Single-Vehicle Accidents on Route 66

J. STANNARD BAKER, Traffic Institute, Northwestern University

•THIS study was part of the Operation 66 Joint Engineering Enforcement Project conducted in the summer of 1964 by the Office of Highway Safety, U. S. Bureau of Public Roads and the seven states on Route 66 between Chicago and Los Angeles (Fig. 1).

To gather information, the highway patrols of the seven states used a special form to supplement each state's official accident report. A copy of the official highway patrol report for each accident was also obtained, except for Texas accidents.

Qualifying accidents outside of incorporated places between San Bernardino, California, and Joliet, Illinois, were reported. Most of the route was on sections of I-15, 40, 44 and 55. The remainder was on US 66. Accident data were collected between June 1 and October 31, 1964. Traffic volumes by hour and type of vehicle were counted during one or more week days, at intervals of approximately 150 miles.

Except for completing the supplementary report, each highway patrol followed its usual reporting procedure for the single-vehicle accidents. The procedures were not exactly the same. It may be, therefore, that some states reported a greater proportion of minor accidents than others.

Data collection was planned to require no more than an additional hour for the investigator to record the supplementary single-vehicle accident information. Hence, no claim can be made that accidents were investigated in depth. A 37-page instruction manual was provided for the supplementary form. Each reporting officer was supposed to receive from a supervisor a day's instruction in this special work.

There have been other studies of single-vehicle accidents, notably a continuing one by the California Highway Patrol (1). It is mainly a statistical treatment of biographical data, accumulated violations and accident experience of involved drivers. Contributing factors are listed.

ACCIDENTS REPORTED

For the purpose of this study, supplementary reports were required for four standard types of motor-vehicle traffic accidents:

1. Collision on road with parked motor vehicle,
2. Collision on road with fixed object,
3. Overturned on road, and
4. Ran off road.

For this study, the road was defined as including both pavement and shoulder.

From the four types of accidents reported, those in which there was a supported claim that a non-contact motor vehicle encroached on the path of the vehicle directly involved or otherwise clearly influenced its behavior were eliminated.

A total of 951 accident reports was received. Of these, 12 were not used because they were other than the specified four types; 89 more were eliminated because non-contact vehicle involvement was well supported. This left exactly 850 reports to be tabulated.

Of the 850 single-vehicle accidents, only 17 or 2.0 percent were fatal (Table 1). This gives a severity ratio of 21.8 injury and 26.3 damage-only accidents for each fatal

Paper sponsored by Committee on Highway Safety and presented at the 46th Annual Meeting.

TABLE 1

SEVERITY OF ACCIDENTS

Severity	Number		Percent	
Fatal		17		2.0
Class A injury	164		19.3	
Class B injury	141		16.6	
Class C injury	66		7.7	
Total injury		371		43.6
No injury		447		52.7
Injuries not known		15		1.7
Total accidents		850		100.0

accident. The National Safety Council's estimate (2) for all "reportable" traffic accidents in 1964 gives a ratio of 34.8 injury and 348 damage-only accidents per fatal accident. Thus, single-vehicle accidents on Route 66 appear much more severe than traffic accidents as a whole. But this would be expected because of the generally high operating speeds on Route 66.

The types of vehicles involved are given in Table 2. Note that 105 out of 735 or one car in seven in a single-vehicle accident had a trailer. Of these, 57 percent were cargo trailers; 30 percent were house trailers; 11 percent were other motor vehicles; and 3 percent were boat trailers. Of the 20 trailers towed by trucks (not including semitrailers), 35 percent were other motor vehicles; 30 percent were cargo trailers; 30 percent were house trailers; and 5 percent were boat trailers.

Three kinds of special data were sought in this study: (a) factual (objective) information about the circumstances of the accidents; (b) opinions (subjective) about contributing

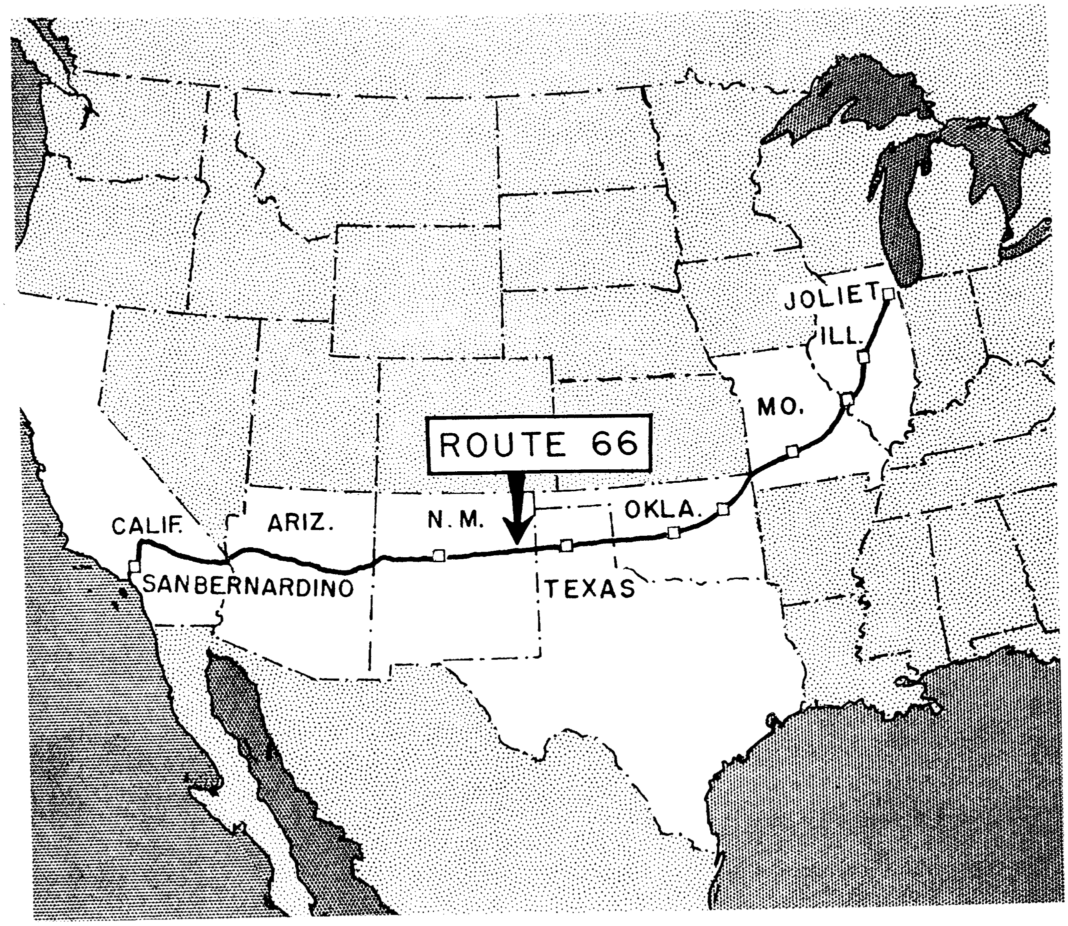

Figure 1.

