TRANSPORTATION RESEARCH RECORD 609

Highway Safety, Traffic Records, and Law Enforcement

TRANSPORTATION RESEARCH BOARD

COMMISSION ON SOCIOTECHNICAL SYSTEMS
NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY OF SCIENCES
WASHINGTON, D.C. 1976

Transportation Research Record 609
Price $2.00
Edited for TRB by Susan L. Lang

subject areas
51 highway safety
52 road user characteristics
53 traffic control and operations

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Library of Congress Cataloging in Publication Data
National Research Council. Transportation Research Board.
Highway safety, traffic records, and law enforcement.

(Transportation research record; 609)
1. Traffic safety–Congresses. 2. Traffic regulations–Congresses. 3. Highway departments–Data processing–Congresses. I. Title. II. Series.
TE7.H5 no. 609 [He5614] 380.5'08s 77-23422
ISBN 0-309-02584-2 [388.3'14]

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Contents

Studies of Roadside Hazards for Projecting Fatal Crash Sites

Paul H. Wright, Georgia Institute of Technology
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This paper presents a survey of road curvature, superelevation, gradient, and number and distance from the roadway of roadside hazards conducted in Georgia at 300 sites of fatal crashes into fixed objects and at 300 comparison sites 1.6 km (1 mile) from the accident site. More than 26 percent of fatal crash sites and only 8 percent of comparison sites had road curvature greater than 6 deg combined with downhill gradient of -2 percent or less at or approaching the sites. Fifty percent of fatal crash sites and only 23 percent of comparison sites were at or near curves greater than 6 deg irrespective of gradient. A state study found that only 22 percent of roadways throughout the state had curvatures of more than 5.5 deg. Nonlocal roads accounted for 83 percent of the fatal crashes into fixed objects but comprised only 33 percent of the roads in the state. In 98 percent of the cases objects struck were within 15 m (50 ft) of the pavement edge. Top priority should be given to modification of roadside hazards on and near curves greater than 6 deg, particularly those on nonlocal roads where the downhill grades are -2 percent or less.

Most U.S. roads are bordered by natural and man-made unyielding structures (trees, rocks, poles, guardrails) that are hazardous roadside objects. When vehicles collide with these objects, the occupants are either maimed or killed. The magnitude of the danger is difficult to assess because most single-vehicle collisions are categorized as noncollision rather than as fixed object. In 1974, the National Safety Council listed 13 500 deaths in the noncollision category and only 3600 deaths in the fixed-object category (1). A few states have modified their reporting categories to reflect accurately the toll caused by roadside object collisions. In 1974, Pennsylvania reported 766 occupant fatalities in single-vehicle crashes. Of that amount, 689 or 90 percent of the accidents were caused by collisions with fixed objects (2). Undoubtedly, the vast majority of occupant fatalities in single-vehicle accidents, which average more than 17 000 per year in the United States, result from collisions with unyielding structures along the roadside.

The technology is readily available for either removing roadside hazards or modifying them or the immediate environment so that the energy of errant vehicles can be managed to protect occupants from intolerable energy transfers (3, 4, 5, 6, 7). However, these hazards are so numerous that immediate removal or modification is infeasible, and some method is needed to identify those that should have priority treatment. The results of this study provide criteria for identifying road locations where fatalities caused by collisions with roadside hazards are likely to occur. The numbers and types of hazards in defined areas contiguous to the crash sites are also identified.

METHOD

The study was designed to identify and compare roadway characteristics at two sites. The site where one or more vehicle occupants died when the vehicle struck a roadside object was termed the crash site. A site located 1.6 km (1 mile) upstream, which the vehicle had likely passed before reaching the crash site, was termed the comparison site. The differences noted between the roadway characteristics of these sites can be used to identify other sites where fatalities are likely to occur. Comparison of characteristics of crash and comparison sites with characteristics of other Georgia roadways provides additional criteria for selecting sites for modification.

During a 14-month period ending in April 1975, virtually all locations where fatal collisions into roadside objects had occurred in the 108 contiguous counties in north and central Georgia were studied (Figure 1). This area includes a variety of land usage (rural, suburban, urban), roadway types, and topography. The Georgia State Patrol routinely mailed fatal accident reports to the research team. Those accidents in which the fixed object had not been struck or had not been a significant factor in the fatality were excluded.

Engineering measurements were made by a three-person team in a 0.3-km (0.2-mile) section at each site. Measurements were referenced from an object most likely to receive impact or cause vehicle occupant death. Crash sites were determined by locating a point along the roadway edge immediately adjacent to a selected object. The comparison site was located 1.6 km (1 mile) upstream from the crash site (Figure 2). The choice of turns at T- or Y-intersections was randomly selected in the

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location of comparison sites.

Curvature, superelevation, and gradient were measured both upstream and downstream from crash and comparison sites. Measurements began 15 m (50 ft) from each site and continued every 30 m (100 ft). Curvature and superelevation measurements ceased at 137 m (450 ft); gradient measurements ceased at 152 m (500 ft).

Figure 1. Area studied (shaded).

Distance was measured by using a 30-m (100-ft) cloth tape. Horizontal curvatures were measured by applying the middle ordinate method described by Baker (8) that consists of measuring the curve on the edge of the roadway and by converting the middle ordinates to degrees of curvature at the centerline of the roadway. Superelevation and gradients were measured at the center of the road on the side where the driver approached the crash location. These measurements were made with a specially designed instrument consisting of a 1.2-m (4-ft) carpenter's level having an adjusted calibrated leg. Curvature, superelevation, and gradient data for Interstate highways were taken from plan and profile sheets.

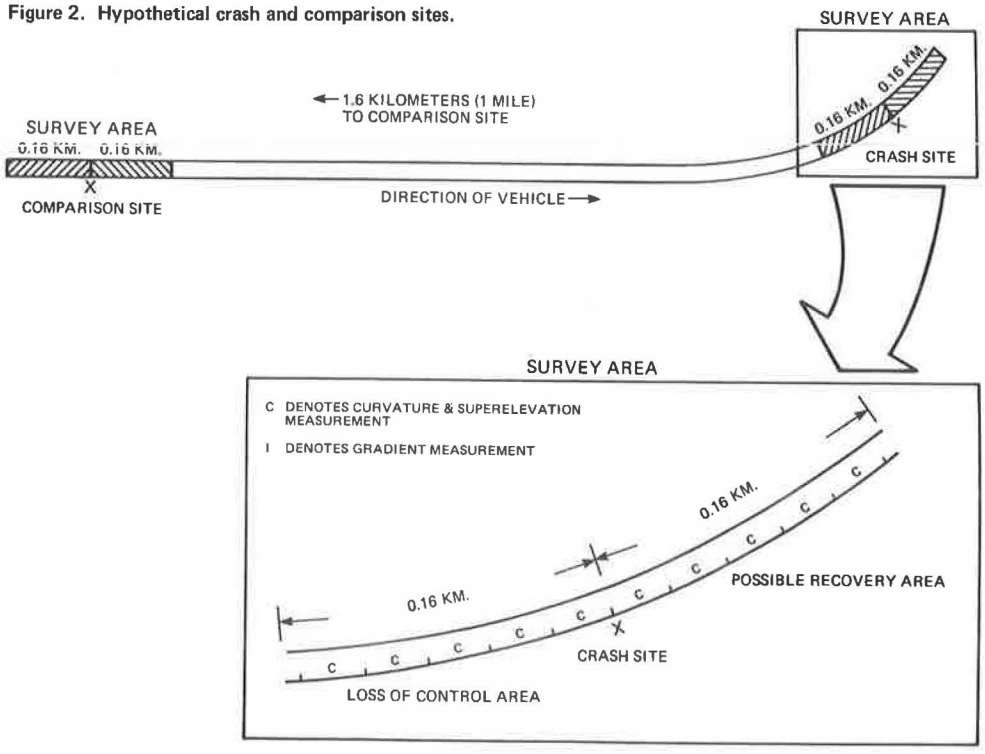
In the survey area, various fixed objects were inventoried in 3-m (10-ft) segments of a 9-m (30-ft) border along the pavement edge. Other road characteristics, which included type of road, number of lanes, and widths of pavement and shoulder, were also recorded.

The Georgia Department of Transportation supplied curvature length data derived from a 25 percent sample of the 41 216-km (25 600-mile) public road network. The department also provided distances by functional class for the complete 161 325-km (100 202-mile) system. The data served as a basis for estimating the amount and type of Georgia roadway that would require hazard modification by using this study's criteria.

RESULTS

The largest difference between crash and comparison sites was road curvature. More than 80 percent of the crash sites had curvature within 152 m (500 ft) whereas only 55 percent of comparison sites had curvature within this range (Figure 3). The road curvature within 152 m (500 ft) of the sites was greater than 6 deg for more than 50 percent of the crash sites but less than 24 percent of the comparison sites. The difference in distributions of curvature between crash and comparison sites would not normally occur by chance fluctuations in sampling (χ^2 = 80.1, d.f. = 7, $p < 0.001$). Only 22 percent of the 25 per-

Figure 2. Hypothetical crash and comparison sites.



cent sample of all Georgia roads had curvature greater than 5.5 deg.

The severest degree of curvature was usually found near to or upstream from the crash site. Figure 4 shows the percentage of road curvature greater than 6 deg at intervals upstream and downstream from crash and comparison sites. The largest differences occur in the area from -107 m (-350 ft) upstream to 15 m (50 ft) downstream. More than 69 percent of the vehicles crashing on or near curves left the outside of the curve, that is, the right side of a left-bending curve or the left side of a right-bending curve (Figure 5).

Although the results for superelevation are not shown, they closely parallel those for curvature. The cases where high curvature and low or nonexistent superelevation occurred were too few to separate the two variables as factors for identifying sites where fatal crashes into fixed objects would occur.

Roadways approaching crash sites exhibited more downhill gradient than those approaching comparison sites. Figure 6 shows the average road gradients at 30-m (100-ft) intervals within 152 m (500 ft) of crash and comparison sites. Average gradients decreased at each interval before crash sites but not before comparison sites. Extreme uphill gradient was more common beyond crash sites than beyond comparison sites, suggesting that

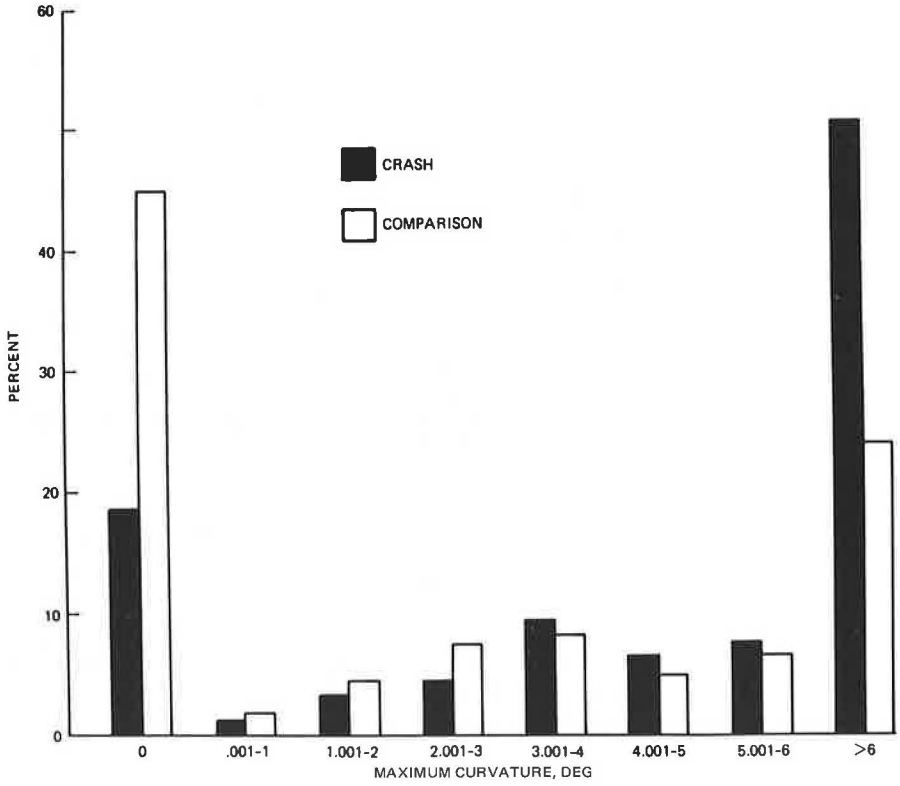


Figure 3. Maximum road curvature by distance from crash and comparison sites.

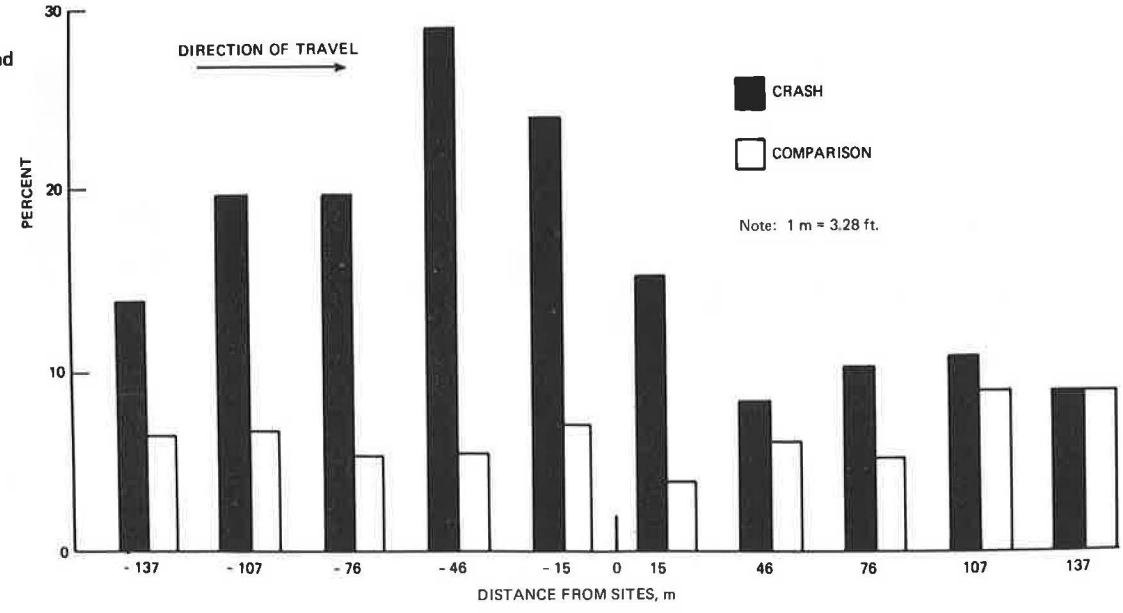


Figure 4. Road curvature > 6 deg by distance from crash and comparison sites.

Table 1. Analysis of variance for gradient ±152 m from crash and comparison sites.

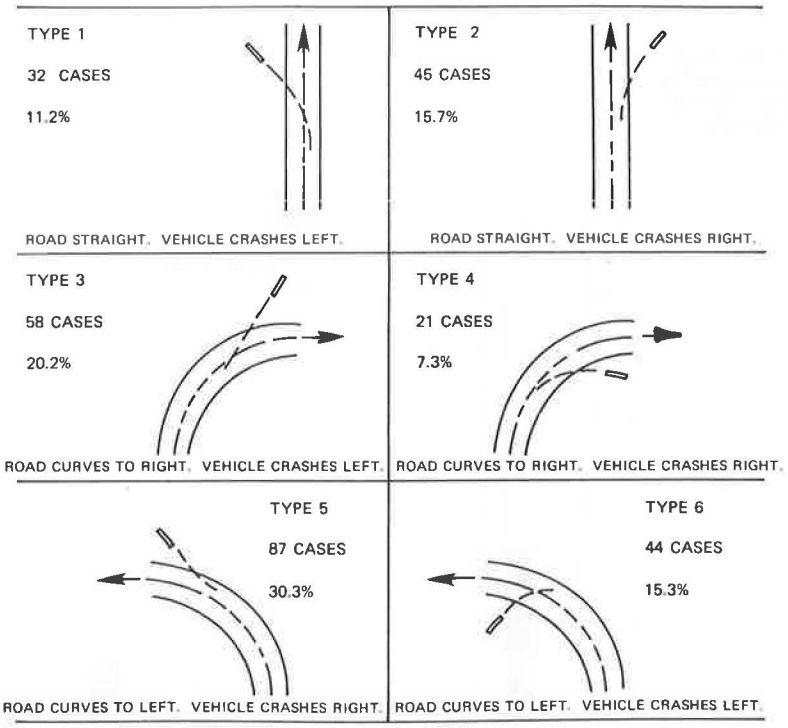
Source of Variation	Degrees of Freedom	Mean Squares	Variance Ratio, F	Significance
Differences of crash and comparison sites	1.0	40.873	4.905	$p < 0.05$
Differences among measuring points	20.0	11.294	1.355	
Residual	6.490	8.333		

Note: 1 m = 3.28 ft.

crash sites were closer to points where downhill gradient ended and uphill gradient began. The analysis of variance in Table 1 indicates that the average differences in gradient between crash and comparison sites would not have occurred as a result of random fluctuation in sampling ($p < 0.05$).

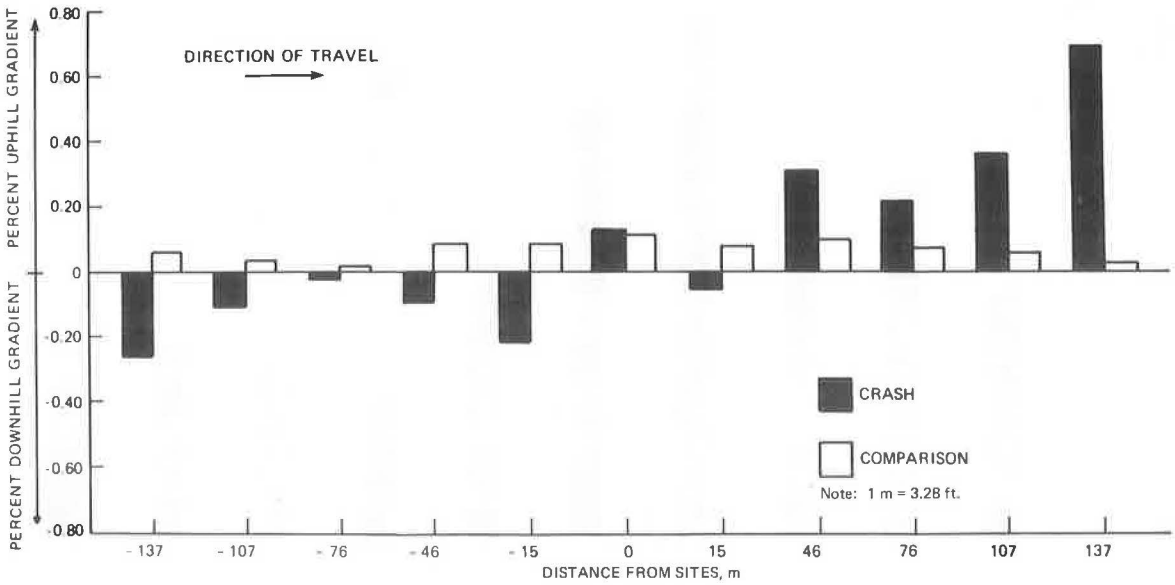
Crash and comparison sites were not characterized substantially more by extreme downhill gradients than by moderate downhill gradients. Figure 7 shows the minimum gradients observed at 152 m (500 ft) upstream from crash and comparison sites. The frequent minimum gra-

Figure 5. Fatal crashes into roadside objects by type of curvature.



