A Method of Investigating Highway Traffic Accidents

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● THE PURPOSE of this study is the development of a methodology for determining the causes of highway traffic accidents. The study is being conducted through the Engineering Experiment Station of The Ohio State University under sponsorship of the Ohio Department of Highway Safety. This study is only part of a more comprehensive study of highway traffic accidents which is under way, and the report which follows must be considered as an interim report. Time has not permitted a complete evaluation of many of the observations and findings from the field work.

It is generally agreed that the three major factors contributing to highway traffic accidents are the driver, the road, and the motor vehicle. The premise on which this study was undertaken is that the driver is responsible for keeping his vehicle under control at all times. All other factors can then only contribute to, or detract from, the driver's ability to properly handle his vehicle.

To eliminate or control some of the many variables present in any traffic accident, such as blaming other drivers or pedestrians, this study was limited to those accidents which are classified as one-car. A one-car accident is defined as one which involves one passenger car and no other moving object, either animate or inanimate. Only passenger car accidents occurring on a county or state rural highway involving a non-commercial auto, and which were reported and investigated by the Ohio State Highway Patrol, were included.

Based on a comprehensive statistical examination of the record of all one-car accidents occurring in Ohio in 1955, the state was divided into three areas so that each area had approximately the same number of probable rural one-car accidents. During the summer of 1956 all of the rural one-car accidents occurring in each of these areas within a four-week period were investigated. Each time period was consecutive, but none of the three time periods overlapped.

The research project was divided into two phases. A team of engineers examined all of the roadway and traffic control devices which were thought to have possibly contributed to each accident, and a team of sociologists interviewed the drivers involved. An advisory board of faculty members in sociology, psychology, mechanical engineering, civil engineering, and medicine served as consultants in the development of the technique of accident investigation.

The samples used in the engineering phase, and those used in the social research phase, are not entirely the same, because all of the accident scenes were investigated, but not all of the drivers were interviewed. The highway engineering phase of the study includes a sample of 375 one-car accidents; the driver phase, as handled by the social research team, includes only 201 male drivers who were involved in one-car accidents.

The highway phase of this study is reported in a separate section of this paper, as is also that phase which concerns the driver. Another section contains the joint tentative conclusions of the authors.

HIGHWAY FIELD MEASUREMENTS

At the site of each one-car accident the following were determined:

1. Exact location of the accident and the path followed by the accident car.
2. Pavement cross-section, number and width of lanes (hereafter referred to as road type and lane width.)
3. Shoulder cross-section.
4. Safe speed.
5. Sight distance available for passing.

6. Dry pavement coefficient of friction.
7. Pavement ridability.
8. Presence of advisory speed signs and pavement marking.

Field measurements were made in approximately 375 cases by an engineering research assistant, who drove a specially-equipped new 1956 passenger car rented from the Ohio Department of Highway Equipment. Each car was equipped with an airplane ball-bank indicator (Figure 1), a calibrated Stewart Warner survey speedometer (Figure 2), and an American Automobile Association braking reaction-time device (Figure 3). In addition, each assistant had an Abney clinometer, a 50-ft tape, a small ruler, and a camera.

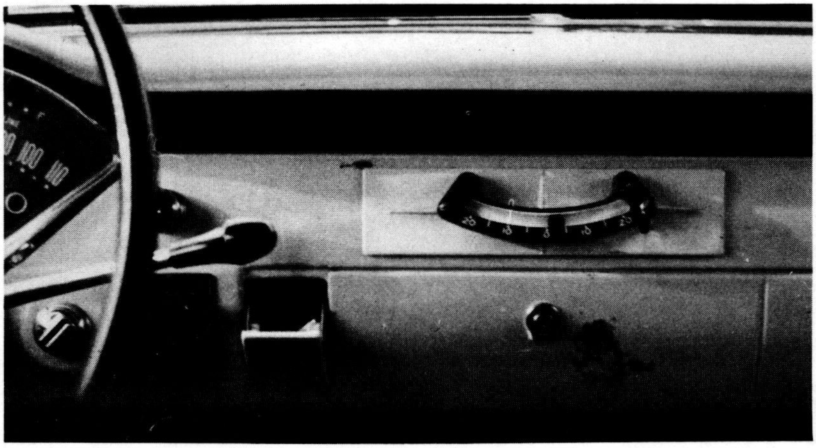

Figure 1. Airplane ball-bank indicator.

All measurements were recorded and later punched into I. B. M. cards. Photographs were obtained at each location where measurements were taken and these photographs were used as an aid to insure correct data being punched on the I. B. M. cards.

Accident Location and Road Conditions

The exact location of each accident was determined using the State Highway Patrol Report (HP-3), the survey speedometer, and, on occasion, by observance of property damage reported by the Patrol. The approach to each location (the path the accident car followed prior to the accident) was determined in the same manner. The length of approach studied was approximately one mile.

At each location the pavement cross-section and the number and width of lanes were determined by observation and measurement. This information was recorded as road type and lane width. The shoulder cross-section in each case was determined by measurement.

Determination of Safe Speed

The safe speed at each location and on the approach to each location was determined using the ball-bank indicator and the survey speedometer. The safe speed was that speed at which a reading of 10 degrees on the ball-bank indicator was observed. A reading of no more than 10 degrees is generally considered as the limiting value for safety. The average safe speed observed on three runs was recorded to the nearest 5 mph. This method is similar to the standard method of determining ball-bank safe speed (1).

Sight Distance Available for Passing

The sight distance available for passing at each two-lane road accident location was determined by measuring the most distant point on the pavement which the observer

