PRELIMINARY DRAFT

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Managing the Traffic Crash Risk: Strategies and Programs for Human-Oriented Highway Safety Research

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May 1978

Report No. UM-HSRI-78-19

FOREWORD

This discussion draft was prepared as a part of a larger examination of past and future directions in highway safety sponsored by the Motor Vehicle Manufacturers Association under a grant of unrestricted funds to The University of Michigan Highway Safety Research Institute. This document is one of a series of papers and reports being developed under this effort. The first paper, Managing the Traffic Crash Risk: A Conceptual Framework, was published in draft form in July 1977, and is now being refined to reflect comments made by reviewers.

This document is also being circulated for comment within the highway research and policy communities. As with the previous paper, we welcome suggestions for improvement of its substance and presentation. Because the document is preliminary and will most likely be revised, we ask that any use of its content, for other than review purposes, be discussed with us in advance.

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1.0 INTRODUCTION

This discussion draft was prepared as a part of research activities performed under a project entitled Highway Safety Planning Study. The project is sponsored by the Motor Vehicle Manufacturers Association. The research is being performed by the Policy Analysis Division of The University of Michigan Highway Safety Research Institute.

This draft is being circulated to colleagues for review and comment. After refinement it will be published as a report for general distribution. Additional reports on other aspects of the project will also be published from time to time.

1.1 Background

The Highway Safety Planning Study was begun in October 1976, under MVMA sponsorship, through a gift of funds to The University of Michigan. The general objective of the project is to establish within the private sector an authoritative source for a thorough and continuing examination of the traffic crash problem in the United States. The general objective was translated into a series of specific objectives by the Policy Analysis Division staff.

The specific objectives of the project were to examine the overall highway safety problem and past highway safety efforts by:

1. developing and prioritizing statements of highway safety problems;
2. identifying key policy actions that should be taken on the basis of current knowledge;
3. developing and prioritizing statements of research needs;
4. describing existing highway safety research programs; and
5. developing research strategies and designs to address the identified priority research needs.

The focus of the study is the portion of the field that deals primarily with the human component of the Highway Transportation System (HTS). This human-oriented highway safety research encompasses the topics covered by NHTSA's present 18 Highway Safety Standards, plus priority areas of problems and needs identified in section 2.0 of this report.

The project staff first examined existing literature describing the traffic crash problem and past highway safety efforts. The sheer quantity of the available literature required developing some organized approach to categorize and evaluate the identified documents. A first step was to examine the literature to identify a theoretical foundation for highway safety that could serve as a framework for organizing and explaining past research and programmatic efforts.

The literature search revealed an almost total absence of a usable general framework for analysis or explanation of the nation's highway safety programs. Thus, a conceptual framework had to be developed before the research effort could proceed. A conceptual framework was developed in the spring of 1977. The framework and its implications were presented in a briefing for the MVMA Highway Safety Programs Committee in April 1977.

The conceptual framework was further developed during the spring of 1977 and was used to analyze major problem areas to develop a statement of research priorities. A discussion draft of a monograph, Management of the Traffic Crash Risk: A Conceptual Framework, was prepared in August of 1977 and was circulated for review and comment. This draft presented the conceptual framework, discussed major highway safety problems, and identified priorities for research and action. This draft is being revised and will soon be presented for general distribution.

The monograph and this document represent interim reports that are part of a continuing research effort. As such, they necessarily have been presented before analysis is complete. The continued analytical work under the project is expected to identify new information that will alter some aspects of these interim reports. In a similar

sense, comments from reviewers will provide the authors with greater insights, point out errors, identify problems in communication, and generally improve the presentations. Thus, a reader should view these as interim rather than final reports.

1.2 Scope and Approach of Report

This report addresses specific objective five: the development of research strategies and designs to address high-priority research needs. It describes general research strategies and broad program designs.

The technical approach that has been followed is consistent with the general project design previously described. A general literature search was conducted to identify published information describing the nature of the traffic crash problem and past highway safety efforts. A conceptual framework was constructed to analyze and examine this information. These analyses produced:

1. a statement of priorities among highway safety problems;
2. an identification of policy actions that should be taken on the basis of current knowledge; and
3. a statement of priorities among research needs.

These were reported in the document entitled, Management of the Traffic Crash Risk: A Conceptual Framework. Using these findings as a base, a detailed inventory of existing research programs was undertaken. The objective was to compare existing research efforts with the identified research priorities. Differences are being examined to determine if additional research was required or if existing research approaches should be modified. This inventory has not yet been completed, but significant trends have been identified that provide an initial basis for the research recommendations presented here. The completed inventory will contain an in-depth examination of contract and grant awards made by federal sponsors of highway safety research and will be used as a basis for more detailed research recommendations to be published later.

1.3 Report Organization

The report has been organized to present the preliminary findings in an order consistent with the project objectives and task structure. Section 2.0 summarizes the information on research priorities presented in the report entitled, Management of the Traffic Crash Risk: A Conceptual Framework. These research priorities provide a background for section 3.0, which presents interim results of the Planning Project with regard to the fifth objective--the development of research strategies and designs to meet the identified needs. General research strategies are described, and a general research program structure is identified.

Section 4.0 presents observations and insights resulting from the general analytical work of the Planning Study. Areas discussed are (1) high-priority research topics, (2) research policy issues, and (3) research sponsorship.

2.0 PRIORITY PROBLEMS AND HIGHWAY SAFETY NEEDS

The information presented in this section is summarized from our prior report, Management of the Traffic Crash Risk: A Conceptual Framework. This section first presents a summary of conceptual framework, then a summary of the priorities discussed in chapter seven of that report.

Our approach has been to develop a conceptual framework to explain the highway safety process, use the framework to identify basic problems and the information needed to approach the solution of the problems, and, then, establish priorities among the identified problems and needs.

The statement of priority problems and information needs forms a basic statement of research requirements. These requirements can then be compared with past and current research activities to identify unmet needs. Obviously, if existing research adequately addresses the identified research requirements, there is no need for additional research program planning. If, however, significant problem areas are not being addressed, additional research needs must be defined. The definitions should logically identify basic strategies or assumptions as well as the research programs.

We have chosen to state research requirements in broad terms. This has been deliberately done to ensure adequate examination of the major areas of concern. We have deliberately avoided stating research requirements in terms of specific projects. This has been done to avoid too early closure that would exclude from consideration concepts or approaches that could contribute to the reduction of the traffic crash risk.