Note: Excludes 13 cases where curves had more than 1 type of bend or information was missing.

Figure 6. Average gradient of road by distance from crash and comparison sites.



dient approaching sites was -2 percent or less for crash sites and greater than -2 percent for comparison sites.

The combined factors of maximum road curvature and minimum gradient did substantially discriminate between crash and comparison sites (Figure 8). Maximum curvature greater than 6 deg combined with minimum gradient of -2 percent or less occurred at 26 percent of the crash sites and only 8 percent of the comparison sites.

Since crash and comparison sites were on the same or similar roads, there was no difference between number of lanes or pavement width. Thus, the average differences in these factors were not significant ($p > 0.04$). There was also no significant difference in width of road shoulder between crash and comparison sites ($p > 0.05$).

The roadways were classified functionally for each crash location by using the classifications of the Georgia Department of Transportation (Figure 9). Only 17 percent of crash sites were on local roads, which make up 67 percent of the roads in the state. Based on its percentage of all roads, each type of nonlocal road had a greater percentage of fatal crashes than would be expected.

Potential hazards near the roadside differed little between crash and comparison sites (Table 2). Of the objects that apparently took the brunt of impact, about 90 percent were within 11 m (35 ft) from the pavement edge

Figure 7. Minimum gradient of road by distance upstream from crash and comparison sites.

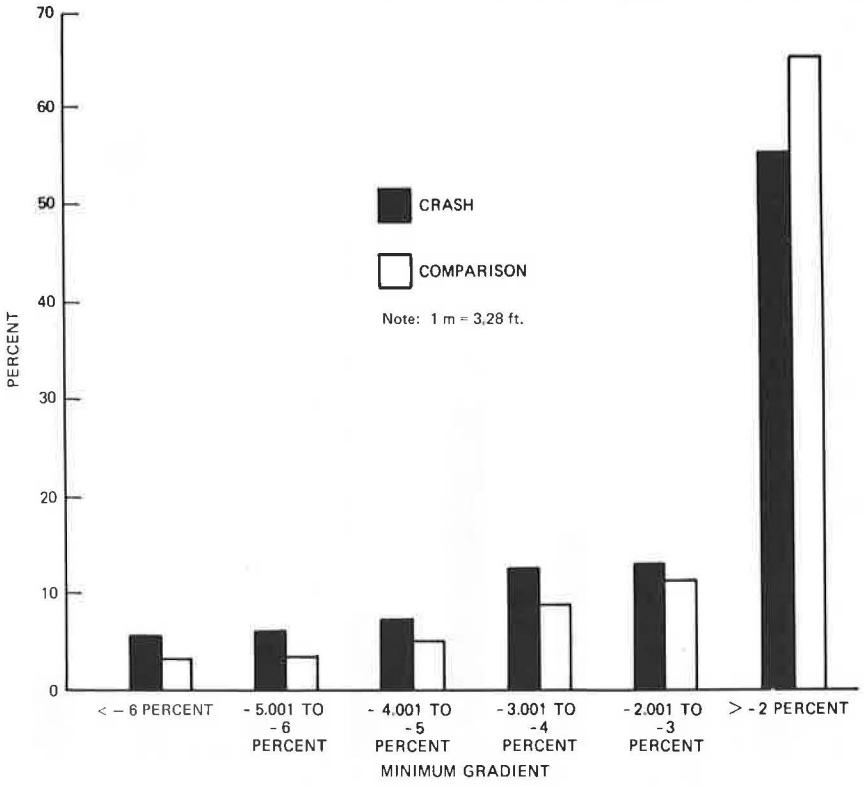
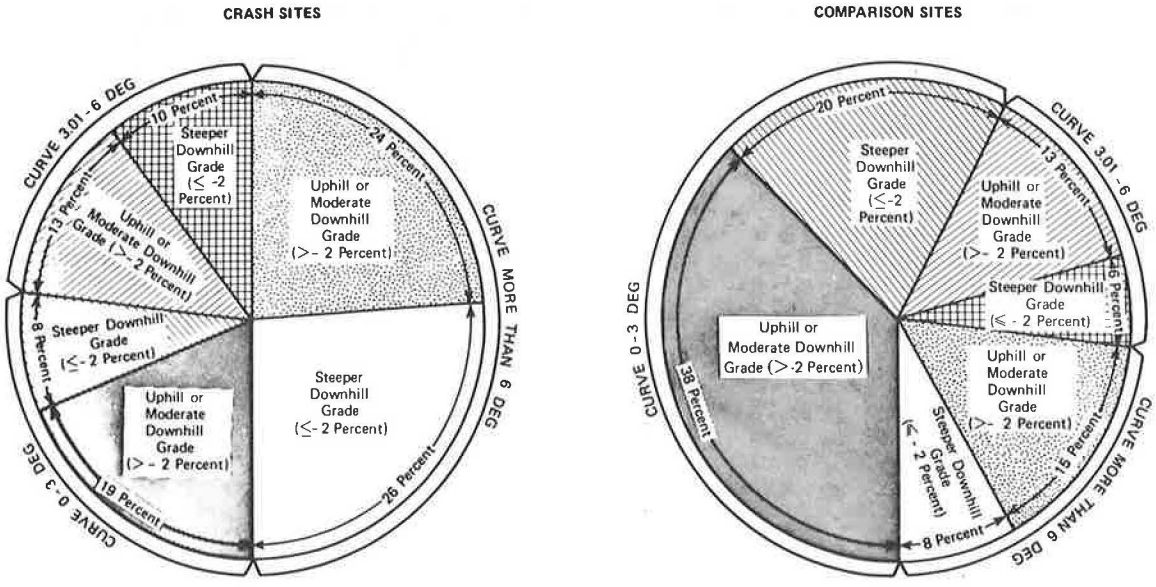


Figure 8. Combinations of maximum curvature and minimum gradient at crash and comparison sites.



(Figure 10) and 98 percent were within 15 m (50 ft). The objects struck and the percentage of fatal crashes involving them are as follows:

Objects	Percent	Objects	Percent
Trees	39	Guardrails	7
Embankments and ditches	23	Signs	5
Utility poles	14	Bridge abutments	3
		Other	19.3

Table 3 gives the average number of objects in a path on each side and upstream of the crash site. There were about 6 narrow potential hazards and 5 m (15 ft) of elongated potential hazards.

RECOMMENDATIONS

The results of this study indicate that roads or roadside objects exhibiting hazardous characteristics should be modified or where applicable removed. The following discussion summarizes this study's findings and recommendations.

Roads exhibiting the following characteristics are

Figure 9. Relation of crash sites and all Georgia roads by functional classification.

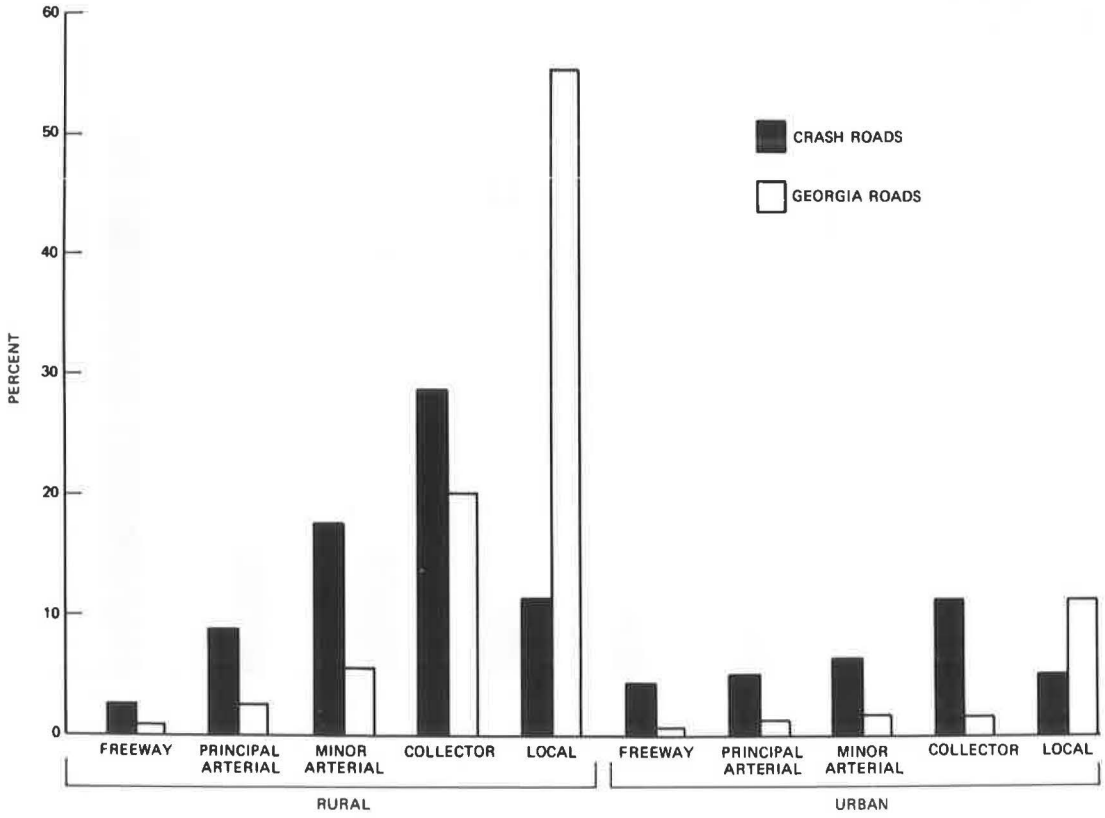


Table 2. Average number of narrow potential hazards and length of elongated potential hazards 9 m from pavement edge and 161 m from site.

	Upstream From Site								Downstream From Site							
	Crash Sites				Comparison Sites				Crash Sites				Comparison Sites			
Potential Hazards	0 to 3 m	3 to 6 m	6 to 9 m	Total	0 to 3 m	3 to 6 m	6 to 9 m	Total	0 to 3 m	3 to 6 m	6 to 9 m	Total	0 to 3 m	3 to 6 m	6 to 9 m	Total
Narrow, number																
Trees	0.7	2.7	3.9	7.3[a]	0.7	1.8	3.0	5.5	1.0	3.1	4.9[a]	9.0[a]	0.5	2.8	3.4	6.7
Utility poles	0.6	0.4	0.3	1.3	0.6	0.5	0.3	1.4	0.6	0.4	0.2	1.2	0.8	0.4	0.2	1.4
Traffic sign/signal posts	0.7	0.2	0.1	1.0	0.6	0.2	0.1	0.9	0.6	0.2	0.1	0.9	0.7	0.2	—[b]	0.9
Street luminary poles	0.1	—[b]	—[b]	0.1	—[b]	—[b]	—[b]	0.1	—[b]	—[b]	—[b]	—[b]	—[b]	—[b]	—[b]	0.1
Other	1.3	2.0	1.7	5.0	1.6	2.0	1.0	4.6	1.4	1.7	1.5	4.6	1.8	1.2	1.1	4.1
Total	3.4	5.3	6.0	14.7[a]	3.5	4.5	4.4	12.5	3.6	5.4	6.7	15.7	3.8	4.6	4.7	13.2
Elongated, m																
Guardrails	3.3	3.4	0.5	7.2	3.2	1.2	—[b]	4.4	4.9	3.0	—[b]	7.9	2.4	3.0	—[b]	4.4
Curbs	9.7	1.7	0.5	11.9	11.2	1.6	0.1	12.9	9.8	1.9	0.1	11.8	11.7	2.4	0.3	14.4
Embankments	11.1	19.1	4.8	35.0	8.6	16.6	3.8	29.0	9.7	18.7	5.2	33.6	8.3	20.7	4.3	33.3
Banks/cuts	4.5	9.9	4.7	19.1	4.7	9.5	4.2	18.4	5.0	11.9	5.9	22.8	5.7	12.6	3.6	21.9
Ditches	13.1	18.1	4.4	35.6	14.9	13.4	3.0	31.3	15.8	15.6	3.7	35.1	12.6	18.3	4.7	35.6
Median barriers	0.5	0.7	0.0	1.2	1.2	0.1	—[b]	1.3	0.5	—[b]	0.5	1.0	0.9	0.1	0.1	1.1
Total	42.2	52.9	14.9	110.0	43.8	42.4	11.1	97.3	45.7	51.1	15.4	112.2	41.6	57.1	13.0	110.7

Note: 1 m = 3.28 ft.

[a]Significantly different ($p < 0.05$, two-tailed) from comparison sites. [b]<0.05 but not 0.00.

listed according to degree of hazard and modification priority.

1. Curvature greater than 6 deg combined with a downhill gradient of -2 percent or less prior to or in curves,
2. Curvature greater than 6 deg,
3. Curvature greater than 3 deg combined with downhill gradient of -2 percent or less, and
4. Curvature greater than 3 deg.

Figure 10. Distance of objects from roadside at crash sites.

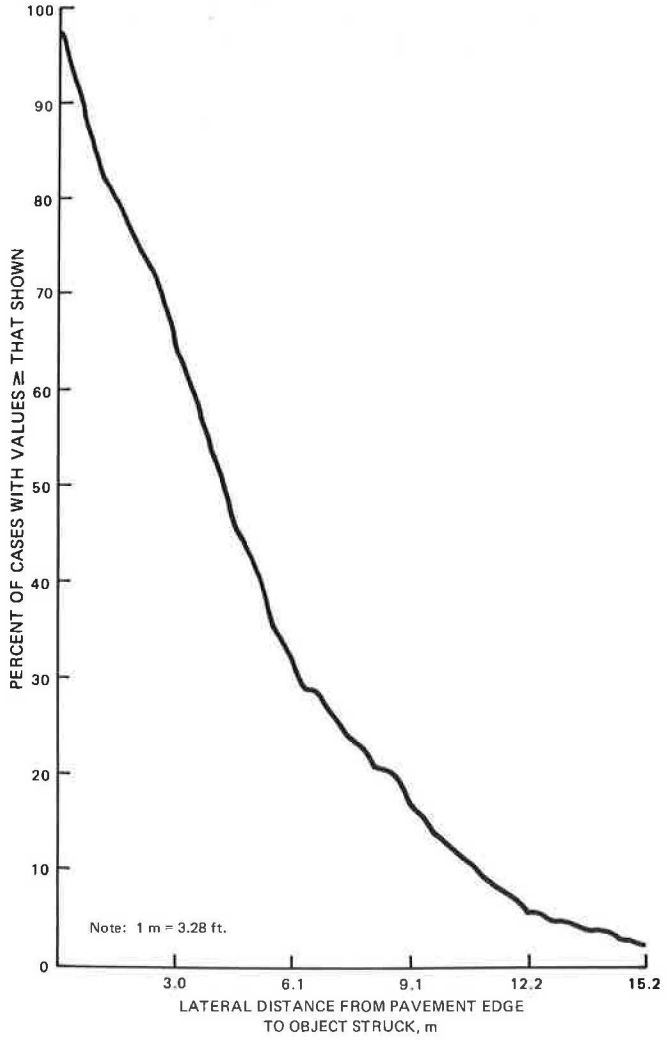


Table 3. Average number of narrow potential hazards and length of elongated potential hazards 4.6 m to each side and 27 m upstream from crash site.

	Vehicle Path Beyond Crash Site (m)			
Potential Hazards	0 to 9	9 to 18	18 to 27	Total
Narrow, number				
Trees	1.2	1.3	1.4	3.9
Utility poles	0.1	—[a]	0.1	0.1[b]
Traffic sign/signal posts	0.1	—[a]	—[a]	0.1
Street luminary poles	0.0	—[a]	0.0	—[a]
Other	0.6	0.5	0.3	1.4
Total	2.0	1.8	1.8	5.5
Elongated, m				
Guardrails	0.5	0.2	0.2	0.9
Curbs	0.2	0.1	0.1	0.4
Embankments	0.6	0.3	0.4	1.3
Banks/cuts	0.3	0.4	0.4	1.1
Ditches	0.5	0.4	0.2	1.1
Median barriers	0.0	0.0	0.0	0.0
Total	2.1	1.4	1.3	4.8

Note: 1 m = 3.28 ft.
[a] 0.05 but not 0.00. [b] Total not equal to sum because of rounding.

Fatal crash locations can further be narrowed to nonlocal roads. Although the available state road data did not allow degree of curvature and gradient to be assessed by type of roadway, it is clear that fatal crashes into roadside objects occurred mostly on nonlocal roads. The obvious approach to reducing the number of roadside hazards is to identify the types of roads in a given state that have a history of noncollision and fixed-object fatalities and to apply the noted curvature and gradient criteria to likely crash sites. Although the number and types of hazards on a road may differ because of climate, land use, and other factors, the involvement of curves and gradient in likelihood of impacting hazards is undoubtedly similar in all areas.

A number of researchers have attempted to relate road characteristics to crashes with some success (9, 10, 11, 12, 13). However, a clear set of factors used to identify likely crash locations caused by roadside hazards has not emerged prior to this study. Previous studies have included nonhomogeneous sets of crashes, have failed to distinguish injury severity, or have used arbitrarily defined road segments. By studying only fatal crashes into fixed objects and by referencing the roadway characteristics to specific crash sites this study presents a clear profile of hazardous locations.

The modifications at a particular location depend on a number of factors: number and types of hazards, width of right-of-way, cooperation of utility companies and others who erect and maintain objects on or off the right-of-way, and costs of alternative means of modification. In some cases it may be possible to reduce or eliminate curvature and gradient and modify or remove hazards. In other cases only modification or removal of the hazards may be feasible.

