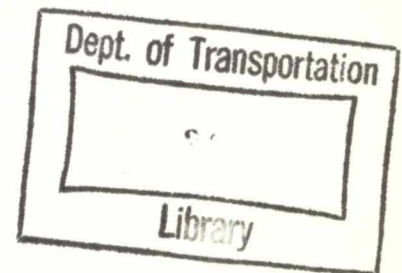


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ACCIDENT AND NEAR ACCIDENT CAUSATION: THE CONTRIBUTION OF AUTOMOBILE DESIGN CHARACTERISTICS

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A study was conducted to (1) determine the frequency and severity of driver/vehicle design mismatch problem contribution to accidents and near accidents, (2) relate driver and vehicle characteristics to severity and frequency of problems experienced by drivers, (3) develop and validate the method used to measure mismatch problems, and (4) identify vehicle design countermeasures which would reduce problem frequency or severity. Based upon recommendations by experts, literature reviews, focus panels and preliminary question testing, five direct mail questionnaires were developed and pilot tested on a sample of 800 U.S. Government employees. Results were analyzed and a modified questionnaire recommended for a large scale survey of drivers. The questionnaire contained questions on vision, controls, steering, braking, shifting, and seating. Subsequently, a direct mail survey was conducted by three private institutions which surveyed 10,000 drivers from California and New Hampshire. The 3500 returns citing 1691 near accidents or accidents for various mismatch questions were analyzed by driver and vehicle demographic variables. Results strongly indicate that the survey approach is valid and that driver/vehicle design mismatch problems are not trivial as contributors or causes of accidents. Most frequent and severe problems experienced are vision related, e.g., oncoming headlight glare, window obscuration due to weather, and mirror information and glare. Steering and braking problems were also significant. Driver height, age, weight, sex, experience and exposure, and vehicle age, size (type), and model are uniquely related to specific mismatch problems experienced.					
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METRIC CONVERSION FACTORS

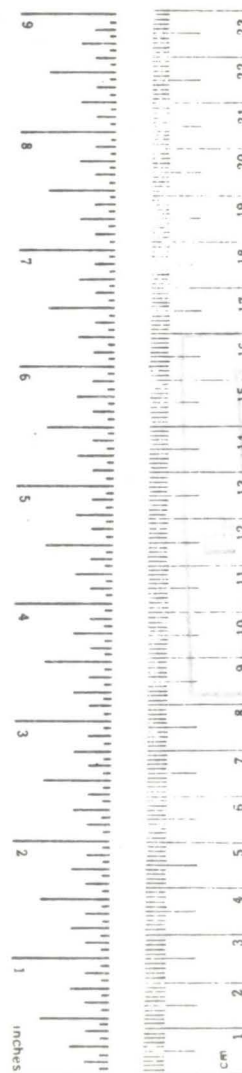
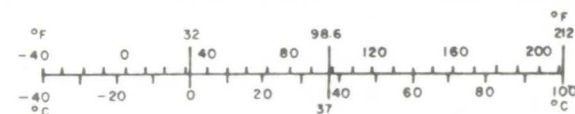
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in ²	square inches	6.5	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft ³	cubic feet	0.03	cubic meters	m ³
yd ³	cubic yards	0.76	cubic meters	m ³
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exact). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Page 52-55, NIST Catalog No. C-11-10-286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
	square centimeters	0.16	square inches	in ²
	square meters	1.2	square yards	yd ²
	square kilometers	0.4	square miles	mi ²
	hectares (10,000 m ²)	2.5	acres	
MASS (weight)				
	grams	0.035	ounces	oz
	kilograms	2.2	pounds	lb
	tonnes (1000 kg)	1.1	short tons	
VOLUME				
	milliliters	0.03	fluid ounces	fl oz
	liters	2.1	pints	pt
	liters	1.06	quarts	qt
	liters	0.26	gallons	gal
	cubic meters	35	cubic feet	ft ³
	cubic meters	1.3	cubic yards	yd ³
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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SUMMARY

It is commonly believed that automobile accidents are almost exclusively due to driver error, obvious exceptions being the result of mechanical breakdowns, such as blowouts, engine failure, and so on. However, previous analyses of vehicle designs reveal that specific design characteristics may tend to increase the probability of accidents. For example, automobiles having relatively wide roof posts/pillars may be involved in more accidents than those having relatively narrow posts/pillars because the former provide less visibility to drivers and, therefore, require more frequent head and torso movements of drivers. Thus, while vehicle design characteristics may not be *directly* responsible for accidents, they may very well act as catalysts which tend to alter the magnitude of accident rates. Unfortunately, previous accident investigation research either did not address vehicle design factors as contributors to accidents or gave only cursory consideration to such factors. Thus, the importance of driver/vehicle mismatch problems has remained a tenable but essentially untested hypothesis.

The present study was intended to explore that hypothesis in some detail. Principal objectives were to (1) determine the frequency and severity of driver/vehicle design mismatch problem contribution to accidents and near accidents, (2) relate driver and vehicle characteristics to severity and frequency of problems experienced by drivers, (3) develop and validate the method used to measure mismatch problems, and (4) identify vehicle design countermeasures which would reduce problem frequency and severity. Based upon recommendations by experts literature reviews, focus panels and preliminary question testing, five direct mail questionnaires were developed and pilot-tested on a sample of 800 U.S. Government employees. Results of the pilot study were analyzed and a single, modified questionnaire was recommended for a large scale survey of drivers. This questionnaire contained questions on vision, controls, steering, braking, shifting, and seating. Drivers were asked to respond to each question in terms of

the degree to which a problem was experienced. Response categories included "No Problem," "Annoying," "Potential Danger," "Close Call," and "Caused Accident."

The large scale direct mail survey was conducted by three private institutions which sampled 10,000 drivers from California and New Hampshire (encompassing all forms of weather conditions). Nearly 3500 drivers returned their questionnaires, citing 1691 near accidents or accidents associated with various driver/vehicle mismatch problems. Analysis of the results revealed that the most frequent and severe problems experienced were vision related, e.g., oncoming headlight glare, window obscuration due to inclement weather, difficulty of gaining information from mirrors, and headlight glare on mirrors. Of the top 20 problems, 15 were vision related. Steering and braking problems also emerged as significant sources of near accidents and accidents. In addition, it was found that driver height, age, weight, sex, experience and exposure, and vehicle age, size and model were uniquely related to specific mismatch problems experienced.

In considering known statistics relating to accidents per miles driven, average length of automobile ownership and the average number of miles driven per year, a specific analysis of the data indicated that driver/vehicle mismatch problems are contributors to *at least* 7.5 percent of all accidents. Arguments are presented which suggest that this computed value may well be a gross underestimate. In any event, 7.5 percent is substantial, amounting to approximately 1.7 million accidents per year, and indicating that driver/vehicle mismatch problems cannot realistically be dismissed as trivial sources of accidents.

Driver/vehicle mismatch countermeasures are discussed in relation to potential design criteria conflicts or trade-offs. In some cases, for example, an obvious solution to a problem appears to compound another problem. In most cases, however, conflicts are not apparent.

To the authors' knowledge, this study is the first of its kind and, in our opinion, provided results which exceeded our expectations. Response to the questionnaire, especially by auto club members, was significantly greater than anticipated, suggesting considerable interest in the subject matter on the part of drivers. Further, the

frequency and magnitude of driver/vehicle mismatch problems experienced by drivers indicates that the questionnaire approach is a most viable tool for gaining a thorough understanding of accident causations. It is strongly recommended that a more refined (and possibly shortened) questionnaire be administered to a much larger sample of drivers. The wealth of data generated by such a survey could easily serve as a data bank for both deriving, at least tentative, automotive design standards and design guidelines for the automotive industry. At minimum, the survey would reveal what problems drivers in general are experiencing. And, in the last analysis, should that not be a primary basis for improving vehicle designs?

ADDENDUM

Driver/vehicle mismatches occur when some aspect of vehicle design fails to allow for limitations in the driver's capability. Because few accident investigation programs have concentrated on this area, there has been much uncertainty over the consequences of driver/vehicle mismatch problems in the "real world." This study has been the first, large scale, systematic investigation of these problems using a questionnaire technique and, as such, has provided much valuable information that should be useful in planning the direction of future research and rulemaking. The reader, however, should be careful when interpreting the results because of the limitations in the data. These limitations were, in part, a result of the constraints on the methodology the contractor had to observe because of Office of Management and Budget and Privacy Act restrictions. These constraints included the inability to make follow-up interviews and limitations on what populations could be sampled. As a result, the response rate, 39%, was relatively low and there may be biases in the data. Thus, the data should be considered more indicative of the relative extent of driver/vehicle mismatch problems than their absolute magnitudes.



Michael Perel
Contract Technical Manager

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I. INTRODUCTION

A. PROBLEM STATEMENT AND PURPOSE

There is relatively widespread belief among human factors researchers involved in vehicle design that driver/vehicle mismatch problems are at least partially responsible for a significant number of vehicle accidents. A broad variety of driver/vehicle mismatch problems have been hypothesized over the years as the result of numerous control design, anthropometric, vision, reach, steering and braking studies, and by reviews of contemporary vehicle designs in light of established human factors design principles. A few examples of these hypotheses will serve to better define the meaning of driver/vehicle mismatch and illustrate the pervasiveness of potential problems.

Small drivers have been observed to have difficulty, at least in some vehicles, reaching hand and/or foot controls to the extent that optimum operation is severely degraded. Do small drivers, notably females, have more close calls and/or accidents due to this difficulty?

Brake and accelerator pedals in some vehicles are very close together and on different planes, possibly resulting in inadvertent operation of a pedal or delayed response to brake operation. Do such designs lead to increased close calls or accidents?

Tall drivers have complained that interior mirrors obscure their forward vision of pedestrians, motorcycles, cyclists, and even larger vehicles approaching from the right. Is this a problem for tall drivers or drivers in general?

Older drivers and, again, perhaps smaller and therefore weaker drivers have complained about vehicle handling during tire, brake, or steering failure, especially in larger vehicles. Is this a significant accident producing or contributing problem and is it related to vehicle type and/or driver age and stature?

The hypothesized design problems are said to reduce driver performance, particularly reaction time and accuracy, e.g., operation of the wrong control or operating it too slowly in a time critical situation, being blinded by glare, and not being able to quickly view the

entire rear hemisphere. Although some evidence exists which supports the hypothesized design problems, it is by no means extensive or unequivocal.

In recent years, considerable research by government and industry has focused on the improvement of automobile controls and their operability, vision aids, and driver/vehicle packaging. However, neither the magnitude nor the specifics of the driver/vehicle mismatch problem has been clearly established or defined. The result is a running disagreement between human factors safety advocates, who point to vehicle design deficiencies, and automotive industry spokesmen, who cite a lack of evidence in support of the human factors specialists and point to the driver and the environment as by far the principal factors associated with accidents. This disagreement, while undoubtedly based at least partially on technical/scientific grounds, unfortunately appears to have political and economic overtones. It is no secret, for example, that industry in general tends to resist government regulation. The extent of the resistance seems highly correlated with implementation costs to industry. And, in general, industry's position cannot be set aside as groundless. The cost impact of a regulation is almost never negligible and empirical support for the regulation, therefore, should be an essential requisite for its enforcement.

The relation between driver/vehicle mismatch problems and accident involvement being a primary question of interest, it would appear logical and desirable to call upon actual accident data for purposes of confirming or rejecting such a relation. Unfortunately, conventionally acquired accident data are simply inadequate sources of valid information and the likelihood of generating more appropriate data in the foreseeable future appears less than encouraging. The simple reason for this state of affairs is that accident reporting systems have been, and continue to be, designed to answer other questions and, largely, to ignore vehicle design characteristics, other than equipment failure, as contributors to accidents. Accident investigations are almost exclusively concerned with establishing driver fault and associated circumstances for insurance purposes and potential legal proceedings. Recently,

efforts have also been directed toward intensive post-crash examinations of occupant injuries and vehicle structure. Reorienting investigators and data collection forms to include driver/vehicle mismatch design problems appears to be an impractical approach for gathering such data in the future.

An alternative to the study of accidents is the "critical incident" technique developed and implemented by Flannigan (1954) in the area of aircraft safety. This technique has been generally widely applied, although, surprisingly, sparingly in the automotive field (Fivars, 1975). Because it has gained an excellent reputation as a technique for identifying design problems and suggesting countermeasures, it would seem particularly useful for application to driver/vehicle mismatch problems and their potential solutions.

The purpose of this study was to study a relatively large sample of the passenger vehicle driving population to (1) determine the frequency of driver/vehicle mismatch problems being encountered, (2) assess the relative criticality of such problems to accident involvement, and (3) identify specific countermeasures to eliminate or reduce such problems. The approach to be taken was to include some form of the critical incident or near-accident technique. In addition, a number of methodological issues surrounding use of the critical incident technique and its application were to be explored.

B. A REVIEW OF CRITICAL INCIDENT RESEARCH

1. Introduction

The critical incident technique is a method of identifying errors and unsafe conditions which contribute to potential and actual accident events. A classic article by Flannigan (1954) traces the history and application of the approach, primarily in a military setting, although the technique has been widely used in one form or another for the past 20 years. A bibliography of over 600 critical incident studies by Fivars (1973), however, cites only a handful of studies applying that approach to automotive safety. These typically deal with drug and alcohol effects on driver behavior and generally focus on driver error

measures of critical incidents. A brief review of relevant literature focusing on the use of the critical incident technique in highway safety is presented below.

2. Literature Review

One of the first reported uses of the critical incident technique in the investigation of near accidents during driving was that of McFarland and Mosely (1954). They used a trained observer who accompanied truck and bus drivers on their normal routes. In the study of truck drivers, 17 drivers were observed on 20 trips totaling 5000 miles. The criteria for judging driver errors or critical incidents were how soon the driver recognized an emergency and what response(s) he made. Forty-eight near accidents were recorded. Table 1 shows the incidents grouped according to major error type made by drivers. As can be seen, the most frequent incident/type of error was a "dangerous assumption" by the driver.

During the 3900 miles of long distance driving by 24 bus drivers, 66 critical incidents were reported. These were categorized as shown in Table 2. In this study, "cornering," defined somewhat uniquely as "following too closely in approaches to pass another vehicle," emerged as the most frequent type of error.

Vehicle design problems were apparently not considered as critical factors in the research by McFarland and Mosely because only the drivers' skills were being observed and evaluated. These researchers did, however, interview 250 professional truck and bus drivers on the subject of design features of their vehicles. Table 3 lists "problem" design features and the number of comments made about them. More than 300 "ideas" were offered in the total pool of 1144 responses.

Some important design problems discussed by the drivers were:

- . *Vision:* Comments on defective vision were three times as frequent with bus drivers as compared to truck drivers.

Bus drivers were concerned with blind spots caused by large rear-view mirrors, and truck drivers referred to door posts as causing blind spots. Defective windshield clearing was frequently mentioned.

Table 1

TYPES OF ERRORS IN NEAR ACCIDENTS OBSERVED IN LONG HAUL TRUCK OPERATIONS

(After McFarland and Mosely, 1954)

Errors Resulting in Near Accidents	Number	Percent
Dangerous assumptions	13	27.0
Errors in passing	7	14.6
Operator unprepared	5	10.4
Operator taking complete defensive action	5	10.4
Gross negligence	4	8.4
Operator inattention	3	6.3
Operator indecision	3	6.3
Highway maintenance	3	6.3
Operator taking partial defensive action	2	4.2
Failure to observe posted "danger" signs	1	2.1
Failure to help other operator	1	2.1
Situations deliberately caused by drivers	1	2.1
Total	48	100.2

Table 2

NEAR ACCIDENT FREQUENCIES IN RELATION TO DRIVER FAILURE

(After McFarland and Mosely, 1954)

Nature of the Situation	N	Percent	Number Chargeable to Bus Driver
Cornering: following too closely in approaches to pass	44	66.7	44
Errors in approach, shifting and laning during passing	8	12.1	8
Following too closely	5	7.5	5
Operator dozed	3	4.5	3
Ran off road	1	1.5	1
Intersection error	1	1.5	0
In wrong lane	1	1.5	1
Vehicle entering roadway	1	1.5	0
Vehicle turning off roadway	1	1.5	0
Pedestrian error	1	1.5	1
Total	66	99.8	63

Table 3

FREQUENCY OF DESIGN FEATURE COMMENTS BY BUS AND TRUCK DRIVERS

(After McFarland and Mosely, 1954)

Design Feature	Number of Comments
Seats	40
Vision	59
Pedals	27
Hand brake	11
Gear shift	18
Steering wheel	18
Instruments	19
Switches	24
Brakes	8
Ventilation and heating	19
Doors	11
Physiology of the driver	6
Other comments	49
Total	309

- . *Pedals:* Pedals were found to be defective in surface characteristics, size, angulation and pressure requirements for operation.
- . *Seats:* Sixty-nine percent of the truck drivers desired better adjustment of seats. In fact, some adjustable seats could not be adjusted because of limited driver space.
- . *Steering Wheel:* Both truck and bus drivers indicated that the angle of the steering wheel was inefficient; they experienced difficulty in steering at low speeds, and there was a tendency for a brief loss of control after hitting "pot holes" or stones in the road.
- . *Brakes:* Considerable variability in brake lag results in drivers not being able to predict their total stopping distances.

A near accident mail survey of automobile drivers was reported by Forbes (1957). Four hundred questionnaires were distributed; 122 were returned, reporting a total of 179 near accidents. While the sample was probably biased because most of those surveyed worked in the field of traffic safety, the results are nevertheless insightful. The questionnaire defined a near accident as "...just missed being involved in a bad accident on the highway." The results indicate the importance of multiple factors (two to seven) as important in the near accidents.

