviation of each state and the federal funds authorized for all projects within that state (in thousands of dollars) are given at the top of each graph. The height of each column is proportional to the percentage of the state's total federal funds in each of seventeen areas (the 16 standards plus P&A). For most of the graphs the ordinate scale runs from 0% to 50%; however, if any one column exceeds 50% the scale is from 0% to 100%. The value (in thousands of dollars) of federal funds in each of these areas is also shown at the top of each column, and the abbreviation for each standard is given at the foot of the columns.

The standards have been grouped into the six program areas proposed in this report, and read from left to right as follows:

Planning and Administration - P&A

Information Flow - consisting of:

- Motor Vehicle Registration - MVR
- Identification and Surveillance of Accident Locations - IDAL
- Traffic Records - T R

Driver Preperation - consisting of:

- Driver Education - DE
- Driver Licensing - DL
- Pedestrain Safety - P S

Driver Regulation - consisting of:

- Codes and Laws - C&L
- Traffic Courts - T C
- Alcohol in Relation to Highway Safety - ALC
- Police Traffic Services - PTS

Vehicle Regulation - consisting of:

- Periodic Motor Vehicle Inspection - PMVI
- Motorcycle Safety - M/C

Highway Regulation - consisting of:

- Highway Design, Construction, and Maintenance - HDCM
- Traffic Control Devices - TCD

System Restoration - consisting of:

- Emergency Medical Service - EMS
- Debris Hazard Control and Cleanup - DHC

Both the maps and bar graphs provide a quick visual summary of the relative activity in different areas, and have proved very helpful in identifying directions for further analysis. Tabular listings of the number of projects and federal funds authorized by standard area and by state also have been prepared as a basic reference for these analyses.

Table A-1

DICTIONARY - 402 (STATE & COMMUNITY HIGHWAY SAFETY) PROJECTS FILE

Variable Number	Variable Description	Code Values	Missing Data Code	Explanation
1	case id #	(9 digits)	---	Combination of V3, 4, 11, & 14
2	date of data	(6 digits)	---	mo-da-yr of source printout
3	state #	01-52	---	see code book
4	standard #	00-16	---	see code book
5	state - 1st digit	0-5	---	for running analysis programs
6	state - 2nd digit	0-9	---	for running analysis programs
7	standard - 1st digit	0-1	---	for running analysis programs
8	standard - 2nd digit	0-9	---	for running analysis programs
9	fiscal yr - 1st digit	6-7	---	for running analysis programs
10	fiscal yr - 2nd digit	1,7-9	---	for running analysis programs
11	fiscal year	67-71	---	year grant was made
12	state abbrev	4 alpha char	blank	for data listings
13	standard abbrev	4 alpha char	blank	for data listings
14	NHSB proj #	001-909	---	assigned by NHSB
15	type of proj	0-9	---	'9' defines in lieu of matching funds proj
16	tot proj cost hndthous&$	000-998	999	1st 3 digits V19
17	fed fund auth hndthous&$	000-998	999	1st 3 digits V20
18	fed fund spent hndthous&$	000-998	999	1st 3 digits V21
19	total proj cost thous&$	00001-99899	99999	Indicates level of effort
20	fed fun auth thous&$	00000-99899	99999	Usually $\frac{1}{2}$ of V19
21	fed fund spent thous&$	00000-99899	99999	Spent as of date in V2
22	novelness	0-6	9	see code book

Table A-1 Cont'd.

Variable Number	Variable Description	Code Values	Missing Data Code	Explanation
23	degree implementation	0-6	9	see code book
24	hardware content	00-14	99	see code book
25	implementing organiz	00-12	99	see code book
26	user group(s)	00-18	99	see code book
27	training aspects	0-5	9	see code book
28	geographical coverage	0-8	9	see code book
29	proj description	59 alpha char	blank	annotated from NHSI listing

Table A-2

CODE BOOK - SEC. 402 PROJECTS

VARIABLES #3 - STATE # AND #12 - STATE ABBREV

State	Abbrev	Code #	State	Abbrev	Code #
Alabama	ALA	01	New Hampshire	NH	27
Arizona	ARIZ	02	New Jersey	NJ	28
Arkansas	ARK	03	New Mexico	NM	29
California	CAL	04	New York	NY	30
Colorado	COLO	05	North Carolina	NC	31
Connecticut	CONN	06	North Dakota	ND	32
Delaware	DEL	07	Ohio	OHIO	33
Florida	FLA	08	Oklahoma	OKLA	34
Georgia	GA	09	Oregon	ORE	35
Idaho	IDA	10	Pennsylvania	PENN	36
Illinois	ILL	11	Rhode Island	RI	37
Indiana	IND	12	South Carolina	SC	38
Iowa	IOWA	13	South Dakota	SD	39
Kansas	KAN	14	Tennesee	TENN	40
Kentucky	KEN	15	Texas	TEX	41
Louisiana	LA	16	Utah	UTAH	42
Maine	ME	17	Vermont	VER	43
Maryland	MD	18	Virginia	VIR	44
Massachusetts	MASS	19	Washington	WASH	45
Michigan	MICH	20	West Virginia	WV	46
Minnesota	MINN	21	Wisconsin	WISC	47
Mississippi	MISS	22	Wyoming	WYO	48
Missouri	MOU	23	Alaska	ALSK	49
Montana	MONT	24	Hawaii	HAWI	50
Nebraska	NEB	25	District of Columbia	DC	51
Nevada	NEV	26	Puerto Rico	PR	52

Table A-2 cont'd.