In the absence of fixed objects, attention must be given to roadway characteristics that might contribute to vehicle rollover. These characteristics include ditches, culverts, curbs, or embankments. If fixed objects are modified or removed but roadside characteristics contributing to rollover remain, a subset of the fatalities will continue to occur. In every case, the goal should be a clear recovery area for vehicles that leave the road; if objects cannot be entirely cleared, energy management principles should be applied to eliminate the lethal transfer of crash forces to vehicle occupants (3, 4, 5, 6, 7).

The data also provide guidelines for the types of fixed objects and other roadside characteristics that can be expected and their distribution at the locations to be modified. Most fatal crashes occur in curves or within a few hundred meters beyond maximum curvature. Apparently, the driver loses vehicle control while he or she is in or coming out of a curve and not while anticipating the difficulty with a curve. In the cases studied the majority of fatalities would not have occurred had a 15-m (50-ft) roadside area 137 m (450 ft) before and after the maximum curvature been clear of fixed objects and characteristics contributing to rollover. Of the objects struck 98 percent were within 15 m (50 ft) of the pavement edge.

The average roadside area, 161 by 9 m (528 by 30 ft), had nine trees, one utility pole, one traffic sign or signal post, and five other such relatively narrow objects at crash locations. The average length of elongated objects was as follows:

Objects	Length (m)	Objects	Length (m)
Guardrails	7	Banks and cuts	19
Curbs	12	Ditches	36
Embankments	35	Median barriers	1

Guardrails and median barriers may be protective or hazardous depending on their designed ability to gently absorb or redirect the energy of a moving vehicle as well as their proper construction and installation (3, 4, 5, 6, 7).

Since almost 70 percent of fatal crashes occurred on the outside of the curves, that side of the road should take precedence in ameliorative efforts when resources do not allow such efforts on both sides of the road at every available site. It is not known how often a vehicle ran off the inside curve to avoid objects on the outside of the curve. However, to ensure maximum benefit both sides of the road must be modified.

Relatively few objects were found in a 9 by 27-m (30 by 90-ft) path that the vehicles would likely have traveled had they not struck a lethal object. The potential for large reductions in human damage by small efforts in modifying roadside hazards is clear. Failure to act promptly in ameliorative efforts could provide grounds for legal liability (14).

ACKNOWLEDGMENTS

This study was supported by the Insurance Institute for Highway Safety, Washington, D.C. The authors are indebted to J. R. Nix, Georgia Department of Public Safety, who furnished the fatal crash reports, and to Don Crandall, Darrell Elwell, and James Kitchings, Georgia Department of Transportation, who provided information on the state road network. The authors also wish to gratefully acknowledge the able assistance of Michael W. Oliver and David W. Bright, graduate students of Georgia Institute of Technology.

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Abridgment

Roadway Environment Subsystem of the Highway Traffic Records System

W. F. Stambaugh and G. J. Novenski, Wisconsin Department of Transportation

The data base structure of the Wisconsin integrated highway traffic records system is composed of eight data subsystems (1): driver data subsystem, vehicle data subsystem, roadway environment data subsystem, accident data subsystem, emergency services data subsystem, traffic law enforcement and adjudication data subsystem, educational services data subsystem, and safety program management data subsystem.

The safety program management data subsystem and the emergency and educational services data subsystems are included in a total data base. They contain summary data that support the other subsystems and do not require direct operational linkages. The remaining five subsystems constitute the continuous data base and must have direct physical and operational links to form access networks.

Figure 1 shows the designed linkages for the five data-base subsystems. The controls for each of the files within the subsystems do not by themselves provide a link to the other files. The combination of control and data items allows for keys to be built for cross access between the files.

The roadway environment subsystem is composed of integrated files, which accept and store information on the characteristics of public roads. It processes and reports incremental data and summary information through the use of standardized controls and linkages, which provide access to the other subsystems of the traffic records system. The roadway environment subsystem for the state trunk network (STN) consists of ten files that include the essential linkage or control keys for cross access of five traffic records subsystems.

STN DATA CONTROLS

A reference point (RP) is used for control and linkage for seven of the ten files (Figure 2). The RP designates a landmark location on an STN highway and is marked in the field by a posted RP sign. An office reference to RP locations is available on aerial photographs and a common name listing of the landmark.

A reference point is made up of a description of the highway identification and a sequential number. The RP signs show the highway identification on the top of the sign and the sequential number below.

The highway is identified by type, number, and direction. The highway type describes official business routes, planned routes, spurs, and off-main-line features, such as ramps, connectors, frontage roads, safety rest areas, and weight stations (2). Highway type is normally blank for main-line STN highways. The highway number is its officially designated number. The roadway direction is the last portion of the highway identification. Each highway is designated an overall north-south or east-west direction (3). When a highway is divided or consists of a pair of one-way streets, two distinct roadways exist.

The lower portion of the reference point is the sequential number. The numbering starts at the southern or western terminus of each highway and increases sequentially to the north or east to the end of the highway. The number is usually three digits.

The other controls (Figure 1) that serve as linkages between the files are structure identifications, station numbers, and municipality codes. Each bridge on a roadway is identified by a county code, a structure type, and a structure number. Traffic counting locations are assigned a station number made up of a county code and a code specifying the duration of the traffic count. A municipality code is a unique number for each county, town, village, and city in the state.

STN ROADWAY ENVIRONMENT SUBSYSTEM FILES

The ten files of the computerized data base are of two types: control files and data files. Control files provide the basis for identifying highway locations, relating data to those locations, and processing specific data systematically through the use of standardized controls. The first two files discussed here are control files, and the remaining eight are data files.

Publication of this paper sponsored by the Committee on Traffic Records.

Figure 1. Linkages of data-base subsystems.

LINKAGE TITLE	DATA BASE SUBSYSTEMS: Driver	Vehicle	Roadway Environment	Accident	TLE & A**
Driver Name	D	D*		D	D
Driver License Number	C			D	D
Vehicle License Number		C		Ⓓ	Ⓓ
Vehicle Identification Number		C		Ⓓ	
Roadway Location Identifier			C	D	D
Accident Case Number	Ⓓ			C	
Traffic Citation Identifier	Ⓓ	D		Ⓓ	C
Traffic Education Identifier	D				
Emergency Receptor Identifier				Ⓓ	

C=File Control
D=File Data Item
Ⓓ=Not Computerized
* Owner Name
** Traffic Law Enforcement and Adjudication
⬚ =Not Applicable

Figure 2. Roadway environment subsystem for the state trunk network.

FILE: Type	Name	Control Key	DATA: Linkage	Fields
Control	Reference Point	Reference Point		13
	RP Coincidence	Reference Point		13
Data	Event	Reference Point	Municipality Code	8
	Point Name	Reference Point	Structure Identification Municipality Code	12
	Road Alignment	Reference Point		13
	Bridge	Structure Identification	Reference Point Municipality Code	200
	Traffic Index	Station Number	Reference Point Municipality Code	31
	Traffic Counts	Station Number		31
	Municipality	Municipality Code		18
	Boundary	Municipality Code		11

1. The STN reference point file relates all RPs on an STN highway by distance. The location of an RP is independent of the data items it controls.
2. The STN reference point coincidence file establishes an equitable relation between the field-signed RP on a basic highway and its coincident RP on a nonbasic highway.
3. The STN event file provides the capability to follow, or track, the simultaneous occurrences of physical and administrative characteristics along each roadway.
4. The point name file provides the common name and location of local features along the STN highways. The data user can recognize a data location better by relating a local-feature name to an RP than by using the RP number alone.
5. The road alignment file establishes a spatial description of the physical alignment of a highway by the use of a series of geographical points based on the Wisconsin state plane coordinates.
6. The bridge file contains 200 data fields of administrative and structural information plus appraisal and condition-rating information for each structure on or over a federal-aid highway and for each structure maintained by the state but not on a federal-aid highway.
7. The traffic index file serves as a control and link for the detailed traffic characteristic data files. It provides count location descriptions and identifications in conjunction with summarized traffic volumes.
8. The traffic counts file accumulates for subsequent processing the actual traffic volume data obtained in the field.
9. The municipality file stores population, total area, and tax valuation data for all cities, villages, and towns in the state.
10. The boundary file establishes a spatial description for civil unit boundaries based on the Wisconsin state plane coordinates.

OTHER ROADWAY ENVIRONMENT SUBSYSTEM FILES

The computerized data base for the county trunk and local road networks uses three files described above and two additional files. The traffic index and traffic counts file accumulates data for all roads and streets. A shortened bridge file retains 47 data fields for bridges not federally aided. The road inventory file records the physical and administrative characteristics along the county trunk and local road networks.

During 1975 reference points were established for the county trunk network and are being incorporated as the control key in the roadway inventory file.

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Evaluation of Alcoholism Treatment Programs for Drinking Drivers

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In 1971, the National Institute on Alcohol Abuse and Alcoholism (NIAAA) initiated a program to support centers designed to extend and improve the treatment and rehabilitation services available for problem drinking drivers. These centers were located at selected Alcohol Safety Action Program (ASAP) sites of the National Highway Traffic Safety Administration (NHTSA). This paper presents a preliminary evaluation of the clients provided services at these sites. Demographic data, various drinking-related measures, a self-esteem index, and financial and employment status variables were obtained for the large sample of clients who received service from May 1973 through March 1974. Clients were classified into five groups and were compared. The results indicate that for all programs for which follow-up data were obtained (a) the percentage of clients who abstained from alcohol increased, (b) the amount of absolute alcohol consumed per day decreased, (c) behavioral impairment caused by drinking decreased, and (d) self-esteem improved. Although a trend for an increase in financial status was observed, further follow-up study is needed for confirmation. Treatment outcome was more successful with clients showing less involvement with alcohol. The data from this study support the NIAAA premise that is the basis for its support of ASAP programs: ASAP programs include a large number of individuals for whom early intervention into their alcohol problems would be worthwhile.

The driving-while-intoxicated (DWI) problem is of vital concern to two federal agencies, the National Highway Traffic Safety Administration (NHTSA) and the National Institute on Alcohol Abuse and Alcoholism (NIAAA). Although alcohol has been recognized as a significant factor contributing to motor vehicle accidents, program efforts have not differentiated between social drinkers and problem drinkers. Persons with a history of social, psychological, or physiological problems associated with excessive alcohol consumption were defined as problem drinkers. Program efforts were directed toward the alcoholic person and the problem drinker since research indicates that problem drinkers have more serious and fatal motor vehicle accidents than social drinkers (1).

In 1971, NIAAA expanded its program activities to include community-level treatment for the alcoholic person and problem drinker. Concurrent with this NIAAA activity, NHTSA developed community-based programs to provide appropriate services for those individuals arrested for driving while intoxicated. NIAAA then began alcoholism treatment programs for DWIs who had been identified by the NHTSA Alcohol Safety Action Program (ASAP).

In late 1971, NIAAA initiated a program to support 10 alcoholism centers (ACs) designed to extend and improve the treatment and rehabilitation services available for the alcoholic person and the problem drinking driver at selected ASAP sites. In June 1972, the monitoring system for these 10 sites was developed under contract with the Stanford Research Institute. This paper is a preliminary evaluation of the monitoring system, and, in particular, of the 6-month follow-up data for clients who were serviced at the ACs from May 1973 through March 1974 (2).

This evaluation does not represent a precisely designed experiment. It is a real-world evaluation to provide quantifiable data that bear on the critical question of program effectiveness for the various programs tried and the extent to which they seem to differ in effectiveness. Data are presented for four groups of DWIs and for a comparison group of non-DWIs referred by non-ASAP sources. All groups used the 10 ACs for treatment and rehabilitation.

The 10 ACs had a common orientation toward treating the problem drinking driver. Outpatient treatment was stressed. Although there are a number of differences in the organizational structure and in the treatment emphases of the ACs, this paper does not systematically compare the effects of these program variations to treatment outcome.

SAMPLES

Clients were divided into the following groups, which were identified by assignment codes.

Assignment Code	Description
DWI probation	Clients sentenced to probation only, including those who received a jail sentence, fine, or unconditional probation.

Publication of this paper sponsored by Committee on Traffic Law Enforcement.

Assignment Code	Description
DWI school	Clients assigned to attend school only, even though they may have received a jail sentence or fine.
DWI non-AC treatment	Clients assigned to attend other treatment programs such as those of Alcoholics Anonymous, community health centers, and hospitals.
DWI AC treatment	Clients assigned to attend AC treatment programs.
Non-ASAP	Clients contacting or entering AC programs by non-ASAP referral.

DATA COLLECTION

A total of 6015 Client Intake Forms (CIFs) were submitted from the 10 ASAP/AC sites. Table 1 gives the number and percentage of CIFs submitted by assignment code and frequency distribution. The data reporting results for the total sample are heavily weighted to results from Tampa. About 75 percent of the 542 Non-ASAP clients stem from AC centers at Wichita, Columbus, and Columbia. For the DWI Non-AC Treatment group, centers at Tampa and Denver account for 97.4 percent of the data submitted. For the DWI School group, Tampa provides over 90 percent of the data.

DESCRIPTIVE CHARACTERISTICS OF THE INTAKE POPULATION

Demographic Characteristics

Table 2 gives a summary demographic profile of baseline information submitted on the DWI and Non-ASAP clients. In general, the demographic characteristics do not present five widely different population groups, except for the greater racial mix and notably shorter length of time in the present community for the DWI Probation group. All other characteristics (age, sex, ethnicity, marital status, residence status, military status, and education level) show relatively small variations in the profiles of the four DWI groups. The Non-ASAP clients are older and have the highest percentage of females and of those living alone. An example of the magnitude of the differences among the groups is age at entering the program. The mean age for the five groups ranges from 37.9 years (DWI School) to 41.1 years (Non-ASAP); the median age is 39.4 years for the four DWI groups.

Arrest-related characteristics for the various groups are also given in Table 2. The mean level of breath alcohol content (BAC) is lowest for the DWI School and about equal for the other three DWI groups. This level is not available for the Non-ASAP group since this group is in the AC for a non-DWI reason. The arrest data indicate that the DWI School is the most socially intact group of the four DWI groups. This group has the lowest percentage of prior DWI arrests (14.1 percent) and prior non-DWI arrests (16.8 percent). The DWI Probation is next in line on this continuum as shown by a 40.4 percent prior DWI-arrest rate that is only slightly lower than the remaining DWI groups; however, its prior non-DWI arrest percentage of 21.1 percent is considerably lower.

Employment History and Financial Status

Table 3 gives data on baseline employment history and financial status for the intake population. These data suggest an occupational-economic continuum in which the DWI School ranks highest at the professional and income levels and is followed closely by the DWI Probation. The Non-ASAP are ranked the lowest on this continuum. The DWI Non-AC and DWI AC Treatment groups fall in between the two other DWI categories. The DWI Non-AC Treatment is slightly higher on the occupational-economic continuum than the DWI AC Treatment, but the magnitude of this difference was small and did not compare to the clearly lower status of the Non-ASAP.

Client Drinking History

The history of the clients with respect to drinking is inferred primarily from data on arrests, hospitalization, institutionalization, prior alcoholism treatment, and Alcoholics Anonymous attendance. The data in Table 4 suggest that the Non-ASAP show a more severe involvement with alcohol than do DWI. All data categories appear to reflect this alcoholic tendency, except for the percentage of institutionalized. Hospitalization for alcohol-related reasons is reported to have occurred in 33.2 percent of Non-ASAP but for a median percentage of only 2.7 for the four DWI. Similarly, the percentage of clients who reported ever having attended Alcoholics Anonymous is 48.4 percent for the Non-ASAP and a median percentage of 10.3 for the four DWI. The data are likewise consistent for frequent and heavy drinking, arrests, and previous treatment for alcoholism. The average number of days for those institutionalized is also consistent with the preceding, but the percentage of clients institutionalized for the Non-ASAP is not consistent since 30 percent reported being institutionalized. However, this percentage is neither the highest nor the lowest percentage for the five groups that were compared.

Current Drinking Practices and Behavior

Current drinking practices and behavior for the five baseline populations are summarized in Table 5. The average number of days that clients drank during the month preceding arrest (month preceding intake for Non-ASAP) was 8.5 to 12.1 for DWI and 15.7 for Non-ASAP. The percentage reporting abstention was 9 to 22 for DWI and 8 for Non-ASAP. The percentages of clients who reported drinking beer, wine, and liquor are also given in Table 5. Compared to the other two beverages the percentage of clients drinking beer is higher across all client groups, except for liquor in Non-ASAP. Some 66 to 77 percent of the clients reported drinking beer. Liquor was next at 23 to 44 percent for DWI and 73 percent for Non-ASAP. Wine was last at 5 to 12 percent for DWI and 26 percent for Non-ASAP. However, this pattern changes for the average amount of ethanol (absolute alcohol) consumed from the three alcoholic beverages. The quantity-frequent (Q-F) index was used to estimate average daily intake of alcohol in milliliters of absolute ethanol (3). The Q-F index for beer is much higher for Non-ASAP, even though the percent drinking beer is less than for DWI. The Q-F index for wine is low for all DWI except for Non-ASAP. Interestingly, the Q-F index is lower for liquor than for beer in all DWI except for DWI AC Treatment.

The total Q-F index increases progressively across the five client groups from DWI Probation to Non-ASAP; the latter consumed almost five times more than the highest DWI group (DWI AC Treatment). By comparison, some data show ethanol consumption (Q-F index) of 13 mL/d (0.44 fl oz) for the normal U.S. population (age 18 and over) and 23.1 mL/d (0.78 fl oz) for the drinking population. Thus, clients in the DWI Probation and School groups reported drinking less than the normal drinking population, DWIs in the treatment groups reported drinking twice as much as the normal drinking population, and Non-ASAP clients reported drinking almost ten times as much as the normal drinking population. Data for DWI clients, particularly Probation and School groups, may reflect behavior from the month before administration of

the CIF rather than the month before arrest. Therefore, the reported alcohol consumption may be understated relative to the month before arrest.

The overall behavioral pattern associated with alcohol consumption was assessed by using the impairment index, which is based on work by Shelton (4). It involves responses to questions related to the conditions given in Table 5 under behavioral patterns. The impairment index and the percentage of clients that gave positive responses to each question are given in Table 5.

The average impairment index for DWI groups varies from 1.2 (DWI School) to 3.5 (for both DWI Treatment). The Non-ASAP group is considerably higher at 13.4. The DWI Probation have a slightly lower alcohol consumption but an impairment index that is twice as high as the DWI School—these indicate greater behavioral problems related to drinking.