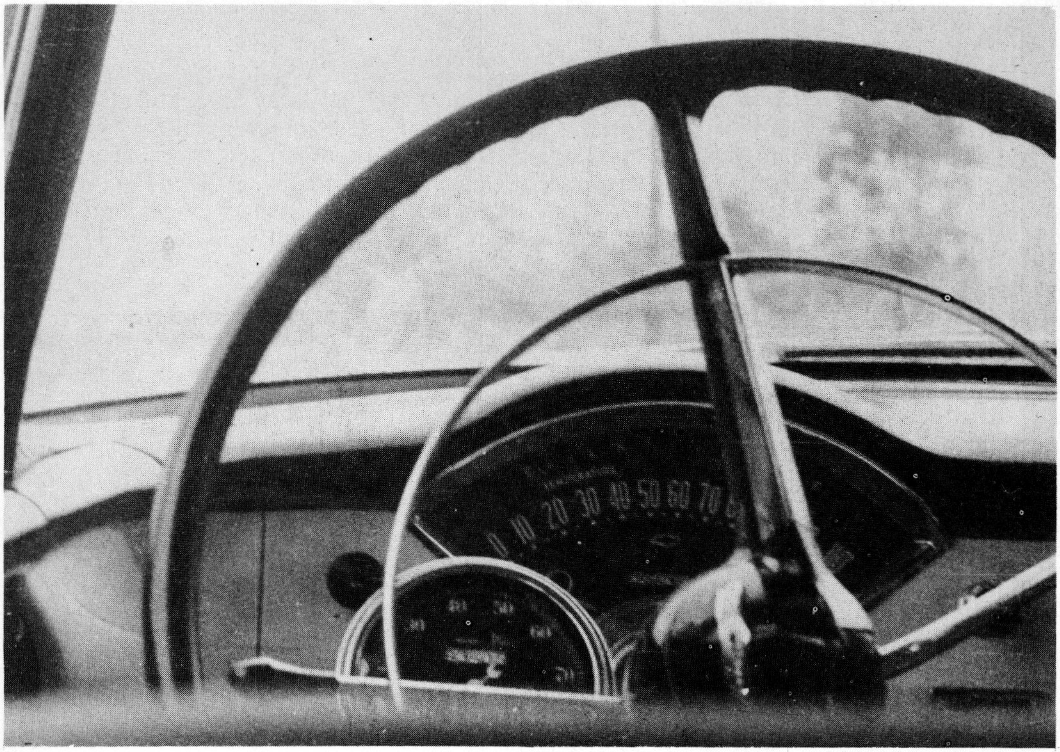

Figure 2. Stewart Warner survey speedometer.

could see clearly. The standard method of determining sight distance for passing on two-lane roads is to measure the distance an object 4.5 ft high can be seen (2). Because each observer operated independently, the method described, rather than the standard method, was used. The measured distances are approximately the same in most cases as those which would have been obtained in the standard manner. At hill crests, however, the distances are somewhat shorter than would have been obtained using the standard method (see Figure 4).

Dry Pavement Coefficient of Friction

To determine the dry pavement coefficient of friction the dry pavement braking distance at 20 mph was measured at each location. The braking distance was measured from the point where the brakes were applied, while the test car was traveling 20 mph, to the point where the car came to rest. The point where the brakes were applied was marked on the pavement by the AAA braking reaction-time device, which, mounted on the front bumper of the test car, was electrically connected to the brake pedal. It fired a blank cartridge containing dye marker the instant the brake pedal was touched. The distance from the dye spot on the pavement to the rear bumper of the test car after it had come to rest was measured and to this distance was added the length of the test car. This method is similar to one used by Whitehurst (3). Distances were roughly

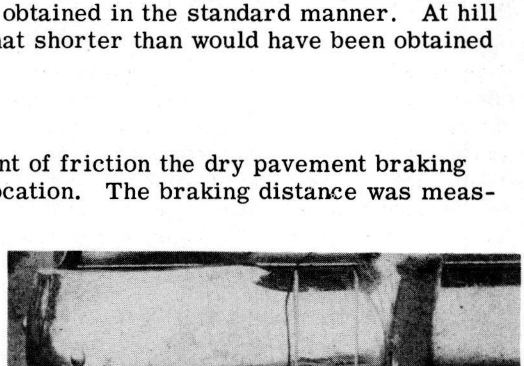

Figure 3. AAA braking reaction-time device.

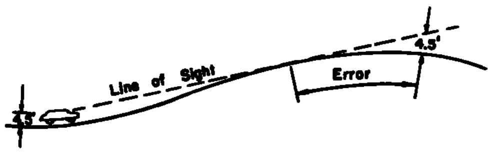

Figure 4. Error in sight distance available for passing at hill crest.

corrected for grade, which was measured with the clinometer (4). Distance corrections used for grade are as follows:

Grade, Percent	Up	Down
0 to 1½	0	0
1½ to 5	+ 1 ft	- 1 ft
more than 5	+ 2 ft	- 3 ft

Pavement Ridability

At accident locations and on the approaches to these locations the adequacy of pavement ridability was determined by observation. Pavements were considered to be inadequate when there were pot-holes, ruts, and other poor conditions present in sufficient quantity to affect the driver's control of the car.

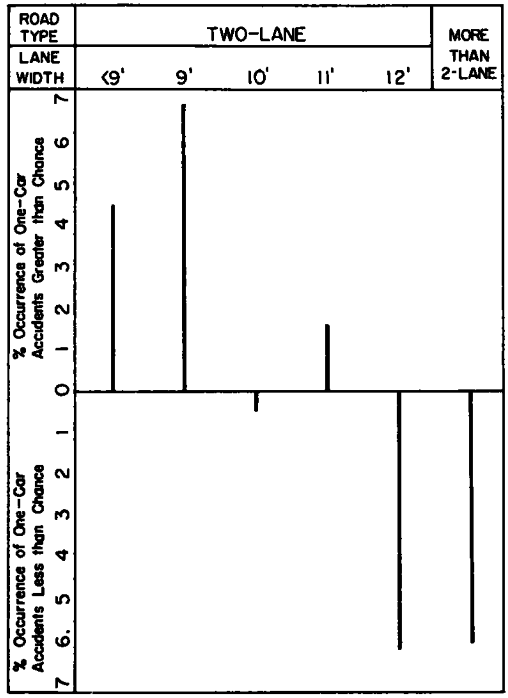

Figure 5. Occurrence of one-car accidents other than chance by number and width of traffic lanes.

Presence of Pavement Marking and Advisory Speed Signs

The presence of pavement marking and advisory speed signs was determined by observation.

Summary of Findings

The road features evaluated in the study are by no means all the features of the road which could contribute to the driver-errors causing accidents. However, because of budgetary, personnel, and time limitations, the study was restricted to the previously listed features, which were considered most important and about which reliable data were easiest to obtain.

Tables 1 and 2 contain a summary of the findings of the engineering phase of the study. In Table 2 the percentages of occurrence of rural one-car accidents on two-lane state highways and the percentages of travel on these roads are tabulated according to the shoulder widths present at the accident sites. The other features studied are tabulated in Table 1 by the number and width of traffic lanes present at the accident sites.

Table 2 shows, for example, that on two-lane roads 15.7 percent of the one-car accidents occurred on roads having 1-ft shoulders, whereas only 1.1 percent of the travel on two-lane roads occurred on these roads. Table 1 shows that 9.9 percent of the accidents occurred on two-lane roads having lane widths of less than 9 ft, whereas while only 5.4 percent of the travel occurred on these roads.

If the percentages of travel by number and width of lanes are considered the percentages of one-car accident occurrence by chance on these roads, then the actual percentages can be plotted against chance, as in Figure 5, which indicates that lane widths of less than 12 ft on two-lane roads appear to contribute to driver errors causing the accidents.