TABLE 2

VEHICLES INVOLVED

Types	Total Vehicles		With Trailer	
	Number	Percent	Number	Percent
Standard cars	519		88	17.0
Compact cars	141		13	9.2
Small and sports cars	75		3	4.0
Total cars	735	86.5	105	14.3
Tractors and semitrailers	47		47	100.0
Trucks	63		20	31.8
Total trucks	110	12.9	64	59.1
Motorcycles	5	0.6	0	0.0
Buses	0	0.0	0	0.0
Total vehicles	850	100.0	169	19.9

factors; and (c) comparisons which help evaluate the reliability of police inferences in accident reporting.

Factual Information About Circumstances

Time of Accidents—Because of the character of the route studied, distribution of accidents differs somewhat from usual countrywide figures (2). Morning and evening peaks are less pronounced (Table 3).

Most accidents, 18.7 percent, occurred on Friday, followed closely by Saturday with 18.0 percent. Tuesday had the fewest, 10.7 percent. The modal hour of the day, without regard to day of week, was 1 to 2 p.m. with 6.4 percent of the total 24-hour accidents; the minimum hour was midnight to 1 a.m. with 2.5 percent.

These values largely reflect traffic volumes. Therefore, risk indexes were computed by dividing the percentage of accidents in each hour by the percentage of traffic counted in that hour. The lowest index, 0.57, was from 9 to 10 p.m. and the highest, 3.43, was from 3 to 4 a.m. (Fig. 2). Darkness is probably a factor in the risk index because most of the high-risk hours are dark. But if darkness is the only factor, the index should be one value for all hours of darkness and another for all daylight hours. But this is not the case. Thus, there are probably differences in quality of driving at different hours of the day for single-vehicle accidents. The hours with high-risk indexes are those during which one would expect to find more drivers who had been drinking, and those in which drivers would probably be most likely to fall asleep.

Seat-Belt Usage—The easiest route from Chicago to Los Angeles obviously carries an unusually high percentage of long-trip vehicles. It is believed that people are more likely to use seat belts on long trips. Therefore, experience on this route should represent maximum use of seat belts for 1964.

Of 2,050 occupants in single-vehicle accidents, only 472 or 23.0 percent were in seats equipped with belts. Of the occupied seats with belts, only 48.3 percent of the occupants had their belts fastened (Fig. 3). Compare this with the 1963-1964 seat-belt usage reports from Automotive Crash Injury Research (3) where 33 percent of occupants were in seats with belts, and 27.6 percent of these were wearing them. The ACIR data were for rural accidents in selected areas but not necessarily on through routes. The much higher percentage of those having belts and who were wearing them on Route 66 suggests that long-trippers are more likely to use available belts.

TABLE 3

PERCENTAGE OF ACCIDENTS IN PEAK HOURS, MONDAY THROUGH THURSDAY

Peak	Countrywide[a]	Route 66
Morning (7 to 9 a.m.)	11.8	7.9
Evening (4 to 6 a.m.)	19.3	10.6
Total	31.1	18.5

[a]Accident Facts, 1965.

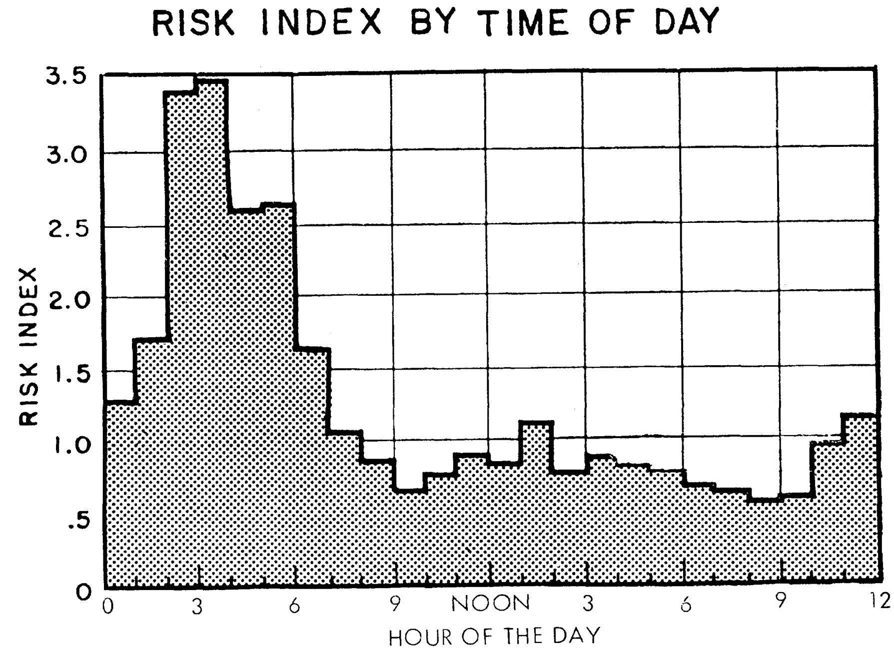

Figure 2.

Among drivers, 31 percent had belts available but only 50.2 percent were reported in use. Of right-front-seat passengers with belts, 43.3 percent had them fastened.

None of the 189 fastened seat belts was reported to have broken in an accident. One driver of a sports car said that his belt was fastened before the accident but unbuckled (without damage) when he turned over twice.

Men used their belts more than women, 51 percent compared to 43 percent (Fig. 4). In the 16 to 19 age group, 54 percent used their belts as contrasted to 43 percent for

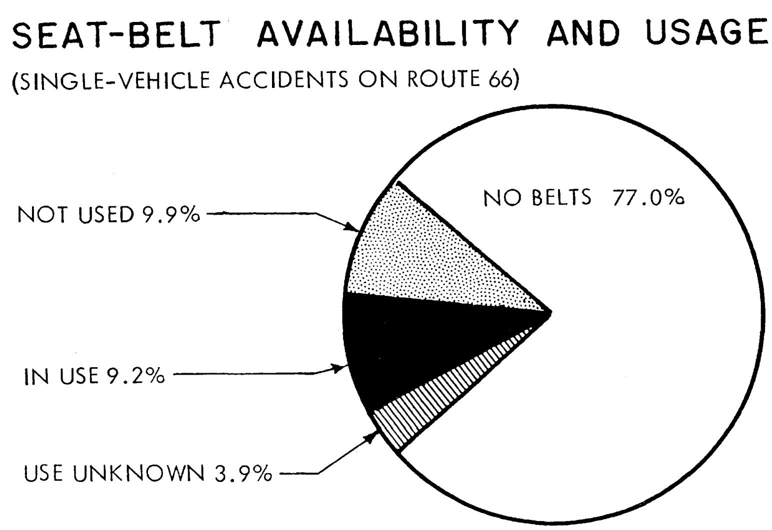

Figure 3.

