U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

Alcohol and Highway Safety 1984: A Review of the State of the Knowledge

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Chapter 1

Introduction

The first comprehensive review of the state of knowledge on the alcohol crash problem, the Secretary of Transportation's *1968 Alcohol and Highway Safety Report, Department of Transportation,* described a problem of major proportions and recommended a wide range of activities to bring that problem under control. Ten years later, a second comprehensive study of the state-of-the-art was funded by the Department of Transportation. That review was conducted by the University of Michigan's Highway Safety Research Institute and resulted in a report entitled *"Alcohol and Highway Safety: A Review of the State of Knowledge, 1978."* That study was based on material selected from an extensive list of literature developed through a survey of 450 individuals who had participated in research and operational programs in alcohol safety. As research in the alcohol/highway safety problem area grows, there is a need to periodically document the newest developments. This is especially important for work in the countermeasure development and test area. States and communities are constantly looking for information on potentially effective countermeasure programs. It is anticipated that this type of update will be performed at two-year intervals.

Based on the 1978 report, the National Highway Traffic Safety Administration issued a summary report on alcohol and highway safety for use by State and local officials and specialists in alcohol and safety. This report provided the technical basis for the development of Federal recommendations for the State and local alcohol safety programs. Recently interest in this area has grown rapidly due to the activities of citizens' groups such as Mothers Against Drunk Driving (MADD) and Remove Intoxicated Drivers (RID). The public concern raised by these groups has resulted in a significant increase in State legislation and an increase in activity at the Federal level as demonstrated by the establishment of a Presidential Commission on Drunk Driving and the passage of new legislation providing for an incentive program for the states to strengthen their drinking/driving laws.

Because of this renewed interest in drunken driving and because there have been significant new programs implemented since the 1978 summary, NHTSA has decided to provide an interim update of the Alcohol and Highway Safety Report. This update is not based on a broad and detailed review of the scientific literature but rather has been revised to include the most clearly important studies and findings during the period from January 1978 to December 1982 and has been reorganized to fit with the current emphasis of program activities on general deterrence to drinking and driving. At the same time, large portions of the original have been left intact. Those sections in which major new information was not available have not been significantly changed. For those interested in the new material which has been added to this update, the new references have been included at the end of this report as a separate list and identified as "New References."

Since the 1978 Report, two important new data systems have been established by NHTSA: The Fatal Accident Reporting System which is a census of all fatal accidents, and the National Accident Summary System which provides an estimate of the numbers and characteristics of injury and property-damage-only crashes. These two systems provide considerable information on the role of alcohol in accidents for the Nation as a whole. These data were not available in the 1978 report. A second example of an important new source of information is the review of world experience with drunken driving problems by H. Lawrence Ross entitled "Deterrence of the Drinking Driver: An International Survey" (*Ross, 1981*). This review has provided evidence for the effectiveness of general deterrence.

Finally, as a result of earlier studies which indicated that lowering the legal age for purchase of alcohol increased teenage alcohol-related accidents, many States have increased their legal drinking age, with the result that it has been possible to study the effect of raising the minimum drinking age. This research indicates that raising the age produces a reduction in teenage drinking/driving crashes.

The limited update of the 1978 Alcohol and Highway Safety Report contained in Chapters 2, 3, and 4 of this volume was produced by Robert B.

Voas of Pyramid Planning. While he is fully responsible for the current version, much of the content remains the work of the original authors: Ralph K. Jones and Kent B. Joscelyn of the Highway Safety Research Institute of the University of Michigan. The original bibliography compiled by these authors has been preserved—see "1978 Reference" list. A new reference list has been compiled for this updated version—see "New References". Citations to the new reference list are italicized in the text.

Chapter 2

General Approaches and Methodological Problems

Alcohol has been suspect as a factor in highway crashes almost since the appearance of the automobile. A 1904 study of fatal crashes involving "automobile wagons" found that a large fraction of the drivers had been drinking before their crashes and observed that:

> Inebriates and moderate drinkers are the most incapable of all persons to drive motor wagons. The general palsy and diminished power of control of both the reason and the senses are certain to invite disaster in every attempt to guide such wagons (*Quarterly Journal of Inebriety* 1904, quoted in U.S. Department of Transportation 1968, p. 147).

Five Approaches to the Study of the Alcohol-Crash Problem

By the 1930's, a scientific basis for defining this suspected alcohol-crash problem had begun to evolve as a result of increasing research activity in the field. Five basic approaches to the problem were followed then—and now (Heise, 1934).

1) Consumption and Elimination of Alcohol

The first and most fundamental approach has been to determine the amount of alcohol in the body. For this, researchers have developed instruments and techniques for measuring the amount of alcohol in various bodily fluids (e.g., urine, saliva, blood) and in the breath. They have studied also the relationships between the amount of alcohol so determined and the amount of alcohol consumed prior to the measurement.

2) Laboratory Studies

Secondly, the behavior of individuals with known quantities of alcohol in their bodies, as determined by the measurements cited above, were studied in a laboratory setting to define the relationships between the effect of alcohol on the behavior so studied, such as the ability to stand erect without excessive swaying, and the effect of alcohol on behavior critical to safe driving.

3) Studies of Driving Performance

In the third approach, an extension of the second, the effect of alcohol on actual driving performance is studied in an instrumented car on a closed driving course or in a driving simulator, or by special observations of drivers using the roadways.

4) Epidemiology of Accidents

The fourth approach is the study of the use of alcohol among different populations of drivers. It is often referred to as an "epidemiologic" approach because it employs techniques commonly used by scientists in the study of the diseases in populations. A variety of such techniques are used, the most important being the controlled study, in which the incidence of drinking drivers in crashes and the incidence of drinking drivers among all those using the roads are studied and compared. The determination of whether and to what extent drivers have been drinking is made by using the methods developed in the first approach. Driving records, health records, results of interviews with the drivers and others, results of psychological tests, and other information have often been used to learn more about the drinking-driving behavior of these populations of drivers.

5) Naturalistic Field Studies

In this fifth approach, scientists have taken advantage of changes which occur in the laws relating to drinking and driving or in economic, social, or physical changes which occur as the result of political and technological developments, to study the role of alcohol in crashes. Recent State changes in drinking-age laws have provided opportunities to determine the effect of limiting alcohol availability to certain age groups. Changes in drinking-driving laws or in enforcement activities provide an opportunity to determine the effect of the legal system on alcohol-related crashes.

Objective: Determine Whether Drinking and Driving is a Societal Problem

The ultimate objective of these five approaches is to provide the information necessary for determining whether combining drinking with driving presents a significant societal problem and, if it does, for defining that problem. This problem definition process involves five steps:

Step 1—Determine How Many Crashes Involve Alcohol

To decide whether alcohol-related crashes constitute a serious problem for the society, the number of crashes which involve drinking drivers must first be estimated. If there are only a few, then the problem is not serious. If there are many, then there is reason to go to the next step.

Step 2—Determine Whether Drinking Drivers are More Involved in Crashes

The next step is to determine whether drinking drivers are more often involved in crashes than other drivers. If they are not, there is no basis for suspecting alcohol any more than any other factor as a cause of the crashes involving the drinking drivers. If, however, one finds significantly higher percentages of drinking drivers among crash-involved drivers than among drivers who have not crashed, then there is reason to suggest that there is, indeed, an alcohol-related crash problem.

Step 3—Determine Whether Over-Involvement is Due to Alcohol

Next, one must determine whether the overrepresentation of drinking drivers in crashes is actually due to the impairment of driving performance by alcohol rather than to some coincident factor. For example, people who drink may tend to drive more at night and be involved in more nighttime accidents, quite aside from any impairing effect of alcohol.

Step 4—Determine Which Types of Drivers are Most Involved

If there is a strong indication that alcohol is a contributing cause of accidents, then research must be undertaken to determine the types of drinking-driving behaviors which lead to crashes and to isolate the specific types of drinking road users involved in these crashes.

Step 5—Develop and Evaluate Remedial Programs

Once the types of drinking behaviors and types of drivers most involved in crashes have been identified, it is possible to conceptualize remedial programs designed to reduce alcohol-related crashes. This is the acid test for the accuracy of our knowledge of accident causes. If we can manipulate the variables we believe to be responsible for crashes and produce a change in the numbers of alcohol-related accidents, then we have provided a credible test of the validity of our theories.

Methodological Problems

The most troublesome difficulties in following this process have occurred in behavioral research on the effect of alcohol on the ability to perform critical driving tasks, in epidemiologic studies of driving populations and in the evaluations of alcohol programs.

Laboratory Research

The difficulty with applying research on the behavioral effects of alcohol to highway safety is the lack of a clear and explicit relationship between the behavior tested and driving tasks. This is particularly true of behavior that has been studied in the laboratory, where most of the tasks examined have been much simpler than those involved in driving. Thus, a gross effect on the laboratory tasks must be found in order to infer an effect on driving tasks. Obviously, in some cases, one cannot quantify the effect alcohol may ultimately have on driving performance.

Recently, studies which use observations of actual drivers on the highways (*Bragg, et al., 1981; Damkot, 1977;* and *Harris, et al., 1980*) and then correlated their behavior with BAC measurements have begun to close the gap between laboratory studies and the real driving environment.

Epidemiology

Different but equally serious problems exist in the epidemiologic literature on alcohol and highway safety. Foremost among these problems is the lack of current, comprehensive studies comparing the characteristics of drivers in crashes with those of a control group of drivers exposed to the same (the road, the time) driving environment as the crash-involved drivers. Such studies are essential for estimating the effect of alcohol on the risk of crashing faced by any given subgroup of drivers that can be defined by the data (such as males, young persons, married persons, social drinkers, alcoholics). Although many well-designed and carefully executed controlled studies have been conducted (Lucas, et al., 1955; McCarrol and Haddon, 1968; Borkenstein, et al., 1964; Perrine, 1974a; and *Farris, Malone, and Lilliefors, 1976*), none provides sufficient detail for calculating up-to-date, nationally representative estimates of alcohol-crash risk as a function of crash severity and a broad range of driver characteristics.

The establishment of national accident record systems (the Fatal Accident Reporting System) provides a source for nationally representative data on the incidence of alcohol in accidents. However, many of the specific types of data which are of special interest in DWI* research are either not collected or incomplete in these files. BAC data, for example, is available only on a small portion of drivers in accidents.

Studies of Driver Characteristics

Studies that have attempted to delve deeply into the characteristics of drinking drivers have encountered a number of problems. Some studies rely on self-reported information about drinking and driving habits and are limited by the subject's ability and proclivity to recall accurately and report such information. Certain characteristics, such as drinking habits, are sometimes estimated by interviewing relatives, friends, or coworkers of the drivers. The perceptions of such persons, obviously, may not provide an accurate picture of the actual characteristics of the drivers. Also, the

*DWI, "Driving While Impaired", and DUI Driving "Under the Influence" used interchangeably in this report

analyses of information collected from the records of both public and private organizations are constrained by the accuracy, completeness, and currency of that data. Comparison of these studies are made difficult by the lack of consistency in the definitions of terms (e.g., "problem drinker") used to describe such characteristics.

Field Studies and Program Evaluations

Most remedial programs are put in place without regard to evaluation requirements. Many problems beset studies attempting to assess the results of such alcohol-safety programs (*Ross, 1981*). Of these problems, the most basic is a failure to rigorously evaluate a program to determine whether it or some other factor was most likely to be responsible for the observed effects. The use of properly constituted control groups for analyzing cause-and-effect relationships has been rare in the field of alcohol and highway safety.

It is important to keep these limitations in mind when studying the literature on alcohol and highway safety (including the literature discussed in this report). The main value of research in the field lies not in providing irrefutable proof of hypotheses about drinking and driving, but in providing data on which to base informed decision-making. Thus, the literature should be interpreted by the individual reader in light of his individual needs and situation. It is better that he be skeptical of research findings and conclusions than that he unquestioningly accept them because they were proclaimed by a renowned expert in a prestigious journal.

Chapter 3

Defining the Alcohol-Crash Problem

This Chapter presents a review and summary of what we know now about the nature and extent of the alcohol-crash problem in the United States. Paralleling the process of defining the problem as outlined in the preceding pages, this section of the report:

- determines whether there is good reason to believe that an alcohol-crash problem exists,
- estimates the likely magnitude of any such problem in the early 1980s, and
- defines drinking drivers and drinking-driving in greater detail to support the development of methods for dealing with the problem.

The information from a wide range of epidemiologic, behavioral, and other research studies makes these determinations possible.

Alcohol and the Human Body

First, an understanding of the basic concepts about the nature of alcohol and its interaction with the human body is helpful. The active ingredient in distilled spirits, wine, and beer is ethanol, a member of a family of chemical compounds known as monohydric alcohols. Ethanol (also called ethyl alcohol, grain alcohol, and, more commonly, just "alcohol") is simpler in chemical composition than any of the other alcohols except one, methanol. It is soluble in water, weighs a bit less than water (its specific gravity is .79) and has a lower boiling point than water (78.3°C) (AMA Committee on Medicolegal Problems, 1970; Leake and Silverman, 1971).

Although alcoholic beverages come in a greater variety of colors, flavors, and bouquets, their chief constituents quantitatively are ethanol and water. Other components appear to have only minor pharmacological significance (Wallgren and Barry, 1970; AMA Committee on Medicolegal Problems, 1970), although some studies (Katkin, et al., 1970) indicate that primary alcohols other than ethanol (called "cogeners") may increase risk-taking and decrease psychomotor performance. A "typical" drink, about three-quarters of an ounce of alcohol, is provided by a "shot" of distilled spirits (1½ ounces of 100-proof alcohol), a glass of fortified wine (3½ ounces of 20% alcohol), a larger glass of table wine (5 ounces of 12% alcohol), or a pint of beer (16 ounces of 4.5% alcohol).

Absorption and Elimination

Absorption of alcohol into the body occurs through the simple process of diffusion: alcohol does not have to be digested before entering the blood. The rate of absorption of alcohol taken orally depends on the quantity taken, its concentration, and especially on the other contents of the gastrointestinal tract. Food in the tract delays absorption. When alcohol is taken with a heavy meal, up to 6 hours may be required for complete absorption (Wallgren and Barry 1970).

After absorption within the body, alcohol is distributed among the organs and tissues in proportion to their fluid content, and the speed with which different organs reach equilibrium depends upon their blood supply. Organs such as the brain and liver reach a given concentration faster than, for example, bone.

The amount of alcohol present in the blood is commonly measured in terms of the *weight* of the quantity of alcohol in a given *volume* of blood (Voas, 1970). In the U.S., it is common to use grams per 100 milliliters. The resulting measurement is then stated in terms of percent alcohol, weight per unit volume. For example, if a given measurement showed .01 grams of alcohol in a 100 milliliter sample of the same blood, the result would be interpreted in the U.S. as a .01% w/v blood alcohol concentration (BAC).

Alcohol is eliminated from the body almost entirely through the process of oxidation. Typically, the rate of elimination is about .015% per hour (Wallgren and Barry, 1970). Roughly speaking, the average person eliminates, each hour, one of the "typical" drinks described above. Alcoholics may, however, have two to three times higher elimination rates (Carlson, 1981). No practicable means of significantly accelerating the elimination of alcohol has been discovered yet.

Methods of Measuring Alcohol in Blood

There are many methods of measuring the amount of alcohol in the blood. The most accurate

and reliable of these test the blood directly, rather than some other fluid or tissue (for example, urine or saliva). Blood collected from an artery or from capillaries provides the best indication of alcohol concentration in the brain. However, for forensic purposes, blood is most frequently drawn from the cubital vein of the arm, which results in a lag in the measured BAC relative to the alcohol concentration in the brain during the absorption phase (Harger, 1974). Laboratory facilities are required to separate the alcohol from the blood and for the subsequent quantitative determination of the alcohol (AMA Committee for Medicolegal Problems, 1970).

In 1927, Bogen introduced breath-alcohol analysis as a medical tool in the United States. Since then, several devices have been developed for use both in the laboratory and in the field. Modern breath tests can be quite precise in their quantitation of breath alcohol. Moreover, because the deep lung breath is in contact with the arterial blood supply about to be pumped to the brain by the heart, BACs measured by means of a breath test can be more accurate during the absorption phase (Harger, 1974). Other less expensive and highly portable breath testers are available for screening purposes in the field where less precision is needed (Moulden and Voas, 1975; Harger, 1974; Dubowski, 1975).

Effects of BAC on Behavior

Alcohol intoxication is most commonly apparent through observation of the behavioral and emotional effects of alcohol consumption. Although these effects vary among individuals and among cultures, there is a universal pattern of reaction to drinking, beginning with feelings of relaxation and pleasure and progressing to heightened emotionalism and disturbances in psychomotor functioning. Ultimately, excessive consumption can cause coma and death.

The behavioral and emotional effects of alcohol consumption are caused by the effects of alcohol on the brain. The measurement of BACs is really an attempt to determine, indirectly, the amount of alcohol in the brain. Since it is not usually possible or practical to extract samples of brain tissue for this measure, materials from other parts of the body are employed. Thus, the presence of alcohol in the body is most commonly measured through chemical tests performed on samples of blood, urine, and/or breath.

Just how much alcohol must be ingested for acute alcohol intoxication to occur varies from person to person. Relevant variables are body weight, body fat, contents of the stomach, speed of drinking, physical health, and the tolerance the individual has developed to the effects of alcohol. Researchers have found that BACs as low as .02% to .03% may affect the performance of some individuals. At a BAC of 0.10% w/v, approximately half of all people will show signs of intoxication. Many people appear to be intoxicated at lower BACs (AMA Committee on Medicolegal Problems, 1970).

Alcohol has a slightly greater effect on performance during the absorption phase than during the elimination phase. This is known as the "Mellanby" effect (*Moskowitz, et al.*, 1979). There may also be a residual effect on driving behavior during "hangover" after all the alcohol has been eliminated from the system (*Laurell and Tornos*, 1982).

It is interesting that there is no generally accepted explanation of how intoxication is caused by alcohol nor is there an adequate basis for pinpointing the components of the central nervous system which are most susceptible to the influence of alcohol (U.S. Department of Health, Education and Welfare, 1971). The major conclusion that can be drawn from existing research on the fundamental nature of alcohol's effects on the nervous system is that there is insufficient knowledge to develop any practicable model for predicting a specific effect on behavior. Without a general, unifying theory, it has been necessary to turn to empirical data obtained through laboratory and field experiments to describe how alcohol affects behavior. (The major findings of these experiments relevant to the alcohol-related crash problem will be discussed later in this report.)

The Presence of Alcohol in Crashes

This section presents the results of several studies of the incidence of drinking drivers in crashes. The primary objective is to determine approximately how many crashes of various levels of severity involve drivers (or motorcycle riders) who were known to have alcohol in their blood at the times of their crashes. A secondary objective is to estimate the incidence of drinking in pedestrians who were fatally injured by being struck by an automobile. In no case should these data be interpreted as showing that the crashes which *involved* drinking road users were necessarily *caused* by the impairment of those drivers or pedestrians by alcohol. Much more evidence than the mere presence of alcohol in the bodies of people who have been in accidents is required to imply cause.

National Accident Files

Until recently, all estimates of the incidence of alcohol-related crashes had to be based on a relatively small number of epidemiologic studies. While a number of these studies were well controlled, they were all limited to a relatively small geographical area, and the extrapolation of the results to the nation as a whole was questionable. Recently the Department of Transportation has established two accident data systems which collect data applicable to the whole nation. These two systems, the Fatal Accident Reporting System (FARS), and the National Accident Sampling System (NASS) provide the best basis for making national estimates of the incidence of alcohol in crashes. However, since the information on drinking by accident-involved road users in these files is incomplete, it is useful to compare the in-

formation in the FARS and NASS with data from the best of the epidemiologic studies.

The FARS (*NCSA, 1981a*) is a computerized file containing standardized data on all fatal traffic accidents which occur each year in the 50 States, the District of Columbia and Puerto Rico. To be included in the file, an accident must involve a motor vehicle moving on a roadway customarily open to the public and result in the death of a person (occupant of a vehicle or a nonmotorist) within 30 days of the accident. The data are collected from State motor vehicle accident record systems, and are based on State source documents (police accident investigation reports, coroner reports and driver license records) transcribed on standard FARS forms. NHTSA contracts with State governments for the provision of these data. In each State motor vehicle record department there is an analyst responsible for obtaining all source documents needed to code the 90 different data elements in the FARS accident record. Each record consists of an accident level, vehicle/driver level and person level form. The FARS record system has been in place since 1975 and contains a complete record of all fatal accidents which meet the criteria for inclusion in the system from January 1, 1975, to the present.

The NASS (*NCSA, 1981b*) is a computerized file of police-reported accidents in the United States designed to provide a stratified random sample of such accidents in order to permit estimation of the total injury and property-damage accidents in the United States. Each sampled accident is investigated by a trained team of investigators. Fifty such teams are located at selected sites throughout the country and investigate approximately 10,000 accidents each year. Operations began in 1979 with ten teams. The accidents selected are nationally representative of the accidents reported to the police in this country. From these data, NHTSA can make estimates of injuries and other accident consequences for the nation as a whole. The NASS investigations focus on information such as vehicle crash protection, driver characteristics, roadside hazards, and injury severity. There are over 300 data elements which are coded in each case investigated. The investigation includes all types of involvements, including pedestrian, heavy truck, motorcycle, etc. All severities of accidents are included—from fatal injury to property-damage only. However, the primary purpose of this system is to augment the census of fatal accidents provided by the FARS with estimates of accidents involving only injuries which do not produce fatalities and accidents which involve property damage only.

Methods of Determining Alcohol Involvement

These two data systems (when the 50 NASS sites are fully operational) could provide an authoritative indication of the incidence of alcohol in accidents of all levels of severity, if reliable information on the drinking of road users in accidents were available in every crash record in these files. Unfortunately, such information is not available in most cases. Two types of information on drinking are available in some crash records. The most critical and valuable information in determining the incidence of alcohol in an accident is a blood alcohol concentration measurement on one of the road users (driver, motorcycle rider, or pedestrian) who was involved in the accident. BAC data, however, are principally available for fatally injured drivers and pedestrians and only rarely available for road users who survive the accident.

A second type of information on alcohol is the report or action of the investigating police officer. He is provided with a place on the accident investigation form to check that the driver "had been drinking" or "was impaired by alcohol." Because police accident reports are often used in litigation, the investigating officers are very conservative in indicating that a driver had been drinking. Therefore, there is a tendency to indicate either unknown or that that driver had not been drinking. Another indication of alcohol involvement, which is obviously highly correlated with the police judgment regarding driver drinking, is the citation of a driver in a crash for driving-while-intoxicated (DWI) or driving under the influence (DUI) of alcohol.

Problems with BAC Measures

The most objective measure of immediate drinking behavior is blood alcohol concentration (BAC). The development of instruments and procedures allowing the accurate measurement of BAC has permitted researchers to define more exactly the relationship between alcohol consumption and impairment of human performance. The conventional psychomotor tests for intoxication used by physicians and the police have been shown to be inaccurate as much as 50% of the time (Mason and Dubowski, 1976). Moreover, an intoxicated driver with a high motivation to avoid arrest may have an increased ability to mask the influence of alcohol on such things as body sway, walking a straight line, and other tests of coordination used by police officers to identify drunk drivers. Technically, BAC describes a chemical state of the body rather than a behavior. Its measurement is not dependent upon the driver's subjective self-report or upon the subjective judgment of a police officer or accident investigator.

Several problems, however, have been associated with blood alcohol concentration data in epidemiologic research and accident record systems. The measurement of BAC requires that the driver provide a sample of blood or expired air for analysis. In most States, drivers may legally refuse to provide such a sample without penalty unless he or she has been arrested for driving while intoxicated. Even if arrested the driver may choose to accept a license suspension under "implied consent" laws rather than furnish a sample. This refusal to provide a sample may introduce

unknown bias into the data in accident files and into the results of the epidemiologic studies.

Beyond that, once the driver's permission has been obtained, there must be action to ensure that the sample taken for analysis will accurately reflect the BAC at the time of the crash or roadside interview. If the crash-involved driver is alive, the sample must be taken within a few (generally four) hours of the crash, before the BAC has been significantly affected by the metabolic processes of the body. This requires that the investigator make the BAC measurement at the roadside or take the driver immediately to the police station.

If the driver has been injured seriously enough to require medical attention, the sample may be taken in the emergency room of a hospital without his explicit permission or knowledge. In a recent review of epidemiologic studies of alcohol-related highway crashes, Perrine (1975) observed that while such an approach minimizes some types of bias, it opens the door for biases resulting from the failure of hospital attendants to obtain samples from all the drivers who are treated, or from delay in obtaining a sample because a driver has already been treated by a private physician before this arrival at the emergency room.

The determination of BAC in fatally injured drivers is a relatively straightforward matter in jurisdictions where such measurements are required by law and routinely made by coroners or medical examiners. There are, however, two major problems in obtaining these measurements. The first occurs when not all of the deceased drivers are tested. A bias caused by the manner in which "samples" are selected may thus be introduced, i.e., certain types of drivers may be systematically eliminated from or selected for the tests. Frequently, even where tests are routinely made, the data may not be forwarded to the motor vehicle department and placed in the accident file.

The second problem occurs when the victim does not die until many hours after the crash and continues to metabolize the alcohol while still alive. In such cases, the BACs taken after death will be much lower than they were at the time of the crash. This difficulty has been avoided in some studies be excluding samples taken from drivers who died more than 4 to 6 hours after the crash. However, the very fact that such drivers are excluded may cause still another bias if, as found in one study (Baker and Spitz, 1970), drivers who survive for longer periods after their crashes are substantially different with respect to drinking-driving than those who survive for shorter periods.

As a result of the factors just discussed, biases exist in the FARS and NASS files and in some epidemiological studies. Voas (*1983a*) has shown, for example, that in the 1982 FARS file, 50% of the fatally injured drivers but only 16% of the surviving drivers have been measured for alcohol with the result reported in the FARS file. Further, his analysis shows that fatally injured and surviving drivers show important variations in certain accident parameters which are known to be related to the probability that the driver has been drinking. Thus, more fatally injured drivers are involved in nighttime, single-vehicle, or rural accidents than are drivers who survive their crashes. As a result, more of the drivers whose BACs have been measured have been in nighttime, single-vehicle, and rural accidents. This means that the drivers with known BACs in the FARS file are not representative of all drivers in fatal accidents. These drivers may, nevertheless, provide a basis for estimating the alcohol involvement of all drivers in fatal crashes when the data are properly corrected for these biases.

Estimates of the Incidence of Alcohol in Crashes

Because the blood alcohol concentration data is incomplete in the FARS and even more incomplete in the NASS file (because relatively few of the NASS accidents involve a fatally injured driver), it is necessary to use some estimating procedure in order to develop data applicable to the nation as a whole. Several estimation systems have been used by different investigators (*Fell, 1982; Meyer, 1982; Maxwell, 1982;* and *Cerrelli, 1982*). Estimates of three different parameters have been made: (1) the proportion of a given type of road user (driver, rider or pedestrian) in fatal accidents who have been drinking; (2) the proportion of fatal accidents which involve at least one road user (driver, rider, or pedestrian) who has been drinking; and (3) the number of victims (fatalities or injured persons) resulting from alcohol-involved accidents. In making these estimates, different investigators have used differing BAC criteria. At least three levels of alcohol use have been considered: "drinking"—BAC $\geqslant$ .01%, "impaired"—BAC $\geqslant$ .05%, and "intoxicated"—BAC $\geqslant$ .10%. It is quite important, of course, to determine exactly what criterion of drinking an investigator is using, since the BAC level chosen will significantly affect the proportion of drivers and accidents labeled as "alcohol-involved."

In making estimates of alcohol involvement in accidents, the normal procedure is to begin with the road users who, along with vehicle and highway factors, have a role in accident causation. This includes drivers, motorcycle riders, and pedestrians (pedal cyclists are often grouped with pedestrians because of their relatively slow movement). Once the drinking status of the road user has been determined, either on the basis of a blood alcohol concentration measurement or on the basis of police report or arrest for drinking-driving, the alcohol involvement of the accident can be determined by using the definition that an alcohol-involved accident is one in which one of these road users had been drinking to the specified level. The number of victims of alcohol-related accidents is determined in turn by counting all victims of an alcohol-related accident (i.e., all victims of an accident which includes at least one road user who

had been drinking. While alcohol information is frequently available on passengers fatally injured in accidents, the presence or absence of alcohol in passengers is generally not used to determine whether an accident was alcohol-involved because passengers are not normally involved in accident causation.

Drinking Drivers in Fatal Crashes

Fell (*1983*) has developed estimates for the proportion of alcohol-involved accidents by type of vehicle involvement, using a sample of data from the total FARS file, which includes those States which have the most complete BAC data. In these States, between 80% and 90% of all fatally injured drivers are tested for alcohol and the results have been collected and placed in the FARS file. Many of the 10% to 20% of the drivers for whom there is no BAC in the FARS file were not tested because they died more than 4 hours after the accident or received transfusions. In any case, the relatively few unmeasured drivers means that the figures obtained on this subset of States for fatally injured drivers are relatively unbiased. The proportion of all fatally injured drivers in the States with the most complete BAC record are shown for 1980-82 in Table 3-1.

Table 3-1.—Comparisons of Alcohol Involvement in FARS 1980, 1981, and 1982

[Fell 1983]

	FARS 1980 (15 States)	FARS 1981 (17 States)	FARS 1982* (14 States)
Percent Driver Fatalities with:			
BAC ⩾ .01	62	60	59
BAC ⩾ .10	50	49	49

*FARS 82 File as of 2/1/83, 90% complete.

Approximately 60% of the drivers each year "have been drinking", while 50% are above the .10% BAC, which is the legal definition of "under the influence" in most State drinking-driving laws. These results are essentially in accord with the findings of four well-designed and well-executed studies of fatal crashes which were conducted in California (two studies), Vermont and Michigan during the period of 1962-69; (Neilson, 1969; Waller, et al., 1970; Perrine, Waller and Harris, 1971; Filkins, et al., 1970). In each of these studies, at least 100 drivers who were fatally injured were measured for alcohol. The results indicated that somewhere between 40% to 55% of all fatally injured drivers tested in these four studies had a BAC of .10% or more, with a mid-point for the four studies of 47%, which is slightly lower than the 49% to 50% value shown in Table 3-1. Since the data in Table 3-1 is based on a much larger set of accidents, it is likely that the figures shown are the best estimates for the proportion of fatally injured drivers with a BAC ⩾ .10%.

Alcohol-Related Crashes by Type of Road User

To estimate the proportion of accidents of various types which were alcohol-related, Fell used the same subgroup of States which had a high proportion of BAC reporting for fatally injured drivers and estimated alcohol involvement in accidents by using a three-part criterion; a driver, cyclist, or pedestrian involved with a BAC ⩾ .01%, or a driver charged with drunk driving by the police, or if anywhere in the accident report, the investigating police officer indicated that a driver or pedestrian "had been drinking" or that there was "alcohol involvement."

While there is some variation, it appears that the proportions are fairly consistent from year to year, at least for those types of accidents in which there are relatively large numbers. Greater variation is shown for the pedalcyclist category—for example, where there are relatively few fatal accidents each year.

Table 3-2.—Comparisons of Alcohol Involvement by Fatal Accident Type for FARS 1980, 1981, 1982

[Fell 1983]

Percent of Fatal Accident Involvement Type* That Had Any Alcohol Involvement**	FARS 1980 (15 States)	FARS 1981 (same 15 States)	FARS 1982 (same 15 States)
Pedestrian	47	48	49
Pedalcyclist	27	34	29
Motorcycle	58	58	58
Medium/Heavy Truck	36	34	35
Car/Light Truck/ Van	60	58	56
Other (Recreational Vehicle, Buses, etc ..	56	54	50
Overall	55	57	56

*Not mutually exclusive.

**On the part of the involvement type and/or driver of other vehicle (if another vehicle is involved). For example, 36% of the fatal accidents involving a medium or heavy truck in 1980 had alcohol involvement either on the part of the truck driver, or a pedestrian/pedalcyclist (if involved) or another driver of another vehicle (if involved).

These estimates appear to be reasonably conservative, since they are all based on actual BACs or on a specific report by a police officer that the driver "had been drinking," that there was alcohol

involvement," or the arrest of the driver. A recent study by Terhune (*1982b*) has shown that in 95% of the cases in which the police indicate that alcohol is involved in the accident, the driver or pedestrian involved had a positive BAC. On the other hand, included in these samples were a significant number of drivers and pedestrians for whom there was no BAC data and no record of a police judgment as to drinking. Voas (*1983b*) has shown that among fatally injured drivers, when police officers' judgment on drinking is recorded as "unknown," approximately 60% of the drivers had a positive BAC, and even when the police officer recorded "no alcohol involved," 23% of the drivers had a positive BAC. Therefore, there are probably a significant number of accidents involving road users with positive BACs which are not classified in Table 3-2 as alcohol-related, because the police officer did not make a judgment on drinking or because the police officer's judgment was not recorded in the FARS file.

It is interesting to note that the proportion of motorcycle accidents which are alcohol-related, as shown in Table 3-2, is approximately the same as that for drivers of automobiles, light trucks, and vans. This finding is supported by a recent study by Baker and Fisher (1977) of fatal motorcycle crashes in Maryland which found that the BAC distributions of fatally injured motorcycle drivers were similar to those of fatally injured drivers of cars and trucks in that State.

Care should be taken in reviewing the results of studies of alcohol involvement in pedestrian accidents, because fatally injured children 13 and under are not measured for alcohol. As a result, most alcohol involvement figures apply only to adult pedestrian accidents. However, the proportion of pedestrian accidents which involve alcohol as shown in Table 3-2 is based on the definition which includes any accident where a driver or pedestrian *of any age* had a BAC $\geq$ .01%, or a driver was cited for DWI without a test, or the police indicated "had been drinking," or "alcohol involved" on the part of the driver or pedestrian on their report without a test. The relatively high proportion of all accidents which are shown to be alcohol related is produced by the inclusion of those accidents in which the pedestrian was not drinking but in which the driver had a positive BAC or was cited by the police.

Fell (*1982*) has summarized the alcohol involvement of fatally injured pedestrians in the FARS file in 1980. Approximately 16% of the 8,000 fatally injured pedestrians were children ($\leq$ 13 years of age) who were not measured for alcohol, and 84% were fatally injured adults. Of the fatally injured adult pedestrians who were tested for alcohol, 48.5% had a positive BAC and 39.1% had a BAC at or above .10%. These estimates of alcohol involvement of fatally injured pedestrians are slightly higher than the best of the epidemiological research studies which have been conducted over the last 20 years (Neilson, 1969; Haddon & Associates, 1961; Waller, et al., 1970; Perrine, 1971; and Filkins, et al., 1970). These studies reported from 31% to 43% of the fatally injured adult pedestrians with a .10% or greater BAC. On the other hand, Blomberg, et al (*1979*), found that 46% of the fatally injured adult pedestrians which they studied in New Orleans had BACs at or above .10%.

Alcohol in Non-Fatal Crashes

The incidence of alcohol is greater in the more serious highway accidents involving a fatality or a serious injury than it is in those accidents which involve property-damage-only or minor injuries. Estimating the proportion of accidents involving less than fatal injury and property-damage-only accidents which are alcohol-related is considerably more difficult than are such estimates for fatalities because a smaller proportion of the road users, drivers, riders, and pedestrians will be measured for alcohol, since they all survived the accident. Moreover, the BACs of the few that are measured are less likely to be representative of the population as a whole, since there is significant selectivity in the measurement of road users in non-fatal accidents, because BAC tests are normally conducted only on those that are charged with the DUI offense. Table 3-3 provides recent evidence from a study by Fell (*1982*) of the proportion of alcohol-related injury and property-damage accidents in relationship to the proportion of fatal accidents which involve a drinking road user.

The data for injury and property-damage crashes were taken from the National Accident Sampling System, using the same definition as for fatal crashes. The definition for "alcohol-involved" was a driver (or other road user) with a BAC $\geq$ .01% or a driver cited for DUI, or a police report that the driver had been drinking or that the accident was alcohol-involved.

These data are generally in agreement with the best of the epidemiological studies which have been conducted in the past. Borkenstein, et al. (1964 and 1974) collected BAC data on 4,570 drivers involved in crashes where there was no indication of personal injury. He found that 16% of these drivers had been drinking and that 5% were above the .10% BAC level. In a study conducted by the University of Indiana during the years between 1971-75 (*Treat, et al., 1979*), of the causes of 2,258 accidents (over 80% of which were property-damage-only), it was found that alcohol was a possible causal or contributing factor in between 3% and 11% of the accidents investigated. Both the Borkenstein and the Treat studies involved accidents occurring throughout the 24 hours per day. In the Treat study, a determination that alcohol was a contributing factor was based on the circumstances of the study. Very few BACs were obtained on drivers. Thus the 8% estimate from the NASS 1979-80 data appears to be a conservative figure for property-damage-only accidents.

Table 3-3.—Summary of Alcohol-Related Accidents Based Upon NCSA Data for 1979-80

[Fell 1982]

	Proportion Alcohol-related		Total accidents		Persons affected
	Intoxicated (BAC ⩾ .10 percent)	Alcohol involved (BAC ⩾ .01 percent)	Reported accidents	Unreported accidents	Number alcohol related
Fatal	47-50	55	45,000	0	24,000 to 27,500 fatally injured persons.
Injury	18	18-25	2,500,000	390,000	708,000 injured persons.
Property damage only	5	8	4,300,000	11,000,000	1,224,000 property-damage accidents involving alcohol.
All accidents	11	11	6,845,000	11,390,000	2,000,000 motor vehicle accidents of all kinds that involve alcohol.

The largest epidemiologic study of injury accidents was conducted by Farris, et al. (*1977*). These data were collected in Huntsville and San Diego, California, where 2,481 drivers were interviewed and BACs were obtained on 97% of the accident-involved drivers. They found that 26% of their injured drivers had positive BACs (in this case, .03% or greater), and that 12% had a BAC of .10% or greater. In another study of injury accidents conducted in Rochester, New York, in the 1979-80 period (*Terhune and Fell, 1981*), the number of drivers who had been drinking was also 25% and the number with BACs above .10% was 20%.

In the Grand Rapids study (Borkenstein, 1964 and *1974*) also measured the BAC of 1,420 injured drivers and found that 8% of these had been drinking (BAC ⩾ .10%). This is a somewhat lower number than the results of other investigators or the NASS data.

Estimating Alcohol-Related Fatalities

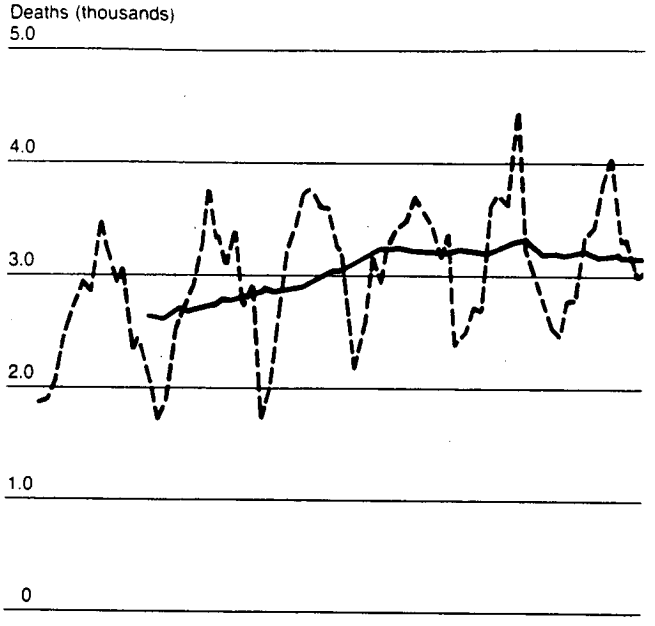
As noted earlier in this Chapter, because all drives in crashes are not measured, statements regarding the numbers or proportions of alcohol-related crashes must be based on estimates. A number of methods have been used to produce these estimates. The procedure used by Fell (*1982* and *1983*) has been described and his estimates have been presented in the previous section. Estimating procedures used by three other investigators (*Cerrelli, 1982, Maxwell, 1982,* and *Meyer, 1982*) are described below.

Cerrelli (*1982*) made the assumption that the actual blood alcohol levels of the drivers for whom there were no BAC data in the FARS file could be predicted based on the investigating police officer's judgment as to whether alcohol was involved in the accident or not. As already noted, when the police officer indicates that the driver has been drinking, the probability that the BAC will be positive is approximately 95% (*Terhune, 1982b;* and *Voas, 1983b*). Where the police officer makes the judgment that alcohol is not involved or makes no judgment with regard to alcohol, the probability that the individual will have a positive BAC is considerably lower. Cerrelli made estimates based on the assumption that these relationships held true for all drivers in the FARS file. His analysis yields somwhat lower results thn those of Fell. He found only 38% of drinking drivers in crashes (BAC ⩾ .01%) and only 30% intoxicated (BAC ⩾ .10%). These lower figures may in part be due to his reliance upon the police judgment of alcohol involvement in crashes, since it is well known that the police are very conservative in making this judgment.

Another approach was taken by Maxwell (*1982*) to the estimation of the role of alcohol in fatal accidents which, in contrast to Cerrelli, produces relatively high estimates of alcohol involvement. Maxwell used a statistical method of Multiple Discriminant Analysis to predict the numbers of drivers at an impaired BAC level (⩾ .05%). The procedure is based on the development of mathematical functions which discriminate between alcohol and non-alcohol use by the driver in accidents utilizing accident characteristics (time of day, day of week, urban/rural, single/multiple vehicle), and roadway factors (interstate versus local roadways), and the driver BAC for those drivers for whom a BAC was present on the FARS file. Using these relationships, predictions were developed (based on those features of the accident in which they were involved) for the BACs of drivers and other road

users for whom no BAC data are available in the FARS file.

Figure 3-1 Estimated Alcohol-Involved Fatalities with 12-Month Moving Average, 1976-1981



SOURCE: Maxwell, 1982.

Once the predicted BACs had been determined, each accident in the file was analyzed to determine whether there was a road user with an actual or predicted BAC at or above .05% in that accident. If this was the case, that accident was then labeled "alcohol-related," and, in turn, all of the fatalities associated with that accident were designed as "alcohol-related." This procedure produces a relatively high proportion of alcohol-related fatalities among all fatalities in any given year. Maxwell estimates that 81% of the highway fatalities which occurred in 1980 and 1981 were alcohol-related! She also noted a slight upward trend in fatalities as shown in Figure 3-1.

One feature of the Maxwell method is that it permits the estimation of the alcohol-related fatalities on a State-by-State basis. These data are shown in Figure 3-2. For each State, the percent of all fatalities which are designated as "alcohol-related" by the Maxwell method as well as the total number of fatalities in the State that are estimated to be alcohol-related are shown. It is well to remember in looking at these data that the study produces estimates of the number of fatalities that occur in accidents in which at least one road user had, or is estimated to have had, a BAC at or above .05%. Thus, these numbers are based on the *incidence* of a road user with a BAC at or above .05% and do not necessarily indicate that these fatalities were *caused* by alcohol. While these estimates are on the high side, they are useful for comparing the extent of the problem in each State.

Variation in Alcohol-Related Fatality Rates

A different approach to the analysis of the FARS file was taken by Meyer (*1982*). He did not attempt to develop an overall figure for the number of alcohol-related accidents in the United States, but rather developed multiple estimates based upon stratifying the fatal accidents into categories involving different accident conditions and different driver characteristics. The end result of his analysis is shown in Table 3-4. This table shows the proportion of all accidents which involved a driver at an impaired BAC ($\geq$ .05%) for accidents meeting specific conditions.

As shown in Table 3-4, Meyer divided the accidents into those that occurred during daylight as compared to dark, and a further division in terms of whether the accident occurred on the weekend or on a weekday. He also divided the accidents in terms of whether they involved a single vehicle accident, or, if multivehicle, whether the driver was in the car that was the striking vehicle, or whether he was in the car that was struck by another vehicle. Finally, the data were also divided by sex and by age (above and below 25) and by urban or rural location.

When this is done, the extent of the variation in the BACs of drivers is striking. For young male drivers in single-vehicle accidents at night on weekends, the proportion of drivers with a BAC at or above .05% is 87%! At the other extreme, the proportion of female drivers 25 or over struck in weekday, daytime accidents is zero percent. This illustrates dramatically the patterning of alcohol involvement in relationship to the characteristics of the accident and of the drivers. It is this patterning that will be explored more in succeeding sections of this chapter, where the factors correlated with alcohol involvement will be examined in greater detail.

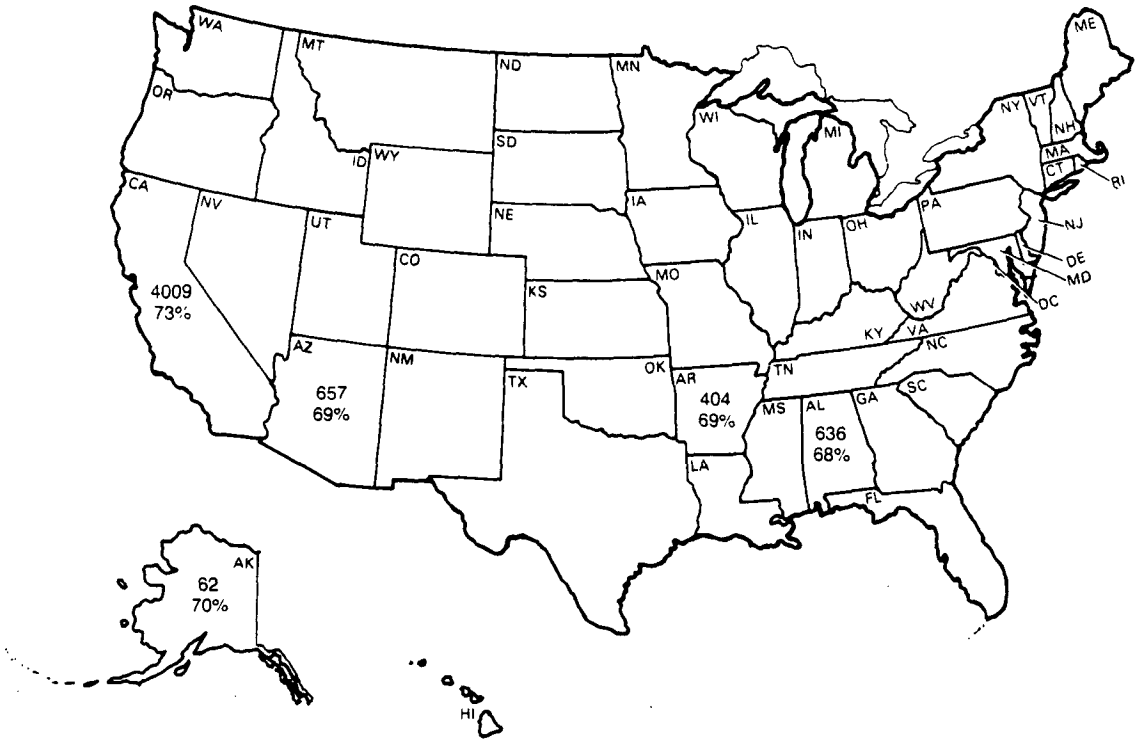
National Implications of Alcohol's Presence in Crashes

The data from the FARS and NASS files, together with the epidemiologic studies described above, were designed to learn more about the alcohol-highway safety problem in the United States. Despite wide differences in the study designs and in their geographical locations and dates, the same trends have consistently been observed:

- Substantial fractions of the more serious crashes involve drivers whose BACs exceed the usual legal limit of .10% w/v and over.
- Small but not negligible fractions of "minor" crashes involve drivers who are legally too intoxicated to drive.

The implications of these findings for the society as a whole are anything but negligible. A rough idea of the highest possible magitude of the alcohol-crash problem in the United States in the early eighties can be determined by assuming that all crashes that involve intoxicated road users are in fact caused by alcohol. This is not to say that

Figure 3-2 Estimates of the Number of Fatalities in 1980 from Crashes Involving a Pediestrian or Driver with a BAC .05%



NOTE: This is not intended as a final product but as an example of the proposed method for presentation of Maxwell, 1982 data. The first five states have been done (using information from "Data for Figure 3-2") as an example.