One of our reasons for choosing this approach lies in the vastly different definitions and perceptions of the term "research" that are used or held within the highway transportation context. The definitions of pure research, basic research, applied research, development, demonstration, and evaluation are subjective at best. So are the applications of those terms. The assignment of various types of projects to particular categories depends greatly upon the perspective and position of the assignor. A project may be labeled as "applied research" by one agency, while a similar project is labeled as "development" by another. The terminology applied by those who conduct the research may add even another dimension.

We have sought to avoid the confusion that grows out of this type of labeling by presenting research requirements in broad terms as statements of problems and highway safety needs.

A broad range of research activity will be required to address these needs ranging from basic research through field evaluation studies. At this point, we are more concerned with attempting to develop a broad research base to support decision-making to reduce crash risk than specifying the precise research domain for the necessary study efforts.

The following sections of this chapter present: (1) a brief description of the conceptual framework; (2) an identification of major problems within the highway safety process; (3) an analysis of basic needs; and (4) a summary statement of priority problems and needs.

2.1 A Conceptual Framework for the Highway Safety Process

The conceptual framework described below is useful for understanding the highway safety process. It is a step toward formal theory. We urge its examination in that context.

The conceptual framework has three basic elements:

- The Highway Transportation System;
- Society; and
- Risk-Management Systems.

The highway safety process entails interactions among those elements for purposes of reducing crashes and crash losses.

The first element of the conceptual framework, the Highway Transportation System (HTS), is defined to include the highway network, system users, and supporting components. The HTS has grown because it has provided positive benefit for our society. Associated with that positive benefit or utility has been such societal disutility as traffic crashes.

Society has reacted when this disutility has been perceived as being too large to tolerate (maximum tolerable disutility) by creating formal and informal systems to control the risk of traffic crashes. We have used the term Risk-Management Systems to describe the agencies, institutions, and individuals who generate those control forces.

The societal decisions that lead to the creation, support and cooperation with risk-management systems are a function of the public perception of the risk* of traffic crashes to society and the value of the risk-management actions in reducing that risk. We must emphasize that it is the public perception of the risk and the public perception of the value of the response that governs societal and individual decision making--not the actual risk or actual value of the risk-management response. The subjective perceptions are formed and influenced by information flow within the highway safety process. This information flow is not direct, and it is shaped by many factors that serve as "filters" to amplify or distort fact.

This general conceptual framework is depicted in Figure 2-1. It is important to understand that the full dimensions of each of the

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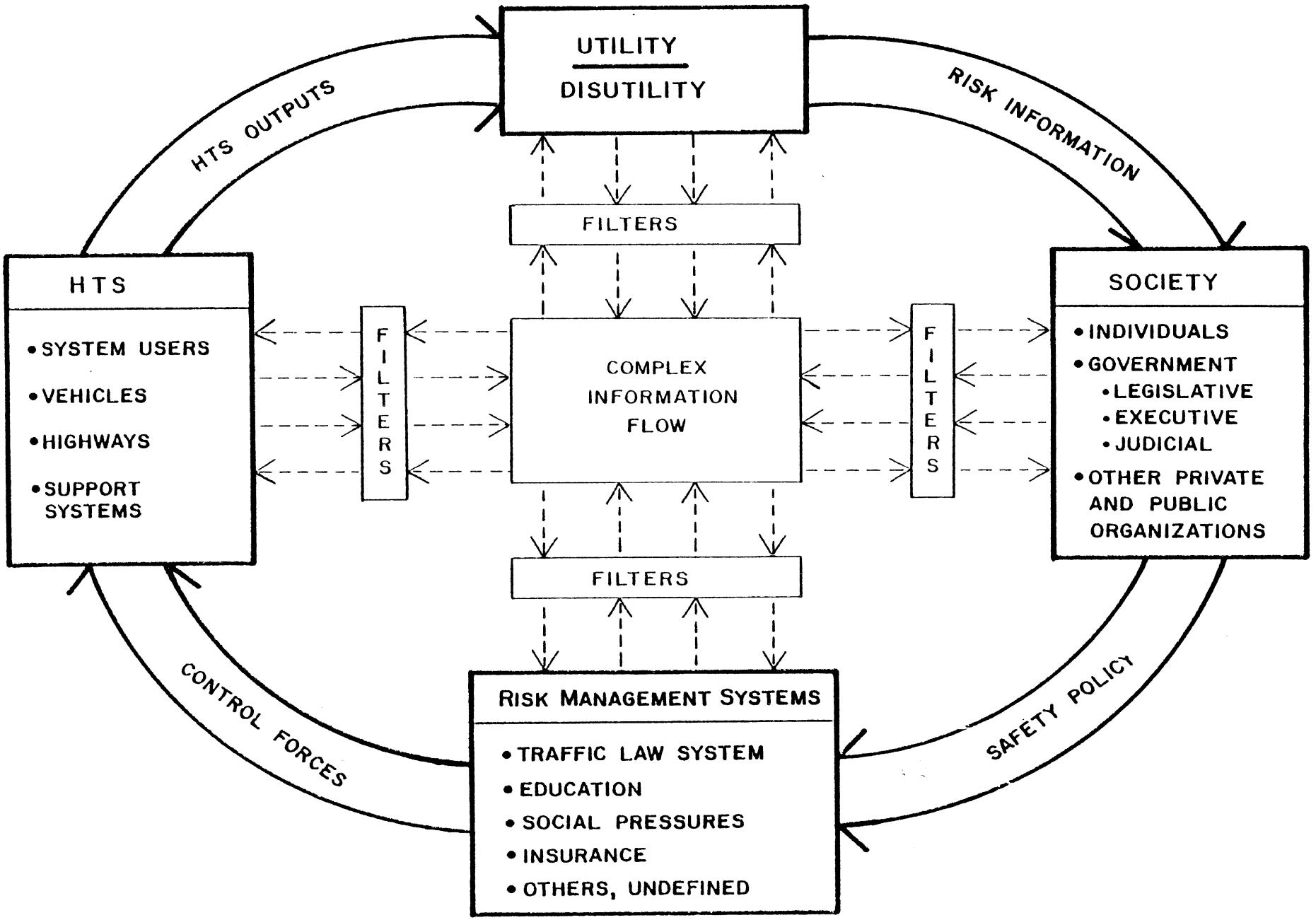
* We use the term "risk" to aid in thinking about future events that will produce loss. We define risk as the probability of the occurrence of an event that will produce disutility.

FIGURE 2-1

THE HIGHWAY SAFETY PROCESS



major components are not well defined in the existing research literature, nor are the effects of the risk-management systems that are identified well established.