It was hypothesized before the questionnaire was distributed that "hurry" would be a major factor and the results showed this to be true. Table 4 indicates the importance of poor visibility, slippery surface, and road design as near accident factors. Tables 5 and 6 indicate the role of driver errors, such as inattention, intoxication, misjudgment and errors of perception. These factors are presented as frequencies and are not rated in terms of their criticalness in causing the near accident. Again, vehicle design factors were not listed, suggesting that they were considered of minor significance.

Crossman and Wright (1968) issued an interim report summarizing a critical incident survey of near automobile accidents. Two versions

Table 4*

POOR VISIBILITY, SLIPPERY SURFACE, AND ROAD DESIGN

Condition	Incidents Involving Drivers		
	In a Hurry	Not in a Hurry	Both
Poor visibility (rain, fog, glare, angle of view, etc.)	23	15	38
Surface wet, slippery, icy	11	7	18
Road design factors (cross road on curve, sight distance, long no passing zone, dip, narrowing pavement)	44	17	61
Totals	78	39	117

Table 5*

INATTENTION, SLEEP, AND INTOXICATION

Condition	Incidents Involving Drivers		
	In a Hurry	Not in a Hurry	Both
"Not alert," "asleep at the switch," etc.	7	3	10
Distracted by passengers, conversation, thinking of something else	20 ^a	8	28
Attention on signal, cross-road, etc., and "did not see car"	3	0	3
Probably inattentive	8	5	13
Asleep, fatigued, drowsy	5	4	9
Intoxicated	2	1	3
Probably drowsy or intoxicated	3	5	8
Totals	48	26	74

^aThirteen (13) of these were reported by bus drivers

*(From Forbes, 1957)

Table 6*

MISJUDGMENT, ERRORS OF PERCEPTION, CONFUSED

Condition	Incidents Involving Drivers		
	In a Hurry	Not in a Hurry	Both
Misjudged:			
Speed of turn or curve	3	1	4
Speed and rate of closing	6	4	10
Passing opportunity	13	1	14
Other driver's intended action	7	6	13
Slippery road condition	1	3	4
Seriousness of hazard	15	6	21
Illusory effects of relative speed, car hidden in dip, misinterpreted officer's signal	4	0	4
Confused by inadequate signs, construction, complex intersection, etc.	2	2	4
Semi-sleep, confused, wrong reaction	0	1	1
Poor choice of procedure (slippery, afraid to pull off, trailer on ice, blocking bus instead of the bus stop)	1	3	4
Totals	52	27	79

*(From Forbes, 1957)

of a questionnaire were mailed to a total of 4000 people. Both forms asked the receiver to return the questionnaire "If you have recently experienced or witnessed a situation which could have resulted in a collision or other traffic accident." The first form (Mark I) was sent to 1000 university employees; 173 were returned. A revised form (Mark II) was sent in monthly batches of 1000 for three months. Out of the 3000 Mark II questionnaires distributed, 275 were returned.

The types of critical incidents reported in the Crossman and Wright study are shown in Table 7. The most common was side-on collision. The factors involved in the incidents are presented in Table 8. Lapse of attention or distracted attention accounted for almost 25 percent of the near accidents. Mechanical failure was a major factor in only 13 percent of the incidents.

Zuercher, Sass, and Weiss (1971) employed the critical incident methodology on a sample of college students and a sample of taxicab drivers. One hundred sixty-two students received a self-administered questionnaire; 21 reported no knowledge of an incident. The taxicab drivers were read the 14 questions on the form by an interviewer; 64 allowed themselves to be interviewed, while 52 refused. The major survey question was open-ended: "Recall once accident or near accident about which you had good knowledge and now recall clearly." The respondents were asked to state which factors were important in causing the incidents and which were important in avoiding them. If more than one factor was stated, they were asked to rank order them in terms of importance.

Table 9 shows the results when the respondents were forced to choose one of the three following categories as the major cause: (1) vehicle design, (2) highway design, or (3) driver or pedestrian. Approximately 78 percent chose the driver or pedestrian as the major cause. Table 10 lists the other factors most frequently cited by those who chose the driver as the major cause. Inattention (24 percent), excessive speed (13 percent), and failure to yield (10 percent), were the three most common. Table 11 shows the most common factors across all three categories of causes. Again, inattention and excessive speed were ranked one and two. The entire list of identified factors could conceivably be termed "driver error."

Table 7*

TYPES OF CRITICAL INCIDENTS

Type of Incident	Mark I	Mark II	Total	Incident Rate 1000/Month
Near Collision: Rear	24	56	80	10.0
Side	47	148	195	24.4
Head	9	27	36	4.5
Other	11	20	31	3.9
	<u>91</u>	<u>251</u>	<u>342</u>	<u>42.8</u>
Loss of Control: Direction	5	30	35	4.4
Speed	1	16	17	2.1
Other	<u>1</u>	<u>0</u>	<u>1</u>	<u>---</u>
	<u>7</u>	<u>46</u>	<u>53</u>	<u>6.5</u>
Other		55		
Total Critical Incidents	98	352	450	49.3

Table 8*

FACTORS INVOLVED IN CRITICAL INCIDENT

Factors Involved	Mark I	Mark II	Total	Percent
Lapse of Attention	26	Self 15 Others 37		
Distracted Attention	7	Self 6 Others 5		
	<u>33</u>	<u>63</u>	96	24.5
Lack of Experience	7	4		
Unfamiliar Vehicle	<u>1</u>	<u>1</u>	13	3.3
	<u>8</u>	<u>5</u>		
Obscured Vision	12	Self 16 Others 8		
Confusing Road Signs	4	Self 4 Others 4		
	<u>16</u>	<u>32</u>	48	12.3
Mechanical Failure	4	1	5	1.3
Total			391	

* From Crossman and Wright, 1968

Table 9*

MOST RESPONSIBLE FOR ACCIDENT OR NEAR-ACCIDENT

	Vehicle Design, Materials, Maintenance	Highway Design, Condition, Maintenance	Driver or Pedestrian	
College Students	12 (9%)	17 (13%)	102 (78%)	131 ^a
Taxicab Drivers	6 (10%)	9 (14%)	49 (76%)	64
	18 (9%)	26 (13%)	151 (78%)	195 ^a

^aTen subjects chose more than one category and were not included

Table 10*

MOST IMPORTANT DRIVER FACTOR CONTRIBUTING
TO AN ACCIDENT OR NEAR-ACCIDENT

Factor	College Students		Taxicab Drivers		Total	
Inattention	36	(36%)	4	(8%)	40	(24%)
Excessive speed	10	(10%)	11	(22%)	21	(13%)
Poor judgment	8	(8%)	0	---	8	(5%)
Carelessness	6	(6%)	1	(2%)	9	(4%)
Alcohol	6	(6%)	4	(8%)	10	(6%)
Inexperience	4	(4%)	0	---	4	(2%)
No use of turn signal	4	(4%)	0	---	4	(2%)
Moving against traffic signal	3	(3%)	2	(4%)	5	(3%)
Failure to yield	0	---	17	(39%)	17	(10%)
Lane changes	0	---	8	(16%)	8	(5%)
Miscellaneous	25	(25%)	17	(27%)	42	(25%)
	102		64		166	

*From Zuercher, *et al*, 1971.

Table 11*

MENTIONED AS A FACTOR CONTRIBUTING TO AN ACCIDENT OR NEAR-ACCIDENT

Factor	College Students		Taxicab Drivers		Total
Inattention	70	(27%)	26	(19%)	96 (24%)
Excessive speed	58	(23%)	18	(13%)	76 (19%)
Poor judgment	21	(8%)	--	---	21 (5%)
Carelessness	16	(6%)	--	---	16 (4%)
Stupidity	--	---	10	(5%)	10 (2%)
Alcohol	13	(5%)	12	(10%)	25 (6%)
Inexperience	10	(4%)	--	---	10 (2%)
No use of turn signal	12	(5%)	4	(3%)	16 (4%)
Moving against traffic signal	8	(3%)	11	(10%)	19 (5%)
Failure to yield	--	---	30	(22%)	30 (7%)
Lane changes	--	---	17	(12%)	17 (4%)
Following too closely	--	---	4	(3%)	4 (1%)
Miscellaneous	59	(23%)	8	(5%)	67 (16%)

*From Zuercher, *et al*, 1971.

The findings of Zuercher, *et al* (1971) are especially interesting because the authors state they were aware of the possible bias to fault the driver and not the vehicle in accident research. In fact, they state "Many forms for accident reports are constructed so the fault can be pinned on a driver. The highway and its current condition or the vehicles themselves are often overlooked." Apparently, they considered that merely investigating near accidents would allow more insight into accident causes--both vehicle and driver--than from actual accident cases. Beyond this assumption, the authors give no other reason why their questionnaire should have been more sensitive to isolating vehicle design problems than previous research.

Two surveys of drivers whose vehicles had controls mounted on the steering wheel stalk were analyzed by the Department of Industrial

Engineering and Operations Research, Wayne State University (undated). One survey of 400 drivers asked drivers if they had ever been "in a dangerous driving situation because of the location or design of a stalk control(s)." The second survey of 405 drivers asked: (1) "Did any delays in finding a control lead to a near miss or an accident?", and (2) "Did delays in operating controls lead to a near miss or an accident?"

Only 26 critical incidents were reported by the 800 drivers surveyed. The principal conclusions reached were: (1) Eighteen of 21 problems associated with finding stalk-mounted controls were divided equally between the horn and dimmer functions; (2) It was unclear whether respondents made a distinction between problems of finding and problems of operating; and (3) Use of the critical incident technique requires a large sample of drivers, trained interviewers, a validated questionnaire, and cooperative respondents.

The majority of automotive safety-oriented critical incident studies, it appears, have focused upon driver, situation, and environmental variables (as have most accident causation analyses) as the cause or as contributors to near accidents. Exceptions (the Wayne State survey and McFarland and Mosely, 1954), which concerned themselves with vehicle design and what we have termed driver/vehicle mismatch problems have identified a number of areas for further study. These include various controls, instruments, anthropometric difficulties, vision, steering, and braking.

C. SURVEY OF AUTOMOTIVE SAFETY EXPERTS

One aspect of the critical incident methodology is to ask persons highly experienced in the area of concern to delineate the critical factors for that area. This procedure was employed in the current study by questioning professionals in the field of automobile safety and design. Those questioned included National Highway Transportation Safety Administration personnel, university faculty, and professional staff of private research firms.

An attempt was made to query representatives of the automotive industry through the Society of Automotive Engineers. The two responses

received, however, stated the belief that driver/vehicle mismatch questions would be wasteful and nonproductive. No driver/vehicle factors were suggested for investigation. In fact, the objectives of the study were regarded by one SAE spokesman as not unlike the act of chasing "witches and elves."

By contrast, the limited questioning of non-industry experts resulted in responses from 14 individuals making 105 research suggestions. The research suggestions were classified into nine potential critical incident categories as shown in Table 12. The most frequently cited category was visibility, accounting for almost 27 percent of the responses. The second and third most frequently cited categories were control operation (18 percent), and lighting (12 percent). Examples of the potential design problems suggested and associated with the nine categories are listed on the following page.

Table 12
MAJOR CRITICAL INCIDENT FACTORS IDENTIFIED BY EXPERTS

Factor	Number of Responses	Percent of Total
Visibility	28	26.7
Control Operation	19	18.1
Lighting	13	12.4
Steering	8	7.6
Braking	8	7.6
Indicators	6	5.7
Seating	4	3.8
Shifting	1	0.9
Miscellaneous	18	17.1
Total	105	

- . *Visibility:* includes glare on windshield, blind spots, obstructed vision, window fogging.
- . *Control Operation:* includes reaching control, position, how well the controlled device works (e.g., do windshield wipers clean adequately), spacing between acceleration and brake and clutch pedals.
- . *Lighting:* includes conspicuity of brake lights and turn signals, warning lights, need for deceleration/acceleration indicators, insufficient headlamp lighting.
- . *Steering:* includes loss of control due to tire failure, vehicle handling ability, loss of power steering.
- . *Braking:* includes wheel lock-up, brake failure.
- . *Indicators:* includes conspicuity of warning lights, coolant level, high beam indicator, turn signal indicator.
- . *Seating:* includes driver posture and fatigue, seat adjustments, leg room.
- . *Shifting:* includes non-standardized shift patterns.
- . *Miscellaneous:* includes distraction by car radios, tape players, two-way radios, motorcycle inconspicuity, road hazards, traffic signs, driver age, driving experience, vehicle make.

D. SOME THEORETICAL CONCLUSIONS

For the most part, previously published research and discussions strongly emphasize the driver as being by far the major cause of accidents. Indeed, some feel that the driver is the *only* contributor to accidents. Since vehicles are obviously completely controlled by drivers and, with unique exceptions, cannot become involved in accidents independent of drivers, it is easy to conclude, therefore, that fault *must* lie with the controller and not with the controlled element. However, it may perhaps be a matter of arbitrary definitions which have led experts and laymen alike to reach and accept such a conclusion. After all, if we were to eliminate the automobile, we would also eliminate automobile accidents. Surely, the automobile plays a significant role.

To illustrate the problem of definition, consider the case in which a hypothetical automobile is equipped with fail-safe electronic sensor systems.¹ Such systems would immediately alert the driver (in time for adequate defensive action) to the dangerous presence of other vehicles. For example, the system would flag the situation in which a driver initiates a lane change and does not see another vehicle in the lane into which he is moving. Assuming this system works, and there is little reason to doubt that it is technically or at least theoretically possible, probably no one would suggest that it would not result in a reduction of lane-changing accidents. Suppose now there is a desire to eliminate this system. Implementation of this desire then results in an *increase* in such types of accidents. Thus, we have decreased and increased accident rate solely by vehicle design modification, indicating that something other than "driver error" is also contributing to accidents.

But we clearly need not resort to futuristic, hypothetical systems to illustrate this rather important but seemingly overlooked consideration. The elimination of rear view mirror systems would undoubtedly lead to higher accident rates. The elimination of turn signal controls/signals would *probably* lead to higher accident rates.² And, as we are all well aware, the establishment of lower speed limits has greatly decreased the accident rate. (While the latter can be viewed as a driver "design" manipulation, it is so only because vehicles are physically designed to reach excessive speeds. Clearly, ~~maximum~~ speed, at least along straight-aways, can be controlled by engineering design.)

A commercial airliner is loaded with safeguard equipment to aid and assist pilots, copilots, and crew. Yet, the visual and control demands on the pilot are almost insignificant in contrast with the automobile driver who is confronted with all sorts of nearby vehicles which are often moving in different directions--not to mention signals, signs, pedestrians, rain, fog, snow, darkness, glare, etc. Compared to the

¹The reader should dismiss such factors as cost and feasibility as objections to this illustration because they are simply irrelevant to the point to be made.

²If not, there is little justification for the inclusion of this system in vehicles.

pilot's relatively simple visual field, the field of the automobile driver can best be described as extreme chaos. Yet, the automobile driver's machine aids are few in number and quality. It should not be surprising, therefore, that the accident rate is exceedingly high. Further, the death rate per year places the "driving institution" in the category of major wars, with the automobile being the most successful and devastating weapon yet devised by man.

Certainly, the immediate causes of most accidents are drivers. But people are well known to be imperfect, incapable of processing *continuously* and *immediately* enormous amounts of information with *absolute accuracy*. But despite our knowledge of man's limitations, we nevertheless expect perfection. Realistically, we should accept the fact that vehicle design factors are extremely important contributory causes of accidents. They can and do alter accident rates.

We view vehicle design factors, with respect to their contribution to accident causation, as a class of catalysts. That is, the presence or absence of a specific design feature alters the magnitude of specific kinds of accident rates.¹ Statistically speaking, the presence or absence of a design feature influences the *probability* of an accident occurring per unit time. In considering the fact that vehicles are comprised of many (relevant to this discussion) design features, their *total* impact cannot but naively be dismissed as negligible.

Historically, scientists have unsuccessfully sought solutions to problems because of erroneous definitions. A classic example was the notion that sterilization or "cleanliness" was not a factor in the death rate of patients who underwent surgery. When the views of physicians Joseph Lister and Louis Pasteur were finally implemented, however, death rates were drastically reduced and *bacteria* were unequivocally defined as catalysts in the development and promotion of disease. Moreover, Lister and Pasteur were no longer viewed by the medical community as having spent useless years "chasing witches and elves." To dismiss vehicle design factors as negligible causations of accidents is, in our opinion, tantamount to ignoring reality.

¹Such a definition would also classify environmental and roadway factors as classes of catalysts as well.

E. SURVEY METHOD SELECTION

With a long list of potential driver/vehicle mismatch questions in hand, and the objective of surveying the experiences of a large number of drivers with regard to these mismatches, a survey method needed to be established. Variables involved in the tradeoff among various possible alternatives were reviewed briefly.

Three possible critical incident survey methods were considered: (1) personal interview, (2) telephone survey, or (3) mail survey. Each method has its strong and weak points in terms of cost, response rate, possible biases, and so on. In the absence of precise information, survey methods being more of an art than a science, the process of selecting the "optimum" method is largely based upon judgment and experience rather than on well-founded principals, as will be seen.

1. Personal Interview

The personal interview survey is the most expensive form of survey. It is estimated that the time actually spent interviewing is only 30 to 40 percent of the total; the rest is used in travel time and recalls. The critical element is the presence of the interviewer which accounts for the major advantage of the method--flexibility. The interviewer can use various forms of interaction with respondents to motivate and to clarify responses. Structured or open-ended formats may be used. Visual or mechanical aids may also be employed. The length of the interview can be longer than with other methods, and response rate is potentially the highest. The major disadvantages include high costs and the possible bias the interviewer may introduce.