The pattern of responses to the behavioral questions is similar to the impairment index values. The DWI School has the lowest values for most questions, followed by the DWI Probation, the DWI AC and DWI Non-AC Treatment groups. The Non-ASAP has the highest values of all groups on all questions. The question of being drunk one or more times during the preceding month is

Table 1. CIFs submitted by assignment code.

	DWI Probation		DWI School		DWI Non-AC Treatment		DWI AC Treatment		Non-ASAP		Total	
Alcoholic Center	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Portland, Maine	—	—	—	—	—	—	87	3.5	16	3.0	103	1.7
Boston	—	—	4	0.3	—	—	591	23.7	—	—	595	9.9
Waterbury	4	2.5	9	0.7	—	—	37	1.5	91	16.8	141	2.3
Tampa	1	0.6	1210	91.3	1099	73.2	340	13.7	18	3.3	2668	44.4
Columbus, Georgia	—	—	—	—	—	—	78	3.1	160	29.5	238	4.0
Columbia, South Carolina	35	22.2	29	2.2	1	0.1	58	2.3	75	13.8	198	3.3
Indianapolis	1	0.6	3	0.2	0	0.0	834	33.5	0	0.0	838	13.9
Wichita	1	0.6	70	5.3	37	2.5	106	4.3	174	32.1	388	6.4
Denver	116	73.4	—	—	364	24.2	160	6.4	8	1.5	648	10.8
Portland, Oregon	—	—	—	—	—	—	198	8.0	—	—	198	3.3
Total	158	100.0	1325	100.0	1501	100.0	2489	100.0	542	100.0	6015	100.0

Table 2. Demographic and arrest-related characteristics.

Characteristic	DWI Probation	DWI School	DWI Non-AC Treatment	DWI AC Treatment	Non-ASAP
Mean age, years	40.0	37.9	38.7	41.0	41.1
Males, percent	91.1	88.6	91.9	93.7	75.4
Ethnicity, percent					
White	66.1	83.5	76.5	74.6	79.2
Black	15.1	13.4	9.7	21.5	19.9
Spanish surname	18.1	2.4	13.4	3.4	0.2
Other	0.3	0.7	0.4	0.6	0.6
Marital status, percent					
Married	54.2	54.3	46.1	48.9	43.4
Married more than one time (of those who have been married)	25.8	33.0	38.6	32.4	39.0
Divorced	15.5	16.1	22.6	19.5	22.7
Residence status					
Living alone, percent	19.9	15.3	22.2	19.3	23.9
Mean years in community	6.3	12.9	12.4	12.0	14.8
Military status					
Active duty and reserves, percent	7.8	4.6	2.0	3.9	1.1
Veterans, percent	53.5	44.8	52.1	50.0	43.9
Mean years of service	4.6	6.1	5.1	4.7	4.8
Education, median years	11.0	11.2	11.0	10.9	10.9
Mean level of breath alcohol content	0.19	0.16	0.19	0.20	—[a]
Mean number previous alcholism treatments	0.0	0.1	0.2	0.3	0.9
Prior DWI arrests	40.4	14.1	43.6	50.0	—[a]
Prior non-DWI arrests	21.2	16.8	31.6	44.9	—[a]
Prior probation	87.8	91.1	87.8	55.9	—[a]
Number of clients[b]	139 to 298	831 to 1325	962 to 1501	1423 to 2490	493 to 1099

[a]Not applicable since arrest records were not obtained for non-DWI clients.
[b]The number of responses is shown as a range for the variables in each column. The range will vary due to (a) differential response rates to individual items or (b) interaction of the source of the items (e.g., a list of items may include responses from more than one form) or (c) both of these.

Table 3. Employment history and financial status.

Characteristic	DWI Probation	DWI School	DWI Non-AC Treatment	DWI AC Treatment	Non-ASAP
Professional and managerial, percent	10.6	14.0	11.6	10.0	8.6
Laborers, percent	13.2	10.7	16.1	19.8	10.4
In labor force, percent	91.1	91.0	93.1	95.3	88.2
Employed full-time, percent	81.7	83.1	80.8	76.0	40.0
Mean number days worked (preceding month)	19.7	20.4	18.7	18.0	11.3
Mean monthly income, $	688	710	635	589	312
Number of clients	129 to 158	1271 to 1323	1409 to 1494	2437 to 2487	530 to 541

interesting because the responses for the four DWI groups tend not to follow the general pattern for the other eleven questions. However, if the several response categories to the number of times drunk are examined, then a general pattern emerges at the higher end of the scale.

CLIENT CHANGE DATA

Changes in Alcohol Consumption

The size and scope of the analyses of client change data were limited by the number of cases for whom 6-month follow-up data were submitted on form CPF. Since the data collection period for this study was from May 1973 through the end of March 1974, CPF could only have become available by virtue of the 6-month follow-up requirement for the sample of clients for whom CIFs were completed before October 1973. This number of CIFs is estimated to be 2615, assuming a CPF was submitted for every client having a CIF. Essentially no CPFs were submitted on the DWI Probation; therefore, this group was excluded from this part of the study. For the 964 clients of DWI School and DWI Non-AC Treatment groups only 429 CPFs were submitted for a completion rate of 36.1 percent. The AC programs should have submitted a total of 1304 CPFs for the DWI AC and Non-ASAP groups; however, only 598 CPFs were submitted for a completion rate of 45.9 percent. For all groups combined, the completion rate was 45.3 percent.

The selective return of CPF follow-up data forms imposes a limitation on the conclusions made concerning program effectiveness. Nevertheless, we believe that there is a consistent pattern to the results and therefore

Table 4. Drinking history.

Characteristic	DWI Probation	DWI School	DWI Non-AC Treatment	DWI AC Treatment	Non-ASAP
Frequent and heavy drinking					
Mean age started, years	22.2	20.5	20.8	22.2	24.7
Mean years this type of drinking	13.7	11.8	16.1	11.6	14.9
Arrests during preceding year					
Mean number for DWI[a]	1.2	1.0	1.2	1.2	1.3[b]
More than one DWI arrest, percent	15.9	1.1	16.1	20.6	24.7[b]
Drinking offenses not related to driving, percent	5.2	3.5	10.5	17.5	20.3
Mean number of arrests	1.5	1.2	1.4	2.2	2.2
Hospitalization during preceding year, percent					
Hospitalized for all reasons	12.9	8.8	16.3	18.6	47.6
Hospitalized for alcohol-related reason	1.3	0.6	4.1	6.1	33.2
Institutionalization during preceding month					
Institutionalized, percent	31.2	36.4	40.9	12.1	30.0
Average number of days for those institutionalized	2.2	1.5	3.0	6.0	12.3
Previous alcoholism treatment during preceding 5 years					
Reported previous treatment, percent	2.6	0.4	7.7	13.0	40.6
Average number of times for those reporting prior treatment	1.0	1.3	1.2	1.6	2.1
Attendance at Alcoholics Anonymous, percent					
Ever attended	2.5	3.0	17.6	19.5	48.4
Attended regularly in recent weeks	0.0	0.2	2.5	4.1	14.2
Number of clients	129 to 158	1205 to 1323	1382 to 1490	2131 to 2485	386 to 542

[a]Including present arrest for DWI. [b]For the 20 percent reporting one or more arrests.

Table 5. Drinking practices and behavior.

Characteristic	DWI Probation[a]	DWI School[a]	DWI Non-AC Treatment[a]	DWI AC Treatment[a]	Non-ASAP[a]
Ethanol consumption during preceding month					
Average days drank	8.5	9.7	12.1	10.4	15.7
Abstrained, percent	22.4	8.6	14.3	15.6	8.4
Drank beer, percent	68.7	76.6	74.6	73.5	66.0
Drank wine, percent	5.3	11.2	9.8	11.7	26.1
Drank liquor, percent	22.7	40.2	39.4	43.9	72.9
Beer Q-F[b]	7.7	10.3	21.6	18.3	42.6
Wine Q-F[b]	0.6	0.9	1.8	2.4	23.1
Liquor Q-F[b]	4.2	4.2	16.0	22.5	150.5
Total Q-F[b]	12.4	15.4	39.7	44.1	215.3
Behavioral pattern during preceding month, percent					
Reported being drunk	44.0	36.7	54.4	37.0	74.6
Longest period between drinks of less than 12 h	3.9	13.5	16.9	12.8	35.2
Longest period of continued drinking of 6 h or more	18.3	14.8	31.0	27.5	66.6
Drank upon awakening	9.2	1.1	12.0	11.2	56.6
Missed meals as a result of drinking	12.5	4.8	20.8	17.3	67.5
Drank alone more than half of the time	13.3	3.5	10.1	11.6	40.4
Had memory lapses due to drinking	7.2	1.4	17.0	16.5	52.5
Had the "shakes" due to drinking	2.6	0.7	15.5	12.2	58.2
Had difficulty sleeping	12.5	2.5	15.3	13.8	59.4
Quarreled with others while drinking	12.4	4.6	17.2	14.8	45.7
Drank on the job or during daily activities	3.9	1.9	6.7	11.7	35.5
Missed one or more days of work because of drinking	4.5	0.8	8.5	9.5	43.4
Impairment index	2.24	1.21	3.51	3.53	13.37
Number of clients	150 to 155	1308 to 1319	1417 to 1462	2451 to 2465	531 to 538

Note: 1 mL = 0.033 fl oz.

[a]For the month preceding arrest for DWI and for the month preceding intake for non-ASAP.
[b]The quantity-frequency for the beverage shown is the average milliliters of absolute alcohol (ethanol) consumed per day for all clients, whether drinking that beverage or not; total Q-F is the average milliliters of ethanol consumed per day for all clients from all beverages.

willing to make tentative inferences from these data with the understanding that more definitive follow-up data should be obtained to confirm these conclusions.

Table 6 gives alcoholic consumption at intake and at 6 months for the four groups of clients having CIFs and CPFs. The amount at the end of the 6-month period, 41.4 percent of the DWI School, 34.8 percent of the DWI Non-AC Treatment, 36.7 percent of the DWI AC Treatment, and 37.8 percent of all clients in the four groups were abstaining from alcohol (Table 6). Compared with data given in Table 5 for all groups at intake, abstainers increased during the 6-month period from about 13 percent to about 38 percent. Table 6 also shows that the amount of alcohol consumed each day also declined for the four groups. The majority of clients either abstained or drank less than 30 mL/d (1 fl oz) of alcohol at 6 months. The clients who consumed more than 89 mL/d (3 fl oz) at 6 months seemed to have an average daily alcohol consumption that was about the same as, or greater than that at intake with the exception of the Non-ASAP who showed a 20 percent decrease from 416.9 to 334.1 mL/d (14.1 to 11.3 fl oz). However, caution must be used in accepting the results of these two groups since very few cases were involved.

Changes in Behavioral Impairment and in Self-Esteem

The impairment index was used to measure the degree of behavioral impairment caused by excessive use of alcohol (Table 7). A measure of client self-esteem was also obtained by clients indicating their agreement or disagreement with the following two statements: "I wish I could have more respect for myself," and "On the whole, I am satisfied with myself." All four groups show a reduction in behavioral impairment from alcohol usage at 6-month follow-up compared to scores at intake. The index of 4.7 for the Non-ASAP suggests that they showed more behavioral impairment from alcohol consumption following treatment than did the other groups.

The data on self-esteem following treatment are consistent with those for behavioral impairment. All four groups showed higher self-esteem at 6 months than they showed at intake. Furthermore, the Non-ASAP group, which showed the greatest behavioral impairment at follow-up, also showed the lowest self-esteem ratings.

Changes in Financial Status and Employment

A 6-month period was too short a time to expect any drastic changes in earning power; however, the trends for this important variable were of interest. The earning measure was based on responses to gross income earning categories. The midpoint of these categories was used to estimate the mean figures for individual clients and then averaged for the client group under analysis.

The average monthly earned income was divided by the average number of days worked to obtain an average daily wage. Since income and days worked are combined into a single figure, it indicates the economic well-being of the client. In addition to this index, the percentage of the groups who were unemployed is also listed although this measure is not so sensitive as the average daily wage. These measures refer to the period of 1 month before either intake or follow-up. Table 8 gives the results reported for three samples: the CIF and CPF samples at intake, and the CPF sample at 6 months. The differences observed between the last two groups are the critical observations for assessing change in financial status among the four treatment groups. The financial status variables on the CIF intake sample are reported to suggest the direction of bias in the CPF intake sample. For all four treatment groups, the monthly income, the days worked, and the average daily wage are consistently poorer for the CIF intake sample than for the CPF sample at intake. This suggests that the subjects studied at intake but not located for follow-up were systematically different from those for whom follow-up data were obtained. The direction of the difference is that those lost to follow-up were economically poorer at intake. The comparison of variables between the CPF sample at intake and at 6 months are crucial for assessing the effect treatment had on these variables. However, the bias noted introduces an additional caution in interpreting the findings as definitive. The small sample size and the relatively short 6-month follow-up period also dampens the effects; therefore, testing for statistical significance in the variables was not considered.

Only the data on the CPF samples for average daily wages reflect any important differences in financial status. The DWI School shows an increase of about $1 and the DWI AC Treatment shows an increase of about $0.50. The other two groups show a decline in average daily wage.

The relative financial characterization of these four groups is similar to what has been observed concerning other previously mentioned variables. The DWI School and DWI AC Treatment groups were the most socially intact, exhibited the least amount of behavioral impairment caused by alcohol, and rated high on the self-esteem index. On the basis of average daily wage, these two groups also appear to be notably better off than the other two groups.

The decline in average daily wage for the DWI Non-AC and the Non-ASAP groups does not necessarily reflect a failure in treatment, since the decline in average daily wage would have been more severe if treatment intervention had not occurred. It is recognized that untreated alcoholism frequently results in a downward economic and social progression.

The unemployment percentage indicates an economic improvement following treatment. The DWI School shows a decline in unemployment from 4.7 to 3.1 percent and Non-ASAP shows a decline from 32.0 to 24.0 percent. The DWI Non-AC Treatment shows no change, but the base percentage is only 1.7 percent, so virtually everyone is employed at both intake and follow-up. This change coupled with the 24.0 percent unemployment figure for the Non-ASAP following treatment, suggests that the difference in umployment rates for these groups at intake to follow-up is not a sensitive and accurate index of change.

SUMMARY

This paper presents data that describes the qualities of the various assignment groups. However, the data can be used to suggest those groups more likely to respond to treatment. It appears reasonable to assume that clients with a greater history of failure from prior alcoholism treatment efforts and from the criminal justice system are less responsive to treatment.

On the basis of this reasoning, the data show that all four DWI groups are generally better off than the Non-ASAP group. Clearly, these DWI groups as groups are more socially intact and more amenable to any kind of treatment than the Non-ASAP; therefore, intervention efforts with potential DWIs hold a greater promise for treatment improvement because the DWIs appear more intact and less involved with alcoholism than Non-ASAP groups. This supports an NIAAA premise for supporting ASAP programs; ASAP programs include a large number of individuals for whom early intervention into their alcohol problems would be worthwhile.

Table 6. Client data classified by alcohol consumption at intake and at 6 months.

Assignment Code	Amount of Alcohol Consumed at 6 Months[a] (mL/d)	Clients		Avg Amount of Alcohol Consumed (mL/d)			
		No.	Percent	At Intake	At 6 Months	Change Amount	Change Percent
DWI school	0	108	41.4	8.9	0.0	-8.9	100.0
	<30	144	55.2	17.7	6.8	-10.9	61.7
	30 to 89	6	2.3	47.0	48.5	1.5	3.1
	>89	3	1.1	17.7	229.5	—[b]	—[b]
Total or average		261	100.0	14.8	7.4	-74	50.0
DWI non-AC treatment	0	57	34.8	23.7	0.0	-23.7	100.0
	<30	96	58.5	51.5	7.1	-44.4	88.5
	30 to 89	9	5.5	87.2	48.2	-39.0	44.8
	>89	2	1.2	75.7	160.9	—[b]	—[b]
Total		164	100.0	44.1	8.9	-35.2	79.9
DWI AC treatment	0	207	36.7	29.9	0.0	-29.9	100.0
	<30	314	55.7	32.8	7.1	-25.7	78.4
	30 to 89	35	6.2	71.0	51.7	-19.3	27.1
	>89	8	1.4	94.3	252.0	—[b]	—[b]
Total		564	100.0	34.9	10.7	-24.2	69.5
Non-ASAP	0	17	41.5	286.5	0.0	-286.5	100.0
	<30	17	41.5	89.3	10.6	-78.7	88.1
	30 to 89	3	7.3	65.6	47.0	-18.6	28.4
	>89	4	9.7	417.2	334.1	-83.1	19.8
Total		41	100.0	201.4	40.5	-159.9	79.9

Note: 1 mL = 0.033 fl oz.

[a]Average mL/d during preceding month. [b]Not calculated because of small number of clients.

Table 7. Client change data classified by alcohol impairment and self-esteem indices.

Assignment Code	Alcohol Impairment Index			Self-Esteem Index		
	No. of Clients	At Intake	At 6 Months	No. of Clients	At Intake	At 6 Months
DWI school	263	0.9	0.3	233	6.3	6.6
DWI non-AC treatment	162	2.7	0.4	150	5.6	5.9
DWI AC treatment	575	2.7	1.0	547	5.4	5.8
Non-ASAP	41	11.7	4.7	41	3.8	4.9

Table 8. Client change data for employment and financial status.

Assignment Code	Sample	Monthly Income ($)	Days Worked	Average Daily Wage ($)	Unemployed (%)
DWI school	CIF at intake	710	20.4	34.80	3.8
	CPF at intake	721	20.7	34.83	4.7
	CPF at 6 months	761	21.2	35.90	3.1
DWI non-AC treatment	CIF at intake	635	18.7	33.96	7.2
	CPF at intake	685	20.1	34.08	1.7
	CPF at 6 months	684	21.4	31.96	1.7
DWI AC treatment	CIF at intake	589	18.0	32.72	13.3
	CPF at intake	687	19.6	35.05	9.3
	CPF at 6 months	683	19.2	35.57	9.7
Non-ASAP	CIF at intake	312	11.3	27.61	35.9
	CPF at intake	353	11.9	29.66	32.0
	CPF at 6 months	287	11.0	26.09	24.0

Within the four DWI groups, the DWI Probation and School appear, on the basis of intake data, less clearly involved with alcoholism than either the DWI Non-AC or the DWI AC Treatment groups. This is clearly observed in terms of the impairment index. By nature, the DWI Non-AC and AC Treatment groups would be expected to deal with more severe cases of alcoholism in comparison to the DWI Probation or School groups. The finding reported is consistent with a policy of assigning clients to these groups, based directly or indirectly on an assessment of the severity of the problem drinking. The data suggest that this process appears successful.