2.2 Problem Analysis

The conceptual framework suggests that problems in managing crash risk may be placed in three general categories. These categories contain problems related to:

- the description of the highway safety process,
- decision making within the highway safety process, and
- communication within the highway safety process.

One of the major deficiencies of the existing literature is an almost complete lack of information that describes the highway safety process in operational terms. The major elements are not identified, their functions are not described, the basic structure and interactions of the process are unknown, and the consequences or outputs of the process are not established. A summary of some of the major problems in describing the highway safety process is presented in Figure 2-2.

A similar problem exists with regard to understanding how and why people make decisions about highway safety. We do not know why drivers make decisions to take risks nor what factors may influence decisions to avoid risk. There is also a lack of knowledge about how risk managers make decisions. Considerable progress has been made in recent years in developing theoretical models of decision-making and understanding psychological and social factors that enter into applications of such models. However, at present, no single integrated theory of decision-making is available for rigorous application to the field of highway safety.

Communication within the highway safety process is also a major problem. No systemwide information system has ever been designed for the entire highway safety process. The most serious problem in

FIGURE 2-2: Summary of Major Problems in Describing the Highway Safety Process

Problem Area	Elements of the Highway Safety Process		
	Highway Transportation System	Risk-Management System	Society
1. Identification and description of components	Inadequate identification of components involved in non-operational functions (e.g., design and support)	Incomplete identification of components, especially in private sector	Incomplete identification of public sector and external elements that interact with the HSP
2. Identification and description of functions	• Inadequate identification of non-operational functions • Lack of hierarchies of functions related to objectives	Functions of most RMSs not identified explicitly	Highway safety-related functions not identified
3. Definition of structure	No rigorous structure interrelating components and functions	Inter-RMS structures not defined. Intra-RMS structures defined for only a few systems	No structural analysis exists
4. Identification and description of outputs	• Utilities and disutilities not described in operational terms • Utilities and disutilities associated with all functions and operational modes not described • Net utility or disutility of functions and operational modes not known	• Effectiveness of control forces not known • Disutilities of control forces not known	Societal demands for disutility control not known

communications is in meeting the needs of the public and operational components of the HTS and the risk-management systems for information for decision making.

This is reflected in the relatively low usage of existing knowledge that is currently available for the design and development of highway safety programs at the federal, state, and local level. In particular, information about the risk-management process is not used and evaluation of existing programs is a rarity. Figure 2-3 outlines some of the major problems in communication within the highway safety process.

These problems, identified above, stem from a lack of theory to focus action. They are direct products of the failure to use existing knowledge and information effectively.

2.3 Needs Analysis

This section presents a brief discussion of what needs to be done to address the basic problems identified in the preceding section. The statement of needs is only a first step toward development of a set of top-level requirements for managing crash risk. Further analyses of problems and needs will be required to develop more comprehensive and detailed statements of requirements. The needs discussed below address the three categories of problems that were described above, i.e.:

(1) the description of the Highway Safety Process (HSP)
(2) decision-making within the HSP, and
(3) communication within the HSP.

2.3.1 Description of the Highway Safety Process. The HSP and its individual parts should be described with respect to its composition, functions, and outputs. A conceptual framework such as the one presented in Section 2.1 of this paper is the first step in development of such a system description, but more detailed descriptions are needed.

FIGURE 2-3: Summary of Major Problems in Communicating Within the Highway Safety Process

Problem Area	Elements of the Highway Safety Process		
	Highway Transportation System	Risk-Management Systems	Society
1. Determination of what information is needed	Done on a formal or deliberate basis only for selected HTS components. Not done systemwide.	Not done on a formal or deliberate basis for most RMSs. Greatest deficiency at local and state level of government.	Not done on a formal or deliberate basis except in conjunction with isolated PI&E "campaigns."
2. Determination of the form and method of delivery of needed information	Done on a formal or deliberate basis only for selected HTS components. Not done systemwide.	Not done on a formal or deliberate basis for most RMSs. Greatest deficiency at local and state levels of government.	Not done on a formal or deliberate basis except in conjunction with isolated PI&E "campaigns."
3. Development and operation of continuing information programs	• No formal programs except those for researchers and for individual organizations. • No systemwide program.	• Appropriate information not provided to units of local and state governments. • No systemwide program.	Done only sporadically in support of specific programs.

The first specific need is that each element and its components be identified and described. The conceptual framework described in Section 2.1 identifies classes of components (e.g., the HTS, RMSs) and gives examples of lower-level components (e.g., drivers, automobile manufacturers, driver licensing agencies). Additional groupings and classifications of components need to be developed and expanded to include each component whose activities are believed to have any significant impact on HSP operations.

Next, it is necessary that the functions of the HSP be identified in hierarchical form. Some top-level functions identified elsewhere in this report include the provision of fast, convenient transportation and the maintenance of HTS disutility at a societally acceptable level. Lower-level functions of the HTS include the design, construction, operation, and support of automobile equipment and highways. The primary function of RMSs are risk identification, risk prioritization, resource allocation, development of strategies and tactics, implementation and operation of programs, and evaluation. The functions of one specific RMS, the Traffic Law System have been identified and related to the primary functions of RMSs in general. Similar but more detailed descriptions of HSP functions must be developed so that all significant activities pertinent to the generation and control of HTS disutility are known and related to HSP objectives.

When the components and functions of the HSP have been defined, they must be interrelated to form a detailed structure of the process. Each top-level function must be related to every other top-level function, and the components involved in the performance of that function must be identified. Similarly, interfunctional relationships must be developed among lower-level functions, so that, ultimately, a network of functions can be created. Such a network

would, among other things, enable one to determine how any given activity performed by any given component might affect other activities and components, and would thus provide a major tool for the practice of risk management.

The last major need for describing the HSP is to define its outputs. In the case of the HTS, this means stating the utilities and disutilities associated with its various modes of operation, its components, and its function. For example, driving at a high speed in a large "luxury" car on an interstate highway has a positive utility, not only to a driver and passengers who want to minimize travel time, but also to organizations that manufacture and support the equipment and facilities involved in such use of the HTS. Even a direct disutility (e.g., a serious crash) that sometimes occurs as a consequence of this mode of operation may have utility to some segments of society (e.g., automobile repair companies, hospital workers). It is essential to risk management that the nature of the significant utilities and disutilities associated with the operational modes of the HTS be specified in relation to the various classes of individuals and organizations that receive the utilities and disutilities. The etiology of crashes is an important element of this "output definition" requirement vis-a-vis the HTS, but it is clearly only one of many elements.