Source: Maxwell, 1982.

alcohol did in fact cause these crashes. A fuller discussion of the causes of crashes is provided in the next section. Obviously, the actual magnitude of the problem will be much less than what would be calculated under the assumption that mere presence of a .10% BAC was synonymous with causality. Also, the use of BAC data on fatally injured drivers to estimate alcohol involvement in surviving drivers for whom no BAC was taken will, as indicated previously, possibly further inflate the role of alcohol in such crashes.

Table 3-3 shows the maximum numbers of different classes of crashes in which alcohol could have played a role in 1979-80 if all crashes involving alcohol had been caused by alcohol. As can be seen, approximately 2475 (.55 × 4500) fatal crashes and 722,500 (.25% × 2,839,000) injury crashes, and 1,224,000 (.08 × 15.3 million) property damage crashes involved a drinking road user.

The societal costs of these crashes may be estimated by applying cost factors developed by NHTSA (Fagin, 1975; and *NHTSA, 1983a*). The factors permit one to express the property damage and injuries from these crashes as long-term losses in societal welfare to (a) the individual (personal consumption loss, pain and suffering, assets consumption loss), (b) society as a whole, due to distributing resources away from welfare-producing activities (medical care costs, property damage costs, legal and court resources, insurance costs), and (c) society, due to direct and indirect losses in productivity. These factors for 1980 in 1980 dollars (*NHTSA, 1983*a) are:

Fatal injury—$268,727

Average personal injury—$3,850

Property damage crash (per vehicle)—$471

By using the figures in Table 3-3, the total cost of accidents in which at least one road user had an "illegal" BAC (at or above .10%) can be calculated. The resulting societal costs are presented in Table 3-5, which indicates that some 10 billion dollars in societal welfare losses could have been prevented in 1980 by preventing all crashes involving an intoxicated road user.

Table 3-4.—Variations in the Probability That an Impaired Driver Will Be Involved in an Accident as a Function of Driver and Accident Characteristics

[Meyer, *1982*]

Vehicle role	Sex	Dark				Light			
		Friday-Sunday		Monday-Thursday		Friday-Sunday		Monday-Thursday	
		>25	⩽25	⩽25	>25	>25	⩽25	⩽25	>25
Single vehicle	Male	.87	.84	.81	.83	r .65 u .57	r .62 u .49	r .50 u .37	r .43 u .29
	Female	r .78 u .89	.74	.72	.62	.39	.32	.27	.23
Stricking	Male	.72	r .72 u .64	.64	.64	.35	.32	r .24 u .15	.26
	Female	.52	.66	.53	.38	.15	.31	.16	r .04 u .09
Struck	Male	r .55 u .43	.48	.32	.38	.18	.21	.07	r .03 u .09
	Female	.32	.28	.23	.22	.07	.12	.00	r .10 u .00

r=rural accidents.
u=urban accidents.

Table 3-5.—Estimate of Losses Due to Accidents Involving an Intoxicated (BAC ⩾.10 pct) Road User

	Number in 1980*	Loss per occurrence***	Total loss
Fatalities	24,000	$268,727	$6,449,448,000
Persons injured	708,000	3,850	2,725,800,000
Vehicles damaged	**2,227,680	471	1,049,237,280
Total			10,224,485,280

* From Table 3-3.
** 1.82 vehicles per property-damage-only accident; Table II-1, p. II-2, *NHTSA 1983a.*
*** *NHTSA, 1983a,* p. 1-4.

Alcohol and Crash risk

These estimates suggest only how large the alcohol-crash problem might be; they cannot be used to support more specific statements. Ideally, one would like to know how many crashes each year are caused by alcohol so that a priority could be assigned to the problem and resources could be allocated to programs to reduce the number and consequences of such crashes. Unfortunately, traffic crashes are far too complicated to permit such a simplistic statement to be made. Most traffic crashes involve so many factors that alcohol can be considered only one of many.

For example, the drunk driver who runs off the road at a curve on a rainy night and hits a tree is in an accident involving a number of contributing causes: alcohol, wet pavement, reduced visibility (darkness) and roadway engineering (curve, tree on the shoulder). Each element contributed to the accident; none was in itself sufficient to produce the crash. To determine the causal role of alcohol in crashes, it is necessary to separate out the alcohol from all the other factors which contributed to this event.

Epidemiological Studies

Epidemiological studies attempt to do this by surveying the characteristics of accidents, and of accident-involved drivers in an effort to isolate those factors which are most significant in accident causation. Two principal methods have been used to study the role of alcohol: "Case Control" studies, in which the incidence of alcohol in drivers in crashes is contrasted with the incidence of alcohol in drivers using the road at the same times and in the same places, but who are not involved in accidents. The second method contrasts the incidence of alcohol in drivers responsible for accidents with the incidence of drinking in drivers in crashes who are the innocent victims of another

driver's mistake. In each case, the risk of crash involvement is expressed as a ratio between the incidence of a given BAC in a crash-involved (or responsible) as compared to a non-crash-involved (not responsible) driver. If a BAC of .10% or greater occurs in only 2% of the drivers using the road at times and places of fatal accidents, but occurs in 50% of the drivers in fatal accidents, then a driver with an illegal BAC is roughly 25 (50÷2) times more likely to be in a fatal accident. The relative risk or accident liability is 25 to 1.

A critical requirement of epidemiological research has always been the establishment of a comparison population. The characteristics of the sick are compared with those of the healthy to detect traits which predispose an individual to be a victim of the disease. In accident research, this selection of a comparison population involves the key concept of *exposure*. Not all U.S. citizens own or operate vehicles, and there are large variations in the mileage driven each year by those who do. Thus, there are large differences among individuals in the extent that they are at risk of becoming accident involved. Males, for example, constitute 52% of the licensed drivers in this country, but were involved in 69% of the accidents in 1981 (*NCSA, 1981b*). This might seem to indicate that they were poorer, more dangerous drivers. However, males drove 70% of the vehicle miles logged in the nation during 1981 (*NCSA, 1981b*). Thus, their accident involvement was almost exactly what would be expected from their exposure.

Thus, a distinction must be made between the incidence of a given factor or road user characteristic in the population as a whole; the incidence in the population specifically at risk; and the incidence in the crash population. As will be seen in the section on the characteristics of people who drink and drive, there are considerable differences among groups in *exposure* to alcohol-related crashes as well as in the risk of, or liability to, crash involvement given equal exposure.

Case Control Studies

The first drinking-driving study to compare crash-involved drivers with drivers using the road but not involved in crashes was conducted by Holcomb at Evanston, Illinois, in 1938 (Holcomb, 1938). Holcomb's study compared the BACs of a sample of drivers who had been in personal injury crashes with those of a sample of drivers who had not been in crashes but who had been using the same roads as the crash-involved drivers. This is a crucial comparison. Without it, Holcomb's finding that 25% of the crashed drivers had been legally too drunk to drive by today's standards would have had little meaning, since it could have been possible that the same percentage of drivers who had not crashed had also been legally drunk. Holcomb's finding that only 2% of the drivers who had not crashed were drunk, while 25% of the crash-involved drivers were drunk. Suggesting that drunk drivers are twelve and a half times more likely to be in crashes than sober drivers.

Holcomb's data were still not sufficient to conclude that consumption of alcohol "caused" the crashes. Rigorous statements about cause could be made only if the crashed and the non-crashed drivers and their driving situations had been exactly the same in every respect except blood alcohol concentration. Because of the impossibility of meeting this condition, epidemiologic data can never prove cause, but only imply it. The more closely the two groups match each other on relevant variables, the stronger the implication of causality.

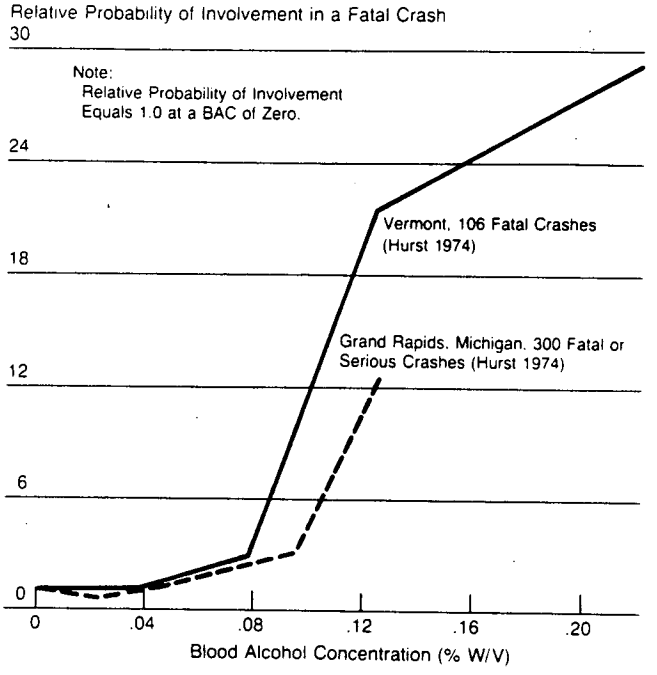
Data on the behavior and characteristics (and particularly the BACs) of the larger driving population exposed to, but not involved in accidents, have been obtained through a number of roadside voluntary breath test surveys (Carr, et al., 1974; Sterling-Smith, 1976). In epidemiologic studies, roadside surveys are designed so that the environmental conditions under which crashes occur are matched, that is, controlled for. The procedure is to stop a sample of non-crash-involved drivers using the roads under these conditions (usually by a uniformed police officer) and ask them to provide a breath test and volunteer information to researchers. Information is collected on vehicular factors, such as make, model, and year of car, and on such human factors as drinking and driving habits, origin and destination of trip, age, employment, etc.

Many roadside surveys conducted in recent years have been designed to evaluate safety programs (Lehman, et al., 1975) rather than provide a control for a specific type of accident. The object of this kind of roadside survey has been to provide data useful in describing larger driving populations (making international comparisons [Carr, et al., 1974; *Hause, et al., 1980,* for example]) the extent to which this population drives after drinking, and especially any changes in BACs which may occur as a result of safety programs (*Levy, et al., 1978*).

The results of the controlled studies relative to alcohol-crash risk are most meaningfully presented in terms of "relative probability of a crash." This measure was first used in the Toronto study (Lucas, et al., 1955) in 1952. More recently, Hurst derived a more rigorous theoretical basis for this measure (Hurst 1970) and has applied it to the best controlled studies of fatal, injury, and property-damage accidents. Included among these are the study by Borkenstein, et al., (1974) in Grand Rapids, Michigan and Perrine, et al. (1971) in Vermont. His interpretation enables one to calculate the probability of being involved in a crash if a given BAC has been reached, relative to the probability of crash involvement at a zero (or lowest measured) BAC level.

Figure 3-3 depicts the results of applying Hurst's method to the Vermont study of fatal crashes and to a subset of "fatal or serious" crashes from the Grand Rapids study. The figure shows that the risk of being in a crash begins to increase very rapidly at BACs in the neighborhood

Figure 3-3 Relative Probability of Involvement in Fatal Crashes for Drivers with BACs at Given Levels



of .08% and become extremely high at the very high BACs. There is a greater than 20 to 1 relative probability of crashing at BACs over .15%. The calculations show that the probability of being involved in the Vermont fatal crashes for those top intoxicated to drive legally (BAC at .10% w/v or more) was 12 times as high as for those who had not been drinking at all. The calculations for the less serious crashes in the Grand Rapids sample also indicate a greatly increased crash risk for legally intoxicated drivers over nondrinking drivers but they indicate the risk to be lower than that calculated for the Vermont study.

The data from the controlled studies also indicate an increased probability of involvement of high BAC drivers in the less severe categories of highway crashes. At a BAC of .10%, the relative probability of involvement in any kind of nonfatal crash on a year-round 24-hour-a-day basis was about 3.5 in the Grand Rapids study (Figure 3-4). The Toronto study, conducted only during evening hours, indicates a relative probability of nonfatal crash involvement of about 1.5 at a BAC of .10%. The Huntsville and San Diego studies of personal injury crashes (*Farris, et al., 1977*) revealed relative probabilities of crashing somewhere in between those of the Vermont and Grand Rapids studies of fatal accidents (Figure 3-3) and those found in the Toronto and Grand Rapids studies of all nonfatal crashes (Figure 3-4).

Finally, similar risk curves describe the relationships between adult pedestrian BAC levels and accident involvement as shown in Figure 3-5. These data are taken from a study by Blomberg, et al (*1979*) in which 86 fatally injured adults (14 or older) were compared with three control groups; a "random" control group made up of pedestrians tested at locations chosen at random, at times evenly distributed through the 24-hour day and 7 days a week; a "site" control group made up of adult pedestrians tested at the accident location on the same day and within 30 minutes of the accident time; and finally, an "age/sex" control group in which the comparison was limited to a control subject of the same sex and as close as posible to the same age found at the accident site.

This significance of control group selection is shown by the results in Figure 3-5. The most closely matched control group (age/sex) showed a significant rise in risk only above a BAC of .15% to .20%, whereas less well-matched groups showed rises in the risk curve at lower BACs. This finding is consistent with the hypothesis that safe walking behavior is less complex than safe driving behavior and therefore, it takes a higher BAC to produce an increased risk of accident.

BAC and Crash Responsibility

A second epidemiological method which has been used to explore the role of alcohol in crashes is to contrast the blood alcohol concentrations of drivers who are judged to have been responsible or have caused an accident in comparison to drivers who were in the same accidents but were judged to have been the innocent victims of the responsible driver (or at least to have made a relatively small contribution if any to the cause of the accident). At first blush, this would seem to be the best way to determine whether alcohol causes accidents. We would expect that drinking drivers would drive dangerously and cause accidents. Therefore, if drinking produces accidents, those drivers who are responsible for crashes should have more alcohol in their blood than their innocent victims (*Terhune, 1982*).

While this approach would seem straightforward, it is generally more complex than it appears, because it is difficult to establish the extent to which a particular driver in an accident was responsible or not responsible for causing that crash. It is important to distinguish between two approaches to determining responsibility for accidents. Our legal system is typically based on the finding of fault with the driver determined to be legally responsible, required to pay damages to those road users who may have suffered losses or been injured. In this approach to responsibility, emphasis is usually placed on whether a driver committed an illegal, irresponsible or risky action which produced the crash. Since most accidents are investigated by police, it is likely that if a traffic law has been broken, such as speeding or going through a red light, this will be recorded and, in the event of a law suit, the individual who was guilty of this driving infraction would normally be held responsible for the accident.

The research scientist attempts to delve more deeply into the multiple factors that may have had

a role in producing a given crash (see, for example, *Treat, et al., 1979*). The researcher may recognize that the driver contributed to the cause of the accident by going through a red light. On the other hand, the researcher may also note that the driver who was hit could have avoided the accident by reacting more quickly and swerving out of the way. Thus, the scientist is likely to find that both drivers contributed, to some extent, to the production of a particular crash event. In most accidents, there is no 100% responsible or 100% innocently involved driver.

With these caveats in mind, it is still possible to measure (at least roughly) the extent to which a given driver contributed to a car crash (*Terhune, 1982b*). This is normally done by trained researchers making use of the investigator's description of the accident. The earliest study which attempted to make use of an analysis of the culpability of the driver and compare the results with their BACs was done by Smith and Popum (*1951*). They rated the contribution of each sampled driver to his accident, using a ten-point scale. The ten points were assigned either to the driver or to factors outside the driver, such as other drivers, the vehicle or the environment, thus a given driver's score could vary from zero (no contribution to the accident), to ten (fully responsible for the accident). They compared the measured BAC in drivers within the category of zero to two as compared to those drivers with high responsibility who scored in the eight to ten category. They found that drivers with BACs in the region of .15% to .17% were 26 times more likely to have been assigned a high responsibility score from eight to ten than were drivers with a zero BAC.

Figure 3-4 Relative Probability of Involvement in Personal Injury Crashes for Drivers with BACs at Given Levels

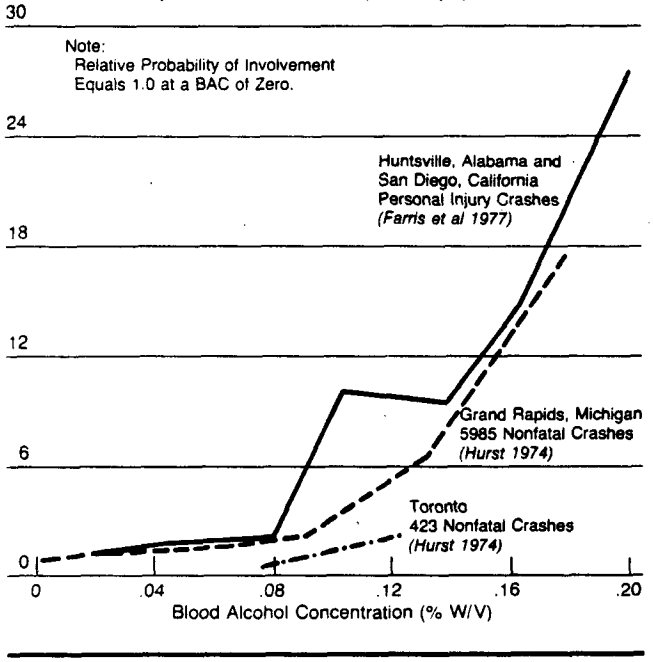
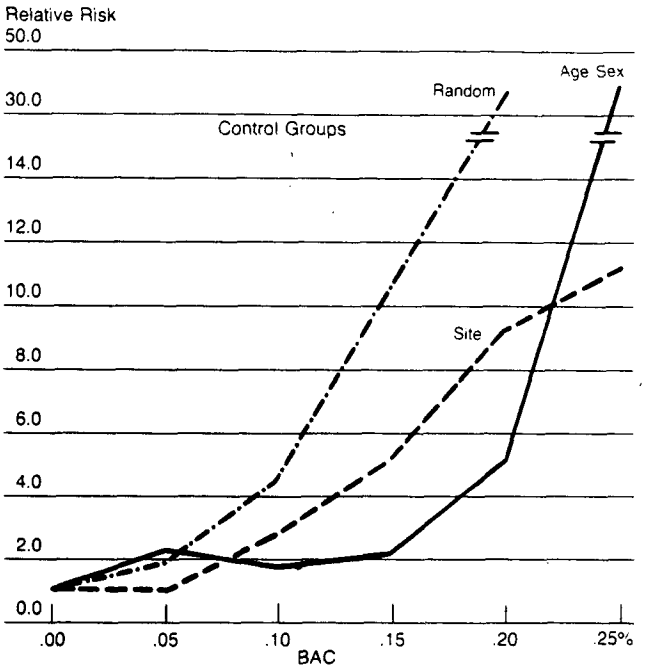


Figure 3-5 Relative Risk of Involvement in a Fatal Pedestrian Accident as a Function of BAC



SOURCE: Blomberg, et al., (1979)

Several other researchers (McCarroll and Haddon, 1962; Perrine, Waller and Harris, 1971; Waller, 1972; Baker and Spitz, 1970; *Terhune, 1982b)* have also compared the blood alcohol concentrations of responsible and nonresponsible drivers. All found some relationship between responsibility and BAC. Some of these investigators attempted to objectify and simplify the process of determining responsibility by setting up specific criteria for the designation of responsibility. For example, in a two-vehicle crash, if only one vehicle was moving, the driver of the moving vehicle would be judged to have been responsible. All such simplifying assumptions, while adding to the objectivity of the ratings, can be expected to reduce the validity of the determination of responsibility and therefore reduce the expected correlation between responsibility and alcohol use.

Some investigators have attempted to use the differences in responsibility for a crash as a method of developing control or comparison data where it was not possible to conduct roadside surveys of drivers at times and places of accidents. This concept was first used by Borkenstein and his coworkers (*1974*) when they made the assumption that the distribution of BACs among drivers "innocently" involved in motor vehicle crashes would be the same as the drivers using the road but not accident involved. In this way, the characteristics of the exposure sample could be determined by looking at the characteristics of all of the drivers in accidents who were judged to have been involved through no fault or error of their own. In this view, these drivers were involved in an accident purely by chance, and therefore they are a random

sample of drivers using the roads at the same times and places. This approach to the development of a control sample for accident-involved drivers has been labeled the "induced exposure" procedure and has been used by several investigators (Thorpe, *1967;* Carr, *1969;* and Joksch *1973*).

The induced exposure, approach, of course, only provides an approximation of the exposed group, since there are relatively few drivers who are completely innocent of any responsibility in producing a crash, and therefore the designation of the innocent driver can only be approximate in any case. Thus both the case control and the induced exposured approaches to determining the causal role of alcohol in accidents provide only approximate results. The case control is limited for two reasons. First, there is no way to assure that all individuals in the exposure group have been selected in a way that assures that the only difference between them and the accident involved drivers is the occurrence of an accident. That is, that all relevant factors (except BAC) have been controlled.

Secondly, the case control method is limited and may give results somewhat on the low side because the accident-involved drivers are not all fully responsible for their accidents. As noted, there are a number of drivers involved in the accidents who have very little responsibility for these crashes. These individuals are hypothesized to be similar, if not identifical, to the control population. Therefore, to the extent that drivers in the exposure sample are compared to *all* accident-involved drivers, the true role of any factors that contribute to an accident will be underestimated because a number of the drivers in the accident sample are there purely by chance.

The driver culpability approach is limited by the difficulty and unreliability of estimating the extent to which a given driver is responsible for the crash. A particular threat to the validity of such studies is the danger that the factor of interest (BAC) will enter into the judgment of responsibility. Thus, for example, in some accident reports made by police officers, the evidence that a driver has been drinking is likely to result in the officer designating that driver as responsible for the crash.

When the crash-involved drivers in case control studies are divided into those who are viewed as responsible for their accidents as compared to those who were innocently involved, the calculation of risk curves (as in Figures 3-3 and 3-4) clearly show the difference in the significance of BAC between drivers who are responsible and not responsible for crashes. This calculation was done by Hurst (1974) on the data from the Grand Rapids study. His results are shown in Figure 3-6. As this figure shows, the probability of being responsible for a fatal accident rises rapidly at BACs above .05%, whereas the probability of being innocently involved in an accident remains level and does not increase with increasing BAC. The same result was found in the Huntsville/San Diego study (Figure 3-7) by Farris, Malone, and Lilliefors (*1977*). This provides further evidence for the causal role of alcohol in crashes.

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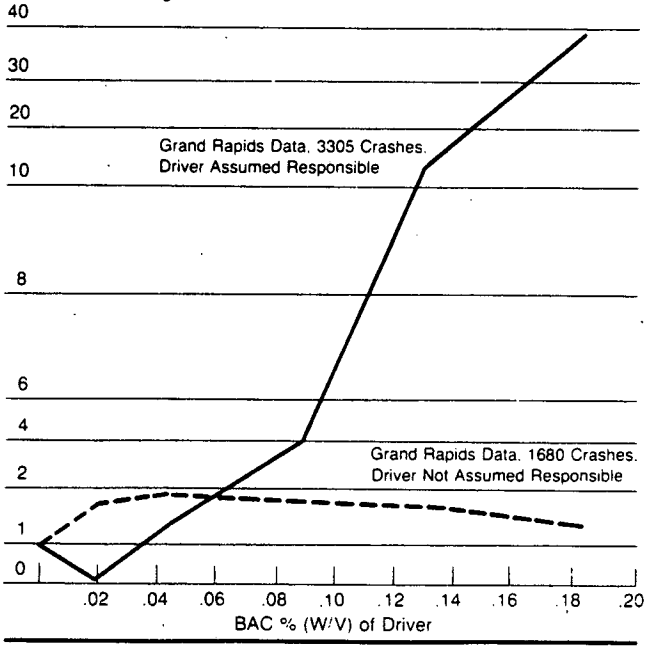
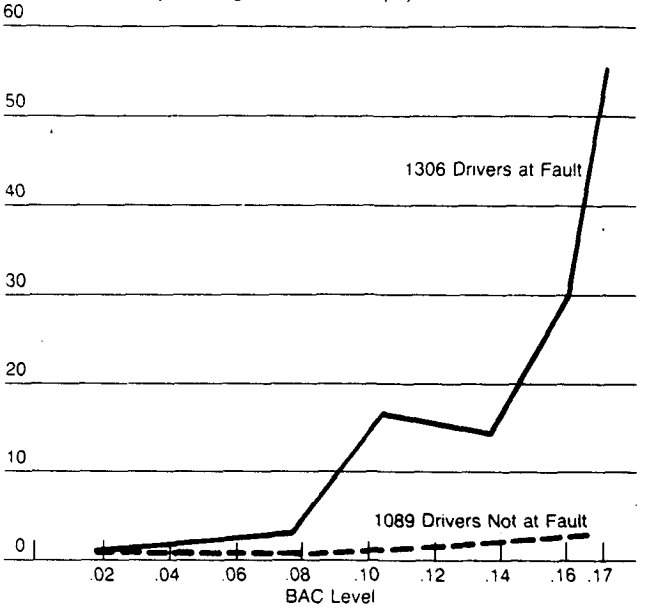
Figure 3-6 Relative Crash Probability for Drivers Assumed Responsible and Those Not Assumed Responsible as a Function of BAC, Where 1.0 = Relative Probability at Zero Alcohol



Behavioral Studies

In contrast to the epidemiologic studies, which examine crashes after they have occurred, behavioral studies follow an experimental approach to determine how alcohol might cause future crashes. These studies are designed to elucidate the mecha-

Figure 3-7 Relative Probability That a Driver Is at Fault or Is Not at Fault in an Accident as a Function of His BAC Level. This Probability Is Relative to the Probability That a Driver with BAC Less Than 0.03% Is at Fault in Accident



SOURCE Farris, Malone and Lilliefors (1977)

nism by which alcohol produces crashes. If the epidemiologic studies provide the primary evidence that drinking and driving causes accidents, then behavioral studies provide the exploratory links which show how drinking affects human performance, how this in turn produces dangerous driving, which results in crashes.

From a scientific standpoint, it would be ideal to conduct these experiments under real-world driving conditions, ensuring the ability of individuals of different ages, drinking habits, personalities, etc., to drive an automobile in various highway environments (e.g., nighttime, daytime, heavy traffic, light traffic) after drinking various amounts of alcohol. For obvious reasons, such realistic experiments are not possible, necessitating experiments that only approximate actual driving conditions and behavior.

This lack of a clear connection between laboratory behavior and driving tasks seriously limits the usefulness of all laboratory studies of the effects of alcohol on human behavior. Because most of the laboratory tasks studied have been much simpler than those in driving, only a gross effect on the performance of tasks in the laboratory could be safely interpreted to imply an effect on driving performance. In such cases, of course, we cannot precisely describe—quantify—the ultimate effect alcohol would have on driving performance.

A wide range of behavior thought to be related to driving has been studied in these experiments. For the purposes of discussion, we have categorized the experiments as those conducted in laboratories, those conducted in driving simulators and on closed driving courses, and those conducted in naturalistic field settings.

Laboratory Experiments

Behavioral studies in the laboratory investigations have been concerned with (1) simple processes, involving the ability to perform relatively uncomplicated tasks not requiring much motivation or understanding, and (2) complex processes involving verbal performance, problem solving, learning, memory, mood, and emotions.

Most of the scientific studies of simple processes concern one or more of the following:

- Interactions of nerves and muscles, such as those that would occur in moving the steering wheel of an automobile.
- The purely sensory aspects of vision, such as the ability to read a highway sign under given conditions.
- Tracking—the ability to maintain an index at some predetermined or moving position, as might be required to keep an automobile on a roadway.
- Time-sharing—the ability to perform two or more activities intermittently, such as keeping an automobile on the road while monitoring the speedometer to maintain a legal speed.
- Attention—such as the ability to maintain concentration on the roadway ahead while driving.
- Attitude or mood change, such as the willingness to take greater risks in driving.

The classical technique used in studying neuromuscular effects is the Romberg test, which measures the ability to stand upright without swaying. Several studies using this technique have found that all of the individuals tested exhibited a significant amount of swaying at BACs over .10%; that many were affected at much lower BACs (e.g., .075%); and that the BAC at which their swaying began to increase significantly was between .04% and .05% (*Alkana, et al., 1978;* Franks, et al., 1976; Fregly, Bergstedt, and Graybiel, 1967, Goldberg, 1943; Indestrom and Cadeniu, 1968). Other studies, however, indicate that experienced drinkers can, if motivated, overcome these impairing tendencies at BACs as high as .20% (Laves, 1955; Prag, 1953). The exact relationship between these driving tests and performance is not known. However, standing on one leg (*Tharp, et al., 1981*) is a test frequently used by police to detect impairment in the drinking driver.

Much research has been conducted on the influence of alcohol on vision. It indicates that vision per se is not greatly affected by alcohol at BACs of less than .10%; but above that, it becomes impaired in most persons (Honneger, Kampschulte, and Klien, 1970; Mortimer, 1963; Newman and Fletcher, 1941). However, the ability to distinguish close, but separated, moving objects seems to be consistently impaired at much lower BACs, some-

times as low as .02% (*MacArthur and Sekuler, 1982;* Honneger, Kampschulte, and Klein, 1970).

Related to the ability to track moving objects is the control of eye motion, which is affected by alcohol. Nystagmus (small oscillating motions of the eye) have been shown to increase with BAC (*Baloh, et al., 1979*) and has been developed into a test for police to use in apprehending drunk drivers (*Tharp, 1981*). Studies of the effect of alcohol on other modalities of vision (some possibly significant for driving, such as peripheral vision, length of fixation, and glare recovery) show little or no impairment at low to moderate BACs, but increasing impairment at BACs above .08% (Lewis, Dustman, and Beck, 1969; Lewis, 1972; Mortimer, 1963; Moskowitz, 1974; Newman and Fletcher, 1941; Adams, et al., 1976).

Studies indicate that "simple" tracking performance does not appear to be seriously degraded at BACs of less than .10% (Chiles and Jennings, 1969; Colquhoun, 1962; Newman, 1949; Talland, Mendelson, and Ryack, 1964), but the performance of "complex" tracking tasks has been degraded in many individuals at BACs in the .05% to .10% range (*Linnoila, et al., 1978;* Binder, 1971; Levine, Greenbaum, and Notkin, 1973; Mortimer, 1963). The ability to divide attention between tasks can be impaired at very low BACs (i.e., .02%) and is often impaired at BACs above .08% (Billings and Wick, 1972; Gurner, Ludwig, and Domer, 1964).

This ability to divide attention between two tasks may be an important factor in accidents, since driving involves a division of attention between keeping the vehicle on the roadway and watching for other traffic (Moskowitz, 1974). In any case, it has been proposed that the police can use the inability of some drinkers to divide their attention between two tasks as a sign of impairment (*Tharp, et al., 1981*).

Studies of the higher, more complex process of the brain point to a dichotomy in the effect of alcohol on mood and emotion (Wallgren and Barry, 1970; Warren and Raynes, 1972; Kelly, Myrsten, and Goldberg, 1971). Some individuals are stimulated by alcohol and become exhilarated, cheerful, and friendly; but others are depressed and become quiet, relaxed, sleepy, and unable to think clearly.

Other studies of more complex behavior indicated that risk-taking may be increased at moderate BACs for introverts and light drinkers (Coldwell, et al., 1958; Cutter, Green, and Harford, 1973; Goodwin, Powell, and Stein, 1973). Moreover, low doses of alcohol have been observed to improve the intellectual performance of heavy drinkers and alcoholics while having the opposite effect on light drinkers (Mello, 1972; Wallgren and Barry, 1970). Alcohol has been found detrimental to memory, particularly the long-term memory of heavy drinkers (Ehresing, et al., 1970; Wallgren and Barry, 1970; Weingartner and Faillace, 1971a and 1971b).

There are indications that alcohol may impair combined sensori-motor tasks (e.g., tracking) more than it impairs more intellectual activities (e.g., arithmetic calculations) (Sidell and Pless, 1971). Experiments also suggest that one's performance in complex sensori-motor tasks (e.g., card sorting) is more impaired than in light drinkers by moderate amounts of alcohol than in heavy drinkers is provided by one study (Goodwin, Powell, and Stein, 1973).

What all these findings mean is that some behavior that appears to be related to driving performance is impaired by alcohol, but the exact nature and extent of the impairment and its frequency of occurrence among different individuals at given BACs cannot be stated. But the most serious shortcoming of all studies of this type, as indicated earlier, is the lack of any clear relationship between the behavior studied in the laboratory and driving. It is difficult to understand, for example, exactly how the results of a Romberg test or an experiment in sorting playing cards conducted in a laboratory setting pertain to the tasks that must be performed in driving an automobile on a busy expressway at night. Without an explicit relationship, it cannot be said precisely how an observed impairment affects the probability of having an automobile accident. The most that can be said is that some behavior studied in the laboratory is consistenly and significantly impaired in most individuals as BACs approach .10%. Many persons, particularly lighter drinkers, have shown impairment at much lower BACs. Only a relative few of the heaviest drinkers appear to suffer little impairment at BACs much greater than .10%

While the relevance of these experiments to predicting accident involvement remains to be demonstrated, the results can be used by the police in assessing the extent of alcohol impairment in drivers who are involved in accidents or who have been stopped because their driving was erratic or unsafe (see Chapter 4).

Experiments Using Driving Simulators and Closed Driving Courses

In order to observe the effects of alcohol in more realistic conditions, researchers have tried to approximate actual driving conditions by using driving simulators in the laboratory or an actual vehicle on a carefully controlled driving course. While these two types of experiments provide a closer approximation to real-life driving conditions than the laboratory experiments described above, the usefulness of the findings of these studies—especially simulator studies—is also limited (Edwards, Hahn, and Fleischman, 1969). In simulator and closed-course driving experiments, the speeds achievable are much lower than average highway speeds and the tests last for a relatively short time. The tests also require much simplier skills than ordinary highway driving.

The results of the driving simulator studies have highly conflicting, leading one reviewer to observe that "there appears to be no driving behavior on which the effects of alcohol have been reported more than twice with complete consistency"

(Heimstra and Struckman, 1974). The reviewer did note that there was sufficient consistency among the studies to suggest that the impairment of the higher mental processes was a major contributor to reduced driving performance. This conclusion is supported by another simulator study that concluded that moderate amounts of alcohol impaired performance of complex, concurrent tasks, more than simple tasks (Landauer and Milner, 1971).

Closed-course driving experiments indicate that the ability of many drivers to perform parking maneuvers becomes impaired at BACs as low as .04% to .06% (Bjerver and Goldberg, 1950). Closed-course driving performance at low speeds appears to be degraded for average drinkers at BACs of .08% to .10%, but less so for heavy drinkers (Goldberg and Harvard, 1968). Closed-course driving performance at moderate speeds has been shown to be impaired at BACs as low as .05% to .07% (*Atwood, et al., 1980; Lovibond, 1979; Laurell, 1977;* Lovibond and Bird, 1970; and Seehafer, Huffman, Kinzie, 1968). *Schewe, et al. (1978)* have also found similar impairment in closed-course riding of mopeds and bicycles.

Some recent studies of drivers performance at the University of Vermont have indicated that moderate amounts of alcohol, producing BACs of .07% to .10%, increase accelerator reversals and, possibly, steering inaccuracy (Huntley and Centybear, 1974; Perrine and Huntley, 1971). The Vermont studies also suggest that the driving performance of extroverted persons may be more degraded by alcohol than the performance of other persons (*Damkot, 1981*).

As with laboratory experiments, simulator, and closed-course driving experiments have not been useful in developing quantitative estimates of the crash risk associated with drinking and driving. They tend to support the epidemiologic findings that alcohol-crash risk starts to rise at a BAC of about .08% to .10%, but they do not inform us on the magnitude of these increases in risk. They do, however, give us some basis for explaining how alcohol can impair driving and produce accidents. The most popular current theories stress the role of complex processes (divided attention, information processing demand) rather than simpler factors such as reaction time in crash causation.

It should also be kept in mind that any effects on driving produced by alcohol will be modified by the presence of other drugs (see Moskowitz, 1981, for a review of alcohol-drug interactions) and the state of the driver. Fatigue, for example, may exacerbate the impairing effects of alcohol (Ryder, et al., 1981).

Because of the artificial nature of the driving simulator in closed-course driving experiments, researchers have attempted in recent years to obtain data on alcohol involvement and driving performance in a more realistic setting using unobtrusive measures. Damkot (*1977*), working in Vermont, set up a roadside voluntary breath test survey in such a way that measures could be made of the performance of vehicles as they approach the roadblock stop. Records were made of vehicle speed and lateral position of drivers on the rural roads as they approached the roadblock sites. His data indicated that drivers with BACs in the range of .08% to .15% may drive faster and come to a stop less smothly than drivers without alcohol.

Bragg and his coworkers (*1981*) used a method similar to Dankot and observed the speed and alignment of a vehicle just as it approached a roadblock in which a voluntary breath sample was collected. They were able to develop a measurement technique using pneumatic tube devices stretched across the road which could improve the identification of high BAC drivers (.08% or greater). Using this device, approximately 13% of the drivers stopped would have a BAC above the limit compared to 7% of the drivers with such high BACs if drivers were stopped at random.

Harris, et al. (*1979* and *1980*) placed observers in police cars who noted the driving behavior of nighttime drivers and stopped those who made unusual maneuvers (such as a too-wide turn), and obtained breath samples. Through this procedure, they were able to develop a manual for police use which provides a prediction of the probability that a driver who makes specified unusual maneuvers will have a BAC of .10% or greater.

Another approach that has been used to increase the realism of driving is to allow subjects who have consumed alcohol to drive on actual roadways but with a safety driver. Observers in the vehicles with these drivers can make ratings of their driving behavior. Mortimer and Sturgis (*1979*) and De-Gier *(1979)* have both found changes in driving performance of individuals with low levels of alcohol.

Such research under real driving conditions may ultimately provide a better means of estimating the probability of crash involvement—particularly if the measurements can be taken unobtrusively. The placement of observers in the vehicle undoubtedly influences the driver and therefore, even though real roadways may be used, a driver's performance is probably affected.

The People Who Drink and Drive

The data presented earlier in this chapter indicate that the consumption of alcohol is a major factor in a large number of highway crashes and that it does impair driving performance. The objective of this section is to summarize what is known about the behavior and characteristics of people whose combined patterns of drinking and driving appear to create an abnormally high risk of their being involved in a crash.

Two basic types of research provide the data necessary to define the problem of alcohol and highway safety more sharply. The first is the epidemiologic study, used previously in this report to develop broad statements describing the drinking-driving problem and to be used now for a more detailed definition of groups of drinking drivers.

These studies begin with the collection of crash data, and particularly with the identification of crash-involved road users, and then attempts to study in some depth the characteristics of these groups.

Research of the second type surveys and/or tests selected groups of people. These studies are designed to learn more about the demographic characteristics, the drinking and driving habits, the physical and psychological attributes, and the attitudes of drinking drivers. Researchers then go on to relate these characteristics to the driving records of these road users. Studies that attempt to relate such survey and test data to findings from epidemiologic studies are also considered here.

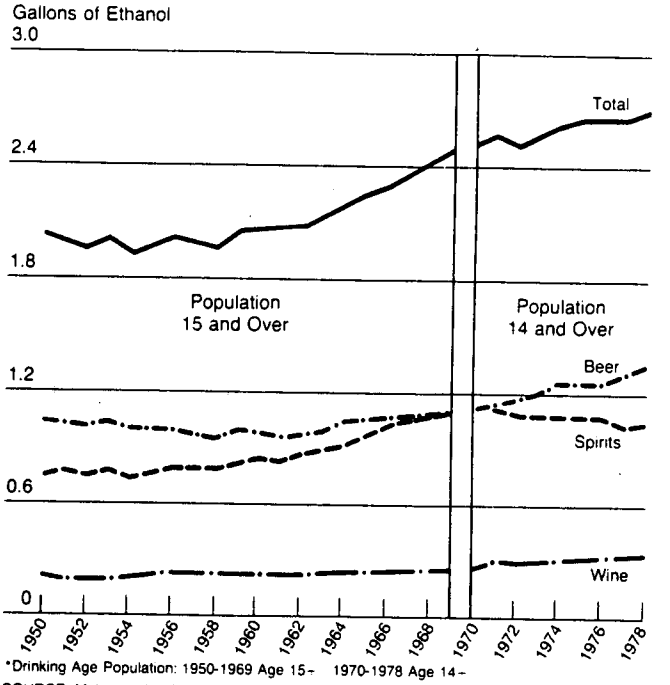
The specific findings about the people who drink and drive are preceded in the paragraphs that follow by a more general discussion of drinking and drinking patterns in the U.S. and elsewhere. Current statistics on alcohol consumption are provided along with some of the more widely used definitions of types of drinkers. Such information is essential to viewing the alcohol-crash problem in its proper perspective—that is, within the context of the larger societal problem of which it is a part.

As shown in Figure 3-8, consumption of alcoholic beverages in the United States has increased over the last several decades. The relatively stable consumption of about 2 gallons of ethanol per adult per year during the 50's rose in the 60's to more than 2.5 gallons per adult by the end of the decade, a 25% increase. The rise continued more slowly in the 70's to more than 2.7 gallons per adult by 1978, an increase of approximately 8%. In part, this reduced rise during the 1970's may be due to the trend toward lower proof of alcoholic beverages in the United States (Malin, et al., 1982).

National alcohol consumption now appears to average about 1 ounce of ethanol (approximately two drinks) each day for each person 14 years old or older. Since about 35% of the population say they abstain, those who drink must consume a daily average of 1.5 ounces of ethanol, that is, three drinks. Such averages are misleading however, since a small portion of the adults drink far more than average. The distribution of average daily consumption as determined from four national surveys is shown in Figure 3-9. As can be seen, the largest portion of drinkers drink less than one ounce a day and the consumption amount falls off rapidly as consumption increases. The individuals at the upper end of this curve, however, consume a large portion of the total amount of alcohol sold in the United States. It is estimated, for example, that the 11% of the adult population 18 years and older who are the heaviest drinkers consume about half of all beverage alcohol sold (*Malin, et al., 1982*).

Table 3-6 provides information on typical drinking patterns in the U.S. It gives the number of drinks per month as a function of sex and age.

Figure 3-8 Apparent U.S. Consumption Per Year of Alcoholic Beverages in Gallons of Ethanol Per Capita of the Drinking-Age Population*, 1950-1978



*Drinking Age Population: 1950-1969 Age 15- 1970-1978 Age 14-
SOURCE: Malin, et al., *1982*, p. 106

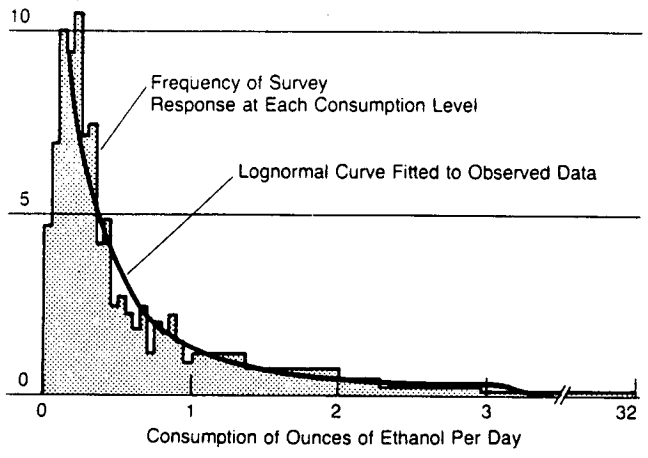
This table shows the consumption patterns that would be expected in the U.S.: males drink more than females and younger age groups contain fewer abstainers and more drinkers than older age groups.

Figure 3-10 shows the pattern of consumption of the three major types of alcohol—beer, liquor, and wine. The most important feature of this graph is the heavy use of beer by the youngest segments of the population since it is the younger drivers that are the most overrepresented in accidents. Overall, Americans consume nearly as much ethanol from beer (49%) as from wine (12%) and liquor (39%) combined. Per capita consumption, when averaged over the U.S. population aged 14 and older, equals nearly 30 gallons (or the equivalent of 320 12-ounce cans) of beer each year (*Malin, et al., 1982*).

The very heavy consumption of alcohol by some adults would be expected and does lead to various types of social and health problems. Table 3-7 presents the relationship between the amount of drinking and the occurrence of social consequences of drinking. As the data show, some social consequences occur even to relatively light drinkers. But there is a clear increase in the numbers of social problems as the amount of drinking increases with between a fourth (males) and a third (females) reporting such problems if they consumed four drinks or more per day (*Clark and Midanik, 1982*). For a further discussion of drinking problems as they relate to drivers, see the section in "Drinking Violaters" in this Chapter.

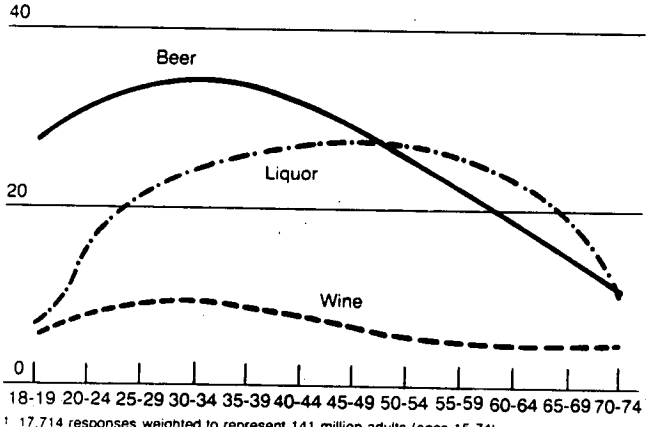
Roizen (*1982*) has reviewed the role of alcohol in "serious events" which produced traumatic injury

Figure 3-9 Frequency Distribution of Consumption for a National Sample of Alcohol Users



SOURCE: Four pooled surveys from Louis Harris and Associates, 1972-1974 (from *Malin, et al., 1982, p. 115*)

Figure 3-10 Self-Reported Beverage Preference by Age (Percentage, Weight)[1, 2]



1 17,714 responses weighted to represent 141 million adults (ages 15-74).
2 Remaining percentages not shown on the chart are nondrinkers or those persons without a beverage preference.

SOURCE: *Malin, et al., 1982, p. 119*

and summarized the proportion of these events in which alcohol was used by one of the individuals involved. Her results are summarized in Figure 3-11. Shown are the number of studies which Roizen was able to locate and the range of percentage involvement for various types of accidents and crimes. It is clear from this graph that traffic accidents are not the only traumatic injury events which involve alcohol but that alcohol underlies a number of probems behaviors as well as presenting a general health problem to individuals who are excessive drinkers.

Table 3-6.—Drinking Patterns in the U.S. Adult Population by Age (in percentages)

Age	Drinking Categories			Total N
	A	B	C	
Males:				
18-20 yr	5	79	17	37
21-25 yr	10	54	36	82
26-30 yr	20	50	29	87
31-40 yr	25	55	19	154
41-50 yr	27	52	21	107
51-60 yr	32	51	17	130
61-70 yr	38	53	8	91
70 plus	41	45	13	72
Females:				
18-20 yr	31	64	5	52
21-25 yr	15	78	6	130
26-30 yr	30	65	5	125
31-40 yr	27	65	9	208
41-50 yr	43	46	10	137
51-60 yr	50	46	4	143
61-70 yr	61	38	1	102
70 plus	61	39	0	103
Total sample:	33	54	13	1,772
Males	25	54	21	762
Females	40	54	5	1,010

A—Abstainer.
B—Drinkers: 1 to 60 drinks per month.
C—Drinkers: More than 60 drinks per month.
Source: *Clark and Midanik, 1982, p. 29.*

In making studies of the relationship of drinking to traffic accidents, it is obviously important to be able to categorize or measure the level of drinking. Two approaches have generally been used. On the one hand, the quantity and frequency with which alcohol is used is determined by a self-report questionnaire and, on the other, the number of drinking "problems" are determined from self-reports from official records. The amount of drinking and the numbers of problems are obviously correlated. However, no precise or direct relationship exists as is shown in Table 3-7. Moreover, while alcoholism is generally accepted as a health problem there is as yet no fully objective medical syndrome upon which all researchers agree. Consequently, many definitions are used in the literature on the effect of alcohol on human behavior.