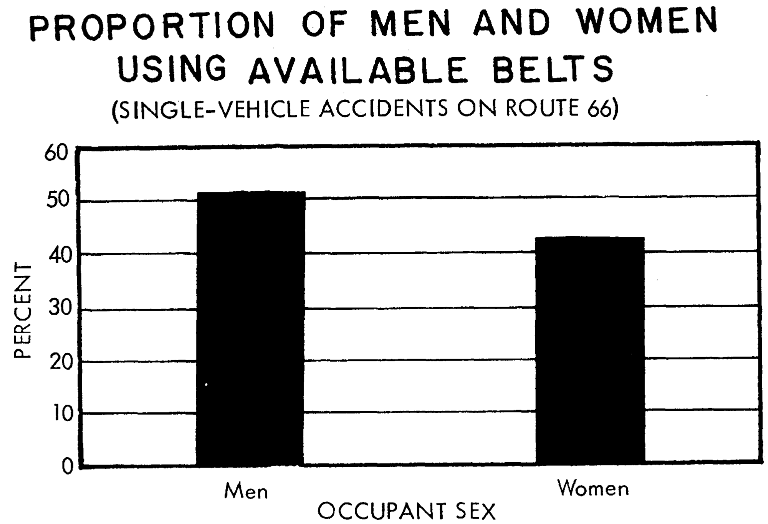

Figure 4.

older people and 38 percent for younger children (Fig. 5). The highest percentage, 60, of seat-belt users were male passengers less than 16 years old. The lowest percentage, 28, were male passengers 30 or more years old. Seat belts appear to be catching on with the younger generation.

Operational Failure—To escape accident, the road-vehicle-driver system must operate so as to avoid three principal hazards: (a) left roadway (jumped the track), (b) struck object while still on roadway, and (c) overturned before leaving roadway. If one of these hazards is not avoided, the car-driver-road system has failed in some operation required for safety. The operational failure describes the accident. Note that these operational failures differ from the four standard types of accidents which were required to be reported in this study. Leaving the roadway is leaving the pavement, not "running off the road," which includes shoulder; striking an object is "collision

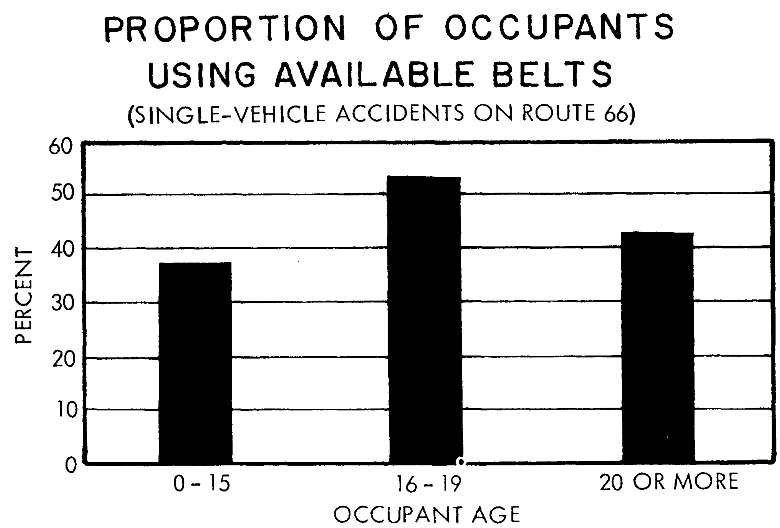

Figure 5.

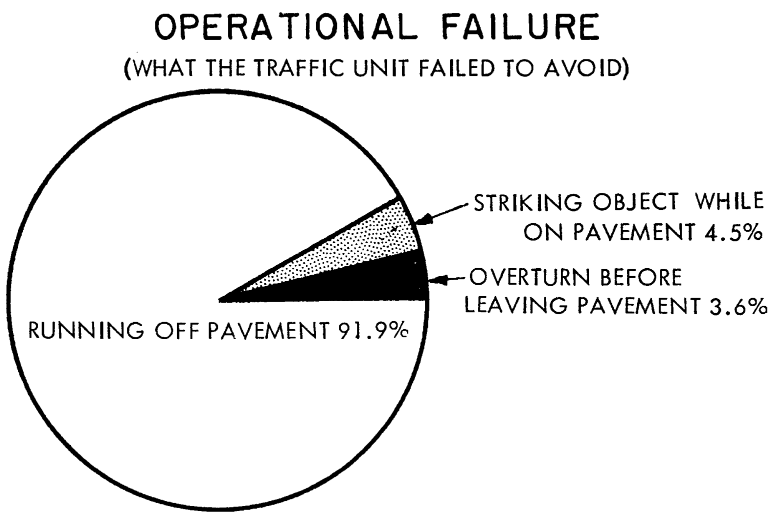

Figure 6.

with parked motor vehicle" or "collision with fixed object," but only before the vehicle leaves the pavement. A vehicle is considered to have left the roadway when one wheel is off the pavement.

Operational failure No. 1, "left roadway," accounted for 781 or 91.9 percent of the accidents studied. It includes many accidents in which the vehicle overturned or struck an object on the shoulder or after running off the shoulder (Fig. 6). It does not include accidents in which vehicles overturned on the pavement after they had run off and come back on. The greatest part of these left-roadway accidents were on straight roads, mainly because Route 66 has so few curves. Road alignment was as follows: straight, 79.4 percent; moderate curve, 14.8 percent; sharp curve, 1.9 percent; ramps, channelization, etc., 3.9 percent.

Because vehicles drive on the right side, 1.38 times as many vehicles left the right side of the roadway compared to the left (Table 4). Of the 729 vehicles which left the roadway not at intersections, 231 or 31.7 percent managed to come back on again before they got into trouble (Table 5); of those which went off to the left first, 25.4 percent got back on again; of those which went off to the right first, 36.2 percent returned. However, the return was not successful in preventing the accident. Figures 7 and 8 show the off-roadway experience diagramatically. In Figure 8, data are shown for one-direction and two-direction roadways separately. Off the left in one-direction traffic would be into the median. Arrows with little bars across the tips indicate that the vehicle crossed the median into the opposite roadway. Arrows with dots at the end or angle indicate that a solid object such as a guardrail or embankment was struck.

TABLE 4

SIDE ON WHICH VEHICLE LEFT ROADWAY[a]

Road	Left	Right	Total
Curve to left	21	38	59
Curve to right	36	29	65
Straight 1-way (divided)	201	233	534
Straight 2-way (undivided)	48	123	171
Total	306	423	729

[a]Fifty-two vehicles left roadway at intersections.

The foregoing leads to a consideration of the attitude of the vehicle when it left the roadway. This is given in Table 6. In 56.8 percent of the left-road accidents, the car was sideslipping (yawing) or weaving; the driver was apparently out of control by some maneuver before he ran off the pavement.

From where the vehicle left the pavement to where it came to rest varied from a few feet to more than a thousand. Figures 9, 10 and 11 show the final positions for shoulder widths of less than 4 ft, from 4

TABLE 5

CARS RETURNING TO ROADWAY AFTER LEAVING IT

Road	Off Left		Off Right	
	Number	Percent	Number	Percent
Curve left	4	19.0	15	39.4
Curve right	11	30.5	8	27.6
Straight 1-way	50	24.8	87	37.3
Straight 2-way	13	27.1	43	35.0
Total	78	25.4	153	36.2

to 12 ft, and for more than 12 ft. The dashed line parallel to the roadway edge shows to scale the width of the shoulder. Without knowing how many vehicles left the roadway and did not have accidents, it is impossible to evaluate the effect of the width of shoulder as far as safety is concerned. Such additional data would be virtually impossible to obtain. Figure 12 shows the percentage of vehicles coming to rest more than the specified distance from the edge of the roadway. This corresponds reasonably well with data from other sources (4).