It is necessary that HTS disutilities be stated not only in terms of the losses associated with a particular event but in terms of the probability (i.e., risk) that the event will occur. Further, to evoke an effective risk-management response, HTS disutilities must be described in relation to other disutilities (e.g., fire, disease) and their associated risks.

The outputs of RMSs are control forces designed to maintain acceptable HTS disutility. As such, they are more difficult to

describe than the outputs of the HTS, because it is necessary to define not only their nature and origin but their purposes, effects, and costs. Thus, for example, a control force in the form of a driver license suspension imposed by an administrative agency must be examined to identify its purpose (of, say, preventing crashes involving teen-aged drunk drivers), its effectiveness in accomplishing its purpose, and the total cost of RMS resources expended in applying that force. It is also important to identify any negative effects associated with potential applications of that force (e.g., the violation of fundamental constitutional rights by denial of due process).

Finally, the specific nature of society's "outputs" must be known. These should be described in terms of required reductions in specific risks and in terms of what constitutes acceptable control forces for such risks.

Meeting the above needs will produce a comprehensive and detailed description of the Highway Safety Process. Kept up to date, the description will provide a running history of the constituents, objectives, and outputs of the HSP, and thus will comprise the first basic ingredient for designing, operating, and evaluating programs of risk-management.

2.3.2 Decision-Making Within the Highway Safety Process. Factors important in deciding how to deal with HTS risk must be identified and described. Three specific needs are germane to decision making within the HSP.

The first need relates to formation of perceptions about the outputs of the HTS and RMSs. It was noted earlier in this report that perceived risk often does not equal actual risk and that perceptions about utilities of the HTS and disutilities of RMS control forces may also be inaccurate. Thus, there is a need to determine the nature of societal, HTS, and RMS perceptions of the risks and

utilities of the HTS and RMS control forces, and to understand how those perceptions are formed. It is necessary to know, for example, how perceptions of crash risk due to speeding vary with demographic characteristics, and how effective speed "traps" are in reducing crash risks.

The concept of maximum tolerable disutility due to crashes was introduced in Section 2.1 as an essential element of highway safety. There is, therefore, a need to describe this reference value of disutility for different groups of individuals from the HTS, RMSs, and society in general. The need for such knowledge is fundamental because it forms the basis for determining the specific objectives of RMSs at any point in time. Combined with information about actual and perceived disutility, it allows one to ascertain if society's safety requirements are being met and the extent to which control forces should be applied to meet those requirements.

For example, knowledge that, all things considered, the requirement that an average driver's chances of being killed in a crash over a driving lifetime not exceed one in 1,000, when they are actually more than 25 in 1,000, could have very significant implications for risk-management. Such knowledge would indicate that RMSs were not satisfactorily accomplishing their objectives, since actual risk greatly exceeds that which is acceptable, and perceived risk is much lower than actual risk. On the other hand, a finding that drivers who use a heavily patrolled roadway during nighttime hours can expect to be involved in some kind of serious crash once in every 1,000,000 trips, when their safety requirement is one serious crash in 100,000 trips, might indicate a misallocation of police resources. In either case, maximum tolerable disutility must be known in order to measure RMS performance.

The last need in this category is to understand how decisions about responses to risk are made. In the case of the HTS, this means, for example, that one understand why one driver's response to

a given perceived risk will be risk avoidance, while another driver's response will be to accept the risk. By the same token, the public in one jurisdiction may demand immediate action against a given perceived risk, but the same risk in another jurisdiction may leave the public apathetic. Finally, one police agency may respond to a given increase in perceived risk by allocating more patrol cars to a given stretch of highway; but a police agency in another, apparently similar, jurisdiction may take no action at all to deal with the same amount of increase in risk. Thus, there is a need to know the significant factors that lead to such wide differences in responses to the same perceived risk, and to know how to manage these factors so as to obtain optimal responses from the decision-makers.

2.3.3 Communication Within the Highway Safety Process. The accumulation of a body of knowledge about the nature and effects of the HSP will be of little use unless such knowledge is disseminated and understood by the components of the process. Effective means for accurately communicating needed information within the HSP is thus a basic requirement for risk management.

Three specific needs are generated by this general requirement. First, there is the necessity to determine the nature of information needed by each component of the HSP. In general, each component will need at least some of each type of information defined by the above specific requirements, but the depth and scope of the information will vary greatly among components. For example, the information needs of traffic court judges with respect to identification of risk due to drunk-driving are different than the information needs of the automobile designer. Both need to know about the magnitude of the risk associated with various blood alcohol concentrations, but the designer needs more detailed and precise information about how alcohol affects vehicle-driver interactions and thereby increases crash risk. However, traffic court judges need a more in-depth

explanation of the effects of a given treatment regimen for alcoholic drivers.

Individuals and organizations that are often not considered to be a part of the HSP should also be provided information about highway safety and their role in it. For example, physicians should be aware that certain types of injuries are more likely to appear than other injuries and should be prepared to identify and treat those injuries when examining a crash victim.

Secondly, the appropriate form and method of delivery of the information must be determined for each component of the HSP. For example, the automobile designer might best be reached through technical reports and journal articles, while traffic court judges might respond better to an intensive seminar involving colleagues and other peers with specialized knowledge about alcohol-related crashes and treatment methods for alcoholism. The mass media would be a better vehicle for informing segments of the general public about alcohol-crash risk and the responses of RMSs to that risk.

Finally, continuing communications programs must be designed and implemented. The programs must provide needed information in effective form to all components of the Highway Safety Process.

2.4 Summary and Conclusions

Our new conceptual framework has been used to analyze major problems and needs in managing crash risk. Examination of the past operation of the HSP reveals a range of problems inhibiting the effective management of risk. The problems fall within the following three categories:

(1) the description of the societal process (i.e., the Highway Safety Process) through which the disutilities of highway crashes are generated and controlled,

(2) decision-making within the Highway Safety Process (HSP), and

(3) communication within the HSP.

Major problems contained in these three categories may be listed as:

Description of the HSP

- The components of the HSP are not identified and described.
- The functions of the HSP are not identified and described.
- A detailed structure relating the components and functions has not been developed.
- The outputs of the process are not defined.

Decision-Making

- The nature of perceptions about the HSP and its outputs have not been determined and it is not understood how these perceptions are formed.
- Maximum tolerable disutility due to highway crashes has not been described.
- The process through which decisions about how to respond to crash risk are made has not been described and is not understood.

Communication

- The nature of the information needed by each component of the HSP has not been determined.
- The appropriate form and method of delivery of needed information has not been determined.
- Continuing communications programs to provide needed information in effective form to all components of the HSP have not been developed.