Three categories of drinkers are commonly of concern to traffic researchers: the social drinker, the problem drinker, and the alcoholic. Although social drinkers and problem drinkers tend to be seen as mutually exclusive categories at a given

Table 3-7.—Quantity/Frequency of Drinking by Various Social Consequences Due to Drinking (in percentages)*

Classes of social problems reported as a consequence of drinking	Approximate number of drinks per month					
	Less than 2	Between 2 to 10	Between 10 to 60	Between 60 to 120	Over 120	Total
Males:						
Spouse	0	1	2	0	6	2
Friends, relatives	2	1	7	3	14	6
Police, accidents	0	1	3	6	20	5
Job	0	0	2	(**)	5	1
Any of the above social consequences	2	2	9	9	27	9
Sample (N)	(84)	(103)	(206)	(75)	(87)	(555)
Females:						
Spouse	0	0	0	0	0	0
Friends, relatives	(**)	1	5	11	37	4
Police, accidents	0	1	3	4	17	2
Job	0	0	(**)	1	4	(**)
Any of the above social consequences	(**)	2	6	16	37	5
(N)	(185)	(174)	(188)	(37)	(16)	(600)

* The percentages are weighted figures: totals shown are the actual number of cases. Slight variations in these totals occur because of nonresponse, etc.

** Less than 0.5 percent.

Source: *Clark and Midanik, 1982,* p. 38.

time, any one individual may be a problem drinker at one time in his life and a social drinker at others. Moreover, there is a considerable overlap between the problem drinker and the alcoholic categories. Not every problem drinker is an alcoholic, but the alcoholic is certainly a problem drinker. It is probably best not to think in terms of sharply defined categories, but rather to consider the social drinker, problem drinker, and alcoholic as simply segments along a continuum of increasing consumption of, and increasing problems related to, alcohol.

The definitions of social drinkers, problem drinkers, and alcoholics used here are what is commonly meant by the terms (Joscelyn and Jones, 1971). "Social drinkers" are those whose consumption of alcohol is part of their socially defined interactions with family, friends, neighbors, and coworkers. For the social drinker, alcohol enhances the occasions when it is used. Alcohol in this context is both a symbol of shared feeling and, for some, a means of relaxing just enough to be comfortable in sharing feeling. The health and social functioning of the social drinker are not impaired by his pattern of alcohol consumption.

"Problem drinkers" refers to those whose pattern of alcohol consumption either contributes to or is symptomatic of the disruption of their relationships with family, friends, neighbors, and coworkers. Alcohol is not necessarily the cause of the problems of the drinkers in this category; it may be just one element of behavior displayed by people with interpersonal problems who also drink immoderately.

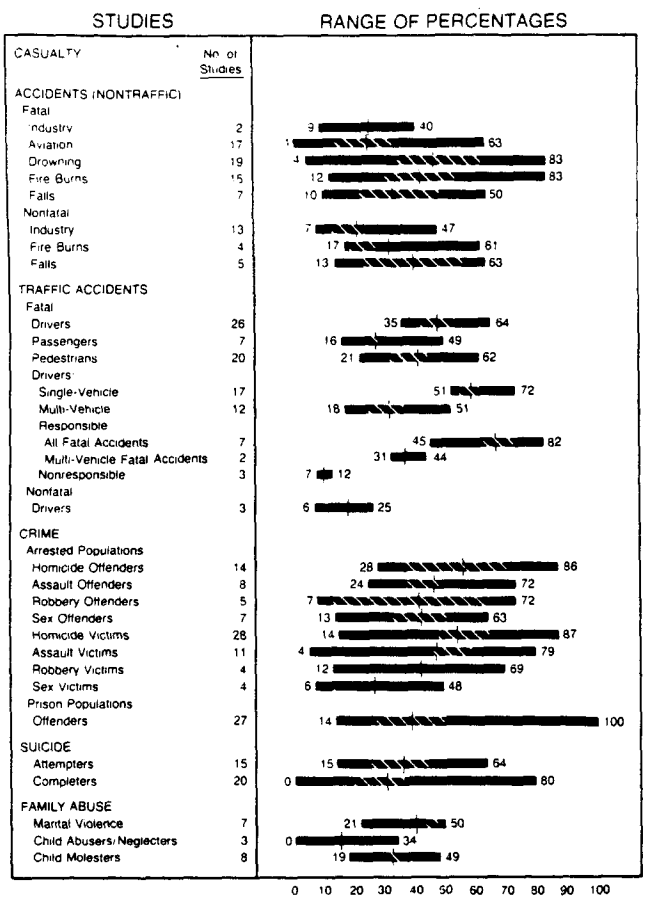
The "alcoholic" is a person whose nervous system has developed a tolerance to alcohol; over a period of time, he requires more and more alcohol to achieve a given effect. The alcoholic is likely to drink in order to cope with social interactions. Thus, he may drink before as well as during the party or ceremony. Yet, in spite of his priming, he fails to cope because he cannot control his drinking. He is unable to act upon evidence that he has reached a point in his drinking at which the benefits of drinking have begun to decline rapidly and drinking itself becomes a problem. For the alcoholic, however, in contrast to the problem drinker, drinking is not just one of an array of problems. The drinking patterns of alcoholics clearly contribute to problems of poor health, social disruption, and economic instability.

Characteristics of Drinking Drivers

Researchers contributing to the literature on the alcohol-crash problem categorize the variables for describing drinking drivers in several ways. For this report we have adopted the three categories Perrine used in his recent review (1975), and added a fourth, to describe the results of epidemiologic research:

1. Variables that are primarily biographical, including such demographic characteristics as sex, age, race, etc.
2. Variables that relate particularly to driving, such as the number of previous crashes, driving experience, number of driving interactions with law enforcement agencies, etc.

Figure 3-11 Findings of Studies of Alcohol Involvement in Serious Accidents and Crimes[1]



[1] Studies use measures such as BACs, police reports of drinking, witness reports, self-reports.

Source: Roizen, 1982, p. 181

3. Variables that describe an individual's drinking practices, such as the quantity and frequency of his drinking and the type of beverage he consumed; and
4. Variables which have been analyzed in various psychometric studies and which are classified here as personality and stress variables.

Of course, there are interactions among these four categories of variables, and these cannot be ignored.

The purpose of examining the variables in these categories is to determine the incidence of various subgroups of drivers in alcohol-related crashes, which in turn is a function of:

- Exposure (amount and type of driving) to alcohol-related crashes, and
- The alcohol-crash risk—that is, the relative risk of crashing after drinking—given equal exposure (miles of driving after drinking).

This difference between *exposure* and *crash risk* was discussed earlier. Male drivers are overrepresented in alcohol-related crashes (see below) primarily because they do more nighttime driving than females not because per-mile driven they have a higher risk of being involved in a crash. This difference is important in the development of safety programs as discussed in Chapter 4.

The data on the incidence of a particular type of road user in crashes (when available) are presented first to estimate the importance of the variable to the overall alcohol-crash problem. Next, the available exposure data on drivers using the road but not involved in crashes (i.e., data from roadside surveys) are presented. Finally, to estimate the alcohol-crash risk, the data from controlled studies are provided.

It would be preferable to use controlled studies exclusively when discussing crash risk, but such studies do not provide enough data on the relevant subgroups of road users to calculate their risk. Note that without data from controlled studies, no explicit quantitative statement can be made about crash risk after drinking.

Considerable care is required when interpreting the findings of studies of individuals who drink and drive. The studies are useful in developing a better understanding of groups of drinking drivers but of course they cannot be used to identify a given individual as a certain alcohol-crash threat. Moreover, different characteristics that have been associated with alcohol-crash risk are difficult to combine to form a composite picture or "profile" of "high-risk" drivers. The reader is advised to use caution in creating such profiles even as an aid to understanding the common characteristics of high-risk drivers. Particularly, the use of simplistic profiles to describe priority targets for countermeasures should be avoided.

The reader should also be aware that many of the variables which describe drinking drivers are not independent. Thus, an effect that may seem to be due to one variable may just as well be due to another variable that is closely related to the first variable. These "confounding" effects often make it difficult to infer which variable is most associated with an observed effect.

Biographical Variables: Sex

Among those variables classified as biographical, sex has been found to be one of the best differentiators of drinking drivers. Males are consistently over-represented in all kinds of drinking-driver populations, particularly among crashed drivers with high BACs, that is, with BACs greater than .08%. Studies in California (Waller, et al., 1970) and Michigan (Filkins, et al., 1970) found that about 90% of the fatally injured drivers who had been drinking were males, compared to 81% to 88% of those who had not been drinking.

Similar results have been reported in studies of less serious crashes. For example, the Huntsville/San Diego study of personal-injury crashes found

that 68% of all drivers is such crashes were male and 83% of all crashed drinking drivers were male (*Farris, Malone, and Lilliefors, 1977*). The Grand Rapids study of crashes of all types (most of which were of the less serious property-damage variety) showed 78% of the drivers to be male and 88% of the drinking drivers to be male (*Borkenstein, et al., 1974*).

Roadside surveys conducted in controlled and noncontrolled studies have shown a predominance of males among both drinking and nondrinking drivers (Table 3-8). The Vermont study found that 79% of its control group of nondrinking drivers were male, while 83% of those with BACs exceeding .10% were male (Perrine, Waller, and Harris, 1971). The Grand Rapids survey, the combined results of the National Roadside Survey, and the ASAP surveys showed almost identical percentages of males at BACs approaching zero, but much higher percentages of males among drivers whose BACs were .08% or or above (*Borkenstein, et al., 1964; Wolfe, 1975*).

Table 3-8.—Percentages of Males Among Low-BAC and High-BAC Drivers in Roadside Surveys

Survey	BAC	
	Negative	⩾.10%
Vermont (Perrine, Waller, and Harris, 1971)	[1] 79	83
Huntsville (*Farris, Malone, and Lilliefors, 1977*)	[2] 67	[3] 86
Grand Rapids (Borkenstein, et al., 1964)	78	[4] 95
National Roadside Survey and ASAP (Wolfe, 1975)	[5] 79	91

[1] BAC <.02%.
[2] BAC <.03%.
[3] BAC >.03%.
[4] BAC ⩾ .08%
[5] BAC <.05%.

None of the studies cited above (or others which have investigated this variable) found any evidence to suggest that the reason for the higher incidence of male drivers in alcohol-related crashes was that males were somehow poorer drivers after drinking than females. One the contrary, data from the Grand Rapids study indicate the opposite may be true. The data show that although a male's crash risk at a BAC of .08% was about twice his crash risk at zero BAC, the relative crash probability of females at a BAC of .08% was nine, or about 4.5 times higher than that of males. The study found little difference between the relative probability of males crashing and females crashing at the lower BACs. If anything, females have slightly less risk at such BACs. A study of nighttime drivers (Carlson, 1971), however, found drinking females to be more frequently involved in crashes than drinking males, even at the lower BACs, and suggested that inexperience with drinking may have been the cause.

In short, research shows that there are far more male drivers exposed to, and involved in, alcohol-related crashes than female drivers. This is due more to the fact that the men drive more than women (especially after drinking) than to any inherent difference between sexes in tolerance to alcohol. Evidence that males drive more is presented in Table 3-9, which shows the role of occupants in accidents of all levels of severity taken from NASS data. Sixty-two percent of drivers are male, while 58% of accident-involved passengers are female.

Table 3-9.—Accident-Involved Occupants by Sex and Role; NASS 1981*

	Number of occupants	Percent male	Percent female
Auto driver	8,300,000	62	38
Auto passenger	4,100,000	42	58
Truck driver	1,800,000	89	11
Truck passenger	710,000	59	41
Other driver	490,000	88	12
Other passenger	310,000	46	54
Total	16,000,000	60	40
Percent distribution of personal travel**		60	40

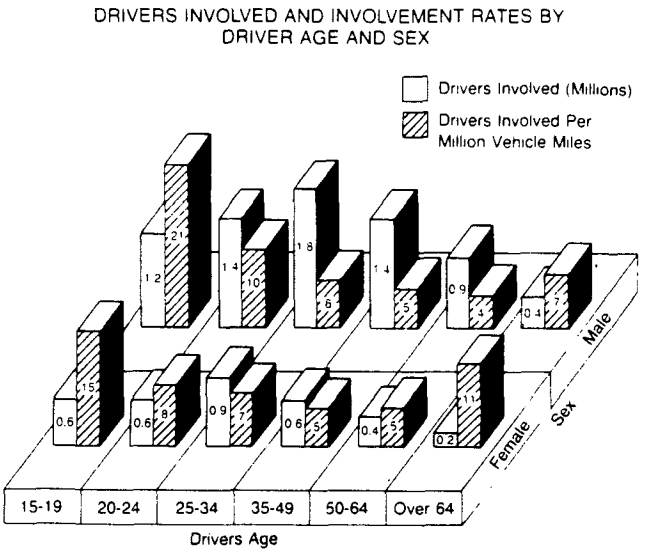
* *NCSA, 1981b.*
** Travel proportions for males and females are based on the 1977 Nationwide Personal Transportation Study.

Biographical Variables: Age

Before considering the variation among driver age groups in involvement in alcohol-related crashes, it is useful to be aware of the overall variation in driver accident involvement as a function of age. This is provided by Figure 3-12, taken from the National Accident Sampling System (*NCSA, 1981b*), which shows the numbers of drivers involved in accidents of all levels of severity in relationship to the number of vehicle miles driven. The number of vehicle miles driven is taken from the National Personal Transportation Study, which is a self-report household survey. As can be seen from this figure, teenage drivers have a considerably higher accident involvement rate, both among males and females, than does the average driver. The lowest accident involvement rates per vehicle miles driven is in the 35 to 65 age group.

The relationship between driver age and involvement with any amount of alcohol in a fatal

Figure 3-12 Drivers Involved and Involvement Rates by Driver Age and Sex*

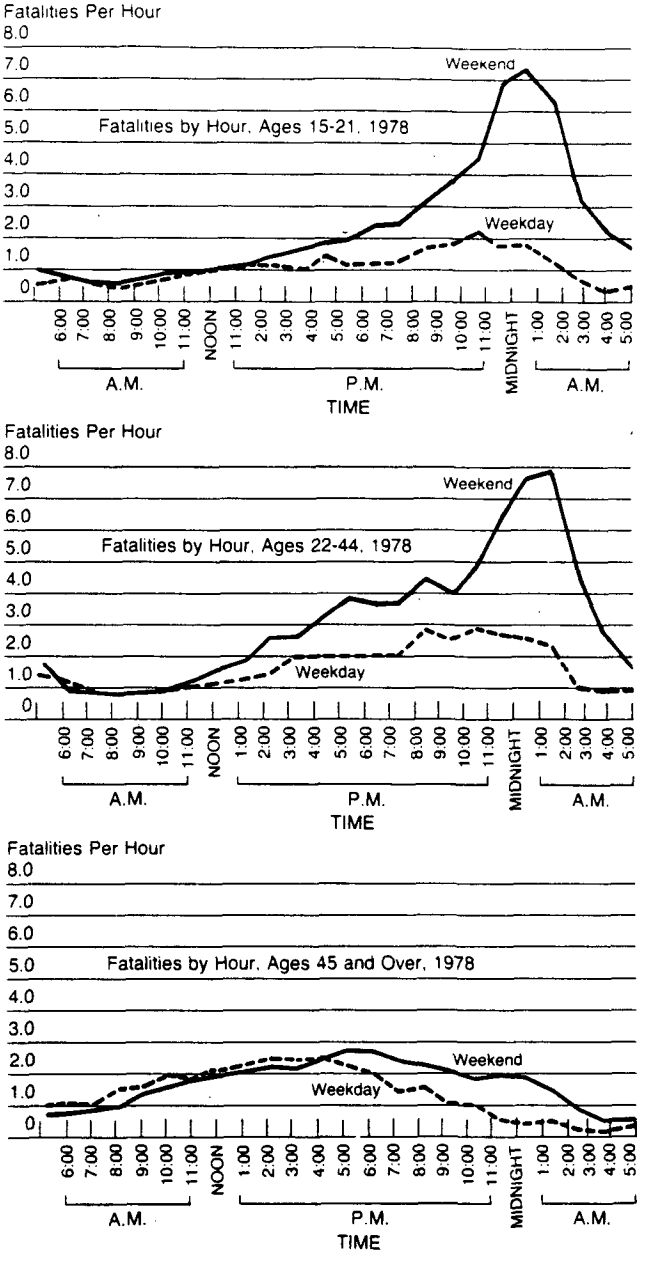


Based on the 1977 nationwide personal transportation study and the 1979-1981 national accident sampling system

NCSA 1981b

crash is shown in Table 3-10. Vehicle miles are estimated from the National Personal Transportation Survey, while the number of drivers with a positive BAC is estimated by extrapolating from the 15 States which report alcohol data most completely to the FARS. As shown in this table, the teenage drivers have an alcohol involvement rate of approximately 4½ per 100M vehicle miles, as compared to 1½ for the drivers in the 25 to 44 age range. The very lowest involvement rates are seen among the middle-aged and elderly drivers from age 45 onward. Both Figure 3-12 and Table 3-10 provide only a portion of the exposure picture because each uses as its exposure data the Personal Transportation Survey collected using interviews of a national probability sample of U.S. households. Mileage estimates developed in this way may not be comparable among all age groups of drivers.

Figure 3-13 Fatal Accidents Per Hour of the Day for Three Age Groups



SOURCE: National Highway Traffic Safety Administration, "Fatal Accident Reporting System. 1978 Annual Report" (Washington, D.C.: U.S. Department of Transportation, 1978).

Table 3-10.—Alcohol Involved (BAC≥.01 percent) Fatal Accident Rates for Various Driver Age Groups [1]

Driver age	Percent of driver license population [2]	Percent of vehicle miles traveled [3]	Number of vehicle miles traveled (per 100,000,000)	Number of alcohol-involved fatal accidents [4]		Alcohol-involved fatal acident per 100,000,000 vehicle miles traveled
				Number	Percent	
16 to 17	3.2	1.95	295	1,350	5.4	4.58
18	2.2	1.97	298	1,375	5.5	4.61
19	2.4	2.31	349	1,550	6.2	4.44
20	2.5	2.74	414	1,400	5.6	3.38
21	2.6	2.31	349	1,425	5.7	4.08
22 to 24	7.0	8.38	1,266	3,925	15.7	3.10
25 to 44	42.1	46.88	7,081	10,625	42.5	1.50
45 to 54	12.8	17.53	2,648	1,750	7.0	0.66
55 to 64	12.4	10.72	1,619	1,100	4.4	0.68
65 plus	10.6	5.10	770	500	2.0	.....
Totals	100	100	15,106	25,000	100	.....

[1] (*Fell, 1983*).
[2] Source: Highway Statistics 1980 (FHWA).
[3] Source: 1977 National Personal Transportation Survey tapes ("Characteristics of Licensed Drivers and Their Travel"), FHWA, October.
[4] Extrapolated from FARS 1980 (15 Good States to the Nation) Alcohol Involved= BAC ≥.01 percent.
[5] Alcohol involved fatal accidents per 1,000,000 VMT—Number of alcohol-involved fatal accidents for age group/number VMT for age group per 100,000,000.

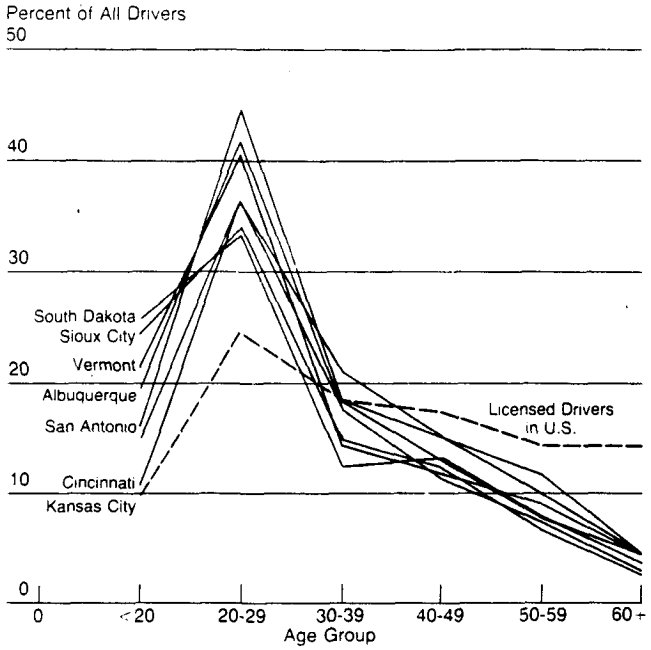
There is evidence of this in data taken from the FARS file and shown in Figure 3-13 (*Voas and Moulden, 1981*). This contrasts the time of occurrence of fatal accidents for weekends and weekdays for three age groups. As can be seen, the driving pattern of the working-age population (22 to 44) is such that the largest number of fatalities per unit time occur late at night on weekends. During weekdays, there is some increase in the rate of accidents during the late-night hours but it is much less marked. This accident rate trend reflects the recreational driving pattern in the United States; the most dangerous driving conditions, at least per-unit time, occur in the late-night hours. Young drivers (21 and below) have a pattern that is quite similar to adults, with the highest number of accidents per hour occurring late at night. It is notable that the accidents of these young drivers are even more concentrated at nighttime and on weekend nights than is the case for the drivers in the age 22 to 44 group.

A dramatically different pattern is seen for drivers age 45 and older. Here the peak accident involvement period is in the early evening, around 5:00-6:00, and the late night (and particularly weekend late night) pattern almost completely disappears. Thus, overall mileage rates may not reflect actual exposure to drinking-driving accidents, which, as discussed below, occur primarily in the late-night hours.

Studies of drivers not involved in crashes but stopped for roadside surveys have shown that younger drivers are more frequently on the roadways late at night. This is illustrated in Figure 3-14, which shows the results of roadside surveys conducted at seven alcohol safety action program sites during the early 70s (*Voas and Moulden, 1981*). The involvement of age groups under 20 and between 20 and 29 is well above their proportion in the licensed driver population, whereas the presence on the road at night of drivers 30 and older is significantly less than their proportion in the driver licensed population. Thus, drinking aside, the younger drivers are more exposed to late-night accidents, and therefore are more exposed to being in an accident with another driver who has been drinking, whether or not they have been drinking themselves.

While young drivers do more of their driving at night than do their older peers, they are somewhat less likely to have been drinking. For example, the Vermont study of drivers surveyed at the times and places of fatal crashes found that 9% of driv-

Figure 3-14 Age Distribution of Drivers Using the Road at Night in Seven Areas of the United States



SOURCE: National Highway Traffic Safety Administration, *Alcohol Safety Action Project: Evaluation of Operations, 1972*, Vol. 2 (Washington, D.C., U.S. Department of Transportation, April 1, 1974).

ers under 20 years of age had been drinking, compared to 14% of drivers who were older than 20. The Huntsville study of drivers using the roads at the times and places of injury crashes found that about 8% of its under-20 drivers had been drinking (BAC of at least .03%) but 12% of its over-20 drivers had been drinking (*Farris, Malone, and Lilliefors, 1977*). The combined results of a National Roadside Survey and the nighttime surveys conducted under NHTSA's Alcohol Safety Action Project showed 6% of its under-20 drivers had BACs of at least .05%, compared to 14% of drivers over the age of 20 (*Wolfe, 1975*). Similar results with regard to drivers over 60 years of age were obtained in all of these studies; that is, older drivers were less likely to have been drinking than drivers as a whole (*Farris, Malone, and Lilliefors, 1977;* Waller, et al., 1970; *Wolfe, 1975*).

Data from the Huntsville study (*Farris, Malone, and Lilliefors, 1977*) and the Grand Rapids study (Borkenstein, et al., 1964) indicate that the crash risk of very young drivers is higher after drinking than it is for drivers from other age groups (Figure 3-15). However, no increase in relative crash probability is noted for the oldest age groups except at the higher BACs.

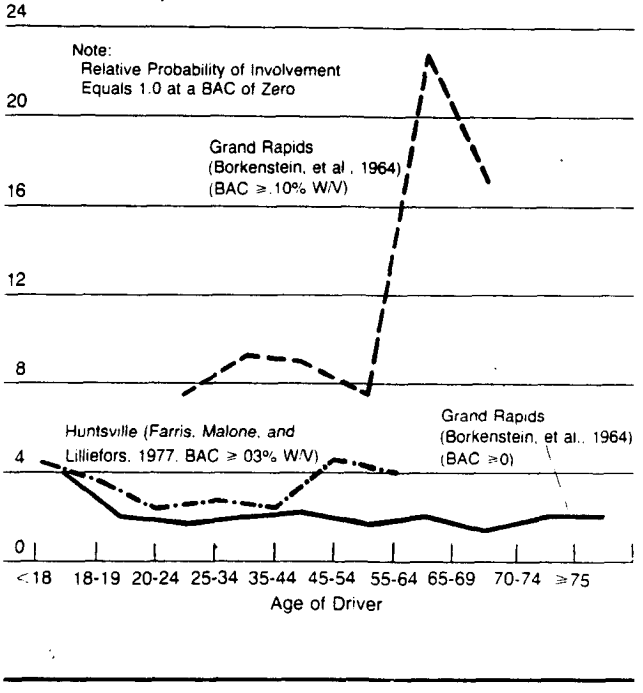
The presumed reason for the higher alcohol-crash risk faced by younger drivers is their relative inexperience with driving after drinking, but there are few behavioral data on the differential effects of age to support this hypothesis.

In view of the epidemiologic evidence of the increased crash risk faced by young drinking drivers, it might be expected that the lowering of the legal drinking age in some States in the early '70s would be accompanied by an increase in the number of alcohol-related crashes involving young drivers in those States. And that when the drinking age was raised back by some of these same States in the late '70s and early '80s, the number of alcohol-related crashes involving teenagers would decline. Analyses of alcohol-related crashes in several States indicate that, indeed, such an effect did occur, but these studies leave some question as to the amount of the effect (*Douglas, Filkins, and Clark, 1974; Whitehead, 1976; Zylman, 1976; Williams, et al., 1981; Smart and Goodstadt, 1977;* Smart & Schmidt, 1976; Ferreira and Sicherman, 1976; Douglas and Freedman, 1977; *Douglas, 1982;* and *Wagenaar, 1982*). The use of drinking age laws as a traffic safety countermeasure is discussed further in the next chapter.

Biographical Variables: Marital Status

Studies of drivers' marital status have shown that married persons comprise the largest percentages of drinking drivers who have crashed and of drivers using the road. For example, in the California study 17% of the fatally injured drivers were divorced or separated, 16% were single, and 61% were married (Waller, et al., 1970). The Vermont study found that of 18 fatally injured drivers, age 25 or older and with BACs of at least .10%, only one was "widowed, divorced, or separated," 13 (72%) were married, and four were single (Perrine, Waller, and Harris, 1971). The Grand Rapids data on less serious crashes also found that married drivers appeared most frequently among crashed drinking drivers (Borkenstein, et al., 1964, Table 39).

Figure 3-15 Relative Probability of Crash Involvement for Drivers, by Age



The Grand Rapids data also showed that separated or divorced drivers with BACs of at least .05% had a slightly higher relative crash probability than married drivers who, in turn, had a slightly higher relative crash probability than single drivers. Other studies have found that divorced or separated fatally injured drivers were more likely to have been drinking than other fatally injured drivers (Waller, et al., 1970; Filkins, et al., 1970).

Unfortunately, many of the studies that have investigated the effect of marital status on exposure to or involvement in alcohol-related crashes have not attempted to control for interactions between marital status and age. Thus, it is usually not clear whether an observed difference in crash risk is due to marital status or age. Certainly, research conducted to date does not prove that marital status is strongly related to exposure or crash risk.

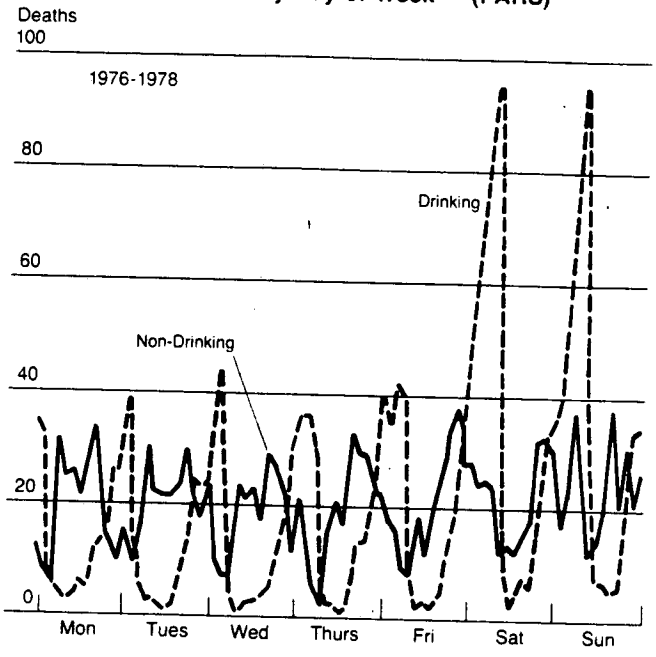
Other Biographical Variables

There are indications that persons of "lower" occupational levels are overrepresented among drinking drivers, but these findings are not conclusive because of the confounding effects of other variables such as age and sex (Borkenstein, et al., 1964; *Wolfe, 1975;* Perrine, Walter, and Harris, 1971). Increased alcohol involvement among nonwhites has been explained in one study as a socioeconomic rather than a racial effect (Zylman, 1972a). Persons in low income groups were especially overrepresented among nighttime drivers in a nationwide survey, particularly at very high BACs (i.e., greater than .15%), where they outnumbered other drivers by a factor of three to one (*Wolfe, 1975*). Less educated persons were found more frequently among drinking drivers in some older studies (Borkenstein, et al., 1964), but more recent studies show less of an educational effect except at high BACs (Perrine, Waller, and Harris, 1971; *Farris, Malone, and Lilliefors, 1977: Wolfe, 1975*). Farris, Malone and Lilliefors (*1977*) found that low occupational level and low education level were over-involved in injury crashes generally.

Driving Variables: Time of Day and Day of Week

It would be logical to expect that crashes involving drivers who have been drinking would occur with higher relative frequency at the times of day when people tend to drink more, i.e., the evening hours and on weekends. That this is the case is shown in Figure 3-16, which plots the number of driver fatalities per hour in California (*Voas, 1982a*) for two groups; those with a BAC of .00% and those with a BAC $\geq$ .10%. As can be seen, the drivers who were under the influence tended to die in accidents which occurred around midnight each day with a peak frequency on Friday and Saturday nights. Sober drivers tended to die in accidents which occurred in the late afternoon/early evening rush hours.

Figure 3-16 Comparison of Alcohol and Non-Alcohol Involved Fatally Injured California Drivers in Fatal Crashes by Two-Hour Periods by Day of Week — (FARS)



*Voas, 1982a.

The findings of past research studies confirm this time relationship as shown in Figure 3-17. Data on crashes in California indicate that over 85% of all drivers fatally injured in single-vehicle crashes occurring in the hours between 9 p.m. and 6 a.m. had BACs of at least .05% (U.S. Department of Transportation, 1968). By contrast, only about 40% of such drivers in the 3 p.m. to 9 p.m. period had such high BACs.

Less serious kinds of crashes exhibit this same trend. The Huntsville/San Diego study (*Farris, Malone, and Lilliefors, 1977*) showed that 63% of all drivers in personal injury crashes occurring from midnight to 3 a.m. had been drinking (that is, they had BACs of .03% or more), but that fewer than 20% of such drivers had been drinking from 6 a.m. to 6 p.m.

Previous research has also confirmed the trend with respect to weekend versus weekday crashes. Such a trend has in fact been noted in several studies (Filkins, et al., 1970; Waller, et al., 1970; *Farris, Malone, and Lilliefors, 1977*), but it is much less pronounced than that observed for nighttime hours versus daytime hours (Figure 3-18). The largest differences were found in Wayne County, Michigan (Filkins, et al., 1970), where 65% to 75% of drivers killed in crashes occurring on Fridays, Saturdays, and Sundays had BACs of at least .05%, compared to about 50% of those killed in crashes on Mondays, Tuesdays, Wednesdays, and Thursdays.

There is also a trend toward higher frequencies of noncrash-involved drinking drivers in the nighttime driving population. The very late nighttime period has a particularly high percentage of drink-

Figure 3-17 Percentage of Crash-Involved Drivers Who Had Been Drinking, by Time of Day

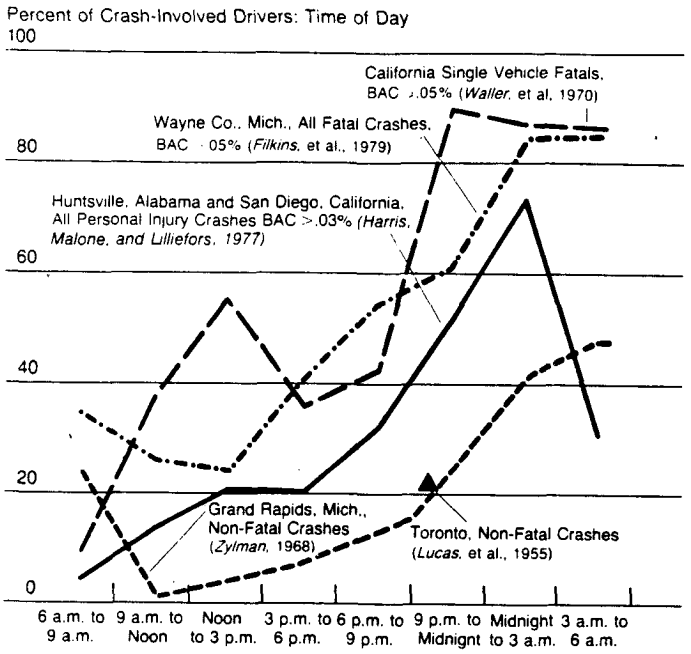
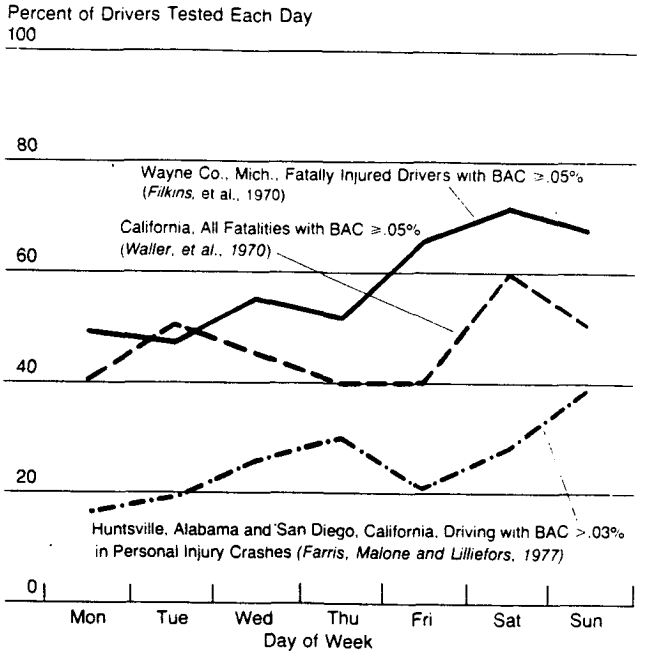


Figure 3-18 Percentage of Crash-Involved Drivers Who Had Been Drinking, by Day of Week



ing drivers, as high as 30% in the Huntsville and San Diego study and over 20% in the Grand Rapids and ASAP surveys (*Farris, Malone, and Lilliefors, 1977*; Zylman, 1973b; and *Wolfe, 1975*). The studies also provide some evidence that drinking-driving occurs more frequently on weekends than on weekdays, but the effect is not as noticeable as for nighttime versus daytime drivers.

Zylman (1973b), using data from the Grand Rapids study attempted to estimate the effect of the time of day on crash risk. He states that his unpublished data show that the risk of BACs over .05% was more than three times as high during the hours between 9 a.m. and noon as it was during the hours between 3 a.m. and 6 a.m.!

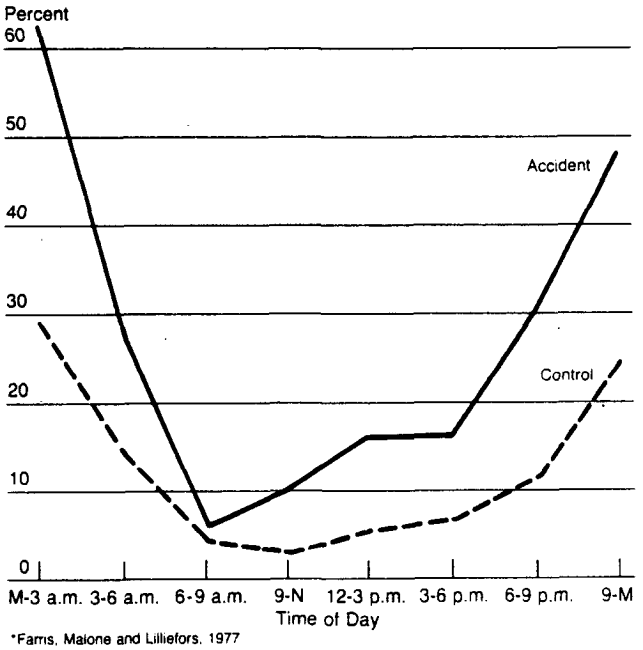
He speculated that this could have been because the higher density of daytime traffic increases the demands on drivers, resulting in increased crash probability even at low BACs.

Data from the Huntsville/San Diego study given in Figures 3-19 and 3-20 show the relationships between drivers on the road and crash-involved drivers. Both groups have the highest involvement at night and on the weekends but the relative ratios may be greatest during the daytime. For example, the ratio from 3 p.m. to 6 p.m. is 15% to 5%, or 3 to 1. The ratio from midnight to 3 a.m. is 63% to 29%, or about 2 to 1.

Driving Variables: Annual Mileage and Origin of Trip

Conflicting results have been obtained with respect to the relationships between the annual mileage driven and drinking drivers (Borkenstein, et al., 1964; *Wolfe, 1975*). There are indications

Figure 3-19 Percentage Plots of Accident and Control Drivers with Positive BAC (≥.03%) by Hour of Day in Huntsville and San Diego*



*Farris, Malone and Lilliefors, 1977

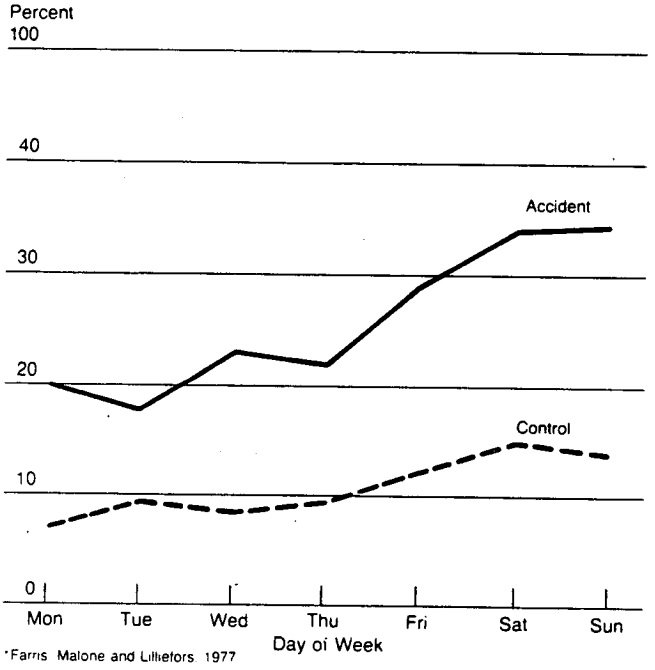
that persons who drive relatively infrequently have a higher crash involvement (*Farris, Malone, and Lilliefors, 1977*) and are overrepresented among drinking drivers on the road (*Wolfe, 1975*), and among drinking drivers in crashes (Borkenstein, et al., 1964). The relative risk of a crash after drinking may also be higher for the

very-low-mileage driver (Borkenstein, et al., 1964). The origin of the trip which occasioned the illegal drinking-driving is most frequently a bar or tavern or another peron's home (*Wolfe, 1975*; Carlson, 1972).

Driving Variables: Previous Crashes and Enforcement Actions

Research suggests that drinking drivers have had slighly more previous crashes than other drivers. The Wayne County, Michigan, study found that 59% of its fatally injured drivers who had experienced one or more crashes in the preceding 6½ years had BACs of at least .10% when killed, but that only 53% of the fatally injured drivers who had had no crashes in this period had BACs so high (Filkins, et al., 1970). The Vermont study reported 9% of its roadside-survey drivers without alcohol had two or more crashes in the past five years, and 13% of the drivers with BACs of 10% had had two or more crashes in the same period (Perrine, Waller, and Harris 1971). A third study of fatally injured drivers in California (Waller, et al., 1970) found that drivers who had been drinking had a slightly higher average number of past accidents per driver (1.37) than drivers who had not been drinking (1.25).

Figure 3-20 Percentage Plots of Accident and Control Drivers with Positive BAC (≥.03%) by Day of Week in Huntsville and San Diego*



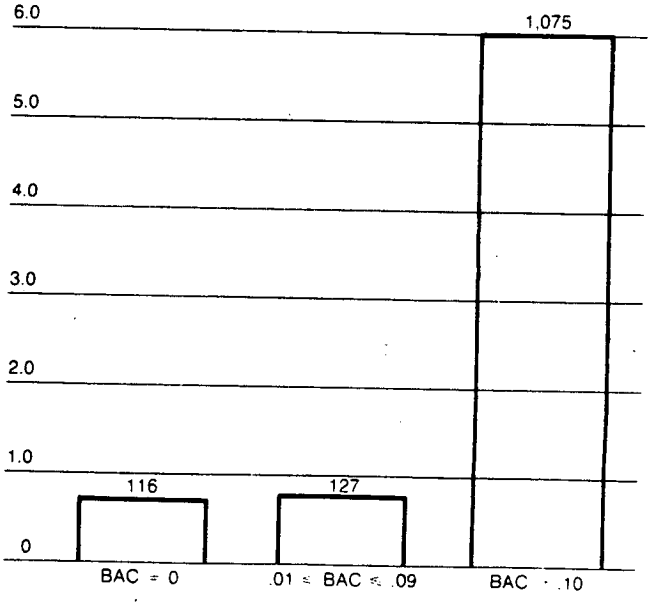
*Farris, Malone and Lilliefors, 1977

Drinking drivers also tend to have more enforcement actions against them. Data from the NASS (*NCSA, 1981b*) indicate that 7% of the drinking drivers in accidents of all levels of severity have a previous DWI conviction as compared to only 1% of non-drinking drivers. Similar data from the FARS file (*NCSA, 1980*) is shown in Figure 3-21. Drinking drivers in accidents are also more likely to be operating on suspended, revoked, or expired licenses, as shown from the NASS data presented in Figure 3-22.

The Wayne County study of fatally injured drivers found intoxicated drivers had nearly nine times the percentage of convictions for driving under the influence of liquor as nonintoxicated drivers (Filkins, et al., 1970). A recent study of drivers who were found to be responsible for fatal crashes in Boston noted a similar trend with respect to citations for driving under the influence of alcohol or for public drunkenness or for both (*Sterling-Smith, 1976*). Neither study, of course, provides a sufficient basis for concluding that the number of previous citations or previous crashes is somehow a causal factor in alcohol-related crashes.

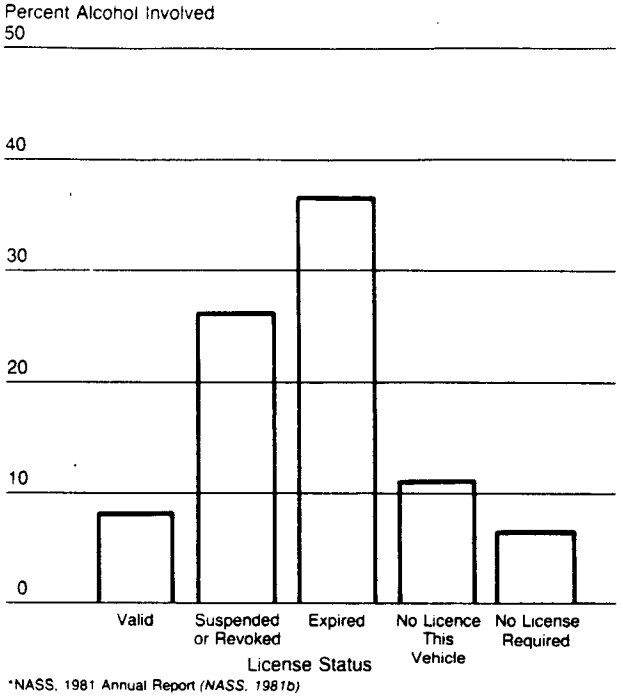
Persons arrested for driving while intoxicated (DWI) generally have more prior driving convictions than the average driver and perhaps more prior crashes (Filkins, et al., 1970; Perrine, Waller, and Harris, 1971). Their driving records have been found to be similar to those of fatally injured drivers with high BACs, but their prior convictions for driving offenses are more numerous than those of either fatally injured drinking drivers or noncrashed drinking drivers. The BACs of persons arrested for DWI are nearly always at illegally high levels (Shupe and Pfau, 1966). DWIs are seldom female, very young, or very old. They are usually arrested during weekends and at night and are often engaged in "low status" occupations (Filkins, et al., 1970; Perrine, Waller, and Harris, 1971). There are no data from controlled studies to provide a quantitative estimate of the alcohol-crash risk of persons arrested for DWI.

Figure 3-21 Alcohol Test Results of Drivers in Fatal Accidents with Known Results and One or More Previous DWI Convictions*



*FARS 1980 Annual Report (*NCSA, 1980*)

Figure 3-22 License Status and Alcohol Involvement of Drivers in Accidents of All Levels of Severity*



*NASS, 1981 Annual Report (NASS, 1981b)

Drinking Variables

Several studies have examined variables that describe an individual's drinking patterns. They have attempted to develop relationships between such variables and the biographical and driving variables discussed in the two preceding sections of this report. Data on drinking patterns have been derived entirely from questionnaires administered in various types of interview situations, e.g., to persons stopped during roadside surveys, to DWIs identified during record searches and later contacted by interviewers, to persons being treated for alcoholism in hospitals, and to survivors of persons killed in crashes. The accuracy of such reports is, therefore, dependent on the ability of an individual to recall information and his willingness to report it accurately if it is recalled.

Because the information sought is frequently sensitive (about problems with alcohol, such as the frequency of driving while intoxicated), respondents may conceal or distort their habits. Thus, to obtain scientifically significant data, studies on drinking patterns relative to drinking-driving must be carefully designed and executed. The skill of the interviewer is often crucial in eliciting valid responses. Most studies have not provided detailed descriptions of their research procedures, so that it is not possible to assess them here. The reader should keep in mind the inherent limitations of research on drinking patterns when reviewing the material presented below.

Drinking Variables: Frequency and Quantity of Drinking

The Grand Rapids study (Borkenstein, et al., 1964) was the first in this country to attempt to collect hard data on drinking habits directly from crash-involved drivers and drivers using the roads at the times and places of the crashes. The data permit one to calculate the crash risk of drivers with various self-reported drinking habits. The results show that at moderate BACs (.05% to .07%), the Grand Rapids drivers who drank more frequently faced a much lower relative crash risk than infrequent drinkers. In other words, moderate amounts of alcohol seemed to be less risky for these apparently more experienced drinkers. Further, the relative crash probability for the least frequent drinkers turns out to be quite high, even at moderate BACs.

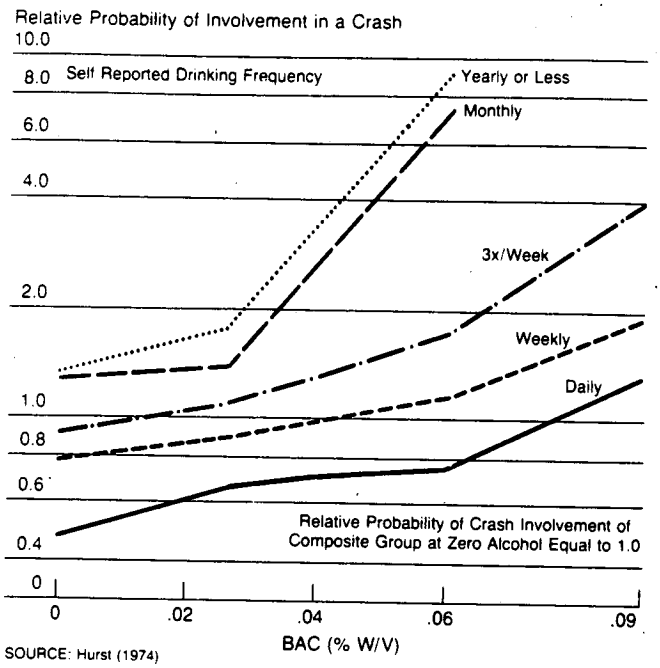
Hurst (1974) has also calculated the relative probability of crash as a function of drinking frequency for the Grand Rapids drivers, but used a different baseline value. He obtained a given group's probability of a crash, given some value of BAC, relative to the probability of a crash for *all* drivers, given a zero BAC. His results (Figure 3-23) show that the more frequent drinker faced a lower relative crash risk at any given BAC than the less frequent drinkers. In fact, the crash risk of the daily drinker at a BAC of about .08% was found to be approximately the same as that of drivers as a whole at zero BAC. Nevertheless, the relative crash risk of all drivers (including frequent drinkers) increased with increasing BACs. Further, the trends were such as to suggest the existence of very high relative risks for even the frequent drinkers at high BACs (greater than .15%).