The object struck is of interest to those considering roadside improvements to reduce severity of single-vehicle accidents. The data apply to both struck-object-before-leaving-roadway and ran-off-the-road accidents (Table 7). These objects do not necessarily stop the vehicle or damage it severely, although it may roll over after striking.

Operational failure No. 2, "struck object while still on roadway," accounted for 38 or 4.5 percent of the single-vehicle accidents studied. Because the vehicle must have struck the object while all wheels were on the pavement, it follows that the object struck must have been on or very close to the pavement. In some cases, however, the vehicle was crosswise on the road when it struck the guardrail or other roadside object. The object could be as much as 5 ft from the pavement and be struck by rear-end overhang while the wheels were still on the pavement (Table 8). Guardrails were the most common objects struck.

Fifteen of the 38 struck-object accidents were in Arizona. This was the most conspicuous difference among states in the data gathered. The kinds of objects hit in Arizona were as varied as among the other states, so there seems to be no logical explanation for the larger number.

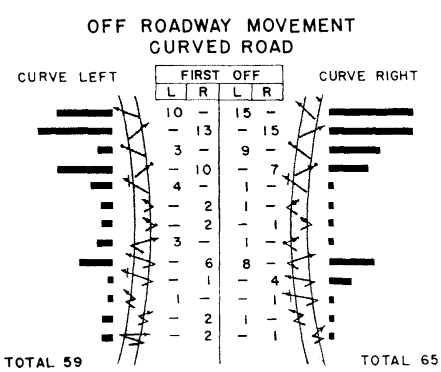

Figure 7.

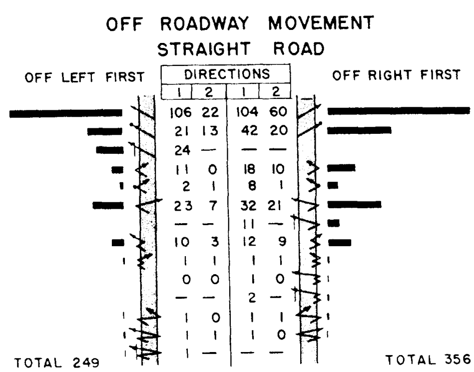

Figure 8.

TABLE 6

ATTITUDE OF VEHICLES LEAVING ROADWAY

Bearing	Percent
Going straight without yaw	41.2
Sideslipping in a sharp turn	47.9
Had been weaving side to side before leaving road	8.9
Unknown	2.0

Operational failure No. 3, "overturned before leaving roadway," accounted for 31 or 3.6 percent of the single-vehicle accidents studied. Straight or nearly straight and dry roads accounted for 64.4 percent; ramps, channelization, narrowing and driveways, 16.1 percent; slippery pavement (2 accidents), 6.5 percent; high wind (2 accidents), 6.5 percent; and unknown, 6.5 percent.

Vehicles which overturned after leaving roadway were classified as left-roadway operational failures. The percentage which overturned-on-roadway varies greatly with the type of vehicle (Table 9).

Of the 630 cars without trailers, the small percentage which overturned before leaving the roadway is due to the predominance of standard vehicles, none of which over-

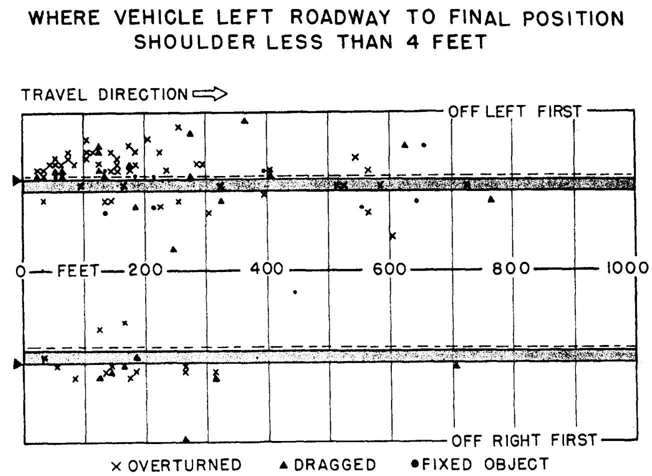

Figure 9.

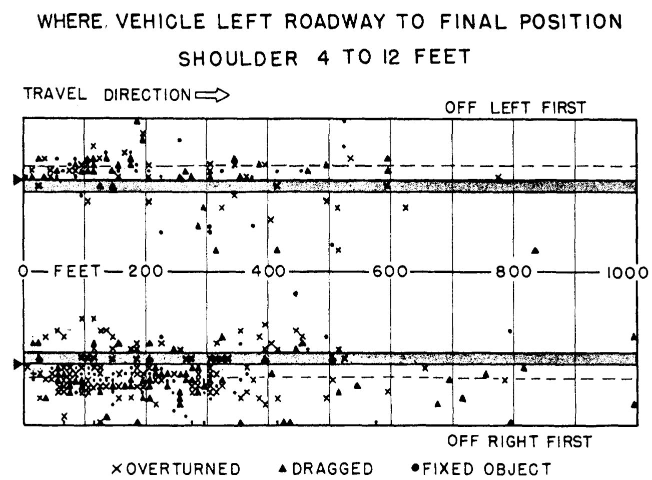

Figure 10.

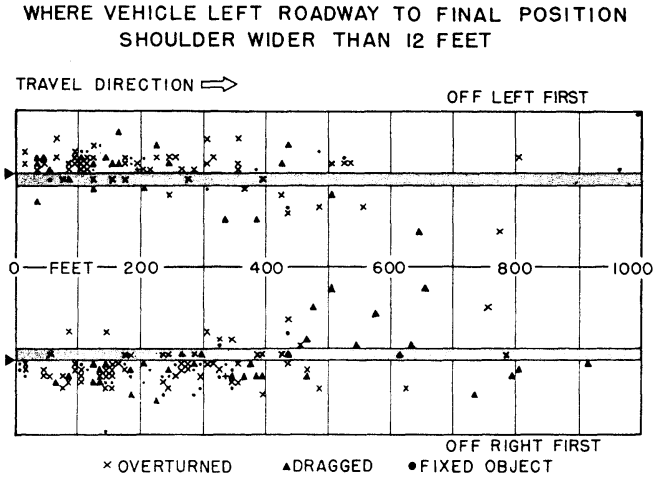

Figure 11.

turned (Fig. 13). Of the five small cars which overturned before leaving the pavement, four were Volkswagens and one was a Renault Dauphine.