Major needs in highway safety have been identified. With respect to the HSP as a whole, these needs may be stated as:

- A comprehensive theory of highway safety should be developed.
- The perception of highway crash risk should be made more accurate.
- The HSP and its components should be adequately described.
- Existing knowledge should be used.
- RMS actions should be evaluated.

With respect to the Highway Transportation System (HTS), major needs in risk management are:

- Components should be more fully identified and described.
- Operations should be more fully identified and described.
- User decisions should be understood.
- Utilities should be described in operational terms (e.g., the reasons for risk-taking or safe driving).
- Disutilities due to crashes should be adequately identified and described in operational terms that will support risk-management actions.

Within the Societal component of the HSP, major needs are:

- Risk perception should be made more accurate.
- The processes through which perceptions are formed should be described and understood.
- Methods for changing perceptions should be developed.

Major needs of Risk-Management Systems have been identified as:

- RMSs should be identified and defined.
- RMSs should engage in system management.
- Risk-management action by state and local units of government should be increased.
- The process of risk management should be followed.
- Information on the effectiveness of risk-management strategies and tactics should be provided to RMSs.
- A wider range of risk-management strategies should be considered and less reliance placed on traditional countermeasures.
- The effectiveness of the control forces of RMSs should be determined and made known to the public.
- Public support of control actions should be increased by developing control forces that do not in themselves generate excessive disutility.

It is concluded that there is also a clear need for a more formalized and extensive analysis of risk management needs, and for the development of focused programs to meet those needs. That such an analysis has not been conducted in the past is due in large part to the lack of an adequate theory or conceptual framework as a basis for identifying needs.

3.0 RESEARCH STRATEGIES AND PROGRAMS

This section reports the results of the Planning Project efforts focused on the fifth specific objective--the development of research strategies and designs to address the identified priority research needs. This task is a continuing effort; this report represents a first iteration.

Our approach has been to identify general research strategies and major program areas that must be included within a comprehensive highway safety research effort to address the major problems and needs previously identified. This task will continue to develop more detailed descriptions of programs that will include, when appropriate, the identification of specific, high-priority projects. Subsequent reports will present these findings.

This section is presented in two parts. First, general research strategies are described. This is followed by an identification of major research program areas.

3.1 General Research Strategies

Strategy I — An organized body of theory of highway safety should be developed.

Discussion — The lack of order within the field of highway safety in both research and action programs reflects the lack of an organizing framework. Theory is needed to provide (1) a method of organizing existing knowledge; (2) principles and rules for making decisions; (3) a way to focus inquiry; (4) a common way to communicate; and (5) order and direction for action to reduce the risk of traffic crashes.

Strategy II — The scope of highway safety research should be broadened to include all aspects of the highway safety process.

Discussion — An examination of past highway safety research reveals that significant areas within the highway safety process (e.g., the role of societal perceptions of risk) have been ignored. The limited scope of past research has resulted in highway safety action or countermeasure programs of equally limited scope. It is unlikely that significant reductions in risk will occur until research and action programs address the full breadth of the highway safety process and consider the range of factors that lead to the generation of risk within the Highway Transportation System.

Strategy III — The nature of research activity must be broadened to include all types or phases of research relevant to the reduction of the risk of traffic crashes and crash loss.

Discussion — Research may be defined in a variety of ways. Types of research (or phases of research) range from basic through applied to demonstration projects. An examination of past highway safety research efforts reveals that very little basic or applied research related to human-oriented highway safety is being conducted. NHTSA, for example, conducts no basic or applied research. Since we know so little about the operations of the Highway Transportation System and the important roles that human decision-making plays within the system, the lack of basic and applied research focused on highway safety problems must be viewed as a deficiency.

Strategy IV — Highway safety research should be balanced so that all priority areas of the highway safety process receive proper attention.

Discussion — Examination of past research efforts reveals that significant research funding has been devoted to the highway and vehicle, with emphasis placed on the crash phase with a goal of injury reduction. Human factors have not received significant attention, although they have been reported as playing the major causative role by almost all researchers examining traffic crash causation. Past research has also focused almost exclusively on the disutilities of the Highway Transportation System.

Discussion (Continued)

Unsafe driving acts have been studied. In general, the studies have not attempted to determine why people drive safely or what utility is associated with the unsafe driving acts. This narrow focus of past research has resulted in the development of equally narrow countermeasure programs that focus heavily on the vehicle and the environment. Most human-oriented programs rely heavily on negative approaches (e.g., traffic law enforcement). Some educational programs have been attempted, but their effectiveness is not established.

Strategy V

A deliberate effort should be made to increase the quality of highway safety research.

Discussion

A review of past research reveals that the quality of individual studies varies greatly. In some cases this simply represents the capabilities of the researchers involved. In other cases the quality of the work product is directly related to deficiencies in the design of the research that were set forth in the statement of work by the sponsor. The sponsor's designs are simply executed by the contractor. The lack of flexibility in the contracting process, in particular, that of NHTSA, greatly contributes to this problem.

Strategy VI

A deliberate effort must be made to increase the usefulness and use of research findings.

Discussion

There appears to be very limited use of research findings and existing knowledge by decision makers. Frequently, program decisions are made without using information that is available. This is particularly true at the state and local level. The reasons for this are not clearly established.

It is very difficult to readily access past research. Many reports are not indexed. Many reports are not in print--having been originally distributed in limited quantity. Retrieval from central sources such as the National Technical Information Service is not always a rapid process nor apparently well understood by local governmental personnel.

Strategy VII — The level of effort devoted to highway safety research should be increased.

Discussion — It is almost axiomatic that researchers will recommend more research. We do not wish to argue that point nor disappoint those who expected that we would suggest that more research is required. We suggest, however, that even non-researchers examining the current state of highway safety would conclude that additional research effort is appropriate.

The highway safety problem is a significant national problem. The costs to society in terms of non-quantifiable losses such as death, pain, and suffering and the quantifiable costs of injury, death and property losses, rank high in any list of public health and safety problems. If it were purely a health problem, one would expect a public cry for a new institute of health safety to deal with the problem.

The examination of societal response to the problem of highway crashes indicated that there is a significant lack of understanding of what produces crashes or what reduces crashes. We do not know how to control the traffic crash problem.

Examination of the crash-reduction effort also reveals that it is a relatively low technology area compared to other aspects of society. The Highway Transportation System does involve technology but the safety efforts, in general, make only limited use of technology.