The Vermont study (Perrine, Waller, and Harris, 1971) investigated the combined effects of frequency of drinking and quantity consumed on drinking driving and found a higher percentage of males among drivers who reported a high Quantity-Frequency Index (QFI). Also, many teenagers were found to have high QFIs, but QFI decreased with a person's age. Fewer married persons had higher QFIs than other persons. Heavy drinkers were more likely than others to engage in drinking-driving at all BACs but had no more prior crashes or license suspensions. DWIs were heavier drinkers than either fatally injured drivers or drivers not involved in crashes. There were indications that crash-involved drivers were slightly heavier drinkers than other drivers and that drivers in alcohol-related crashes were heavier drinkers than drivers in nonalcohol-related crashes.

Drinking Variables: Type of Beverage and Place of Drinking

Studies that have investigated the type of beverage preferred by drinking drivers agree that beer is preferred by about two to one over other beverages by drinking drivers (Borkenstein, et al., 1964; Perrine, Waller, and Harris, 1971; *Wolfe, 1975*). An

Figure 3-23 Relative Probability of Crash Involvement by Self-Reported Drinking Frequency at Given BAC Levels



SOURCE: Hurst (1974)

especially high preference for beer has been expressed by drivers with high BACs and drivers who report that they are heavy drinkers.

The place of drinking most frequently reported by drinking drivers was their own home (two out of three) (Borkenstein, et al., 1964; Perrine, Waller, and Harris, 1971). About 25% said they usually drank at public establishments or at parties. The higher BACs have most frequently been found among drivers who said they drank at public establishments (*Wolfe, 1975*). None of these studies shows that beer drinkers have a higher alcohol-crash risk then other drinkers given an equal BAC, nor do they show any strong, direct relationship between the place of drinking and the risk of crashing.

Drinking Variables: Alcoholics and Problem Drinkers

The terms "alcoholics" and "problem drinkers" have been defined generally in an earlier section of this report. Unfortunately, there is no specific detailed objective definition of either of these terms. Neither can be explicitly equated to a given level of alcohol consumption, though research (*Polich and Orvis, 1979; Clark and Midanik, 1982*) provides a clear indication that the level of consumption is substantially related both to alcohol dependence and adverse social defects. Because of the lack of agreement on the definition of either term—problem drinking or alcoholism—there is no precise estimate of the proportion of the adult population who can be considered to have a drinking problem.

In a 1979 national household survey of drinking practices, Clark and Midanik (*1982*) used three categories of symptoms to define problem drinking. First, *a high level of consumption.* Secondly, self-reports of behaviors and/or characteristics associated with *alcohol dependence* (see Table 3-7), which includes such actions as skipping meals when drinking, sneaking drinks, morning drinking, drinking before a party in order to be sure to get enough, blackouts, gulping drinks, hands shaking after drinking and morning drinking to get rid of a hangover. Particularly related to dependence appears to be such reports as fear that one is an alcoholic, attempting to cut down or quit drinking but failing to do so, finding it difficult when drinking to stop before becoming completely intoxicated.

The third category of response related to problem drinking was *adverse social effects* (see Table 3-7), which included breaking off of a relationship with a spouse, friend or relative due to drinking or pressure from friends to cut down on drinking; problems with the police including DWI and arrests for public drunkenness; automobile and other accidents involving injury and/or property damage; and finally, job problems, including loss or near-loss of a job because of drinking.

Based on this survey, Clark and Midanik found that 15% of adult male drinkers and 3% of adult female drinkers could be classified as heavy alcohol consumers based on a consumption rate of 120 or more drinks per month. They also found 5% of the adult male drinkers and 2% of the adult female drinkers were experiencing symptoms which indicated dependence upon alcohol. Finally, 9% of the males and 5% of the females had experienced adverse social consequences of drinking within the last year.

Based on these results, it would appear reasonable to state that between 5% to 15% of adult males and between 2% to 5% of adult females are at substantial risk for the development of either alcoholism or serious problem drinking. These estimates are in line with previous estimates provided by the National Institute for Alcohol Abuse and Alcoholism (NIAAA). The third special report on Alcohol and Health (*DHEW, 1978*) estimates that 10% of U.S. drinkers can be considered to be problem drinkers.

If as many as 10% of the adult population are problem drinkers, they could account for a large portion of these accidents, since relatively few drivers are involved in serious drinking-driving accidents. However, there is a wide range of views on the role of persons with drinking problems in crashes. This range is illustrated by the different conclusions reached by two long-time researchers in the field of alcohol and highway safety (Waller and Zylman).

In reviewing applicable research prior to 1965, Waller (1968) observed that alcoholic drivers in particular appeared to have nearly twice as many crashes per vehicle-mile traveled as do nonalcoholic drivers. Waller estimated that, in California,

alcoholic drivers could be involved in 41% to 62% of "known drinking accidents" and concluded that "the overwhelming weight of evidence is that alcoholism plays a very substantial role, and probably the major role, in the occurrence of traffic accidents involving the use of alcohol."

Zylman, on the other hand, has stated that the role of alcoholics in crashes has been exaggerated. He cautions against branding all alcoholics as "high-risk drivers" and cites studies which indicate to him that the driving records of alcoholics are not as bad as others have stated. He notes that many studies have suggested that other psychological and social stress factors often interact with alcoholism to create behavior that leads to crashes and that "the misuse of alcohol is only one manifestation of deviant behavior" (*Zylman, 1976*).

Researchers attempting to determine the extent to which problem drinkers are involved in alcohol-related crashes have used two broad approaches. First, they have attempted to determine the proportion of problem drinking drivers among 1) drinking drivers in roadside surveys (the general drinking-driving population); 2) drinking drivers in crashes, and 3) arrested drinking drivers. Secondly, they have studied the drinking histories of identified alcoholics to determine the relative frequency with which they are involved in alcohol-related crashes or arrested for driving under the influence. Examples of such studies are described below:

Roadside Survey Drivers

The Grand Rapids study surveyed its control group of drivers to determine if and how BAC was related to symptoms of problem drinking. It found that persons who reported they "got high" on a weekly basis comprised 29% of drivers with BACs of .08% or greater, but were only 6% of drivers with zero BACs. Also, 21% of drivers with BACs of .08% or greater said they and drinking "problems," compared to 6% of drivers with zero BAC. Similar relationships were found between reports of hangovers and blackouts and BAC (*Borkenstein, et al., 1974*).

Drinking Drivers in Crashes

To provide clues or "indicators" about the involvement of alcoholics and problem drinkers in alcohol-related crashes, the research of Waller, Zylman, and others have had to rely on data from many, not necessarily reliable, sources such as hospital records, driver records, accident reports prepared by police officers, and interviews with surviving relatives of fatally injured drivers. One such indicator, fatty degeneration of the liver, has been associated with excessive drinking over extended periods of time. Studies in California (Waller, et al., 1970), Michigan (Filkins, et al., 1970), and Vermont (Perrine, Waller, and Harris, 1971) have found that fatally injured drivers with high BACs were much more likely to have fatty livers than fatally injured drivers who had not been drinking. The Vermont study found that the distribution of fatty liver changes among highway fatalities with zero BAC was more similar to that found among persons in the general population than to the distribution found in highway fatalities who had been drinking.

A recent study of fatally injured Boston drivers said to be most responsible for their crashes found that 67% of the drivers in the alcohol-related crashes had a history of problem drinking (*Sterling-Smith, 1976*). Only 25% of the drivers in the crashes not related to alcohol had a history of problem drinking. Of the drivers with BACs of .20% or greater, 72% were said to have had known problems with alcohol. The validity of these findings is not known because of the manner in which a history of problem drinking was determined though interviews with relatives of deceased drivers.

Arrested Drinking Drivers

Within the field of highway safety, the most widely used techniques for screening drivers for alcohol-related problems is the Mortimer-Filkins test. The questionnaire, interview, and scoring procedure which make up this technique and variations of them have been used extensively in the Alcohol Safety Action Projects (ASAPs) funded during the early 1970s by the National Highway Traffic Safety Administration. The arrested driver is questioned about his health; arrest and driving history; marital, family, and work history; and drinking history (Kerlan, et al., 1971). On the basis of a summary score he is categorized as a social drinker, presumptive problem drinker, or problem drinker. In three ASAPs in which full use was made of the Mortimer-Filkins test, it was found that about 55% of the drivers who had been apprehended for driving while impaired (DWI) could be classified as problem drinkers (Filkins, et al., 1973). It should be noted that the characteristics of arrested drivers may not be representative of accident-involved drivers (Zylman, 1974).

Driving Records of Alcoholics

The University of Michigan's Highway Safety Research Institute (HSRI) analyzed the medical records, group therapy records, driving records, criminal records, and death certificates of 1,517 hospital patients diagnosed by physicians as alcoholics (Filkins, et al., 1970). The study found that the crash rate (not necessarily alcohol-related crashes) for the alcoholic drivers was about twice as high as the crash rate for the same age group (27 to 75 years) for Michigan drivers as a whole. Convictions for driving while intoxicated were also relatively high for the alcoholics, and the crash rate of alcoholic males was about 50% higher than the crash rate of alcoholic females. In comparing the alcoholic driver with other groups of drivers, the HSRI study found that the mean number of crashes for alcoholics was similar to that for fatally injured drivers with high BACs, but higher than the mean number of crashes for drivers as a whole and for fatalities with low BACs.

Recently Vingilis (*1983*) has made an extensive review of the literature directed at answering the question "Drinking drivers and alcoholics: are they from the same population?" She concludes that they are not. She notes, however, that while the majority of drinking drivers are not alcoholics, that within the general drinking-driving population there are high-risk groups such as arrested DWIs, 30% to 50% of whom might fit a general non-specific definition of alcoholism. She states that "the fact that high-risk drinking drivers are generally younger, more socially integrated, and stable than alcoholics, and yet clearly have drinking patterns and problems nearly as deviant as alcoholics, indicates a possible predilection towards alcoholism."

In summary, studies indicate that persons with severe drinking problems are disproportionately involved in all kinds of crashes, including alcohol-related crashes. They also show that drivers in crashes who have been drinking and drivers arrested for DWI are more likely than non-drinking drivers to have drinking patterns similar to alcoholics and problem drinkers. The definition of problem drinking is too vague, and the data on drinking problems of crash-involved drivers too limited, to permit a definitive statement about the role of problem drinking in highway accidents.

Variables Describing Personality and Exposure to Stress

Studies of personality and stress variables that may be related to drinking-driving have not been conclusive and offer little basis for generalization. There is some evidence that alienated and hostile young men are more likely than others to drink frequently and heavily and to be involved in crashes and traffic law violations (Pelz and Schuman, 1974). Such persons who are also low in personal efficacy may run an even greater risk of being in a traffic incident. Further, research suggests that drivers who are inordinately tense, depressed, fatigued, and given to risk-taking may be especially likely to cause serious alcohol-related crashes (*Sterling-Smith, 1976*). Shinar, et al. (*1978*) found, as might be expected, that emotionally upset drivers were more likely to be involved in accidents due to inattention.

Studies of drivers convicted of driving while intoxicated found them to be more aggressive, more depressed, less self-esteeming, less responsible, and less in control of themselves than drivers in general (Selzer, Vinokur, and Wilson, 1977; Selzer and Barton, 1977; Selzer, et al., 1977). Some personality characteristics commonly thought to be much associated with highway crashes in general (belligerence, negativism, etc.) have not been found to occur more frequently in alcohol-related crashes (Fisher, 1967; Schmidt, 1972).

Summary and Conclusions

A major tool for studying the role of alcohol in highway crashes is the epidemiologic study of the incidence of drinking among various populations of drivers, particularly drivers who have crashed and drivers who have been exposed to highway environments similar to those of the crashes without crashing. Epidemiologic studies have been conducted, for many years in many different locations. Their objectives, designs, and executions have varied widely for no national program has existed for methodically investigating the many variables that describe the complex driver-vehicle-environment interactions incident to highway crashes. For the most part, it appears that research has proceeded in the directions of greatest interest to individual investigators rather than along lines that would support the objectives of coordinated programs of risk reduction. Conversely, coordinated risk reduction programs based on a preliminary understanding of the problem have been largely unable to generate sufficiently rigorous data for wider application.

As a result, the first step commonly taken in such programs—problem identification—must be performed by piecing together bits of information gleaned from many exploratory studies never intended for global application. Such an approach is scientifically hazardous but necessary if further progress is to be made.

In many respects the picture that emerges is remarkably consistent. Some 40% to 55% of all driver fatalities in the studies had blood alcohol concentrations high enough for the driver to be considered legally too intoxicated to drive in most States (i.e., BAC at .10% or above). An even higher percentage (55% to 65%) of the drivers who were killed in single-vehicle crashes had BACs of at least .10%. Nine to 18% of all drivers in personal-injury crashes and 5% of drivers in property-damage crashes were legally intoxicated.

The national impact of these figures is enormous. If one assumes that the national percentages of accidents involving road users who had BACs of .10% based on data from the Fatal Accident Reporting System and from the National Accident Sampling System, then intoxicated drivers or pedestrians were involved in the following numbers of crashes in 1980:

- Fatal crashes: 28,000 (47% to 50% of all fatal crashes)
- Personal injury crashes: 520,000 (18% of all personal injury crashes)
- Property damage crashes: 750,000 (5% of all property damage crashes)

The societal costs of these crashes is estimated to be on the order of $10 billion. The losses would be even higher if one counted the hundreds of thousands of crashes that involved lower but possible impairing BACs. Of course, not all of these crashes can be said to have been caused by alcohol, but these figures do provide a rough idea of the upper limit to the alcohol-crash problem in the United States.

The epidemiologic studies do indicate that the risk or relative probability of being in a crash increases as the concentration of alcohol in the blood

increases. The relative probability of a crash starts to rise sharply as a BAC of .08% is approached. At a BAC of .15%, the relative probability of a fatal crash could be as high as 15 to 20. The probability of being in less serious crashes also increases after drinking, but not to as great an extent.

Experimental studies of the effect of alcohol on human behavior lend support to these epidemiologic findings about crash risk. More important, the experiments provide evidence that many of the crashes that involve alcohol occur because the drivers are impaired by alcohol. The experiments do not, however, provide any basis for determining how many crashes may be attributed to alcohol impairment. The usefulness of experimental data in defining and dealing with the alcohol-crash problem is, in fact, severely limited by the lack of explicit relationships between the behavior studied and critical driving tasks.

A number of variables describing drinking drivers and drinking driving have been studied in the literature. Variables which appear to be related to alcohol-crash involvement are summarized in Table 3-11. These variables are related to the incidence of drivers in crashes with the specified characteristic. In many cases, they are primarily related to differences in *exposure* rather than to differences in crash risk given equal mileage driven.

Of the variables that have been studied in the literature, sex is one of the best differentiators of drinking drivers. Males occur far more frequently than females in the exposed population and in alcohol-related crashes. The preponderance of males among drinking drivers is thought to be a consequence of social customs which call for males to do most of the driving, particularly at night when most drinking-driving occurs. One study found that at high BACs, females, in fact, faced a four-to-five times greater crash risk than males.

With respect to age, both the youngest and oldest persons have been found less frequently than others among heavy drinking drivers. The youngest drivers, however, appear to have a much greater alcohol-crash risk after drinking (particularly at low BACs) than persons of other age groups. Inexperience with both drinking and driving has been suggested as a reason for the higher relative involvement of young drivers in alcohol-related crashes. In one study, older drivers had higher crash risks at higher BACs than other drivers.

In the category of variables specific to driving history, research suggests that drinking drivers have had substantially more enforcement actions against them than other drivers. Drinking drivers have been found to have on the order of 50% more prior contacts with traffic law enforcement agencies than other drivers.

Table 3-11.—Correlates of Alcohol Crash Involvement

Driver characteristics	Low involvement	Higher involvement
Sex	Females*	Males.
Age	Teenagers 20*	20 to 40.
Prior arrests	None	One or more.
Drinking	Low quality and frequency*.	High quantity and frequency.
Drinking history	Social drinkers.	Problem drinker/ Alcoholic.
Type of beverage		Beer.
Marital status	Married	Widowed, divorced, separated.
Occupational level.	High	Low.
Race	White	Non-white.
Income	High	Low.
Education	More	Less.
Miles driven	High annual mileage.	Low annual mileage.
Trip origin		Bar, tavern.
Place of drinking	Home	Public bar, tavern.
Number of previous crashes	None	One or more.
License status	Valid	Suspended/ Revoked.
Crash Characteristics.		
Type of accident	Multiple	Single.
Time of accident	Day	Night.
Day of week	Weekday	Weekend.

*While individuals with these characteristics are less frequently involved in alcohol-related accidents, at any given BAC level, they will have a higher risk per mile of driving because alcohol has a greater effect on light or inexperienced drinkers.

Among the category of variables related to the characteristics of the crash itself, time of day has shown some of the strongest relationships to drinking-driving patterns. As might be expected, drinking-driving is primarily a nighttime phenomenon. Drinking drivers are found two to four times as often in nighttime crashes as in daytime crashes. The same trend occurs among the nighttime driving population as a whole, particularly at the higher BACs. On the other hand, there is some evidence that the relative risk of a run-of-the mill crash after drinking is less during the nighttime

than during the daytime. With respect to day of the week, alcohol-related crashers and drinking drivers are also more frequent on weekends that on weekdays, although the effect is not nearly as great as it is for time of day.

The relationships that have been studied with respect to quantity and frequency of drinking indicate that, as might be expected, crashed drivers are generally more likely to have a higher BAC than noncrashed drivers and relative crash risk tends to decreased with increased drinking frequency, indicating that the more experienced drinkers are somehow better able to cope with the effects of alcohol in driving. Nevertheless, even more frequent drinkers have a higher crash risk at any positive BACs than they do at a zero BAC. Studies also show that beer is the beverage most preferred by drinking drivers, expecially those with high BACs and those who report that they are heavy drinkers.

Much attention has been given in the literature to the drinking-driving habits of alcoholics and problem drinkers, although many studies do not provide precise definitions of the latter term. Studies do provide evidence that persons with severe drinking problems are overrepresented among fatally injured drivers who have high BACs; that is, greater than .10%. More than half of all DWIs tested in three Alcohol Safety Action Projects were found to be problem drinkers. Other research indicates that alcoholics in particular have much higher crash rates than the driving population as a whole, perhaps even twice as high. The literature does not provide a reliable basis for quantitative estimates of the alcoholic-crash risk of alcoholics and problem drinkers, or of the number of alcohol-related crashes that involve alcoholics.

While it is important that operational programs be based on knowledge gained through research, extreme caution must be used when applying research findings on the characteristics of drinking drivers to operational programs. No characteristic discussed above or any combination of such characteristics can identify any given individual as a sure-fire perpetrator of future alcohol-related crashes. In no instance can it be said that all persons possessing certain characteristics are high-risk drivers (e.g., alcoholics, young males). The data can help to determine the gross alcohol-crash risk of entire groups of drivers, but are far more difficult to apply to individual drivers.

Chapter 4

Dealing With the Alcohol-Crash Problem

From the survey of the literature conducted for this report and summarized on the preceding pages, it is clear that excessive drinking plays a major role in a larger number of crashes. Moreover, the literature has provided clues for identifying the characteristics of groups of drivers who are involved in such crashes. The objective of this section is to summarize and review critically what has been done in the past to remedy the alcohol-crash problem.

Figure 4-1 Opportunities for Reducing Alcohol-Related Crash Losses

	Crash Avoidance	In-Crash Injury Reduction	Post-Crash Injury and Cost Amelioration
Driver Factors			
Vehicle Factors			
Environment (Roadway) Factors			

In order to develop a remedy, it is necessary to have a concept of the causes of the problem so that the actions taken can be related to the factors which are believed to underlie or produce the accidents which are to be forestalled. In Chapter 3, the research on the relationship of alcohol to crash involvement was reviewed. It was noted that one of the problems with the laboratory, simulator and driving range studies is that they have not provided a good basis for determining the exact relationships between alcohol consumption and accident involvement. Nevertheless, these experiments have given some hints to the mechanisms which underlie alcohol-related crashes. Before beginning a review of past efforts to reduce drinking-driving crashes, it is important to briefly review current theories regarding the mechanisms that underlie crash involvement.

Approaches to Reducing the Losses Due to Alcohol-Related Crashes

The various approaches to reducing highway accidents can be classified in accordance with the matrix in Fig. 4-1 *(Haddon, 1970)*. This diagram highlights the fact that accidents can be reduced by working on one of three elements of the highway system: the driver, the vehicle, or the environment. Thus, the probability that an accident will occur can be reduced through improving the skill of drivers or through better engineered, safer vehicles (improved brakes, better taillight systems, etc.) or by building safer roadways (wider shoulders, fewer curves, better lighting, etc.). The diagram also points to the fact that the remedies can be directed not only at total crash avoidance, but at reducing the consequences of an accident through the use of safety belts or by using breakaway signposts which reduce the damage to a vehicle that runs off the road. Finally, better emergency medical service, and rehabilitation programs reduce the consequences of injuries produced by crashes.*

Most alcohol safety programs have centered on the driver, because it is the alcohol in the driver's system that produces the impaired driver performance that results in crashes. It is important to note, however, that vehicle or roadway design improvements which make driving safer are likely to reduce alcohol-related accidents. Moreover, such improvements help *all* drivers and reduce accidents of *all* types. In this chapter, we will not

*Several terms have been used to describe these three segments of the problem. Accident researchers normally speak of "pre-crash, crash, and post-crash" phases. Public health specialists generally use the terms "primary, secondary, and tertiery prevention."

attempt to review all safety programs or all the vehicle and/or roadway design improvements which can result in reducing accidents. Only the vehicle and roadway design changes which are believed to have specific relevance for the drunk driver will be covered.

Interest in the alcohol safety problem has focused on the human element. Not only because alcohol obviously affects only the human component of the highway system, but also because driver error has been implicated in between 80% to 90% of accident investigation studies (Treat, et al., 1977). The general theories of how driver error contributes to the production of crashes can be classified under two major headings: those that center on the lack of knowledge or skill on the part of the driver and those that emphasize the willingness of drivers to accept risks, despite their knowledge of the best or safest practice. A brief review of these theories is useful, specifically with regard to the elements of the theories which provide a basis for explaining the effects of alcohol on crash involvement. This understanding is a basis for considering potential remedies to the drinking-driving problem.

Skill Theories

Driving is obviously a task which requires a certain amount of skill and knowledge to perform safely. This has been recognized by the emphasis placed upon driver education for novice drivers in public high schools and through private driving schools and by the requirements established by the States for skill tests prior to licensing drivers. The importance, not only of initial skill but of experience, appears to be supported by the higher accident rates of novice drivers. The role of skill appears to be most dramaticaly illustrated in the accident experience of novice motorcyclists where the greatest accident risk occurs in the first 6 months of riding. Because, particularly in the United States, nearly all drivers receive their licenses as teenagers, it has generally been difficult to separate the role of experience from other attitudinal factors which are correlated with youth.

Contrasting evidence for the significance of skill comes from the higher accident rates of the elderly, which seem to be related to deterioration of physical skills (vision and reaction time). The significance of this problem, however, is reduced by the greater experience of the elderly, together with the lower exposure rate. The large mid-age range group of drivers from 25 to 65 have the lowest accident rate per mile. This group enjoys both the benefits of initial driver training and the knowledge that comes from considerable experience with driving, as well as good physical health, which underlies adequate skill in the driving task.

The method by which alcohol interacts with driving knowledge and skill to produce accidents is not entirely clear. One potential basis for explaining the effect of alcohol is the so-called spare capacity model (*Welford, 1968;* Brown, 1962b), which suggests that the capacity to handle and operate a vehicle is usually greater than that normally required by the driving task, as the driver has a certain amount of "spare capacity" which he can draw on for emergency situations. This spare capacity, however, can be reduced by such things as fatigue, intoxication, lack of skill, inexperience, and unfamiliarity with the driving route (*Wilde, et al., 1971*).

Moskowitz (1975) and others have demonstrated the information processing level of the driver is reduced when divided attention is required under alcohol. Thus, drinking may reduce the "spare capacity" which the driver normally enjoys, producing an information overload which results in an accident.

Risk-Taking Theories

A second major category of theories regarding accident causation revolve around the problem presented by accidents and injuries caused by such factors as excessive speed, running red lights, and failure to use safety belts. In most of these situations, it appears that the driver knows the right action to take, but fails to take it. These accidents, therefore, do not appear to result from a lack of knowledge or skill, but rather from "intentional" risk taking. NHTSA has labeled such driver actions as "unsafe driving acts" and has sponsored several studies to define these actions and to determine their frequency in accidents as compared to their frequency among non-crash-involved drivers (*Lohman, et al., 1976; Marks, et al., 1982*).

The theories developed to account for this type of action can be traced to Mendelsohn (*1964*), who hypothesized that road users who operate vehicles or walk on roadways operate in the context of two interdependent probability systems: the objective risk of being involved in an accident and their subjective estimate of the accident probability. Mendelsohn suggested that, where the subjective estimate of risk corresponds closely to the actual objective risk, accidents would be least frequent. On the other hand, where there was a discrepancy between the vehicle operator's subjective estimate of risk and the real risk, with the latter being greater, there would be a higher number of accidents.

A related theory proposed by Taylor (*1964*) suggested that the subjective risk perceived by the driver multiplied by the speed of the vehicle would be a constant over time, so that when the perceived risk increased, the speed would be reduced and vice versa. Taylor attempted to measure the perceived risk through the galvanic skin response (palmar sweating), while drivers were operating a vehicle on the roadway encountering various driving situations. He found that the measured skin response remained essentially even throughout the driving and suggested this was due to adjustments in speed by the driver as he encountered situations perceived to be more or less dangerous.

This type of research has led to the proposal of a risk compensation theory (*Peltzman, 1975; Wilde,*

1976; and *Adams, 1983*). This theory holds basically that drivers operate at a fixed level of subjective risk-taking. Any factor in the environment which increases the subjective perception of risk would result in safer and more careful driving. On the other hand, any factor which resulted in a perception that the driving task was safer would result in increases in speed and other risk-taking, since the vehicle operator would adjust his driving to a perceived level of risk.

This theory, if correct, has very important consequences for safety programs, since it suggests that safety improvements in vehicles and roadways which result in a reduction in the perceived risk of driving would be compensated for by increased risk-taking by the driver. Thus, as roadways are improved, the average speed at which drivers operate their vehicles increases. The most dramatic example of this claim is that of Adams (*1983*) in which he suggests that the actual benefits from motorcycle helmet wearing laws will be less than expected because motorcyclists will take greater risks in their riding, since they will feel that the helmet makes an injury less likely.

Peltzman (*1975*) argues that at present, the level of risk perceived by road users is tolerable and that this explains the lack of recent progress in reducing overall traffic hazards. Joksch (*1976*) has challenged Peltzman's theory and critiqued his statistical procedures. Nevertheless, Joscelyn and Jones (*1978*) argue that traffic safety is basically a "risk-management" process and that public perceptions of risk are important in achieving risk reduction.

Alcohol can be hypothesized to relate to these theories regarding risk acceptance in three ways: first, intoxication has been alleged to affect judgment and might thereby result in greater risk taking; second, alcohol is known to reduce attention to peripheral events and may be hypothesized as a result to reduce perception of threats, which in turn might reduce perceived risk; third, it has been suggested that heavy drinkers/alcoholics may take more risks even when sober, so that the overinvolvement of drinking drivers might be explained as an indirect correlation between certain character traits, risk taking, and alcohol consumption.

Several research workers have attempted to determine the effect of drinking on risk taking. Wade and his coworkers (*1980*), studied the effect of alcohol on increased risk taking on a driving range. They concluded from their study that risk taking was increased but that it was caused by degraded perceptual and psychomotor capabilities, not by greater risk acceptance. Browning and Wilde (*1979*), using verbal ratings of risk by drinking and nondrinking passengers being driven on the highway, found no effect due to alcohol.

These general theoretical approaches to the causes of accidents provide insights into the methods which might be used to reduce the drinking-driving accident problem. In the past, there has been a tendency to develop and implement safety programs with little thought given to analyzing the underlying factors which produce crashes. Without a concept of what causes crashes and what specific road user populations are most involved in alcohol-related crashes, it is likely that a safey program, however well intentioned, will miss the mark and fail to produce the expected reductions in accidents. Moreover, a careful analysis of the factors which result in accidents is necessary in order to perform an effective evaluation of safety programs. Hence, the items to be measured are determined by the highway safety model, which is believed to underlie crash causation.

Based upon these concepts, this chapter examines generic approaches to drunk driving programs with respect to their targets, their methods, and, most importantly, their results.

Targets

This discussion of the targets of programs to reduce the losses from alcohol-related crashes is concerned with the extent to which the programs have identified precisely what they have attempted to control. At the most general level, their targets are the losses from alcohol-related crashes, but more specific definitions (both expicit and implicit) are sought in reviewing these programs. Thus, an attempt is made here to determine what kinds of "losses" were to be reduced by the programs and whether such losses were to be reduced by decreasing the number of alcohol-related crashes or by decreasing the number of fatalities and injuries resulting from the crashes once they occurred. The review also attempts to determine whether the control measures used in such programs were directed primarily at the driver (e.g., convincing him not to drive after drinking), at the vehicle (e.g., designing devices to warn other drivers about the presence of a drunk driver), or at the highway environment (e.g., designing signs more likely to be comprehended by intoxicated drivers). Finally, the review attempts to identify any specific groups of drivers that were addressed by the programs, such as social drinkers, young drivers, nighttime drivers, etc.

Controlling Exposure

With respect to the identification of specific groups of road users who are overrepresented in alcohol-related crashes, it is important to keep in mind that there are two basic approaches to reducing the incidence of crashes. First, the exposure of these high-risk groups can be reduced by changing driver licensing regulations and/or liquor sales laws so that certain individuals (young novice drivers, for example) are either issued driving permits which do not allow them to drive at night, or are prohibited from purchasing liquor. Similarly, the licenses of alcoholics could be suspended or limited to certain types of driving. Such limitations are permitted in the driver licensing regulations of some States for all individuals who have a medical

or physical problem which increases their crash risk.

The second major approach to dealing with high-risk groups is to attempt to decrease their relative crash risk—that is, the number of accidents per mile driven. One method is to increase the knowledge and skill of such individuals, if this is presumed to be the basis for their greater crash involvement. If risk taking is seen to be the primary problem, then a program must be implemented to motivate them (through the threat of arrest and prosecution, for example) to refrain from the hazardous behavior (speeding, drinking, etc.)

In some cases, there can be a conflict between the two approaches. As in the case of driver education for novice drivers, Robertson and Zador (*1977*) have suggested that the primary impact of driver education is to make it possible for young people to obtain their driving licenses earlier and, therefore, that it increases their exposure to accidents. Since they claim that driver education has little benefit in reducing the risk per mile driven, they find that driver education increases, rather than decreases, accident involvement by increasing exposure while failing to improve safety.

Data presented in the last chapter demonstrated that young drivers are more exposed to nighttime alcohol-involved accidents because of their life style, which result in their being on the road late at night on weekends. Barring young drivers from driving at night or from the purchase of alcohol is believed to reduce their exposure to accidents. But it does so at the cost of limiting their freedom. A considerable controversy regarding the legitimacy of safety measures which principally restrict exposure rather than increasing safety per unit of exposure has resulted from arguments between the proponents and the critics of programs which attempt to increase highway safety, principally through controlling exposure. In the course of discussing alcohol safety programs which have been implemented in an effort to reduce drinking and driving, it is important to clearly distinguish between those countermeasures which are principally directed at reducing exposure as compared to those which are intended to improve safety without limiting road use of alcohol consumption.

Methods

The discussion of methods is limited to those used by alcohol-safety programs that have specifically addressed drinking drivers only, rather than programs aimed at drinkers or drivers in general, such as prohibition, State and local measures to restrict alcohol use among drinkers generally, and programs to treat alcoholism or to educate general public on the symptoms of alcoholism. Programs aimed specifically at drinking drivers include minimum drinking-age laws, restricted licenses for novice drivers, campaigns to enforce laws against driving-under-the-influence, and public information campaigns on the greater crash risk faced by drinking drivers. For purposes of discussion and analysis, such programs are grouped according to their general approach:

- Vehicle/roadway engineering programs
- Exposure reduction programs
- Criminal justice programs
- Health care programs
- Public information and education programs
- Systems programs

Vehicle/Roadway Engineering

Vehicle and roadway engineering approaches to the controlling of alcohol-related crashes include those design changes which are believed to be specifically beneficial to drinking drivers. One example of such a change is the installation of passive restraints which benefits all vehicle occupants, but are believed to be particularly beneficial to drinking drivers, since there is considerable evidence that drinking drivers and possibly their passengers use safety belts less frequently than do sober drivers. This chapter will cover only those specific design recommendations which are believed to have special benefits to drinking drivers, and will not cover the large numbers of safety engineering programs which can reduce crashes for all classes of road users.

Exposure Reduction

Exposure reduction refers to programs which are directed specifically at reducing the exposure of certain high-risk drinking-driving groups. Three types of programs which have been implemented are laws to limit alcohol sales to individuals under the age of 21; restricted licensing programs for novice drivers, which bar driving at night until the individual has accumulated a certain period of accident-free driving experience; and medical requrements, which bar the issuance of licenses to alcoholics and problem drinkers.

Criminal Justice

The legal approaches to controlling alcohol-related crash losses are based on a set of official rules—laws—which prohibit drinking-driving behavior believed to present an unacceptably high risk to society. Failure by a driver to comply with such rules, should he be caught, results in such punishments as a fine or jail sentence, the threat of which is believed to act as a deterrent to the prohibited behavior. The deterrence is accomplished, according to the theory either through the effect of the punishment in preventing the punished parties from repeating the act (called "special deterrence" in the literature) or by preventing most or all members of the population at large from driving after drinking through the fear of being caught and punished, called "general deterrence" (*Zimring and Hawkins, 1973*).

Health Care

Programs approaching the problem as a matter of the health care system are aimed at the underlying drinking problems that often exist among individuals who drive with high BACs (Filkins, et

al., 1970; Waller, 1968). Various treatments and therapies are applied to such individuals in an effort to induce more moderate drinking habits or to eliminate drinking entirely (e.g., Alcoholics Anonymous). Rehabilitation programs, such as classes for those convicted of driving while intoxicated, for all types of drinking drivers are also included in this category.

Public Information and Education

Public information and education attempts to reduce the incidence of drinking-driving by campaigns informing and educating various population groups about the nature of the problem. Such programs address drinking-drivers directly by attempting to get them to refrain from the practice in the future or indirectly by attempting to enlist the support of other persons in actions against drinking-driving. A TV commercial designed to motivate persons to drive an intoxicated individual home from a party is an example of the indirect approach.

Systems

Most past and proposed programs for dealing with the drinking driver employ two or more of these four approaches simultaneously. There are few examples of programs using one approach exclusively. Programs which methodically employ several approaches have been called "systems" approaches in the literature (Voas, 1975b). Only one example of a full-scale systems approach has been documented (the National Highway Traffic Safety Administration's Alcohol Safety Action Project).

Evaluations

The present report's discussion of the specific programs representative of each of these approaches is concerned with how well they have worked in accomplishing their stated or implied objectives relative to reducing crash losses. Such a judgment is essential to the design of better control programs in the future. Unfortunately, program evaluation has been one of the weak links of traffic safety research. New highway safety programs are rarely designed or implemented as experiments. Rather, they result from a political and social process which frequently make them difficult, if not almost impossible, to evaluate. The scientist rarely has the privilege found in the laboratory of setting up a truly experimental design where two randomly assigned sets of road users can be exposed to a traffic condition which varies only in the specific program element of interest.

Lacking this type of experimental control, most program evaluations have made use of "quasi-experimental designs" (Campbell and Stanley, 1966). Where appropriate comparison groups are available and where adequate statistical procedures are utilized, these quasi-experimental procedures can provides credible evidence of effect. Unfortunately, much of the time these critical elements are not available. Moreover, there is often considerable pressure upon program managers to demonstrate effectiveness. Therefore, many preliminary, or inadequately evaluated, studies which produce positive results get into the literature, whereas more adequately evaluated studies which show no effect or negative effects are likely to go unpublished.

Despite this probable bias in the evaluation literature, it is useful to consider the results of Nagy (*1982*) who conducted a "meta-analysis" of 37 primary prevention studies involving 94 difference measures of impact in the public health field. Most of the studies that Nagy used in his analysis were from the general field of public health, which included programs designed to reduce the use of drugs, anti-smoking programs and programs directed at ameliorating such problems as heart disease and hypertension. Only three of the projects he reviewed had to do with traffic safety, and only one of these was related to alcohol safety. Nevertheless, his findings are instructive in considering evaluation of the six approaches to reducing drunk driving accidents just described.

From the reports he reviewed, Nagy summarized the benefits reported on the basis of the percent of the control group who were surpassed by the average person who received the intervention. His results are shown in Table 4-1. Technological intervention, such child-resistant medicine containers and drug therapies for persons with early stages of hypertension and/or combinations of approaches involving these two elements, appear to have the highest average benefit. Less effective were programs relying on education, treatment or legal sanctions and public information.

Table 4-1.—Amount of Benefit From a Public Health Program by Type of Intervention

By intervention type	Percent of controls surpassed by average person	Number of effect sizes
1. Technology	99	9
2. Drugs	82	10
3. Combination	79	28
4. Education	66	21
5. Other (psychotherapy/legal)	59	13
6. Information/media	58	13
Total		94

Source: Nagy *1982*.

It is results of this type which have led many safety specialists to emphasize the use of technology as embodied in improved vehicle and roadway design as the most effective approach to reducing accident involvement. On the other hand, there is

an indication from this analysis based on the public health literature that programs which combine several approaches can be effective. It is important not to overemphasize these results, since it is probable, as noted earlier, that they represent a selected set of evaluation data, since negative results are less likely to appear in the literature.

Accepted at face value, these results indicate the difficulty which has been encountered in the past in demonstrating the benefits of education, treatment, and legal programs. Since the vast majority of driver centered programs—particularly those related to the drunk-driving problem—make use of these procedures, it is clear that there is only borderline evidence from the experience in public health for the effectiveness of these techniques. Therefore, the traffic safety specialist should be on his guard regarding claims for effectiveness and should insist upon the presentation of good evidence for effectiveness before accepting the validity of claims for the success of such programs. As each of the six approaches described above is reviewed in this chapter, an attempt will be made to summarize what is known regarding the evaluation of the countermeasure programs.

Vehicle/Roadway Engineering Programs

Interest in alcohol countermeasures has centered on the driver and his behavior. This is based, of course, in part on the finding that driver error is involved in approximately 90% of all accidents and that vehicle and environmental factors play a much smaller role (*Treat, et al., 1977*). A number of investigators have argued that insufficient attention is being given to vehicle and roadway design countermeasures which could significantly reduce the drinking-driving problem. Robertson (*1977*), for example, argues that community programs to control the drinking driver have failed and are inherently defective in that they require the sort of conforming behavior that is difficult, if not impossible, to obtain through public information and enforcement programs. He argues that instead, public health principles should be applied to motor vehicle crashes, such as reducing the possibility of injury through energy-absorbing steering columns, passive restraints, and speed-limiting governors on vehicles.

Haddon (*1980*), Baker and Haddon, (*1978*), and others have also suggested improved safety engineering of the vehicle and/or the highway as an effective approach to reducing drinking-driving accidents. However, it should be noted that Borkenstein (1975) suggests that "the drinking driver seems to remain as a stubborn residue even when the traffic fatality rate of a nation is very low." He presents evidence to suggest that alcohol increases as a proportion of all fatal accidents as the total number of such accidents decline. That is, as other highway safety problems are improved, but little progress is made with the drinking driver, the drinking driver becomes a larger proportion of the total problem.

Task Simplification

Wade and his coworkers (*1978*) note that alcohol effects seem to increase with the complexity of the driving situation and suggest that the design of both vehicles and the roadway environment should be directed toward reducing driver workload. Because alcohol degrades skills, it is probable that anything that simplifies the driving task would have a tendency to reduce drinking-driving accidents along with the accidents of those who have not been drinking. The "spare capacity" model of accident causation, discussed in the previous section, would suggest that simplifying the task (which would reduce the possibility of information overload) would be especially beneficial to the driver whose "spare capacity" was reduced by alcohol.

Arguments such as those of Allen and his coworkers (*1978*) and Johnson (*1981*) that drinking-driving countermeasures should be directed towards reducing the driver workload are contradicted, at least in part, by the research of Perchonok (*1979*), who studied 7,421 police reports of traffic accidents in New York State, with particular attention to those involving drinking drivers. He found that drinking drivers had a propensity to have accidents in low-demand rather than in high-demand situations. For example, rather than having most of their accidents at intersections where other vehicles were present and the driver was required to observe their behavior as well as control his own vehicle, most of the accidents were of the run-off-the-road type, where only the driver's vehicle was involved and there was no special or unusual hazard in the roadway. If, in fact, drinking-driving accidents occur in low-demand situations, then reducing the driving complexity may not be differentially effective in reducing drinking-driving accidents.

The "risk-compensation" hypothesis also raises an issue with regard to the utility of simplifying roadway and/or vehicles as a method of reducing drinking-driving accidents. Wilde (*1976*) argues that drivers establish a basic risk acceptance level with which they are comfortable. If vehicles are made safer in a way that is clear or obvious to the driver, then Wilde suggests that the driver may adjust his risk-taking level upwards. If this occurs, it would be expected to increase accidents, at least partially offsetting any gains from the new safety measure. In this case, some of the advantage of a safety design is lost due to increased risk taking by the driver.

One example of a safety measure which resulted in increased "risk taking" is provided by a study which showed that the speed of driving on icy roads was increased when studded tires were installed on cars (*Berggrund and Ytterbom, 1976*). Adams (*1983*) claims that the "failure" of

motorcycle helmet laws to reduce rider deaths also illustrates this principle.

If roadways and vehicles were improved so as to simplify the task of the driver, undoubtedly there would be an overall reduction in total highway accidents. The specific question of interest to this review is whether there are roadway and/or vehicle engineering changes which would be of special value to the drinking driver. One example of such a countermeasure is a passive restraint system. There is evidence that the drinking driver is less likely to use the safety belt. Dalgaard (*1977*), reporting on the implementation in Denmark of a mandatory safety belt usage law, noted that, while usage rates increased from 25% to 82% among the general population, the usage rate for drinking drivers and for passengers under the influence of alcohol was considerably lower. Fell (*1982*) also reported that fewer drivers in fatal crashes with an illegal BAC were using safety belts than were those who were sober. Farris, et al. (*1977*), found the same to be true among drinking drivers in injury accidents. For this reason, it appears that the use of passive restraints might be differentially effective with drinking drivers.

Other vehicle design features recommended for reducing alcohol-related crashes are separate turn and brake indicators which were studied by Attwood (*1978*), who found that when brake and turn indicators were combined, performance deterioration began with a BAC of .05%, whereas when they were separated, deterioration began at .08%. Since there is evidence that drinking drivers are more likely to be speeding at the time of their accidents, Roberston (*1978*), among others, has suggested speed-limiting governors on vehicles as an accident countermeasure. Such devices might be particularly effective in reducing alcohol-related accidents.

A number of researchers have suggested roadway engineering improvement which might be of special value in reducing drinking-driving accidents. Wade et al. (*1978*) suggested that highway engineers could compensate for the greater variability in performance of intoxicated drivers in simulator studies by improving intersection design, signal timing, line delineation and signing, and particularly curve advisory speeds. Johnston (*1981*) also emphasized the importance of providing the drinking drivers with better information on curve delineations. An experiment conducted by Shinar, et al. (*1980*) provided evidence that improved roadway delineation reduced the run-off-the-road errors of drinking drivers when compared to sober controls.

Other Technology-Oriented Concepts

Considerable interest has been shown in devices which could be placed on a motor vehicle to prevent operation by an impaired driver or to warn the public and other drivers that a vehicle was being operated by an individual who was impaired. Breath test devices that measure the driver's BAC directly were considered first, but are receiving little attention today because of the ease with which they can be defeated (Voas, 1970). A second class of device would measure a driver's ability to perform tasks related to driving or thought to be critical in avoiding crashes. This class includes devices that would measure reaction time, coordination, steadiness, proficiency at divided attention tasks, and short-term memory. Such devices have been built and tested, but have not been placed in general use (*Moulden and Voas, 1975*). Ranges of cost-benefit ratios for several such devices were estimated by Moore, et al. (*1976*) and presented as a function of such parameters as deterrent effect, usage rate, etc. The legal issues in implementing such devices have been reviewed by Ruschmann, et al. (*1979*).

Any of these methods for assessing impairment could be used in conjunction with other devices which might prevent an impaired driver from starting his car (the Alcohol Safety Interlock System [ASIS]) or warn other drivers of the presence of impaired drivers (the Drunk Driver Warning System [DDWS]). Such devices might incorporate a feature that would require a driver to insert his driver's license or other identification into a reading device as a condition for passing the impairment test (Voas, 1970).

Because the ASIS, which prevents operation of the vehicle, could result in cars being stalled in dangerous situations, current development is focused on the DDWS approach, using a Critical Tracking Test (CTT), which is a 20-second task performed prior to starting the vehicle. It requires the potential driver to keep a needle in the center of a special display by turning the steering wheel. While application of such devices to all vehicles sold in the U.S. has been proposed, current research is limited to court ordered installation on the cars of convicted drinking drivers.

It has also been suggested that driving performance be continuously monitored for clues that would betray alcohol impairment (Voas, 1970; Moore, et al., 1976). When such a continuous monitoring device indicated an unacceptably high impairment on the part of the driver, a warning signal would be given (perhaps a flasing light) or a speed governor would be activated. A similar system has been designed to prevent truck drivers from falling asleep. It measures steering wheel reversals and sounds an alarm when the driver's steering performance falls below some critical level.

Mechanical or electronic devices have been proposed which would restrict someone convicted of driving-while-intoxicated to driving only during certain specified hours. The device might use a light sensor or timing mechanism, either to activate an interlock or to give a warning signal if the vehicle were being driven during restricted (e.g., nighttime) hours. Alternatively, an operating time recorded could be used to indicate if the vehicle

had been driven during restricted hours (*Moore et al., 1976*).

NHTSA has sponsored research to evaluate the public acceptability of these types of devices (*Vayda and Crespi, 1981*), potential legal constraints on their use (*Ruschmann, et al., 1979*) and on the potential cost effectiveness (*Moore, et al., 1976*).

Exposure Reduction Programs

As noted in the introduction to this section, a major reason for the overrepresentation of certain groups in alcohol-related crashes is not that these drivers have a higher rate of crashes per mile driven, but rather that they drive more miles—particularly more miles during the late night hours in which the majority of alcohol-related crashes occur. One method for reducing the numbers of alcohol-related crashes without necessarily making the roads, vehicles, or even drivers safer is to reduce the number of miles driven by those groups who are overrepresented in the population exposed to drinking and driving crashes. There are two approaches to reducing exposure: reducing the access to a vehicle or reducing the access to alcohol of the drivers who are most exposed to alcohol-related crashes.

The United States has a long history of political and social controversy over the extent to which access to alcohol should be controlled by the government. To a lesser extent, there has been some controversy regarding the freedom with which the states should issue drivers' licenses to both young people and to individuals with various types of physical disabilities. The broad social issues involved in these controversies are beyond the scope of this summary of the state of the art in alcohol and highway safety. Only the studies most specifically relevant to the control of drinking and driving are reviewed here.