CODE BOOK - SEC. 402 PROJECTS

VARIABLES #4 - STANDARD # AND #13 - STANDARD ABBREVIATION

Standard	Abbrev	Code #
Planning and Administration	P & A	00
Periodic Motor Vehicle Inspection	PMVI	01
Motor Vehicle Registration	MVR	02
Motorcycle Safety	M/C	03
Driver Education	DE	04
Driver Licensing	DL	05
Codes and Laws	C & L	06
Traffic Courts	TC	07
Alcohol in Relation to Highway Safety	ALC	08
Identification and Surveillance of Accidence Locations	IDAL	09
Traffic Records	TR	10
Emergency Medical Service	EMS	11
Highway Design, Construction and Maintenance	HDCM	12
Traffic Control Devices	TCD	13
Pedestrian Safety	PS	14
Police Traffic Services	PTS	15
Debris Hazard Control and Cleanup	DHC	16

Table A-2 cont'd.

CODE BOOK - SEC. 402 PROJECTS

Variable #22 - Novelness - departure form existing conditions

	Codes
Degree of novelness undefined or of no meaning	0
Continuation of present functions - no change in technique or procedure involved (also matching or state funds, etc.)	1
Specifically a continuation of a previous 402 project (special case of code # 1)	2
Expansion or improvement in capability of an existing project or program - function enhanced but otherwise unchanged	3
Revision or modification of an existing project or program - function significantly changed	4
Conversion from manual to automated operation specifically specified (special case of codes # 3 or 4)	5
Study, develop, or implement a new program, procedure, or system - provide a capability not previously present	6

Table A-2

CODE BOOK - SEC. 402 PROJECTS

VARIABLE #23 - DEGREE OF IMPLEMENTATION	CODES
Degree of implementation undefined or of no meaning	0
Level of implementation unaffected by project or routine or normal operation stated or implied	1
Project culminates in feasibility study or before-the-fact system analysis	2
Provides for survey, inventory, or data collection	3
Culminates in recommendations, plan, or proposed operating criteria or procedures	4
Institutes a prototype, trail, experimental or developmental operation	5
Provides for evaluation or after-the-fact analyses	6

Table A-2

CODE BOOK - SEC. 402 PROJECTS

<u>Variable #24 - Hardware content</u>

		Code
Hardware content undefined or of no meaning		00
Hardware considerations specifically not involved		01
Hardware involved but not specified		02
Procurement of	diverse equipment necessary for implementation of project specified	03
" "	surface transport vehicle(s) specified (car, ambulance, truck, motorcycle,...)	04
" "	other-than-road transport vehicle(s) specified (helicopter,...)	05
" "	communications equipment	06
" "	measuring or monitoring equipment used as an enforcement aid (speed measuring equip, breathalyzer,...)	07
" "	combinations of equipments used as enforcement aid (combinations of speed measuring, vehicle, communications equipment,...)	08
" "	surveillance or monitoring equipment other than enforcement aids (traffic counters, TV surveillance,...)	09
" "	measuring or testing equipment used for mechanizing operations (visual accuity, scoring of test,...)	10
" "	educational or training aids (simulator, audio-visual,...)	11
" "	optical data recording or retrieval equipment (micro-film, photographic cameras, projectors,...)	12
" "	medical aid equipment	13
" "	electronic data processing equipment (key punch, terminal, cpmputer, optical character recognition,...)	14

(Procurement includes purchase, lease, or obtaining the use of, in some way)

Table A-2

CODE BOOK - SEC. 402 PROJECTS

Variable # 25 - Implementing organization(s)

	Codes
Implementing organization undefined or of no meaning	00
Diffuse, complex, or multiply involved organizational arrangements	01
Motor vehicle registration agencies	02
Driver licensing agencies	03
Highway or public road agencies	04
Law enforcement agencies	05
Courts or legal agencies	06
Legislative or governmental agencies	07
Educational agencies	08
Researchers or consultants	09
Service organizations (auto clubs, safety institutes, ...)	10
Emergency medical agencies	11
Motor Vehicle Inspection agencies	12

Table A-2

CODE BOOK - SEC. 402 PROJECTS

Variable # 26 - User group(s)

	Codes
User group not specified or of no meaning	00
Stated or implied that user group is same as implementing organization	01
AS DISTINGUISHED BY DRIVER TYPE	
General driving public	02
Beginning or inexperienced driver	03
Experienced driver	04
Handicapped or disadvantaged drivers	05
Traffic offenders	06
Professional drivers (chauffeur, taxi, truck, bus,...)	07
AS DISTINGUISHED BY MODE OF TRAVEL	
pedestrian	08
Bicyclist	09
Motorcyclist	10
Passanger	11
AS DISTINGUISHED BY ORGANIZATIONAL AFFILATION	
Motor vehicle administration personnel	12
Highway engineering personnel	13
Law enforcement personnel	14
Judiciary or legislative personnel	15
Training personnel	16
Service orgainzation personnel (auto clubs, community interest groups,...)	17
Emergency medical personnel	18

Table A-2

CODE BOOK - SEC. 402 PROJECTS

Variable # 27 - Training aspects

	Codes
Training not involved, unspecified, or of no meaning	0
Training involved but not specifically defined	1
Preparation of manuals or instructional materials	2
Training in the use of new equipment, techniques, or processes specified	3
Project primarily for the training of some user group	4
Conferences, briefings, or familarization sessions	5

Table A-2

CODE BOOK - SEC. 402 PROJECTS

VARIABLE # 28 - GEOGRAPHICAL COVERAGE	Code
Extent of project unspecified - state-wide coverage implied	0
Extent of project unspecified - less than state-wide coverage implied	1
State-wide coverage specified	2
County-wide coverage specified	3
Metropolition area coverage specified (pop. 50,000 or more)	4
Local area coverage specified (town, village, small city)	5
State/county coverage specified	6
County/city or county/local coverage specified	7
Coverage of 3 or more geographical groups specifically specified	8

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