Age and Sex of Driver—There is nothing unusual about the distribution of single-vehicle accidents according to sex of driver: 71.6 percent were male and 28.4 percent female. For both male and female drivers, those 20 to 25 years of age were involved in more single-vehicle accidents than any other five-year age group—23.6 percent for males and 16.7 percent for females. For both sexes the number of accidents diminished steadily with age. The distribution of those accidents doubtless reflects to a large extent differences in miles driven by the age and sex groups. Unfortunately, exposure data on which risk indexes could be computed were obtained only in Arizona. If the percentage of drivers of each age using Route 66 was the same in all states as in Arizona, the risk index by age would be about as given in Table 10. The risk index for the average driver would be 1.00. Drivers 30 years old and 65 years old are about average.

Risk Index by Type of Vehicle—Types of vehicles involved have been enumerated in the discussion of the accidents reported and in connection with overturning accidents. Counts were made in each state to determine the proportion of each type of vehicle using Route 66. From these data it was possible to compute a risk index by major types of vehicles. The risk of a standard car without trailer was established at 1.00 as the base for this index. Values for vehicles of other kinds are given in Table 11.

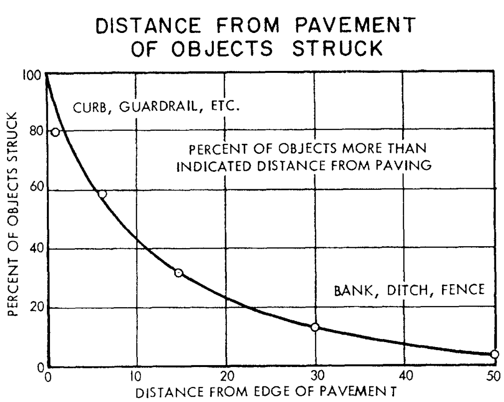

Figure 12.

In general, compact cars are $2\frac{1}{4}$ and small cars $3\frac{1}{2}$ times as risky as standard cars. Adding a trailer multiplies the risk by approximately four. Actually, there were only four small cars with trailers in accidents so that the risk index for this type is not statistically significant, but it is compatible with the other indexes. Because no bus had a single-vehicle accident during the study period, the index for buses is zero. Buses probably do have the lowest risk index but an index based on a sample large enough to show some bus accidents would obviously not be zero.

The considerable differences in risk indexes of the three classes of passenger cars are paralleled by the differences in percentage of those cars that overturn on the road as mentioned earlier, but the total number

TABLE 7

DISTANCE FROM ROADWAY OF OBJECT STRUCK

Distance (ft)	Percentage	Principal Objects Hit
Less than 1	20.1	Curb, guardrail, barricade
1 to 6	21.2	Guardpost, delineator, guardrail
7 to 14	26.8	Bank or ditch, guardrail, information sign
15 to 29	18.3	Bank or ditch, fence, culvert
30 to 49	9.9	Bank or ditch, fence
50 or more	3.7	Bank or ditch, fence

of overturning accidents is so small that overturning cannot alone explain the differences in risk indexes.

Indeed, nothing in the data collected explains the risk-index differences among the three groups of passenger cars without trailers. Because guesses will inevitably be made to explain this phenomenon, three different, speculative possibilities are mentioned here.

One possible explanation might be the least speculative. The much higher risk index of young drivers has been noted. For economic and cultural reasons, young drivers seem to be much more likely than older drivers to be on long, fast trips in small and compact cars. Thus a difference in driver skills or attitudes may also explain the difference in risk indexes of the three classes of cars.

Second, there is a substantial proportion of rear-engine cars among the compacts and a large proportion of rear-engine cars among the small cars. No standard cars have rear engines. Thus there is a correlation between rear-engine construction and risk index. However, from these data, one cannot justifiably reach the conclusion that this correlation indicates any cause-and-effect relationship.

A third inference may also be made. Many parts of Route 66 are exposed to areas where high winds are common. Wind was suggested as a contributing factor in a number of the accidents reported. Generally, the area of a car exposed to wind pressure varies as the square of its linear dimension; doubling car size would quadruple surface area. But weight varies as the cube of linear dimension; doubling the linear dimensions will multiply the weight by eight. Therefore, the ratio of weight to wind pressure area varies as the $^3/_2$ power of car length. In other words, the larger the car is, the greater its road friction resistance will be compared to its wind area. Large cars will be deflected or buffeted less by sudden gusts of wind or air blasts from passing trucks. Thus, wind will trigger fewer drivers of large than of small cars into losing control.

TABLE 8

OBJECTS STRUCK WHILE VEHICLE STILL ON ROADWAY

Guardrails	8
Bridge rails or structures	7
Traffic control devices	7
Barricades	5
Culverts	2
Information signs	2
Railroad crossing gates	2
Rock slides	2
Guard post	1
Divider reflector	1
Parked car	1
Total	38

Opinions About Contributing Factors

The circumstances which are thought of as contributing factors in traffic accidents are, unfortunately, rarely conditions which can be objectively observed or which leave unmistakable signs after the accident. Therefore, determination of causative factors is largely a matter of inference. Conclusions concerning such factors are consequently opinions of those making the inferences and must be evaluated accordingly.

Information about causative factors solicited by the supplementary report form for this study inevitably reflects stereotypes or common patterns of the investigator's beliefs, lack of time to seek further proof (for example, by disassembling the

TABLE 9

VEHICLES OVERTURNING BEFORE LEAVING ROADWAY

Type	Number	Percent
Motorcycle	2	40.0
Truck and trailer	3	13.1
Car with trailer	13	12.3
Truck without trailer	3	7.0
Tractor with semitrailer	3	6.8
Car without trailer	7	1.1
Total	31	3.6

PROPORTION OF CARS WITHOUT TRAILERS OVERTURNING ON PAVEMENT

AS PERCENTAGE OF ALL IN SINGLE-VEHICLE ACCIDENTS

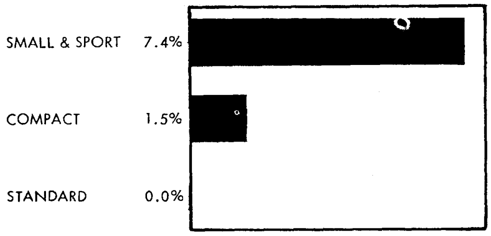

Figure 13.

vehicle), and the limitations of investigators' scientific training. Nevertheless, highway patrol officers attending the accident are in the best position to make inferences relating to contributing factors. Therefore, until better procedures are available, cautious consideration must be given to their opinions as expressed in special schedules on the supplementary report form. This part of the study, therefore, has many characteristics of an opinion poll.

Speed—The supplementary report called for a "best estimate" of speed and also a possible minimum and maximum value. In two-thirds of the reports, the minimum estimate was given as 5 mph less and the maximum estimate as 5 mph more than the best estimate. With such uniformity of range, only the best estimates are shown in Table 12 and Figure 14. Almost half of the accidents occurred where the speed limit is 70 mph because most of the route is posted for that speed.

Note in Figure 15 that the percentage of accidents at more than the speed limit diminishes steadily as speed limits increase. Most of the investigators' speed estimates of more than 75 mph were substantiated by witnesses. Some occurred while the violator was actually being pursued.