Drinking Age and Accidents

Toward the end of the 1960s, a number of States began to lower the legal age for purchase of alcohol, in line with other legislative changes in the age of majority, such as the voting age. A number of research studies were conducted of the impact of this lowering of the age for purchase of alcohol on accidents involving teenage drivers between the ages of 18 and 21. The majority of these studies indicated that the number of alcohol-related accidents (generally measured indirectly, through accident surrogates such as nighttime, single-vehicle accidents) increased among the age groups affected by the reduction on the legal drinking age (*Douglass, 1982; Douglass, et al., 1974; Smart and Goodstadt, 1977; Whitehead, 1976*). These results, however, were not unanimous. Zylman (*1975*) found no reduction in fatal accidents among Michigan youth following the reduction in the drinking age, and Warren, et al. (*1977*) suggested that some of the reductions found in the Canadian provinces might be an artifact of change in definition of the law with regard to driving while intoxicated.

Overall, however, the evidence was sufficiently strong to result in a number of States passing legislation to increase the drinking age. In all, 23 States have raised their drinking age since 1978. This legislative trend is important because the major argument for the raising of the minimum age for purchase of liquor in those States which have enacted such laws has been as a highway safety countermeasure to reduce drinking and driving accidents among teenage drivers. Unfortunately, the increases in the drinking age have frequently involved a change of only one or 2 years, making the evaluation of the impact of such laws difficult. Nevertheless, in the last 3 years, over a half dozen studies of the effect of such increases have been conducted. These are summarized in Table 4-2.

Table 4-2.—Recent Studies of the Impact of Raising the Drinking Age Laws

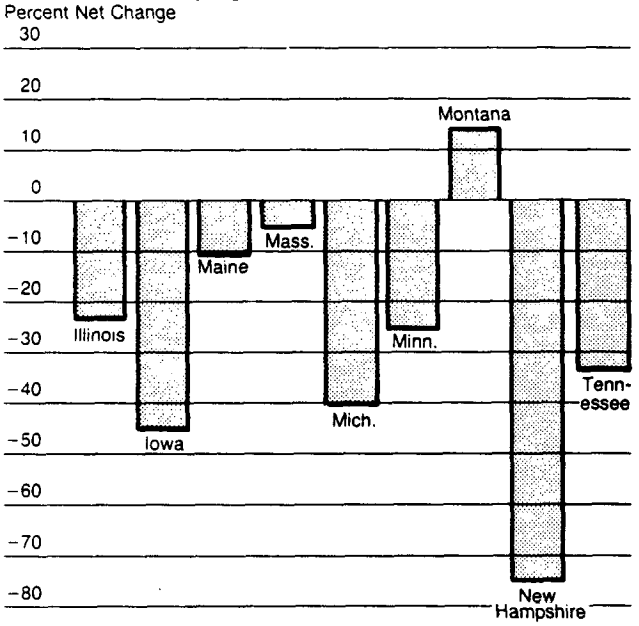
Year	State	Result of increase in drinking age	Researchers
1979	Massachusetts	No effect	*Roy and Greenblatt, 1979.*
1980	Michigan	Accidents reduced	*Wagenaar, 1981.*
1981	Maine	....do	*Klein, 1981.*
1981	Illinois	....do	*Maxwell, 1981.*
1982	9 States*	Accidents reduced in 8 States	*Williams, et al., 1975.*
1982	United States	States with lower drinking age laws had more injury accidents.	*National Center for Statistics and Analysis, 1982.*
1983	Massachusetts	Accidents reduced	*Hingson, et al., 1983.*

*In Illinois, Iowa, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, and Tennessee, accidents were reduced. Accidents rose in Montana.

Two of these studies have involved a number of States. Williams, et al. (*1975*), using data from the Fatal Accident Reporting System (FARS), studied the frequency of nighttime fatal accidents among teenage drivers in nine States that had raised their legal minimum drinking age and concluded that eight of the nine States had experienced a reduction in crash involvement among the affected age group. The average reduction for these States was 28%. The results are shown in Figure 4-2.

The National Center for Statistics and Analysis at NHTSA conducted the study (*1982*) using data on injuries due to auto accidents from the National Electronic Injury Surveillance System of States with lower and higher minimum drinking ages. Those States with lower minimum drinking ages had significantly greater nighttime serious injury rates, while there was no difference between States with high and States with low minimum drinking ages in daytime injury rates. The study concludes that higher state minimum drinking age is effective in reducing the nighttime serious injury rate for drivers under 21 years of age.

Figure 4-2 Net Changes in Teenage Driver Involvement in Nighttime Fatal Crashes After Changes in the Legal Minimum Drinking Ages



SOURCE: Williams, et al., 1981

As can be seen in Figure 4-2, the results to date of studies increasing the drinking age have generally been favorable. However, these laws have been in place for only a short time. During that time, other factors which could produce a reduction in accidents have been present. Partyka, (*1982*) for example, studied the reductions which occurred in total fatal crashes nationally in 1981 and developed evidence that most of this change was due to reduced driving by teenage drivers. She explained this reduction as due to a greater early impact of the economic recession on young drivers. While the preponderance of evidence seems to indicate that *lowering* the legal age for purchase of alcohol *increased* the number of alcohol-related crashes among young drivers, the question of whether *increasing* the legal age of purchase will *reduce* accidents remains to be proven when longer experience with these higher age laws generates sufficient data for a more definitive analysis of impact, from which the effect of transient economic factors can be eliminated.

Effects of Drinking Age Changes on Alcohol Consumption

While considerable evidence exists for an increase in teenage accidents when the legal age for purchase of liquor is reduced, and there is also some evidence for decreases in accidents when it is raised, the influence of drinking age changes on alcohol consumption (a necessary assumption to the theory that lowering the drinking age increases alcohol-related crashes) is less clear. Barsby and Marshall (*1977*) surveyed liquor sales data and came to the conclusion that there were no significant increases in consumption of distilled spirits after reductions in the minimum age of purchase in those States which changed their drinking age law. However, their study was limited to total liquor sales of which the teenage drinker would only be a small portion. Further, their study was limited to distilled spirits, and it is well known that the beverage of preference for teenagers is beer.

Rooney and Schwartz (*1977*) found a negative effect in a survey of high school students in five northeastern States. They reported that 42% of the seniors in the States with 18-year-old drinking ages compared with 45% in the States with 20- or 21-year-old limits reported consuming beer at least weekly. Thus their conclusion was that there was a "forbidden fruit" effect in which teenagers drank more when prohibited by law from purchase of liquor. Maisto and Rachal (*1980*), on the other hand, came to a contrary result in their survey, based on a nationwide probability sample of youth. They found that in States with higher drinking-age laws, youth reported less drinking and driving, less accessibility of alcoholic beverages and less frequent intoxication.

Moreover, Wolfe (*1975*) provides more objective evidence in the results of a national roadside breath test survey, where 15% of the 18 to 20-year-old respondents were driving with at least .05% BAC in 18-year-old drinking law states, compared with 11% in the 20 to 21-year-old drinking law States. Wolfe's results support those of an earlier study by Clark, et al. (*1973*) in which roadside surveys of drivers on the road at night before and after the reduction in the drinking age law in Michigan showed a substantial increase in alcohol consumption among the age groups affected.

Overall, there is evidence for the effectiveness of raising the minimum age for purchase and consumption of alcohol as a method of reducing *exposure* of teenage drivers to alcohol-related acci-

dents. Admittedly, much of the evidence is based on the use of surrogate measures for alcohol-related accidents, rather than on data limited to those accidents which have been determined to be caused, at least in part, by drinking or where an intoxicated driver (as verified by a BAC test) was involved. In addition, both the reduction in the legal drinking age during the late 60s and early 70s, and the raising of the drinking age in the late 70s and early 80s have occurred during periods in which other factors were having a strong effect on accident involvement (the growth of the teen population due to the post-WW II baby boom, the energy crisis of 1973-74, the 55-mile per hour speed limit, and the recession of 1981-82). The continuing trend to raising the minimum age for purchase of liquor should provide opportunities for the collection of additional data on the effect of such laws on the incidence of teenage drivers in alcohol-related accidents.

Alcohol Control Laws

In addition to limiting the age for purchase and consumption of alcohol, many States have adopted laws which limit or control the sale of alcoholic beverages, in part as a source of revenue for the State, but more generally as a result of various arguments that such laws will reduce alcohol-related problem behavior. Aldoory (*1980*) has reviewed the literature and the effects of liquor pricing and taxation and other control laws on alcohol-related problems. He notes an increasing interest in the use of such limitations by experts which favor a public policy based on a public health model of the alcohol consumption problem. Matlins, et al., (*1976*) conducted a study for the National Institute on Alcohol Abuse and Alcoholism of existing laws for alcoholic beverage control in the 50 States. This study included visits to ten states and 275 interviews with local officials. He concluded that ABC laws can influence alcoholic beverage consumption and may prevent alcohol-related problems, but noted that the current ABC system concentrates principally on economic issues and regulation of the industry and that the officials involved generally believe that ABC laws have little effect on consumption.

Room and Mosher (*1980*) argue for activist ABC policies. They suggest that when ABC violations (such as serving minors) are detected, the Liquor Control agency should offer the offending licensee training or educational programs. They believe that ABC boards should be more active in training their own enforcement personnel and in offering training to tavern owners and to bartenders. The California Alcohol and Beverage Control Board developed such a program and implemented it with some success (in terms of the acceptance of the training by restauranteurs). Interest in the program, however, was reduced when California legislature revised and weakened the laws regarding third party liability for alcohol-related accidents. Dram shop laws (*Mosher, 1982* and *1983*) appear to have an important role in encouraging restauranteurs and bar owners to take greater care to remain within the ABC rules regarding liquor sales and to avoid serving minors and obviously drunk persons.

Some partisans argue for even stronger use of governmental authority to control the sale of alcoholic beverages as a means of reducing problems related to alcohol use, particularly drinking and driving. Plymat (*1979*) suggested (1) raising the price of alcoholic beverages; (2) controlling and restricting alcoholic beverage advertising; (3) banning the provision of free alcoholic beverages on commercial airlines; (4) increasing alcohol taxes; (5) requiring warnings in advertising and on liquor labels; (6) giving incentives to whiskey distillers to produce alcohol for use as gasohol; and (7) raising the legal drinking age. Perhaps the most radical recommendation was made by Robertson (*1981*) who recommended introducing additives to alcoholic beverages to reduce excessive use.

Few of these proposals have been evaluated. Surveys of the relationship between State laws, and accident involvement have yielded equivocal results (*Moore and Gerstein, 1981; Cooke, 1981;* and *Matlins, et al., 1976*). Lacey, et al., (*1981*) attempted to evaluate the effect of a reduction in sales restrictions when liquor by the drink became available in seven North Carolina counties in 1978. This analysis of data on the DUI arrest rate indicated that, in counties which had liquor by the drink, there was a significant decrease in the average daily arrest rate and a significant rate increase in control counties which did not have liquor by the drink. In both sets of counties, alcohol-related crashes increased from the pre-period to the post-period when liquor by the drink was permitted. They tentatively concluded that the introduction of liquor by the drink did not have negative consequences in terms of highway safety.

Limitations in Teenage Driving

While there is an obvious need to prepare teenage drivers seeking their first driving permits to operate a vehicle on the roadway, there has been considerable controversy over the years as to the effectiveness of driver education as a safety countermeasure. Studies of the impact of attendance at driver education classes on the accidents of young drivers following licensing have been contradictory. To a great extent, this has been because of the inadequacy of the research designs which made it impossible to distinguish between changes in exposure produced by attending driver education (students who take driver education tend to drive more) and the effects on the probability of accident involvement per mile driven.

Robertson and Zador (*1977*) correlated the accident rates for 16- and 17-year-olds in States which provide a larger versus smaller portion of their teenage population with driver education and came to the conclusion that the States which provided driver education to the largest proportion of their youth also had the highest accident rates.

They argued that driver education was a negative factor in safety, because it resulted in the earlier licensing of young drivers who have a higher involvement in highway accidents. Seaver, et al. (*1979*) extended the Robertson/Zador work and found the impact to be less significant than their original claim, but nevertheless confirmed the general trend that States which provided driver education to the largest portion of their teenage youth had the highest accident rates.

One method proposed for reducing the impact of this early licensing of teenagers is the use of provisional licenses for those 16- and 17-year-olds who apply for a license below age 18. The provisional license would limit driving at nighttime when most alcohol-related accidents occur, by not permitting the teenager to drive after a given hour—perhaps 10 p.m. to 12 a.m. without a driver over 21 in the car. The concept was also extended to motivate improved driving during the daytime by making a period (perhaps 6 months) of accident- and violation-free driving a requirement in order to receive a full, unlimited driving permit. NHTSA has proposed such a model provisional (graduated) licensing system for young novice drivers (*Croke and Wilson, 1977*).

Williams, et al. (*1982*), studied four States which had implemented curfew laws for young drivers and found that when the accident rate per hour of the day was compared with States with and without the law, that those States with the curfew law had fewer young-driver accidents at nighttime. They also included a before-and-after study of young driver accidents in Maryland in which they reported that young-driver accidents were reduced following the implementation of a graduated licensing law for 16- and 17-year-old drivers. McKnight, et al. (*1983*), made a more detailed study of the impact of the Maryland graduated, novice licensing system. They found that while accidents were reduced following the implementation of the law, it appeared that this was part of a long-term downward trend which began before the new program began. On the other hand, McKnight and his coworkers found that traffic law violations were reduced among novice drivers in Maryland. This suggests that the motivating effect of maintaining a good record in order to be given an unrestricted licensing appeared to be having an impact.

Too little data are available at this time to fully evaluate the benefit of licenses providing for graduated restrictions for novice teenage drivers. However, the procedure appears to have considerable face validity. If the early results of Williams, et al. and McKnight, et al. are confirmed, as experience grows with this new procedure, additional evidence for the effectiveness of the law may be accumulated. It is interesting to note that the graduated licensing law appears to reduce accident involvement in two ways: first, by limiting the exposure of 16- and 17-year-old drivers to nighttime (alcohol-related) accidents, and secondly, by motivating an increase in safe driving as evidenced by the reduction in traffic offenses during daytime driving.

Denying Licenses to Alcoholics and Problem Drinkers

Most State licensing statutes give authority and the responsibility to the director of the Department of Motor Vehicles to deny licenses to individuals with physical disabilities that may present a risk to themselves and to the public (*Gregory, 1980*). It is under such statutes that licenses are denied to those with visual defects and other medical problems. Waller (*1968*) has reviewed the medical conditions which can affect driving and came to the conclusion that individuals with the types of conditions which may produce sudden unconsciousness and other significant performance problems have an accident rate approximately twice that of the normal licensed drivers.

Most States attempt to control the issuance of licenses to individuals with physical problems that could affect driving through a system of medical boards. Individual license applicants are required to indicate on the license application whether they have a medical problem (alcoholism is usually among these), and if the answer is in the positive, the applicant will be required to obtain a statement from his physician. If the problem is serious, the case may be referred to a State medical review board.

The problem with such procedures is that they are dependent in the first instance on a self-report by the applicant who is motivated to obtain a license and therefore likely to minimize any medical condition he has, particularly problem drinking. The second limitation is presented by the fact that most applicants are allowed to seek a statement from their personal physician rather than an independent State certified examiner. Finally, not all States have a program of actively referring medical cases to a medical review board. The result of these limitations is that few alcoholics or problem drinkers are denied licenses through these procedures.

It has been proposed that physicians should report to the Department of Motor Vehicles individuals whom they diagnose as being alcoholics or problem drinkers (*Gregory, 1980; Smith, 1980*). When such reports are received, the Director of Motor Vehicles has the power to refer the case to a medical review board. However, most physicians are naturally reluctant to report their private patients to the Motor Vehicle Department. Furthermore, the evidence regarding the relationship of alcoholism and accident involvement is somewhat equivocal as noted in the discussion of drinking patterns and accident involvement in Chapter 3. The drinking patterns of some alcoholics differ from those of accident-involved drivers (*Vingilis, 1983*), and some alcoholics have normal or better-than-normal driving records (*Zylman, 1976*). To date, there has been no research on the effectiveness of any of the medical programs implemented

by State licensing agencies to deny licenses to alcoholics and problem drinkers through the establishment and enforcement of medical requirements for a driver's license.

Based on the current evidence of the relationship between a diagnosis of alcoholism and highway accident involvement, there is too little evidence for most States to permanently deny driving permits to alcoholics. A procedure which required attendance at a treatment program prior to licensing of a diagnosed alcoholic might be supportable, based on the results of treatment programs for convicted drinking drivers (*Nichols, et al., 1978; Reis, 1982a, 1982b, and 1983*) providing a system could be implemented which would both accurately identify alcoholics and motivate them to accept the treatment. (See the discussion of the health approach below.)

Criminal Justice Programs

The legal approach to controlling drinking and driving is a system of institutions that generate and enforce laws. Joscelyn and Jones (1972) have described this traffic laws system as a social control system which functions to maintain drinking-driving risk (as well as other highway transportation risks) at some societally tolerable level. In doing this, the traffic law system performs four basic functions: law generation, enforcement, adjudication, and sanctioning. The legal system has two major objectives; controlling the behavior of all highway users through a system of regulations governing drinking-driving behavior which are enforced by the police and the courts to insure that failure to abide by their requirements results in significant penalties to the motorist (general deterrence). The second objective of the legal system is to identify those individuals who routinely fail to abide by these regulations and to bring them under control so that they can be prevented from further illegal and dangerous behavior (special deterrence).

The first of these objectives is primary prevention through general deterrence. Deterrence is the basis for the legal approach directed at controlling all road users. The premise of deterrence is that an unwanted behavior can be prevented by the threat of punishment (Zimmering and Hawkins, 1973; *Ross, 1982*). The most consistently stated theory of deterrence is that persons contemplating a prohibited activity will refrain from acting if the expected pleasure derived from the activity is less than the expected unpleasantness resulting from some threatened punishment (Andenaes, 1966). Or, as summarized by Ross (*1982*), "the efficacy of a legal threat is a function of the perceived certainty, severity, and swiftness or celerity of punishment in the event of a violation of the law."

It is important to note here the use of the words "perceived certainty," since it is the perception of the risk of apprehension, prosecution, conviction and punishment rather than the actual probability which is believed to be the significant factor in creating deterrence. Thus, a well-publicized enforcement program may have a greater impact than one which receives less publicity, even though the numbers arrested and convicted may be the same.

The second major function of the legal system is to identify, through the enforcement and adjudication and sanctioning process, individuals who offend against the standards of good conduct embodied in the drinking-driving laws. By identifying such individuals and convicting them of an offense, the legal system brings them under direct control of the courts. This permits the implementation of actions directed at preventing reoccurrence of the offense. Such actions may consist purely of punishment or retribution, which is intended to make the experience sufficiently painful that the individual will be deterred from repeating it. Alternatively, the actions may be taken which are designed to prevent further offenses directly by "incapacitating" the individual through withdrawal of his license, so he's not permitted to drive, or through incarceration, which presumably prevents both drinking and driving. Finally, a set of countermeasures may be applied to the individual which are intended to rehabilitate the offender and change his behavior through education or treatment of his presumed drinking problem. All of these procedures are generally subsumed under the heading of "special" or "specific" deterrence.

Clearly, most sanctions have both a "general" and a "special" deterrent effect. The principal feature that differentiates general from specific deterrence is that specific or special deterrance is applied to drivers who are individually identified; whereas general deterrence applies to all potential offenders, none of whom are specifically identified to the State.

Law Generation

Voas (*1982b*) has traced the history of the development of drinking-driving laws through three phases: administrative, behavior-based, and chemistry-based. The earliest attempts to control drunk driving were by means of denying or withdrawing the license to operate automobiles from individuals who were known to be alcohol abusers or who the police apprehended driving while drunk. It was not until just before the First World War that statutes were passed which specifically made drinking and driving a criminal act. The State of New York passed a drinking/driving law in 1910, and in 1924, the State of Connecticut jailed 254 drivers for driving while intoxicated. These early drinking-driving statutes described the offense in terms of the behavior of the driver, initially using the term "drunken driving" and later, as it became obvious that individuals who did not appear drunk still could be sufficiently impaired to be a risk on the road, the terms became modified to "driving under the influence of alcohol" or "driving while impaired."

All of these descriptions of behavior, however, were subject to considerable debate and misunderstanding. A major step forward was achieved in Norway when the drinking-driving offense was defined, not in terms of behavior, but in terms of a chemical test for alcohol in the blood. This first illegal per-se law was passed in 1936. Shortly afterwards, in 1939, Indiana became the first State in the Union to make use of a chemical test as part of the arrest process. However, the test was used only after the driver had been apprehended and charged with driving under the influence by the police officer. Following the Second World War, disposable breath test devices began to be used in Scandanavia by the police in order to make a preliminary determination of whether the individual had been drinking heavily enough to be charged with drunk driving *before* he or she was taken to the station for an evidential test. Britain applied this preliminary test system in the Road Safety Act of 1967. Since that law was highly successful initially in reducing drinking-driving accidents (Ross, 1973 and *1982*), interest in preliminary tests developed rapidly in the United States.

Concurrent with the Road Safety Act of 1967, a new technology of electronic breath testing, making use of the fuel cell and semiconductor sensors was emerging (*Moulden and Voas, 1975*). These electronic sensors could be engineered into small portable units and used by the police at the roadside for multiple tests at relatively low cost. The availability of these devices and the success of the British Road Safety Act led to the enactment of preliminary breath test laws by a number of the States during the last 15 years. In addition, the States have been adopting the illegal per-se legislation which simplifies the prosecution of the drinking-driving offense by avoiding the subjective nature of behavioral descriptions and specifying that it is against the law to be in control of a vehicle with a blood alcohol level above a certain amount—generally .10% BAC (*NHTSA, 1983b*).

A final element in the development of a chemistry-based enforcement system was implemented in Sweden in 1974, when the police were specifically authorized to establish roadblocks at which all drivers were stopped and, once stopped, all drivers measured with a preliminary breath test device. Those over the Swedish limit (0.5%) were charged with the DUI offense and taken to the station for an evidential blood test.

Currently there are three basic enforcement systems in use throughout the world. These are outlined in Figure 4-3.

Figure 4-3.—Three Basic DUI Enforcement Systems Used Throughout the World

	United States Behavior-based	Scandinavian countries Chemistry-based	Britain, Canada, Australia Mixed
Selecting vehicle.....	Accident involvement illegal-erratic driving	Roadblock.....	1) Accident involvement 2) Traffic offense 3) Officer suspicion
Detecting alcohol....	Odor of alcohol, slurred speech, etc. 1) Preliminary breath test..... 2) Sobriety tests	Preliminary active test required.	Preliminary active test required
Measuring impairment.	Evidential breath test.....	Evidential blood test	Evidential blood or breath test

The United States still uses the behavioral-based system, which involves the identification by the police officer of vehicles in the traffic flow which are being operated erratically or involved in an accident. Once such vehicles are stopped, the officer must smell alcohol or observe some action by the driver which gives him the "reason to believe" that the driver has been drinking and be impaired by alcohol. The third step, then, is to collect evidence of behavioral impairment through psychomotor sobriety tests. If these tests indicate impairment, the officer can then place the driver under arrest and require (under implied consent statutes) that he or she take an evidential test for alcohol. In this system, the chemical test is used only after the driver is placed under arrest and is not part of the apprehension process itself. Some States have recently provided for preliminary breath tests. In

those States, the officer may request such a test from the motorist prior to placing him under arrest. These tests are used only for the guidance of the officer and the results are not presented as evidence in court.

In contrast to this primarily behavioral approach to apprehension of drivers, the Scandinavian countries use a system which, at least in some instances, is completely independent of the driver's behavior. In this procedure, all vehicles using a given roadway are stopped by the police at a roadblock, and once stopped, every driver, irrespective of whether he appears to have been drinking or be impaired, is given a preliminary test for alcohol. If this preliminary test is positive, then the driver is placed under arrest and taken to the station for the evidential test. Within this system, driver behavior plays no role. This is believed to have a potentially deterrent effect, since individuals cannot avoid arrest by attempting to drive carefully and avoid the attention of the police officer or by taking care to appear sober and respectful when speaking to the officer so that he will not be aware that the driver has been drinking (*Voas, 1982b*).

Britain and the Commonwealth countries have an intermediate system which, like the United States, is dependent upon selecting from the traffic flow vehicles which are driving erratically, illegally or accident-involved. However, once the vehicle has been stopped, the police officer has the authority to demand immediately and without further evidence of drinking or impairment, a preliminary breath test. If the driver is over the BAC limit, the police officer can arrest the driver, and take him to the station for the evidential test.

Because of public interest in the drunk driving problem, alcohol safety legislation in the United States is in flux. The status of the laws in 1983 has been summarized by NHTSA (*1983b*). In 1983, 25 States had legislation which makes it illegal per-se to be in charge of a vehicle and have a blood alcohol content of .10% or greater. One State (Iowa) had an illegal per-se law at .13%. In addition, all States also had laws which make the given BAC level presumptive of intoxication. Four of the States had specified a presumptive level between .05% and .08%. The other 36 set the presumptive level at .10% or above. In addition, 20 States had legislation which provided for preliminary breath testing.

Another element of the chemistry-based system which is coming into greater use in the United States is the roadblock or checkpoint procedure (*Compton and Engle, 1983*). The use of this procedure raises issues under the Fourth Amendment to the U.S. Constitution. However, applicable court cases appear to provide a basis for conducting checkpoints which meets constitutional requirements (*IFFT, 1983; Compton and Engle, 1983*). A recent survey by the International Chiefs of Police indicates that localities within at least 25 of the 50 States are currently conducting checkpoint operations from time to time (*Voas, 1983c*). With the increase in legislation providing for illegal per-se laws, preliminary breath test laws, and with the increasing use of sobriety checkpoints, the enforcement system within the United States is gradually moving from the behavioral-based to the chemistry-based enforcement system (*Voas, 1982b*).

Enforcement

Several studies have reviewed enforcement practices in the United States during the 1970s (Joscelyn and Jones, 1971; Planning and Human Systems, Inc., 1976; Oates, 1974; *Summers, et al., 1980; Jonah and Wilson, 1983*). Major steps in the enforcement process are shown in Figure 4-4.

The process begins with the police officer on patrol observing vehicle behavior to select cars out of the traffic flow which appear to be driven by drunk drivers. Once the vehicle has been brought safely to a stop, the officer must initiate an interview during which he attempts to determine whether the driver has been drinking and whether there is any evidence that that drinking is producing impairment. If he has initial evidence of drinking and possible impairment, he then moves on to assessing the extent of the impairment. This can be done by two methods: requesting a preliminary breath test or inviting the driver out of the vehicle to perform a set of psychomotor "sobriety" tests. In many cases, both procedures are used. If these tests indicate that the driver is impaired by alcohol, the officer will then make the formal charge of driving-while-impaired by alcohol and take the offender to the police station for an evidential breath test. It is at this point that the implied consent legislation, which requires the driver, on pain of losing his license, to submit to a chemical test to determine the level of alcohol in his breath or blood.

Identifying the Vehicles of Drunk Drivers

Recently, NHTSA has sponsored research to develop more refined procedures for carrying out these major enforcement activities. Harris and his coworkers (*1979*) conducted a survey of nearly 1300 DUI arrest reports and consulted with experts to determine the driving symptoms which police used to detect drinking drivers. Based on the identification of the most important visual cues, an experiment was conducted in which trained observers accompanied police officers on patrol and recorded over 600 instances of unusual driving behavior. In each case, the patrol officer stopped the vehicle and measured the blood alcohol concentration of the driver with a portable breath tester. Based on these data a detection guide was developed to facilitate the identification by police of the alcohol-impaired driver. Following this initial research, these cues were tested in field studies in which over 4600 patrol stops were made and BACs correlated with the observed cue. The final guide developed through this research describes 20 visual cues

which have been found to account for approximately 90% of all stops made by officers patrolling for drunk drivers. For each cue, a probability that the driver is at or above a BAC of .10% is provided. These probabilities range from 50% to 80%.

Vingilis, et al. (*1983b*) tested the training program developed by Harris and a control program (informal discussion) and found that both tended to increase arrest rates about equally. There was no evidence that the experienced officers changed the cues they were using to detect drunken drivers as a result of the training, but the experienced officers thought that the training would be useful for inexperienced officers.

Detecting Drinking

The second step in the arrest process is to interview the driver after the vehicle has been brought to a safe stop. To date, little research has been done in the initial phase of the arrest process. Ruschmann, et al. (*1980*) indicate that their analysis of the case law relating to the use of preliminary breath testers requires that the officer have probable cause to proceed to this step in the enforcement process. Such probable cause must be collected in part through the interview which gives the officer reason to believe that the driver has been drinking and may be impaired by alcohol. IFFT (*1983*) noted that the courts have given little direction as to what constitutes an adequate basis for determining that an individual has been drinking or may be impaired. The State Supreme Court of Oregon (State vs. Clark, p.2d 123, Oregon, 1979) has taken judicial notice of the following symptoms or signs as indicative of alcohol intoxication:

1. Odor of alcohol on the breath.
2. Flushed appearance.
3. Lack of muscular coordination.
4. Speech difficulties.
5. Disorderly or unusual conduct.
6. Mental disturbance.
7. Visual disorders.
8. Sleepiness.
9. Muscular tremors.
10. Dizziness.
11. Nausea.

No researchers have attempted to quantify these symptons or signs in a way which could be useful to the police in increasing the probability that they will detect a drinking driver. Some research has been conducted on the ability of police officers and researchers to estimate the extent of drinking on the basis of a brief interview with a driver. Zusman and Huber, (*1979*), found that skilled interviewers identified only 45% of the drivers above .10% as having been drinking. Vingilis, et al., (*1982*) obtained evidence that Canadian police officers apparently failed to detect 95% of the drivers who were at .08% BAC and above. This relatively low probability of being detected apparently affects the subjective, perceived probability of arrest among Canadian drivers. Bragg and Cousins (*1977*) reported evidence that Canadian drivers viewed the probability of being arrested for drunk driving *if stopped by a police officer after drinking as one in 200!*

There is a need for research which would quantify the various cues available to the officer at the point of interview to assist the officers in making these determinations. It has also been proposed that the preliminary test might be given to all drivers who commit a traffic violation as is done in Britain (*Hricko, 1969*). It is not clear whether this would be constitutional under the Fourth Amendment, but the issue should be brought before the courts and tested. Another approach involving passive sensing of alcohol is currently undergoing development and testing (*Voas, 1983c, d, e, and f*). The passive sensor is a device which pumps air from in front of the face of the driver and detects alcohol in the expired breath. Since the expired air being tested is mixed with environmental air, the passive sensor can never be as accurate as a preliminary breath test device. However, since it does not require the driver to cooperate, it is believed to be permissible to use this device without probable cause to believe that the individual has been drinking or is impaired (*Ruschmann, et al., 1980*). If this is the case, it can be used on all drivers stopped by the police.

Measuring Impairment

The next phase of the arrest process involves the determination by the police officer (once he has obtained evidence of drinking) of the extent to which the driver is impaired by alcohol. This can be accomplished by two methods: first, by use of a preliminary breath test device, if this is authorized by State legislation; and secondly, by the use of sobriety tests. While the psychomotor sobriety tests generally take somewhat longer and are in some ways more intrusive and embarrassing to the driver, the courts have not limited the application of such tests in the arrest process and, therefore, these do not currently require special State legislation in order to permit their use.

The National Highway Traffic Safety Administration developed a system of guidelines for the performance of preliminary breath testers (Federal Register, Vol. 38, No. 212, Nov. 5, 1973). These requirements were embodied in a series of tests which were conducted on any devices submitted by breath test manufacturers. Qualification under this program resulted in being placed on the "Qualified Products List." This system both spurred the development of preliminary breath test devices and helped insure that high-quality products were available to police agencies. Three basic types of devices are currently in use. "Balloon" or "baggie" tests make use of a color change produced by a chemical reaction when alcohol-laden breath comes in contact with a dichromate solution. More widely used are two electronic sensing methods, one based on a semiconductor or Taguchi cell, and the other on fuel cell sensors.

While these devices vary somewhat in their ease of use and resultant acuracy, several have been shown to be highly accurate and reliable (*Flores, 1981*).

A large number of tests have been used by the police and in laboratories to assess impairment due to alcohol (Snapper, et al., 1981). A series of studies have been undertaken to objectify and improve the psychophysical "sobriety" tests which are commonly used by the police to detect impairment in drinking drivers (*Burns and Moskowitz, 1979; Tharp, et al., 1981; Tharp, 1981; Anderson, et al., 1983*). Burns and Moskowitz (*1979*) conducted a study of the commonly used sobriety tests and came to the conclusion that there was a reasonably high correlation between the tests and BAC. They were able to select the tests that were most valid for selecting BAC and to improve the quantitative scoring of these tests. Tharp, et al. (*1981*) tested this new sobriety test battery consisting of the walk-and-turn, the one-leg stand test, and the horizontal gaze nystagmus test with ten police officers who administered the test to 297 drinking volunteers with BACs between zero and .18%. The officers were able to classify 81% of the volunteers on the basis of whether their scores were above or below the .10% BAC level.

This test battery was exposed to a more extensive field test by Anderson, et al. (*1983*) who obtained data from four police departments that made use of the procedure on some 1500 drivers stopped for investigation. They found that, taken together, the gaze nystagmus test and the walk-and-turn test produced an 80% correct classification of drivers who were above or below the .10% BAC level by a preliminary test. The gaze nystagmus test alone was correct in 77% of the cases, while the walk-and-turn test and the one-leg stand were 68% and 65% respectively. The availability of this improved psychomotor test battery should be particularly significant to those police departments in States which do not have preliminary breath test laws.

The Booking Process

Once the officer has probable cause to make a DUI arrest, he can charge the driver with DUI and invoke the implied consent law to require an evidential test. In most jurisdictions this means transporting the offender to the police station for final processing. A major impediment to increasing the efficiency and effectiveness of enforcement in the United States has been the relatively intricate and time-consuming procedures required of the police officer in order to book an individual for drunk driving. Some jurisdictions require that the driver be detained until he is sober enough to drive safely. Little and Cooper (*1977*) have surveyed the legal issues which will arise in releasing drunk drivers into the custody of a friend or family member to be taken home as one method of simplifying the booking procedure.

Studies of the enforcement procedure have indicated that the intricacy and the time consumed in making an arrest is a major factor in limiting the number of arrests that are made by police officers. Data from 73 jurisdictions compiled by Fennesy, et al. (1968), indicated that a typical full-time enforcement officer made only 1.83 arrests per year for alcohol impairment. Low levels of enforcement were also observed in other jurisdictions (Joscelyn and Jones, 1971; Dihrberg and Rivo, 1971; U.S. Department of Transportation, 1975a). Based on these data and roadside survey data, Borkenstein estimated that on the order of 2,000 violations occur for every arrest (Borkenstein, 1975). Using Borkenstein's Grand Rapids data, Voas (*1982b*) estimated that on an average, a driver can drive 5,000 miles before being arrested for a DUI offense.

Special DUI enforcement programs, such as those mounted in the alcohol safety action projects (U.S. Department of Transportation, 1978) can increase arrest by a factor of two or three. However, even in such cases, the overall probability of arrest remains relatively low (Borkenstein, 1975). Two studies have attempted to determine the probability of arrest in an area being actively patrolled by a special alcohol enforcement group (*Beitel, et al., 1975;* and *Hause, et al., 1980*). In these studies, roadside voluntary surveys of drivers were used to estimate the number of drivers at illegal BACs. These data were compared with the number of vehicles which came in contact with the police officers and with the number who were arrested at each BAC level. Both studies yielded similar results, indicating that the probability of arrest in a heavily patrolled area is about one in 300.

Public Information Support for Enforcement

Because of the rather low probability of arrest, even in areas which are actively patrolled, public information programs which inform drivers of the presence of the special enforcement effort and of the penalties for drinking and driving are very significant to the effectiveness of the enforcement effort. The primary objective of information campaigns used in the legal approach is to increase the public perception of the probability of apprehension for a drunk driving offense (Ross, 1973; Wilde, 1975). One of the best examples of the use of such a campaign is the British Road Safety Act of 1967. As part of this campaign, the British Government undertook a public information program to inform drivers of the new BAC limit and the procedures that would be followed by law enforcement officers in apprehending drinking drivers, with emphasis upon the use of the preliminary breath test. Also publicized were the penalties associated with the conviction for DUI.

The perceived probability of apprehension was apparently raised by the Act and a significant decrease in casualties per 100 million vehicles was noted by Ross (1973). However, the impact of the new law was greatest in the months immediately following its implementation and, after three

years, the casualty rates began to approach their former levels. Ross (1973) attributes this decay in program effectiveness to a realization by the public that the actual probability of apprehension was much lower than was first perceived, resulting in an erosion of the deterrent effect.

Ross (*1982*), in his international survey of alcohol enforcement programs, noted other occasions where new laws or intensified enforcement first produced a reduction in accidents which, however, disappeared after a period of time. Voas and Hause (*1983*) reported on a special enforcement study in Stockton, California, which lasted for three years. During the first year, considerable coverage by the mass media was given to the project, because of its novelty. During the second two years, little attention was paid by the press to the program. They found that the largest reductions in drinking-driving accidents occurred during the first year and that accidents returned close to baseline levels during the last two years of the project (although there appeared to be a continuing deterrent effect when accident rates in Stockton were compared with the rising accident rates in comparison cities).

Based on these results, and the surveys of Ross and others, Voas and Hause (*1983*) suggested that three distinct phases could be detected in most enforcement programs. The first, "publicity phase," comprised the period during which the public reacted principally to public information and developed an increased expectancy of apprehension if they violated the law.

The second phase consisted of "reality testing" by the public in which they observe the actual presence of the police and noted the number of arrests made. Since it is rarely possible for the police to live up to the high expectations produced by a good public information program, the driver's initial increase expectancy of arrest is not forfeited and the perception of risk tends to return to the baseline level. As a result, any accident benefits seen during the first phase tend to decrease.

The third phase was described as an "adjustment" phase in which a new base level would be created, based on both the public information and the perceived level of enforcement activity. Based on this theoretical formulation, Voas and Hause argue that public information programs should avoid overstating the probability of apprehension, since this would make it more difficult for the police to live up to the public's expectations.

Increasing Perception of Probability of Arrest

Recently, NHTSA has collected and cataloged the existing DWI enforcement-oriented public communication aims and materials (NHTSA, 1983c). The various public information themes which have been used in an attempt to increase the public perception of the probability of arrest are categorized under the particular element of the enforcement process which they emphasize. In addition, Anderson, Schweitz and Snyder. (*1983*) have developed a categorization of potential enforcement adjudication and public information strategies for increasing general deterrence to driving while intoxicated. This report is important because it notes a number of features of the enforcement activity which are believed to relate to the driver's risk perception, and therefore affect general deterrence. Among the factors claimed to affect the driver's risk perception is the risk of being observed or seen by the police, the risk of being stopped by the police, the risk of being identified as an alcohol-impaired driver, the risk of being arrested, convicted, and punished for DUI, and, finally, the perceived severity of the DUI penalty. Their report lists a number of methods for manipulating these risks in an effort to persuade drivers that there is a high probability of being arrested for DUI.

The importance of actions which the police take which are short of an arrest for drinking and driving itself needs further investigation. Borkenstein (1975), noted that the number of DUI arrests is very small and, while some increases can be achieved, it is likely that the actual arrest rate will never be sufficiently high to deter all drivers. He suggested that a lesser offense with which police could charge motorists more frequently and with less processing time and paperwork could be effective in increasing deterrence. He proposed that police officers be empowered to test drivers who committed certain hazardous moving violations and that if they were found to have a BAC above a minimum level, that they could be charged with a driving offense "aggravated by alcohol." While this offense would not carry the severe sanctions that are applied to driving while impaired, it would be recorded on the driving record, so that individuals who repeatedly offended would be known to the motor vehicle department.

Voas (*1982c*) has stressed the potential impact to be gained from frequent contacts with the police which do not result in DUI arrests but do produce a concern upon the part of the driver who is checked for alcohol that he is running a high risk of arrest. One method for achieving this effect is "sobriety checkpoints." Bragg and Cousins (*1977*) have shown that Canadian drivers believe they have only a 1-in-1445 chance of being stopped if they are driving impaired. Cameron, et al. (*1980*), demonstrated that the roadblock system which stops all drivers can persuade drivers that the chance of being stopped has increased. Voas (*1982c*) has also suggested that stopping and interviewing a larger number of drivers may be effective in promoting word-of-mouth publicity of the enforcement program and support the efforts of non-drinkers to intervene in drinking-driving situations. Compton and Engle (*1983*) have produced a guide to the use of sobriety checkpoint procedures.

Another action which may increase the perceived risk of drinking and driving is the use of administrative per-se revocation of driving licenses (*English, 1983*) which permits the police officer to

pick up the license and give the drinking driver a notice of revocation when the driver refuses a breath test or provides a result over the legal limit. This "Revocation On Administrative Determination (ROAD)" law insures the swift application of significant penalty—subject, of course, to the right of hearing and judicial review.

Adjudication and Sanctioning

Adjudication and sanctioning are functions performed by the so-called "lower" courts in the United States. The process is basically the same as for other serious traffic violations and requires at least one court appearance. In some jurisdictions, the accused violator is first arraigned, that is, formally charged, advised of his rights and possible punishment, etc., and then enters his plea to the charge. If the plea is "guilty," the court imposes a penalty and disposes of the case. A plea of "not guilty" requires a trial (either with or without a jury, depending on the jurisdiction) following rules and procedures prescribed for criminal trials. A verdict of guilty may be appealed, leading either to a review by an appellate judge or to a new trial (Joscelyn and Jones, 1971). More detailed descriptions of the adjudication and sanctioning process applicable to drinking-driving and crashes are provided in several recent studies sponsored by the National Highway Traffic Safety Administration (Joscelyn and Jones, 1971; Institute for Research in Public Safety, 1972: Jones, et al. 1976).

The Adjudication Process

The enforcement/judicial process has two aspects of significance to the effectiveness of its operation. There is a *formal system* which purports to behave as the written law provides and as intended by the legislators. Side by side with the formal system is an *informal system* which consists of generally "off-the-record decisions" by all the participants in the enforcement/judicial activity (Voas, 1975). This informal system tends to make the official system more flexible for the individual case. The informal system relieves pressure at one point by relaxing activities at another, so that, in some cases, the overall outcome may be the nullification of the intended effect of the law. Some investigators (Joscelyn and Jones, 1971; *Voas, 1975;* and *Wilson, 1975*; *Ross, 1976*) have suggested that, as a result of the flexibility provided by this informal system, the probability that a penalty will be imposed is inversely related to the severity of that penalty.

Studies of police discretion (Little, 1972) suggest that they may be less likey to arrest if the penalties are greater because: (1) they know that the evidential burdens will be greater—they are likely to have to spend more time in court and more time will be required in preparing the case; and (2) they also feel more compassion for the individual driver, particularly if they feel that the penalty is inappropriately harsh.

If the penalties are harsh, the defendants are more likely to hire lawyers, request jury trials and take actions which will delay the adjudication process. Prosecutors, in turn, may have to react to increased penalties by spending more time in case preparation (gathering witnesses, etc.) and, since most prosecution staff are overburdened, they are more likely to agree to reductions in pleas in order to avoid the extra caseload.

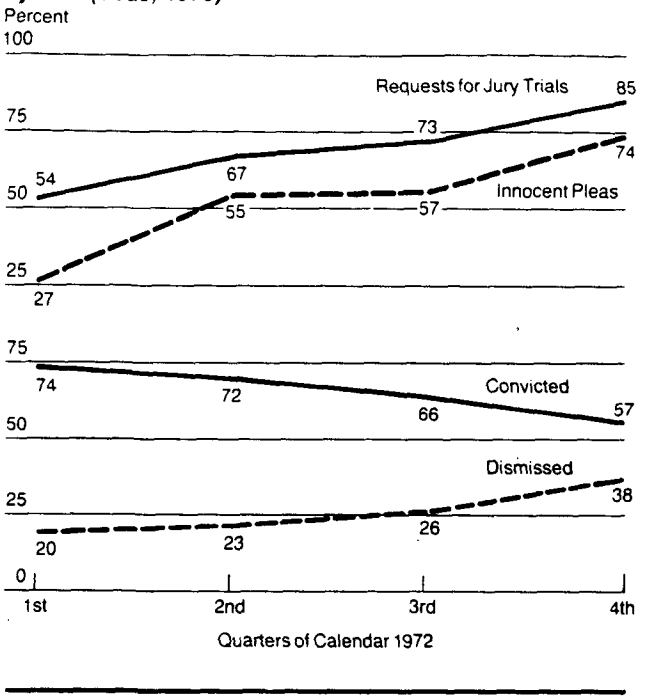
Factors said to inhibit a prosecutor from charging a suspect include a belief that conviction and punishment will not result because of a "lenient" court, a belief that punishment will be too harsh, lack of understanding of the alcohol-crash problem, and lack of sufficient resources to prepare and present cases (Joscelyn and Jones, 1971; *Voas, 1975;* Institute for Research in Public Safety, 1972, Wagner, 1976). Similar factors have been found to have an adverse effect on the adjudication and sanctioning functions. The effect of overly servere punishments is claimed by some experts to be especially serious (Joscelyn and Jones, 1971).

The courts also feel the same pressures. If there are more innocent pleas, more trials are required. More trials mean larger backlogs, particularly if the defendant requests a jury trial. The resulting pressure from backlogs makes the court more open to plea bargaining. Several researchers (*Voas, 1975; Ross, 1976; Little, 1972*) have reviewed evidence for the tendency of the courts to nullify servere penalties. Several examples of this tendency to nullification were collected as part of the final report on the ASAP program (NHTSA, 1979). Perhaps the most dramatic example is shown in Figure 4-5, which summarizes data from the Phoenix ASAP program illustrating the response of the system when the State Legislature imposed a one-day mandatory jail sentence for drinking and driving. Requests for jury trials, innocent pleas, and dismissed cases rose, while the proportion of those convicted was reduced.

Data reported by ASAP sites showed that about 54% of persons arrested for DWI were actually convicted of DWI. In some sites, many individuals were purposely "diverted" from the legal system in the pretrial phase to motivate their participation in treatment and rehabilitation programs, and this undoubtedly resulted in a lower conviction rate than could have been obtained under a strictly legal approach. If attendance at a treatment program is an acceptable outcome of a DUI prosecution, then at least 80% of the persons arrested in the ASAP projects were "successfully" processed through the courts (*NHTSA, 1979*).

Because the use of diversion programs resulted in arrested DUI drivers avoiding a license suspension which has been shown to be an effective countermeasure (*Hagen, et al., 1980; Salzberg, et al. 1981*) and because treatment programs for problem drinkers employed during the ASAP program were not successful (*Nichols, et al., 1978*), NHTSA has recommended against trading off license suspension for attendance at treatment programs. Recently, the public support for stricter DUI law enforcement which has been generated by such

Figure 4-4 The Impact of Increased Severity (Mandatory Jail Sentence) of Penalty on the Phoenix ASAP Court System *(Voas, 1975)*



groups as MADD and RID (see Public Information Programs) appears to have changed the legislative and judicial climate, as demonstrated by the large number of States passing laws which provide for more severe penalties of DUI (*Williams, et al., 1983; NHTSA, 1983b*).

Whether this change in public attitude regarding the need for tough sanctioning of the drinking driver will result in the courts imposing greater sanctions without becoming bogged down with greater backlogs is not yet clear. The National Institute of Justice (*1983*) conducted a survey of communities which impose mandatory jail sentences. Their results indicated that these sentences were being imposed and served. William, et al. (*1983*) also surveyed DUI sanctioning practices and they came to the tentative conclusion that many of the mandatory jail sentence requirements were being avoided by one or another means.

Sanctions

Penalties have a number of functions in the criminal justice system. While general deterrence is the most frequently mentioned purpose of sanctions, it is only one of many methods by which punishment may prevent crime. Some of the major functions are listed below.

1. Retribution

The traditional purpose of penalty is to punish. This grows out of a moral tradition that evil merits retribution. The moral issue is not, of course, an appropriate concern of scientific research, but the concept of retribution is significant in the implementation of penalties because it stresses the underlying societal expectation that penalties must be based on bad, blameworthy behavior. Retribution is not justified unless the act is evil, and the extent of the retribution must be reasonably proportional to the vileness of the act. This has been a significant problem in the past in the drinking-driving enforcement area because of the tendency of juries to believe the accused was simply unlucky to be arrested. "There but for the grace of God go I" is frequently their reaction to drunk driving prosecutions. As long as the public seeds the drinking and driving offense as something everyone does, with an arrest a chance matter, the possibility of assessing significant penalties will be impeded.