These factors--the magnitude of the problem, the lack of knowledge of how to effectively deal with the problem, and the relatively low use of technology in a high-technology society--all suggest that increasing the level of research would contribute to more effective management of the traffic crash risk.

3.2 Research Program Structure

This subsection presents a general outline of a research program structure for highway safety research. Major program areas are identified that contain related programs. These programs, in turn, contain

families of related projects. The purpose of this presentation is to develop a top-level description of the major program areas that can serve as the basis for discussion of future research directions.

The concept of a program area is one that must be understood to follow the logic of the presentation. The program areas have been identified as major topic areas of relatively the same priority. They may be thought of as links in a chain. Research must be undertaken in each program area to complete the "chain" so that the problems and needs of highway safety can adequately be addressed. While each program area may be viewed as an equally important link in the chain, it is clear that the areas are not of the same magnitude in the sense of the amount of research required to adequately develop answers to the problems and needs associated with each area. Some program areas will contain many programs with literally hundreds of projects. Others will have more limited scope. The importance of a program area flows from the relevance of the topics included--not from the number of projects or programs subsumed within the program area.

We have previously identified major problems and needs as being associated with the various elements of the highway safety process described by our conceptual framework. This same theme has been followed to identify four major program areas:

- General Highway Safety Process Research
- Highway Transportation System Safety Research
- Societal Highway Safety Research
- Highway Safety Risk-Management Systems Research

The scope of these major program areas will be described in greater detail later in this subsection.

In identifying major problems and needs we noted that three basic problem areas could be identified. These included:

- Description of the highway safety process and the constituent elements of the process.
- Identification of the decision-making processes related to the generation and management of traffic crash risk.
- The communication and use of information about crash risk and the effectiveness of the risk-management process.

These problems generate needs that pervade all aspects of the highway safety process. Thus, we have used these problem areas to identify programs within each major program area.

In developing our conceptual framework, we noted that the highway safety process was basically a risk-management process. We specifically identified risk-management systems as one major element of the conceptual framework, but noted that the process of risk-management permeated all aspects of the highway safety process. We noted that the risk-management process could be succinctly stated to include the following steps:

- Risk Identification;
- Establishment of Priorities Among Risks;
- Determination of the Allocation of Resources;
- Selection of Risk-Management Strategies and Tactics;
- Implementation of Risk-Management Actions; and
- Evaluation of Outcomes in Terms of Risk Reduction.

The risk-management process as it relate to each major program area also becomes an appropriate research program within each major program area.

This, then, led us to state the basic structure for a general research program in highway safety. The general program is divided into four major program areas of equal importance. Each program area, in turn, is composed of programs that address the following topic areas:

1. Description,
2. Decision-Making,
3. Communication of Information, and
4. Risk-Management.

This approach is illustrated in Figure 3-1. Each program is composed of families of projects that address the major topic of the program. It may be expected that a single project may logically address topics in more than one program or more than one program area (See Figure 3-2). The derivation of the need for the project, however, would flow from an analysis of problems and needs in the major program area. The identification of specific needs would lead to the identification of the specific project.

The following subsections describe each major program area in greater detail and provide a preliminary indication of the programs that would be included within each program area. Examples of projects that would fall within programs are provided for illustration only. The illustrative projects are not recommended as priority research projects. They are presented for the purpose of explanation only.

3.2.1 Program Area A -- General Highway Safety Process Research. Programs and projects within this program area are concerned with problems and needs that are top-level concerns or permeate all aspects of the highway safety process. Problems and needs related to overall management of the traffic crash risk fall within this program area.

Program A-1 Description of the Highway Safety Process

Projects within this program are concerned with the identification of the nature of the highway safety process. The development of theories, models, conceptual frameworks and other methods of explanation are included.

Particular emphasis is placed on the description of the interrelationships of the constituent elements of the highway safety process. Another concern is the description of the highway safety problem in the context of other societal risks.