TABLE 1

SUMMARY OF FINDINGS OF ROAD FEATURES

No. of Lanes	Lane Width, ft	Percentage of Travel[a]	Occurrence of Accidents[c]	Shoulder Height at Edge of Pavement[c]		Geometrics[c]		Pavement Coef. of Friction[c,f]	Pavement Ridability[c,g]	Pavement Marking[c]		Advisory Speed Signs[c,h]
			Percent	Uneven	Lower	Safe Speed[d]	Sight Distance[e]			Not Vis	Total Missing	
2	<9	5.4	9.9	70.3	56.8	62.2	78.5	48 3	70.3	78.5	56.8	
2	9	16.9	23 8	74.2	69.6	46.1	86.5	37.7	40.5	46.1	24.7	
2	10	34.2	33.7	72.2	70.7	41.3	65.0	30.5	22 2	26 2	10.3	
2	11	8.0	9 6	66.7	30.6	47.2	55.6	45.5	16.7	19 4	8.3	
2	12	21.8	15.6	70.7	15 5	41.4	72.5	53.1	8.6	32.8	15 5	
>2	Var.	13 6	7.5	86.6	10 3	17.8	0.0	12.5	0 0	3 3	3.3	
Total	—	—	100.0	72.9	52 0	43.3	66.9	38 1	26.9	34.6	18.4	17.1

[a] Based on 1952 traffic volumes / 1956 mileage, from Ohio Dept. of Highways Bureau of Planning Survey
[b] Rural one-car accidents on state highways
[c] Percentages of those in fourth column.
[d] Compared with 50-mph speed limit.
[e] For two lanes, compared with AASHO standard for 50-mph design speed.
[f] Braking distance at 20 mph compared with AASHO standard extrapolated to 20 mph
[g] Deteriorated or inadequate pavement ridability.
[h] Absent where safe speed is at least 5 mph less than safe speed on the approach. Assumed not required when safe speed at location is greater than 45 mph.

If the percentages of travel by shoulder width on two-lane roads are considered the percentages of one-car accident occurrence by chance on these roads, then the actual percentages of accident occurrence can be plotted against chance, as in Figure 6, which indicates that shoulder widths of less than the standard partial 4-ft shoulder appear to contribute to the driver errors causing these accidents.

The standards for shoulder cross-section require that the shoulder be even with the edge of the pavement (5). Sub-standard shoulder heights were present at nearly three-fourths of all the accident locations studied. The fact that nearly seven-eighths of the accident locations, on roads having more than two lanes, had shoulders which were other than even with the edge of the pavement is somewhat surprising.

The rate of occurrence of accidents at locations having shoulders lower than the pavement edge, as might be expected, varied from least on roads having more than two lanes to most on the narrower

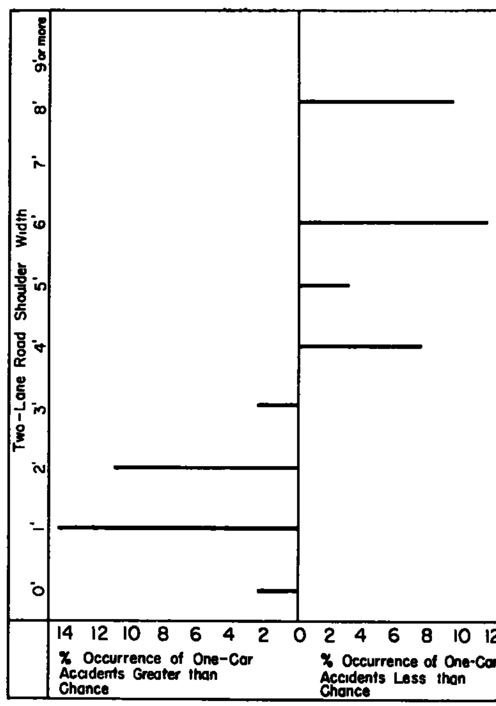

Figure 6. Occurrence of one-car accidents other than chance by shoulder width on two-lane roads.

TABLE 2

SHOULDER WIDTH FINDINGS

Shoulder Width	Travel on 2-Lane Roads,	Occurrence of Rural One-Car Accidents on 2-Lane Roads
ft	Percent	Percent
0	2.4	4.9
1	1.1	15.7
2	5.5	16.8
3	17.1	19.7
4	19.3	11.9
5	10.2	7.2
6	20.9	9.6
7	2.4	2.3
8	11.6	2.3
9+	9.4	9.6

TABLE 3

1952 OHIO AVERAGE DAILY TRAVEL, IN VEHICLF-MILES, BY SHOULDER WIDTH VS ROAD TYPE AND NUMBER OF LANES

No of Lanes	Lane Width ft	Shoulder Width 0	1	2	3	4	5	6	7	8	9 or more	Total
2	9[a]	5,098	39,348	248,981	519,116	365,892	91,734	78,524	16,237	5,171	4,850	1,374,951
2	9	3,881	51,527	527,606	1,303,390	1,187,065	556,462	480,618	75,946	67,193	33,812	4,287,500
2	10	23,957	33,770	254,754	1,510,476	1,786,866	1,061,678	2,146,097	215,469	1,064,051	555,275	8,652,393
2	11	38,613	29,983	49,306	225,337	360,899	199,278	497,913	45,396	333,030	253,852	2,033,607
2	12+[b]	453,417	92,616	111,516	188,847	529,737	317,555	1,371,078	161,675	1,067,676	1,209,663	5,503,780
> 2		-	-	-	-	-	-	-	-	-	-	3,454,978
Total		524,966	247,244	1,192,163	3,747,166	4,230,459	2,226,707	4,574,230	514,723	2,537,121	2,057,452	25,307,209[c]

[a]7- to 17-ft total pavement surface

[b]24- to 60-ft total pavement surface marked as two-lane.

[c] Two-lane total = 21,852,231.

TABLE 4

1956 OHIO RURAL STATE HIGHWAY MILEAGE BY SHOULDER WIDTH VS ROAD TYPE AND NUMBER OF LANES

No of Lanes	Lane Width ft	Shoulder Width 0	1	2	3	4	5	6	7	8	9	Total
2	9[a]	21 81	136 62	852 90	967 01	530 00	142 71	171 74	18 68	15 48	21 67	2,878.62
2	9	9 87	153 07	955.68	1,727 27	1,257 13	576 93	509 99	63 22	85 51	61 97	5 400 64
2	10	27 18	34 48	282 99	1,043 88	1,059 59	533.59	1,063 86	99 64	566 68	240 93	4,952 82
2	11	17 10	10 42	21 56	89 32	132 57	72 44	180 84	13 71	169 91	114 96	822 83
2	12+[b]	86 65	21 34	29 99	43 35	124 35	76 35	315 63	30 53	294 33	345 14	1,367 66
> 2		-	-	-	-	-	-	-	-	-	-	498 09
Total		162 61	355 93	2,143 12	3,870 83	3,103 64	1,402 02	2,242 06	225 78	1,131 91	784 67	15,920 66[c]

[a] 7- to 17-ft total pavement surface.
[b] 24- to 60-ft total pavement surface marked as two-lane
[c] Two-lane total = 15,422.57.

two-lane roads. The percentages of occurrence at locations having shoulders higher than the pavement edge can be obtained by subtraction. The shoulder height data are given in Table 5.