The follow-up data are critical because whatever selective factors resulted from initial assignment to the various groups were controlled by comparing intake to follow-up data. A large decline in behavioral impairment and in alcohol consumption was shown for the four follow-up groups. The decline at follow-up was much greater for some groups than for others: the Non-ASAP showed a mean consumption of 40.5 mL/d (1.37 fl oz) of absolute alcohol whereas other groups were much lower. The critical variable for percentage of group abstaining from alcohol increased almost threefold over intake percentage. Thus, in terms of both abstinence and average alcohol consumption, improvement at follow-up for all groups was found.

It seems likely that with a sizable reduction in alcohol intake there will also be a sizable reduction in behavioral impairment, and this may well spill over to improve the client's own self-esteem rating. As a matter of interest, the self-esteem ratings did considerably improve at 6 months over intake values.

A reduction in alcohol intake seems to be a necessary but not sufficient condition for client improvement in other areas of functioning. By ultimately improving control over alcohol consumption, clients will lead more socially and economically productive lives. However, the reported data on economic improvement are tenuous. Nevertheless, the trends are interesting and consistent with the other findings in this study: a trend toward improved earnings at follow-up for the DWI School and for the DWI AC groups. It does not appear accidental that these same groups also show higher scores on the other criterion measures.

The average daily wage was considered a useful measure for group comparisons of this type. However, further follow-up data are required before the economic trends can be established. Economic measures, such as the average daily wage, must be employed with caution since economic times change and over a long time period wages will presumably be affected.

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Economic Analysis of Alcohol Safety Countermeasures

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This paper discusses a 10-month study performed for the National Highway Traffic Safety Administration. The purpose of the study was to conduct a detailed benefit-cost analysis of seven alcohol safety countermeasures. This analysis determined the potential for successful implementation of each countermeasure in terms of the estimated cost-effectiveness and provided base-line information for research funds allocated for the development of countermeasures. The countermeasures analyzed were the sober pill, self-tester, evidential roadside tester, noncooperative breath tester, alcohol safety interlock system, continuous monitoring device, and operating-time recorder. A set of benefit/cost ratios was calculated for each countermeasure. Sensitivity analyses were performed on the crucial assumptions and key elements of costs and benefits to test their impact on the benefit/cost ratios. The potential for successful application of each countermeasure was assessed on the basis of the benefit/cost ratios and social, technological, and legal feasibility. All seven countermeasures are either in the conceptual or the experimental testing stages of development. Due to the paucity of reliable data, the findings of the analysis focused on the requirements for economic feasibility (a benefit/cost ratio in excess of 1) rather than individual feasibility. The values for critical parameters were determined and used to find the cost-effectiveness for each countermeasure. Specific recommendations for each countermeasure are made regarding further research.

The research described in this paper was sponsored by the National Highway Traffic Safety Administration (NHTSA) (1). The purpose of the study was to conduct a detailed benefit-cost analysis of seven alcohol safety countermeasures. This analysis determined the potential for successful implementation of each countermeasure in terms of the estimated cost-effectiveness and provided NHTSA with base-line information so that research funds can be allocated for countermeasure development. The countermeasures analyzed were the sober pill, self-tester, evidential roadside tester, noncooperative breath tester, alcohol safety interlock system, continuous monitoring device, and operating-time recorder. This paper describes the methodologies developed for estimating the benefits and costs of the countermeasures and summarizes the results, conclusions, and recommendations of the study.

A brief description of the physical and operational characteristics for each countermeasure is given in Table 1. The physical characteristics refer to what the device is, how it works, and what the current stage of development is; the operational characteristics refer to how the countermeasure will be used by the target population.

A set of benefit/cost ratios for the countermeasures was calculated on the basis of the mode or scale of application (restricted or universal). To test the impact of benefit/cost ratios, sensitivity analyses were performed on the crucial assumptions and key elements of cost and benefit. The potential for successful application of each countermeasure was assessed on the basis of the benefit/cost ratios and social, technological, and legal feasibility.

BENEFIT MEASUREMENT

The potential benefit of each countermeasure was estimated by using the empirical relationships derived by Hurst (2, 3), which measured the impact of estimated changes in breath-alcohol concentration (BAC) levels on crashes and fatalities. The standard societal costs of crashes and fatalities adopted by the U.S. Department of Transportation (DOT) were applied to the reduction projections for estimating the benefits in dollar terms, i.e., $200 000/fatality, $7200/personal injury, and $300 property damage/crash. (DOT has revised the societal cost estimates to $234 900/fatality, $11 200/personal injury, and $500 property damage/crash.)

Measure of Effectiveness

The measure of effectiveness used for estimating potential benefits was the reduction in alcohol-related crashes. The formula for calculating net benefits with this approach is

$$B = \$7200(\Delta I) + \$300(\Delta K) + \$200\,000(\Delta F') \quad (1)$$

Publication of this paper sponsored by Committee on Traffic Law Enforcement.

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Table 1. Physical and operational characteristics of countermeasures.

Countermeasure	Characteristics	
	Physical	Operational
Sober pill	A drug that would reduce the impairing effect of alcohol on driver performance. The drug is currently in the conceptual stage of development.	The drug would be nonprescription, taken orally and made available to the public for voluntary use.
Self-tester	A fixed or portable device for unsupervised use by drivers that measures breath-alcohol concentration (BAC). Prototype devices are currently available.	The device would indicate when driving should be avoided (hazardous BAC level) and made available to the public for voluntary use by drivers.
Evidential road tester	A portable device that accurately measures and records BAC levels. Prototype devices are currently available.	The device would be used by police on patrol duty; it would eliminate the need for trips to the police station if the driver did not register a high enough BAC level. The BAC readings could also be used as evidence in court.
Noncooperative breath tester	A device that would detect the presence or absence of alcohol on the driver's breath without his active cooperation. The technology exists for such a device, but prototype devices are not available at this time.	The device would be used by police as a prearrest screening test for alcohol levels.
Alcohol safety interlock system	An in-vehicle device that tests the driver (BAC and related performance) before allowing the vehicle to start. Prototype devices are currently available.	The device would either be assigned by the courts on a restricted basis to cars of DWI[a] offenders or be installed on a universal basis to all new passenger vehicles.
Continuous monitoring device	An in-vehicle device that monitors BAC-related driving performance. When performance is unacceptable, a warning signal is given and recorded. This device is currently in the conceptual stage of development.	The device would be assigned by the courts to cars of DWI offenders. The device would permit voluntary discontinuation of driving after the warning is given; noncompliance would result in penalty.
Operating-time recorder	An in-vehicle device that would record the time of day and day of the week when the vehicle is driven. The technology exists for such a device, but prototype devices are not available at this time.	A device that would be assigned by the courts to cars of DWI offenders. The driver would be restricted from operating the vehicle during high-risk hours. The device would monitor compliance; noncompliance would result in penalty.

[a]DWI = driving while intoxicated.

Table 2. Potential savings from alcohol-related crashes.

Item	Total Number of Crashes	Alcohol Related (%)	DOT Societal Costs ($)	Potential Savings (billions of $)
Fatalities	57 000	0.50	200 000	5.70
Injuries	5 189 000	0.30	7 200	11.21
Property damage	24 850 000	0.15	300	1.12
Total				18.03

Table 3. Breath alcohol concentration by time of day and day of week.

BAC Level (%)	Night During the Weekend	Night During the Week	Day During the Weekend	Day During the Week	Average
0.00 to 0.01	0.773	0.809	0.901	0.941	0.878
0.02 to 0.04	0.092	0.077	0.040	0.024	0.049
0.05 to 0.07	0.061	0.051	0.027	0.016	0.032
0.08 to 0.09	0.024	0.020	0.010	0.006	0.013
0.10 to 0.14	0.036	0.031	0.016	0.009	0.020
0.15 or more	0.014	0.012	0.006	0.004	0.008

where

ΔI = average number of injuries per alcohol-related crash,
ΔK = number of alcohol-related crashes, and
$\Delta F'$ = average number of fatalities per alcohol-related crash.

To apply the formulas for calculating the savings in societal costs that would result from implementing a countermeasure, it was necessary to estimate the number of personal injuries per alcohol-related crash and the number of fatalities per alcohol-related crash. The percentages shown in Table 2 (4) were used in the following manner to obtain the estimates.

$\Delta K = 0.15 \times 24\ 850\ 000 = 3\ 727\ 500$
$\Delta F' = 0.5 \times 57\ 000 = 28\ 500$
$\Delta F'/\Delta K = 28\ 500/3\ 727\ 500 = 0.007\ 65$
$\Delta I = 0.3 \times 5\ 189\ 000 = 1\ 556\ 700$
$\Delta I/\Delta K = 1\ 556\ 700/3\ 727\ 500 = 0.417\ 6$

Hurst has demonstrated that the relative probability for accident involvement can be 19 times higher for drivers with BAC level greater than 0.15 than for sober drivers. Therefore, countermeasures that focus on reducing the number of drivers with elevated BAC levels will have a greater than average impact on reducing the number of alcohol-related fatalities and personal injuries (2). According to Hurst's estimates, the appropriate values for the average number of fatalities per alcohol-related crash and the average number of personal injuries per alcohol-related crash are twice those for all crashes. To provide a range of values for the analysis, calculations for each countermeasure were made by using the average number per alcohol-related crash as the lower or pessimistic estimate and the Hurst estimate as the upper or optimistic estimate. The values for fatalities per alcohol-related crash ($\Delta F'/\Delta K$) were: average estimate = 0.007 65 and Hurst estimate = 0.001 52. The values for personal injuries per alcohol-related crash ($\Delta I/\Delta K$) were: average estimate = 0.4176 and Hurst estimate = 0.8352.

Requirement for BAC Data

To apply the Hurst methodology, the expected savings in crashes was estimated by using the overall distribution of BAC levels and the distribution of BAC levels for people involved in crashes. To assess the total effectiveness of the countermeasures, BAC data that represented driving during all hours of the day and each day of the week were needed. The four primary sources that were reviewed and assessed for data on the overall BAC distribution were

1. U.S. National Roadside Breathtesting Survey (1973),
2. Accident and Control Data, Grand Rapids, Michigan (1963),
3. Alcohol Safety Action Program (ASAP) Baseline Data, Washtenaw County, Michigan (1965), and
4. ASAP Data Tapes, NHTSA (1973).

The three primary sources that were reviewed and assessed for data on the BAC distribution in crashes were

1. Accident and Control Data, Grand Rapids, Michigan (1963),

2. ASAP Data, Nassau County, New York (1970), and
3. ASAP Data Tapes, NHTSA (1973).

The assessment of the data sources revealed that the U.S. National Roadside Breathtesting Survey provided the best representative data for determining the overall BAC distribution nationally, while only the Accident and Control Data from Grand Rapids provided the combination of both overall BAC distribution data and data on BAC distribution in crashes. The Hurst methodology that estimated the accident-reducing potential of the various countermeasures requires the use of consistent data for both of these categories in a given area. It would have been desirable to use the national data to compare BAC distributions for crash and control groups, but the data services were limited. Therefore, it was assumed that the relative probability of crash involvement is strictly a function of alcohol consumption and that differences due to geographic variations are not statistically significant. Further data are required to test the validity of this assumption.

No BAC distribution data were available for the day of the week, the night of the week, and the day during the weekend; therefore, a methodology was developed for estimating time distribution. The procedures for deriving these BAC distributions are presented in the General Research Corporation's (GRC) final report (1).

COST MEASUREMENT

The cost element in the benefit/cost ratio is the cost of developing, producing, and implementing the countermeasures. Only incremental costs were considered in the analysis. Costs already incurred by research and development of countermeasures are sunk costs and are not relevant for comparing the costs and benefits of implementing the countermeasure. Only those future costs that are directly attributable to countermeasures were included. In addition to excluding sunk costs, all costs and benefits that would have occurred regardless of whether the countermeasure was undertaken were excluded. For example, increased court costs associated with the evidential roadside tester were measured by subtracting the total court costs without the countermeasure from the total court costs if the countermeasure were in use.

Since many of the countermeasures are in the early stages of development, reliable cost data do not exist; therefore, expert opinion was relied on to obtain estimates. Several interviews were held with prominent individuals familiar with the research and development of the countermeasures. Ten elements of cost were considered: research and development; manufacturer's selling price; installation costs; maintenance costs; inspection costs; testing equipment; cost of malfunction; public information; increased enforcement costs of police, courts, and corrections; and removal costs.

In order to provide a basis for comparing the benefits and costs of each countermeasure, a period comparison or estimated economic life for each countermeasure had to be determined. A period of 10 years was used for the analysis.

Since costs and benefits accrue at different rates over time, discounting was used to take into account the time value of money. All costs and benefits were discounted to the present, and the benefit/cost ratios were stated in terms of average annual benefits and costs. The Office of Management and Budget has chosen a rate of 10 percent for use in discounting cash flows for all projects that involve the expenditure of federal funds (5). This rate was used for the countermeasures.

Accident trends over the next 10 years were given consideration. From 1960 to 1970, the number of vehicles on the road increased from 73 869 000 to 108 375 000 and the number of accidents increased from 11 429 000 to 22 116 000 (6). The potential for reducing accidents in 1970 was therefore substantially greater than in 1960. If this trend continues, the potential for reducing accidents in 1985 would be greater than in 1975. However, the amount of driving will not increase nearly as rapidly over the next 10 years, because of the energy crisis and the presidential decision to reduce the rate of gasoline consumption over the next few years. A conservative approach was taken and it was assumed that the potential for accident reduction in 1975 would be the same as that for each year through 1985. This assumption applies to all countermeasures and does not affect the relative ranking of the benefit/cost ratios.

HURST'S METHODOLOGY

Hurst's epidemiological model was used to estimate the accident-reducing potential for each countermeasure (2). This model uses the overall BAC distributions, the BAC distributions in crashes, and the application of Bayesian statistics to determine the relative likelihood that a driver will be involved in an accident at different BAC levels. The relative probabilities are based on empirical evidence derived by Hurst that drivers with higher BAC levels have a greater likelihood of being involved in an accident than drivers with lower BAC levels.

Assumptions

The major assumption underlying the Hurst relationship between BAC and crashes is that someone driving with a BAC level of 0.20 percent would, if driving with a lower BAC (e.g., 0.10 percent), have the same relative likelihood of crash as someone who ordinarily drove with a lower BAC. Thus, if it can be demonstrated that a proposed alcohol countermeasure (e.g., the alcohol interlock), can effectively reduce the average BAC for those who use the countermeasure, then empirical relationships are established and can be used to estimate the expected reduction in accidents.

The Hurst model also assumes that the relative probability of a crash at varying BAC levels reflects only the causal influence of the alcohol ingested and, therefore, that drivers with higher BAC levels have a greater likelihood (probability) of being involved in an accident than drivers with lower BAC levels.

Model

The Hurst model for estimating the expected reduction in crashes (C) by lowering the BAC level from B to P is

$$\Delta I_p = \sum_{B=P}^{K} I_B \left\{ [RP(C/B) - RP(C/P)] / RP(C/B) \right\} \qquad (2)$$

where

ΔI_p = expected reduction in crashes from the application of the countermeasure that reduced the BAC from B to P,
I_B = expected number of crashes that would occur at a BAC level of B without the application of the countermeasure,
K = maximum value of BAC obtainable in the sample,
RP(C/B) = relative probability of a crash at a BAC level of B, and
RP(C/P) = relative probability of a crash at a BAC level of P.

The relative probability of C given B is

$$RP(C/B) = [P(C/B)]/[P(C/B_O)] = \left\{[P(C)P(B/C)]/[P(B)]\right\}\Big/\left\{[P(C)P(B_O/C)]/[P(B_O)]\right\} = [P(B_O)P(B/C)]/[P(B)P(B_O/C)] \quad (3)$$

where

$P(B_O)$ = absolute probability of observing a BAC level of 0.00 to 0.01 percent,
$P(B)$ = absolute probability of observing a BAC level of B,
$P(B_O/C)$ = conditional probability of observing a BAC level of 0.00 to 0.01 percent, given that a crash has occurred, and
$P(B/C)$ = conditional probability of observing a BAC level of B, given that a crash has occurred.

The first two probabilities may be empirically derived from the overall BAC distributions given in the Accident and Control Data, and the last two conditional probabilities may be empirically derived from the BAC distributions in crashes that are also given in the Accident and Control Data.

In the application of the Hurst model to the individual countermeasures, the following relative probabilities were derived from the Accident and Control Data.

BAC Level (%)	Relative Probability	BAC Level (%)	Relative Probability
0.00 to 0.01	1.0	0.08 to 0.09	1.933
0.02 to 0.04	1.0	0.10 to 0.14	5.74
0.05 to 0.07	1.36	0.15 or more	18.97

A relative probability of 5.74 for BAC = 0.10 to 0.14 percent means that, under similar traffic conditions and at the same time of day, a driver with this BAC level would be 5.74 times more likely to be involved in an accident than a driver with a BAC level of 0.00 to 0.01 percent. A driver with a BAC level of 0.08 to 0.09 percent would be only 1.933 times more likely to be involved in an accident than this latter driver. Thus, if a driver were shifted from BAC = 0.10 to 0.14 percent to BAC = 0.08 to 0.09 percent, his risk of being involved in an accident is 33 percent of what it was at the higher BAC level. The potential saving is equal to 66 per cent of the cost of crashes at the higher BAC level [(5.74 - 1.933)/5.74 = 0.66].

The remaining tasks were to estimate the impact of the countermeasure's use on the BAC levels of those using it and to estimate the number of crashes ($\hat{I}_B$) that would potentially be affected by the application of the countermeasure. If the application of the alcohol safety interlock is 100 percent effective, then to prevent a driver with a BAC greater than 0.09 percent from driving the limit is set at 0.1. The Hurst formula is used to calculate the expected reduction in accidents by reducing the BAC level from 0.10 to 0.14 percent and 0.15 or more to 0.09 percent. Since only a limited number of drivers have the device, then I_B must be adjusted to reflect the crashes that are potentially affected ($\hat{I}_B$). This adjustment was made in the following manner:

$$\hat{I}_B = \left\{[P_B(912.5)X]/(T_B)\right\} I_B \qquad T_B = P_B T \quad (4)$$

where

P_B = proportion of drivers at BAC level B,
912.5 = average number of trips per person (2.5) per year (365 d) (7),
X = number of drivers who have the device,
T = total number of trips per year,
T_B = total number of trips per year at a BAC level of B, and
I_B = number of crashes per year at a BAC level of B.