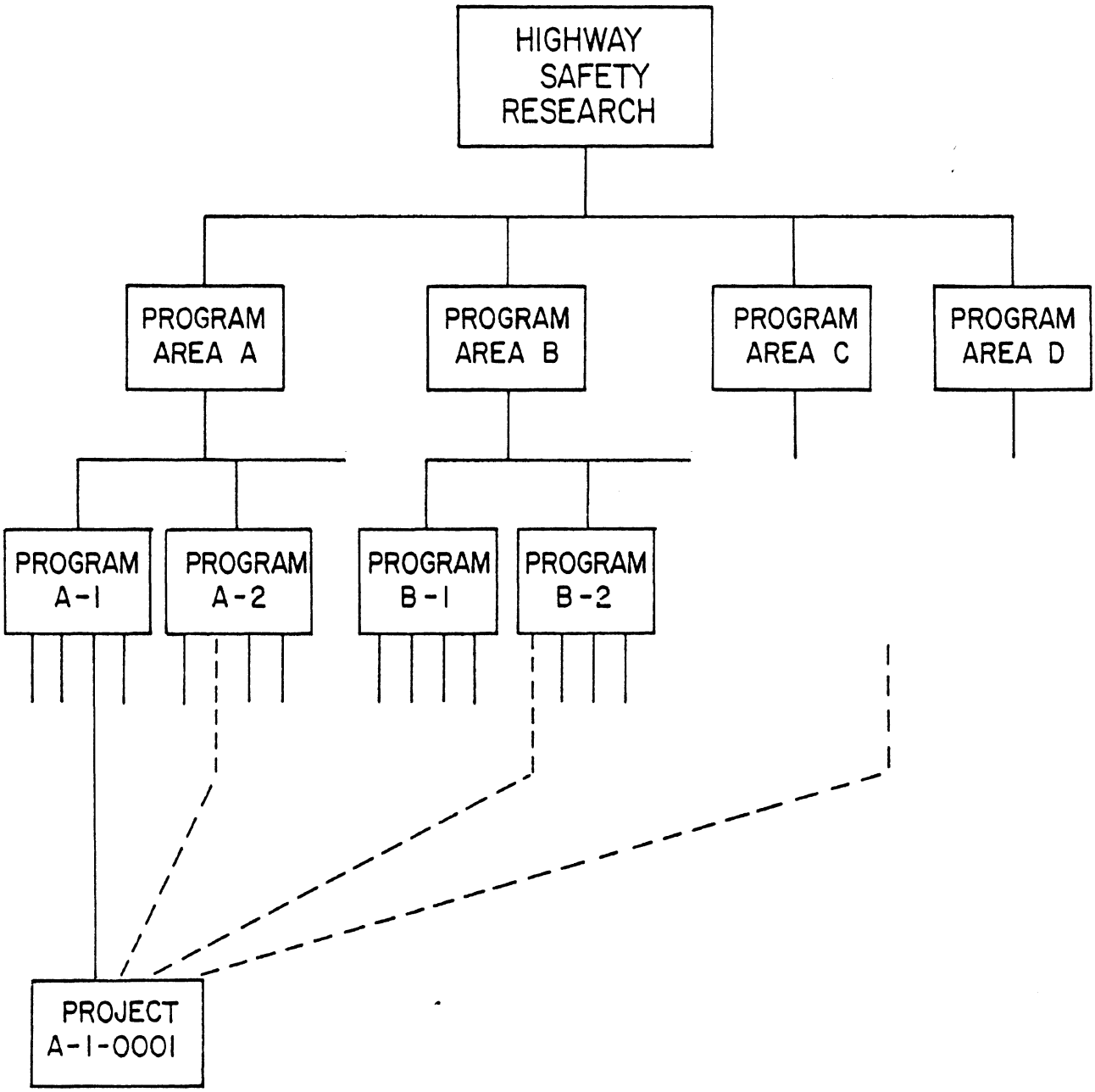
FIGURE 3-1

HIGHWAY SAFETY RESEARCH ARRAY

Program Areas / Topic Areas	A Highway Safety Process	B Highway Transportation System	C Society	D Risk-Management Systems
Description	A-1	B-1	C-1	D-1
Decision Making	A-2	B-2	C-2	D-2
Communication of Information	A-3	B-3	C-3	D-3
Risk Management	A-4	B-4	C-4	D-4

FIGURE 3-2

STRUCTURE OF HIGHWAY SAFETY RESEARCH



Program A-2 Decision-Making in Highway Safety

Projects within this program are concerned with broad aspects of human decision-making as it relates to highway safety. How risk is perceived and how the risk-management processes are perceived are concerns. The way in which top-level decisions about highway safety versus other safety issues are perceived is also of interest. The decisions of priority interest are those of a policy nature that affect the highway safety process as a whole.

Program A-3 Communication of Information

Projects within this area are concerned with the communication and use of broad elements of information that relate to the overall operations of the highway safety process. The use of information in policy formulation and implementation is a particular concern.

The identification of information users and the methods in which they receive and use information for policy making would be examined.

Program A-4 Risk Management-Highway Safety Process Level

Projects within this area are concerned with the application of the risk-management approach to top-level decisions within the highway safety process. These would include basic decisions about the priorities among risks, development of broad strategies for highway safety, resource allocation, action program implementation, and overall evaluation of the effectiveness of the highway safety process. The management level of interest would be the Congress and senior elements of the executive branch in the federal government and similar components of state and local governments.

3.2.2 Program Area B -- Highway Transportation System Safety Research. Programs and projects within this area are concerned with the Highway Transportation System as one of the constituent elements of the highway safety process. The examination of the HTS is done in the context of the safety implications of its operations and outputs. Thus, research programs are focused on the HTS in the context of highway safety.

Program B-1 Description of the Highway Transportation System

Projects within this program would describe the objectives, functions, components, structure, and outputs of the HTS. Such components include drivers, vehicles, the highway environment, and the support systems. Outputs include the positive benefits or utilities, such as mobility and convenience, and costs of disutilities, such as traffic crashes.

The factors which create utility and disutility must be carefully described. Disutility descriptions, such as the present accident investigation efforts, must be continued but broadened to describe the factors creating the initial risk as well as methods that can reduce risk once a crash has occurred.

Program B-2 Decision-Making within the HTS

Projects within this program will examine the decisions that are made to create and operate the HTS and the safety implication of those decisions. Decision-making by system users (e.g., drivers, pedestrians, and passengers) will also be examined to understand how people are placed in risk.

Program B-3 Communication of Information

Projects within this program will examine how information is communicated and used within the HTS. Information related to each element of the HTS will be examined, users identified, the method by which information is used identified, and the impact on highway safety assessed.

Program B-4 Risk Management-Highway Transportation System

Projects within this program will examine the general management process of the HTS to determine the safety implications. A distinction is made here between general management activities and specific risk-management actions which are covered as a separate element of the conceptual framework. The management process examined here is that directly related to overall HTS operations. An objective would be to identify general management decisions that lead to increasing or reducing crash risk.

3.2.3 Program Area C -- Societal Highway Safety Research.

Programs and projects within this area are concerned with examining the role that the societal element of the highway safety process plays in the management of the traffic crash risk.

Program C-1 Description of the Societal Role

Projects within this program will identify and describe the nature and extent of the societal role in highway safety. Identification of the ways in which society acts to influence factors that generate risk or reduce risk within the Highway Transportation System are of particular interest. Description of how society creates and influences risk-management systems is also included.

Program C-2 Decision-Making by Society

Projects within this program will focus on the basis for societal decisions about highway safety. Many of the same concerns that are of interest in Program A-2 are of interest here as well. The focus of projects within Program C-2 is on individuals and groups whose decisions influence the more formal policy-making bodies and risk-management systems.

Program C-3 Societal Communication of Highway Safety Information

Projects within this area share the general concerns of communication of information projects in other program areas. The focus of projects within this program is on individuals and informal groups. The objective is to identify how information about risk, risk avoidance, and risk management is communicated within the societal element of the highway safety process and to develop methods to make the communication more effective.

Program C-4 Societal Risk-Management Actions

Projects within this area are concerned with identifying and describing risk-management actions within the societal element. An example would be a project that demonstrated how a community could assess its highway safety problem and obtain an adequate response from the formal risk-management systems within that community.

3.2.4 Program Area D -- Risk-Management Systems Research. This program area is concerned with examination and improvement of the formal and informal systems that society has created to exert control forces on the highway transportation system to reduce the risk of traffic crashes. This program area is very large in scope and includes many elements of existing research efforts.

Program D-1 Description of Risk-Management Systems

Projects in this program address a critical objective--the identification and description in functional terms of the formal and informal systems used to control the operations of the HTS. The scope of the program is broad. Not only must existing risk-management efforts be identified and described, but also new, innovative approaches that have not been fully used must be identified and described.

Program D-2 Risk-Management System Decision-Making

Research projects in this program will focus on the decisions made within the risk-management systems. Projects will examine existing decision processes to identify problems and to suggest improved decision-making approaches.

Program D-3 Risk-Management System Communications

Projects in this program will identify information needs for risk-management system operation, identify information users, and develop methods for improving the use of information for risk management.