2. Telephone Interview

One of the major advantages of the telephone over the personal interview is economy. The speed and efficiency of the telephone survey allows more interviews per unit time. The danger of interviewer bias is lessened and respondents tend to be more frank. When using a structured format, the respondent doesn't see the length of the questionnaire beforehand. The interviewer can motivate and direct the respondent.

The major disadvantage--sampling--is that not every one has a telephone or listed number. During the day, one is most likely to contact women. Multiple choice questions or long lists of comparisons can be difficult to comprehend over the phone. Also, once the interview is completed, no further responses can be obtained.

3. Mail Survey

The most important feature of the mail survey is the questionnaire. With no interviewer to direct or clarify the information sought, the questionnaire must be carefully designed. Pilot testing of the questionnaire is essential. Inducements or incentives may be necessary to achieve a high response rate. At least one and frequently two follow-up mailings are needed to increase returns.

The major disadvantage is that there is often inadequate response. Another difficulty is that the person who answers may not be the person to whom the questionnaire was sent. The respondent can read the entire questionnaire before answering the first questions, which may affect his responses. In general, the questionnaire cannot be too long; six to eight pages is frequently cited as being the maximum tolerable. However, with surveys of special groups, 20 page questionnaires have had an adequate return rate.

The most obvious advantage of the technique is its relatively low cost. It can also receive wide distribution and "bad neighborhoods" are not overlooked. The response rate is generally very rapid; of the questionnaires that will be returned, 90 percent are usually returned within two weeks. With certain subject matters, the reply is often more accurate because the respondent has sufficient time to think or examine records before answering. While the method is free from interviewer bias, it is susceptible to mailing list biases. If respondents are chosen from a mailing list that is too old or has been used in previous surveys or sales promotions, biases can be introduced.

A summary comparison matrix for the three methods is presented in Table 13. Much of the information presented above is derived from two excellent sources (Ferber, 1974; Erdos, 1970).

Table 13

COMPARISON OF SURVEY METHODOLOGIES ON IMPORTANT SELECTION CRITERIA

Comparison Factor	Personal Interview (PI)	Telephone Interview (TI)	Mail Questionnaire (MQ)
Cost	Most expensive	2/3 cost of PI	Cheapest, depends on response rate
Interview length	Can be long, 1-2 hr	30-60 min	6-8 pages
Distribution	Limited by work hours of respondents and bad neighborhoods	Requires listed numbers	Requires only mailing addresses
Response rate	Highest potential; can reach 85 percent	Slightly less than PI	Usually below 50 percent
Follow-up	When respondent is not home	When respondent is not home	At least one reminder sent 3-5 days after original
Speed	Slow	Moderate: Depends on number of interviewers	Fast: Usually 90 percent of returns in two weeks
Biases	Susceptible to interaction of interviewer and respondent	Less than PI	Least susceptible
Complexity/depth	Can use complex materials and visual displays	Complex, but no long lists or many choices	Complex is o.k.; if too long, poor response rate
Critical element	Interviewer	Interviewer and questionnaire	Questionnaire
Quality	Highest potential for most information yield	Very good; greater frankness than PI	Depends on the questionnaire
Training	Interviewers	Interviewers	None
Flexibility	Most flexible	Good, usually uses structured format	Least flexible
Incentives	Not usually required	Sometimes needed	Often used to increase responses
Elaboration on responses	Yes	Yes	No
Response completeness	Good because of interviewer feedback	Same as PI	May be poor
Assumptions about requirements	Few	Few	Must be literate

F. FOCUS PANELS

1. Purpose

The focus panel or group interview represents an often-used technique to aid in the development of survey questions. In addition, panels are helpful in gaining insights into the capability and/or willingness of potential respondents to handle the subject matter being considered for the survey. Focus panels were used in this study to bridge the gap between the general categories of interest expressed in the survey of experts and the specific survey instrument content to be developed. Specifically, we sought to answer questions such as:

- . What level of detail can people recall?
- . What do such terms as "near accident" and "close call" mean to people?
- . What stereotypes regarding accident or near accident causation do people have?
- . Are general or specific questions better for eliciting driver/vehicle mismatch problem experiences?
- . Are people reluctant to discuss near accidents and/or accidents?

2. Panels

Two focus panels were conducted. Each panel was comprised of five or six members and lasted from two to three hours. Discussions were tape recorded for subsequent play-back and analysis.

Panel members were recruited from staff member friends, friends of friends, and those responding to local advertisements. They were paid \$15 for their participation. The first group consisted of six members, while the second contained five members. Two staff members--a moderator and listener/notetaker--were also present at each meeting.

A total of six females and five males, ranging in age from 20-32 years and having 4-17 years driving experience, comprised the groups. Occupations included housewives, teacher, engineer, telephone operator, cost analyst, military serviceman, mail carrier, and unemployed person. Vehicles represented included a Toyota, Torino wagon, M.G., Duster, Gremlin, Mustang, Galaxie, Pinto, Porsche, Anglia, and Volkswagen.

3. Procedure

Focus panel discussions were held in a conference room between 7 and 10 PM. Upon arrival, members were requested to complete a brief form to assure payment and to gather minimal biographical data. They were informed that the discussion would be recorded but that all comments would be treated in the strictest confidence. The group was given a brief description of the intent of the discussion and the goals of the research.

The interviewer initially employed a nondirective, open ended, unstructured approach, interrupting only to keep discussion moving and within the areas of interest. Two basic questions were posed to the group. The first and most unstructured question was intended to determine whether or not members would cite driver/vehicle mismatch problems at all. The second question, introduced about midway through a session, was used to focus the group on these latter types of problems. The two questions were:

- 1) Would you describe a near accident in which you were involved--a close call which was frightening and almost resulted in damage or injury, but for some reason an actual accident was avoided?
2. What features of your vehicle or other vehicles, roadways, signs and signals in your experience have led to unsafe situations in which you were almost hit or your car almost hit someone or something else?

4. Focus Panel Results

Tape recordings were reviewed as many times as necessary to insure that all relevant discussion data were obtained. The analyst summarized each near accident situation described by a participant. The relevant commentary by each panel member is summarized in Appendix A with minimal editing to increase clarity.

In addition to these specific pieces of information, a number of general findings emerged. First, it became clear that the category "near accident" was too restrictive to include all of the various hazardous experiences which the respondents had had. They talked about

annoyances, potentially dangerous situations and actual accidents, as well as that category of events which we had defined as near accidents. In order to increase the amount of data to be gathered in a subsequent survey, it was apparent that several categories ranging from "no problem" to "accident" would be desirable to allow respondents to at least rank order the severity of the problem experienced. Limiting responses to a "near accident" category would preclude many negative experiences occurring in more or less severe categories.

Second, in response to the request to describe near accidents, group members almost universally did so in very vague terms, assigning causes to conventional stereotypes, such as the "other driver" and "didn't see him," when causes were assigned at all. Virtually no one suggested vehicle design or driver/vehicle mismatch problems, as we had conceived them, as causes or contributors to near accidents.

When directly questioned about specific vehicle design features, however, such as controls, mirrors, parking brake location, and so on, group members described numerous driver/vehicle mismatches which ranged from annoying to accident causing. When questioned as to why no one mentioned these earlier, the typical answer was that they "didn't think of them." Therefore, it became clear that the survey instrument should be very specific with regard to design factors in order to stimulate memorial processes and focus respondents on vehicle characteristics.

Third, the range of vehicle/driver mismatch problems mentioned was relatively extensive. For examples they included a man whose seat-back would fall to the horizontal position without warning, almost causing loss of vehicle steering control, to a woman whose knee disengaged the parking brake upon entering her car, to a man who tilted his rear view mirror upward, rendering it unusable, because of following headlight glare. A specific, yet extensive, set of survey questions was clearly indicated.

II. PILOT STUDY METHOD AND RESULTS

A. INTRODUCTION

Questions developed for subsequent pilot study evaluation were generated from several primary sources, including:

- . Expert survey results which identified numerous potential mismatch problems and specific questions of interest;
- . A literature review of critical incident, accident and driver/vehicle interface studies which defined general as well as specific areas of interest;
- . Focus panels which identified a few areas of interest that had not been revealed by other sources;
- . Many hours of discussion among ourselves, NHTSA staff, and other professionals in the field of human factors engineering and automotive safety.

The large number of research questions and hypotheses were then analyzed to determine additional data needs. For example, to test a hypothesis regarding driver stature and control reach, certain anthropometric data were needed. Similarly, in order to be able to relate mismatch problems to vehicle size, familiarity, etc., several categories of demographic data were defined. These included driver height, weight, age, sex, years driving experience, experience with the vehicle of interest, vehicle manufacturer, body type, age, and equipment.

The process of questionnaire development is highly subjective. There are, however, a number of principles which aid in the selection of questions, wording, formatting, and scoping the survey instrument. The process is iterative in that considerable rewriting is required in order to satisfy criteria for achieving specific goals. Thus, while a major goal was to acquire a sufficient amount of information from respondents, it was recognized that the questionnaire must be simple, relatively short and appear to require little of the respondent's time for completion in order to reach a second goal, namely to achieve a relatively high return rate.

One very large category of data, situation/environmental factors, was omitted from the present survey for two reasons. First, its inclusion

would have increased the size of the questionnaire to such an intolerable extent that response rates would likely have been severely curtailed. Second, situational data seemed to fall into the category of useful but unessential information. To a large degree, accident data currently available identify situational factors associated with accidents. We know, for example, the proportion of accidents occurring at different times of the day, in rain, snow, and dry weather, on two and four lane rural and urban roads and highways. There seemed to be little practical value in acquiring redundant information, especially in light of the requirement to keep the questionnaire brief.

Perhaps the most important initial decision to be made was that of (1) gathering extensive data on a single critical incident or near accident, probably only a limited number of which would involve mismatch problems, or (2) gathering data on as many mismatch problems as a driver could relate. After considerable agonizing, the latter approach was selected over the former. The primary reason was that the in-depth approach would, as suggested, likely result in fewer mismatch type incidents, since a respondent could only provide a large amount of situational and other detailed data about only one incident on a fixed size questionnaire. The alternative would permit a respondent to identify as many driver/vehicle mismatch caused incidents as he has experienced and to rate the severity or criticality of each. The breadth and statistical superiority of this latter approach appeared better suited to assessing the magnitude of the mismatch problem. The in-depth approach appeared to be more suitable as a follow-up study, once specific problem areas of interest had been delineated. However, the above rationale notwithstanding, it was considered useful to compare both approaches in a pilot study.

B. QUESTIONNAIRE DEVELOPMENT - ALTERNATE FORMS

Five pilot study questionnaire forms were developed for pilot study testing. These alternate forms were to serve primarily as a basis for evaluating a number of questions prior to finalizing a survey instrument to be subsequently used on larger samples. The five forms varied with respect to length (4, 5, and 6 pages), type of question (check versus

open ended), specific questions and format. Each of the five alternate forms are described briefly below. The questionnaires themselves are presented in Appendix B.

Form I is the longest of the forms, six pages, and represents what we believed to be the most exhaustive in terms of content that would still result in a reasonable response rate. It asks respondents to check the category representing the worst or most hazardous experience they have had for each of 50 vision, steering, control/display, etc., potential mismatch questions. In addition, it requests, as all forms do, biographical and vehicle description data. Also, each pilot study form requests a short critique of the form itself. An open-ended question was included to assess response rate and quality of response.

The second form (Form II) is identical to Form I except that the response checkoff format was varied. The respondent was required to fill in a number (scale value from 1 - 5) representing his experiences (from "no problem" to "caused accident") rather than simply to check one of five available response categories. The Form II format required a simple coding step by the respondent but had an advantage in that the questionnaire appeared much shorter than Form I. We hypothesized that Form II would result in a greater response rate than Form I.

Form III was designed to determine how much useful information was being lost by the grouping of specific questions used in Form I to shorten overall questionnaire length. In Form I, separate questions, such as vision limitations due to glare from the left side mirror, right side mirror, and inside mirror, were combined into one question since a break-out of each potential problem area resulted in a very lengthy questionnaire. In Form III, specific question elements are broken out as individual questions but only a limited number of questions are presented.

Form IV is simply a shortened version (4 pages) of Form I, designed to test the effect on return rate of questionnaire length. It excludes all visibility-related questions, which represent about half of the check-off questions of Form I. Biographical and vehicle data are the same.

Form V is an open ended, fill-in type questionnaire which we hypothesized (based on previous survey experience) would not be completed by many respondents. However, we were interested in the quality

and extensiveness of information it might provide. A particular pilot study fill-in question(s) could ultimately find its way into the revised questionnaire form if it provided especially useful information.

C. PILOT STUDY METHODOLOGY

1. Pilot Study Constraints

The pilot study was conducted under a number of constraints which dictated a less than ideal plan. First, we were unable to use a random sample of the driving population because of the indefiniteness surrounding OMB approval of any questionnaire submitted to more than ten persons in the public domain. We were, therefore, restricted to U.S. Government employees, a sample for which OMB approval was not required.

Second, a local group of several hundred was desired so that telephone follow-up of a subsample, especially non-respondents, could be conducted at reasonable cost. Thus, a sample of over 800 Federal Aviation Administration employees located in the Los Angeles area were obtained. Unfortunately, it was discovered that the home address mailing list could not be made available to us as we were originally led to believe was possible. Therefore, the questionnaires were necessarily distributed through the Western Region FAA internal mail system rather than by direct mail.

Finally, we found that the Federal Privacy Act presented substantial time-frame difficulties if the respondents were to place their names and phone numbers on returned questionnaires--a requirement for telephone follow-up of the sample. Unfortunately, the Privacy Act requirement for anonymity and schedule conflicts precluded relating a specific returned questionnaire with a respondents name and phone number. At best, we were able to request, on the questionnaire, that respondents call us.

2. Procedure

The Western Region FAA telephone directory was used to select a sample of 800 names. These 800 were randomly assigned to one of two cover letters used with each of five questionnaire forms (Figs. 1 and 2). The two cover letters differed only in that the second contained the



U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
WASHINGTON, D.C. 20590

IN REPLY REFER TO:

N43-40

Dear FAA Employee:

Would you please do us a favor?

15.6 Million auto accidents occur each year. Of these, about 46,000 end in deaths and almost 4.5 million end in injuries. All of these accidents can't be due solely to driver negligence. The National Highway Traffic Safety Administration is conducting a survey to find out what other factors are involved in these accidents. We are particularly interested in learning about driver problems with vehicle components, such as mirrors and controls, that can help the driver prevent an accident from occurring if they are designed properly. Will you please help us find out about the vehicle safety problems you have had by taking a few minutes to fill out the enclosed questionnaire?

Please complete and return the enclosed questionnaire (in the postage paid envelope) at your earliest convenience. To acquire and maintain your trust, we ask that you do not put your name on the questionnaire. If you would like to tell us on a confidential basis more information about the safety problems of your vehicle or your reaction to this questionnaire, please take a few minutes to phone (213) 674-1301 collect and talk to our research consultants who are conducting this study.

Many thanks for your help.

Sincerely,

P. Robert Knaff
Director
Office of Driver and
Pedestrian Research
Research and Development

2 Enclosures

Fig. 1--Cover letter 1



U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
WASHINGTON, D.C. 20590

IN REPLY REFER TO:

N43-40

Dear FAA Employee:

Would you please do us a favor?

15.6 Million auto accidents occur each year. Of these, about 46,000 end in deaths and almost 4.5 million end in injuries. All of these accidents can't be due solely to driver negligence. The National Highway Traffic Safety Administration is conducting a survey to find out what other factors are involved in these accidents. We are particularly interested in learning about driver problems with vehicle components, such as mirrors and controls, that can help the driver prevent an accident from occurring if they are designed properly. Will you please help us find out about the vehicle safety problems you have had by taking a few minutes to fill out the enclosed questionnaire? Because you are one of only 800 people selected for the survey, your response is crucial to the success of the project.

Please complete and return the enclosed questionnaire (in the postage paid envelope) at your earliest convenience. To acquire and maintain your trust, we ask that you do not put your name on the questionnaire. If you would like to tell us on a confidential basis more information about the safety problems of your vehicle or your reaction to this questionnaire, please take a few minutes to phone (213) 674-1301 collect and talk to our research consultants who are conducting this study.

Many thanks for your help.

Sincerely,

P. Robert Knaff
Director
Office of Driver and
Pedestrian Research
Research and Development

2 Enclosures

Fig. 2--Cover letter 2

following additional sentence in the first paragraph: "Because you are one of only 800 people selected for the survey, your response is crucial to the success of the project." A total of ten different cover letter/questionnaire forms were employed.

Envelopes addressed to each FAA employee in the sample, containing the questionnaires and prepaid postage return envelopes, were distributed through the FAA internal mail system.

D. PILOT STUDY RESULTS

When the questionnaires were returned, each was coded with regard to date received, form number, sex of respondent, and cover letter. Since the pilot study was not intended to gather statistical data for exhaustive analysis, only the first 30 returns of each form (excluding Form V) were analyzed in any detail. All responses to the first and fifth questions in Form V were evaluated because these questions were particularly unique and represented the core of this questionnaire. None of the demographic data except sex was tabulated, since interest was centered only on the degree to which respondents provided such data.

1. Response Rate

The overall response rate for all five survey forms was 53 percent at the end of the 28th day following questionnaire distribution (Fig. 3).¹ The two four-page short forms (Forms III and IV) had the highest response rates of 62.5 and 65.0 percent, respectively. These were followed by Forms I, II, and V, in that order. Table 14 summarizes response rate data. It is to be noted that Form I had a response rate of 58.1 percent, only slightly lower than Forms III and IV, even though the former was a substantially longer questionnaire.