2. Incapacitation

Another purpose of penalties is to prevent the repetition of the offense by making it impossible for the individual to offend again. Jail, by physically removing the criminal from society, provides a good example of an effort to "incapacitate" criminals. In the drunk-driving area, incarceration can have the same purpose. However, most jail terms are too short to produce a significant reduction in the exposure to drunken driving. A more significant type of incapacitation is the suspension or revocation of the driving license. Recently, another form of incapacitation relevant to drinking and driving has begun to be tested. The State of Colorado has made it a requirement in its drinking-driving legislation that individuals convicted of drunk driving and referred to treatment programs must agree to abstain for a year. The legislation requires the State Department of Alcohol and Substance Abuse to monitor the abstinence of such individuals.

3. Rehabilitation

A modern emphasis in corrections has been that incarceration should be accompanied by rehabilitation. This procedure is based upon the concept that forced education can produce—through a changed understanding of the facts—a modification of attitudes and motivation which does away with the need or desire to break the law. The extent to which rehabilitation has been achieved within the criminal justice system is controversial, but evidence for effect is scant.

4. Specific Deterrence

"Specific" or "special" deterrence refers to the effect on the offender of the experience of being penalized. The concept is consistent with the learning theory which holds that a negative reinforcement following upon a specific act will tend to reduce the probability that that behavior will be repeated. It is to be distinguished from rehabilitation in that rehabilitation is directed at eliminating the inclination to offend by changing the basic attitudes of the individual. In deterrence, the inclination to offend is not affected, but the fear of the penalty is intended to counteract that inclination and prevent the individual from an actual offense. *Specific deterrence is therefore dependent upon the*

sentence as actually implemented. However, it is also true that the impact of that sentence may vary with the individual, depending on his *perception* of its severity and fairness.

5. General Deterrence

As with specific deterrence, general deterrence is based on building up the fear of being penalized as a method of controlling behavior. However, in this case, the fear is promoted in individuals who have not experienced the penalty. It is the effect of the penalty on the total population at risk, most of whom are not arrested and convicted for drunken driving. Since the individuals deterred do not actually experience the penalty, this type of deterrence is particularly dependent upon public information. The public must be made aware of how the penalty has been changed. In the case of some penalties, such as imprisonment, with which most of the public may be unfamiliar, it may be necessary to dramatize how it "feels" to be jailed. General deterrence obviously depends heavily upon public information (since those who are deterred do not actually experience the penalty). *It is the perceived certainty and severity of the penalty rather than the actual severity which is important in general deterrence.* This contrasts with the specific deterrent effect where no public information is presumably unimportant, since the individual to be deterred has a direct experience of the penalty.

6. Restitution

One of the functions of the penalties which is coming more and more into vogue as a penalty for DWI is to provide a means of restoring to society in general, or to victims in particular, the losses which were produced by the crime of which the offender is guilty. Community service—one type of restitution—has recently commanded a great deal of attention, particularly since the Public Law 97-364 (which provides incentive grants to the States) permits the use of ten days of community service as an alternative to the mandatory 48-hour jail sentence for the second DWI offense.

7. Financial Support

A major problem for the traffic enforcement and the judicial system in handling the drinking driver is the cost of the facilities and services which must be provided. A recent NHTSA contract (*McKnight and Voas 1982*) investigated the opportunities for establishing self-supporting alcohol safety programs. This study comes to the conclusion that such programs can be supported by funds collected from the convicted drinking driver provided that approximately $500 can be collected from each person convicted of drunken driving. Thus, an important function of the fine as a penalty for a drinking-driving conviction is to raise funds for the support of the system. This is independent of any effect in deterring the behavior of the person fined or of the driving public in general.

Interrelationship Among Sanction Functions

In most instances, it will not be possible to separate the seven types of effects described above. In some cases, the distinctions drawn above may be unimportant except for theorists. For example, the license suspension penalty would be expected to obtain its effect through two mechanisms: incapacitation (present at least in part for the period of suspension) and specific deterrence (present for the full follow-up period). In the case of the jail sentence, the incapacitation would be negligible. If there were no differences in the driving records of the individuals in these two groups, theorists could argue that jail sentences produce a greater specific "deterrence" because the total effect of the jail sentence would have been due to deterrence, whereas a portion of the effect of the license suspension could be attributed to "incapacitation." There might be some way to separate these effects by studying the extent to which the license revocation was more advantageous during the suspension period following conviction. In any case, such academic distinctions, while of some interest, are not critical to safety specialists.

One aid to the systemization of the penalties for drunk driving is the matrix shown in Figure 4-5. Listed here are the broad categories of corrective actions such as incarceration and license suspension against the seven functions of court sanctions described in the preceding section. In the cells of the matrix there is an indication of the extent to which evidence is available (see "Evaluation of Legal Programs" below) on the impact of the sanction and what is known regarding the direction of effect. For completeness, the table includes sanctions which would not be considered traditional, such as community service. Also included are court programs such as treatment (see "Health Approach") which are not normally considered "sanctions." Finally, an indication of the stress which the use of a sanction places on the court system is indicated.

Evaluation of Legal Programs

Scientific evaluations of the drinking-driving enforcement and adjudication system have rarely been conducted in the United States. Somewhat more is known about traditional traffic enforcement, some of which may be applicable to DUI programs.

Enforcement of Speed Limit Laws

A number of reviews have been made of the literature on the effect of traffic enforcement on general deterrence (*Darwyck, et al., 1977, 1979; Voas, et al., 1976; Ross, 1982; and McKnight, et al., 1983*). The enforcement of speed limits has lent itself best to the requirements of researchers. By placing loops in the highway or through radar, it is possible to make accurate measurements of the traveling speed of vehicles on a highway. This permits rather detailed measurements of the effect of vari-

ous enforcement procedures. On a "micro" level, it has made possible the measurement of the effect on travel speeds of various enforcement configurations.

Research summarized by Darwyck, et al. (*1977*), demonstrates that a marked patrol car parked parallel to the roadway almost invariably has a significant effect on the speed of traffic passing the patrol car. More importantly, the speed effect extends both up and down the highway. Joscelyn, et al. (*1978*) demonstrated that the effect on speed in the downstream direction was exponential, reducing by half every 900 meters. The upstream effect occurs even before the marked vehicle is in sight, apparently due to signals from vehicles passing in the opposite direction who flash their lights at oncoming traffic or through CB radio communication.

There is also some evidence for the effectiveness of enforcement symbols in reducing accidents. The significant reduction at the national level in fatalities produced by the enactment of the national maximum speed limit of 55 miles an hour gives indirect evidence for the potential effectiveness of an enforcement system for speed limits (*Klein, 1981b*). Specific experiments which demonstrated accident reductions were conducted in California (*California Highway Patrol, 1970*), and by the States of Connecticut and Utah (*Klein, 1981a*). All of these studies give evidence that the halo effect in both space and time—produced by enforcement symbols—can both increase compliance with traffic safety laws and produce small reductions in accident frequency.

Enforcement of Drunk Driving Laws

Ross (*1982a, 1982b*), in a recent review of worldwide efforts to enforce drunk driving laws, concentrated on programs conducted abroad, most of which used techniques not currently available to the U.S. police. He calls attention to studies which found accident reductions due to new legislation on special enforcement programs, such as the application of roadblocks, in Victoria, Australia, New Zealand and, the Netherlands, and in France. In Britain, the procedure established by the Road Safety Act of 1967 of requiring a breath test of every individual who broke a traffic regulation or was involved in an accident was also shown to have an impact upon accidents. He also reviews the alcohol programs of Sweden and Norway, which have been in place for a long time and concludes they were ineffective. Ross concludes that attempts to deter drinking drivers through legal programs has only a temporary effect. Snortum (*1981*), Votey and Shapiro (*1983*), and Voas (*1982b*) have argued that the Scandinavian law enforcement effort has been effective as indicated by the lower percentage of drinking drivers in roadside surveys conducted in Scandinavia and as indicated by the lower proportion of fatally injured drivers who are impaired by alcohol.

As noted, few studies of drunk driving enforcement programs have been made in the United States. The overall report on the ASAP program (*Levy, et al., 1978*) provided the first evidence for the effectiveness of intensified alcohol enforcement. However, these projects also involved a number of activities in addition to police enforcement (see section on the Systems Approach).

Because the effect of the enforcement activities could not be separated from the other countermeasures implemented in the ASAP program, the National Highway Traffic Safety Administration mounted a special enforcement demonstration in the City of Stockton, California (*Voas and Hause, 1984*). This project provided funds only to the police department and only for enforcement activities. In this project, ten extra alcohol patrols were deployed on Friday and Saturday nights. This resulted in a 200% increase in DUI arrests the first year of the project. For the 3 year period of the project, Friday and Saturday night accidents were reduced by 15%, while daytime accidents (not related to alcohol) rose 12%. Comparison of accident trends in Stockton with four similar cities in California and with the trend for the State as whole indicated that this reduction could not be attributed to factors outside of Stockton. A study by Klein (*1982*) of a special alcohol enforcement in Maryland also gives evidence for the effectiveness of intensified police activity.

Evaluation of Penalties

As Ross (*1982b*) notes in his review, the studies of law changes involving only penalties have been very limited. He describes in his book only three, all of which, as Voas (*1982b*) points out, were cases in which the threatened penalty was not actually implemented. Homel (*1980*) provides a review more specifically directed at the effects of sanctions, and Hagen, et al. (1978) have reviewed several U.S. studies. A brief review of the most salient studies of penalties in the United States is presented below under three broad headings: Effects on General Deterrence, Effects on Specific Deterrence, and the Extent of the Distribution of the Courts.

Studies of General Deterrence

I. Imprisonment

A major argument for the use of imprisonment as a penalty for DUI is its supposed effect on general deterrence. However, the evidence for such an effect is sparse.

The Chicago Crackdown

During the Christmas period of 1970, Chicago Judge Raymond Berg attempted to increase the penalties on convicted drinking drivers by specifying a minimum 7 day jail sentence. While there were initial claims that this reduced drinking and driving accidents, a study by Robertson, et al., (1973) demonstrated that the threat was not carried out and that, in fact, only a few drivers (approximately 10%) actually served seven-day jail sentences. Moreover, accident rates in the Chicago

FIGURE 4-5

OVERVIEW OF PENALTIES APPLIED TO CONVICTED DRINKING DRIVERS

		1	2	3	4	5	6	7	
PENALTY	DESCRIPTION/NOTES	RETRI-BUTION	INCAPAC-ITATION	REHABIL-ITATION	SPECIFIC DETERRENCE	GENERAL DETERRENCE	RESTITUTION	FINANCIAL SUPPORT	SYSTEMS STRESS
TRADITIONAL									
Jail	Duration and type of facility and scheduling most important variables	X	Short term	–	Research negative	Research negative	–	Expen-sive	High
License Actions	Three types: Restriction, suspension, revocation Varies in length	X	Rela-tively long term	–	Research positive	No research	–	Low cost	High
Fines	Monetary penalties include fines, fees, and assessments	X	None	–	Research positive	No research	May contrib-ute to Victims Fund	Provides funds	Little
Probation/Suspension of Sentence	Extent of monitoring is significant	X	?	?	Research inconclu-sive	No research	?	Expen-sive	Little
NON-TRADITIONAL									
Community Service	Includes service to injured party	X	None	?	No research	No research	Yes	Moderate cost	Little
Vehicle Impoundment	Includes vehicle tag confis-cation, vehicle impoundment, and vehicle confiscation	X	Long term	–	No research	No research	–	Moderate cost	High
TREATMENT/ REHABILITATION									
Driver Improvement and Rehabilitation	Didactic educational programs primarily applicable to social drinkers	–	None	Some	Research positive	No research	–	Expen-sive	Little
Treatment Program	Group therapy primarily applicable to problem drinkers/ alcoholics	–	None	Partial	Research positive	No research	–	Expen-sive	Moderate
Abstinence Requirements	Monitored programs involving supervised antiabuse or measures for monitoring drinking	X	Long term	Partial	Research equivocal	No research	–	Moderate cost	Little

area did not differ significantly from a nearby control area, Milwaukee.

The State of Washington One-Day Jail Sentence

In 1980, the State of Washington enacted a new drinking-driving law which, among its provisions, provided for a one-day jail sentence for all first-time DWI offenders. The initial results of a study by Jacobson (*1980*) indicated that there was no evidence that this new law had had an impact on accidents in the State of Washington. Even if a general deterrent impact had been demonstrated, it would be difficult to separate the effect of the penalty from other elements of the new legislation which included a new illegal per se law. The study is important, however, from the fact that it indicated that the intent of the law was carried out in that jail sentences increased from 10% to 50% of DWI convictions before the law to nearly 100% following implementation of the new law.

II. License Action

Polling results indicate that the most feared penalty for DWI among drivers who have not been arrested is the loss of license. However, no studies which clearly demonstrate the effectiveness of the license action (independent from other sanctions) for *general deterrence* have been reported.

Connecticut Crackdown on Speeders

In this well-known study by Ross and Campbell (1968), the Governor of Connecticut claimed that individuals who were arrested and convicted of speeding would lose their licenses. The principal feature of the program appeared to be the increased penalty related to suspension of the driving privilege. A detailed study of the program found, however, that, despite the policy of the government, the loss of license did not invariably follow on conviction and the impact of the program on accidents in Connecticut was not significant when compared with nearby States.

The Minnesota Administrative Per Se Law

The State of Minnesota enacted a provision to their implied consent law which required the suspension of the license not only for refusal to take the test, but in the event that the driver acquiesced to the test but had a result over .10% BAC, the license was also withdrawn. This toughened penalty appears to have been carried out as intended (with some delays due to court challenges). Reeder (*1981*) has reviewed this program under

contract to NHTSA and reports a claim that the probability of arrest is lower in Minnesota than elsewhere. However, there has been no scientific evaluation of the impact of this law in Minnesota.

III. Fines

The public appears less aware of the fine as a deterrent for drinking-driving. Advocate groups are more likely to push for jail or license restrictions as a general deterrent.

Vermont Young Drinking Driver Campaign

During the ASAP program, Waller and Worden (*1973*) developed a unique public information campaign directed at young drinking drivers. The campaign was based on roadside surveys which indicated that youthful drivers with high BACs were drinking beer but claimed to believe that beer had little or no alcoholic content. He also found that the drivers were unaware of the monetary penalties for drinking and driving, not only those imposed by the courts but also the increase in automobile insurance premiums. A campaign was developed which included a number of different issues. The alcohol content in beer was one of those presented. In addition, the cost to the individual of a drinking-driving conviction was also stressed. This campaign was measured through a follow-up roadside survey in which breath alcohol concentrations were collected. The results indicated that there was a small but statistically significant reduction in the BAC levels of young drivers following the campaign. The extent to which this can be attributed to the information on the penalties for drinking driving as compared to the other elements of the campaign is not known.

IV. Other "Penalties"

Treatment programs have been widely used as an alternative to traditional sanctions in the U.S. (see section on Health Approach). The extent to which they constitute a "penalty" which has a *general* deterrent effect is unknown. However, in at least one case, the stigmatizing of drunk driving as "sick" behavior appears to have had a deterrent effect.

The Lackland Air Force Base Experiment

The Lackland Air Force Base Experiment reported by Barmack and Payne (1961) is perhaps one of the best-known examples of a scientific evaluation of an alcohol safety program in the United States. This experiment is often treated as if it were a change in enforcement. However, the principal change appeared to be in the actions taken by the Military command at Lackland Air Force Base in the event of involvement in an alcohol-related accident or of an arrest for drinking and driving. Drunk driving was characterized as "sick" behavior and individuals who offended were required to receive a medical examination with the possibility that this would be followed with either psychiatric treatment and/or separation from the Service. This program was shown to have a marked effect on accidents involving airmen stationed at Lackland when compared to personnel at similar air force bases in Texas. If it is accepted that the principal change at Lackland was in the preceived penalty, this is probably the best example of a demonstrated impact from an increase in the penalty for drinking and driving. Its relevance for civilian traffic is limited, however, since the military obviously has considerably more power over its members than is available to the courts in the United States.

Summary

Overall, the studies of the general deterrent effect of penalties have been very limited. These studies have generally yielded negative results. However, the interpretation of these results is made difficult by the fact that, in most cases, the penalties provided by the law were not actually implemented. As a result, it is not clear whether the penalty itself is ineffective or whether stringent penalties fail because they cannot be implemented in the United States in the current climate formed by public attitudes toward drinking and driving. In order to separate the impact of the penalty itself from the probability of its implementation, a situation is needed in which the penalty is not only proposed but actually implemented across the board in a consistent manner so that its impact can be studied. The current emphasis being given to the drinking-driving problem and the extensive press coverage of the alcohol safety area may produce sufficient change in public attitudes to support more stringent penalties. This may provide an opportunity to conduct better studies of penalties than have been possible in the past.

Studies of Specific Deterrents

The largest and best-controlled studies of the impact upon individual offenders of a court-imposed remedy have concerned the effectiveness (or lack thereof) of education and treatment programs for drinking drivers. These studies (*Nichols, et al., 1978; Reis, 1982a, b, and 1983*), which are discussed in the section on the Health Approach, involved "no treatment controls" and random assignment which permits full experimental control of the treatments—a procedure which is not likely to be available in the study of the sanctions. The few studies of traditional sanctions which are available have generally involved correlational control for subject differences.

This lack of experimental control is important because reviews of the effectiveness of penalties in the criminal justice system have generally produced somewhat anomalous results from the standpoint of deterrence. As Zimring and Hawkins (*1973*) note:

> . . . those treated more leniently have lower rates of subsequent criminality than those punished more severely. But when such comparisons are controlled for differences in the offender groups other than types of punishment, the dominant feature of the results is that the over-

all differences between various methods of treatment are small or nonexistent.

These authors, as well as Homel (*1980*) and others, have suggested that the reason these studies do not find an effect is that there is an interaction between offender type and penalty such that the same sanction may improve the subsequent record of some, while having a negative effect on others.

I. Imprisonment

Imprisonment is believed by its proponents to have a high impact upon the offender. Hearing the cell doors "clang shut," it is argued, so impresses the errant driver that he will be unlikely to risk drinking and driving again. However, a considerable number, particularly of repeat DUI offenders, have been incarcerated previously and may be inured to the experience. For the poor or unemployed, it is possible that a brief period of imprisonment has less impact than loss of license or a heavy fine. In any case, there is no positive (and some negative) research evidence for the effectiveness of jail sentences for DUIs (Buikhuisen, *1969;* Homel, *1980*).

There have been no studies of the special deterrent effect of imprisonment on convicted drinking drivers in the U.S. But foreign studies provide evidence that relatively long-term imprisonment is not effective. The penalties applied for conviction for drunk driving in the Netherlands are relatively high, providing for fines up to $2,000, license suspensions up to 5 years, and prison terms up the 3 months. As with all nations, the actual penalties assessed may be significantly below the maximum permitted by law. However, in the westernmost populated area of the Netherlands, jail sentences were reported to be routinely applied (*Ross, 1982*). Buikhuisen (*1969*) studied the relationship between re-arrest for drinking and driving and the length of jail sentence. He found no statistically significant relationship and came to the conclusion that, while incarceration may eliminate re-offense during the jail term itself (incapacitation), it has no effect on the behavior of the drinking driver following release.

II. License Action

Despite the fact that most suspended drivers continue to operate their vehicles to some extent during the suspension period, license action appears to have a specific deterrent effect. The evidence for special deterrence effectiveness is stronger for this penalty than for any other DUI sanction.

License Suspension in California

Hagen and his coworkers (*1981*) conducted two studies in the State of California on the effect of suspension of the driving privilege on both accidents and repetition of the DWI offense. The first study involved the selection from the California driver license file of two matched groups of DWI offenders, one of which had received a license suspension. The members of the second group had not. In this study, Hagen (*1977*) found that both the accident frequency and the DWI re-arrest frequency was significantly lower for the license suspension group. However, the study is limited by the fact that the groups were equated through correlational rather than random assignment control and the study applied primarily to multiple offenders, since first offenders in California were rarely suspended.

In a second study, Hagen and his coworkers (1980) studied two "experimental counties" which implemented a 1 year treatment program under California Senate Bill 38 which, in return for a year's attendance at a treatment program, permitted multiple offenders to retain their licenses. These experimental counties were compared with counties that had not implemented this law. The results of this study supported the earlier study in the finding that individuals receiving a license suspension both in the experimental counties and in counties which did not implement the new law had lower accident rates than the individuals assigned to treatment.

License Suspension in Washington

Salzberg, et al. (*1981*) in Washington made a study of the driving records of habitual offenders (individuals with three or more serious violations) whose licenses to drive had been revoked and compared them to similar offenders who were allowed to retain their driving permits. Their data covered a period of almost 5 years and demonstrated that revoked drivers had fewer violations and only half as many accidents as drivers allowed to retain their licenses. These studies confirm the earlier findings of Coppin and Van Oldenbeek (*1965*) that individuals who are suspended continue to drive. However, the results of these more recent studies suggest that, despite this continued driving, their accident level is considerably below comparable drivers who do not receive a driving suspension.

III. Fines

Fines are generally assumed to be "painful" and promote specific deterrence by the desire to avoid a repetition of the sanction. However, for some, they may also produce at least a partial incapacitation, since money spent on fines cannot be spent on alcohol or gasoline. To the extent that higher fines are related to the ability to pay, they should be associated with lower recidivism rates, since offense rates tend to be lower among the employed, higher income groups. On the other hand, to the extent that lower fines are associated with jail—an alternative in the U.S. for those unable to pay—a higher rate could result. For these and other "reasons," no simple relationship between the amount of a fine and recidivism should be expected—a fact which is confirmed by a study by Blumenthal and Ross (*1973*), who found no difference between the recidivism rates of 500 first offender DUI drivers

fined, put on probation or referred to rehabilitation programs.

IV. Probation and Monitoring

There is some evidence (provided by the studies of warning letters to traffic offenders) that continued official contact with offenders can have a beneficial effect on behavior. The evidence for the effectiveness of probation—both formal and informal—with drinking drivers is mixed.

The Tennessee Probation Demonstration

This project (*Holden and Steward, 1981*) compared the effect of informal probation (the control group) with supervised probation (12 monthly meetings with probation counselors) and supervised probation plus a treatment/rehabilitation program in 4100 DUIs and found no differences in recidivism or accident rates during the 2 years following conviction.

The Mississippi Probation Demonstration

This study (*Landum, et al., 1980*) compared four "problem drinker" and four "social drinker" groups of 100 DUI drivers. Within drinker types, drivers were randomly assigned to four treatments: (1) probation only, (2) rehabilitation only, (3) combined probation with rehabilitation, and (4) control. No differences in recidivism over the 2 years following conviction were found. However, a rather unexpected reduction in recidivism was found among those selected (at random) for 6- and 12-month followup interviews to administer a "Life Activities Inventory." This result cannot be adequately explained.

Sacramento Comprehensive DUI Treatment Demonstration

In addition to studying the effect of various treatment procedures (see section on Health Approach), this demonstration project (*Reis, 1982b*) collected evidence on the effects of "warning" letters. No difference in accident or recidivism rates was found between randomly assigned groups of convicted DUIs who received or did not receive "warning" letters. Another procedure studied was the 15 minute biweekly meetings which multiple offenders were required to attend for 1 year. During the first year, this biweekly group did as well as those receiving treatment (41% better than the no-treatment controls). However, following the end of the one-year program, the relative advantage of this group declined. By the end of the third year, the biweekly group had only a 14% advantage over the control groups as compared to 26% lower recidivism rate for the multiple offenders who received treatment as well as biweekly meetings (*Reis, 1982a*).

Summary

The sanction literature does not provide strong support for the concept of deterrence—either general or specific with regard to penalties. Ross (*1982*) comes to this conclusion regarding general deterrence.

The experiences reported here do not support the deterrence model in the matter of severity of penalty. It could not be demonstrated that the increase in the statutory severity of sanctions in Finland, the increase in the threat of judicial severity in Chicago, or the increase in actual judicial severity in Traffictown produced declines in indexes of the threatened behavior. However, conclusions about severity based on these cases must be qualified by the knowledge that the drinking-and-driving offense is one for which the general level of certainty of punishment is extremely low.

I suggest that there may well be interaction between severity and certainty—that if the probability of punishment is so low as to be negligible, then severity of the threatened punishment cannot be expected to influence behavior. The studies reviewed here in their cumulative impact justify the policy recommendation to avoid dependence on severe penalties in attempting to cope with drinking and driving, at least as long as the probability of an offender's being apprehended remains very low.

Another factor behind the lack of demonstrable impact traceable to severe sanctions is their disruptive effect on the court system. As Voas (*1982b*) suggests, the evidence indicates severe sanctions are ineffective because they are not implemented. Whether they would be effective if imposed consistently remains to be determined. The continuing pressure from advocate groups such as MADD may provide an environment in which this test can be made.

Health Care Programs

In recent years it has become more and more popular in the United States to regard problem drinking (including alcoholism) as a health problem rather than a crime. In 1967, the President's Commission on Law Enforcement and Administration of Justice estimated that from 40% to 49% of all non-traffic arrests in the U.S. were for alcohol-related offenses (President's Commission on Law Enforcement and Administration of Justice, 1967). Recently, Roizen (*1982*) has reviewed the literature on drinking and crime. She found that up to 85% of homicide offenders and homicide victims had been drinking. The Commission recommended that "drunkenness be taken out of the criminal justice system by establishing detoxification units as part of comprehensive treatment programs and by coordinating and extending aftercare resources.

Paralleling the movement to treat rather than punish drunkenness, some highway safety specialists recommended a health approach for dealing with the drinking drivers. At a conference in 1969, Filkins, of the University of Michigan, described the major functional elements of such an approach as case-finding, diagnosis, prescription, treatment, follow-up and evaluation (Filkins 1969). He recommended that the legal system and the health system better coordinate their efforts in perform-

ing these functions. Filkins also recommended that the legal system act "as the primary case-finders for the immediate future, and (it) should continue to play a prominent role in these functions" of a "combined health-legal approach." Joscelyn and Jones (1971) further developed the concept of a combined approach in their 1970 study which envisaged a drinking-driver control system consisting of agencies of the traffic law system and an even more informal alcoholism control system to treat and rehabilitate drunken drivers.

Targets of the Health Approach

By its very nature, the health approach is directed at controlling the precrash behavior of drivers. The popularity group dealt with is predetermined by its most common mode of entry into treatment and rehabilitation programs and is, therefore, composed of persons arrested for and, for the most part, convicted of, driving while intoxicated or some similar offense. As such, nearly all members of the group will have been legally drunk with BACs of .10% or more at the time of their arrest. Of some 200,000 drinking drivers referred to treatment in the 35 ASAP communities, 50% were classified as problem drinkers, one-third as social drinkers, and the rest not classified by the court diagnostic programs implemented in these projects (*Nichols, et al., 1978*). Reis (*1982a*) found that 90% of *second* offenders could be classified as problem drinkers.

A further breakdown of target populations in order to provide treatments more suitable to specific needs does not generally occur as a part of the court diagnostic program in most jurisdictions. More detailed diagnostic efforts to provide a basis for attempts to deal differentially with subgroups of persons arrested for driving while intoxicated are normally conducted by the treatment agencies, rather than the courts.

In the health approach, the initial function of the traffic law system (TLS) is that of case-finding, identifying individuals among the population of arrested drinking drivers who pose an unacceptably high risk of causing an alcohol-related crash. As in the case of the strictly legal approach, TLS legislative and enforcement components have been the primary performers of the case-finding function, proscribing risky behavior by laws and regulations and by arresting violators of the laws. In general, these laws and the manner in which they have been enforced have not differentiated drivers according to whether they are subsequently to be dealt with through a legal approach or a health approach.

The diagnosis and referral functions are concerned with determining the problem that brought the individual into the drinking-driver control system, and with specifying how the problem is to be treated (Joscelyn and Jones, 1971; Joscelyn, Maickel, and Goldenbaum, 1971; U.S. Department of Transportation, 1975a). The functions are performed by the adjudication and sanctioning components of the TLS within the constraints provided by the body of law. The formal mechanism used by the TLS is the probation system, through which an individual is offered treatment in exchange for a less severe and/or a suspended sanction.

Referral to medical treatment by direct sentencing is not authorized in any State, but several States authorize civil commitment for chronic alcoholics (Reese, et al., 1974). The approach has seldom been used in dealing with problem-drinking drivers (Joscelyn and Jones, 1971; Joscelyn and Jones, 1972). By contrast, referral to nonmedical rehabilitation (schools for persons with DWI convictions) has been authorized by statutes in several States (Reese, et al., 1974; NHTSA, *1983b*).

An extremely wide variety of procedures and methods have been used by the courts in performing diagnosis and referral, especially since the implementation of the ASAP program. The variety of points in the adjudication processes at which diagnosis occurred (Figure 4-3) is illustrative of current practices. Some jurisdictions perform the two functions even before the adjudicative hearing has occurred. In these jurisdictions, the prosecutor plays a key role in the process, determining both the nature and the provider of the treatment. The prosecutor obtains the driver's agreement to undergo treatment and/or rehabilitation in exchange for a promise not to prosecute for the original driving-while-intoxicated charge or, in some cases, any charge. When all charges are dropped, "pretrial diversion" is said to have occurred, and the prosecutor performs the traditional probationary function of the court.

In other jurisdictions, it is more common for diagnosis and referral to occur after the adjudicative hearing. Here, the normal procedure is for the judge to perform the two functions, usually before (but sometimes after) sentencing. In a relatively small percentage of jurisdictions, diagnosis and referral may occur during the treatment process itself, for example, while an individual is attending DWI school.

A critical support function to diagnosis and referral is the provision of information for decision-making. The formal means by which such information is provided is misleadingly called a "presentence investigation" (PSI) because it was originally used in felony cases just prior to sentencing (Reis, et al., 1974). The kinds of information included in a PSI for use in drinking-driving violations vary widely from driver records to a broad range of social, psychological, medical, and economic background information (U.S. Department of Transportation, 1975a).

The sources of information for diagnosis and referral at Alcohol Safety Action Project sites (which are typical of current court programs) were listed in the National Highway Traffic Safety Administration's 1974 "Evaluation of Operations" as:

- A check of the offender's driving and criminal records for arrests and convictions involving alcohol, including BAC at the time of arrest.

Table 4-3.—Stages at Which Background Investigation-Diagnosis Occurred at ASAP Sites

Project	Pre-trial	Presen-tence	Postsen-tence	In treat-ment
Albuquerque	×			
Charlotte	×	×		
Denver		×		
Wisconsin		×		
Nassau County, NY				×
Portland-Eugene		×		
Seattle		×		
Vermont				×
Washtenaw County, MI		×		
Baltimore	×	×	×	
Boston		×		
Cincinnati		×		
Columbus, GA	×	×		×
Fairfax County, VA	×			
Hennepin County, MN			×	
Indianapolis		×		
Kansas City	×	×	×	
Lincoln		×		
Tampa		×		
New Hampshire	×	×		
New Orleans		×		
Oklahoma City		×		
Phoenix	×	×		
Portland, ME	×	×	×	
Pulaski County, AR	×	×	×	
Richland County, SC	×	×		
San Antonio		×		
South Dakota		×		
Wichita	×	×		
Delaware		×		
Idaho		×		
Los Angeles County		×	×	
Puerto Rico			×	
Salt Lake City		×		
Sioux City		×		

- A check for previous contacts with local health or social service agencies (rarely used).
- A personal interview of the offender by the presentence investigator.
- An interview with the offender's family, friends, and employer (rarely applied because of time constraints).
- A written diagnostic test of problem drinking.
- An in-depth medical or psychological evaluation by physicians, psychologists, psychiatrists, or psychiatric social workers (normally done only after referral to treatment).

(U.S. Department of Transportation, 1975a, ch. 5)

The principal problem for the courts in the referral of drinking drivers to treatment is the need to identify the extent of the client's drinking problem in order to make an effective referral. The time available to probation officers and other court workers to make this identification is limited and few of them are specifically trained in alcohol problems. Prior to the implementation of the ASAP program, the most widely used method was simply an informal interview with the defendant. In some courts, a diagnostic test was used—most generally the Michigan Alcohol Safety Test (MAST), developed by Selzer (1971). This test, however, was developed on a group of hospitalized alcoholics and contains questions which appeared to be too obvious and perhaps inappropriate for use with the drinking-driver population.

As part of the ASAP program, NHTSA funded the development of a more subtle questionnaire appropriate to drinking drivers (Filkins, et al., 1973). This Mortimer-Filkins test became the most widely used device within the ASAP court system for identifying individuals who should be referred to treatment. This diagnostic procedure, which involves both a test and interview, still requires considerable time from the probation officer (40 minutes to an hour) and many courts found this to be excessive in relationship to the staff availability. Attempts to make use of the questionnaire form alone indicated that this significantly reduced the validity of the test (*Ennis and Vingilis, 1981*). Several other devices are currently in use for diagnosing problem drinkers in the court. (See Pattison [*1982*] for overall review of the problem of diagnosing alcoholism.)

The significance of the requirement on the court to make an initial identification of drinker category should be kept in mind. The program typically provided to individuals identified as social drinkers is relatively short (frequently a total of 12 hours spread over 4 weeks), compared to the relatively long and intensive treatment provided to problem drinkers (Reis (*1982a*)) found that at least a year's treatment was necessary). The court needs to make this identification in order to establish a probation requirements to be applied to the of-

fender. However, unlike a treatment agency, the court does not need to determine what specific treatment modality will be most effective for a particular individual. The four areas which require assessment at the court level are:

1. Assessment of Drinking Quantity-Frequency

Most of the current assessment effort at the court level is directed at categorizing defendants into one of two or three groups, typically described as "problem drinkers" versus "social drinkers." It is important to keep in mind that drinking practices as described in Chapter 3, fall along a continuum and not into discrete categories. Some ASAP sites and a number of current court programs categorized drinkers into three groups: social drinkers, and level 1 and level 2 problem drinkers.

2. Driving Risk

A problem of critical importance to the court is the safeguarding of the public and of the offender. The court, therefore, needs to have an assessment of the risk that a given offender will drink and drive again. This assessment is primarily utilzied in determining whether a license suspension should be applied, and if applied, whether a vocational license which allows the offender to drive to and from work should be approved. In the ASAP program, the retention of the driver license was often made a motivator for voluntary attendance at treatment. With increasing emphasis on tough penalties, this practice is disappearing. However, limited vocational licenses are still frequently provided. It is important, therefore, for the court to determine what risk convicted drinking drivers present to the public and to themselves if they are permitted to continue to drive.

The ASAP results (*Nichols, et al., 1978*) indicated that problem drinkers had approximately twice the probability of reoffending as social drinkers. Much of this relationship is probably due to the fact that the most problem drinkers are second offenders and the previous driving record is the best predictor of future accident and violation involvement.

In addition to driving record, there is evidence that driving risk can be assessed in part through personality factors. Donovan and Marlatt (*1982*), Booth and Gosswiler (*1978*), and Perrine (*1975*), have identified a number of driver record factors which can be used in predict recidivism and accident involvement.

3. Probability of Compliance with Treatment Requirements

Most studies of treatment programs indicate that a significant portion of those who enter such programs as a result of conviction for drinking and driving fail to complete treatment. The proportion who fail to complete treatment generally depends upon the length and rigorousness of the treatment program. Reis (*1982a*) found, for example, that 30% of the multiple offenders referred to a year-long educational counseling program failed to complete that program, while 45% of those assigned to attend an educational counseling program, including chemotherapy, failed to complete. The court needs to have some measure of the probability that an individual who is assigned to treatment will in fact complete the program, since other measures may be appropriate to those who will not, or cannot, complete a treatment program. Gibbs and Flanagan (*1977*) have reported on sets of factors which appear to be predictive of success in treatment programs. Whether their measures can be used in questionnaires to be administered by court probation officers remains to be determined.

4. Tendency to Use Other Drugs

Those individuals among the clients referred from the court to treatment agencies who use other drugs in addition to alcohol may need special treatment programs. In general, those agencies which provide treatment for drinking drivers also have the facility for treating drug abuse. However, in some cases this may not be true. In addition, the court may wish to prolong the treatment requirement for those who have problems with drugs in addition to alcohol. This, there is a requirement at the court level for assessing the extent to which individuals arrested and convicted of drinking and driving are polydrug users.

At this time, most courts limit their assessment to the first of these four elements. There is a need for the development of appropriate measures for the other three factors which are designed to be used by court staff who are not specialists in alcohol or sustance abuse.

Treatment and Rehabilitation

In 1977, there were 5,900 facilities operating alcoholism programs in the United States and treating 2.4 million clients (*Vischi, et al., 1980*). These facilities were treating a wide variety of clients with a number of different methods. Boche (*1975*) described the major elements of treatment programs as: (1) outreach, assessment, referral; (2) crisis management/detoxification; (3) primary treatment and rehabilitation; (4) transitional/aftercare/extended care; and (5) supportive services. Aside from the assessment and referral element, these treatment services can and do take place both in hospitals, nonhospitals, and residential settings.

Court-based drinking-driving programs have served principally as an assessment and referral system to primary treatment and rehabilitation in the case of the problem drinkers. Making use in most cases of already existing community facilities, few of the court-referred problem drinkers are treated in hospital settings, most being treated in nonresidential facilities which treat other alcohol and drug abuse clients on an outpatient basis.

Drinking-driver rehabilitation programs have fallen into two major classes: educational or didactic training programs for social drinkers, and group therapy and, more rarely, individual therapy or chemotherapy programs for problem drink-

ers. Most programs for social drinkers follow an educational approach based on the archetypical Phoenix DWI course. Since its first formal session took place in 1966, the course has served as a prototype for over 400 programs in the U.S. and Canada (Malfetti and Simon, 1974). Between 1966 and 1973, over 15,000 people convicted of driving while intoxicated attended the course. The course consists of four sessions at weekly intervals, each session lasting about 2½ hours. The methods of instruction included informally structured discussion, films, reading materials, and oral and written exercises requiring self-analysis.

The majority (62%) of all ASAP clients entered such education programs (*Nichols, et al., 1978*). Of those identified as social drinkers, 87% were referred to educational programs, while of those identified by the courts as problem drinkers, 40% were assigned to safety schools. Overall, of the 125,000 persons who entered ASAP schools, approximately 45% were social drinkers, 32% were problem drinkers, and 23% were unidentified drinker types (*Weinstein, 1978*).

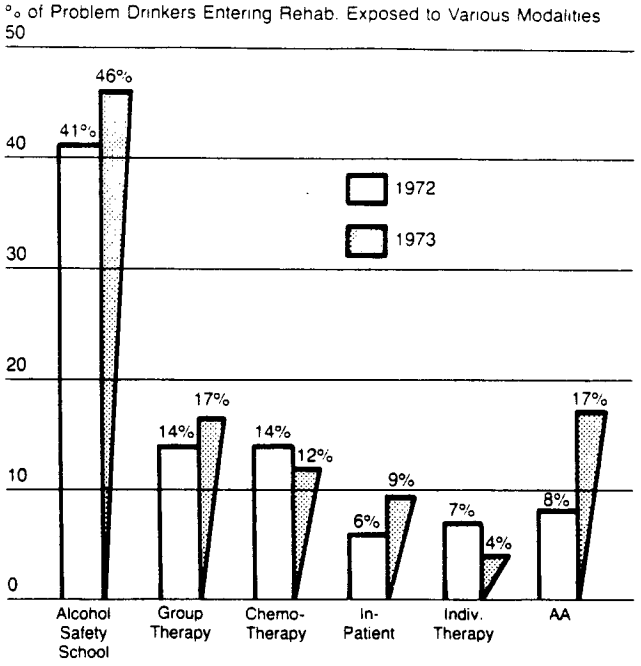
In addition to the normal lecture-presentation of the educational material in these programs, a procedure for providing materials for study at home was developed during the ASAP program. This procedure permits the coverage of the educational materials at lower cost and with less time required of the participant. It was originally developed as a method for providing an informal control group for research on the effectiveness of treatment programs, but when evaluated was found to be an effective means of information presentation, providing the home study was supported by the threat of a test which insured that the clients had made use of the materials (*Reis, 1982b*).

The second major category of treatment programs utilized in the ASAP effort involved the application of psychotherapy or chemotherapy to individuals identified as problem drinkers. An indication of the types of therapy used and the proportions of problem drinkers assigned to these therapies is given in Figure 4-6, which shows the percentage of problem drinkers entering various ASAP treatment programs in 1972-73 (U.S. Department of Transportation, 1975a). The distribution shown in Figure 4-6 is probably reasonably typical of current post-ASAP court programs. Because many courts and communities lack the resources to provide the more expensive group and chemotherapy, a large portion—perhaps as much as half of problem drinkers—still attend alcohol safety schools, even though the ASAP experience (Nichols and Reis, 1974) indicated that didactic lecture programs were less successful with problem drinkers (see Evaluation section below).

Evaluation of the Health Approach

The evaluation of treatment programs for problem drinkers and alcoholics has proven to be a difficult process, with considerable controversy and

Figure 4-6 Use of Basic Treatment Modalities for ASAP Problem Drinkers in 1973



SOURCE: U.S. Department of Transportation 1975a, ch. 5, p.7

relatively few, carefully controlled research studies. Diesenhaus (*1982*) has recently reviewed the current trends in treatment programming for problem drinkers and alcoholics. Mandell, (*1979*), and Yahr, (*1983*), have recently completed reviews of evaluation studies of alcohol treatment programs, while Mann, et al., (*1983*) have reviewed the effectiveness of rehabilitation programs for drinking drivers. Yahr has described well a number of the problems which present themselves to treatment program evaluation:

1. Failure to describe fully the characteristics of the treatment being evaluated.
2. Failure to adequately measure the client characteristics.
3. Interaction between client types and treatment types complicate program evaluation.
4. Many treatment outcome measures have been used, making comparisons between studies difficult.
5. Many studies lack adequate research designs.
6. In some studies, the follow-up period after treatment is too short to reflect the true impact of the program.
7. Many studies lack adequate statistical analysis procedures.

All of these problems are applicable to the evaluation of treatment programs for drinking drivers. However, the evaluators of court-based drunk-driver programs have had certain advantages in that (1) the clients are under court supervision and this often makes it easier to collect follow-up data; (2) several court districts have been willing to establish programs which permit experimental con-

trol (random assignment and no treatment controls); and (3) driver record data (accidents, violations, and arrests for DWI) provides an objective outcome measure for program evaluation. The ASAP program provided the first opportunities to develop well-controlled evaluations of treatment effectiveness. Both the NHTSA (*Nichols, et al., 1978*) and the National Institute for Alcohol Abuse and Alcoholism (NIAAA) (*Eagleston, et al., 1975*) attempted to evaluate treatment programs at ASAP sites.

Eagleston and his coworkers evaluated 18 problem drinking-driver programs established by the NIAAA to operate in conjunction with the ASAPs. They came to the conclusion that these treatment programs produced a positive change on client drinking patterns and other behavioral measures when measured at intake and 6 months following intake. They noted particularly some of the differences between the problem drinkers entering these treatment facilities as a result of a drinking-driving conviction and those clients that entered from another source.

Figure 4-7 provides an interesting example of the differences between a problem drinking group and other sources of input into a treatment center prepared by Ferguson and Kirk (*1979*). It's interesting to note that while there were fewer abstainers among the drinking drivers, the average alcohol consumption was considerably lower than those entering treatment from other sources. The drinking drivers also appeared to be considerably less impaired by alcohol in their life status and were more likely to be employed than other entrants into treatment centers. These data suggest that a drinking driver control system identifies individuals at an earlier stage in their problem drinking and may provide to treatment centers a group with a better prognosis because they have more societal support (intact marriages, families, jobs) than the average person who seeks or is assigned to alcohol treatment.

ASAP treatment evaluation occurred at three levels: the individual project level, multi-project summary evaluations, and overall program evaluations.

Seventeen project level evaluations of ASAP DWI schools were summarized by Ellingstad (1976). The schools were evaluated with respect to their effectiveness in influencing accident involvement; rearrest for DWI; and life changes, knowledge changes, and attitude changes relative to drinking and driving. Of the evaluations which used "adequate comparison groups and a statistical comparison," none showed any positive effect on rearrest rates. A rigorous evaluation of one ASAP DWI school found no difference in subsequent drunk-driving conviction rates between drivers who had attended the school and drivers who had not.

Nichols, et al. (*1978*) summarized the results of the ASAP studies. They reported that the educational/treatment programs to which social drinkers were referred appeared to make a small reduction in the probability that these convicted drinking drivers would not reoffend, as shown in Figure 4-8. In this Figure, survival rates (the proportion of drivers *not* rearrested) are plotted as a function of months after entry into treatment. Social drinkers who received treatment are compared with those who were not referred to treatment. While these data did not come from experimentally controlled studies in which random assignment was used, the number of cases involved is so large that the differences between the two groups in the proportion rearrested are believed to be reliable.

In contrast to this positive finding for the social drinkers assigned to treatment programs, the results in the ASAP program with regard to problem drinkers assigned to treatment programs were negative. In the case of problem drinkers, it was possible to establish more rigorously controlled experiments in which problem drinkers were randomly assigned to a therapy or no-therapy condition. The rearrest rate for the pooled data from all the ASAP projects for problem drinkers is shown in Figure 4-9. Here there is no clear advantage for those who were referred to treatment. If anything, they do more poorly.

In addition to these basic findings with regard to the treatment of social and problem drinkers, some tentative findings were made with regard to the types of treatment. In general, it appeared that programs which involved small interactional groups, as in group therapy, were more likely to have an impact than those which involved large classroom lecture programs. This is illustrated in Figure 4-10 for summed data for all types of drinkers assigned to treatment in the ASAP program.

In addition, some data were collected on the effectiveness of supervised Antabuse programs for drinking drivers who were diagnosed to be problem drinkers. Unlike the majority of problem drinkers assigned to treatment in the ASAP program, those who received Antabuse treatment appeared to do better than the control groups. The data were too limited, however, to draw any firm conclusions.

Finally, some experimentation was conducted with the use of home study programs in place of large lectures to transmit information on the drinking-driving problem to students. Where such information was provided to the students and they were not required to take tests following the use of the material, home study had little or no effect. But where (as in Phoenix, Arizona [*Swenson and Clay, 1977*]) the students were required to pass a test on the material, it was found that the home study program was as effective as the lecture program in reducing recidivism.

Following the close of the ASAP program, NHTSA funded a large demonstration program in Sacramento to evalute more rigorously, than had been possible in the ASAP program, the effective-

Figure 4-7.—Changes in Alcohol Consumption, Impairment, and Social Function in NIAAA-Funded Programs, 1978*

Program type [1]	(N)	Drinking behavior during past 30 days											
		Percent abstaining		Average ethanol consumed per day in ounces		Average number of drinking days		Impairment index		Average number of days worked		Employment rate	
		Intake	Followup	Intake	Followup	Intake	Followup	Intake	Followup	Intake	Followup	Intake	Followup
Alcoholism treatment center	2,183	12	47	4.0	1.4	13	6	12.1	8.1	13	14	70	80
Problem drinking driver	1,257	8	46	2.2	.6	12	5	7.1	3.8	16	17	83	87
Public inebriate	441	20	64	6.6	1.9	13	4	18.8	16.3	5	8	21	43
Poverty	2,634	18	55	4.5	1.6	13	6	15.4	11.4	11	13	58	74
Occupational	137	13	67	5.7	1.1	17	4	14.8	7.8	18	20	89	91
Cross-population	1,507	18	56	4.8	1.7	13	6	16.0	12.0	11	13	65	76
Amercian Indian, Alaska Native	570	16	42	5.6	2.7	10	6	14.1	11.9	6	8	33	51
Criminal justice	238	32	76	4.4	.6	11	2	14.5	8.4	7	8	34	41
Women	295	31	73	3.7	.5	11	3	17.9	12.6	7	10	47	68
Spanish	574	13	51	1.2	.5	8	4	4.7	3.5	18	18	82	87
Black	258	13	42	6.9	2.0	17	8	13.7	8.9	8	11	43	62

* Ferguson and Kirk (*1979*).