Two standards of comparison for minimum geometrics were used. First, the ball-bank safe speed at the accident locations was compared with the 50-mph speed limit in effect when the accidents occurred. All locations having a safe speed at least 5 mph less than the 50 mph speed limit were assumed to be sub-standard. On this basis, sub-standard geometrics were present in more than 40 percent of the locations studied. The breakdown by road type and lane width appears in Tables 1 and 6.

Finally, the passing sight distance was compared with the AASHO standards for 50-mph design speed (6). Sub-standard geometrics, on this basis, were present in approximately two-thirds of the cases. Tables 1 and 7 contain the rates of occurrence by road type and lane width.

In Table 8 the braking distances observed at the accident locations are listed by braking distance, road type, and lane width. These distances were observed at 20 mph on dry pavement and are corrected for grade as previously discussed. The AASHO coefficients of friction for design (6) were used for a standard of comparison. The design values of coefficient of friction are plotted and extrapolated to 20 mph in Figure 7. From these curves the minimum coefficient of friction for a speed of 20 mph on dry pavement was determined to be 0.64 and the corresponding maximum braking distance was calculated to be 20.8 ft (9, 10).

Sub-standard pavement coefficients of friction were present at nearly 40 percent of the accident locations studied. The percentages of occurrence of this feature are tabulated by number and width of lanes in Table 1. It should be noted that the rate is markedly lower on roads having more than two lanes. The data indicate that nearly three-fifths of the accident locations which had sub-standard pavement coefficients of friction had pavements which were otherwise adequate.

As has been previously stated, pavement ridability at accident locations was considered inadequate (or sub-standard) when the pavement surface was deteriorated.

Slightly more than one-quarter of the accident locations had sub-standard ridability characteristics. Table 1 shows the breakdown by road type and lane width. The IBM tabulation of the data appears in Table 10.

Comparisons of the ridability at the accident locations with the ridability on the

TABLE 5

SHOULDER HEIGHT AT PAVEMENT EDGE AT ACCIDENT LOCATION VS ROAD TYPE AND LANE WIDTH

No. of Lanes	Lane Width, ft	Shoulder Height at Pavement Edge, in. Higher 6	4-6	2-4	0-2	Even	Lower 0-2	2-4	4-6	6	No Curb or Shoulder	Total
2	<9	2	-	2	1	11	15	5	-	-	1	37
2	9	-	-	1	3	23	48	10	-	-	4	89
2	10	-	1	-	1	35	66	13	4	4	2	126
2	11	-	-	-	1	12	20	3	-	-	-	36
2	12+	4	-	1	3	17	24	7	-	1	1	58
>2	-	8	1	-	-	4	13	2	1	-	-	29
Total		14	2	4	9	102	186	40	5	5	8	375

TABLE 6

BALL-BANK SAFE SPEED AT ACCIDENT LOCATIONS VS ROAD TYPE AND LANE WIDTH

No. of Lanes	Lane Width, ft	Ball-Bank Safe Speed, mph 0	10	15	20	25	30	35	40	45	50	55	60+	Total
2	<9	-	2	-	1	7	4	4	4	1	2		12	37
2	9	2	1	3	3	5	6	8	10	5	7		39	89
2	10	1	2	3	3	10	13	9	8	4	2	5	66	126
2	11	-	-	-	-	4	7	1	4	1	1		18	36
2	12+	4	-	1	2	4	6	3	5	3	1	2	27	58
>2	-	-	-	-	-	-	2	2	1	-	2		21	28
Total		7	5	7	9	30	38	27	32	14	15	7	183	374

TABLE 7

PASSING SIGHT DISTANCE AT ACCIDENT LOCATION VS ROAD TYPE AND LANE WIDTH

No. of Lanes	Lane Width ft	0.07 or less	0.70-0.08	0.09-0.12	0.13-0.24	0.25-0.31	0.32-0.37	0.38-0 43	0 44-0.54	0.54 or more	Total
2	<9	4	4	7	10	4	1	3	-	4	37
2	9	10	9	20	29	9	3	3	2	4	89
2	10	4	14	15	37	12	14	8	6	16	126
2	11	2	1	3	8	6	2	2	4	8	36
2	12+	2	2	8	22	8	1	1	1	13	58
>2	-	-	-	-	-	-	-	-	-	28[a]	28
Total[b]		22	30	53	106	39	21	17	13	73	374

[a] 2-lane passing sight distance not applicable.
[b] Sample not large enough for further breakdown.

TABLE 8

BRAKING DISTANCE AT ACCIDENT LOCATION

No of Lanes	Lane Width ft	20-mph Braking Distance, ft. <18	18	19	20	21	22	23	24	>24	Total
2	<9	5	2	2	6	1	3	3	5	2	29
2	9	3	12	15	8	8	6	2	6	1	61
2	10	9	24	17	14	8	7	3	5	5	92
2	11	4	3	2	3	1	4		4	1	22
2	12+	2	8	2	3	8	3	4	1	1	32
>2	-	1	1	2	3	-	-	1	-	-	8
Total	-	24	50	40	37	26	23	13	21	10	244

TABLE 9

BRAKING DISTANCE AT ACCIDENT LOCATION VS PAVEMENT RIDABILITY AT ACCIDENT LOCATION

Pavement Ridability	20-mph Braking Distance, ft									
	<18	18	19	20	21	22	23	24	>24	Total
Adequate	18	46	32	24	20	14	6	10	6	176
Inadequate	6	4	8	13	6	9	7	11	4	68
Total	24	50	40	37	26	23	13	21	10	244

approaches and the visibility at the times of the accidents were also made. These comparisons tend to support the theory that change in conditions rather than the conditions themselves, affect drivers. From Table 11 it appears that nearly one-fifth of the accident locations having sub-standard ridability characteristics probably could not have been anticipated by the drivers involved, because the ridability was satisfactory until a short distance before the accident locations. Somewhat more significant is the fact that nearly two-thirds of the accidents occurring at locations having sub-standard ridability characteristics occurred at times of reduced visibility (night, rain, or fog) as reported by the Patrol (see Table 12.)

TABLE 10

PAVEMENT RIDABILITY VS ROAD TYPE AND LANE WIDTH AT ACCIDENT LOCATION

No. of Lanes	Lane Width ft	Pavement Ridability		
		Adequate	Inadequate	Total
2	<9	11	26	37
2	9	53	36	89
2	10	98	28	126
2	11	30	6	36
2	12+	53	5	58
>2	-	30	0	30
Total		275	101	376

TABLE 11

PAVEMENT RIDABILITY ON APPROACH VS AT ACCIDENT LOCATION

Pavement Ridability at Accident Location	Pavement Ridability on Approach		
	Adequate	Inadequate	Total
Adequate	262	13	275
Inadequate	20[a]	81	101
Total	282	94	376

[a] 19.8 percent of accident locations having inadequate pavement ridability probably could not have been anticipated by the drivers involved.