Forms I and II were identical in content but different in format--Form II being about 80 percent of Form I in physical size. It was anticipated that this size difference would result in a greater return rate for Form II. This was not the case, however, as Form II's rate was approximately 9 percent lower (49.4 percent). This finding may reflect

¹An additional one percent was received subsequent to the analysis presented here.

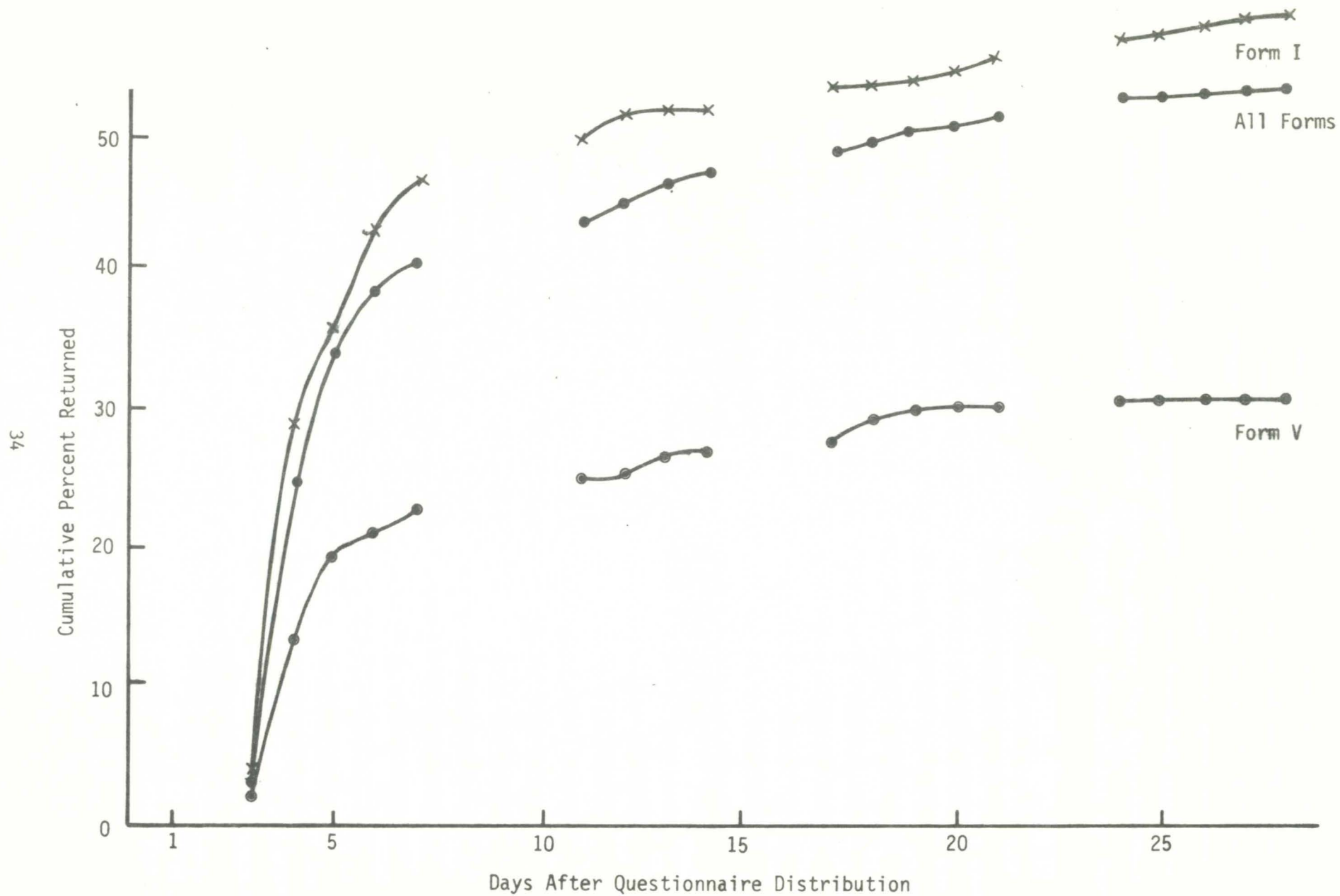


Fig. 3--Percent returns (pilot study) as a function of days after questionnaire distribution.

Table 14

SUMMARY OF PILOT STUDY RESPONSE FOR THE FIVE ALTERNATE FORMS

	Form I (%)	Form II (%)	Form III (%)	Form IV (%)	Form V (%)	All Forms (%)	Total
Total response	58.1	49.4	62.5	65.0	30.6	53.0	42.5
Male	69.9	75.9	69.0	65.4	79.1	71.1	30.2
Female	30.1	24.1	31.0	34.6	20.4	28.9	12.3
Letter 1	48.4	55.7	48.0	51.0	36.7	48.9	20.8
Letter 2	51.6	44.3	52.0	49.0	63.3	51.1	21.7
Total N	91	78	97	107	49	40	325

the possibility that Form II appeared somewhat more complex and/or required a little more effort to answer each question.

Form V had the lowest response rate by far (30.6 percent), in keeping with the results of previous research.

Form I, therefore, emerged as the most cost-effective questionnaire. It provided the largest amount of information, as derived by multiplying content by response rate.

2. Male/Female Responses

The sample of 800 FAA employees was comprised of approximately 44 percent females and 56 percent males. Of the total responses received, however, only 29 percent were from females while 71 percent were from males, yielding 35 and 65 percent response rates for females and males, respectively. These results are not particularly surprising, however, because females tend to be under represented in the driving population and, perhaps of equal or greater importance, probably have significantly less inherent interest in the subject under investigation.

3. Cover Letter

Eighty each of the five forms were distributed with cover letter 1 and identical numbers were distributed with cover letter 2. Of the total returns, 51.1 percent were from the letter 2 group, while 48.9 percent were from the letter 1 group. Letter 2 thus appears to be slightly superior with regard to response rate.

4. Frequency of Close Calls

The 30 respondents to Form I checked 30 "close call" boxes and three "caused accident" boxes. Form II received 33 "close call" and four "caused accident" responses. Forms III and IV received 15 and two, and 23 and two "close call" and "caused accident" responses, respectively. Thus, the total number of "close call" and "caused accident" reports appears to be highly related to questionnaire content. The long forms received about one "close call" check per person and the short forms about one check per two persons. For the open-ended Form V questionnaire, 41 (83 percent) of the 49 returns described "close calls."

The percent of respondents checking each of the five severity categories for each question for each of the five forms are presented in

Appendix B. (Form II results are shown on Form I for simplicity, while Form II itself is at the end of the Appendix.)

5. Some Specific Findings

a. Respondent Automobile Design Suggestions

Forms I and II contained the following open-ended question:

"Try to forget about specific features of cars that you are familiar with and tell us what you would really like to see built into the next car you buy--something that you think would reduce driver errors. If you cannot define what that 'something' might be, try to describe what it might do."

A similar question was included in Form V, except that respondents were asked to suggest design recommendations which might have prevented the close calls they had described:

"Would you please give suggestions on how changes in the features of your car, roadways, signs, other cars, etc., might prevent the near accident that you had from occurring again?"

Analysis of a sample of 60 Form I and II returns revealed that 63 percent of the respondents offered one or more suggestions. These suggestions are shown in Table 15, with minor editing to enhance clarity and simplicity. Visibility improvements clearly comprised the most frequent class of design recommendations. Moreover, of all visibility comments, rear vision, or more specifically, rear/side vision design improvements were most often suggested.

Of the 49 Form V returns, 37 (75 percent) provided recommendations. However, because the Form V question was related to the specific close call reported, it also elicited a sizable number of responses which were centered on driver and roadway factors. Of the total number of suggestions, 51 percent were vehicle oriented, 19 percent were roadway oriented (primarily signs and signals), and 30 percent were concerned with driver factors, i.e., improving driving skills, alertness, etc. As was found for Forms I and II, visibility improvements, particularly rear view visibility, dominated the suggestions, being 73 percent of the total vehicle oriented recommendations.

Table 15

SUMMARY OF RECOMMENDED DESIGN IMPROVEMENTS TO ELIMINATE FUTURE CLOSE CALLS
(PILOT STUDY)

Comment	Year/Vehicle	Comment	Year/Vehicle
<u>Rear Vision (43%)</u>		Adjustable left and right mirrors	Unkown
Improved right rear visibility	68 BMW	Important to see fenders in mirror when parking	71 Duster
Rear window defroster	69 Mustang	Rear window defoggers	71 Duster
Eliminate blind spots due to car design	72 Mustang	Eliminate louvered windows	73 Grand Am
Complete panoramic view to the rear	73 Impala	Better wipers/defogger front and rear	67 Mustang
Better right rear vision	73 Dart Swinger	Better visibility of low small cars at side	70 Chevelle
Rear view mirror that shows all of road behind	70 VW	Wide rear view mirrors	73 Alpha Romero
Rear window wiper	70 VW	Low slope rear windows	73 GTV-2000
Rear window defogger	70 Porsche	Side mirrors without blind spots	76 Van
No obstruction due to rear posts	70 Porsche		
Better right rear visibility	73 Pinto	<u>Forward Vision (17%)</u>	
Better mirrors for vision on both sides	68 Impala	High brake lights	71 Maverick
No glare from mirrors at night	68 Impala	Coasting tail light indicator	69 Corona
Rear window defogger	68 Impala	Improved vision in fog	68 BMW
Eliminate blind spot	73 Pinto	Automatic lane change signal light	73 Comet
Rear window wipers	71 Malibu	Sit higher up to see over hood	73 DeVille
Mandatory left and right mirrors with convex attached	68 Opel	Better forward visibility around trucks, vans, and buses	73 Pinto
Better visibility in both adjacent lanes	69 Mustang	Better sun visors	76 Capri II
Rear window defog/deice	72 Nova	Brighter turn signals front and rear sides	68 Opel
Better rear and side visibility without turning head. Mirror has blind spots	Unknown	Visibility	74 Dasher
	-- 610 Datsun	Brighter turn signal lights	70 Chevelle

Table 15 (continued)

Comment	Year/Vehicle	Comment	Year/Vehicle
<u>Controls (12%)</u>		Simplicity	76 Cheverolet Van
Ash trays that can be reached	70 Chrysler	Low gas warning light	-- Dart Custom
Control location standardized	71 Maverick	Ventilation improvement	76 Capri II
Reach foot pedals by short drivers	68 Electra	Too-close following warning system	71 Malibu
Standardize switches	68 Mustang	Cars are designed fine - drivers are 99% of problem	71 DeVille
Inside controls to adjust mirrors	73 Grand Am	Over the back harness	-- Montego
Better pedal reach with seat all the way forward	69 Charger	Highway patrol doesn't enforce 55 mph limit	Unknown
Standard geometry pedals	73 GTV-2000	Improved driving and vision tests	67 Olds 98
<u>Braking (8%)</u>		Don't hide speedometer by steering wheel	73 Grand Am
Anti skid brakes	69 Mustang	Side vent windows	73 GTV-2000
Four wheel disc brakes	70 Porsche		
Rapid and even braking	69 Mustang		
Handling, nonfade braking	74 Dasher		
Effective brake indicators	Unknown		
<u>Seating (2%)</u>			
Better seats	-- Dart Custom		
<u>Miscellaneous (23%)</u>			
More space for large drivers in small cars	73 VW		
Automatic following distance device	69 Corona		
Gauges rather than lights	69 Mustang		
Mandatory fire extinguisher	69 Mustang		

b. Form V Close Call Descriptions

Of the 41 descriptions of near accidents given by respondents for Form V, 29 percent were associated with lane changing problems on freeways. Either the respondent initiated a lane change, only to discover at the last moment that continuation of that maneuver would result in a collision with an adjacent vehicle, or the other vehicle initiated the lane change, unaware of the driver's presence in the adjacent lane. The descriptions included references to "blind spots" and generally poor rear/side visibility (in keeping with the results obtained from the question asking them to offer preventive measure suggestions, Sec. 5a above).

Twenty-two percent of the descriptions were close calls within four-way intersections. Examples of causative factors included poor forward vision, false assumptions of drivers and demonstration of poor signaling behaviors. Seventeen percent of the descriptions involved lane changing problems similar to those noted above, except that they occurred on two-way surface streets. Thus, nearly half (46 percent) of the total descriptions provided by respondents were lane changing problems.

Of the remaining descriptions, 12 percent were concerned with car-following problems. In most cases, respondents indicated that observation of forward decelerating vehicles occurred "just in time" to avoid a certain accident.

The remaining close call descriptions were varied. Examples were freeway on-ramp merge conflicts, head-on conflicts on two-way surface streets, and autos exiting parking lots which presented potential broad-side collisions.

c. Responses to Control Questions

Form III requested respondents to complete a question which was concerned with problems experienced with finding, reaching, and operating primary and secondary controls. In addition, they were asked to circle the particular control(s) causing the problem. A total of 60 Form III responses were sampled and the frequency with which various controls were circled was tabulated.

Slightly fewer than half of the respondents were at least "annoyed" by some aspect of finding, reaching or operating a control(s), as shown below:

<u>Primary Controls</u>	<u>No.</u>	<u>Secondary Controls</u>	<u>No.</u>
Headlights	0	Radio knobs	2
Turn signals	0	Ashtray	5
Headlight dimmer	9	Lighter	3
Window washer/wiper	3	Vent	3
Defogger	6	Climate control	9
Deicer	3	Interior light	2
Emergency flasher	6	Dashlights	1
Mirror dimmer	4		
Horn	4		

The headlight dimmer and climate control were clearly the most frequently circled controls. These results were not surprising since operation of the headlight dimmer on most cars requires that the driver temporarily reduce his capacity to operate rapidly his primary foot controls (brake and accelerator), and operation of the climate control(s) often requires considerable direct vision which therefore interferes with normal forward and rear vision behavior.

d. Summary of "Other" Responses

Very few respondents provided comments for the category of "other." With few exceptions, e.g., "can't adjust right outside mirror," "louvered windows limit vision," these comments were expressed elsewhere in the questionnaires and provided no basis for development of additional questions.

e. Respondents' Critiques of the Questionnaires

As expected, relatively few comments were expressed by respondents to the question which asked whether they had difficulty understanding how to complete the questionnaires satisfactorily. None indicated difficulty in comprehension. Some comments commended the purpose of the survey, while a few considered it "wasteful" and "foolish." Form IV, which excluded visibility questions, was criticized for not including such questions. Other criticisms involved references to the facts that no maintenance and few vehicle breakdown questions were included. To some extent, however, the critiques were helpful in

providing suggestions indirectly for rewording questions and instructions, and for the addition and deletion of specific questions.

f. Loaning a Card to a Friend

Form V contained a question asking the respondent what he would tell a friend, about to drive his car, that would enhance his safe driving. Suggestions provided were highly similar to, but far less informative than, responses given to the open-ended "design recommendations" question discussed earlier (Sec. 5a).

6. Telephone Interviews

Ten respondents (all males) called the phone number listed at the end of the questionnaires to give additional information on a "confidential" basis. Since this number represents only slightly more than one percent of the total sample, little can be said about soliciting interviews from individuals who have already expended significant effort in completing questionnaires.

In general, the additional information gathered during the interviews was not of greater depth than that obtained from the questionnaires. However, some of the information was broader in scope. One of the reasons for phoning was to cite problems not covered in the questionnaire. Examples cited included (1) protective side mouldings, (2) standardization of brake relining quality, (3) polyglass tires falling apart within a short period of time, and (4) car jack failure. Another reason for calling was to talk about a second car the respondent owned.

One respondent revealed a particularly interesting problem. He was afflicted with arthritis and the condition severely restricted his ability to turn his head or reach controls on some vehicles. He reported that he would avoid making left merges from intersections on a highway because he could not turn his head fast enough from side to side to monitor oncoming traffic. Instead, he would make a right turn and proceed until he could make a U-turn, which then allowed him to travel in the desired direction. With respect to control manipulations, he would use a coat hanger to reach controls (e.g., light switch) and pull them. He reported that, "I'm in real trouble when I operate a car with control switches that turn instead of pull." It would be interesting to find out how

representative this man's driving behavior is of other handicapped drivers.

E. RECOMMENDED MAIN SURVEY QUESTIONNAIRE

All things considered, Form I proved to be the most cost-effective questionnaire employed in the pilot study. However, substantial modifications of Form I were made as a result of evaluating pilot study findings from the remaining forms. The more significant changes are described below.

In contrasting results obtained from Forms I and III, it appeared desirable to obtain greater detail on some of the "compound" design features described in Form I questions. For example, the question, "My vision has been limited because of headlight glare at night on my inside, left or right outside mirrors from cars behind me," was split into two questions, each of which was concerned with a single mirror. There was a suggestion that glare problem frequency and severity was more severe for interior than for left-side mirrors (reference to the right-side mirror was eliminated.)

Second, the format of the Form I control reaching, finding, and operating question was considered inadequate to enable acquisition of responses to specific controls. The controls questions were therefore modified so that more detailed data relevant to current NHTSA rulemaking activities could be obtained.

Third, "other" response categories were dropped from the questionnaire due to insufficient response and, perhaps of equal importance, the need to constrain the overall size of the questionnaire.

Fourth, certain questions in Form I assumed that an experience leading to a potential problem had occurred, e.g., a tire blow-out. Numerous drivers apparently did not have such experiences, making the question "inapplicable." Therefore, an inapplicable response option was provided in the recommended questionnaire for such questions.

Fifth, certain questions which appeared to fall outside the scope of this study were eliminated to save space. For example, the question dealing with driver problems of seeing other vehicles' tail lights was dropped because it did not represent a mismatch problem between the

driver and his own vehicle. (It is of interest to note, however, that there was considerable response to such questions in the pilot study.)