For each countermeasure, it was necessary to calculate an adjusted I_B ($\hat{I}_B$) to reflect the number of trips per year that are potentially affected by the application of the countermeasure. The concept of the trip is the weighting factor rather than exposure to distance. Although distance can be used as the weighting factor, many of the countermeasure devices focus on preventing a trip from occurring, and many of the costs are directly proportional to the number of trips rather than the distance traveled. Furthermore, if the total number of trips in the aggregate for all licensed drivers is closely correlated with distance, then weighting factors based on the number of trips would be identical to those based on distance.

The Accident and Control Data crash distributions were used to estimate the total number of crashes at each BAC level as shown in the following:

BAC Level (%)	Crash Probability	Crashes (I_B)
0.00 to 0.01	0.8654	21 505 190
0.02 to 0.04	0.0364	904 540
0.05 to 0.07	0.0221	549 185
0.08 to 0.09	0.8130	323 050
0.10 to 0.14	0.0310	770 350
0.15 or more	0.0318	790 230

Generation of BAC Distribution

As was previously mentioned, BAC data were available for only night versus weekend periods; therefore, estimates were made for BAC distributions for day of the week, day during the weekend, and night of the week. The existing data from the National Roadside Survey were used as the baseline, and supplementary data from the Accident and Control Data, Zylman (8), and the ASAP Data Tapes were used to estimate the overall BAC distributions. The procedures followed are described in detail in the GRC final report (1). The estimated BAC distributions by time of day and day of the week are given in Table 3. The total BAC distribution is not a simple average of the time of day or day of the week distributions but rather a weighted average in which the weights are based on the percentage of trips associated with each.

RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Sober Pill

The sober pill would be cost-effective (benefit/cost ratio in the range of 4.0 to 5.0) if single doses cost 25 cents and it effectively reduced the BAC level by 0.04 to 0.05 percent. The critical considerations in determining the cost-effectiveness of the sober pill are that

1. It must be technologically feasible,
2. It must not have undesirable side effects,
3. It must be used for at least 1 out of 17 000 trips when the driver's BAC level is 0.05 percent or greater, and
4. A single dose must not cost more than $1.

It was recommended that NHTSA sponsor additional

research to develop a drug that can reduce the BAC level by 0.04 to 0.05 percent without producing undesirable side effects and to develop implementation procedures.

Self-Testers

Self-testers would be cost-effective (benefit/cost ratio in the range of 1.0 to 2.0) if users did not drive 75 percent of the time that their BAC levels were 0.10 percent or greater. The critical considerations in determining the cost-effectiveness of the self-testers are that

1. The driver deterrence rate is unknown,
2. The self-tester must be used for at least 1 out of 10 000 trips when the driver's BAC level is 0.10 percent or greater, and
3. The cost per use must not exceed 80 cents.

It was recommended that NHTSA sponsor additional research to determine the expected public use and level of deterrence under different conditions and to develop implementation procedures.

Evidential Roadside Tester

The evidential roadside tester would be cost-effective (benefit/cost ratio in the range of 1.0 to 2.0) if it deterred 1 to 2 percent of trips that would otherwise be made with a BAC of 0.10 percent or greater. The critical considerations in determining the cost-effectiveness of the evidential roadside tester are that

1. The potential for driver deterrence is unknown,
2. The acceptance and use by law enforcement agencies are unknown,
3. At least 100 units must be in service each year,
4. The incremental court costs per case must not exceed $100, and
5. The incremental rehabilitation costs per case must not exceed $250.

It was recommended that NHTSA sponsor additional research to determine the deterrence potential, determine the willingness of the police and courts to use the device, and develop implementation procedures.

Noncooperative Breath Tester

The noncooperative breath tester would be cost-effective (benefit/cost ratio in the range of 1.0 to 2.0) if it deterred 1 to 2 percent of trips that would otherwise be made with a BAC level of 0.10 percent or greater. The critical considerations in determining the cost-effectiveness of the noncooperative breath tester are that

1. The driver deterrence rate is unknown,
2. The tester must comply with existing legal constraints (laws against illegal search and seizure),
3. At least 100 units must be in service each year,
4. The incremental court costs per case must not exceed $75, and
5. The incremental rehabilitation costs per case must not exceed $200.

It was recommended that NHTSA sponsor additional research to determine the potential for deterrence, develop a device that meets the performance and cost specifications, assess the legal constraints, and develop implementation procedures.

Alcohol Safety Interlock System

The alcohol safety interlock system would be cost-effective (benefit/cost ratio in the range of 1.0 to 2.0) if a device could be developed that had at least 50 percent effectiveness at a BAC level of 0.10 percent or greater, was tamperproof, and required minimal maintenance and installation cost. The critical considerations in determining the cost-effectiveness of the alcohol safety interlock system are that

1. The effectiveness rate must be at least 50 percent,
2. The courts must be willing to impose its use (if it is restricted to DWI offenders),
3. The annual maintenance cost must not exceed $10 per unit,
4. The installation and removal costs for restricted use must not exceed $15.00 and $7.50, respectively,
5. There must be no inspection cost, and
6. If it is used on a restricted basis, at least 1000 units/year must be in service.

It was recommended that NHTSA sponsor additional research to develop a device that meets the stated performance and cost requirements, determine the potential for deterrence, determine the court's willingness to impose restricted use of the device, determine the potential for social acceptance of universal use, and develop implementation procedures.

Continuous Monitoring Device

The continuous monitoring device would be cost-effective (benefit/cost ratio in the range of 1.0 to 1.5) if drivers who have the device abide by the warning 50 to 60 percent of the time. The critical considerations in determining the cost-effectiveness of the continuous monitoring device are that

1. The device must be technologically feasible,
2. The driver-deterrence rate is unknown,
3. The courts must be willing to impose its use,
4. At least 10 000 units must be in service a year,
5. The manufacturing price must not exceed $175 to $200 per unit, and
6. The installation and removal costs must not exceed $15.00 and $7.50, respectively.

It was recommended that NHTSA sponsor additional research to develop a device that correlates driving impairment with the BAC level, determine the potential for deterrence, determine the court's willingness to impose the use of the device, and develop implementation procedures.

Operating-Time Recorder

The operating-time recorder would be cost-effective (benefit/cost ratio in the range of 1.0 to 2.0) if it were 50 to 60 percent effective in eliminating trips made with a BAC level of 0.10 percent or greater during restricted hours. The critical considerations in determining the cost-effectiveness of the operating-time recorder are that

1. The driver deterrence rate is unknown,
2. The courts must be willing to impose its use,
3. The restricted hours must encompass the time when at least 50 percent of the driving that might be influenced by alcohol would be done,
4. At least 10 000 units must be in service each year,
5. The annual maintenance and calibration cost must

not exceed $10.00 per unit, and

6. The installation removal costs per unit must not exceed $15.00 and $7.50, respectively.

. It was recommended that NHTSA sponsor additional research to determine the potential for deterrence, determine the court's willingness to impose the use of the device, and develop implementation procedures.

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Administrative Adjudication of Driving-While-Intoxicated Offenses

Marvin H. Wagner, M. H. Wagner and Company

Recent studies have shown that the enactment of strong laws and the stringent enforcement of those laws by the courts and police have not been empirically proved as effective countermeasures for reducing accidents caused by excessive drinking and driving. A multifaced alcohol countermeasure program is needed to significantly reduce the number of deaths and serious injuries caused by alcohol-related crashes. The problem of drinking and driving can be brought to a manageable level if all of the facilities and services available to states and communities are used. The concept of administrative adjudication, the handling of traffic offenses through an administrative or quasi-judicial approach, has gained widespread attention and is in use in some jurisdictions. The administrative adjudication of first-offense drivers charged with driving while intoxicated would increase the arrests and convictions of drunken drivers. If a driver is repeatedly arrested, the courts will have an indication of the drinking problem and be able to refer the driver to proper treatment or education programs.

Over the past 25 years, the problem of highway fatalities has grown to near epidemic proportions. During 1973, approximately 55 000 persons were killed on the nation's highways (1). Traffic crashes have been identified as the largest single source of death for individuals over 45 years of age (2). According to the U.S. Department of Health , Education, and Welfare, the total number of useful person-years lost to labor is growing and is now approaching the loss due to heart disease and cancer (3). As a result of traffic crashes, hundreds of thousands of persons are seriously injured and billions of dollars in societal losses are sustained each year.

The problems of alcohol-related crashes were first recognized and reported in 1904, but it was not until the 1950s that highway safety investigators began to understand the precise relationship between alcohol and driving. Today, it is indisputable that alcohol is the most significant single factor leading to fatal crashes.

A vital ingredient in the problem is the correlation between the type of drinker and his connection with fatal crashes. Extensive research has clearly established that problem drinkers or alcoholics, who represent about 7 percent of the driving population, are responsible for approximately two-thirds of these fatal crashes (3, 4).

A study by Borkenstein and others (5) shows that there is little increase in crash risk when a person has a blood alcohol level (BAL) of 0.05 percent or below. However, this risk increases sharply to 7½ times the normal risk at a BAL of 0.10 percent. Even more dramatically, the risk increases to 25 times that of the normal level at a BAL of 0.15 percent. Since the social drinker rarely exceeds a BAL of 0.08 percent, it is obvious that the problem drinker and the alcoholic represent a vastly disproportionate risk to the general driving population.

The question of methodology to deal with these heavy drinkers has created a division of opinion among highway safety authorities. The medically oriented experts claim that only extensive alcohol-treatment programs will effectively reduce alcohol-involved crashes; the law enforcement experts point to the limited proof of successful treatment of alcoholics and claim that only strong deterrent laws and enforcement will prevent the continued high incidence of abusive drinking and driving among the entire driving population.

The proponents for strong deterrent actions have pointed to several European experiments that appeared highly successful. The Scandinavian stories of stringent enforcement of strict laws with severe penalties have been reported in many studies (6, 7). The Swedes and Danes claim that only 15 percent of their fatal accidents are alcohol related and that 50 percent of the fatal crashes in the United States are alcohol related. Some U.S. authorities have questioned the accuracy of these data (8). Although the proportionate number of Scandinavian fatalities involving alcohol seems low, the actual number of deaths per 1.6 million km (1 million miles) driven is very high. A closer scrutiny of the comparative statistics would probably show little difference in the percentage of alcohol involvement. It is interesting to note that, at the last few meetings of the International Group on the Effects of Alcohol on Road Accidents of the Organization for Economic Cooperation and Development (OECD), Scandinavian representatives showed a strong interest in the area of rehabilitation and treatment for the drinking driver. In discussing the effectiveness of penal sanctions as an instrument to combat recidivism

Publication of this paper sponsored by Committee on Traffic Law Enforcement.

among subjects convicted for driving under the influence of alcohol, Buikhuisen (9) stated:

> All these studies have one thing in common: among subjects convicted for drunken driving there is a high percentage of alcohol recidivists. This suggests that many of the drunken drivers have drinking problems.... What can we do to combat drunken driving?... We have seen that punishment is not very effective. It does not make much difference whether subjects are sentenced to imprisonment or only to a fine. Even disqualification from driving (suspension or revocation of the driver's license) does not help.... It should be stressed, however, that this alcohol information would not help our problem drinkers. They will continue drinking excessively, unless we succeed in solving their problems.

The 1967 Road Safety Act of Great Britain is often cited to support strict deterrent measures for drinking drivers. This act combined the practice of certainty of apprehension (prearrest breath tests); certainty of conviction (illegal per se at 0.08 percent BAL); and certainty of punishment (mandatory loss of driver's license, stiff fines, and possible jail terms) for drinking drivers. In addition to enactment of the law, a massive public information program was undertaken. The initial effect of the law was astonishing: a 40 percent reduction in alcohol-related fatal crashes for the first year (1968) of operation. In a recent report (10), Ross strongly supported the British program: "The study of the Road Safety Act of 1967 provides support for the hypothesis that subjective certainty of punishment can deter socially harmful behavior as exemplified by drinking and driving in Great Britain."

After the initial dramatic reduction in alcohol and highway fatalities, a significant rise in alcohol-involved deaths has been noted for each succeeding year. These deaths have now returned to the level prior to enactment of the law. Ross (10) also discussed the Road Safety Act of 1967 and its future:

> The Road Safety Act of 1967 was a spectacularly effective law. Its effect on casualties was sharp, immediate, and—given the multiplicity of factors that cause accidents—surprisingly large. As its administration did not require a significant increase in resources for police and courts, its cost was certainly small in relation to the benefits documented in this report. Unfortunately, there are many signs that the initial effect of the legislation is diminishing.

Thus, it seems that a countermeasure program, which includes strict deterrent measures and public information, has a strong initial effect but may not have a lasting effect. There is some evidence that this experience has been encountered in programs of other countries, such as Austria, Czechoslovakia, and Canada (11).

In 1970, a program was initiated in Chicago by a traffic court judge who publicly announced that the policy of the court would be to sentence every person convicted of driving while intoxicated to at least 7 days in jail and to recommend to the secretary of state that the defendant's driver's license be suspended for 1 year. The experiment began in mid-December 1970 and continued through mid-July 1971. Since traffic deaths were reduced in the Chicago area during the time of this program, it was presumed that the mandatory jail approach was working effectively. However, a study (12) raised serious questions regarding the validity of the program's findings. The statistics from Milwaukee, which had no special countermeasure program, were compared with statistics from Chicago. The researchers stated:

> We conclude from the analysis that the change in motor vehicle fatalities that occurred during the Chicago crackdown on drivers convicted of driving while intoxicated was only a chance variation from the fatality rate over the preceding 5 years.... By comparing 1971 and 1970 figures, Chicago officials mistakenly concluded that the decrease occurred because of the crackdown rather than being part of a more general down trend which occurred outside Chicago as well.

Another study (13) also sharply criticized the severe sanction theory:

> We found no demonstrable advantage to any of the nonjail options available to a typical traffic court for the handling of drivers found guilty of driving under the influence of alcohol, within the limitations of our attempts to compensate for the biases introduced by the judge's departure from the scheduled sanctions. Nor does the study offer hope that a jail sentence would bring about the desired improvements in driving records.

Neither of the reports completely rules out the total ineffectiveness of a strong deterrent policy. They merely state that strong laws and strict law and judicial enforcement alone have not been empirically proved to be adequate countermeasures.

Innovative rehabilitation programs do not seem to fare much better. Most of the reports from judges who have initiated rehabilitation programs are mostly anecdotal and have no serious research to support findings. A study on the effectiveness of varying rehabilitation programs (14) stated:

> An experimental evaluation of the effects of different intervention methods, which includes Alcoholics Anonymous, an Alcoholic Rehabilitation Center, films and lectures, and different forms of group therapy, compared with a control group, which were given conventional treatment, was carried out. The results were inconclusive, but suggested that for a short one-year follow-up period, there is little difference between the conventional and the experimental treatment methods, or among different experimental treatment methods. An extended follow-up now underway may invalidate this negative conclusion.

Lackland Air Force Base in Texas had one of the first educational countermeasure programs that involved an extensive evaluation program. This countermeasure program, which included educational, administrative, and psychiatric attributes designed to change tolerance attitudes toward airmen who drink and drive, revealed (18):

> During the year in which the countermeasure was applied, there was a significant reduction in accident experience (from 50 to 60 percent) depending on the criterion employed. The reduction ran counter to rising national, state, and city trends. It also ran counter to the experience at Randolph AFB, a nearby base.

There has not been a follow-up study about the lasting effect of this program. Even though the airmen did not constitute the general driving population, the apparent success of this program has been highly encouraging to the advocates of an alcohol educational and rehabilitation countermeasure program.

The foregoing suggests the complexity of the problem that relates to alcohol and its effect on highway safety. The potential solutions will be equally complex, and an answer will likely not be found within the framework of a single countermeasure area. In 1968, the Alcohol and Highway Safety Report stated, "Since the use and misuse of alcohol takes place in a much broader context than merely the highway, countermeasures concerned specifically with alcohol must also be broadly based." The multifaceted countermeasure concept has been proposed in many different forms over the last few years. Filkins (16) concluded, "It should be obvious by now that many specialists from the health, legal, and social welfare professions must begin to work together to solve the broad problems created by the drinking driver." An extensive treatise by Indiana University (17) stated:

> The social process aimed at controlling the drinking driver is diffuse and ill-organized, but is susceptible to analysis and improvement by the techniques of systems engineering.... The present system can then be engineered so as to increase its efficiency on the basis of high-risk identification and cost-effectiveness. Marked improvement would occur with the institution of management control and information-flow systems and with the development of precise objectives.

Many authorities claim that the potential achievement attained by rehabilitation programs for the alcoholic is extremely poor. Many psychiatrists will no longer accept alcoholics as patients because of the failure of the one-to-one relation. On the other hand, alcohol treatment specialists refute these allegations and are attempting to prove the efficacy of modern techniques for the alcoholic's rehabilitation. The U.S. Department of Health, Education and Welfare (HEW) created the National Institute on Alcohol Abuse and Alcoholism (NIAA) to bring all of the talent and experience of the nation together to combat the tragedy of alcoholism. In a report to Congress, HEW claimed (18):

> Alcoholism is a complicated disorder, but it can be treated successfully. Any technique used indiscriminantly will be much less successful. When the proper treatment modalities are utilized for the unique needs of the particular patient, however, we indeed have cause for optimism.

Therefore, it appears that, if states and communities use the appropriate approach and use all the facilities and services available to them, the problem of drinking and driving can be brought to a manageable level. In addition, the successful operation of an alcohol and highway safety countermeasure program can have a significant impact on the major social problems caused by alcoholism; problem drinkers or alcoholics would be identified at a relatively early stage of their disease and this fact would be forcefully brought to their attention.

ATTITUDE OF CRIMINAL JUSTICE SYSTEM

Police

The general rate of driving-while-intoxicated (DWI) arrests across the country is extremely low and it is estimated that as few as two DWI arrests per police officer per year represents the national average. It is also estimated that there is approximately one arrest for each 2000 DWI violators.