TABLE 12

VISIBILITY VS PAVEMENT RIDABILITY AT ACCIDENT LOCATION

Pavement Ridability at Accident Location	Visibility		
	Normal Daytime	Reduced	Total
Adequate	84	191	275
Inadequate	35	66[a]	101
Total	119	257	376

[a] 65.4 percent of accident locations having inadequate pavement ridability probably could not be seen by the driver due to reduced visibility.

TABLE 13

PAVEMENT MARKING AT ACCIDENT LOCATION VS ROAD TYPE AND LANE WIDTH

No. of Lanes	Lane Width ft	Marking				
		Clear	Partially Worn-off	Totally Worn-off	None	Total
2	<9	8	8	5	16	37
2	9	48	19	7	15	89
2	10	93	20	3	10	126
2	11	29	4	2	1	36
2	12+	39	10	3	6	58
>2	-	27	2	0	1	30
Total	-	244	63	20	49	376

Lack of pavement marking at accident locations was assumed to be a contributive feature of the road in one-car accident causation. Table 13 shows that pavement markings were not clear at more than one-third of the accident locations. Markings were totally missing at nearly 20 percent of the locations. The breakdown by road type and lane width appears in Table 1.

Advisory speed signs were assumed to be required at all locations having a safe speed at least 5 mph less than the safe speed on their approaches. No advisory was assumed to be required where the safe speed at an accident location exceeded 45 mph.

More than one-sixth of the locations requiring advisory speed signs did not have them (Table 14). However, Table 15 indicates that nearly one-eighth of the locations not requiring advisory speed signs nevertheless had them.

THE DRIVER

As previously mentioned, the objective in this study was to attempt to develop an adequate method of research into the causes of one-car accidents. Because it was assumed for the purposes of this study that the driver was primarily responsible for all automobile accidents, the sample was chosen as those one-car accidents in which there were no animals, pedestrians, or other factors involved, to even a secondary degree, other than the road and the auto. In this way it was felt that it would be easier to control to some extent the driver's putting the responsibility on these other factors.

From the standpoint of the social researcher the main concern was getting background material on the driver, along with his stoty of the accident. The emphasis was upon his opinions, ideas, evaluations, and reactions so that the accident might be seen as he saw it and an understanding obtained as to how he felt about it, as well as determining his over-all concept of himself as a driver.

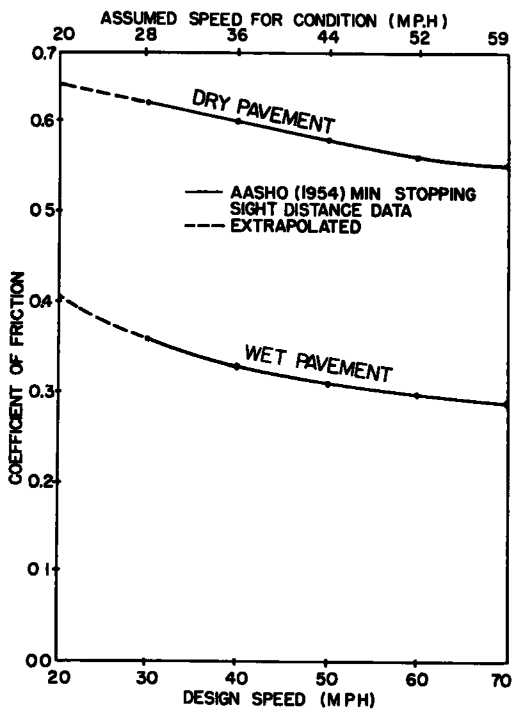

Figure 7. Pavement coefficient of friction vs design and assumed speed.

TABLE 14

SAFE SPEED ON APPROACH VS AT ACCIDENT LOCATION
(No Advisory Speed Sign Posted)

Safe Speed[a] at Accident Location, mph	Safe Speed,[a] mph											
	10	15	20	25	30	35	40	45	50	55	60	Total
10	-	-	-	-	-	-	-	-	-	-	5	5
15	-	-	-	-	1	-	-	-	-	-	1	2
20	1	1	-	1	-	-	-	-	1	-	3	7
25	1	1	1	3	3	1	1	1	-	-	4	16
30	-	1	-	2	3	3	3	1	2	1	4	20
35	-	-	2	3	5	-	3	1	-	-	2	16
40	-	-	2	-	-	2	5	8	3	1	6	27
45	-	-	-	1	-	-	4	1	1	-	4	11
50	-	-	-	1	-	2	-	3	-	-	7	13
55	-	-	-	-	-	1	-	-	-	-	5	6
60	1	1	3	6	-	6	5	3	3	2	134	164
Total	3	4	8	17	12	15	21	18	10	4	175	287

[a] By ball-bank indicator.

TABLE 15

SAFE SPEED ON APPROACH VS AT ACCIDENT LOCATION
(Advisory Speed Sign Posted)

Safe Speed[a] at Accident Location, mph	Safe Speed,[a] mph											
	10	15	20	25	30	35	40	45	50	55	60	Total
0	-	-	-	-	-	2	-	-	-	-	5	7
10	-	-	-	-	-	-	-	-	-	-	-	0
15	-	-	-	-	-	-	-	-	-	-	5	5
20	-	-	-	-	-	-	-	-	-	-	2	2
25	-	-	1	1	4	1	2	1	-	1	2	13
30	-	-	-	-	-	4	4	1	-	1	8	18
35	-	-	-	-	2	2	2	1	1	-	3	11
40	-	-	-	1	-	-	1	-	-	1	2	5
45	-	-	-	-	-	-	-	-	1	-	2	3
50	-	-	-	-	-	-	1	-	-	-	1	2
55	-	-	-	-	-	-	-	-	-	-	1	1
60	-	-	-	-	-	2	3	2	1	-	12	20
Total	0	0	1	2	6	11	13	5	3	3	43	87

[a] By ball-bank indicator.