Finally, several instruction and question wording changes were made to provide a more intelligible survey instrument. Changes in question order and layout were also made to provide better groupings and enhance credibility.

The final recommended questionnaire is described in detail in the following section.

III. LARGE SAMPLE SURVEY

A. INTRODUCTION

This section describes the recommended driver/vehicle mismatch survey questionnaire, the constraints which in large part dictated its form, and the procedures to be followed in its administration. Also, the data analysis plan is described.

1. Alternate Approaches and Constraints

The survey questionnaire evolved to its final content and format through the literature reviews, survey of experts, focus panels, and extensive pilot testing but was also impacted to a fairly large extent by a number of constraints. The basic content of the questionnaire could have assumed numerous forms as could the ultimate procedure for its administration. The more important alternative approaches are outlined briefly below since they may have had certain potential advantages over that ultimately pursued.

First, since memory or recall of critical incidents or close calls is certainly influenced by the passage of time, it might have been desirable for drivers to respond to questionnaire items in "real time," that is, as events occurred. A method was conceived by which agreeable drivers would carry with them, in their vehicles, a set of response forms which would be completed shortly after a close call and immediately returned for analysis. Thus, memory losses of such events could be eliminated as potential problems.

Second, we anticipated that a follow-up telephone interview with at least some respondents and possibly non-respondents to obtain additional information and to provide a check on potential sampling bias seemed appropriate. Conceivably, much additional information could be obtained through the flexibility of a personal telephone interview, e.g., the frequency of the same problem, additional situational data, etc.

Unfortunately, none of these desirable approaches could be pursued within the scope of the current study because of two rather severe constraints. Due to the Office of Management and Budget (OMB) requirement imposed upon NHTSA and the contractor to obtain questionnaire approval and due to the apparent absence of any commitment by OMB on future approval, the initial plan to conduct the survey was abandoned.

Alternatively, the questionnaire was published and various private sources were approached regarding their interest in conducting the survey themselves and furnishing us with results. Several private institutions agreed, and their cooperation is discussed in a later section, but the approach eliminated employing the "real time" and personal and telephone interview methods since no group would undertake the additional expense and logistics problems of those approaches on their own.

In addition, the time delays and constraints imposed by other government regulations relating to privacy precluded access to individual's names and questionnaire responses, thus eliminating the personal follow-up telephone interview.

Such constraints dictated anonymity of responses, a direct mail survey method and development of procedures which were consistent with the limitations of the private institutions willing to conduct the survey.

B. QUESTIONNAIRE DESCRIPTION

The questionnaire used by all groups conducting surveys was identical to that illustrated in Table 16. The instructions describe the questionnaire and indicate how to respond to each question. For the majority of questions, possible responses include "No Problem," "Annoying," "Potential Danger," "Close Call," and "Caused Accident." The respondent is asked to select that response which illustrates the worst experience he has had with the particular problem described. For all questions, the respondent is asked to consider only the experiences acquired with a *single* vehicle. Driver/vehicle mismatch questions are grouped into the following categories: Seeing Difficulties, Vision Limitations, Seating, Braking, Steering, Seeing/Reading Instruments, Car Unfamiliarity, and Finding, Reaching, and Operating Controls. These sets of questions are followed by a question requiring the respondent to identify factors contributing to close call experiences and their magnitude.

Subsequently, respondents are asked to estimate the number of close calls in the last two months and describe a design suggestion(s) that would eliminate or reduce their close calls. The last page of the questionnaire requests vehicle and driver demographic information.

Table 16
PERCENT OF RESPONDENTS
NATIONWIDE VEHICLE SAFETY SURVEY

In answering the questions in this questionnaire, please consider only the car you drive most often. Before answering, please be sure to read the instructions given below.

INSTRUCTIONS

This questionnaire consists mostly of questions which ask you to select one of five possible answers. The answers are (1) NO PROBLEM, (2) ANNOYING, (3) POTENTIAL DANGER, (4) CLOSE CALL, and (5) CAUSED ACCIDENT.

EXAMPLE (Check only one)

PROBLEM	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
My vision has been limited because of: fog, rain or snow on my side or rear windows	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

If your vision has never been limited because of fog, rain or snow on your side or rear windows, you would place a check in the box under "NO PROBLEM". If your vision has been limited and caused you to be annoyed but never seemed to be a danger, you would place a check in the box under "ANNOYING". If your vision has been limited and it placed you in a potentially dangerous position, you would check the box labeled "POTENTIAL DANGER". If your vision has been limited and it almost resulted in an accident, you would check the box labeled "CLOSE CALL". Finally, if your vision has been limited and it resulted in an actual accident, you would check the box labeled "CAUSED ACCIDENT".

For each question, please select the one answer which best describes the worst situation you had with the problem. For example, if the same problem resulted in you having a near accident or "close call" on one occasion and an actual accident on another occasion, you would check only the box labeled "CAUSED ACCIDENT".

Remember, check only one box per item. And only for the one car you drive most often.

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
I HAVE HAD DIFFICULTY SEEING:					
Far enough ahead to detect pedestrians, cyclists, or curves in the road using my low-beam headlights	45.2 1 ☐	27.6 2 ☐	23.1 3 ☐	4.0 4 ☐	0.10 5 ☐ 111
Far enough ahead to detect pedestrians, cyclists or curves in the road using my high beam headlights	87.3 1 ☐	9.2 2 ☐	2.9 3 ☐	0.6 4 ☐	0.03 5 ☐ 112
MY VISION HAS BEEN LIMITED BECAUSE:					
Of rain, snow or fogging on my side windows	37.6 1 ☐	38.3 2 ☐	21.5 3 ☐	2.3 4 ☐	0.21 5 ☐ 113
Of rain, snow or fogging on my rear window	31.5 1 ☐	39.1 2 ☐	26.1 3 ☐	3.0 4 ☐	0.33 5 ☐ 114
Of glare at night from an oncoming vehicle's headlights	16.7 1 ☐	46.3 2 ☐	32.1 3 ☐	4.8 4 ☐	0.15 5 ☐ 115

Table 16 (continued)

MY VISION HAS BEEN LIMITED BECAUSE:

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Of glare at night from another vehicle's taillights	70.9 1 ☐	25.1 2 ☐	3.6 3 ☐	0.41 4 ☐	0.00 5 ☐ 116
Of sun glare reflected from parts of my car.	59.8 1 ☐	29.9 2 ☐	9.7 3 ☐	0.6 4 ☐	0.06 5 ☐ 117
Of headlight glare at night on my inside mirror from cars behind me.	33.1 1 ☐	51.7 2 ☐	14.5 3 ☐	0.7 4 ☐	0.03 5 ☐ 118
Of headlight glare at night on my left outside mirror from cars behind me . . .	45.9 1 ☐	44.6 2 ☐	9.1 3 ☐	0.4 4 ☐	0.00 5 ☐ 119
Inside mirror did not give enough information directly to the rear of my car . .	69.6 1 ☐	15.1 2 ☐	12.1 3 ☐	3.1 4 ☐	0.12 5 ☐ 120
Left mirror did not give enough information to the left side of my car.	70.2 1 ☐	16.1 2 ☐	10.3 3 ☐	3.2 4 ☐	0.15 5 ☐ 121
Right mirror did not give enough information to the right side of my car (Check here if you don't have a right outside mirror ☐) . . . 50%	58.9 1 ☐	21.7 2 ☐	14.9 3 ☐	4.3 4 ☐	0.25 5 ☐ 122
It took too long to get information from my mirrors so I was distracted from looking ahead of me	76.9 1 ☐	14.6 2 ☐	7.6 3 ☐	0.9 4 ☐	0.15 5 ☐ 123
Windshield wipers didn't clear my front window quickly or completely of fogging, rain or snow.	56.0 1 ☐	28.9 2 ☐	13.8 3 ☐	1.4 4 ☐	0.03 5 ☐ 124
Windshield defogger didn't clear the front window quickly or completely of fogging	53.8 1 ☐	29.9 2 ☐	14.9 3 ☐	1.4 4 ☐	0.06 5 ☐ 125

MY VISION HAS BEEN BLOCKED BY:

One of the front, side or back posts supporting my car's roof.	60.5 1 ☐	20.5 2 ☐	14.9 3 ☐	3.9 4 ☐	0.23 5 ☐ 126
The front roofline, hood or trunk.	94.4 1 ☐	4.1 2 ☐	1.2 3 ☐	0.3 4 ☐	0.03 5 ☐ 127
The inside, left or right outside mirrors. .	90.0 1 ☐	6.3 2 ☐	2.7 3 ☐	0.9 4 ☐	0.09 5 ☐ 128
Passengers in the front or rear seats. . . .	61.0 1 ☐	30.2 2 ☐	8.2 3 ☐	0.6 4 ☐	0.03 5 ☐ 129
The front seat or front seat head rests. .	82.3 1 ☐	13.1 2 ☐	4.1 3 ☐	0.5 4 ☐	0.00 5 ☐ 130

SEATING IN MY CAR:

The driver's seat forced me to sit in an uncomfortable or unsafe posture.	91.6 1 ☐	7.2 2 ☐	1.1 3 ☐	0.1 4 ☐	0.00 5 ☐ 131
The seat or chest belt restricted body and head movements to see over my shoulder	70.0 1 ☐	22.9 2 ☐	6.7 3 ☐	0.5 4 ☐	0.00 5 ☐ 132

Table 16 (continued)

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
BRAKING AND SHIFTING OF MY CAR:					
The brake required too much force to operate.	95.4 1 ☐	3.4 2 ☐	1.1 3 ☐	0.2 4 ☐	0.00 5 ☐ 133
Braking was difficult when power brakes failed (Check here if power brakes never failed * ☐). ... 47	69.5 1 ☐	7.3 2 ☐	18.2 3 ☐	4.5 4 ☐	0.40 5 ☐ 134
My legs didn't comfortably reach brake, clutch or gas pedals.	96.0 1 ☐	3.2 2 ☐	0.8 3 ☐	0.0 4 ☐	0.00 5 ☐ 135
My foot slipped off brake pedal or caught side of pedal when moving from gas pedal.	86.0 1 ☐	9.0 2 ☐	4.1 3 ☐	0.6 4 ☐	0.03 5 ☐ 136
I stepped on more than one pedal or the wrong pedal (brake, clutch, gas) because they were too close together ..	92.8 1 ☐	4.6 2 ☐	2.3 3 ☐	0.2 4 ☐	0.09 5 ☐ 137
My leg hit steering wheel or column while moving foot to brake pedal	96.5 1 ☐	4.5 2 ☐	1.0 3 ☐	0.1 4 ☐	0.00 5 ☐ 138
I sometimes shifted into wrong gear because I couldn't tell which gear the shift was in	89.0 1 ☐	9.7 2 ☐	1.1 3 ☐	0.1 4 ☐	0.03 5 ☐ 139
STEERING WAS DIFFICULT:					
When driving in strong winds.	60.6 1 ☐	30.2 2 ☐	8.3 3 ☐	0.8 4 ☐	0.03 5 ☐ 140
When I tried to stop quickly and skidded	75.6 1 ☐	13.0 2 ☐	8.7 3 ☐	2.2 4 ☐	0.48 5 ☐ 141
When a tire blew out (check here if you never had a blow out * ☐). ... 54	61.2 1 ☐	17.1 2 ☐	17.9 3 ☐	3.4 4 ☐	0.38 5 ☐ 142
When power steering was lost (check here if power steering never went out * ☐). ... 50	48.1 1 ☐	19.9 2 ☐	28.5 3 ☐	3.4 4 ☐	0.41 5 ☐ 143
Because steering wheel is normally sometimes very hard to turn	91.3 1 ☐	7.0 2 ☐	1.4 3 ☐	0.3 4 ☐	0.00 5 ☐ 144
Because normal steering wheel movements caused car to change direction too quickly or not quickly enough	93.1 1 ☐	5.1 2 ☐	1.5 3 ☐	0.3 4 ☐	0.03 5 ☐ 145
SEEING AND READING INSTRUMENTS AND GAUGES:					
I have had difficulty seeing gauges or warning lights (temperature, oil, fuel, etc.).	81.3 1 ☐	15.6 2 ☐	2.9 3 ☐	0.1 4 ☐	0.00 5 ☐ 146

Table 16 (continued)

Have you ever driven an unfamiliar car, that is, a rented or borrowed car:

Yes 83.1 ¹ ☐ 147

No 16.9 ² ☐

→ Skip the two questions in the box below

PLEASE ANSWER THESE QUESTIONS

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the gear shift pattern was different than in my car . .	69.6 ¹ ☐	26.7 ² ☐	3.5 ³ ☐	0.3 ⁴ ☐	0.00 ⁵ ☐ 148
When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the location or operation of the controls (horn, lights, climate adjustments, etc.) was different in my car	41.2 ¹ ☐	49.8 ² ☐	8.7 ³ ☐	0.3 ⁴ ☐	0.00 ⁵ ☐ 149

In this section, we are concerned with how well you can find, reach and operate the controls and switches in the car you drive most.

Please indicate whether any delays or confusion in **finding** a control has presented a difficulty and to what degree it caused a hazard. Check **NO PROBLEM** if a finding difficulty has never occurred.

FINDING CONTROLS AND SWITCHES:

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Headlights	94.0 ¹ ☐	5.4 ² ☐	0.6 ³ ☐	0.1 ⁴ ☐	0.00 ⁵ ☐ 150
Climate Control	82.8 ¹ ☐	16.1 ² ☐	1.0 ³ ☐	0.0 ⁴ ☐	0.06 ⁵ ☐ 151
Headlight Dimmer	85.7 ¹ ☐	11.9 ² ☐	2.3 ³ ☐	0.1 ⁴ ☐	0.00 ⁵ ☐ 152
Window Washer or Wiper	88.9 ¹ ☐	9.4 ² ☐	1.6 ³ ☐	0.2 ⁴ ☐	0.00 ⁵ ☐ 153
Defogger/De-Icer	83.4 ¹ ☐	14.6 ² ☐	1.8 ³ ☐	0.2 ⁴ ☐	0.03 ⁵ ☐ 154
Emergency Flasher	87.1 ¹ ☐	11.3 ² ☐	1.4 ³ ☐	0.1 ⁴ ☐	0.00 ⁵ ☐ 155
Horn	89.2 ¹ ☐	8.1 ² ☐	2.2 ³ ☐	0.5 ⁴ ☐	0.03 ⁵ ☐ 156

Have you had any difficulty **finding** any of the controls or switches listed below:

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Radio Knobs					
Ashtray					
Lighter	83.8 ¹ ☐	13.9 ² ☐	2.3 ³ ☐	0.1 ⁴ ☐	0.00 ⁵ ☐ 157
Vent					
Mirror Dimmer					
Interior Lights					
Dash Lights					
Turn Signal					

Table 16 (continued)

Now indicate whether **reaching** has presented a difficulty and to what degree it caused a hazard. Check **NO PROBLEM** if a reaching difficulty has never occurred.

REACHING CONTROLS AND SWITCHES

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Headlights	98.2 1 ☐	1.5 2 ☐	0.30 3 ☐	0.0 4 ☐	0.00 5 ☐ 158
Climate Control	90.0 1 ☐	9.0 2 ☐	0.9 3 ☐	0.0 4 ☐	0.03 5 ☐ 159
Headlight Dimmer	90.4 1 ☐	7.9 2 ☐	1.7 3 ☐	0.0 4 ☐	0.00 5 ☐ 160
Window Washer or Wiper	94.6 1 ☐	4.7 2 ☐	0.7 3 ☐	0.0 4 ☐	0.00 5 ☐ 161
Defogger/De-Icer	89.8 1 ☐	8.7 2 ☐	1.3 3 ☐	0.1 4 ☐	0.03 5 ☐ 162
Emergency Flasher	93.9 1 ☐	5.5 2 ☐	0.6 3 ☐	0.1 4 ☐	0.00 5 ☐ 163
Horn	95.2 1 ☐	3.7 2 ☐	1.0 3 ☐	0.2 4 ☐	0.03 5 ☐ 164

Have you had any difficulty **reaching** any of the controls or switches listed below:

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Radio Knobs					
Ashtray					
Lighter	85.8 1 ☐	11.3 2 ☐	2.7 3 ☐	0.2 4 ☐	0.00 5 ☐ 165
Vent					
Mirror Dimmer					
Interior Lights					
Dash Lights					
Turn Signal					

Now indicate whether any delays or confusion in **operating** a control has presented a difficulty and to what degree it caused a hazard. Check **NO PROBLEM** if an operating difficulty has never occurred.

OPERATING CONTROLS & SWITCHES

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Headlights	97.4 1 ☐	1.9 2 ☐	0.6 3 ☐	0.1 4 ☐	0.00 5 ☐ 211
Climate Control	84.5 1 ☐	13.9 2 ☐	1.5 3 ☐	0.1 4 ☐	0.03 5 ☐ 212
Headlight Dimmer	89.0 1 ☐	8.4 2 ☐	2.5 3 ☐	0.2 4 ☐	0.00 5 ☐ 213
Window Washer or Wiper	90.2 1 ☐	7.9 2 ☐	1.7 3 ☐	0.2 4 ☐	0.00 5 ☐ 214
Defogger/De-Icer	84.4 1 ☐	12.5 2 ☐	2.8 3 ☐	0.2 4 ☐	0.03 5 ☐ 215
Emergency Flasher	92.1 1 ☐	6.5 2 ☐	1.3 3 ☐	0.1 4 ☐	0.00 5 ☐ 216
Horn	91.3 1 ☐	6.1 2 ☐	2.2 3 ☐	0.3 4 ☐	0.06 5 ☐ 217

Table 16 (continued)

Have you had any difficulty **operating** any of the switches or controls listed below:

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Radio Knobs					
Ashtray					
Lighter	87.0	11.4	1.6	0.1	0.00
Vent	☐	☐	☐	☐	☐ 218
Mirror Dimmer					
Interior Lights					
Dash Lights					
Turn Signal					

The following are believed to be possible factors in the cause of accidents. Which of them have played a part in any near accidents or close calls you can think of in which you were involved? Also, how much did the factors contribute to the near accidents?