Contributing Factors—In the supplementary report, the investigator could mark on a list to indicate his opinion relating to contributing factors. The list was subdivided into groups for road, driver, and vehicle. Space was provided in each group to write in other factors than those specifically listed. More than one factor could be listed and the investigator could indicate his degree of certainty by marking yes or possibly. If an investigator listed more than one factor (which investigators did for only 16.5 percent of the accidents), only that one which seemed to be best substantiated by circumstances described or reasoning expressed was tabulated.

The five most frequently mentioned factors were (a) driver asleep, 24.1 percent; (b) slippery road, 13.0 percent; (c) tire failure, 11.9 percent; (d) distractions, 8.7 percent; and (e) alcohol, 8.1 percent. A more detailed listing appears in Table 13.

Examples of other road factors include: pavement narrows suddenly, soft shoulders, drop-off to shoulder; of other driver factors: drag racing, headstrong, blacked out, confused by traffic; of other vehicle factors: overloaded, shifting load, wipers quit in heavy rain, axle or spindle broke, accelerator stuck, smooth tires, trailer collapsed.

Driver factors are more frequent than car and road factors combined. Because most of the investigators' information about contributing factors comes from the drivers, it may be surmised that, if anything, driver factors are under-reported and vehicle and road factors are over-reported.

Drivers tend to explain accidents by circumstances which have least culpability compatible with credibility. Drivers may sometimes tell investigators that they fell asleep when actually they were intoxicated. Driving under the influence is illegal and, therefore, more culpable than falling asleep while driving, which is not specifically unlawful. Likewise, when a driver falls asleep, he may be happy to explain the accident by some road or vehicle condition. In this connection, it is interesting to note

TABLE 10

RISK INDEX BY AGE

Age	Approximate Risk Index	Age	Approximate Risk Index
20	2.4	55	0.7
25	1.7	60	0.8
30	1.0	65	1.0
35	0.7	70	1.3
40	0.6	75	1.7
45	0.5	80	2.2
50	0.6		

TABLE 11

RISK INDEX BY TYPE OF VEHICLE

Vehicle	Without Trailer	With Trailer
Standard car	1.00	4.57
Compact car	2.23	8.48
Small car	3.49	14.47
Truck	0.69	4.33
Tractor and semitrailer	—	1.21
Bus	0.00	—
All types	1.17	2.67

what drivers said when they did not concur with investigators with respect to being asleep or under the influence of alcohol. In 11 (5.4 percent) of the accidents investigators believed falling asleep was a factor, 4 drivers claimed tire failures, 2 claimed distractions, and 1 each claimed confusing road situation, wind blast, sun glare, alcoholic influence, and other driver's condition. In 10 (14.5 percent) of the accidents

TABLE 12

INVESTIGATORS' BEST ESTIMATE OF APPROACH SPEED

Speed Limit	Number of Accidents	Approach Speed				Percentage Over Limit
		Mean	Mode	Lowest	Highest	
30	4	46.3	40	15	85	75.0
35	6	44.2	35	85	55	75.0
40	6	45.0	—	20	65	50.0
45	13	46,2	45	25	65	38.0
50	35	49.3	50	10	85	31.2
55	82	56.2	50	40	80	30.3
60	131	54.7	60	25	75	19.1
65	127	57.3	65	10	85	11.8
70	417	61.1	65	10	110	8.9
75	1	45.0	45	45	45	0.0
Total	822	57.3	65	10	110	15.5

ACCIDENT SPEED
RELATED TO SPEED LIMIT
(SINGLE-VEHICLE ACCIDENTS ON ROUTE 66)

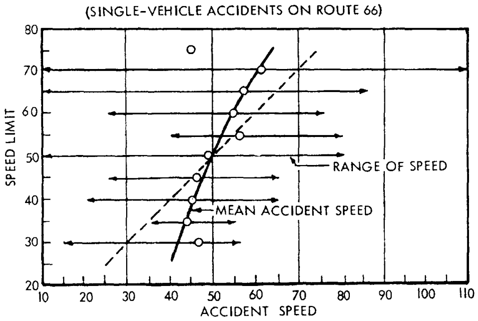

Figure 14.

NUMBER OF VEHICLES AND
PERCENT EXCEEDING SPEED LIMIT
(INVESTIGATORS' OPINIONS IN SINGLE-VEHICLE ACCIDENTS)

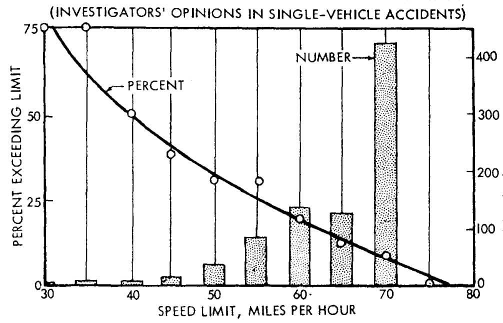

Figure 15.

TABLE 13

INVESTIGATORS' OPINIONS ABOUT CONTRIBUTING FACTORS

Factor	Number		Percent
Road factors, total		155	18.3
Confused by road situation or signs		18	2.1
Unexpected road surface condition		111	13.1
Wet, slippery	110		
Hole, bump	1		
Other		26	3.1
Wind	12		
Sun glare	2		
Object in road	2		
Other	10		
Driver factors, total		378	44.5
Driver asleep or dozed		205	24.1
Alcohol or drugs		69	8.1
Illness		3	0.4
Distraction		74	8.7
In car	49		
Outside of car	25		
Other		27	3.2
Inattention	7		
Lack of skill	6		
Other	14		
Vehicle factors, total		169	19.9
Brake failure		9	1.1
Steering gear failure		12	1.4
Light failure		0	0.0
Tire failure		101	11.9
Other		47	5.5
Trailer hitch	21		
Other	26		
No factor mentioned		148	17.3

listed by investigators with alcoholic influence as a factor, 3 drivers indicated confusing road situations, 2 indicated distractions, and 1 each indicated tire failure, steering gear failure, driver asleep, and illness.

POSITION OF TIRE BLAMED RELATED TO VEHICLE DAMAGE

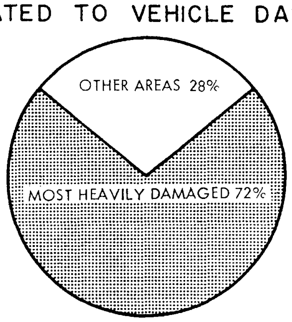

Figure 16.

PRINCIPAL CONTRIBUTING FACTORS BY SEX OF DRIVER

(INVESTIGATORS' OPINIONS)

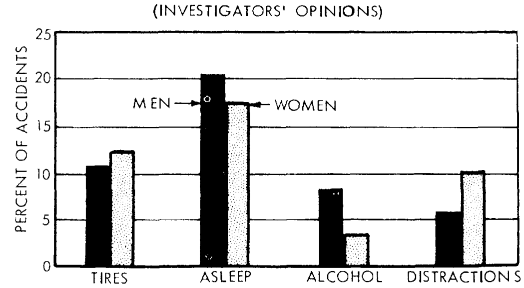

Figure 17.