The perception of the driving population about the likelihood of being arrested and convicted of a DWI offense is also very low. Drivers not only do not consider the risk of being apprehended on the highways but also are aware of the reluctance of judges and juries to convict an average citizen charged with drinking and driving. To reduce the number of drinking drivers, the probability of apprehension and conviction must be real and constant. There must be a consistency in arrest convictions. A manual of the National Highway Traffic Safety Administration (NHTSA) (19) set forth this principle:

> The enforcement program directed toward alcohol-related crashes should be a refinement of the law enforcement agency's current selective enforcement programs. Evidence is mounting that alcohol is present in over 50 percent of fatal crashes and that the probability of a drinking driver becoming involved in a crash increases as the blood alcohol concentration (BAC) increases. Based upon the magnitude and severity of alcohol-related crashes, this refinement to the law enforcement agency's existing selective enforcement program is justified.

The police officer is a reflection of the community and is responsive to the attitudes of the public and the other elements within the criminal justice system. When the public, the prosecutors, the courts, and the corrections departments are indifferent to or easy on drinking drivers, it is difficult and futile for the police officer to act differently. A study by Newman (20) stated, "The apparent lack of communication among police, district attorneys, and magistrates in dealing with motorists who are arrested for drunk or drug driving has caused a breakdown in dealing with these violators." However, it has been amply demonstrated that, through the introduction of a comprehensive alcohol-safety action program in a community that is sufficiently financed and properly motivated, substantial improvements can be made on these arrest figures. A recent NHTSA publication (21) stated:

> In Fairfax County, Virginia, only 75 arrests were made during 1971 when the courts operated under a state law providing for a mandatory one year suspension of the license. In 1972, after the initiation of the NHTSA Alcohol Safety Program (ASAP), which provided for treatment and re-education in place of license suspension, there were just under 3000 DWI arrests.

Therefore, there should be a serious investigation into the most effective and efficient means for increasing apprehension of DWIs by police. This is essential for the development of a manageable and sophisticated system to reduce highway accidents.

Prosecutors

The attitude of the prosecutors throughout the country is certainly no better than that of the police officers and is perhaps even worse in many instances. In an article on the responsibilities of a prosecutor in traffic court, Reeder stated (22):

> Much of the responsibility for failure of the Traffic Law enforcement effort can be laid at the door of indifferent, disinterested prosecutors. An efficient official in this position can prevent the loss of many cases which should result in conviction, if he will bestir himself and assume the responsibilities that are his.

The suggestion that driving while intoxicated is a relatively minor offense for prosecutors was illustrated as follows in instructions to prosecutors on the handling of all forms of criminal prosecutions (23):

> Illustration No. 4. Two uniformed officers brought in a man whom they stopped for reckless driving. The suspect was intoxicated and admitted he had recently been drinking. The lieutenant in charge of the precinct desk informed the suspect that, if he agreed to leave his car at the station and promised to take a taxi home, no charge would be lodged. The suspect agreed to this and was released.
>
> Each day the police handle large numbers of cases involving public drunkenness and minor traffic violations. To prosecute all such cases would place a considerable burden on the criminal justice system. Thus, other considerations are used by the prosecutor to effect selective enforcement at the charging stage.
>
> The relatively minor character of the offenses, the expenses of prosecution, and the harm to the suspect's reputation by prosecution and conviction were all factors in the decision not to charge commission of the offense that the evidence supported.
>
> The man in Illustration No. 4 was sent home to "sleep it off." Neither suspect was an habitual drunkard, at least as far as the police knew.

This work obviously shows an insensitivity to this problem and indicates the usual position held by most prosecutors. The prosecution of drinking and driving offenses is given minimal priority in most jurisdictions.

Many problems are faced by district attorneys in the total criminal practice. One of these problems is the overcrowded conditions of the calendars in most metropolitan areas. As part of his recommendations to defense counsel, Erwin stated (24):

> Observe the trial calendar to see if it is so loaded that there is no time to try all of the cases set. If that is the situation, be ready and so announce. Many times the prosecutor, and occasionally the judge, will suggest that your client plead guilty to a lesser offense in order to save time of the court and the jury, or to prevent continuance beyond the time fixed by law for trial.

The fact of the matter is that in most jurisdictions, if defense counsel is hired by the defendant, then the prosecuting attorney will almost automatically offer a plea

reduced from the DWI charge. Again, we see a serious shortcoming in the attitude and practice of one of the segments of the criminal justice system with regard to the problem of abusive drinking and driving.

Courts

The courts have also paid little attention to the seriousness of the problem of drinkers who drive. By and large, they have not accepted the concept that assistance can be given to problem drinkers, once they have been identified. Instead, judges levy the traditional small fine and, in some instances, suspend the driver's license of the defendant. Generally, no attempt is made to determine the extent of the violator's drinking problem. Many experiments under the present structure have not fully succeeded in improving the system.

At the beginning of 1972, the Arizona legislature enacted a law that required a minimum 1-day jail sentence upon DWI conviction. In Phoenix, the results seriously impeded the progress of the NHTSA Alcohol Safety Action Program (ASAP), which was being conducted there. Innocent pleas rose from 27 to 74 percent over the course of the year. Demands for jury trials increased from 54 to 85 percent over the same period. The dismissal rate increased from 20 to 38 percent, and the proportion of those convicted dropped from 74 to 57 percent. In addition, there was a significant increase in the court backlog and expenses for court operations.

Numerous studies indicate the inability or unwillingness of courts to adequately "attend to" the drunk driver. The traditional system and some of the new experimental programs do not appear to deal appropriately with this problem. Therefore, it is necessary to look toward totally new concepts for apprehending drinking drivers, identifying their individual needs, and taking the necessary actions that would reduce the incidence of recidivism.

IMPROVED TRAFFIC ADJUDICATION PROCEDURES

The National Highway Safety Advisory Committee, which is composed of 35 members appointed by the President, was created by the Highway Safety Act of 1966. The act requires the advisory committee to consult with and make recommendation to the Secretary of Transportation on activities and functions of the transportation department in the field of highway safety.

The Ad Hoc Task Force on Adjudication was established by a resolution of the advisory committee at its meeting November 30, 1972, to "meet with necessary staff of the Department of Transportation to explore effective adjudication of traffic offenses, including administrative adjudication, and consider the ramifications of sentencing alternatives for traffic offenses. . . ." The task force reported to the advisory committee the general findings (25):

> The present traditional lower criminal court processing of traffic violations in the U.S., using sentences of fines and incarceration, evolved for the purpose of determining the guilt or the lack of guilt of an offender charged with a criminal complaint.
>
> Because conviction would involve a jail sentence, adjudication historically has been by the judiciary to accord full protection of constitutional due process. In fact, however, jail sentences are imposed in very few traffic cases and all but the most serious offenses are processed by mail or bail forfeiture. In the present process, self-adjudication and self-sanctioning are the norm.

The task force recommendations included the following:

> To achieve integrated traffic law system components which combine traffic adjudication with traffic safety and improved driver behavior, a new approach to traffic case processing, which contains the following basic features, is recommended:
>
> —Adjudicate a lower-risk category of "Traffic Infractions" by simplified and informal judicial, quasi-judicial or para-judicial procedures.
>
> —Combine "Traffic Infraction" and high-risk criminal traffic offense sentencing with driver improvement and rehabilitation programs.
>
> —Give priority to identifying problem drivers, assigning them to treatment and monitoring the results.

The task force concluded:

> The Task Force believes that adoption by the states of the Report Recommendations and their elements would result in a more ideal traffic law system which will advance highway safety through traffic offense adjudication. . . . However, to achieve this ambitious highway safety goal through a more cost-effective adjudication subsystem may require a higher level of public funding.

Many variations of this approach to the decriminalization of traffic offenses exist. In a recent article (26) Brandt reported:

> The states of New York, New Jersey, Pennsylvania, and Minnesota have classified most moving traffic violations as noncriminal. On October 1, 1972, a number of former criminal offenses, such as reckless driving and driving while intoxicated, became first offense civil forfeiture violations in Wisconsin. In California, parking, equipment violations and most nonmoving offenses, as well as a limited number of moving violations, are classified as infractions. In many states local ordinance traffic violations are considered civil actions in debt to collect a penalty, even though the rules of criminal procedure are generally followed.

After an extensive study in 1967 (27), the California Judicial Council stated:

> In view of the weight of authority that such offenses (minor traffic violations) are not properly classifiable as crimes and the fact that criminal sanctions are not used, it seems desirable that both the criminal classification and the immediate sanction of jail be eliminated and an appropriate classification be provided which conform to the noncriminal nature of minor traffic regulations and to the enforcement needs and practices in such cases.

New York State Administrative Adjudication Program

In July 1970, New York State implemented a law to remove cases that involved most moving traffic infractions from the criminal courts in New York City. New York State was the first jurisdiction (1930) to reduce many minor traffic violations to a new category of traffic infractions. These offenses were heard in the criminal court system until administrative adjudication took effect in New York City. Under the new law, these cases are heard by hearing officers of the Department of Motor Vehicles, who are experienced attorneys. Almost all moving traffic infractions that occur in New York City and Buffalo are part of the new system; however, these offenses do not include DWI. Misdemeanors, such as driving while intoxicated, reckless driving, leaving the scene of an accident, and driving without a license or registration, continue to be heard before criminal court judges.

In this program, judges of the criminal court are replaced by administrative hearing officers. The hearings are conducted with decorum in a quasi-judicial setting. If defendants wish to contest a charge they are given a specific time to appear. In most cases a person can be in and out of a hearing within an hour. Persons found guilty can appeal to an administrative board and, ultimately, have recourse to the state trial court. Under the law, motorists can plead in person or by mail to traffic infractions. Upon filing a denial of charges and $15 security, a motorist who wishes to contest charges of a traffic infraction is granted a hearing before a

referee, who decides the case. The motorist retains the right to be represented by legal counsel at any hearing. He may also, if he so desires, be his own counsel. A motorist who fails to answer a traffic ticket citation is subject to having his driving privilege suspended until a response is made.

The Commissioner of Motor Vehicles is authorized to establish within legal limits a schedule of fines for various infractions. If a specific fine has been set for the charged violation, then a motorist admitting the charge by mail can send the specified fine, the traffic ticket, and the record of convictions portion of his driver's license to the Department of Motor Vehicles.

Recent Supreme Court Decisions Affecting Traffic Court Adjudication

Three recent decisions by the U.S. Supreme Court have made a major impact on the effective adjudication of traffic violations in the courts:

1. Tate v. Short, 401 U.S. 395 (1971), dealt with the automatic conversion of a fine to a jail term upon nonpayment of the fine;
2. Baldwin v. New York, 399 U.S. 66 (1970), dealt with the right to a trial by jury; and
3. Argersinger v. Hamlin, 407 U.S. 25 91 S. Ct. 2006 (1972), dealt with the right to counsel in any criminal trial when faced with imprisonment.

In the Tate case, the court stated that a statute that imposes a fine as a sentence and automatically converts the fine to a jail term when an indigent cannot pay forthwith operates as an invidious discrimination in violation of the U.S. Constitution. Since the decriminalization of the major traffic offenses would remove the potential threat of a jail term, supporters of administrative adjudication initially feared that this holding would minimize the effectiveness of the fine provisions of the new statutes and would result in a decriminalization of traffic offenses. An examination of this decision shows that the court was mostly concerned with the automatic conversion to a jail term when the defendant "cannot forthwith pay the fine" or fails to make "immediate payment." The court did not remove the possibility of jail as a potential sanction for persons who will not pay the fine, as opposed to those who cannot pay the fine. In fact, the court cited statutes from several states, such as California, Delaware, Maryland, Massachusetts, New York, Pennsylvania, and Washington, that had developed procedures to allow for a wide variety of alternative methods for collection or sanction and for the payment of fines in installments.

In the Baldwin case, the court rejected the concept that the label of "felony" or "misdemeanor" should constitute the proper criterion for the severity of the specified penalty: "... no offense can be deemed 'petty' for the purposes of the right to trial by jury where imprisonment for more than six months is authorized." Under this decision, most traffic offenders facing a possible jail term in excess of 6 months may now demand and receive a jury trial. However, as mentioned earlier, the Phoenix defense attorneys take full advantage of the charged DWI's right to trial by jury and clog the courts' trial calendar.

In the Argersinger decision (28), the court held that "absent a knowing and intelligent waiver, no person may be imprisoned for any offense, whether classified as petty, misdemeanor, or felony, unless he was represented by counsel at his trial." The court was not unaware of the effect of its decision on the administration of traffic violations. The impact and expense of court-appointed counsel on the already overburdened judicial administration of traffic offenses were considered by Justice Douglas in his opinion. He indicated that a "partial solution to the problem of minor offenses may well be to remove them from the Court system." Justice Douglas specifically referred to a report by the American Bar Association Special Committee on Crime Prevention and Control (28), which stated:

> Regulation of various types of conduct which harm no one other than those involved (e.g., public drunkenness, narcotics addiction, vagrancy and deviant sexual behavior) should be taken out of the courts. The handling of these matters should be transferred to nonjudicial entities, such as detoxification centers, narcotics treatment centers, and social service agencies. The handling of other nonserious offenses, such as housing codes and traffic violations, should be transferred to specialized administrative bodies.

The initial concern following the Argersinger report was that, should judges wish to preserve their discretion of jail or fine, they would be required to appoint counsel in each case. Such a decision could potentially force a collapse not only of the existing traffic administration system but of the entire criminal process. There are not enough lawyers, judges, courthouses, or court reporters that could meet the time, space, and personnel demands if every traffic offender insisted on his right to counsel.

Apparently, no such catastrophe has occurred within the judicial system. However, the decision does place serious shortcomings on the present judicial discretion of sanctions, and a defense counsel who learns to use this decision to his advantage may play havoc with the existing traffic court system.

RATIONALE FOR THE ADMINISTRATIVE ADJUDICATION PROCESS

One of the most difficult problems facing those persons responsible for alcohol and highway safety programming is the appropriate "handling" of the drinking driver. As stated earlier, there are two major conflicting schools of thought on this matter: the position of taking strong deterrent action, such as mandatory jail terms and long periods of driver license suspension, and the more liberal position of not arresting the driver for any offense but rather placing him in a detoxification center. Many advocates of these positions fail to recognize that there are distinctly different types of drinkers who drive and that each one must be treated differently. The social drinkers, who represent the largest number of drunk drivers, would most probably be deterred from repeating their actions by arrest, adjudication process, and the sanction imposed (educational program and fine). Therefore, they do not need to be jailed or have their driver's licenses suspended. In fact, these actions may be counterproductive and increase the problem. Certainly, in the case of problem drinkers or alcoholics, who are considered responsible for the largest number of alcohol-related fatalities, these stringent measures will not prevent them from drinking and driving again. In most instances, they have little control over their drinking and driving practices and cannot be coerced into refraining from drinking and driving through the threat of jail or license revocation.

To determine the type of educational program or treatment program that would be most effective for the different types of drinkers, some measurement or classification is necessary. While it would be best to conduct a presentence investigation and an alcohol profile test on every DWI arrestee, the time and cost of this operation are far too high for consideration as a practical measure. On the other hand, a second DWI con-

viction within a relatively short period of time (3 to 5 years) strongly indicates a serious drinking problem and the need for a presentence investigation. This principle was stated in a new section in the Uniform Vehicle Code (29):

> Before sentencing any person convicted for a first offense of violating Section 11-902 (Driving While Intoxicated) the court may, and upon a second or subsequent conviction of such an offense committed within 5 years of a prior offense the court shall, conduct or order an appropriate examination or examinations to determine whether the person needs or would benefit from treatment for alcohol or drug abuse.

This concept was also followed by California in 1972 through a law that authorized a presentence investigation for first DWI conviction to determine whether treatment designed for habitual users of alcohol would be beneficial. Such an investigation is mandatory for a second or subsequent conviction.

In terms of the very practical problems of time and expense, what is the most propitious method for apprehending the drunk driver, determining the extent of his drinking problem, and providing appropriate educational or treatment programs to deter him from repeating this offense?

This paper advocates a program that would decriminalize the first DWI offense and process these cases through an administrative adjudication procedure. The principal purpose of this proposal is to achieve the maximum opportunity for detection and identification of drinking drivers. The assumption is that arrests for DWI will be dramatically increased if the time required for a police officer to make an arrest and the time required for the trial of the offender are substantially reduced.

For the social drinker, the apprehension by police, civil penalties imposed in the form of a fine or license restriction, and educational courses should be effective deterrents. But more important, increased detections should provide the alcohol countermeasure program of the community with a system that identifies problem drinkers.

Once an offender has been apprehended a second time, the traditional approach of arrest and trial for a criminal misdemeanor would be appropriate. Certainly, second offenders will be far fewer than first offenders and will be manageable through the existing criminal court structure.

By using the decriminalization and quasi-judicial or administrative adjudication of the offense, this proposed program eliminates the problems created by the requirements for DWI offenses of trial by jury (Baldwin case) or assigned counsel for indigents (Argersinger case). As previously mentioned, the constitutional rights of defendants in criminal cases have caused serious difficulties in most instances in which there has been a large increase in DWI arrests. If more DWI arrests were made (which are needed to accomplish the reduction of alcohol-involved crashes), the existing criminal justice structure would be hopelessly congested for all criminal matters.

In 1972 Wisconsin amended its penalty provisions for DWI by eliminating jail sentences for DWI first offense and increased its potential penalties for second offense DWI. A bill was introduced in the New York legislature to change a first-offense DWI from a misdemeanor to a traffic offense. Primarily, the bill was designed to obviate the requirement of trial by jury for the first DWI offense. In a memorandum supporting the bill the Independent Mutual Insurance Agents of New York State stated:

> This measure represents a step forward in dealing with the problem of the impaired driver, simply because it is aimed to deal in realistic fashion with the evil sought to be prevented by the law. Presumably, the purpose of a law of this type is not to incarcerate or confine violators, but rather to ultimately remove such persons from the highways of New York State. This measure would do just that directly without relying on a solely deterrent basis which has to this point been ineffective.

The bill was overwhelmingly passed by the Senate, but a companion bill in the House was not enacted.

In January 1975, the Committee on Judiciary proposed a revision to the Oregon Vehicle Code that would decriminalize the first DWI offense and make it a Class A traffic infraction subject to a fine of $1000. To date, the Oregon legislature has not acted on this provision.

CONCLUSION

The problems of alcohol and highway safety are a small, but critical, part of a much larger picture: the tragedy of alcoholism. The effects of alcohol on family, friends, and society are quite far-reaching. The massive increases in arrests and the simplified process of adjudication that are proposed not only will assist in the apprehension and reduction of recidivism of drinking drivers but also will serve as a new means for the early identification of existing or potential alcoholics. Generally, the alcoholic will not seek treatment or be guided toward a rehabilitation program until he has reached the later stages of his disease. Through this program and with the appropriate cooperation of local alcohol and health organizations, the opportunity for early identification can be of significant importance in reducing the incidence of alcoholism.