Since the interest was in getting the driver to tell his story of the accident, considerable time was spent in developing a method of contacting and interviewing the driver that would be confidential and reassuring, yet informative. The four interviewers were carefully trained in terms of their interpretation of the study to the driver, and particularly their approach to, and administering of, the schedule itself. The concern throughout the study was to make as certain as possible that the driver understood

TABLE 16

RESULTS OF RESPONSES TO DRIVER CONCEPT QUESTIONS ACCORDING TO FOUR AGE GROUPINGS OF 201 MALE ONE-CAR ACCIDENT DRIVERS

Driver Concept Questions	Age Groupings									
	16-19		20-29		30-39		40+		Total	
Dr. opinion of driving ability as indic. scale	No.	%	No.	%	No.	%	No.	%	No.	%
Better than average	29	46.8	43	70.5	22	68.7	36	78.3	130	64.7
Average or less	32	51.6	18	29.5	10	31.3	10	21.7	70	34.8
No response	1	1.6							1	.5
Total	62		61		32		46		201	
Dr. opinion of chance of same accident again										
Maybe	19	30.6	17	27.9	12	37.5	21	45.7	69	34.3
Don't know	7	11.3	8	13.1	4	12.5	4	8.6	23	11.4
No	35	56.5	36	59.0	14	43.8	21	45.7	106	52.7
Other	1	1.6			2	6.3			3	1.6
Total	62		61		32		46		201	
Dr. estimate of amount alcohol can drink and drive										
None	52	83.8	37	60.7	8	25.0	28	60.9	125	62.2
2 ounces or less	5	8.1	9	14.8	6	18.8	5	10.9	25	12.4
Over 2 ounces	5	8.1	12	19.7	18	56.2	11	23.9	46	22.9
No response			3	4.9			2	4.4	5	2.9
Total	62		61		32		46		201	
Dr. insight as to need to improve dr. habits										
Needs impr. and know how	46	74.2	39	63.9	19	59.4	18	39.1	122	60.7
Needs impr. but doesn't know how can achieve	14	22.6	20	32.8	11	34.4	21	45.7	66	32.8
Other	2	3.2	2	3.3	2	6.2	7	15.2	13	6.5
Total	62		61		32		46		201	
Dr. determination of cause of the accident										
Self	42	67.7	31	50.8	16	50.0	16	34.8	105	52.2
Road	9	14.5	12	19.7	8	25.0	11	23.9	40	19.9
Auto or other driver	9	14.5	16	26.2	6	18.8	16	34.8	47	23.4
Don't know	2	3.2	2	3.3	2	6.2	3	6.5	9	4.5
Total	62		61		32		46		201	

the objective of the study, and that he felt in no way under duress or pressure, but that he was responding of his own volition and desire. In this way it was hoped to get a true and fairly accurate picture of the accident and, at the same time, the opinions and reactions of the driver.

Rating Scale

Throughout the schedule there were questions in which the driver was requested to give his own evaluation or opinion on a scale designed to lend more objectivity to the response. Twice the driver was asked to rate his driving ability as compared to other drivers; once as he himself would rate it, and then again later, as he thought others would rate him. In each case he was asked to give his verbal opinion first before using the scale, so that we could in some way measure the difference, if any.

TABLE 17

RESULTS OF RESPONSES TO DRIVER CONCEPT QUESTIONS ACCORDING TO MARITAL STATUS OF 201 MALE ONE-CAR ACCIDENT DRIVERS

Driver Concept Questions	Marital Status of the Drivers							
Dr opinion of driving ability as indic. scale	Married		Single		Other		Total	
	No.	%	No.	%	No.	%	No.	%
Better than average	70	77.7	53	53.5	7	58.3	130	64.7
Average or less	20	22.3	45	45.5	5	41.7	70	34.8
No response			1	1.0			1	.5
Total	90		99		12		201	
Dr. determination of the cause of accident								
Self	38	43.2	58	58.6	9	75.0	105	52.2
Road	19	21.1	20	20.2	1	8.3	40	19.9
Auto or other driver	28	31.1	17	17.2	2	16.7	47	23.4
Don't know	5	3.6	4	4.0			9	4.5
Total	90		99		12		201	

TABLE 18

RESULTS OF RESPONSE TO DRIVER CONCEPT QUESTIONS ACCORDING TO ARRESTS FOR TRAFFIC VIOLATIONS FOR 201 MALE ONE-CAR ACCIDENT DRIVERS

Driver Concept Question	Amount of Traffic Arrests of Drivers					
Dr estimate of amount of alcohol can drink and drive	None		Some		Total	
	No.	%	No.	%	No.	%
None	65	69.9	60	55.6	125	62.2
2 ounces or less	10	10.8	15	13.9	25	12.4
Over 2 ounces	14	15.0	32	29.6	46	22.9
No response	4	4.3	1	0.9	5	2.9
Total	93		108		201	

TABLE 19

RESULTS OF RESPONSE TO DRIVER CONCEPT QUESTIONS ACCORDING TO PERSONALITY TYPE OF 201 MALE ONE-CAR ACCIDENT DRIVERS AS EVALUATED BY INTERVIEWERS

Driver Concept Questions	Personality-type of driver					
Dr. opinion of chance of same accident again	Normal		Other than Normal		Total	
	No.	%	No.	%	No.	%
Maybe	61	40.4	8	19.0	69	34.3
Don't know	16	10.1	7	16.7	23	11.4
No	81	50.9	25	59.5	106	52.7
Other	1	0.6	2	4.8	3	1.6
Total	159		42		201	
Dr. opinion of driving ability as indic. scale						
Better than average	109	68.6	21	50.0	130	64.7
Average or less	50	31.4	20	47.7	70	34.8
No response			1	2.3	1	0.5
Total	159		42		201	

The scale was made of clear plastic and had no markings on it other than two words at opposite ends: "WORST" on the left and "BEST" at the right. The driver was instructed to place the marker at the point on the scale which would come closest to his own opinion or evaluation. Other than that, no further instructions were given. There was purposely no midpoint or "average" on the scale, as it was felt that most persons tend to place themselves in this category verbally, and they might do the same if the scale was designed that way.

This, in a sense, gave the driver an opportunity to put down his true or honest opinion without being concerned about language, which might be more subjective. It was felt that semantics must be considered and quite possibly the same words mean different things to different people. Also, it is possible for the tone of voice or the inflection of a word or phrase to carry an entirely different meaning than is found in the dictionary. The scale was a means of being more objective and at the same time providing an easy and fairly uniform way of expressing opinions.

By having the driver give his opinion, and that of others, it was hoped to provide him with an opportunity to do some projecting. That is, he could safely and comfortably say what he really wanted to say by claiming it was someone else's opinion and not necessarily his. This, it was felt, was important in this study, because all of these drivers could be expected to be a bit on the defensive about their accidents.

The scale was designed so that an overlay scale with the numbers one through seven could be placed along side of it and the number tabulated after the driver had moved the indicator to the desired spot. The driver was not able to observe this operation, and this gave the interviewer an opportunity to tabulate the number which later was interpreted as follows, reading from left to right: 7, worst; 6, poor; 5, fair; 4, average; 3, good; 2, very good; and 1, best.

Definitions and Delimitations

Amount of alcohol driver estimated he could consume. The driver was asked "How much beer, whickey, wine, etc., do you think you can drink before it would affect your driving?" The amount then was converted into ounces of alcohol using the volume and the percentage of alcohol contained in the particular beverage. This was done on a rather general basis. For instance, all whiskeys were considered to be 100 proof, therefore 50 percent alcohol, so one shot would be comparable to a ½ ounce of alcohol. This is not considered completely accurate, but as an estimate only. Therefore, 2 ounces, or less, was comparable to four beers or shots.