TABLE 14

PERCENTAGE OF ACCIDENTS BY SEX AND AGE GROUP BELIEVED TO HAVE SELECTED FACTORS CONTRIBUTING

Age	Tire Failure	Driver Asleep	Driver Under Influence	Distraction
Less than 20	13.7	29.4	4.9	9.8
20 to 29	11.4	30.2	8.1	7.1
30 to 39	15.7	18.6	8.1	8.1
40 to 49	12.3	18.4	12.3	7.0
50 to 59	16.0	20.4	9.6	4.2
60 or more	14.3	16.4	3.6	16.4
Males	12.9	24.5	9.9	6.4
Females	14.5	20.9	3.8	11.6

By the same principle, we may hypothesize that some drivers may have suggested tire failure as a factor when, in fact, the driver had been drinking, had fallen asleep, or had otherwise been responsible. Such an explanation might be credible if a tire was, indeed, disabled after the accident. Even had the tire been damaged by collision or furrowing in, the investigator would not have at his disposal facilities for removing and examining the tire to determine the nature and probable cause of its disablement. Because tires would most likely be disabled by the accident if they were in the vehicle's most heavily damaged area, the position of the tire which was supposed to have failed was tabulated (Fig. 16). If approximately three times as many tires which were claimed to have failed were in the heavily damaged part as in other parts, it was reasonable to assume that some of these were improperly considered to be a factor in the accident.

The positions on vehicles of tires which investigators believed to have contributed to accidents are (a) rear right, 36.8 percent; (b) rear left, 26.6 percent; (c) front right, 19.3 percent; and (d) front left, 17.3 percent. With front-tire failure, the vehicle went off the roadway much more often on the side on which the tire failed. With rear-tire failure, the reverse seems to be true, but the difference between rear tires is small and probably not significant.

Age and Sex Related to Contributing Factors—The percentage of drivers in each age group believed by the investigator to have been connected with accidents having major contributing factors is given in Table 14. It appears that men are more troubled by falling asleep and drinking, women by tire failure distractions (Fig. 17). Differences for tire failure are probably too small to be significant, but the other factors show interesting variations.

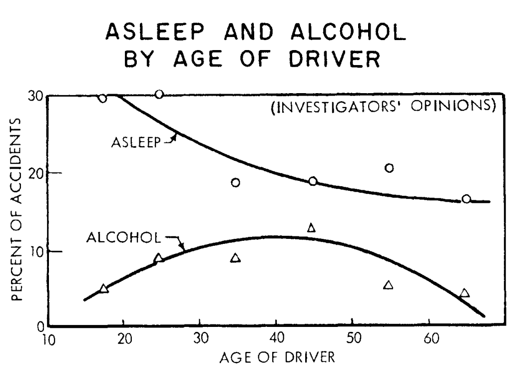

Figure 18.

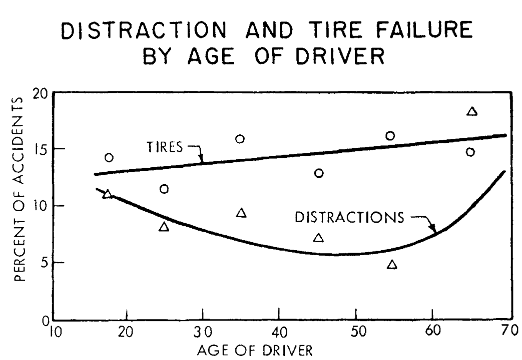

Figure 19.

The variation with age in percentage of accidents believed to have been contributed to by alcohol and sleep is shown in Figure 18. For young drivers, alcohol is conspicuously low and sleep is high One wonders whether the opinions on which these curves are based represent reality or whether young drivers who have been drinking successfully explain their accidents to investigators by claiming to have fallen asleep—and if this is true for young drivers, could it not be true throughout the whole range of ages?

Frequencies of tires and distractions believed to contribute to single-vehicle accidents according to age of driver are shown in Figure 19. Tires appear not to be importantly related to age, unless there is a slight increase in risk with age. Distractions, on the other hand, are high for young and old drivers—a condition which might be expected. The number of these is small so the figure for greater ages is undoubtedly not reliable.

Distractions are generally believed to be important contributing factors to accidents but they are difficult to detect. After the accident, either the driver has forgotten all about the distraction, or he sees no reason to mention it. Distractions are extremely varied, but they separate into two major categories—those within the vehicle and those outside of the vehicle. In this study of 850 single-vehicle accidents, 74 were believed by the investigator to have involved driver distractions. In 49 accidents the distraction was inside the car and outside in 25.

A list of the inside distractions will illustrate their great variety:

1. Children	
Turned to cover or attend baby behind	6
Child alongside driver	3
Looking at child or baby	2
Turned to talk to children	1
Child's balloon blew in driver's face	1
Child pulled shift lever back	1
2. Other passengers	
Talking to driver	5
"Back-seat driving"	2
Watching passenger	2
Trying to awaken wife	1
Horseplay in car	1
3. Smoking and eating	
Dropped lighted cigarette or lighter	4
Reaching for cigarette, food, or water	3
Lighting cigarette	2
Eating	1
4. Adjusting car equipment	
Tuning radio	2
Adjusting sun visor	1
5. Miscellaneous	
Kleenex blew in driver's face	1
Suitcase fell off seat	1
Wasp in car	1
Particle in driver's eye	1
Reaching in car	1
Emotionally upset	1
6. Unspecified in car	5

Perhaps the fact that children are the most common distraction is related to the fact that distractions appear as contributing factors in a greater percentage of accidents involving women drivers than men drivers.

Distractions outside the vehicle are probably less likely to be remembered and reported than distractions inside. Some of the outside distractions may be problems of proper distribution of attention among competing hazards rather than true extraneous distractions. The list follows:

1. Other vehicles	
Vehicle alongside or ahead	4
Vehicle behind	2
Gesturing at overtaken driver	1
2. Looking at scenery	6
3. Problems with own vehicle	
Luggage on roof came loose	1
Trailer acted up	1
Steering gear seemed wrong	1
4. Road construction	
Watching road grader	1
Observing barricades	1
5. Unspecified, probably speculative	7

The unspecified distractions both inside and outside the vehicle may be speculative. Not having other specific, logical contributing factors to explain the accident, the driver and the investigator may have surmised that it was some kind of a distraction but without any idea of exactly what.

How would the driver avoid a similar accident? This question was asked investigators. No specific list of possibilities was provided for checking. For 40 accidents the reply to this question was indeterminate. The 12 ideas offered by investigators are shown in Figure 20. These generally correspond with opinions concerning contributing factors. Driver asleep heads the list in both cases. Speed is prominent—slower for conditions perhaps reflects a tendency of police to explain accidents by "too fast for conditions" when nothing more specific comes to mind. Attention is high on this list but not among the contributing factors, probably because it was not specifically mentioned in the driver-factor check list.