		PLAYED NO PART	CONTRIBUTED SOMEWHAT	CONTRIBUTED GREATLY
Vehicle Factors (your car only)	Average	<u>71.6%</u>	<u>13%</u>	<u>3.8%</u>
Poor vision from car	62	1 ☐	20	8
Steering or braking difficulties	79	1 ☐	2 ☐	3 ☐ 219
Gear shift difficulties	86	1 ☐	2 ☐	2 ☐ 220
Finding and using controls	80	1 ☐	2 ☐	0 ☐ 221
Visibility of other vehicles, pedestrians, signs, etc.	51	1 ☐	7 ☐	1 ☐ 222
			28	8
Driver Factors (yourself only)		<u>70.2%</u>	<u>15%</u>	<u>3.2%</u>
Fatigue	59	1 ☐	25	5
Alcohol/Drugs	80	1 ☐	2 ☐	3 ☐ 224
Disregarding driving rules	74	1 ☐	5 ☐	2 ☐ 225
Inattention	55	1 ☐	12 ☐	2 ☐ 226
Lack of driving skills	83	1 ☐	29 ☐	6 ☐ 227
			4	1
Environmental Factors		<u>45.7%</u>	<u>34%</u>	<u>9.0%</u>
Darkness	54	1 ☐	29	6
Rain/snow/ice	39	1 ☐	2 ☐	3 ☐ 229
Fog	44	1 ☐	36	14
Sun glare	46	1 ☐	2 ☐	3 ☐ 230
			36	9
			35	7
Roadway Factors		<u>48%</u>	<u>31%</u>	<u>8.0%</u>
Poor signs (location/readability)	47	1 ☐	33	8
Poor road conditions	50	1 ☐	2 ☐	3 ☐ 233
Poor street markings	47	1 ☐	29 ☐	8 ☐ 234
			31	8

How many close calls or near accidents have you had due to all reasons in the last two months.
(Write number in box) 236/237

Could you tell us what you would really like to see built into the next car you buy – something that you think would reduce driver errors. If you cannot define what that "something" might be, try to describe what it might do.

Table 16 (continued)

Please complete the following questions **carefully** and **completely** so we can relate problems to vehicle designs and driver characteristics.

Describe the vehicle you drive most often.

Vehicle Manufacturer (Ford, Chrysler, V.W., etc.)

Model (Pinto, Vega, 240Z, etc.)

Year

What is the body style of the above vehicle? (Check all appropriate boxes) ²⁴⁷

- | | | |
|---|--|---|
| 1 ☐ 2 Door 49% | 4 ☐ Station Wagon 13% | 7 ☐ Pickup 7% |
| 2 ☐ 4 Door 35% | 5 ☐ Hard Top 30% | ☐ Other (Specify) 1% |
| 3 ☐ Convertible 2% | 6 ☐ Van 3% | |

Which of the following equipment do you have on your vehicle? (Check all appropriate boxes) ²⁴⁸

- | | | |
|---|---|--|
| 1 ☐ Air Conditioning 50% | 4 ☐ Automatic Transmission 75% | 7 ☐ Rear Window De-ice/Defogger 27% |
| 2 ☐ Power Brakes 61% | 5 ☐ Right Outside Mirror 35% | 8 ☐ Cruise Control 9% |
| 3 ☐ Power Steering 68% | 6 ☐ Rear Window Wiper 5% | |

Has the vehicle's standard equipment been modified in any way?

- | | |
|-----------------|--------------------------------|
| Yes | 1 ☐ 9% |
| No | 2 ☐ 88% |
| No Answer | 3% |

If yes, please describe: _____

How many miles do you drive this car per year? ²⁵³

- | | |
|--|---|
| 1 ☐ Under 1,000 3% | 3 ☐ 5,001-10,000 36% |
| 2 ☐ 1,000-5,000 17% | 4 ☐ Over 10,000 43% |

Finally, for purposes of comparing your answers with others in the survey, would you please give the following information about yourself:

Your sex:

- | | |
|--------------|--------------------------------|
| Male | 1 ☐ 63% |
| Female | 2 ☐ 37% |

What is your present age? _____ years ^{255/256}

Your total years of driving experience? _____ years ^{257/258}

About how tall are you? _____ feet _____ inches ^{259/260}

What is your approximate weight? _____ pounds ²⁶¹

Please place the completed questionnaire in the enclosed pre-stamped envelope and mail it at your earliest convenience.

Thank you for your cooperation.

The questionnaire content thus provides a potential data base of over 60 driver/vehicle mismatch problems and driver/vehicle identifying and descriptive data which can be interrelated during analysis. Additional questions are described in some detail in the "Results" section.

C. SAMPLE DESCRIPTION

Three private institutions expressed interest in conducting a survey using the questionnaire. These were (1) the New Hampshire Division of the American Automobile Association (N.H. AAA), (2) the Southern California Automobile Club (SCAC), and (3) Vector Enterprises, Inc., publisher of a weekly consumer-oriented newsletter. Vector also agreed to coordinate the activities of all groups. The first two groups had access to computerized member mailing lists while the third obtained a sample of California drivers from the California Department of Motor Vehicles. Detailed data describing the composition of these groups were principally unavailable or considered non-publishable, due to their confidential nature by the institutions, but a brief description of the samples follow. Demographic data for respondents are presented in a later section.

1. New Hampshire AAA Sample

The N.H. AAA provided Vector Enterprises with a random sample of 3000 names and addresses from their computerized membership files. The sample was composed of members throughout the state who were, as is typical of such groups, older, more affluent, owners of newer vehicles, and probably better educated than the U.S. population of drivers.

2. California Sample

Vector Enterprises agreed to participate in the research due to its inherent interest in public safety and consumer products. The staff contacted the California DMV and obtained a listing of a random sample of 2000 registered motor vehicle owners in the state. The sample was generated from vehicle license numbers which were developed using a three-digit alphabetic and three-digit numeric code representing license numbers issued during the late 1960s and 1970s. Of the 2000 "numbers" submitted, 1885 usable names and addresses were generated. The manner in which numbers were developed resulted in a flat distribution of vehicle age,

that is, approximately an equal number of vehicles by year. Drivers sampled are probably slightly older than the state average since vehicle owners were selected.

3. Automobile Club of Southern California Sample

The SCAC selected a random sample of 5081 members from their membership files. The sample included drivers from San Diego to Fresno county and from the coast to the Nevada and Arizona border. Generally, it represented the lower two-thirds of the state. Club members tend to be more affluent, older, drive newer vehicles, and generally better educated than the U.S. driving population.

D. METHOD

Identical survey questionnaires were mailed to the individuals selected in each of the three samples. The New Hampshire AAA sample of 3000 and California State sample of 1885 were sent questionnaires by first class mail on 15 November 1976. A follow-up reminder post card was sent five days later. The SCAC sample of 5081 was sent questionnaires two weeks later but no reminder post card was used. All questionnaires were mailed in the usual envelopes used by the participating institutions and were introduced by cover letters on their stationary and signed by an officer of the institution. The cover letters and reminder post card are reproduced in Appendix C. Cover letters differ somewhat since they were modifications of a recommended letter provided to the participating groups.

Each mail-out was accompanied by a prepaid first-class business reply envelope for questionnaire return.

Five weeks were allowed for the return of New Hampshire AAA and California State questionnaires, while only three weeks were available for SCAC returns due to their late mail-out. Returns are discussed in detail in the "Results" section.

E. EDITING, CODING, AND PROCESSING

Returns were carefully reviewed as they were received. The review included examination for completeness and legibility. Responses to questions requiring coding, such as vehicle make and model and open-ended,

fill-in questions, etc., were then coded for keypunching. Two coders received several hours of training to insure proper interpretation of responses and reliable coding of data.

All responses were keypunched onto cards using a "multi-punch" capability which allows high density card use, thereby reducing the number of columns and, therefore, cards. A table of "marginals" was obtained which summarized all of the responses in terms of frequency and percent. Data were subsequently "cleaned," i.e., punches in incorrect columns were identified and corrected and a table of "cleaned" marginals was generated.

The marginal tables were used to select specific cross-tabs and calculations for further analysis, and to generate overall demographic and question descriptive data. It became apparent rather quickly that not all possible combinations of questions and demographic data nor the numerous possible cross-tabs and sublevel cross-tabs of interest could be examined within the scope of the current effort. Therefore, specific subsets of data were selected for more thorough analysis. These are detailed in the "Results" section, but briefly noted here.

Driver height, weight, age, sex, mileage per year, and total years driving and vehicle age and type served as primary demographic variables and each had several levels. These variables were examined across the 52 questions which appeared most important on the basis of analyzing marginal table summary results. The cross-tabs are reproduced in Appendix D.

F. STATISTICAL ANALYSIS

Responses to the 52 potential driver/vehicle mismatch problems can be summarized in the form of frequencies of responses to each of the five severity categories from "No Problem" to "Caused Accident." These are readily converted to percentages. Also, weights can be assigned which represent level of severity numerically. For example, 1 can be assigned to "No Problem, 2 to "Annoying," 3 to "Potential Danger," and so on. Then, a mean value can be computed from the distributions arising from the use of the numerical weighting scale.

Strictly speaking, computations of means from such weighting schemes assumes that they derive from equal interval scales. More often than not, psychological interval scales are seldom "proven" to be valid. Usually, they are simply accepted as being reasonably valid on the basis of face validity, i.e., they *look* like equal interval scales. For all practical purposes, the assumption of empirical validity is of little importance as the interpretations of resulting data would tend strongly to be the same, whether the scale was indeed of equal intervals or of some pattern which systematically deviates somewhat from equal intervals. In any event, the five-point scale employed in this study appears to approach an equal interval scale sufficiently for purposes of differentiating between questions with respect to problem severity.¹

Differences between means signifies that the underlying distributions are shifted, i.e., the central tendencies or the bulk of the response frequencies tend to shift from one end of the scale toward the other. However, because the distributions were expected to be highly skewed and in the same direction, χ^2 tests of significance were chosen rather than parametric statistical tests.² In effect, χ^2 tests indicate whether or not two distributions differ significantly with respect to frequencies of responses to the five categories of severity. Since, as noted, all distributions were expected to be of the same general shape and order, a significant χ^2 strongly suggests that the computed means of the distributions also differ significantly.

The primary dependent variable was intended to be frequencies of "close calls" and "caused accidents." However, to regard the other categories as negligible or of no importance was soon determined to be a mistake, because much meaningful data would have been erroneously eliminated or degraded. Consider, for example, driver/vehicle mismatch problems for which no close calls or caused accidents are reported. It does not follow from such results that the various problems are (1) never associated with close calls or accidents, e.g., sample size

¹See Guilford (1954, Chapter 10) for a further discussion of equal interval scales.

²This was indeed found to be true. With few or no exceptions, all distributions were unimodal and of the same general shape, heavily skewed to the right, i.e., toward value "5."

may have been insufficient to detect them, and (2) of equal importance or, perhaps more correctly, of equal unimportance. Distributions derived from the entire five-point scale are therefore much more sensitive than use of the last two categories in discriminating among mismatch problems. Thus, distributions and mean scale values were subsequently considered to be quite important in the analysis of survey data.¹

¹A rank-order correlation of .73 between mean scale values and the frequency data from the last two categories was subsequently computed, providing evidence supporting the use of mean scale values in interpreting findings. Such a correlation, although high, probably would have been even higher had close calls and/or caused accidents been reported for all problems described.

IV. RESULTS

A. INTRODUCTION

The responses of the 3478 respondents to the more than 100 potential driver/vehicle mismatch questions, open-end questions, and demographic questions are presented in this section. First, overall return rates by sample are summarized and driver and vehicle demographic data are presented. Validity of the critical incident technique is discussed and responses to certain unique questions are summarized. Then responses to individual questions are described and the relation between driver and vehicle variables and driver/vehicle mismatch questions are statistically analyzed for significance.

The section is organized as outlined below:

- . Description of Survey Responses

- Questionnaire Returns

- Vehicle Related Responses

- Respondent-Driver Related Responses

- Validity of Close Call/Near Accident Technique

- Importance of Driver/Vehicle Mismatch Problems

- Frequency of Close Calls

- Number of Close Calls in the Last Two Months

- Suggested Design Improvements

- . Scale Value Analysis

- Overview

- Results of Significance Tests

B. DESCRIPTION OF SURVEY RESPONSES

Almost 3500 usable responses to the survey questionnaire were received. These are overviewed below in terms of response rates and driver and vehicle demographic summaries. Also, overall responses to driver/vehicle mismatch and other questionnaire items are reviewed.

1. Questionnaire Returns

A total of 9966 questionnaires were sent out to the three samples in New Hampshire and California. A total of 3855 were returned for an overall return rate of 38.7 percent. The New Hampshire AAA returns totaled 1503 or 50.1 percent. The Southern California Automobile Club (SCAC) returns totaled 1766 or 34.8 percent, and the California sample return totaled 588 or 31.1 percent. Of these totals, 3478 were found usable for analysis. Approximately 250 SCAC returns were received too late to meet the computer analysis schedule constraints, while nearly all usable returns were available from the other two samples.

A uniquely high New Hampshire return rate was probably due to several factors. First, the sample was composed of individuals who were substantially older than the other samples and probably had more time available for responding. Second, the reminder card sent four days following the questionnaire no doubt increased returns. Also a full five weeks were allowed for returns.

The SCAC sample had a lower rate of 34.8 percent, at least partially because of the shorter return period permitted, the lower age distribution of members, poor mail-out time (i.e., over Thanksgiving), and the absence of a reminder card. In considering the 250 returns which arrived too late for analysis, the actual SCAC rate was 40 percent.

Finally, the California sample of registered vehicle owners returned the fewest questionnaires, 31.1 percent. This relatively lower rate appeared, in part, to be due to the large number of "undeliverables" (12 percent) which resulted from address changes. Also this sample lacked the "club" membership loyalty which is said to increase member responsiveness to questionnaires. Eliminating the 12 percent "undeliverables," the adjusted rate becomes 35.4 percent.

Rather than view the California sample return rate in a negative sense, it is perhaps of greater interest to ask why it was as high as it was. The actual rates of the SCAC and California samples were only a few percentage points apart, 40.0 percent and 35.4 percent, respectively. In view of the fact that the California sample was widely distributed across the state and more younger (and typically less responsive) drivers than the other samples, it is surprising that the return rate was not lower. It may be noted further that a somewhat similar study which employed only a 1-1/2 page questionnaire and a highly similar California sample was able to achieve no higher a rate (31.6 percent), even with the use of reminder letters (Case, Burg, and Baird, 1974). It is of interest to note also that the cover letter for the California sample contained the Consumer Newsletter name and logo and indicated consumer representation, which may have provided the necessary influence on many individuals who subsequently returned their questionnaires.

The return rate on a daily basis is shown in Fig. 4 for the three samples. The effect of the reminder cards appears evident in the response rate four to five days following its mailing.

In conclusion, the overall return rate of 38.7 percent is considered quite high, considering the questionnaire length (seven pages of questions) and its complexity. Extensive pilot testing and numerous re-writes of instructions and questions, as well as the overall attractiveness of the format, undoubtedly contributed to this rate.