Responsibility for the one-car accident. Here the driver was not asked directly who or what he thought caused the accident. Rather, the question was phrased as follows: "How do you think that this accident might have been prevented?" If he indicated that he made some definite error which actively contributed to the accident, or if it came out that some aspect of the variables which were under the driver's control were not handled in such a way as to prevent the collision, he was considered responsible. This means that, either by contributing positively or by failing to prevent the accident, the driver was responsible. This delineation was based on the one used by Ross A. McFarland in his report, "The Development of Procedures for Detecting Accident Repeaters." If the driver indicated that the highway design, construction, signing, etc., was at fault this was classified as "road" in terms of responsibility. When the weather, the other driver, or the auto was deemed by the driver to be the cause of the accident the responsibility was placed in the "other" category.

Although 243 complete and valid interviews were obtained, only 201 were used for this phase of the study. The 42 that were not used were all women drivers who were involved in one-car accidents. The remaining 201 were all men drivers. Women were not included because they may not have been representative numberwise yet due to the sex factor they would have influenced the results. Findings on women drivers will be included in the final phase of this study as a comparative group.

Because the entire interviewing situation was aimed towards getting the true feeling and evaluation of the driver, there was no attempt to interview anyone who resisted or refused. In other words, the entire sample of drivers represents only those drivers here would probably be due to chance only 5 percent of the times. The chi squares were, in each case, greater than the necessary value for the various degrees of freedom needed in each of the tables. For the sake of consistency and to facilitate ease in reading the tables, the general sample of the 201 drivers has been used. However, when the chi square check was made each of the net samples was used.

Results of Driver Concept Compared to Background Factors

There was found to be no relationship between the following background factors and driver concept: community size, number of jobs in past five years, job tenure, and method of learning to drive. The most significant findings were, as might be expected, in the comparison with age. In each case there was indication that how a driver views himself and the accident might be influenced by his age.

Driver concept and age. It was found that for opinions as to their general driving ability the younger drivers (that is, those in their teens) tend to rate themselves as average or worse, whereas older drivers think of themselves as better than average. Those 40 years of age and older appear to think of themselves as better than any of the others, with the 20-year-olds following close behind.

When asked about the possibility of having another accident, the younger drivers are more certain that they will not have another one. The 20-year-olds were a little more certain than the teenagers; the 30-year-old group was next; and those the least certain were those over 40, who felt that they had about a 50 percent chance for another such accident.

When asked to estimate the amount of alcohol they can drink before it will affect their driving ability, the teenagers said that they should not and/or could not drink anything and drive safely, whereas the 30-year-olds strongly believe they could imbibe more than four beers or shots of whiskey (approximately more than 2 ounces) and still manage to drive safely. The 20-year-old group and those over 40 agreed that about 60 percent of the time they cannot drink and drive.

The teenagers strongly believe that their driving habits can be improved. Conversely, the older drivers (those over 40) are satisfied with their driving as it is or maintain that they do not know how they can better their driving ways. This could be a matter of insight or self-evaluation on the part of the driver and might indicate a lack of knowledge of their own driving habits and/or what good driving habits are.

Again, the indications are that the younger driver, particularly the teenager, differs considerably from the older driver. The driver over 40 believes that his accident was not due to any error or lack of proper preventive action on his part, despite the fact that 95 percent of these accidents were considered to be the driver's fault primarily. Those drivers between 16 and 19 years of age took the responsibility for the accident in nearly three cases out of four. The other age groups responded as did the general sample.

Driver concept and marital status. When asked to show how they rate themselves on the scale as to their driving ability, it was noted that the single man believes less often than the married man that he is about average as a driver. The married men must feel fairly confident of their driving skills, as they said that for the most part (77.7 percent) they are better than average.

In the matter of determining responsibility for his one-car accident, the married driver places the blame on the road and other factors (the auto and other drivers) in more than one-half the cases. The bachelor accepts the responsibility in most of the cases.

It should be noted that 34 percent of the married men are under 30 years of age, whereas 90 percent of the single men are in this age category. It may be that age is a factor causing the variation in the results, rather than the marital status.

Driver concept and amount of alcohol consumed before accident. Of the five driver concept questions, only two appeared to have any relationship when compared with the amount of alcohol consumed on the trip. Those who drank on the trip were considerably more uncertain about their chances for having a similar accident, because 22 percent of them said they did not know about this compared to only 7 percent of the nonwho were willing to talk about their accident experiences and other matters concerned with their driving history and such. It was possible to get response from approximately 40 percent of those who were involved in one-car accidents during the time of the study. A remaining 10 percent were responsive to questionnaires sent to them, which made a total of 50 percent response of all those involved. Therefore, this sample of 201 drivers is not necessarily representative of one-car accident drivers, but only those who were willing and able to talk to the investigators. Those who were injured were seen at home, often in a convalescent stage; but no attempt was made to get data on those who were killed.

Method of Determining Driver Concept of Self

Means of contacting and interviewing. A letter of interpretation was sent to each driver within ten days after the accident, requesting an appointment for an interview. The interviewer spent as much time with each driver as was necessary to establish a good friendly relationship. The purpose of this was to develop a feeling of confidence and relaxation on the part of the driver so that a more accurate picture of his real feelings, opinion, and attitudes about the accident, his driving ability, habits, and behavior could be obtained. The investigators were encouraged by the results, because in many cases the drivers confided to the interviewers a great deal more meaningful material about themselves and the accident than the accident report indicated.

Preliminary study: Two separate pilot studies were conducted prior to the actual study to develop the schedule, revise it and to learn the best method of operating in the field. Even before the schedule was pilot tested it was revised three times with the aid of an advisory group of engineers, sociologists, and psychologists. The schedule that finally evolved consisted of a total of 82 statements covering the driver's information on the accident and background material on himself, and contained the five driver concept questions.

Concept Questions and Selected Background Material

The five questions excerpted from the general One-Car Accident Study schedule covered the following information:

1. Driver's opinion of his ability as a driver compared to other drivers, as shown by him on the scale.
2. Driver's opinion of the probability of the recurrence of a similar accident.
3. Driver's estimate of the amount of alcohol he can consume before it affects his driving ability.
4. Driver's insight as to the need of improving his driving habits and how this might be done.
5. Driver's determination of cause of the accident.

In an effort to determine if there was any relationship between how a driver sees himself and the data collected on him, a comparison was made of responses to the concept questions and some general and specific data on his background material. The material used for this included the following:

1. Age of the driver.
2. Marital status.
3. Education.
4. Size of community in which he resided.
5. Traffic arrest history.
6. Personality type of the driver as evaluated by the interviewer.
7. Number of full-time jobs in the past five years.
8. Job tenure on present job.
9. Method of learning to drive.
10. Amount of alcohol consumed within 6 hr prior to accident.