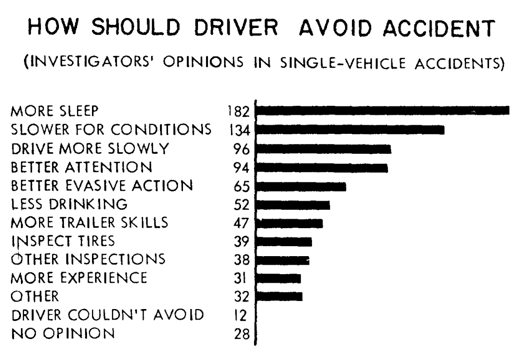

Figure 20.

Comparisons to Evaluate Reliability of Opinions

In this study, a crude effort was made to gain some idea of how highway patrol officers arrive at conclusions in usual working situations. Some of this evaluation has already been suggested in connection with tabulating their conclusions.

For comparison purposes, in addition to reporting their own conclusions, investigators were also asked to report conclusions of drivers. Admittedly this is no elegant research technique, but it does give some tentative insights which might not otherwise be available.

In general, investigators appear to accept drivers' versions of how and why the accident occurred, but they may disagree in a few instances, especially where observable conditions contradict drivers' statements.

Speed—Police estimates of speeds are consistently higher than drivers' estimates, especially above the speed limit. Drivers average speed estimate was 54. 8 mph, that of police 57. 3 mph. The difference seemed to be about the same for all speed limits at which there were enough accidents to give reliable figures. Police believed 128 drivers were exceeding the speed limit as opposed to 50 drivers who admitted to more than the limit. For the most common speed limit, 70 mph, only four drivers admitted going faster. None of these acknowledged more than 75 mph. Police, on the other hand, considered 37 to have been exceeding 70 mph. Only 17 exceeded that limit by as little as 5 mph. One driver was reported at 95 mph, one at 100 mph, and one at 110 mph. Perhaps drivers would have admitted higher speeds to others than police, but this is doubtful.

Contributing Factors—In general, investigators and drivers agree remarkably on contributing factors. Of 573 cases for which both driver and investigator offered an opinion, there were 537 in which they agreed and 36 in which they disagreed. In other words, the investigator differed from the driver in only 6. 3 percent of the cases. This probably means that in a large number of cases the investigator accepts the driver's opinion. Perhaps in many cases the driver's statement is the only information on which he can base an opinion. But the inference can also be made that practically the same results would be obtained by having drivers themselves report the contributing factor as by having the investigators do it, at least in single-vehicle accidents.

The most common disagreements were 21 accidents in which police considered sleep or alcohol to have been a factor, whereas drivers offered less culpable explanations.

Skill—More than other kinds of accidents, single-vehicle accidents suggest a failure of the driver to control his vehicle. That would generally mean lack of skill either in driving strategy in anticipation of possible hazards or in tactics in coping with actual hazards. Yet among the 850 single-vehicle accidents, investigators indicated only six in which lack of skill was a contributing factor and in only four cases did drivers suggest lack of skill. But lack of skill was not specifically listed to be checked in the supplementary report. As an unquestionably prominent factor in single-vehicle accidents, it was purposely omitted to determine to what extent investigators or drivers might mention it as a factor in accidents without having it suggested by listing. Compare the few cases in which lack of skill was mentioned with the frequent occurrence of accidents which clearly appear to involve such lack of skill as steering too much, braking on slippery surfaces, and inability to cope with a trailer. The comparison strongly suggests that investigators try to use only the categories specifically called for on the report form and shun the opportunity to record "other." This means that to get more reliable analysis of contributing factors, report forms should either be elaborated to include very long lists of categories or should mention no specific categories. In the latter case, investigators would probably resort to stereotypes of their own or their department's, especially stereotypes which conform to classifications of law violations.

The California study (1) reported faulty driving as the second most common cause (after speed). It accounted for 25. 0 percent of all single-car accidents. The difference between the Route 66 study and the California study suggests that opinion-gathering methods have a strong influence on determination of contributing factors. For example, as mentioned earlier, skill does appear more prominently in the opinions as to how the accident could have been prevented than in the contributing factors.

Combinations of Contributing Factors—Variation among states is considerable in the proportion of accidents in which investigators expressed no opinion about contributing factors. These variations are doubtless partly and perhaps largely accounted for by differences among investigators—differences mainly in training for investigating and forming opinions. That is, it is probable that two investigators with the same information about an accident would apply different techniques and standards and so come up with different conclusions about contributing factors.

The accidents for which no factor was named vary from 5. 4 percent in Texas to 31. 5 percent in Missouri. Accidents in which two or more are suggested vary from 10. 3

percent in Oklahoma and New Mexico to 45.9 percent in Texas. In other words, Texas leaned toward multiple factors. Missouri investigators seemed reluctant to offer opinions.

Most accidents, when skillfully reconstructed and analyzed, appear to have numerous contributing factors which combine to cause them. Four or five factors are common and sometimes the number goes to a dozen. But in the investigators' reports of these accidents, a single factor seemed to be the rule. This suggests that these investigations are too brief and the investigators insufficiently trained to do more than a superficial job of determining the combinations of factors that cause accidents. The listing of factors in this study shows: no factor mentioned, 17.4 percent; one factor only, 66.1 percent; and more than one factor, 16.5 percent. In only a very few cases were three or four factors indicated. One accident was listed with five.

The most common combination is sleep and alcohol (23 accidents). It is, perhaps, logical that these might combine. For several reasons, people who had been drinking might be more likely than others to doze while driving.

The second most common combination, distraction and sleep (10 accidents), makes no sense. If a person is sleeping he is not subject to the usual distractions; conversely, if he actually was distracted he was probably not sleeping.

The next most common combination is sleep and tire failure followed by confusing situation combined with slippery road (each combination with six accidents). Neither of these is a very convincing combination. Certainly it seems unlikely that a driver would both doze and experience a tire failure, although it may be argued that the sleepy driver is less able to cope with a tire failure because he has to awaken first.

A considerable number of the combinations given are not complementary contributing factors. Complementary factors are those which go together like tire failure and lack of skill. This fact suggests that many of the reported combinations are actually speculative alternatives, not real complementary combinations. Thus the investigator could have meant that the accident might have been due to a slippery road or a tire failure rather than a slippery road and a tire failure.

The factor which most commonly combines with others is a wet or slippery roadway. It is combined with almost every other listed factor, especially with lack of skill, distractions, and driver asleep. It would be complementary to lack of skill, but probably an alternative to driver asleep.

REFERENCES

1. Causes and Characteristics of Single-Car Accidents. California Highway Patrol, Part 1, Feb. 1963; Part 2, Oct. 1964; Parts 3 and 4, Jan. 1965; First Follow-up, Oct. 1966.
2. Accident Facts, 1965. National Safety Council, Chicago, 1965.
3. Stern, Arthur. Seatbelt Utilization. Bulletin 8, Automotive Crash Injury Research, Cornell Aero. Lab., Buffalo, N.Y., 1966.
4. Huelke, Donald F. Non-Intersectional Automobile Fatalities—A Problem in Roadway Design. Highway Research Record 152, pp. 103-119, 1967.