2. Vehicle Related Responses

The frequency of responses by vehicle manufacturer, year, body style, and vehicle equipment are summarized in the following sections. Vehicle make/model frequencies are presented in Appendix E.

a. Vehicle Manufacturer

The frequency and percentage of manufacturers (e.g., Buick, Toyota, Mercury) represented in the survey are presented in Table 17. The most frequently reported vehicles are Chevrolets (17.3 percent) and Fords (16.5 percent) as expected. The smallest U.S. made vehicle frequencies are Lincolns (0.7 percent or 23 vehicles), Chrysler (2.7 percent), and Cadillacs (2.8 percent). The sample of respondent-owned vehicles is quite

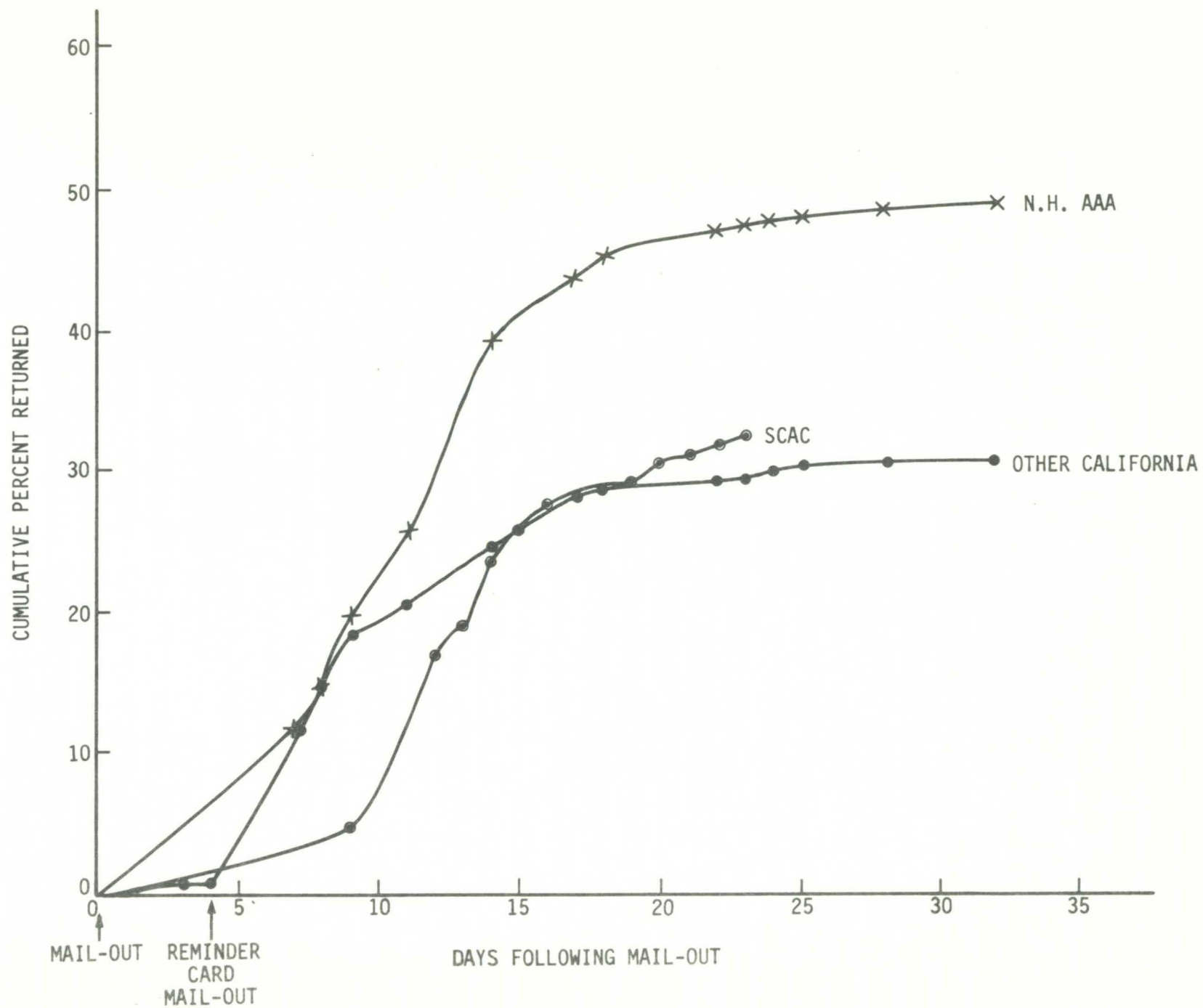


Fig. 4--Daily questionnaire return rate for the three samples

Table 17

SUMMARY OF VEHICLE MANUFACTURERS REPRESENTED IN SAMPLE

Manufacturer	N	%	Manufacturer	N	%
American Motors	113	3.3	Pontiac	166	4.8
Audi	18	0.5	Porsche	14	0.4
BMW	16	0.5	Puegot	7	0.2
Buick	176	5.1	Renalt	6	0.2
Cadillac	98	2.8	Saab	19	0.6
Chevrolet	594	17.3	Subaru	13	0.4
Chrysler	94	2.7	Toyota	109	3.2
Datsun	126	3.7	Triumph	4	0.1
Dodge	236	6.9	Volkswagen	176	5.1
Fiat	15	0.4	Volvo	51	1.5
Ford	568	16.5	Miscellaneous	12	0.3
Honda	13	0.4	None specified	60	1.7
Jaguar	5	0.1	Two or more specified	91	2.6
Lincoln	23	0.7	All purpose	45	1.3
Mazda	22	0.7	TOTAL	3441	100
Mercedes	45	1.3			
Mercury	125	3.6			
MG	5	0.1			
Oldsmobile	180	5.2			
Opel	15	0.4			
Plymouth	181	5.3			

representative of the U.S. population with regard to U.S. made vehicles as far as can be determined. While data provided in *Automobile Facts and Figures* (1975) does not lend itself to exact comparison, the relative frequencies appear similar. In 1972, for example, Ford's production was 21.2 percent of the U.S. total. The sample is comprised of 16.5 percent Fords. In 1972, Dodge production was 6.3 percent of the U.S. total and the sample consists of 6.3 percent. Chrysler's production was only 2.5 percent of the U.S. total, while the sample is comprised of 2.7 percent. Other data show similar trends, indicating that the survey sample is fairly representative of the U.S. population.

The numbers of each manufacturer and model are shown in Appendix E. For analytic purposes, vehicles were classified as subcompacts, compacts, intermediates, full size, and other (pickups, vans, and all purpose). Passenger cars were classified solely on the basis of wheelbase--subcompacts having a wheelbase less than 101 inches, compacts between 101 and 111 inches, intermediates between 111 and 120, and full size greater than 120 inches. Vehicles often considered sport, luxury, or speciality followed the aforementioned classification.

b. Vehicle Age Distribution

The percentage distribution of vehicle ages represented in the total sample and subsamples are presented in Table 18, along with national distributions approximated from *Automobile Facts and Figures* (1975) data representing 1974. The total sample differs from the U.S. population of vehicle age in that the sample is comprised of significantly more newer vehicles. Even considering the 8 percent no-answer respondents, older vehicles are under-represented in the sample. The New Hampshire AAA respondents had the highest percentage of newer vehicles (50 percent, 1974 or newer) compared to the U.S. population (30.1 percent, 1974 or newer). Both automobile club sample respondents drive relatively newer vehicles because they are more affluent and older and one can appreciate the need for vehicle reliability in the New Hampshire climate.

While the sample under-represents vehicle age and limits the generality of results to the population as it currently exists, the

focus on newer vehicles is of greater interest to the goals of the study itself, i.e., current vehicle design features and mismatch problems. There is little interest in vehicles greater than 10 years old.

Table 18

VEHICLE AGES REPRESENTED IN TOTAL SAMPLE AND SUBSAMPLES (PERCENT)

Vehicle Age	Total Sample	SCAC	N.H. AAA	Other Calif.
Pre-1968	9 (19.4) ¹	15	4	9
1968 - 1969	9 (14.5)	10	8	8
1970 - 1971	16 (17.9)	16	13	23
1972 - 1973	25 (18.5)	24	25	25
1974 - 1975	21 (23.2)	18	24	18
1976 - 1977	11 (6.9)	11	26	9
No Response	8	7	9	9

¹ National distribution, 1974 (*Automobile Facts & Figures*, 1975)

c. Vehicle Body Style Distribution

The vehicle body style responses by subsample are shown in Table 19 as the percent of respondents who selected a style from one of the questionnaire check items. Totals exceed 100 percent due to multiple responses (e.g., two-door and station wagon plus four-door and station wagon). The only major differences among samples are the prevalence of four-door vehicles in the New Hampshire AAA (possibly related to driver age bias) and the frequency of "other" vehicles in the California sample. "Other" vehicles include jeeps, carry-alls, four-wheel drive wagons, etc.

Table 19

DISTRIBUTION OF RESPONDENTS' VEHICLE BODY STYLE BY SAMPLES (PERCENT)

Vehicle Body Style	Total	SCAC	N.H. AAA	Other Calif.
Two door	49	57	39	56
Four door	35	27	47	27
Convertible	2	3	2	2
Stationwagon	13	12	14	14
Hard top	30	29	29	34
Van	3	3	2	5
Pickup	7	9	6	6
Other	1	0	0	6

d. Vehicle Equipment

Table 20 summarizes the major equipment on vehicles driven by respondents. The three subsamples differ substantially with regard to some equipment items. Air conditioning is reported by 65 and 62 percent of the California samples and only 27 percent by the New Hampshire AAA sample. Climate is an obvious explanation. In addition, that sample has more equipment associated with newer and American made vehicles. In addition, they appear to have more rear window defoggers, again related to climate and vehicle age. California drivers have more right side mirrors.

Table 20

DISTRIBUTION OF VEHICLE EQUIPMENT BY SAMPLES (PERCENT)

Vehicle Equipment	Sample			
	Total	SCAC	N.H. AAA	Other Calif.
Air conditioning	50	65	29	62
Power brakes	61	60	62	59
Power steering	68	64	74	62
Automatic transmission	75	72	80	70
Right mirror	35	39	29	37
Rear window wiper	5	5	4	4
Rear window defogger	27	26	30	25
Cruise control	9	11	8	10

3. Respondent-Driver Related Responses

Driver demographics are summarized below to describe and evaluate the representation of the sample of respondents. Included are driver age, height, weight, driving experience, and exposure.

a. Driver Age Distribution

The total sample of respondents' age distribution is shown in Table 21, for eleven age categories, in percentage form. Also shown is the percentage composition for the three subsamples. Data in parenthesis show the approximate distribution of the U.S. driving population derived from *Automobile Facts and Figures* (1975) data.

It is readily apparent that the total sample is *not* representative of U.S. driver age and that subsamples differ substantially. Compared to the U.S. population, the sample(s) is under-represented considerably with regard to younger drivers and over-represented with regard to older drivers. Twenty-three percent of the total sample reported being 65 years of age or older while the national population of that age is only 4 percent. The California sample most closely

approaches the national distribution but is also biased toward older drivers. The New Hampshire AAA had an even higher percentage of 65 or older drivers (34.9 percent), as did the SCAC (16.3 percent). The impact of this bias on results is discussed elsewhere in detail.

Since all driver age categories are represented in the total sample, although some categories contain relatively small numbers, analysis of the age variable is nevertheless possible.

Table 21
DISTRIBUTION OF RESPONDENT DRIVER AGE BY SAMPLE (PERCENT)

Age	Total Sample	SCAC	N.H. AAA	Other Calif.
16 - 20	1.2 (9) ¹	1.7	0.2	2.3
21 - 25	6.9 (13)	9.4	2.8	11.0
26 - 30	9.0 (12)	10.9	5.5	13.1
31 - 35	7.6 (10)	8.4	5.8	10.1
36 - 40	6.4 (9)	7.1	3.7	11.7
41 - 45	6.8 (9)	7.6	5.7	7.6
46 - 50	7.7 (9)	8.3	6.5	9.4
51 - 55	10.7 (8)	10.7	9.6	13.5
56 - 60	9.6 (7)	9.0	11.4	6.4
61 - 65	11.2 (6)	10.5	13.9	6.2
Over 65	22.9 (4)	16.3	34.9	8.9

¹Estimated U.S. national distribution from *Automobile Facts and Figures* (1975).

b. Driver Height Distribution

The distribution of respondent driver height is shown in Table 22 as percentage of the total sample. The distribution is approximately normal with a slight negative skew. Comparison of the data with the U.S. driving population is difficult, due to the lack of current information. When compared to the measurements reported by Stoudt, *et al.*,

(1965), which represents the population from 18 to 79 years of age in 1960-1962, the responding sample is approximately 2 inches taller, on the average. The discrepancy is likely accounted for by the tendency of people to overstate their own height, to state height with shoes, and age of Stoudt's data, i.e., average height of Americans is known to be increasing rather continuously. Thus, the respondent sample appears fairly representative of the height distribution of U.S. drivers. In the sample, 0.7 percent and 1.6 percent are under 5 ft and over 6 ft, 4 in, respectively.

Table 22

DISTRIBUTION OF RESPONDENT HEIGHT FOR TOTAL SAMPLE (PERCENT)

Height (in.)	%	Height (in.)	%
Under 58"	0.2	68 - 69"	17.8
58 - 59"	0.5	70 - 71"	19.0
60 - 61"	4.2	72 - 73"	12.3
62 - 63"	10.4	74 - 75"	3.7
64 - 65"	13.4	76 - 77"	1.2
66 - 67"	16.8	Over 77"	0.4

c. Driver Weight Distribution

The distribution of weights of respondent drivers is presented in Table 23 as a percentage of total respondents. The distribution is approximately normal with a mean between 151-175 lbs and is slightly positively skewed. The percentage below 101 lbs is 0.9 while the percentage above 250 lbs is 0.4. The data compare favorably with that reported by Stoudt, *et al.*, (1965).

Table 23

DISTRIBUTION OF RESPONDENT WEIGHT FOR TOTAL SAMPLE (PERCENT)

Weight (lbs.)	%	Weight (lbs.)	%
Under 101 lbs	0.9	176 - 200 lbs	19.5
101 - 125 lbs	14.4	201 - 225 lbs	4.4
126 - 150 lbs	27.8	226 - 250 lbs	1.7
151 - 175 lbs	31.0	Over 250 lbs	0.4

d. Distribution of Miles Per Year and Total Years Driving

Tables 24 and 25 show the total years driving experience and mileage per year reported by respondents. With regard to total years driving, it is clear that the sample contained relatively few inexperienced drivers, i.e., less than four years (2.7 percent), and an abundance of highly experienced drivers, i.e., 50 years or more (17.7 percent). This finding is obviously a function of the age bias noted earlier. With regard to mileage per year, the three subsamples are approximately the same except that the California sample appears to drive slightly more miles per year than the SCAC or New Hampshire AAA sample. Overall, 43 percent of the respondents drove 10,000 miles or more per year.

Table 24

DISTRIBUTION OF RESPONDENTS' TOTAL YEARS OF DRIVING EXPERIENCE

Years Experience	%	Years Experience	%
0 - 4	2.7	30 - 39	17.0
5 - 9	7.7	40 - 49	19.4
10 - 19	18.7	Over 50	17.7
20 - 29	17.0		

Table 25

DISTRIBUTION OF RESPONDENTS' DRIVING MILEAGE PER YEAR

Miles/Year	Sample			
	Total %	SCAC %	N.H. AAA %	Other Calif. %
Under 1000	3	3	2	2
1001 - 5000	17	19	18	14
5001 - 10,000	36	36	34	37
10,001 and Over	43	41	44	46

e. Sex of Respondents

The percent of males and females who responded to the questionnaire are shown below in Table 26. Sixty-three percent of the responses were by males while 37 percent were by females for the total sample, and this is quite representative of the subsample percentages as well. Forty percent of the SCAC population is female, so a random sample of that membership should have resulted in a sample of approximately that percentage of females. Response to the questionnaire by SCAC members is 38 percent female suggesting little bias between response rate for males and females.

Table 26

SEX OF RESPONDENTS BY SAMPLE (PERCENT)

	Total Sample	SCAC	N.H. AAA	Calif.
Male	63	62	65	61
Female	37	38	35	39

4. Validity of Close Call/Near Accident Technique

A fundamental premise upon which this study was based, as well as a premise upon which many previous critical incident studies have been based, is that close calls or critical incidents are positively related to actual accidents and that they are simply more frequent, though less severe, events than accidents. If the positive predictive nature of the relationship between close calls and accidents can be established, the former (either as observations or as reports by those involved) can provide a data base for accident causation studies unconstrained by factors now limiting the use of accident data in such studies.

The original intent was to obtain accident data by make, model, and vehicle year for New Hampshire and/or California and correlate that data with close call rate for survey make, model, and year results. Several hundred data points would have been available for correlation. It soon became apparent, however, that not only were such specific data unavailable, usable accident data of any general sort were unavailable. Thus, we sought other categories or variables upon which calculations could be based.

The Highway Loss Data Institute (HLDI) publishes claim frequency by vehicle make, model, and year (from 1972-1976) from selected insurance companies. The survey sample results, however, are not compatible since they encompassed earlier model vehicles and yielded sample sizes of make, model, and year too small for statistical reliability. On the other hand, it was possible to combine survey data for four vehicle types (subcompact, compact, intermediate, and full size) over all years and to combine equivalent data for 1972-1976 from the Highway Institute publications.

Figure 5 illustrates the relation between close call frequency per vehicle reported by respondents and the actual accident claim frequency reported by the Highway Loss Data Institute (1972-1976). Subcompacts have the highest claim frequency and the highest close call rate. Accident and close call data for intermediate and full size vehicles fall along a straight line, indicating a very strong relation. Compacts fall within the trend but have a relatively lower claim

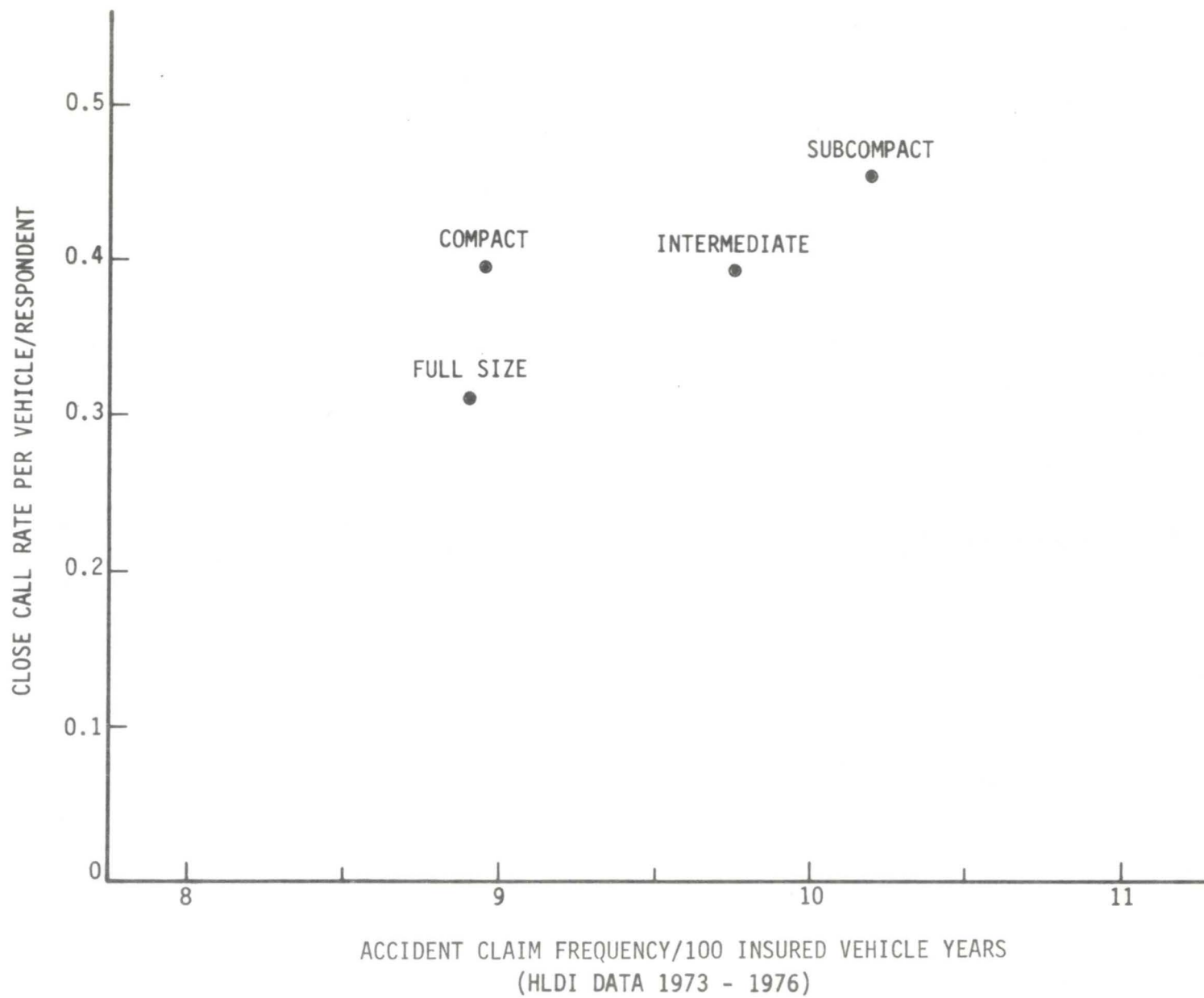


Fig. 5--Relation between accident claim frequency and close call rate

frequency. Apparently, there is a fairly high relationship between claim frequency and close calls for vehicle type.