There can be many impediments to the implementation of this plan. One of the more serious is the general attitude of the criminal justice system toward the use of retributive sanctions against drinking drivers. It must be clearly shown that these repressive measures have not succeeded in the past, and there is no reason to believe that they will be effective in the future. There will also be strong challenges to the removal of constitutional rights for defendants such as trial by jury and counsel for indigents. By removing the incarceration provisions, these rights will no longer need to be exercised. The most important consideration should be the removal or reduction of the threat to loss of life, limb, and property caused by irresponsible actions of individuals. Many authorities speak of DWI as a criminal offense, but most people do not consider drunk drivers as criminals. They are usually thought of as "unlucky" for being caught.

Therefore, if the public does not change its tolerant attitude toward the drinking driver and implement serious social castigations for his deviant behavior, then the most effective and appropriate means for dealing with drunk drivers is a simplified administrative procedure.

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Evaluation of the Halo Effect in Speed Detection and Enforcement

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The halo effect is the effect on driver behavior beyond the point and time when enforcement is applied or when an enforcement symbol, such as a patrol vehicle, is observed. Research indicates that driving behavior is affected for about 1.5 to 6.5 km (1 to 4 miles). Some researchers (1, 2) have found that drivers reduce their speed when they observe a stationary patrol but not when they observe a moving patrol vehicle.

The purpose of this study was to determine if specific treatments on a section of NC-55, a two-lane rural roadway, could extend the halo effect. The study was done simultaneously with a study to evaluate a visual speed indicator (VSI) sign that displayed the message YOUR SPEED IS _____ as the vehicle passed over induction loop detectors buried in the northbound-lane pavement. If the vehicle was traveling at 90 km/h (56 mph) or more, the words SLOW DOWN were displayed. The sign and its related logic and data collection system (station 2) were located about 13 km (8 miles) south of Durham, North Carolina. Two other logic and data collection systems were located about 3.2 km (2 miles) upstream (station 1) and downstream (station 3) from the sign. The three stations also served as data collection locations in this study. The induction loop indicators for each station were placed at the approximate midpoint section of the roadway. Additional downstream speed profiles were collected in the vicinity of the VSI by an observer operating a radar unit mounted on a post near the roadway and connected to a speed-recording chart.

HALO EFFECT STUDY

The initial evaluation of the VSI was to determine whether the sign display would alter driver speed characteristics without police enforcement. The measurement taken at station 3 was intended to identify any carry-over or halo effect.

Since the VSI involves a static or point measurement of speed, it was thought desirable to compare the relative effectiveness of this technique with three other static enforcement techniques that involve the use of the static radar device.

1. The speed-check zone method (4) involves using a sign designating the zone and a partially concealed radar-equipped enforcement unit. The enforcement unit was located some 305 m (1000 ft) upstream from the VSI detector loops. The speed-check zone sign was placed near station 1.
2. The parked patrol car method involves using a marked patrol unit parked along the east side of NC-55 near the VSI detector loops.
3. The speed enforcement scene method involves using a patrol unit with its roof flasher activated to simulate an arrest. The patrol unit was parked on the east shoulder of NC-55, near the covered VSI, behind the "arrestee's" vehicle.

Thus, it was possible to have five-treatment experimental designs: the three static enforcement methods, the VSI sign display, and a control treatment in which the VSI sign was covered and no patrol unit was present. Each treatment was replicated three times over a 3-week period and assigned randomly each week. All recording devices at VSI sites were activated between 7:15 and 8:00 a.m., and other data that depended on the treatment were collected between 8:30 and 10:15 a.m.

Special Procedures

Whereas previously reported studies and the evaluation of VSI used downstream stations at 1.6, 3.2, 4.8, or 6.4-km (1, 2, 3, or 4-mile) distances, this research measured effects within the first 0.4 to 0.8 km (¼ to ½ mile) past the treatment point. The three enforcement methods provided speed observations upstream from the location of the enforcement unit. The latter measurement was provided by the radar unit deployed by the highway patrolman.

Downstream radar profiles were provided by a radar unit mounted near the roadway about 61 m (200 ft) before the VSI sign. The radar antenna was concealed in a grey

Publication of this paper sponsored by Committee on Traffic Law Enforcement.

box, which resembled a mailbox, located about 2.4 m (8 ft) east of the pavement edge. The radar-power unit and recorder were located behind a natural screen of small pine trees above the ditch.

Data Collection and Analyses

Field studies were performed over the 3-week period from April 21, 1975, to May 12, 1975. The data accumulated in the 3-week period primarily consisted of individual speed readings recorded at the three induction loop locations and of 100 to 150 radar profiles recorded at downstream stations for each 2-h study period. Although the halo effect study could not provide matched speeds other than near the treatment location, it was possible to correlate general speed characteristics (mean and median) because of the relatively short time period.

The analyses were primarily concerned with the speed characteristics (mean, median, 85th percentile, speed variance) at the three VSI recording stations. Analyses of variance were also conducted for mean speed, 85th percentile speeds, and percentage of all speeds exceeding 88.5 km/h (55 mph).

RESULTS

Speed characteristics obtained for each treatment and replication were analyzed, and the following trends were noted.

1. All enforcement treatments caused a substantial reduction in mean, median, and 85th percentile speeds in the vicinity of the enforcement unit (the VSI treatment caused only a minor reduction);
2. At a point 305 m (1000 ft) past the VSI sign detectors, all treatments experienced a speed increase of 3.2 to 9.7 km/h (2 to 6 mph) over the lowest values measured at station 2;
3. At the recording station 3.2 km (2 miles) downstream, all treatments experienced speeds that were almost equal to values measured 3.2 km (2 miles) upstream;
4. Variation of vehicle speeds was somewhat reduced near enforcement units compared to stations 1 and 3; and
5. All enforcement treatments greatly reduced the number of vehicles traveling faster than 88.5 km/h (55 mph) by 30 to 50 percent and greatly increased the number of vehicles traveling slower than 72.4 km/h (45 mph) at station 2 near the VSI sign by 10 to 30 percent.

Figure 1 shows the approximate average speed profiles of all vehicles passing through the study section. As shown by the control curve, there is a slight effect at station 2. This effect is due to either the highway geometry or the minor intersection and gas station a short distance downstream from the station. Compared to the control, the VSI sign has only a minor effect, less than 1.6 km/h (1 mph), on the mean speed of vehicles passing the display. All three static enforcement techniques produce a substantial speed reduction from 8 to 13 km/h (5 to 8 mph) at the treatment location. However, traffic began to recover speed within 305 m (1000 ft) past the treatment, and then completely regained its speed within 3.2 km (2 miles) upstream from the treatment.

ANALYSIS OF VARIANCE

The speed data were organized into two-way analysis of variance tables; the three replications and five treatments yielded 14 deg of freedom. Mean speeds, 85th percentile speeds, and percentage of vehicles traveling faster than 88.5 km/h (55 mph) were selected as the most important speed characteristics to be analyzed.

As a result of these analyses, it was found that there were no significant differences among replications (or days of the week) at any location for any of the variables studied. There was a very significant difference (at a level smaller than 0.5 percent) at most locations in the effects of the treatments studied, but there was no significant difference (at a 5 percent level) at station 3.

Since there were no differences in replications, data were combined for each treatment at each location. Each of the three variables was again organized into two-way analysis of variance tables; the 5 treatments and 5 locations yielded a total of 24 deg of freedom. These analyses yielded the following results.

1. There were no significant differences (at a 5 percent level) among the three enforcement techniques, between the activated VSI sign and the control condition, and between the speed characteristics for station 1 and station 3;
2. There was a very significant difference (less than 0.5 percent level) between enforcement treatments and

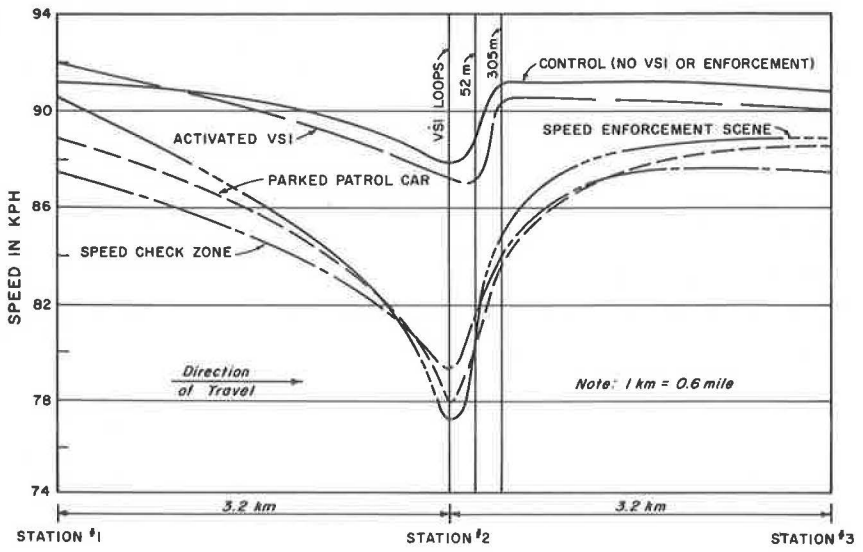

Figure 1. Northbound mean speed profiles on NC-55, spring 1975.

nonenforcement treatments (VSI and control) and between observations at station 2 and at stations 1 and 3; and

3. Mean and 85th percentile speeds and percentage of vehicles traveling over 88.5 km/h (55 mph) were significantly higher at a point 305 m (1000 ft) past the enforcement treatment than corresponding values measured at either the VSI detector loops or 152 m (500 ft) past the loops.

CONCLUSIONS

1. The use of a speed enforcement scene, a speed-check zone, or a parked patrol vehicle produces substantial and significant reductions in mean, median, and 85th percentile speeds in the vicinity of the enforcement unit.
2. All three enforcement techniques significantly reduce (and almost eliminate) the percentage of vehicles traveling faster than 88.5 km/h (55 mph). Furthermore, they also reduce the speed of all vehicles to the point of increasing the percentage of vehicles traveling slower than 72.4 km/h (45 mph).
3. All three enforcement techniques reduce the variability of speeds at the enforcement location.
4. The VSI sign had no significant effect on vehicle speed and was no substitute for actual enforcement activity.
5. The halo effect began to disappear 305 m (1000 ft) past the enforcement treatment and was completely gone at a point 3.2 km (2 miles) downstream.

The use of various enforcement techniques has received rather widespread attention over the years; however, a firm relationship does not exist between the various techniques and resultant effects on traffic behavior. The studies fail to show that the halo effect continues for any considerable distance beyond the symbol, a perplexing problem for enforcement agencies with limited staffs.

There are perhaps other innovative enforcement techniques that may be considered in the future, especially as efforts increase to obtain compliance with the 88.5-km/h (55-mph) limit. However, before any ideas are advanced to any degree, the concepts should be evaluated to determine the maximum payoff for each enforcement dollar spent.

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Abridgment

Analysis of the Relation of Accidents and the 88-km/h (55-mph) Speed Limit on Arizona Highways

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This is a report of an investigation to establish if there is a causal relationship between the reduced number of traffic accidents and traffic fatalities in Arizona in 1974 and the 88-km/h (55-mph) speed limit. All segments of Interstate, U.S., and state highways that, prior to 1974, had posted maximum speed limits in excess of 88 km/h (55 mph) were studied. All data were obtained from the Arizona Department of Transportation highway accident records for 1973 and 1974.

Every traffic accident that occurred in the study area was analyzed. Accidents were classified according to degree of severity: fatal, injury, and property damage only (PDO). Each class was further categorized according to month and light conditions. Light conditions were divided into day, night, and dawn or dusk.

DRIVER

Characteristics of drivers involved in fatal accidents were age, sex, physical condition, and familiarity with the fatal accident location. The age distribution of drivers remained practically unchanged. The proportion of male and female driver involvement remained unchanged. The physical condition of the drivers involved in fatal accidents did not change appreciably during the 2-year study. The proportion of drivers who were familiar with the accident location rose from 51 to 56 percent between 1973 and 1974. The proportion of the drivers who were listed as being unfamiliar with the location dropped from 29 to 27 percent.

VEHICLE

The relative involvement rate for the various categories of motor vehicles did not change appreciably between 1973 and 1974. Pickup trucks and automobiles showed a small decrease in accident involvement, and truck involvement increased from 10.9 to 14.6 percent. It is surmised that a large number of private vehicles were not driven while commercial trucks continued to operate and, consequently, constituted a relatively larger proportion of the total vehicles exposed to traffic conflicts. The proportion of in-state and out-of-state vehicles that were involved in fatal accidents remained almost constant. The use of seat belts did not contribute in any appreciable way to the decrease of fatal accidents in the study area since use of seat belts declined by 2 percent.

ACCIDENT ENVIRONMENT

The factors that were included in the accident environment category are new vehicle registrations, total vehicles registered in Arizona, passenger cars entering Arizona, Arizona Department of Public Safety speeding citations, and travel on Arizona highways.

New passenger car registrations declined by 27 percent, and new commercial vehicle registrations declined by 29.5 percent. The total number of passenger cars registered in 1974 showed about a 3 percent increase, and commercial vehicles showed a 5 percent increase. The proportion of commercial vehicles to total vehicles remained the same in 1974. The number of passenger cars entering Arizona decreased by about 13 percent (almost 1 million cars) in 1974. The number of speeding citations issued on Arizona highways indicated the intensity of enforcement of the posted speed limits. Speeding citations increased about 13 percent from 1973 to 1974. It was not possible to isolate those speeding citations that were issued in the study area. However, it was assumed that the increase in citations occurred as a result of enforcing the 88-km/h (55-mph) speed limit.

The following data were provided by the Arizona Department of Transportation and indicate that considerable changes occurred in highway speeds and speed distributions for each segment of the highway system per year. Both average passenger car speeds and the standard deviations of the speed distributions decreased. Thus, accident severity and the ratio between fatal accidents and all accidents could be expected to decrease.

Publication of this paper sponsored by Committee on Traffic Law Enforcement.

Highway	Mean Speed (km/h) 1973	1974	Standard Deviation 1973	1974
Interstate	110.6	97.1	13.82	9.31
US	100.8	91.5	12.99	10.24
State	101.3	93.4	13.65	12.19

In 1974, interstate vehicular travel declined about 17 percent and non-Interstate vehicular travel declined almost 20 percent.

FATAL ACCIDENTS

The following data (1) show the relationships between study area and total statewide fatal accidents.

Year	Study Area	Arizona	Percent
1973	308	817	37.5
1974	161	658	24.5
Reduction	147	159	

Almost a 50 percent reduction in study area fatal accidents was experienced between 1973 and 1974. The significant reduction in study area fatal accidents accounted for over 92 percent of the total reduction in statewide fatal traffic accidents. Thus, it was concluded that the accident reduction experienced on those Arizona highways affected by the 88-km/h (55-mph) maximum speed limit almost solely accounted for the entire 1974 statewide reduction in fatal accidents. Apparently, highways characterized by lower speed limits and more urban conditions accounted for a larger proportion of total highway fatalities; fatalities on those facilities increased from 29.2 to 42.3 percent, but urban and local travel in 1974 increased as well. Fatalities on highways outside the study area remained constant or slightly increased.

The proportion of multivehicle fatal accidents decreased from 31.8 to 24.2 percent. This reduction might have occurred since there are fewer opportunities for multivehicle collisions when travel is reduced.

On Interstate highways, the fatal accident rate per 160 million vehicle-km (100 million vehicle-miles) dropped from 3.27 to 2.14. On other highways in the study area, the yearly average fatal accident rate dropped from 5.74 to 3.64. The reduction in accident rates presents clear evidence that the fatal accident reductions experienced in 1974 cannot be explained simply by pointing to the reduction in travel. Since every other factor that has been analyzed to this point has demonstrated negligible variation between the 2 years, then it appears reasonable to conclude that the drop in fatal accident rates can be attributed to the decrease in travel speeds and the decrease in speed variation within the traffic stream.

The ratio of injuries to deaths is a measure of the severity of accidents. An increase in the injury-to-death ratio (I/D ratio) means that accidents have become less severe. In this study, the ratio for the study area rose from 9.41 to 11.71. The factors that could account for an increase in the I/D ratio are improvements in vehicle design, improvements in highway design, elimination of roadside hazards, increased use of seat belts, and lowering of impact speeds. All of these factors would tend to make automobile accidents less serious. The first three factors were introduced into the accident environment too slowly and in increments too small to cause a 24 percent increase in the I/D ratio for 1 year. Consequently, it appears that the lowering of impact speeds caused the 24 percent change in the I/D ratio.

Light Condition

The proportion of all nighttime accidents to total accidents in the study area increased from 34.2 to 38.6 percent. This increase may have resulted from an increase in night driving since motorists attempted to drive 1973 distances at 1974 speeds.

ACCIDENT RATES

Although the average number of accidents per 160 million vehicle-km (100 million vehicle-miles) on Interstate and non-Interstate highways in 1973 was almost equal (107.0 and 104.5 respectively), the 1974 rates exhibited distinct differences. The rate of decrease was 36.0 on Interstate highways and only 10.5 on non-Interstate highways. The rate for the entire study area decreased from 105.9 to 81.4 or a 23.4 percent decrease.

CONCLUSIONS

1. Driver characteristics did not affect the 1974 reduction in fatal accidents.
2. Vehicle characteristics did not affect the 1974 reduction in fatal accidents.
3. Traffic-related environmental factors that influence driving conditions and travel patterns changed between 1973 and 1974.
4. All categories of accidents decreased in the study area in 1974. The number of fatal accidents and the number of total accidents had the highest relative decrease on Interstate highways.
5. Interstate highways that had speed limits of 120 km/h (75 mph) in 1973 had the largest decrease in total accident rates. Non-Interstate highways that had speed limits of 104 km/h (65 mph) in 1973 had substantially smaller decreases in injury, PDO, and total accident rates than those on Interstate highways.

Since it has been shown that, other than reduced travel and reduced speeds, no major changes took place in the study area in 1974, the accident reductions are attributed to reduced travel and speed. However, the calculated accident rates removed the effect of variations in travel. Thus, it is concluded that the reductions in fatal, injury, PDO, and total accident rates are attributable to the reduction in speeds and the greater uniformity of speeds within the traffic stream. A major finding of this research is that the reduction of fatal accidents in the study area accounted for over 92 percent of the total reduction in statewide fatal traffic accidents experienced in 1974.

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