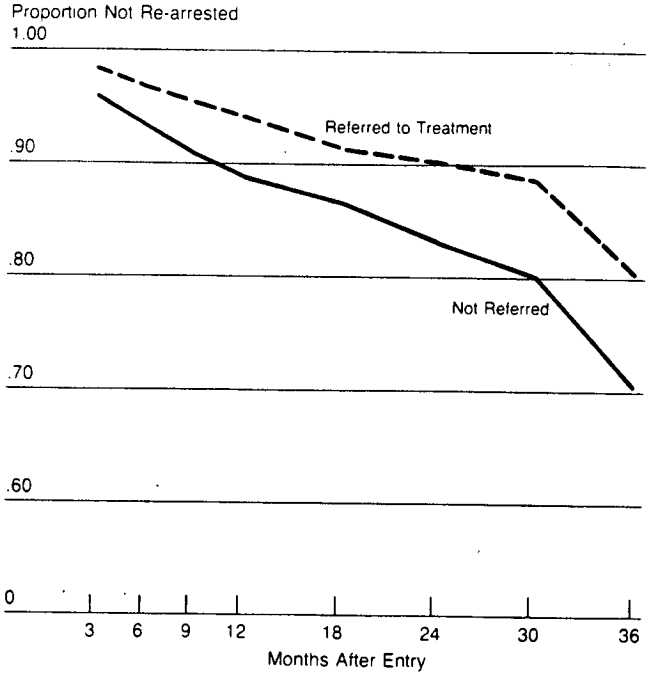
[1] Sample size varies slightly for each program type and for each variable reported on. Actual sample size available in Ferguson and Kirk 1980.

[2] The Impairment index is a multiitem scale that is completed at intake and followup. The index captures information about the occurrence of signs of behavioral impairment or physical dependence during the preceding 30 days; the higher the score, the greater the alcohol-related impairment.

ness of treatment for problem drinkers and education for social drinkers (*Reis, 1983*). In this program, multiple offenders (90% of whom were diagnosed to be problem drinkers) were randomly assigned to two major types of therapy: traditional group therapy and a novel "skills training" system, which attempted to assist the problem drinkers to overcome social inadequacies which were hypothesized to underlie their drinking problem. In addition to attending these therapy sessions, the clients were required to attend biweekly interview sessions under the California law, which provided for treatment programs for multiple offenders. Under this law, those who participated in the treatment program were required to attend for a 1 year period (a somewhat longer time than the typical ASAP period, which had been limited in general to no more than 6 months).

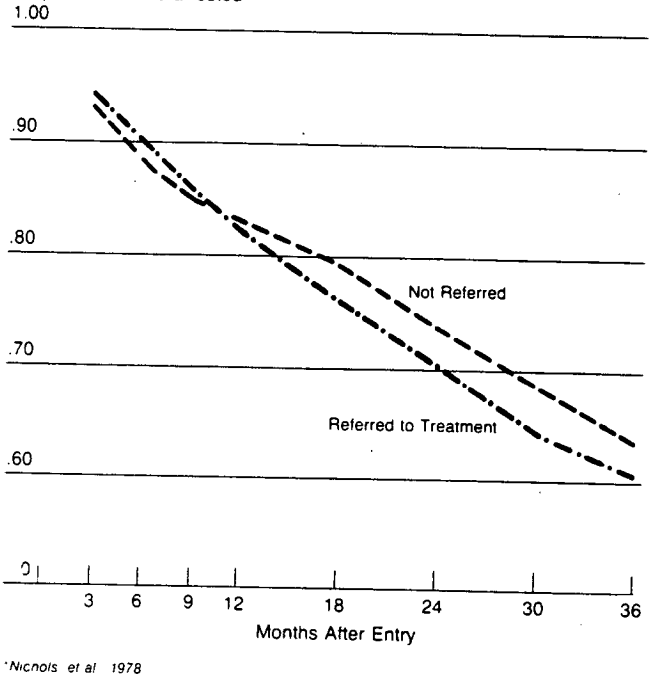
The results of this study of multiple DUI offenders (*Reis, 1982a*) indicated that a relatively intensive treatment program conducted for a period of at least a year, could produce a reduction in the recidivism rate of problem drinkers, as shown in Figure 4-11. Thus, the result for this large study, which was better controlled than those carried out in the ASAP program tended to demonstrate a positive, rather than a negative, result for the

Figure 4-8 Survival Rates for Social Drinkers Referred and Not Referred to Treatment*



*Nichols, et al., 1978

Figure 4-9 Survival Rates for Problem Drinkers Referred and Not Referred to Treatment*

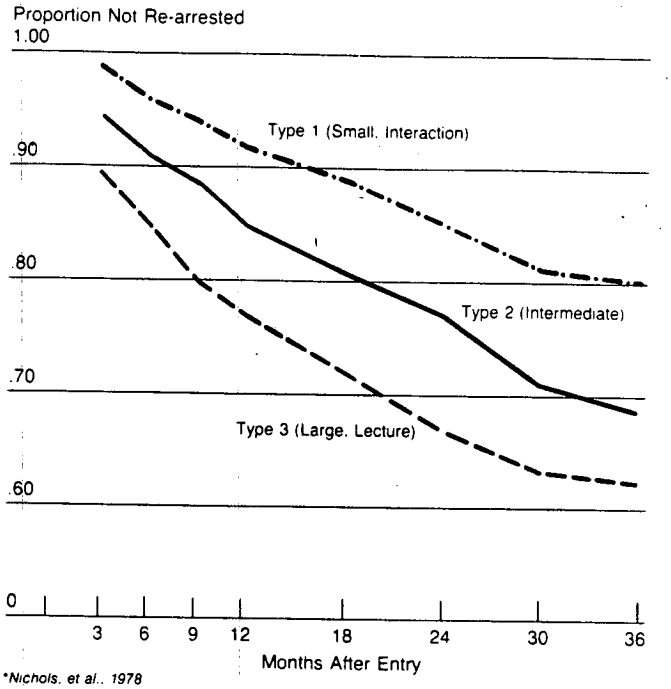


*Nichols et al 1978

effectiveness of treatment of problem drinkers. Reis attributed the difference, at least in part, to the length of treatment.

It is important to note that while the problem drinkers who received therapy were clearly better than the controls who received no treatment, a group of problem drinkers who were not treated

Figure 4-10 Survival Rates for Undifferentiated Drinker Types Attending Three Types of Alcohol Education Schools*



*Nichols, et al., 1978

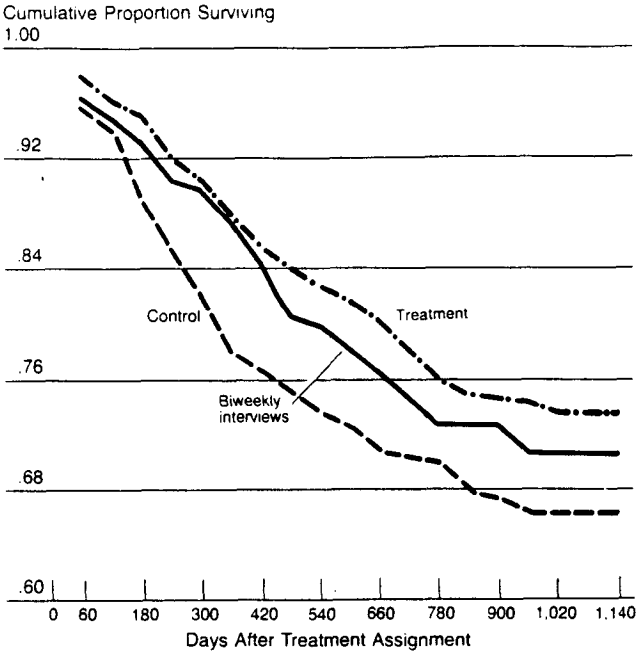
but were required to attend biweekly individual interviews did as well as those who were treated—for the first year following entry into the treatment. In the second year, however, the treated group were clearly better than both the biweekly interview and control groups.

Using treatment programs to reduce the recidivism of problem drinkers appears to be difficult and expensive. Convicted drinking drivers diagnosed to be problem drinkers appear to benefit from treatment programs which provide small group settings (Nichols and Reis *1974*) and which are intensive and extensive enough to impact their drinking problem. While the exact length of time required clearly must vary with the individual and is not well defined, it appears that programs of less than a year's duration are not likely to be effective, at least on a group basis.

The exact types of therapy which are most effective have not been identified. It appears that traditional group therapy, which focuses upon the alcohol consumption as the central issue in treatment, is at least as effective as those procedures which attempt to treat the drinking problem by focusing on emotional and personality issues believed to underlie problem drinking *(Reis, 1982a)*.

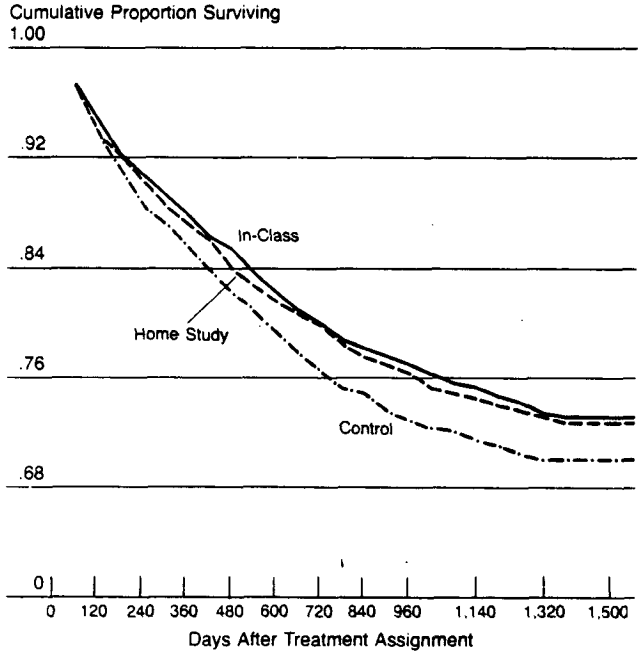
Considerable additional evaluation of treatment programs will be necessary before the types of procedures and the lengths of treatment required for drinkers of various types can be specified with any precision. Nevertheless, as Mann, et al. *(1983)*, note in their review of evaluations of DWI rehabilitation programs, the pessimism of the early assessments of the effectiveness of treatment programs for drinking drivers may have been prema-

Figure 4-11 Cumulative DUI Survival Rates for Three Groups of Multiple Offenders *(Reis, 1982a)*



ture. It appears that properly designed, intensive therapy programs, with sufficient duration may have beneficial effects on the knowledge, attitude and reoffense rates of drinking drivers.

Figure 4-12 Cumulative DUI Survival Rates for First Offender Treatment Groups *(Reis, 1982b)*



In addition to the study of problem drinkers, a random assignment study was established for first offenders, most of whom were social drinkers. First offenders received an education program principally using lecture and classroom techniques. Their recidivism rates were compared with a second group which received a home study course and, finally, with a third (control) group who received no treatment. This study *(Reis, 1982b)* confirmed the ASAP results which had demonstrated that social drinkers can benefit from an educational program. But, in addition, it demonstrated that a home study program can be as effective as a lecture program, as had been suggested by the results obtained at the Arizona ASAP. The results for the three treatments of first offenders are shown in Figure 4-12.

Taken together, the ASAP and Sacramento results appear to indicate that convicted drinking drivers who are diagnosed to be social drinkers can, as a group, benefit from a wide variety of educational and treatment programs. Attendance at such programs appears to produce a small reduction in the probability that they will be reconvicted of the drinking-driving offense.

Public Information and Education Campaigns

Public information and education campaigns have been developed for use as distinct countermeasures to the drinking-driving problem and for use in conjunction with other types of countermeasures. Public information programs directed at supporting enforcement activities have been discussed above under the section on the legal approach. In the following subsections of the present report, several examples of public information and education programs are described in terms of their targets, their methods, and their findings.

Targets of Public Information and Education Campaigns

There is considerable agreement among research specialists *(Wilde, et al., 1971; Lindemann, et al., 1980; Korenbaum, 1982)* that to be effective the specific behaviors to be modified and the specific groups to be contacted in PI&E campaigns must be identified. Most past alcohol in relation to highway safety public information and education campaigns have been directed toward the "social drinker" who may find himself in a situation in which he must decide how much to drink if he has to drive, or having consumed a given amount of alcohol, must decide whether to drive. Within the social drinker category, young drivers have frequently been singled out for education programs.

Two efforts of defining target populations for public information and education campaigns against drinking and driving are particularly worthy of note. The Vermont ASAP (Wordon, Waller, and Riley 1975) used the results of a roadside survey to identify the high-risk group, to determine the characteristics of the risky behavior indulged in by this group, to identify the type of media to which the group was normally exposed, to identify the appeals most likely to influence the group's behavior, and to evaluate the impact of the

resulting campaign. The target population thus defined by the Vermont ASAP consisted of males 16 to 30 years of age (45% teenage males), who were beer drinkers; were single, divorced, or separated; had less than high school educations; worked as laborers, operatives, farm workers, in service occupations, or were unemployed; had one or two traffic citations in the previous 3 years; went to drive-in movies with other young males; listened to the radio in their cars; looked at TV news; read newspapers; and went to auto races.

The target audiences defined by the 35 ASAPs in the U.S. (U.S. Dept. of Transportation, 1975a) have included bar patrons, package store patrons, legislatures, police, physicians, youths, drinking-drivers convicted of DWI, and the general drinking-driving population. Specifically excluded were problem drinkers who it was believed were unlikely to be able to respond to mass media appeals.

The second particularly noteworthy attempt to define a target population was made by Grey Advertising (1975). As a result of nationwide surveys in 1974, Grey concluded that campaigns on alcohol safety should focus on so-called "social conformers" and "aggressive restrainers," since these groups were found to account for both most of the people exposed to alcohol-related situations and for most of the situations. The groups were defined as follows:

- Social conformers: males and females, 20 to 45 years of age, well educated, higher than average income, white collar occupation; likely to offer to drive an intoxicated friend home or to ask him to stay over or to call a taxi if it is considered socially acceptable to do so; serve food with drinks; are moderately heavy drinkers, can identify the potential DWI situation and take action, and
- Agressive restrainers: males, less than 35 years of age, less education than social conformers, less income, residing in the northeastern U.S.; have positive attitudes towards alcohol, are less knowing of alcohol's effects, can identify potential DWI situation and take action; one-third find themselves in alcohol-related situations two or more times a week; one-half drink most often at home; are heaviest drinkers, prefer beer; friendships and affiliations are very important; willing to use physical restraint with intoxicated friends who decide to drive.

The objectives of programs aimed at these two groups should be, according to Grey Advertising:

- to correct misinformation about alcohol consumption,
- to identify potential DWI situations, and
- to persuade people to take appropriate action in potential DWI situations (Grey Advertising, Inc., 1975).

The extent to which the intended users of the Grey study, ASAP cites, actually adopted its recommendations is not known.

In 1982, NHTSA published the results of a new effort to identify the traget groups and target messages for public information programs *(Pawlowski, 1982a and 1982b)*. These studies used two techniques: individual interviews with early and middle adolescents, and young adults, and focus groups with parents of teenagers and groups of adult males. Both teenagers and their parents saw the problem of measuring and describing impairment due to alcohol as a major difficulty in their own decisions about drinking and driving and in influencing others regarding drinking and driving.

Parents and adult males stressed the need for massive public awareness campaigns because it was felt the general public did not understand the full significance of the DWI problem and its cost to society. Teenage respondents indicated that formal education had been of little value in influencing drinking and driving behavior, but there was indication that presentations by victims of traffic accidents produced a stronger emotional reaction and had a potential for a more lasting impact on behavior.

Of special interest was the apparent importance of parental influence on teenage drinking drivers, despite the fact that parents appear to rarely communicate with their children about the drinking-driving problem. Nevertheless, teenagers expressed concern about parental reactions to their drinking and driving.

Finally adults—both parents and single males—were reticent to take action to intervene in drinking-driving situations. Considerable effort in public information will be required to change the social climate to reduce the tolerance for irresponsible drinking and produce greater opposition to DWI and, thereby, encouraging intervention. Some of these themes are woven into a booklet *(Creative Associates, Inc., 1982)* developed under this effort which provides "suggestions for developing prevention programs to reduce the incidence of alcohol-impaired driving."

Applications of the Public Information and Education Campaigns

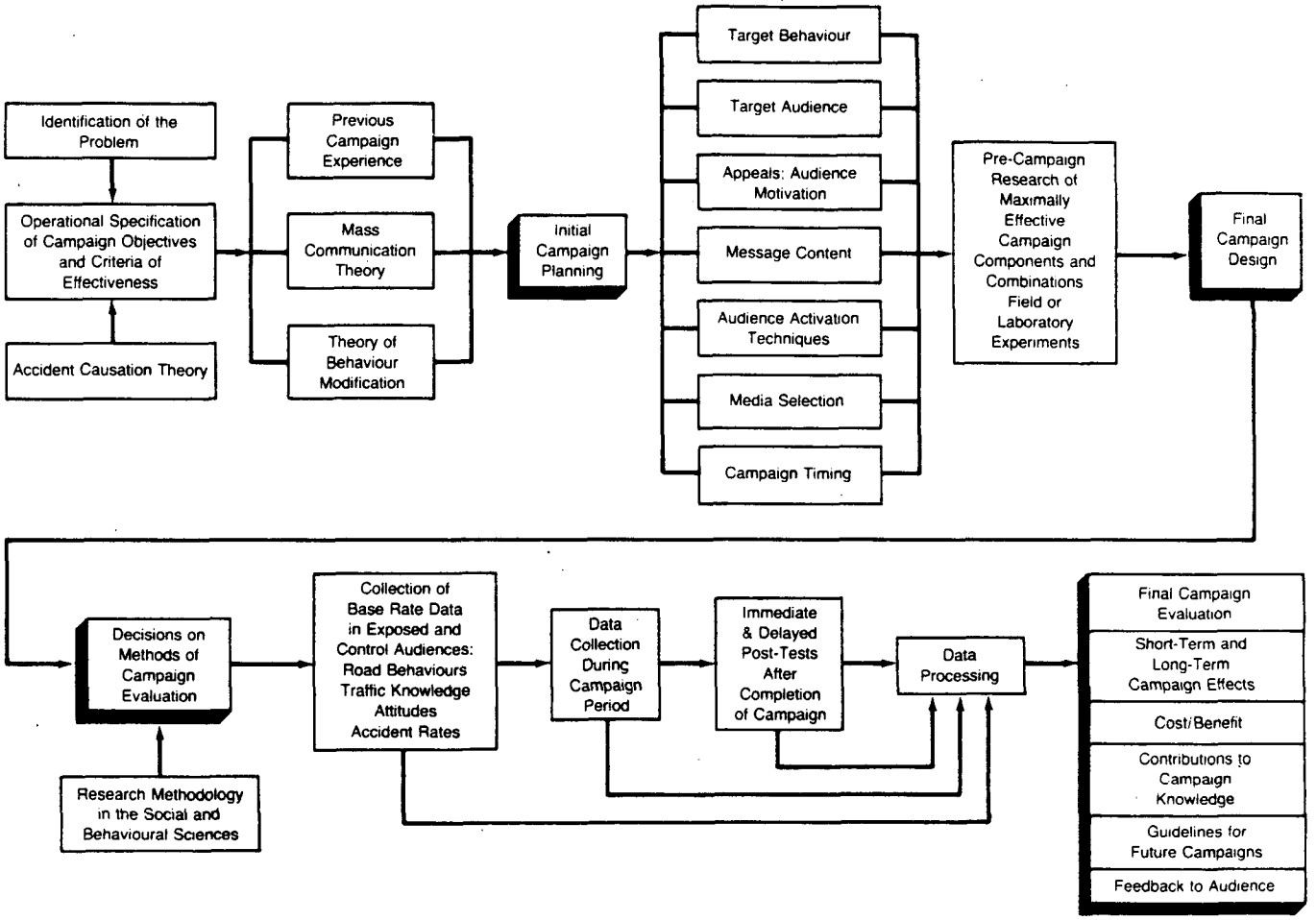
The term "public information and education" includes a wide range of activities which fall into at least four major areas: (1) formal education in public or private schools; (2) organizing or working through volunteer groups, service and social clubs; (3) news dissemination and publicity promotion; and (4) mass media programs. The latter most commonly comes to mind when the term "public information and education" is used, yet at the community level, the most effective method for getting out information may be the more informal activities which fall under the first three headings.

Development and management of mass media campaigns has become a complex, scientific art which requires considerable expertise. One of the best recent studies of the use of mass media for safety campaigns was performed by the Organization for Economic Cooperation and Development

(Wilde, et al., 1971). This publication provides an overall conceptualization of the process by which such campaigns are designed, operated, and evaluated. This is summarized in Figure 4-13. This diagram may at first put off the reader because of its apparent complexity, but it highlights the many factors that must be taken into account in planning a campaign and it emphasizes the need for good evaluation of public information campaigns in order to insure that they are effective and to modify the campaign's where they fail to have impact.

Highlighted in Figure 4-13 are seven elements which the campaign manager must identify: The target behavior to be modified, the target audience to be contacted, the appeals to be used with that audience to motivate change, the actual content of the message, the procedures to be used to get the audience to take action, the selection of the most effective media, and, finally, the timing of the campaign for maximum effect and to avoid competing media efforts. As noted earlier, reviews of past media campaigns *(Wilde, et al., 1971; Korenbaum, 1982;* and *Lindenman, et al., 1980)* have indicated that campaigns that do not clearly define the target behavior and target group are rarely successful.

Figure 4-13 Diagram of the Process for the Development and Evaluation of Safety Campaigns (*Wilde, et al., 1971*)



A significant problem in the education of drinking drivers revolves around the effort to assist individuals to estimate their own blood alcohol content and to sense their and their associates' impairment levels. Pawlowsky *(1982b)* noted that in the adult focus groups which he investigated, participants had considerable difficulty defining alcohol impairment. Those who felt able to measure their own impairment still could not communicate the concept of impairment to others. The use of illegal per se BAC levels in drinking-driving laws places additional emphasis on knowledge of the quantity of alcohol required to bring an individual to a given BAC level.

Several researchers have attempted to study the capabilities of individuals to estimate their BAC

levels *(Sharman, et al., 1978;* and *Lansky, et al., 1978).* The results of these tests have tended to show that individuals could not estimate their BAC levels very well. Lansky and his coworkers found some evidence that alcoholics could monitor their BACs less effectively than nonalcoholics.

To assist individuals in monitoring their BACs, it has been proposed that self-test devices should be distributed to the public through liquor stores or should be available in bars. Picton *(1979)* evaluated one coin-operated breath testing device for use in a bar and found that with "a minimal amount of user cooperation, the device was capable of accurately measuring BAC." However, in order for such devices to work, it is necessary for drinkers to refrain from consuming alcohol for 15 to 20 minutes before they test themselves. This is often difficult to achieve with patrons of a bar. Some safety specialists have feared that coin-operated testing devices in bars would provoke contests to see who could reach the highest BAC.

Oates *(1976)* conducted a study to determine the impact of knowing one's BAC in a bar. In his experiment, a researcher sought volunteers to take breath tests in the bar and then, once the test had been taken, explain the meaning to the drinkers. An observer was stationed in the parking lot to determine whether the drinker who took part in the procedure would avoid driving if the test showed him to be over the legal limit. The test demonstrated that individuals who participated in the information presentation were not significantly more likely to refrain from driving than were individuals who were not exposed to the information.

Another method of presenting information on the relationship between drinking and BAC is by means of small "know your limits" cards. These cards provide estimates of alcohol based on the average results of studies of alcohol consumption in the laboratory. O'Neill, et al. *(1983)* found that there was so much variation in the BACs of individuals drinking under controlled conditions that nomographs based on averages would be inappropriate, since they could significantly under- or overestimate the BAC. Burns and Moskowitz *(1980)* studied the effect of food and body weight on alcohol absorption and came to the conclusion that 1,000-calorie meals—largely carbohydrates and proteins—could reduce the mean BAC obtained in a standard dose of alcohol by as much as 40%. They also found that overweight men should reduce the numbers of drinks to reach a given BAC level by as much as 10% and overweight women by as much as 25%. This variability in BAC levels makes campaigns directed at educating the public regarding illegal BACs more difficult.

In at least two campaigns, an attempt was made to change the social value attached to driving after consuming alcohol. Researchers at Lackland Air Force Base (Barmack and Payne, 1961b), having examined the relevant customs and values concerning consumption of alcohol by airmen stationed at the base, and having found that reckless driving after drinking was not only tolerated by the group but was seen as courageous and daring, decided that assigning a different and conflicting value to this behavior was essential. Reckless driving after drinking was recharacterized as sick, disturbed behavior. This characterization was supported by a policy requiring that airmen in accidents resulting in loss of duty time of 24 hours or more would be required to undergo psychiatric evaluation and possible referral for psychotherapy, which might lead to a recommendation for a medical discharge. The enforcement of this policy was preceded by an educational program to inform airmen of the details of the new policy.

An Australian campaign (Australia's Unique Press Campaign 1974) against drinking and driving, which began in July 1974, used an approach similar to that used at Lackland Air Force Base. The campaign used the offensive word "SLOB" to describe drinking drivers. The strategy was to use social sanctions. In the existing social climate there were frequent pressures to drink before driving and the intoxicated driver was sometimes treated sympathetically or with amusement. The campaign assumed that a driver's desire to avoid a negative label and the resulting shame would reduce the number of drinking drivers. The campaign focused on the susceptibility of the drinking driver to social definitions of what is considered tasteful or appropriate behavior.

In the United States, the ASAPs sponsored by the National Highway Traffic Safety Administration have conducted public information campaigns (U.S. Department of Transportation 1975a, ch. 6). The objectives for these campaigns were defined in terms of waves or phases. The objectives of the first wave was to develop an awareness among the public of the dangers and consequences of drinking and driving. In the second wave, attempts were made to personalize the problem by identifying drunk drivers as friends, relatives, and acquaintances in order to counteract the tendency to see the drinking driver as a deviant. The stimulation of social and peer group concern and the description of specific actions which might be taken to cope with drinking drivers were objectives of the third wave. The fourth wave focused on specific calls for action.

The ASAP public information materials have been collected and organized into a compendium of resource materials by Grimm and Huber (1980), and by Grimm, et al. *(1982).*

An important change which has occurred since the end of the ASAP period has been the growth of citizens' activist groups *(Vejnoska, 1982).* Organizations such as Mothers Against Drunk Driving (MADD), Remove the Intoxicated Driver (RID), have been highly effective in organizing public effort to bring pressure upon legislatures and the courts to take action in the drunk driving area. This effectiveness is manifested by the large number of new drinking driving bills which have been recently introduced into State legislatures.

The efforts of these groups also resulted in the establishment of a Presidential Commission on Drunk Driving. This movement has also assisted in the development of student groups, such as Students Against Drunk Driving (SADD), which are providing a focus for high school students' participation in the alcohol safety program. Methods for making effective use of these organizations and their organizing procedures at the community level have been prepared in a manual by NHTSA (Golden, *1982*).

Evaluation of Public Information and Education Campaigns

In a review of road safety campaigns, Wilde (1971) concluded that media campaigns cannot bring about behavioral changes and result in few significant attitudinal changes, but that such campaigns can be successful in transferring information. Swinehart (1972) and Swinehart and Grimm (1972) concurred in this conclusion, stating that the mass media are not effective in changing attitudes or inducing action, but are good in conveying information. Any alterations of individual drinking-driving habits which result from such campaigns were seen as an unexpected side effect. Only in cases where media campaigns are combined with other types of countermeasures is there significant behavioral change. Thus, the case of the British Road Safety Act of 1967 (Sheppard, 1978; Ross, 1973), the case of the Lackland Air Force Base (Barmack and Payne, 1961b), and, to a lesser extent, the 1969 Canadian campaign (Kates, Peat, Marwick and Co., 1970) are the three major examples of campaigns whose impact went beyond a gain in knowledge.

The inadequacy of the designs for evaluation and of other features of campaign development has made it difficult to determine the exact nature and extent of the impact of most alcohol-highway safety media campaigns. Pre- and posttesting has been done for almost all campaigns, but very few of them have used control groups. Even the British and Canadian cases did not use control groups. Members of the control group used, informally, in the case of the Lackland Air Force Base were not randomly selected, nor were members matched with members of the treatment group on any basis other than the fact that they were airmen assigned to a base in Texas.

Media campaigns in Edmonton (Farmer, 1975; Farmer and Stroh, 1973) and Ontario (Morton, et al., 1975; Peirce, et al., 1975) used control groups which, in each case, were cities selected to match treatment cities in terms of size and relative isolation from the media of the treatment cities. Both campaigns were successful in transferring factual information about the contents of drinking-driving laws. A media campaign in Sydney, Australia (Freedman, Henderson, and Wood 1975), did not use a control group, but it did claim statistically significant positive changes in the public's knowledge of the role alcohol plays in crashes, of the legal BAC limit, of penalties associated with DWI convictions, and of the amount of alcohol which can be consumed by the average person before he reaches the legal BAC limit.

In the case of the British Road Safety Act of 1967 (Ross 1973) results of public opinion surveys conducted in September 1967, and January 1968, indicated that while only 27% of a random sample of adults knew of the fixed BAC limit before the campaign, 29% knew of it after the campaign. The post-campaign survey indicated that 99% of drivers knew that alcohol consumption would be detected by a breath test, 95% knew that refusal could lead to arrests, and 27% correctly described disqualification as a minimum penalty, while 42% described it as a maximum penalty.

In the U.S., the public information and education campaigns conducted by the NHTSA-sponsored ASAPs (U.S. Department of Transportation 1975b, ch. 6) concentrated their efforts on:

- the awareness by the public of the drunk-driving problem and the relationship between levels of blood alcohol and the risk of a crash.
- the public's interpretations of myths about alcohol.
- the public's perception of personal responsibility for drinking-driving behavior, and
- the reduction of alcohol-related crashes and resultant death or injury.

The ASAP evaluation concluded that "in each area of concentration, substantially more sites with public information activities achieved positive results than sites without an effort" (U.S. Department of Transportation 1975a, ch. 6 p. 1). Telephone surveys designed to evaluate these programs provided evidence that they had an impact on public attitudes, knowledge and, to some extent, behavior associated with drinkers' driving problems (*Croke, 1977*). Is should be noted that all of the ASAPs conducted other types of countermeasures concurrently with the public information and education campaigns and that few used more than pre- and posttesting in their evaluation of campaign effectiveness.

On nine questions asked in pre- and posttest surveys, sites with public information and education campaigns indicated greater gains in knowledge than sites without such campaigns. The questions dealt with the nature of the alcohol-crash problem, the effect of alcohol on the body and BAC, and the perceived probability of apprehension for drunk driving.

To conclude, there is some evidence that public information and education campaigns can increase the public's knowledge about drinking-driving laws and its understanding of the effect alcohol has on the body and on driving skills. There is little evidence to show that public information and education campaigns change either attitudes or behavior. In the few cases in which behavioral change occurred, that is accident rates were reduced, public information and education campaigns were conducted in conjunction with other countermeas-

ures. In most cases, the impact of the public information and education campaign could not be isolated from the impact of other countermeasures.

Thus, research does not show that informational compaigns in general are ineffective; it indicates merely that they have not been successful in reducing crashes when used alone. There is evidence that they have been effective in supporting other alcohol-safety approaches, particularly the legal approach. That purely information programs which are not conducted in conjunction with other actions should have limited effect is not surprising.

Such campaigns are competing with the much larger amount of general advertising for the sale of alcohol. There is considerable controversy over the effectiveness of beverage advertising and the extent to which it increased alcohol consumption (*Bourgeois and Barnes, 1979*), and whether such advertising is increasing alcohol misuse and risk taking when drinking (*Mosher, 1981*). It is also possible that previous evaluations of drinking-driving campaigns may not be predictive of their current effectiveness, since the major organizational and political efforts of special interest groups such as MADD and RID have created a new social climate which could increase the effectiveness of informational programs.

The Systems Approach

The term "systems approach" appears to have been introduced in the early 1950s to describe techniques being developed for managing large and complex aerospace projects (Jones and Joscelyn, 1976). Its distinguishing feature is its concentration on the whole problem rather than its component parts. One of its most successful practitioners, Simon Ramo, has described it as follows:

> It is an approach that insists upon looking at a problem in its entirety, taking into account all the facets, all the intertwined parameters. It is a process for understanding how they interact with one another and how these factors can be brought into proper relationship for the optimum solution of the problem (Ramo 1971, p. 11).

One example of the application of the systems approach to the alcohol-crash problem was the Joscelyn and Jones analysis of the so-called drinking driver control system (Joscelyn and Jones, 1971). These same authors *(1978)* have developed a broader systems approach to overall "risk-management" in highway safety. The 1971 study used the functional analysis technique, a basic tool of the aerospace systems approach, in conjunction with standard research methods from the social sciences (e.g., survey research) to develop statements about the implicit objectives, functions, requirements, and operational modes of the "system."

In 1969 the National Highway Safety Bureau (later the National Highway Traffic Safety Administration) of the U.S. Department of Transportation announced the nationwide Alcohol Safety Action Project (ASAP), many of whose activities have been reported earlier in this report, and established the Office of Alcohol Countermeasures to manage it. The program provided financial assistance to and coordinated the efforts of, at first, nine and, ultimately 35 individual ASAPs around the country. From the beginning, ASAP embraced the systems approach, declaring that "In planning and managing an ASAP, the project director will need to use the systems approach, in order to properly integrate all of the complex aspects involved. He should consider the project as a whole system made up of several subsystems which are related to and dependent upon each other. The project director must take these relationships and dependencies into consideration in order to maintain proper balance in the operation of the subsystems" (McKnight, Adams, and Personeus, 1971).

No other alcohol safety program of comparable scope, depth, and size has attempted the systems approach to the same degree as ASAP, although some jurisdictions have applied and are continuing to apply some of its concepts on their own. For this reason, the remainder of the discussion of the systems approach to drinking-driver control will be limited to ASAP, with particular emphasis on what is most relevant to the systems concept, rather than on the individual countermeasures discussed previously in this report to illustrate other approaches.

ASAP Targets

Aside from the systems approach, which was implemented through the establishment of a central management office and an ASAP project director in each community, the second novel feature of the ASAP program was the focus on the problem-drinker driver who had been identified in the Department of Transportation, 1968 report on Alcohol and Highway Safety (U.S. Department of Transportation 1968) as having a major role in the alcohol safety problem. An estimate of the involvement of problem drinkers in alcohol-related crashes has been depicted graphically in a chart which appeared in numerous ASAP reports over the past several years (e.g., U.S. Department of Transportation 1974a; Voas 1975b). The chart also presents data from a 1971 Department of Health, Education, and Welfare report (U.S. Department of Health, Education, and Welfare, 1971) showing 21% of all adult American males to be "heavy" drinkers. One-third of these heavy drinkers (7% of all adult males) were said to be problem-drinking drivers who could only be rehabilitated by a safety program, and two-thirds were heavy social-drinking drivers who could be deterred by a safety program.

ASAP also placed emphasis on drinking drivers who drive at night and on weekends, drawing upon research (summarized earlier in this report) which had indicated an increased incidence of alcohol-impaired drivers using the roads and involved in crashes at such times (U.S. Department

of Transportation, 1975a). Some ASAPs designed their enforcement efforts to intercept intoxicated drivers on main thoroughfares connecting drinking establishments with residential neighborhoods, and a few sites concentrated on areas having high rates of alcohol-related crashes.

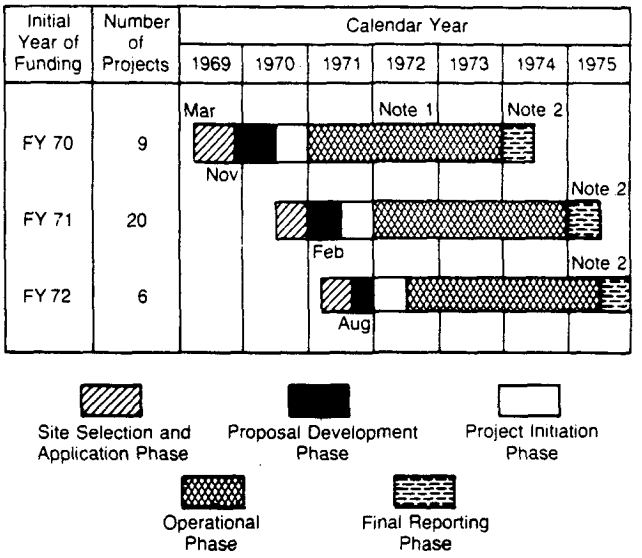
The ASAP Approach

The ultimate goal of the Alcohol Safety Action Program was to "demonstrate and evaluate the feasibility, methodology, and impact of comprehensive, multifaceted countermeasure programs designed to reduce the incidence of alcohol as a causal factor in motor vehicle crashes" (Crittenden, 1970).

Individual ASAP projects were to be conducted at the local level, emphasizing improved law enforcement, traffic court procedures, public information, and special efforts to counsel and assist drivers. The local activities were to be complemented by State-level efforts in driver licensing, motor vehicle registration, traffic records and legislation. Each project would be supported by about $500,000 a year in federal funds provided to a State or local governmental agency which would act as a prime contractor to NHTSA. Federal funding support would continue for three to four years, after which it was hoped that full State or local funding would be provided to continue each successful project (Crittenden 1970).

The first group of nine ASAPs began operation in 1971 (see Figure 4-14). Twenty-six additional ASAPs initiated operations in 1972. The locations were widely distributed around the U.S. and included one site in Puerto Rico (see Figure 4-15).

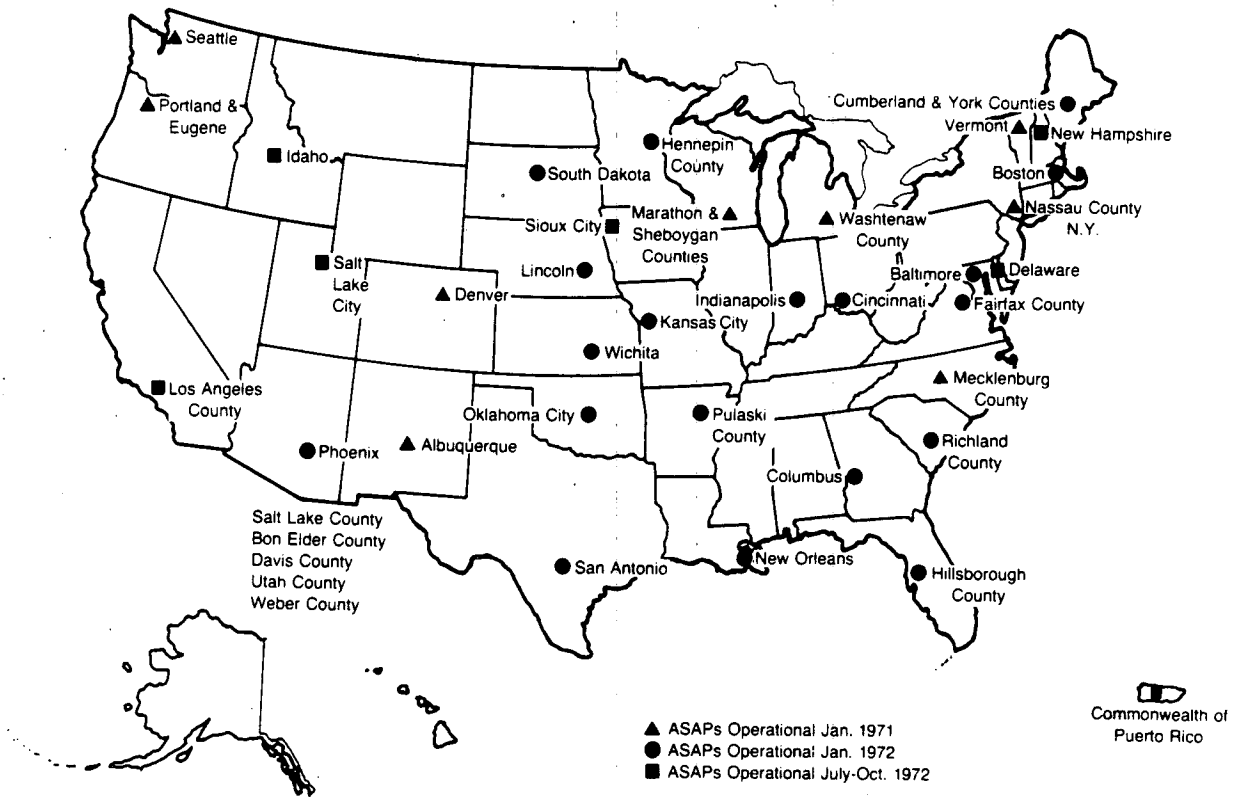
Figure 4-14 Operational Phasing of the Alcohol Safety Action Projects



Note 1. Operational Period Varies in ASAPs
Note 2. Reporting Period Varies in ASAPs

Source: U.S. Department of Transportation 1974a, p. 2

Figure 4-15 Locations of the Alcohol Safety Action Projects



Source. U.S. Department of Transportation 1974a. p. 1

ASAP used a combination of the legal, health, public information and education, and technological approaches in its attack on the alcohol-crash problem. It used the term "countermeasure" to describe a separate action against the "threat" imposed by the drinking-driver, terms drawn from the aerospace and defense sectors which originated its systems approach. Eventually, five separate categories of countermeasure activities evolved (U.S. Department of Transportation, 1975a):

- enforcement,
- judicial and legislative,
- presentence investigation and probation,
- rehabilitation, and
- public information and education.

There is considerable documentation on how the systems approach was actually implemented in ASAP. NHTSA maintains a file of over 200 project reports in its documentation center, most of which can be accessed through the Transportation Research Board's TRIS Computerized literature reference system. A summary of project activities in each of the major countermeasure areas is provided in the NHTSA final summary reports on the ASAP program *(NHTSA, 1979)*. Much of what was learned in the area of management and practical application of countermeasures was summarized in a manual prepared by Hawkins, et al. *(1976)*.

The original Handbook for Directors of Alcohol Safety Action Projects (McKnight, Adams, and Personeus 1971) provided only a one page description of the systems approach (as a subheading under "The Detailed Project Plan") as a means for coordinating ASAP activities in the various countermeasures areas. However, a series of workshops for project directors was sponsored by NHTSA and, in addition, seminars were given to enforcement personnal, prosecutors, judges, probation officers, legislators, and other operational personnel associated with the program also stressed the systems approach and described in fairly specific terms each major element of ASAP and how it related to other elements (Nesbitt, McGill, and Lipecky 1976; Nesbitt 1975; Institute for Research in Public Safety, 1972b and Indiana University

1974). Notably missing from any of the material provided the new ASAPs was detailed guidance on how to design a drinking-driving control system. Two of the major tools of the aerospace systems approach (system management and system effectiveness evaluation) were, however, given much emphasis.

Evaluation was specially emphasized in ASAP, and detailed evaluation requirements were placed on the individual sites (Promisel, Blomberg, and Oates, 1971; U.S. Department of Transportation, 1973). The evaluation philosophy was based on a "chain of action" approach. First, an assessment was made of the severity of the alcohol-crash problem and the intensity of the safety program prior to the initiation of ASAP activity. Next, ASAP input in dollars and effort was related to the problem and to existing safety-program efforts. The output of ASAP in terms of countermeasure activity was then measured and compared to the investment in order to obtain an estimate of the degree of which additional resources generated additional activity. Finally, an attempt was made to determine the impact of all the increased spending and activity on the alcohol-crash problem itself.

The evaluation regimen imposed on the individual ASAPs was important from a systems standpoint because of its emphasis on the objectives of the project. It made it necessary for the project (and the Office of Alcohol Countermeasures) personnel to think in terms of the purposes of their countermeasures and to relate project activities to those purposes.

The Evaluation of ASAP

The first results of ASAP's systems approach were published in the "Alcohol Safety Action Projects: Evaluation of Operations—1972" (U.S. Department of Transportation, 1974a). The data were taken from eight projects that had collected 3 years of "baseline" data (i.e., before the start of ASAP operations) and 2 years of "operation" data (i.e., after the start of operations). In addition, there were 2 years of baseline data and 1 year of operational data from 21 sites that were initiated a year later than the first eight sites.

After an ASAP investment predicted to be about $6.40 per licensed driver over the 3½-year period of each ASAP, large increases in alcohol-safety activities occurred. DWI arrests rose more than 100% overall and 60% of those arrested were "processed" by the courts—that is, convicted, given presentence investigations, or referred to rehabilitation by the courts.

The increases in activity were not, however, reflected in proportionate decreases in night fatal crashes. On the average, night fatal crashes per licensed driver per year decreased from 12.9 to 12.5, or about 3%. No correlation was found between activity and impact. Further analyses of night fatal crashes indicated a statistically significant reduction in such crashes for sites with 2 years of operating experience, but no significant reduction for sites with only 1 year of operation. By contrast, the overall trends of night fatal crashes in the reporting States were said to be upward rather than downward. Similar results were obtained for total fatal crashes. It was estimated in the analysis that ASAP resulted in from 64 to 174 lives saved over a period of 2 years in the eight initial sites. This was converted to a dollar savings to society of from 13 to 35 million, compared to an outlay of approximately 14 million dollars over 3½ years (U.S. Department of Transportation 1974a).

An obvious deficiency in the first ASAP evaluation of operations (and one that was pointed out by the NHTSA report) was the lack of control groups to compare with the ASAP sites. In 1974, Zador (1976) attempted to correct this deficiency "by comparing year-to-year variations in fatality statistics between groups of areas with ASAPs and comparison groups of areas without ASAPs." A statistical model was used to test whether the ratio of fatalities in an ASAP area to the combined fatalities in the ASAP area and its comparison area changed systematically from year to year.

Based on his analysis, he concluded that there were no systematic fluctuations and specifically, no systematic reduction of the proportion of fatalities in ASAP areas after the introduction of the program. The year-to-year fluctuations were found to be no larger than would have been expected on the basis of chance alone. Moreover, Zador found that the decreases in the proportion of night fatal crashes to day fatal crashes in ASAP areas, while statistically significant, were equally present in the comparison areas. He concluded the ASAP countermeasures could not have been responsible for the observed reductions in the ratio of night fatal crashes to day fatal crashes, and that "ASAPs, as large-scale social programs, have been ineffective" (Zador 1976, p. 48).

In a later interim evaluation report (U.S. Department of Transportation, 1975a), NHTSA used additional data to analyze the impact of the 21½ later ASAPs after 2 years of operation. This 1974 report found some evidence of reduced numbers in alcohol-related fatal crashes which could be attributed to ASAP. The report also responded to Zador's criticism of NHTSA's previous evaluation stating that his "control" groups were actually comparison groups that did not adequately match the ASAP groups. NHTSA stated that "special traffic safety activities conducted during the demonstration period represent serious confounding effects not considered in the conclusions drawn" and that "comparison groups matched solely on total population and population rates of growth as used in the (Zador) study are not sufficient" (U.S. Department of Transportation, 1975a, ch.1, p.4).

A later response to Zador by Johnson, Levy, and Voas (1976) questioned his conclusion that the ASAPs were ineffective "as large-scale social programs," because his analysis only tested the hypothesis that ASAP reduced fatalities and made no test of the "broader social, catalytic organization impacts of ASAP." Johnson, Levy, and Voas

(1976) also stated that Zador's analysis was not sensitive enough to detect reductions in alcohol-related crashes of less than 20%. In a 1977 article, Zador repudiated NHTSA's criticisms and held to his original conclusions about ASAP's ineffectiveness as a large-scale social program.

In the final overall evaluation of the ASAP program *(Levy, et al., 1978)* an attempt was made to meet these criticisms more fully by selecting data from appropriate comparison sites. A special project was funded *(Monaco, 1977)* to select comparable localities which had not implemented special alcohol programs during the ASAP period. Overall, 27 community characteristics were considered as a basis for selecting these comparison sites. Statistical analysis demonstrated that—percentage urban population, dollars spent in eating and drinking establishments, legal drinking age, gas expenditures per capita, and population change—had the strongest relationship to nighttime fatal acidents (a surrogate measure for "alcohol-related accidents"). These factors were used through a cluster analysis procedure to select 11 comparison sites for the 35 ASAPs *(Levy, et al., 1978).*

The evaluation applied a separate "time series analysis" *(Box and Tiao, 1975)* procedure to comparing nighttime (8 p.m. to 8 a.m.) fatal accidents at each ASAP site with the trend in daytime (8 a.m. to 8 p.m.) fatal accidents at the same site and nighttime accidents at the appropriate comparison site. The assumption being that nighttime fatal accidents reflect changes in alcohol involvement and the daytime accidents indicate other changes (the economy, fuel availability) which may impact accidents. The analysis indicated that 12 of the 35 ASAP sites had significant reductions in nighttime accidents, while none of the comparison sites for these ASAPs demonstrated a reduction in nighttime fatal crashes.