Program D-4 Risk-Management System Operations

Projects within this area are concerned with improving the functioning of all formal and informal risk-management systems. Projects on management, training, and technology transfer are included. Projects that develop and implement new, innovative strategies and tactics are also included. Evaluation of specific risk-management efforts would be another example of projects within this program.

3.3 Summary and Conclusions

A first iteration at identifying research strategies and programs was made. Seven major strategies for meeting priority research needs are suggested:

- develop an organized body of theory of highway safety,
- broaden the scope of highway safety research to include all aspects of the highway safety process,
- broaden the nature of research activity to include all phases of relevant research, from basic research to demonstration projects,
- balance highway safety research activity to focus proper attention on all priority areas,
- increase the quality of highway safety research,
- increase the usefulness and use of research findings, and
- increase the level of effort devoted to highway safety research.

General research programs in highway safety can be generated by tabulating program areas versus topic areas. Relevant program areas are:

- General highway safety process research,
- Highway Transportation System research,
- Societal highway safety research, and
- Highway safety risk-management systems research.

Major topic areas of concern in each program area are:

- description of the highway safety process and its constituent elements,
- identification of the decision-making processes related to the generation and management of traffic crash risk,
- communication and use of information about crash risk and the effectiveness of the risk-management process, and
- the risk-management process.

Specific projects addressing these sixteen research programs need to be developed in a systematic fashion. Also, the programs themselves should be defined in more detail in a more in-depth program of "research on research." Finally, a set of priorities specifying which programs and projects should be conducted to what extent, in what order, and in which time periods should be developed. Some initial observations and insights about research priorities and related issues are discussed in the next section.

4.0 OBSERVATIONS AND INSIGHTS

The information presented in this interim report is preliminary in nature. The inquiry has been constrained by the availability of information and by the level of effort available for examination of existing information. It would not be appropriate to state, on the basis of this limited inquiry, formal conclusions and recommendations. The nature of the inquiry has led the principal investigators to make some observations and share some insights developed as a result of the research efforts. These are presented in the following sections.

4.1 Priority Research

Three research topics have been identified as having the highest priority for the near-term future. These topics span all the program areas identified previously. Projects addressing these topics would be placed within the context of the most appropriate program, but the outputs would be of benefit to other program areas as well. These topics are described below.

Topic I Perception of Risk and Risk Management

The subjective perceptions of the risk of traffic crashes and the value of risk-management approaches form the basic constraints and sustaining forces for the highway safety process. How perceptions are formed, how perceptions change, and what factors influence perceptions are basically unknown.

Until more objective perceptions can be developed, it is likely that the highway safety process will simply follow the direction suggested by the most persuasive voice.

Topic II — Information Utilization and Technology Transfer

A finding of this study and others is that the use of existing knowledge and technology in the field of highway safety is relatively low. This is particularly true at the local government level.

The ways in which information is transmitted and used are not well known. The individuals who should be using research findings are not adequately identified. Methods for disseminating information that are well known within the education and communication science communities have been applied only to a limited degree in the past.

It is as critical to ensure that existing, valid knowledge is used as it is to expand the existing knowledge base.

Topic III — Develop New Risk-Management Approaches

Examination of the range of risk-management approaches now in use or under apparent consideration reveals that heavy reliance is placed on conventional risk-management systems such as the traffic law system.

These approaches are primarily negative in nature, relying on the substitution of a present threat such as arrest for the more indefinite risk of a traffic crash.

Consideration needs to be given to more positive approaches. For example, reduction of the benefits associated with risk-taking should be examined.

4.2 Research Policy Issues

One of the most striking results of assessing research efforts against the conceptual framework is that the process reveals how narrow research has been in the field of highway safety. Recommendations of past studies almost invariably suggest more research of the same nature and scope. Use of the conceptual framework shows that significant areas of the highway safety process have received only limited attention. The scope of past research has not been adequate. Thus it is important to broaden the scope of inquiry of highway safety research.

As part of this broadening of scope, consideration must also be given to developing a balance. Research has tended to concentrate on the highway environment and the vehicle. Only limited research attention has been given to the human component of the highway transportation system. Examination of past funding indicates, at a first look, that a relative balance has been maintained among the components of the Highway Transportation System. The funding for human-oriented research, however, has been heavily biased toward demonstration programs such as ASAP. These programs have consumed significant funds with insignificant results. They cannot be viewed in the same context as past vehicle and highway research efforts. Thus, we conclude that the emphasis on human-oriented research should increase. Demonstration programs should follow developmental research projects, not preempt them.

A comment must be made as well on the quality of research. The present research funding process of NHTSA encourages low bidders and discourages researchers interested in addressing non-obvious but seminal problems. Typically, NHTSA conducts research procurement by the competitive contract solicitation method. Approximately four weeks is allowed from the announcement of a procurement (Request for Proposal) until the due date for the proposal. Some of the procurements have work statements that could cover research efforts ranging in magnitude from one to one hundred years of professional effort. This produces a bidding jungle that attracts the segment of the research industry that can afford to invest in proposal writing and discourages the research community that operates from universities or other non-profit organizations.

The result has been a lack of continuity in many programs. Work started by one group is continued by a second. Lessons learned in the first effort must be relearned by the second group. Work products of

extremely uneven quality have been produced and disseminated. If the conclusions fit the policy objectives of the moment, the research may be used to support action programs or defend past efforts.

The relatively small research community in highway safety has made it difficult to obtain the type of critical comment that is common in broader research areas. Individuals are reluctant to openly criticize the NHTSA program and the work products of their colleagues because of the perceived consequences. We believe it very important for the future of highway safety research that quality control methods be developed and implemented.

4.3 Research Sponsorship

Our initial examination indicates that the vast majority of human-oriented highway safety research is sponsored by governments. We estimate that at least 75 percent of the total funding in this area flows from federal sources. Private sector funding represents only a small portion of the whole--probably about ten percent.

We suggest that it is important to review present funding levels. We believe that, when all factors are considered, the expenditure of additional funds for research in highway safety is justified and necessary. This suggests increased expenditures by both the public and private sectors.

The respective research roles of the public and private sectors should be examined. It is likely that under both present and future funding patterns the vast majority of research will be funded by the federal government. It then becomes very important to ensure that the policy issues of scope, balance, and quality discussed previously are adequately addressed within the federal program.

This suggests that an important role for the private sector is to help ensure that these objectives are met. The private sector can

be far more influential and effective by funding efforts to produce better quality federal research. The private sector should place greater emphasis on funding basic and applied research to develop policy directions for general highway safety research and on funding the evaluation of federal research programs to ensure that proper attention is given to scope, balance, and quality.