The chi square test of association was run on each of these combinations to determine if there was any statistically significant relationship between the concept questions and the background factors. Fourteen of these combinations were found to be statistically significant at the 5 percent level, which means that any differences shown drinking drivers who disclaimed any knowledge. Yet more of the non-drinking drivers than those who drank said that it is possible that they might have an accident. About 7 percent more of the non-drinkers than of the drinking drivers were sure that they would not have another similar mishap.

On the question about their estimation of amount of alcohol they can consume before it affects their driving, the non-drinkers were overwhelmingly convinced that they should not or could not imbibe and drive without it bothering them in the operation of the vehicle. Almost the reverse is true of those who drank on the trip. These men are quite sure they can hold their drinks and drive, in fact well more than one-half of them stated that they can take more than four shots of whiskey or four bottles of beer without effect on their driving ability.

Driver concept and traffic arrest history. Of those drivers who had no arrest history for traffic violations it was found that they are generally of the opinion that they shouldn't, or possibly couldn't, drive and drink without the drinking negatively affecting the performance of their driving. Considerably fewer of them (15 percent) believe they can take more than four beers or shots without adverse effect, whereas twice as many (30 percent) of those with some traffic arrests think that they can.

Driver concept and education of the driver. It is interesting, and possibly significant, to note that there is a direct correlation between the amount of education a driver has and his recognition of how he can improve his driving habits. Those with an elementary education (44 percent) for the most part do not know how they can improve, but do believe they need improvement in more than 85 percent of the cases. Ninety percent of the drivers who had post-high-school education believe they need improvement, and in three cases out of four they made suggestions as to how this might be done—that is by driving slower, using hand signals, etc.

In terms of placing responsibility for the accident, it appears as though the drivers with the elementary education are less likely to accept it for the accident than those who attended high school. However, the sample is so spread out in the post-high-school-educated group that the results are not considered meaningful.

Driver concept and personality type of driver as evaluated by interviewer. Of the 201 male drivers, 42 were considered as either withdrawn, conforming, or aggressive by the interviewers. When compared against the "normal" group the results on the driver opinion scale are quite interesting. Those in the "normal" group are inclined to place themselves in the better category considerably more often than those who were described as other-than-normal. Only one-half of the other-than-normal group considered themselves as better, as compared to the normal who rated their driving ability above average in 68. 6 percent of the cases.

In the matter of the possibility of having another similar accident, the other-than-normal drivers think the chances not too good that they would do so. They were certain in 60 percent of the cases that they would never get into such a mishap again, but only one-half of the "normal" group said that they wouldn't be involved again in a one-car accident.

Summary of Findings and Conclusions

It would seem that the teenagers view themselves as only mediocre drivers who could improve their driving habits, but they don't think they can drink and drive safely. In regard to their one-car accidents the younger drivers blame themselves, but don't think they are likely to make the same mistake again. The driver who is over 40 feels that the responsibility for the accident is due the road and, primarily, the auto and other drivers, even though nearly all of these accidents were selected because they were at least 95 percent driver caused. Apparently, since the older driver puts the blame on others, he is of the opinion that such a mishap may occur again because it is more or less "out of his hands." This is, perhaps, a fatalistic type of thinking. In line with this type of defensive thinking, the older drivers see themselves as better drivers, in most cases, than other drivers on the road. Also, they seem to realize that they could improve their driving habits, but they don't know how in most cases. Those over 40 are rather conservative, compared with the 30- to 39-year-olds, when it comes to drinking and driving. Here the 30-year-olds show a definite opinion that they can consume considerably more alcohol than other drivers before it affects their safe operation of the auto.

From the findings to date there appears to be some possible connection between the driver's marital status and two concept questions. The married men are more inclined to have a higher opinion of their ability to drive and are more likely to believe that the road, auto, or other driver was responsible for their one-car mishaps. But this may be due more to age than marital status.

Those drivers who did drink within 6 hr before the accident seem to be a bit more uncertain about the possibility of this type of accident occurring to them again than do the non-drinking drivers. As might be expected, the trip drinking drivers believe they can safely drive and drink more often than those who didn't imbibe on the trip.

The more education a driver has the more inclined he is to be aware of how to improve his driving habits. Those drivers who had only elementary schooling took less personal responsibility for the accident than did the driver with the 9th to 12th grade education.

Personalities of the drivers, as seen by the interviewer, seemed to have some effect on the driver's concept of himself regarding his driving ability and his opinion of the chance of having a similar accident in the future. The "normal" personality said that his chances are about fifty-fifty, and he thinks of himself as a better driver more often than does the driver who appeared to be "other than normal."

The driver who was arrested on traffic violations thinks that he can drink and drive, more so than the non-arrested driver.

It would seem that from the standpoint of the general study dealing with the driver, there have been some fairly encouraging results as far as being able to develop a confidential approach and personal interviewing technique. The drivers who were contacted and interviewed were, for the most part, apprehensive, and in some cases fearful of the consequences of participating in the study. Therefore, it was rather surprising that they were willing to confide as much material to the interviewers as they did. It would appear that by giving the driver a chance to tell his own story, assisted by a trained and skillful interviewer, much valuable information may be obtained concerning causes of particular accidents, as well as being able to find a yardstick for measuring the driver's emotional, intellectual, and sociological make-up and the possible relationship between these factors and the accident.

It may well be, if this sort of approach were used to get a better picture of the general driving public, it might give some interesting and hopefully significant data about the man behind the wheel. If an effective program of accident prevention based on the education of the driver is ever to be attained more must be known about what sort of individual he is. This, it is believed, can be done if the driver is approached properly and if the interviewing situation is one in which the driver is "sold" on the idea that he is an important person who has something important to tell.

As for the concept question phase of this study, it is not yet feasible to draw any definite conclusion because of the many obvious unknowns. It appears that the interviewers were able to get some rather interesting responses from the drivers on the questions asked, but in view of the limited and somewhat selective nature of the sample it would not be practical to do anything other than suggest that such a technique may have merit. It might be utilized as a sort of test to measure driver insight or awareness of self of the general driving public.

CONCLUSIONS

If any reduction is to be made in the terrible price which the citizens of the United States are paying in terms of lives and property damage due to highway traffic accidents, a vigorous and continuous program of research into traffic accidents is vital. Regardless of how the highway engineer looks at the cause of highway traffic accidents, it is still the driver who is going to cause or avoid the accident. Therefore much more research is needed in the behavior of the driver as he operates the automobile on the road.

The method employed in this study, that of interviewing the drivers who have survived one-car accidents, seems to produce factual and reliable results. Studies of many more cases with evaluation of variables, and with correlation of the conditions of the roadway as evaluated by the engineer, are needed before conclusions can be drawn as to the cause of one-car accidents. The only conclusion which can be drawn at this time is that the methodology described here gives promise of producing desired information.

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