In addition to fatal accident data, 19 of the 35 ASAP sites conducted voluntary roadside breath test surveys (before and after the projects began) in an attempt to determine the effect of the project activities on the number of drinking drivers on the roads. Overall, the numbers of drunk drivers (BAC≥.10%) were reduced in these 19 projects from 52 per thousand to 45 per thousand. The authors of the report *(Levy, et al., 1978)* concluded that most of the project impact in the 12 sites which showed reductions in nighttime fatal accidents could be attributed to the "increased general deterence to drunk driving by social drinkers, that is, those whose drinking and driving behavior was most subject to modification through the threat of increased enforcement." They came to this conclusion because, as described earlier in this report, the treatment programs for problem drinkers conducted at the ASAP sites had not proved to be effective in reducing receidivism and accidents among this high-risk group.

No comprehensive critique of this final ASAP report or alternative evaluation similar to that conducted by Zador (1976) has been published. Reed *(1982)* argues for a slightly lower estimate of the total lives saved in the ASAP program (425 instead of 506) and notes several problems in the evaluation relating to "incomparable sites" (some ASAPs were cities, some counties, some statewide); inadequate control sites (chosen after ASAPs ended); "overaggregated evaluation" (all fatal accidents for the whole 3-to-5 year project period summed together, even though countermeasures change during the course of the program).

Ross *(1982)* summarizes his view of the Levy, et al. report as follows:

> . . . although the post hoc selection of control communities weakens the quasi-experimental design of the final evaluation, the analysis was well done under the circumstances. It supplied evidence supporting the proposition that some programs involving enforcement of prevailing U.S. laws could, in the short run, produce declines in drinking and driving and in associated casualties. The analysis is too approximate, and the negative cases too prominent, to conclude much beyond this.

Summary and Conclusions

Alcohol and highway safety has been a concern for three-quarters of a century in the United States, but has been particularly emphasized in the last 15 years since the formation of the Federal Department of Transportation. Since that time, a number of large, national programs to reduce alcohol-related accidents have been implemented by the federal government, States, and localities. During this 15-year period, a number of different countermeasures have been applied to the drinking-driving problem, mostly with limited or unknown success. Despite the general lack of documented effectiveness, much has been learned regarding the drinking-driving problem and the methods of alleviating it.

While the drinking-driving problem is highly complex and unlikely to yield to simplistic solutions, it has become somewhat easier to study and deal with this issue than many other traffic safety hazards because of the relatively objective measure—blood alcohol content—which is available for gauging the incidence of alcohol among road users in accidents. The combination of the improvement in the technology of chemical testing and the growth and maturity of improved data systems—the Fatal Accident Reporting System (FARS) and the National Accident Sampling System (NASS)—provides a basis to believe that our knowledge of the basic mechanisms which produce alcohol-related crashes and our ability to control the losses due to such accidents may grow relatively rapidly in the future.

Four factors have limited progress in the last 15 years, despite the attention given to alcohol safety.

1. The Lack of Careful Formulization of Programs

Most remedial programs for drinking-driving accidents were undertaken without a detailed analy-

sis of the objectives of the program or the mechanisms by which such programs were expected to have impact. Because target behaviors, target groups, and countermeasure methods were not well defined, it has been difficult to make use of what was learned in even those programs that appear to have been successful.

2. Readiness to Accept Positive Results in an Unsophisticated Manner

Most safety programs are launched by government agencies which naturally have an interest in their success. Since accidents are a varying statistic which rise and fall to the large number of unknown and unmeasured factors, it is probable that a certain number of countermeasure programs—whatever their net effectiveness—will be associated with reductions in accidents. If we count only the positive results and ignore all those instances in which accidents rise, then it is easy to be misled regarding the effectiveness of specific countermeasures. Many if not most reports of special safety efforts fail to provide for adequate comparison data. The result is a system which pushes positive results into print and assigns negative results to oblivion.

3. Lack of Sophisticated Evaluation Techniques

Because accident statistics vary from month to month and year to year, relatively sophisticated statistical techniques are required to assure that chance differences are not interpreted as a significant effect. Many program reports, particularly those in the popular press, simply provide this year's raw accident count and compare it with last year's results. This type of simplified data presentation can be misleading, particularly where the numbers of accidents in a specific community is small and, as a result, chance variation is large.

4. Lack of Comprehensive Accident Statistics

Until 1975, there was no comprehensive statistical registry of fatal accidents in the United States. As of 1983, there is still not a comprehensive statistical base for injury and property damage-only accidents, since the National Accident Summary System is still not fully implemented. This situation, however, has been improving rapidly, with both of the Federal Government's national statistical records systems (FARS and NASS) becoming more comprehensive and complete, and with the States' accident records systems improving both in accuracy and completeness. Of special importance to the drinking-driving area is the growing completeness and accuracy on data on the blood alcohol content of accident-involved road users.

This chapter has summarized seven different types of countermeasure approaches to the reduction of losses from alcohol-related accidents. It has not been possible to examine in detail the effectiveness of the dozens—if not hundreds—of different types of programs which fall into these seven areas. Rather, the largest, best evaluated programs have been reviewed, including those efforts which stand out as examples of unique or different approaches to the problem of the drinking driver. Safety professionals considering the implementation of one of the approaches described in this chapter will not want to be dependent upon the overview given here. They should make use of the references listed in the back of this volume to obtain the detailed reports by those who actually conducted the program in order to be sure that they fully understand the specific actions implemented in the original programs. Review of these orginial reports will also make it possible for each safety specialist to come to his own evaluation of the significance of the results. A brief summary of the general findings for each of the seven areas is given below.

I. Hazard Reduction Through Engineering

There is evidence, by analogy to the broader field of public health, that the most effective methods for reducing a health problem is through environmental engineering. Most highway safety research specialists tend to stress roadway and vehicle improvement as the best long-term solution to the general problem of highway safety. Many believe that it is the most effective solution for the drinking-driving problem itself.

Some researchers have suggested that any simplification of the driving task will be particularly beneficial for drunk drivers, because they have a reduced capacity to handle the more intricate traffic conflict situations which produce accidents. Other researchers question this approach, arguing that safety measures which are obvious to the driver may encourage higher speed driving and greater risk taking which vitiates, at least in part, some of the value of the engineering improvement. The reduction in the accident rate per 100 million vehicle miles over the last 20 years in the United States suggests that improved safety is not completely counteracted by increased risk taking. Nevertheless, it is obviously true that as roads have been improved, vehicle speeds have increased. Meanwhile, the absolute numbers of fatalities have grown or remained stable up until recently.

Researchers have suggested that because many of the drinking-driving accidents involve single vehicle, run-off-the-road crashes, reducing the curvature on highways and clearing the shoulders of obstacles or using breakaway signs would be particularly effective in reducing drinking-driving crashes. One specific improvement which has been evaluated and found to be effective is improved roadway edge delineation.

Among the vehicle engineering improvements which have particular relevance to the drinking-driving problem is the engineering of taillights, which has been shown to reduce errors by drinking drivers. Data on seatbelt use also clearly demonstrates that both drinking drivers and their passengers are less likely to make use of active restraints. For this reason, it appears logical that passive restraints or automatic seatbelts would be

particularly efficacious in reducing the severity of injuries due to drinking-driving accidents.

A number of vehicle-borne devices designated to reduce the probability that a vehicle will be operated by a drinking driver have been proposed and studied by the Federal government. The idea of an "intelligent car" which would not permit a drunk to drive is an obviously attractive solution to the drinking-driving problem. The remarkable progress in microcomputers make such devices appear within reach of our technology. However, human performance is so variable, and the problem of making such systems reliable and tamperproof is so great, that no device which can be cost effective placed on all cars has been developed. To date, most research has been limited to devices which would be placed on the cars of individuals convicted of a drinking and driving offense. Such devices would not directly affect the operation of the car but would call attention to the car if it was operated by an impaired driver. These "Drunk Driver Warning Systems" (DDWS) may have some value for use by the courts in controlling the driving of individuals convicted of a DWI offense.

II. Exposure Reduction

Excessive and abusive drinking has been recognized for well over a century as a particular health problem and the cause of a large number of social problems from traumatic injury and death to joblessness and marital breakups. An historically popular approach to the reduction of drinking problems has been governmental control of alcohol sales and distribution in an effort to reduce the problems which result from excessive use of alcoholic beverages. The major social experiment with this approach was, of course, prohibition. Following prohibition, many of the States retained controls which limited the access to alcohol by young people or controlled the sales (State liquor stores, etc.) in ways intended either to limit the supply or, at a minimum, to realize taxes from the sales of alcohol.

Following the Vietnam war, many States took steps to reduce the voting age and other age limits on adults prerogatives, such as the age of consent for marriage. With this change came a trend to reducing the legal age for purchase and consumption of alcohol from 21 to 18. While not unanimous, the majority of the traffic safety studies which were undertaken to determine the impact of this change indicated that nighttime alcohol-related accidents of teenaged drivers increased in those States which reduced the legal age for purchase of alcohol.

These research results have led to a recent trend to raise the legal age for purchase of liquor back toward age 21 in many States that had previously reduced it. This trend has only just begun, but the initial studies provide some indication that raising the drinking age reduces alcohol-related crashes. Since the trend has only just begun, and since many States have raised the drinking age only by 1 or 2 years, the data are still too limited to provide strong assurance that the accident increases demonstrated when the drinking age was reduced can be reversed when and if the legal purchase age is restored to 21.

In addition to using drinking restrictions as a method of reducing exposure to alcohol-related accidents, several States have attempted to use license restrictions for novice drivers as a method of reducing exposure to nighttime alcohol-related crashes. These license restrictions are intended to prevent nighttime driving until the novice driver has obtained considerable experience driving during daylight hours. They are also designed to motivate the drivers to be cautious by making the issuance of an unrestricted license dependent upon developing a good initial driving record. The early evidence on the effectiveness of these procedures is positive, but the data are still too limited to provide a clear, credible demonstration of the effectiveness of this procedure.

III. Legal Deterrence

Criminal justice programs, which involve the passage, enforcement, and adjudication of laws designed to promote safe driving, are principally directed at "general deterrence,"—dissuading the total population of drivers from drinking and driving by use of the threat of apprehension and sure, swift punishment. A secondary objective of the legal approach is to identify and bring under control of the State those drivers who regularly commit drinking-driving offenses so that they can be supervised, reeducated, and/or treated with a view to changing their behavior in the future.

While all legal programs involve both the general and specific deterrent effect, the first large scale federal program—ASAP—tended to emphasize special deterrence because of its focus on the problem drinker as a major contributor to alcohol-related accidents. In the last 5 years, greater emphasis has been given at both the Federal and State level to the general deterrent effect of the legal system, as the best method for achieving near term reductions in alcohol related accidents. Special deterrence is seen as being less effective in the near term because so few drivers are brought into the system through arrest and conviction and because of the failure during the ASAP program to find good remedies for reducing the recidivism and accident involvement of drivers convicted of drinking driving offenses.

The general deterrent effect of the legal approach is believed to be dependent upon three main elements: (1) The probability of appehension, (2) the severity of the penalty, and (3) the speed with which penalty follows upon the offense. A recent worldwide review of drunk driving programs indicates that there is considerable evidence that highly publicized enforcement efforts produce at least short-term reductions in the numbers of alcohol-related accidents. Some countries, such as the Scandinavian nations, appear to have achieved a lower rate of alcohol-related accidents and to

have fewer drinking drivers on their roads than is typical of the United States. There is considerable controversy, however, as to whether this represents the impact of their drinking-driving laws or whether it is purely a cultural phenomenon related to attitudes regarding alcohol use. Relatively little information is available on the second two elements believed to be important in the development of deterrence: The severity of the penalty, or the speed with which the penalty follows upon apprehension.

Enforcement

Three broad types of enforcement systems can be distinguished among the methods used around the world: The behavior-based system typical of the United States involves the selection of vehicles from the traffic flow based on erratic driving believed to be symptomatic of drinking driver performance; the identification of drinking through an interview with the driver following the stopping of the vehicle; and the use of psychomotor sobriety tests to demonstrate alcoholic impairment. This leads to the officer officially charging the driver with DWI, which is followed by an evidential test of breath or blood alcohol content.

In contrast to this "behavioral" system is the "chemistry-based" system currently typical of Scandinavia where a large portion of the enforcement effort involves stopping *all* vehicles at roadblocks and testing *all* drivers for alcohol. Those found to be above the legal limit are invariably charged with drunk driving and taken to the police station for an evidential blood test. At least in principle, this system is completely independent of any driver behavior, such as erratic or illegal driving or appearance of intoxication. The third system involves a mixture of the "behavioral" and chemistry based approach. It is found in Britain, Canada, and Australia. In this system, vehicles are selected from the traffic flow based on erratic or illegal driving, but once stopped, *all* drivers are required to provide a breath test independent of whether they show any behavioral signs of drinking.

In recent years, there has been a trend within the United States to move from a purely behavioral-based system to the chemistry-based system as indicated by the passage of laws which make a BAC "illegal per se" and by the wider use of preliminary breath test devices by the police at the roadside and finally, by the implementation, by a number of police departments, of sobriety checkpoints in which all vehicles are stopped and drivers checked for alcohol.

The last several years has seen a rapid development in enforcement technology. Research has been undertaken in the specific vehicle maneuvers which indicate that the driver may be impaired by alcohol. A manual describing these signs is currently available for the police. Further, the relationship between psychomotor tests and BAC has been studied and improved set of sobriety tests developed for use by the police.

Methods for breath alcohol detection and measurement have continued to improve. Highly accurate pocketsized test devices are now available for police use at the roadside. Just emerging is a technology of passive sensing, which while yet to be proven, gives promise of providing a method for rapidly screening drivers for drinking. The Federal government has also reviewed the legal issues which arise in the use of sobriety checkpoints and developed a manual on the procedures for this enforcement technique.

Evaluations of enforcement programs have demonstrated that public information is an indispensable element to producing deterrence. The materials which have been used in recent years by community police agencies in publicizing special enforcement efforts have been collected and made available by the Federal government. Research is underway to better identify the specific themes and content of public information programs which will be most effective in persuading drivers of the high probability of arrest if they do drink and drive.

Adjudication

The second major element of the legal approach is the court system, which must process the individuals charged with drinking and driving. Comprehensive efforts to deal with the drinking-driving problem, such as that embodied in the ASAP program, have indicated that the courts are frequently a major obstacle to increasing the total number of drinking drivers apprehended and sanctioned for drunk driving. Deterrence theory requires that the courts process rapidly and sanction uniformly and reliably those apprehended for drinking and driving.

The courts in the United States, however, provide individual equity within the legal process. Attempts to increase penalties and to insure uniformity of their application through making such penalties mandatory, have frequently resulted in disruption of the courts. As the severity of the penalty increases, the effort of the defendant to avoid the penalty also increases, resulting in the greater employment of lawyers, which in turn increases the legal maneuvering such as requests for delays and jury trials. Such maneuvering increases backlogs and puts pressure upon the court system (prosecutors and judges) to plea bargain in order to avoid lengthy trails.

As a result, increases in penalties are frequently accompanied at the court level by an increase in reduced pleas and nol-prossed cases. In some instances in the past, this process has effectively nullified the legislature's intent to increase sanctions for drunk driving. More recently, with the formation of special interest lobbying groups such as Mothers Against Drunk Driving (MADD), public pressure on both the courts and the legislature has been intensified and there is some evidence that the courts have been able to increase the severity

of sentencing without experiencing as much disruption as in the past.

A number of different penalties are available to the courts: jail, fine, license suspension, community service, referral to education and treatment programs, and probationary restrictions. Few of these alternatives have been fully evaluated. Morever, evaluation is not easy, since each of these penalties is believed to have a number of different effects upon those who receive them. Considerable research has been done on the effect of license restriction, and this appears to be effective in reducing the recidivism and the accident involvement of those who receive this penalty. A recent study funded by the Federal government has also shown that a treatment program for drinking drivers can be effective, providing it is sufficiently intensive and long enough to promote recovery from problem drinking.

The evidence available for the effectiveness of other types of penalties is much more limited. Clearly, individuals sentenced to jail do not cause accidents while incarcerated, but there is as yet no evidence that once released such individuals have lower accidents or rearrest rates. Fines have considerable value to the community in that they help support the drinking-driving enforcement effort, but there is little indication that a fine will reduce the probability that an individual will reoffend, except possibly in those cases where the income of the driver is low enough so that payment of a fine reduces the amount available to meet the expenses of driving.

The recent development of stronger public support for tough drinking-driving penalties may provide opportunities for the evaluation of both traditional and novel sanctions for drinking drivers which have not been available in the past. Until such research evidence is available, it will be difficult to determine the relative effectiveness of the various sanctions that are available to the court.

IV. Rehabilitation Programs

Arrested drinking drivers typically have very high blood alcohol concentrations (the average arrested drinking driver has a BAC in the region of .18 to .20%). Moreover, a large proportion of the individuals arrested for drunken driving have previous alcohol-related offenses. This has led some researchers to believe that a significant portion (perhaps one- to two-thirds of all arrested drinking drivers) can be classified as problem drinkers. In the course of the nationwide ASAP program during the early 70s, diagnostic data collected on convicted drinking drivers confirmed that at least one-third of those convicted for this offense could be classified as problem drinkers, while one-third were classified as social drinkers and one-third in between.

To the extent that involvement in an alcohol-related accident or arrest for DWI is an indication of a medical problem, treatment would appear to be a potential countermeasure. The "health/legal" approach was envisaged as a procedure whereby the legal system would identify problem drinkers and become a case finding method for the health community. Just as the authority of the employer is used to motivate problem drinking employees into treatment so the authority of the court would be used to motivate the problem drinker convicted of DWI into the health care system.

This health approach was implemented in all of the ASAPs. It was the remedy most carefully evaluated during these programs. The results of this evaluation demonstrate that "social drinkers" can profit from almost any educational or therapy process, as indicated by a small reduction (10 to 15%) in the probability that they will reoffend as drinking drivers.

Attempts to treat problem drinkers, on the other hand, were uniformly shown to be ineffective within the limits to which such treatment programs were implemented in the ASAP program. The ASAP data indicated that the small group discussion approach was more effective than large lecture programs for problem drinkers. But the value of this result was reduced by the fact that none of these approaches appeared to have produced a better result than the traditional punitive sanctions. In several cases, treatment programs for problems drinkers proved to be counterproductive, resulting in higher rearrest rates. This seemed to be particularly true where, in return for attending treatment, the convicted drivers were allowed to retain their licenses. In this case, they were likely to drive more than those not sent to treatment whose licenses were suspended. The resulting increased exposure led to more accidents and a greater chance of being rearrested for drunk driving.

Following the ASAP period, an evaluation of a large treatment program was funded in Sacramento, California, in an effort to develop evidence of effectiveness through a more tightly controlled research study. This reseach corroborated the ASAP results with regard to social drinkers, showing that they do profit (in tems of reduced recidivism) by attendance at an educational program. In addition, however, it demonstrated that, for most social drinkers, a home study course is as effective as a lecture program.

With respect to problem drinkers, the outcome of this study contrasted with the ASAP in that a significant reduction in recidivism (40%) was obtained through a year-long relatively intensive program. The results were interpreted as indicating that treatment can be effective with problem drinkers, provided it is sufficiently intensive and lasts long enough (a minimum of a year) to impact on the drinking problem which these drivers exhibit.

As a result of these studies, there is evidence for the effectiveness of both education programs for social drinkers and treatment programs for problem drinkers, but much remains to be learned. It appears that some social drinkers profit from education, but others do not. It is not known whether it

is possible to distinguish who will profit and who will not. It is also not known whether it is possible to design educational programs which will benefit those who currently do not profit from this type of treatment. It also appears that intensive long-duration treatment can be effective for problem drinkers convicted of DWI. But it is not yet clear whether there are different types of therapy that would be effective with different types of problem drinkers, nor whether further extension of the treatment period beyond a year would yield further benefits.

V. Public Information Programs

Public information programs have generally been shown to be effective in communicating information and, in some cases, appear to modify the attitudes of the individuals to which they are directed. They have rarely been shown, however, to effect the behavior of the public when used alone. Nevertheless, there are several well-documented cases (the British Road Safety Act, for example) where public information *in combination with new legislation or special enforcement* programs has produced at least temporary reductions in alcohol-related accidents.

Public information includes a number of different activities; information offices to assist in news management; speakers' bureaus to work with volunteer organizations as well as mass media communications. The development of effective mass media programs is a complex problem which requires considerable research. This "target audience" which must be reached through the media program must be identified. The methods for gaining their attention and motivating their action must be determined.

Regular evaluation of the impact of such programs is also required to insure that they are having the effect intended. The best controlled evaluations of public information programs (such as those directed at increasing safety belt use) have tended to indicate that mass media programs are not effective, in and of themselves, in producing a behavioral change or an accident reduction, unless they are accompained by other governmental or private programs.

VI. Systems Progams

The best examples of the systems approach in the area of alcohol and highway safety were the 35 ASAPs funded by the Federal government between 1970 and 1975. These projects attempted to produce an integrated alcohol safety system at the community level and to provide support to all elements of that system in an effort to reduce alcohol-related crashes. The projects were successful in establishing a community alcohol safety office with a project director who, through the control of project funds, had considerable influence on the various agencies participating in the drunk driving control system.

The ASAP experience indicated that these offices can be effective in overcoming the bottlenecks and other problems that frequently occur in the processing of drinking drivers when an increased enforcement effort produces more pressure on the courts and on treatment facilities. The overall evaluation of the ASAP indicated that there was a reduction in nighttime fatal crashes in approximately a third of the sites. This reduction was attributed principally to an increase in general deterrence that was, for the most part, a direct result of the increased enforcement effort. The extent to which the system improvement contributed to the effectiveness of this enforcement effort is not known.

Following the termination of Federal funding, many of the centralized ASAP coordination offices disappeared, though the coordination function was preserved within one or another local government entity in some cases. With the growing public interest in the drinking driving problem there has been a re-emergence of the need for a coordinating system at the local level. Currently, the most popular approach to this coordination is through the formation of local or State drunk driving committees or commissions. While these bodies have no direct administrative authority, they can be effective in bringing together the different government agencies which must coordinate their activities if there is to be an effective drunk driver control system. These committees can also highlight inadequacies in the system and promote local and State governmental action to pass new legislation where required.

Because of the obvious significance of the interrelationship between the emphasis given to drunk driving by the police, the procedures they use to appehend and arrest drivers; the resources of the courts to process arrested drivers and, finally, the capability of treatment and corrections agencies to handle drivers convicted of DWI, there is considerable face validity to the need for a "systems" approach which provides a coordinating system for the various agencies involved in alcohol safety programs. There is, however, relatively little hard evaluation data which demonstrates the value of the systems approach or provides an indication of which coordination activities are most significant to an effective local safety program.

Recent Evidence of Progress

While a number of individual programs have given some evidence for the effectiveness of a specific countermeasure applied in a specific locale at a specific time, there has been little evidence of overall national progress in the field of alcohol and highway safety. In part this has been due to the lack of comprehensive data systems which can reflect year-to-year changes in the number and severity of traffic accidents. With the maturity of the Fatal Accident Reporting System, however, trend data are becoming available.

The FARS provides data for an 8-year period from 1975 through 1982. From 1980 to 1982, there was a 14% reduction in total fatal accidents. A recent analysis of this reduction by Hedlund, et al.

(1983), provides evidence that approximately 2% of the 14% reduction may be due to alcohol safety programs. Table 4-4, taken from that study, shows that there appears to have been a reduction from 50% to 48% in the proportion of fatally injured drivers with BACs at or above .10%.

Whether this reduction in the proportion of all accidents which are alcohol related results from highway safety efforts or whether it is another manifestation of the current economic recession is not clear. It is possible that the recession differentially impacts upon drinking-driving accidents because it reduces recreational driving (and recreational drinking) more than the driving necessary for going to or from work. The recession may also differentially impact on alcohol-related accidents because of its effect on one segment of the population. Teenagers, for example, may lose their jobs and therefore their ability to drink and drive before older adults are affected by the recession. Since young drivers are overexposed and overinvolved in alcohol-related accidents, a reduction in their driving would reduce the proportion of all accidents which are alcohol related.

Nevertheless with these caveats in mind, the data presented by Hedlund, and his coworkers offers the first indication that there may be progress at the national level on this most difficult and complex problem. With the availability of new enforcement technology; with a number of new programs to curb drunk driving being implemented; with these programs more strongly supported by public opinion; with more interest and attention being given to program evaluation; and, finally, with better accident record systems in place, we may hope that in the near future, our knowledge of how to control the drinking-driving problem will be significantly improved. Hopefully, this increased knowledge will ultimately be reflected in more effective programs and in reductions in drinking-driving accidents.

Table 4-4.—Reductions in the Percentage of Fatally Injured Drivers With High BAC's in the 15 States With Most Complete Alcohol Data in the FARS *(Hedlund, et al., 1983)*

BAC	1980	1982	Change
0.00 pct	38.5	40.9	+2.4
0.01 to 0.09 pct	11.5	11.1	−0.3
0.10 pct and above	50.1	48.0	−2.1

Chapter 5

Alcohol and Highway Safety Research Needs

Introduction

This chapter deals with priority research needs in the context of the nationwide anti-drunk driving effort. It starts with the view of the current nationside effort to curb drunk driving and where it appears to be heading. (Nationwide effort, as used here, means efforts at all levels of government, private organizations, institutions and individuals—i.e., everything that is going on.) What additional or new information would be helpful to support these efforts now and in the future is then specified. The second consideration discussed is one of priority judgments regarding which projects are the most important to work on now, given the finite resources that are available, are made basically on a number of criteria, and inputs from various viewpoints, but they necessarily represent a human judgment. Thus, what follows is a review of the most important research needed to support the national effort. Specifically discussed is the work required to identify and develop the methods and techniques that can be used by States, communities and the private sector to reduce alcohol-impaired driving.

Research Purpose and Objectives

The research indicated in this section is designed to lead to individual behaviors that will avoid alcohol-impaired driving. A summary of the important human factors leading to these behaviors, and thus important areas for research, can be found in NHTSA Technical Note, Reducing Alcohol-Impaired Driving: Surveys for Use in Measuring Program Effectiveness (*NHTSA, 1983d*).

The research required to develop methods and techniques that will achieve these avoidance behaviors can be classified in four main priority areas:

1. Research that supports the development and application of practical methods and techniques that will constitute effective *general deterrence* programs (i.e., techniques that develop and maintain the perception of the risk of detection and negative consequences).
2. Research that supports the development and application of practical methods and techniques that will be effective in changing societies' norms and behavior (i.e., techniques that develop and maintain responsible attitudes about the problem, individual responsibility, and the action one can take to avoid alcohol-impaired driving).
3. Research that leads to practical methods for people to use to determine when they or others are impaired so that they should not drive.
4. Research to provide technically sound and practically useful information about the alcohol problem and solutions to highway safety managers.

Each of these areas is treated below.

General Deterrence

The objective of research and development in this area is to identify, develop, and support methods and techniques which will produce and maintain a perceived risk of detection and negative consequences sufficient to induce individuals to modify their behaviors so as to avoid alcohol-impaired driving.

It is expected that people have a broad and general perception of the risk of detection and consequences for DWI but that, as DWI enforcement programs are implemented and publicized, they may develop different perceptions regarding various aspects of the system (e.g., the chances of being caught are high, but the chances of a serious penalty are very low). Thus, research and development should treat the following aspects of risk: being observed, being stopped, being identified as a DWI, suffering consequences, and the severity of the consequences. Projects need to treat not only the techniques and operations of the legal/enforcement system that relate to these risk perceptions (e.g., police deployment influences the risk of being observed), but also the related public information and communication channels that transport information about the DWI system and programs.

Some of the projects currently underway or planned are as follows:

- Determination of the Required Level of Perceived Risk
- Effectiveness Determination for Enforcement and Public Information Countermeasure Combinations
- Development and Evaluation of Sobriety Checkpoints for DWI Detection

- Development of On-the-Road Detection and Psychophysical Tests
- Evaluation of a Breath Test at Traffic Stops Procedure
- Evaluation of Citizen Reporting of DWIs to Police
- Development of Accurate Legal Perceptions of BAC Levels
- Evaluation of Community Service Sanctions for DWI
- Determination of Hardship License Effects
- Evaluation of Jail/Fine Sanction
- Evaluation of Short-Term License Suspension
- Evaluation of Administrative License Removal

By way of further explanation, the research issues associated with two general deterrence topic areas are briefly described below.

(1) Increasing the opportunities to screen and detect drunk drivers within the limits of acceptance by the public and courts.
   - Through observation of driving behavior, is it possible and feasible to screen drivers (i.e., identify those one would have "reason to believe" are intoxicated) in the course of normal driving or in a particular location without interfering with them?
   - Is it possible and feasible to meet judicial and legal requirements (e.g., "reason to believe") in order for police officers to undertake a DWI investigation, when engaged in some or all classes of other traffic investigations?

(2) Improving the understanding by the public and those involved in court proceedings of the nature and relationship of legal BAC levels, alcohol impairment levels dangerous for driving, and public perception of being drunk.
   - How do people view these three concepts and what are key factors that would need to be treated to improve understanding?

Prevention

The objective of research and development in this area is to develop responsible attitudes and the necessary knowledge and skills so that individuals will take action to avoid their impaired driving and to deter others from driving impaired. Three areas appear important:

1. Attitudes about the problem,
2. Acceptance of individual responsibility, and
3. Knowledge and skills to permit effective individual action.

Survey data seem to indicate that the DWI problem *in general* is widely accepted, but it is not clear whether enough people think that they or their associates may contribute to impaired driving. While the urgency of the DWI problem calls for immediate action to change attitudes and norms, it is recognized that the knowledge base for developing successful prevention programs has some serious deficiencies. Thus, both program development and more fundamental research seem needed.

Some of the projects currently underway or planned are as follows:

- Development of Procedures for Self and Host Determination of Impairment,
- Identification of DWI Attitudes and Approaches for Change,
- Development of New In-School Programs,
- Evaluation of Testimonials by Teenage DWI Offenders,
- Determination of Necessary Youth Attitudes and Skills, and
- Development of Intermediaries (e.g., Bartenders) Intervention Programs.

By way of further illustration, the research issues associated with two prevention topic areas are briefly described below.

1. Increasing the perceived and actual responsibility of persons providing alcohol (e.g., party hosts, businesses) for the prevention of impaired driving by those who are being served.
   - Are there motivational and legal approaches that are feasible, practical, and likely to reduce alcohol-impaired driving (as directed from obvious drunkenness)?
2. The Department and other agencies are mounting efforts to reduce the large number of injuries and fatalities that involve youth and alcohol in highway crashes. The need for programs aimed specifically at this target population and this problem is well recognized. However, there is a lack of knowledge about the attitudes, and possibly skills, that are necessary and sufficient to lead to behaviors that avoid DWI. Research is needed to obtain basic information necessary for the development of effective youth attitude-change programs including:
   - A determination of the validity of untested program premises, identifying those which contribute to successful program activities and those to be discarded.
   - Identification of the necessary and sufficient youth attitudes which need to be developed and changed to achieve DWI avoidance behaviors.

Impairment Information

The objective of research and development in this area is to provide people with information and/or techniques so that they will know their impairment level at the time when a drinking or driving decision can be made.

This is not as easy and straightforward as it seems. People need information so that they can establish levels of impairment above which they do not want to go. (It is becoming more recognized that the legal limit is usually an upper-bound

rather than a desired target.) They need some way to determine whether they are at a given point in time relative to that level and what intake or waiting time would be acceptable.

It should be noted that this information is *necessary* even though people have been motivated through prevention and/or deterrence programs.

Projects are underway to evaluate "know your limits" cards and breath testers that can be made available to the public in drinking establishments. More work may be needed on those topics.

In addition, the following topic area and associated research issues have been identified.

Improving the ability of citizens to determine when they or others are impaired so that they should avoid driving.

- Are there reasonably effective ways that ordinary citizens can learn to spot dangerous impairment in themselves or others without the use of equipment or BAC calculations (e.g., internal or observable cues)?

Systems Support

The objective of research and development in this area is to develop and provide technically sound and practically useful information about the alcohol problem and solutions to highway safety managers. In general, this means:

1. Providing updated information on the state of knowledge—as it is important for program managers and applied researchers.
2. Providing evaluation instruments for studying the effectiveness of various programs and techniques.
3. Providing a basic data base regarding drinking-driving attitudes and behaviors that can be used to answer programmatic questions.

These kinds of activities are different from the others in a number of ways including the fact that they do not develop specific techniques or programs, but rather bring together information or information-gathering techniques for use by others. Examples of the kinds of projects are:

- Publication of the report of which this is a part.
- Development of a survey item inventory for assessing attitudes and behavior.
- Planned biannual review of topics of interest (e.g., role of problem vs. social drinker).

Chapter 6

New Directions in Alcohol Programs

Introduction

This chapter considers the requirements for an effective community drinking-driving program based on the information summarized in this volume. The intention is to provide the framework within which States and communities can develop the detailed legislation and countermeasure programs which are necessary to deal with the drunk driving problem in their locality. Emphasis is placed upon a comprehensive, integrated program at the local level, since sporadic, isolated efforts which have frequently characterized drunk driving programs are not likely to be effective in dealing with the complex problem which heavy drinking combined with driving presents to this nation.

The attack upon the drinking-driving problem requires the coordination of efforts at all levels of government—local, State and Federal. Within each locality, it requires the integration of the efforts of independent elements of the executive and judiciary. The police, the courts, corrections agencies, and treatment providers must be coordinated, to say nothing of schools, transportation officials and State liquor control agencies and motor vehicle departments. All of these must be coordinated in an integrated attack upon the multiple target groups that make up the drinking-driving problem: the heavy or problem drinkers who may be responsible for the majority of alcohol-related fatal crashes but who, unfortunately, are less likely to be deterred by educational and deterrence programs; the larger mass of social drinkers who account for somewhat smaller, but large, segment of the drinking-driving problem; and the drinking pedestrian who has only rarely been the subject of any concerted community countermeasures program.

Some past programs have shown promise and some have even demonstrated reductions in alcohol-related deaths. However, it is apparent that, despite some short-term successes, the war on drunk driving is far from being won. This lack of bottom-line success has prompted a reappraisal at the local, State and national levels. The approach described in this chapter calls for renewed action at all levels. Drunk driving is not the intractable problem many feel it to be—but the methods for solving it are complex and difficult—there are no easy answers. The proposed concepts and programs in this chapter reflect this awareness. They are believed to offer significant promise for further reduction in drinking-driving deaths and injuries in this country.

Integrated Program

Solving the problem requires an integrated effort by all levels of government and society. But it must be recognized that drunk driving is first and foremost a local problem, not a Federal one. It has reached national importance because it has first become a significant problem in every community in this nation. This distinction has more than rhetorical importance, however, because it is the local and community emphasis which is essential to any solution. The ultimate responsibility for solving this problem must be placed and accepted by localities. It is in our cities, towns, and counties where the primary resources for controlling the drunk driver reside. It is there where society's attitudes toward drinking and driving are established and reinforced and it is there where the tragic consequences of drunk driving are most acutely felt.

State government has both a direct and a supportive role. Establishing drunk driving laws is a State prerogative. State and local law enforcement agencies, courts and licensing agencies have a direct role in the arrest and sanctioning of offenders. State government is involved in the collection and distribution of financial resources to local and State agencies. State government is also involved in planning, record-keeping, policy formulation and providing guidance to local communities.

The Federal Government has an indirect support function to facilitate action in the States and communities. Through a carefully chosen program of countermeasure research, with technical and financial support, the Federal Government must stimulate and catalyze effective programs within the States.

Current Approach

The current approach is based upon a concept or model emphasizing seven major points.

1. *General Deterrence Approach (short-term)*—Conducting programs oriented toward deterring the majority of drunk drivers who

are never arrested (rather than "treating" the few who are) for short-term impact.

2. *Community Focus*—Placing program emphasis and responsibility at the local level.
3. *Systems Approach*—Integrating the coordinating, enforcement, prosecution, adjudication, education/treatment, public information/education, and licensing functions at the local and State level as appropriate.
4. *Financial Self-Sufficiency*—Assessing fines, court costs, treatment tuition fees, etc. to convicted offenders to defray the costs of local/community programs.
5. *Citizen Support*—Generating community/citizen support for comprehensive community programs (to provide a political base for increased countermeasure activity).
6. *Prevention (long-term)*—Efforts toward changing societal attitudes toward drinking and driving through long-term prevention/education programs.
7. *Increase Safety Belt Usage*—It is a proven fact that the use of safety belts will result in a significant reduction in the severity of injuries resulting from crashes. Use of the safety belt is the best proven defense against the drunk driver.

To reduce the drunk driving problem in both the short-term (2 to 10 years) and long-term, requires all of the above elements.

First, programs at any level must be of a *general deterrence* nature, that is, designed to impact and deter the vast majority of drunk drivers who will never be arrested. Programs which focus exclusively on the relatively few DWIs arrested each year (only about one in every 2,000 drunk trips results in a DWI arrest) will not significantly reduce next year's alcohol-related problem.

Second, the prime responsibility for solving this problem and the forum for action must be at the *local* level. The Federal Government cannot solve this problem, it can only promote and facilitate local/State solutions.

Third, there now exists in every State and locality the basic elements of police, courts, treatment, and media to deal with the drunk driver problem. The problem is that these elements are not working well individually, nor as an integrated system. Based upon NHTSA's ASAP experience, creating a locally coordinated/managed countermeasure system—which integrates the functions of the police, prosecutors, the courts, probation, education/treatment, public information (media), and licensing agencies—improved both the effectiveness of the system as well as its individual components.

Fourth, solving the drunk driving problem requires a substantial investment in local and State resources over a sustained period of time. One shot, short-term emphasis programs set up by special State (or Federal) appropriations will have a transitory effect at best. With the general trend toward shrinking State (and Federal) highway safety-related funding, year-to-year maintenance or operating budgets for key State agencies (police, courts, treatment, etc.) are being threatened or reduced. As was seen in the ASAP projects, alternate sources of funding which would provide for sustained program operations are available. One of these prime sources are the DWI offenders themselves. By redistributing the offender fines, court costs, education/treatment tuition fees back to the local governments who pay for police, prosecutors, treatment, etc., programs could be made financially self-sufficient.

Fifth, one of the principal barriers to effective drunk driving programs is in the broadest sense, political. Political pressure from concerned citizenry on State and local governments (including police, courts, and other involved agencies) is simply not present to a degree necessary to alter the priorities assigned to this issue. As we have recently seen throughout the nation, an organized and informed body of individuals, many of whom are victims of drunk drivers, can bring about major advances in State laws and alcohol programs. By providing technical guidance to such groups, as to effective countermeasures and techniques for program improvements, the Federal Government can help develop this political support for increased countermeasure activity in the States and communities.

Sixth, in the short-term, general deterrence programs offer promise for the control of the present drinking driver population. In the long term, however, a societal norm must be established that makes drunk driving socially unacceptable behavior. Achievement of such a goal, as widely divergent from the present social attitude, as it is, will require decades of effort. The focus for such an effort must be the predriver population—our youth. Through long-term prevention/education programs in schools and within our communities, responsibile attitudes toward alcohol use and driving must be established.

Finally, regardless of our level of success in achieving a reduction in alcohol-related crashes, a certain number will inevitably occur. In those counties where signficant levels of safety belt usage have been achieved, there have been dramatic reductions shown in both numbers and severity of all classes of injuries. Virtually all vehicles in this country are equipped with these life-saving devices, but only a small percentage are actually used. The achievement of a high level of safety belt usage can reduce both the number and severity of injuries.

This integrated approach should be viewed as more of a shift in emphasis or a refinement of the present drunk driver control system, rather than a fundamentally different approach. The principal task in the 1980s is to promote this comprehensive approach and to facilitate its adoption in the States through the careful application of technical and financial support. The staff and funding resources available for alcohol traffic safety programming necessitates a highly focused approach.

Program efforts (manpower and funding) must be directed toward promoting necessary changes in State and community alcohol programs through the careful use of *seed monies, technology transfer, technical assistance, training, and networking efforts.* Instead of expending tremendous resources to undertake widespread, Federally financed demonstration programs, future program activities must be designed toward catalyzing specific State and local program efforts which can "sell themselves" to other communities and to other States. Implicit in this new approach is the understanding that resources must be *concentrated* in carefully chosen *"target" States and communities* with receptive "climates" in order to enhance the possibility of effecting significant change.

With the recent evolution of an involved citizen constituency, and the considerable base of experience afforded by the ASAP and State programs, it is felt that sufficient ammunition can be brought to bear to mount a significant attack on the drunk driving problem in this country.

Statewide Network of (Comprehensive) Community Drunk Driving Programs

The goal of State and community emphasis programs is the formation of a statewide network of comprehensive, community-based programs in every State. The formation of an integrated, locally coordinated drunk driver control system (out of the many local and State agencies responsible for controlling the drinking driver) amplifies the effectiveness of each component. Such programs can reside in every *major political subdivision* (county, city, or region) within the State. One of the primary determinants for selecting the appropriate geopolitical level would be the level of local government primarily responsible for enforcement, prosecution, adjudication, and treatment services. Each State/community would, of course, select the particular jurisdictions (or aggregate of jurisdictions) as appropriate.

NHTSA Alcohol Program Synopsis

The NHTSA alcohol and highway safety program is comprised of six major efforts: (1) The Comprehensive Target State Program; (2) Individual Countermeasure Programs; (3) Public Information and Networking; (4) State/Local Highway Safety Grant (402) Program; (5) Alcohol Traffic Safety Incentive Grant 408 Program; and (6) Alcohol and Highway Safety Research and Development (see Chapter 5 on Alcohol Research).

1. Comprehensive Target State Program

The objective of the target State program is to promote the adoption of a comprehensive, community based, general deterrence program in selected "target" States. The program will concentrate NHTSA technical resources (in-house staff, 403-funded contracts efforts) *on volunteer target States and communities that are receptive to implementing the comprehensive community based program described.* Participating States would be required to commit substantial State and local resources to assist in program implementation. NHTSA staff and contract resources would then promote and assist the selected jurisdiction in improving countermeasure operations (police, courts, licensing, public communication, etc.), improving legislation, developing citizen support, expanding private sector involvement, and implementing a locally coordinated drunk driver deterrence system.

2. Individual Countermeasure Programs

Complementing the activity in the selected target States will be individual countermeasure area programs addressing needs in several or in some cases all of the remaining States.

The objective of the individual countermeasure program is to improve State and local program effectiveness and efficiency in the following countermeasure areas: Enforcement, Prosecution, Adjudication, Diagnosis and Referral, Education/Treatment, Licensing, Public Communications, Education (K-12, driver education), and management and evaluation.

NHTSA countermeasure and technical specialist will identify State and local deficiencies in their respective areas and conduct technical asssistance programs with emphasis on jurisdictions (State or local) most receptive to change. It is anticipated that a limited number of individual target States will be selected for special emphasis (e.g., to promote PBT laws, police training, improved court procedures) but that general technology transfer efforts will be conducted nationwide. Program activity within each countermeasure area is designed to achieve a series of objectives through a coordinated program including research and development, specialized training and workshops, materials distribution, and increased use of networks of organizations and individuals to promote program objectives.

3. Public Information and Networking

Past experience has indicated that two promising public information strategies which work particularly well in the alcohol area are: (1) enhancing the success of methods such as enforcement by making drinking drivers aware of expanded DWI programs; and (2) encouraging voluntary decisions to prevent driving after heavy drinking.

Campaigns that emphasize the likelihood of being apprehended for drunk driving have shown evidence of success in this country and abroad. A program in Vermont from 1972 through 1974 showed a decline from 21% to 7% of high risk drivers on the road with .05% BAC or higher (persons who consume over three drinks per sitting at least once a week). A 1967 campaign in England and a 1969 campaign in Canada also showed behavior change.

However, a significant problem with this approach is that it must be reinforced by energetic, continuous enforcement. Because this may not be feasible in the long run, a concurrent public information program must be conducted to develop

widespread norms against drunk driving. From 1972 to 1976, NHTSA ran a campaign of this sort with the theme, "Friends Don't Let Friends Drive Drunk." It demonstrated clear results, including a 5% increase in the number of people taking action to prevent a friend from driving drunk; and a 12% increase in number of people offering to let an intoxicated friend spend the night.

Furthermore, annual surveys by NHTSA show evidence that these gains have been maintained over the years. It appears appropriate, therefore, to enhance these gains through public information efforts emphasizing voluntary decisionmaking and individual responsibility.

The objective of the public information and networking program is to increase public awareness of enhanced alcohol countermeasure activities especially enforcement (sanctions), to catalyze and encourage the public's willingness to take action to prevent themselves or friends from driving after heavy drinking.

NHTSA's drunk driving public information program will be designed to reach all segments of the public through carefully chosen combinations of interpersonal networks and mass media. The mass media efforts will focus on the most effective PI&E approaches at the local level and will develop a central theme from the local programs for use in a national campaign. New themes designed to influence individuals to take personal action to prevent their own driving after excessive drinking will be emphasized in the technology sharing and technical assistance.

Previous strategies have focused on those personal associates who are in contact with the excessive drinker and have promoted measures, such as calling a cab, driving him home, having him spend the night, etc. to prevent an intoxicated person from driving. The new strategy intends to maintain the willingness to take such measures with friends, but to add on ideas of how individuals must take responsibility for their own drinking and driving behavior through "pre-planning" measures before drinking starts. These include counting drinks to limit consumption, eating food along with drinking to retard absorption, arranging in advance for someone else to drive, etc.

4. State/Local Highway Safety Grant (402 Program)

Since 1975, States have been directing approximately 12% of the total 402 funds appropriated toward alcohol safety-related activities (including alcohol selective enforcement). It is anticipated that the percentage of 402 funds applied to alcohol-related programs will initially rise to approximately 35% to 40%.

Rather than diffusing program efforts over as many as 18 different program areas, the 402 program should concentrate and direct the expenditure of Federal resources to high payoff emphasis areas such as Alcohol and Highway Safety. With such an emphasis, it is believed that State and community efforts can not only be maintained but increased. Alcohol is a major emphasis area of the 402 program. Therefore, State highway safety planning should place renewed emphasis on controlling the drinking driver through development of comprehensive coordinated alcohol safety programs.

One of the major objectives of the 402 program is to support State and local efforts to implement comprehensive community-based drunk driving programs and to improve countermeasure effectiveness and efficiency within such programs.

State Highway Safety Planning and Program Development Strategies—In developing State Highway Safety Plans, program managers will be requested to give priority to innovative and impact projects. Alcohol project proposals which spread the activity so thinly over a wide area that a measurable result is unlikely should be avoided. Rather than funding single program elements where the other program elements are not in place, emphasis should be placed on establishing and implementing comprehensive community alcohol highway safety programs.

5. Alcohol Traffic Safety Incentive Grant (408 Program)

Recent actions of a concerned citizenry, State, local highway safety officials, State legislators, and Governors Task Forces, etc. have focused the attention of the executive branch and Congress on the issue of drunk driving and the need to provide incentives for State/local community leaders to place a higher priority in dealing with the drunk driver problem. Accordingly, Congress enacted an alcohol traffic safety incentive grant program, PL97-364 (23 USC 408).

The incentive grant program is directed at getting drunk drivers off the road and encouraging States to adopt comprehensive alcohol traffic safety programs. The legislation reinforces the national movement to end the public indifference, and to increase efforts to deter people from driving while impaired by alcohol. It provides the necessary incentives for the States to increase penalties and to enact comprehensive programs that have been proven effective.

NHTSA has been urging officials across the nation to use more of their highway safety funds to attack the drunk driver problem with emphasis on development of locally funded and coordinated alcohol traffic safety programs. States and local communities are also being urged to improve apprehension techniques, streamline court procedures to handle increased caseloads, strengthen DWI laws, and increase media coverage of enforcement activities so that public perception of arrest/increased sanctions for DWI is increased. NHTSA is committed to providing guidance, technical assistance, and resources to State and local communities to help achieve this end. But, more needs to be done to encourage States to reduce significantly the needless slaughter on our nation's highways.

Thus, Congress in addressing this problem providing funding for an alcohol incentive grant program to be used as seed money to assist and reward those States that take effective steps toward establishing comprehensive programs aimed at deterring drunk driving.

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