Another dimension upon which a correlation could be based is driver age, since there is a clear difference in accident involvement frequency as a function of age. The California Highway Patrol (1964) reports accident involvement by age of California drivers. These data are plotted in Fig. 6, along with close call relative frequency by driver age reported by all respondents to the survey. Again, while the two sources are not perfectly matched, there appears to be a strong positive relationship. The rank order correlation between close call reports and accidents by age is .943 ($p < .05$).

Additionally, there is strong evidence that close call reports are positively related to accidents for certain roadway accident causation classifications. Data reported by Klein, *et al.*, (1975) show that survey respondent "close call" reports due to shoulder drop-off and loose material on the roadway correlated positively with California Highway Patrol accident data with regard to those roadway hazards.

Finally, it was noted in Sec. III that a rank order correlation of .73 was found between mean scale values of all question responses and the combined frequencies of "close calls" and "caused accidents." A rank order correlation of .74 was also found between the two categories, "close calls" and "caused accidents." As reported by drivers, therefore, a strong association between "close calls" and "caused accidents" exists.

5. Relative Importance of Driver/Vehicle Mismatch Problems

As emphasized previously, driver/vehicle mismatch problems are considered by many to be trivial, with regard to their contribution to vehicle accidents, when compared to other factors such as inattention, alcohol, road conditions, etc. Indeed, most accident investigation forms have ignored the types of problem under consideration in this study in favor of the more "traditional" causes and contributors.

In order to test the hypothesis that driver/vehicle mismatches are non-trivial, a series of specific questions were designed into the survey form (Questions 219-235). Seventeen possible near accident

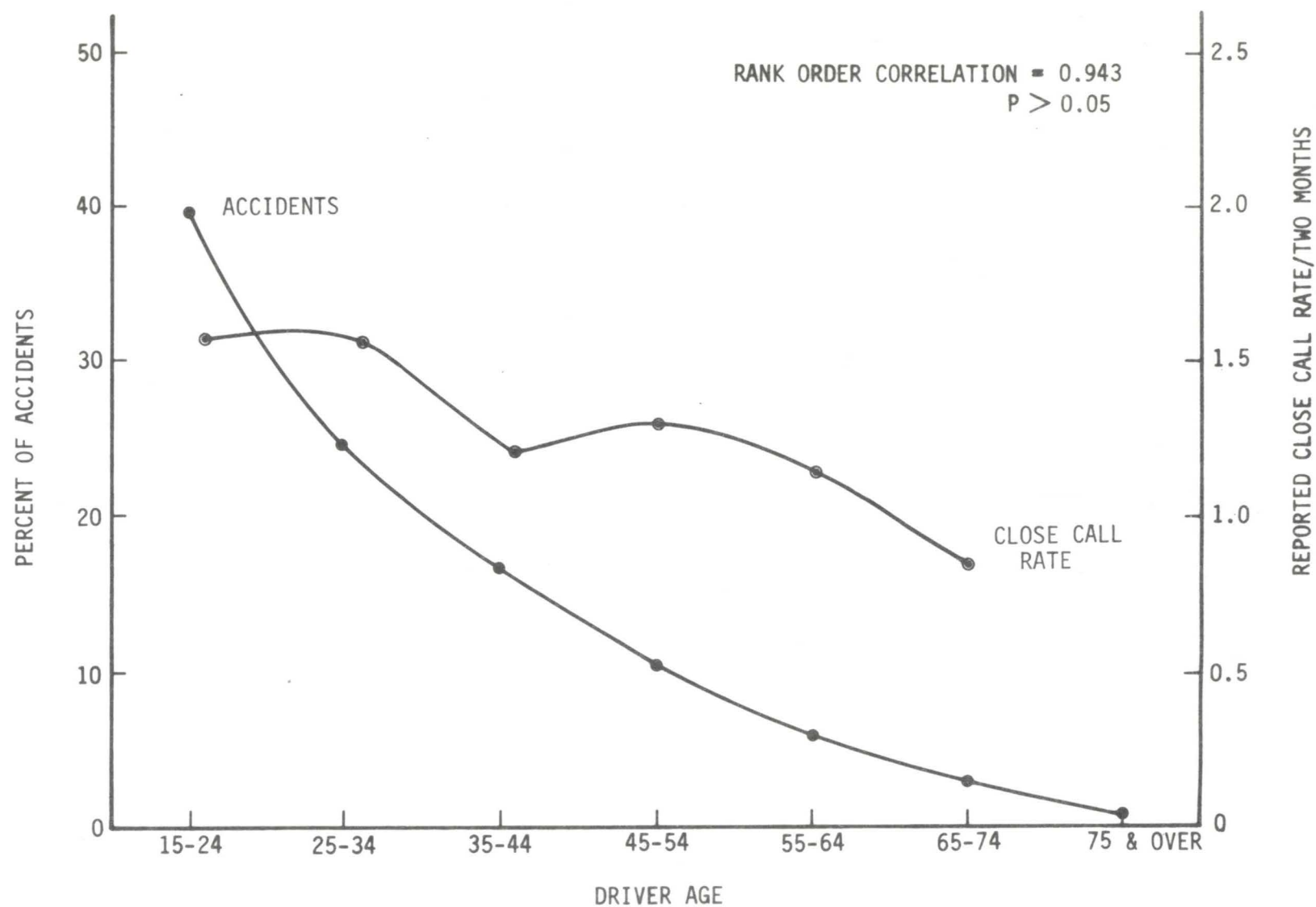


Fig. 6--Relation between driver age and percent of accidents¹ and close call rate²

¹California accidents in 1961 (*California Highway Patrol*, 1964)

²Close calls in the last two months (current study)

or close call causes or contributors were identified and grouped into four headings. These were "vehicle factors," "driver factors," "environmental factors," and "roadway factors." The vehicle factors category is comprised of problem areas from the preceding mismatch questions. Driver, environmental, and roadway factors were derived from accident statistics. Respondents were asked to check which factors played a part, and how much a part they played in previous near accidents or close calls they had experienced.

As reported by respondents, vehicle factors contributed "somewhat" or "greatly" to 16.8 percent of close calls, while driver, environmental, and roadway factors contributed 18.2, 43.0, and 39.0 percent, respectively. Reports of such experiences indicate that while vehicle factors may not represent the greatest contributors, they certainly are *not* trivial.

Of vehicle factors selected, vision from the vehicle and visibility of other drivers were by far the most frequently cited. Steering, braking, and control problems are apparently much less critical to respondents.

Driver factors cited most frequently as contributors were fatigue and inattention, while a few respondents reported alcohol/drugs, disregard of driving rules, and level of driving skill as being important.

Environmental factors cited included rain/snow/ice, fog, sun glare and darkness, in that order, as contributors to close calls. Roadway factors are about evenly split between "poor signs," "road conditions," and "street markings."

6. Frequency of Close Calls

A total of 3478 respondents cited 1573 "close call" and 118 "caused accidents" experiences (see Appendix F). The ratio of close calls to caused accidents is 13.3 to 1. Forty-five percent of the respondents experienced close calls and 3.4 percent experienced accidents. Almost 50 percent of the respondents, therefore, experienced either a close call or accident due to a mismatch problem. Since only one response was permitted per question, problems which tend to re-occur frequently for the same individual are not represented, and the percentages are likely, therefore, to be underestimates.

The majority of responses, as anticipated, fell into the "no problem," "annoyance," and "potential hazard" severity categories, but between those categories significant shifts are apparent. Some mismatch problems are very annoying but not indicated to be severe, while for others, if a problem is experienced, it tends to be severe.

7. Number of Close Calls in the Last Two Months

Respondents were asked to "fill in" the total number of close calls they had experienced in the preceding two months (Questions 236/237). Only 53 percent of the returns contained answers to this question. The low response rate may be due to the relatively inconspicuous location of the question in the questionnaire format and possibly the difficulty of remembering the number of close calls over a specific, narrow period.

The responses to the question are summarized below by demographic variables. The frequency of close calls decreases with 20 or more years of driving and generally with driver age, possibly because of the decrease in exposure for older drivers. Of greater interest is the apparently greater close call frequency for short drivers. A χ^2 test indicated the difference to be non-significant at $p < .05$, however.

There is also a trend for heavier drivers to have fewer close calls. When drivers under 175 lbs are compared to drivers over 175 lbs, the difference in close call frequencies was determined to be significant ($p < .01$), with heavier drivers having fewer close calls.

Close call frequency also appears related to vehicle type--the smaller subcompacts and compacts having a greater frequency than intermediate and full size vehicles--while pickups/vans/all-purpose vehicles also have a high frequency. The difference was found to be significant beyond the .01 level of confidence.

The relationship between miles/year and close call frequency (which is positive) was also found to be significant ($p < .05$). This effect probably reflects increased exposure accompanying increased miles/year.

Table 27

RELATION BETWEEN THE NUMBER OF CLOSE CALL EXPERIENCES IN THE LAST TWO MONTHS AND DRIVER/VEHICLE VARIABLES

Driver/Vehicle Variables	Number of Close Calls in the Past Two Months (%)					Driver/Vehicle Variables	Number of Close Calls in the Past Two Months (%)				
	None	One	Two	Three or More	Mean		None	One	Two	Three or More	Mean
<u>Years Driving</u>						<u>Vehicle Type</u>					
0 - 5	23	31	29	17	1.53	Subcompact	31	33	23	13	1.35
6 - 20	28	31	25	16	1.51	Compact	38	29	19	14	1.35
Over 20	46	28	16	10	1.12	Intermediate	45	27	18	10	1.19
<u>Driver Age</u>						Full size	45	27	18	10	1.13
16 - 25	27	26	29	18	1.57	Other (Pu/Van/Ap)	36	30	22	12	1.25
26 - 35	26	34	24	16	1.55	<u>Vehicle Age</u>					
36 - 45	37	29	23	11	1.22	1967 - older	45	26	19	10	1.26
46 - 55	38	30	20	12	1.29	1968 - 1969	44	26	18	12	1.19
56 - 65	46	27	17	10	1.14	1970 - 1971	49	28	18	5	0.95
Over 65	60	24	8	8	0.84	1972 - 1973	35	30	22	13	1.34
<u>Height</u>						1974 - 1975	34	31	19	16	1.35
61" - under	41	22	21	16	1.68	1976 - 1977	33	32	21	14	1.41
62 - 67"	41	29	18	12	1.66	<u>Sex</u>					
68 - 73"	38	29	20	13	1.66	Male	39	28	20	13	1.25
Over 73"	33	27	26	14	1.61	Female	40	29	19	12	1.28
<u>Weight</u>						<u>Miles/Year</u>					
125 lb - under	38	30	22	10	1.45	Under 1000	53	23	20	4	0.73
126 - 175 lb	40	29	19	12	1.66	1001 - 5000	54	24	13	9	1.04
176 - 225 lb	39	28	20	13	1.75	5001 - 10,000	42	29	17	12	1.20
Over 225 lb	31	26	21	22	1.77	10,000 - over	31	31	24	14	1.39

8. Suggested Design Improvements

The pilot study indicated that there was a substantial number of meaningful responses to a question designed to elicit respondents' suggestions for vehicle designs which they believed would eliminate or reduce the frequency and/or severity of close call experiences. The open ended fill-in question (238/241),

"Could you tell us what you would really like to see built into the next car you buy--something you think would reduce driver errors. If you cannot define what that 'something' might be, try to describe what it might do,"

received 3630 responses. These were classified and coded into one of 24 categories for computer analysis.¹ The categories are shown in Table 28, along with the number of responses and the percentage of respondents "suggesting" an item in a category.

Visibility improvements of one sort or another by far dominate the suggestions. Vision related categories (1,2,3,4,11,12,13,15,16, 20 and 21) comprise 52 percent of all responses, the greatest responses being in the "better rear view mirrors" and "defogging of other windows" categories which comprised 20.1 percent of all responses. The other large category was "non-crash prevention" (24) which included responses primarily related to post-crash injury and damage prevention such as bumpers, roll bars, air bags, etc.

The overall emphasis upon vision improvements is clearly in agreement with responses to individual driver/vehicle mismatch questions which clearly indicate visibility as a source of the critical incidents.

The categorized frequency of responses to this question were related to driver and vehicle variables. Variables included vehicle type (subcompact, compact, intermediate, and full size), vehicle age in two-year increments from 1967-1977, driver age, and driver weight. A number of statistically significant trends emerged which are illustrated in Table 29. Significant relations are indicated by positive (+) and negative (-) signs. A positive sign indicates that there is a

¹Categories were based on an initial review of several hundred responses. The categories are at different levels of specificity to remain consistent with the levels provided by respondents.

Table 28

SUMMARY OF DESIGN IMPROVEMENT SUGGESTIONS IN ORDER OF RESPONSE FREQUENCY

Rank	Response Categories	N	Percent of Respondents
1	Better rear view mirrors	372	10.3
2	Defog other windows	355	9.8
3	Reduced windshield glare	252	6.9
4	Better vision from vehicle	243	6.7
5	Better hand controls	196	5.4
6	Driver skill improvement/law enforcement	191	5.3
7	Better seats/belts; less constraining	188	5.2
8	Better controls/indicators	162	4.5
9	Better signaling between cars	142	3.9
10	Better malfunction monitoring	137	3.8
11	Add right side mirror	128	3.5
12	Better headlighting	125	3.4
13	Add rear window wiper	119	3.3
14	Better braking	109	3.0
15	Reduce mirror glare	106	2.9
16	Smaller pillars	94	2.6
17	Better handling and suspension	79	2.2
18	Better steering	61	1.7
19	Better mirror adjustability	47	1.3
20	Headrests that don't block view	45	1.2
21	Mirrors that don't block view	39	1.1
22	Standardize dashboard	36	1.0
23	Better foot controls	27	0.7
	Non-crash prevention	377	10.4

Table 29

SIGNIFICANT RELATIONS BETWEEN DESIGN IMPROVEMENT SUGGESTIONS AND
DRIVER/VEHICLE VARIABLES

Design Improvement Suggestion	Vehicle/Driver Variables			
	Vehicle Type	Vehicle Age	Driver Height	Driver Weight
Posts that do not block vision from car			— (p<.10) ¹	
Headrests/seat backs that do not block vision from car	— (p<.05) ²		— (p<.01)	
Mirrors that do not block vision from car			+ (p<.01) ³	
Less constraining seats/seat belts			— (p<.01)	
Better hand controls		+ (p<.05)	— (p<.05)	
Reduce oncoming glare	— (p<.02)			

¹ All significance levels based on χ^2 tests

² Negative relation

³ Positive relation

positive relation between the relative frequency of a response category and an increase in the variable. For example, "mirrors that do not block vision from car" was significantly more frequently cited by tall respondents than by short respondents. All other significant response categories are negatively related to height.

Posts and headrests more often block vision of small drivers and the latter have greater difficulty with seat belts constraining their mobility and with hand controls.

The desire for better hand controls increases with vehicle year, i.e., the newer the vehicle the more frequent the response. Headrests blocking vision and oncoming glare are more frequently cited as needing improvement by drivers of smaller vehicles as shown in the "vehicle type" column.

C. SCALE VALUE ANALYSIS

1. Overview

As described in Sec. III, the questionnaire contained over 100 questions. Of these, 62 required respondents to check one of five categories of problem severity they had experienced, i.e., from "no problem" to "caused accident." Another 17 questions required respondents to check one of three categories of problem severity, i.e., from "played no part" to "contributed greatly." The remaining questions were demographic in nature or asked for written responses.

An initial computer run of the data from the 62 five-point scale questions was performed in order to discriminate between questions which elicited differential responses in terms of experienced severity. This screening process resulted in the elimination of ten questions for which the relative frequency of responses in the last two severity categories was quite low. Data from the remaining 52 questions were then subjected to a detailed computer analysis.

As noted earlier, statistical comparisons between questions and between demographics within a question are based on the distributions of responses to the five category scale. Significant differences and trends are cited in terms of mean scale values which reflect shifts in the distributions. Since the great bulk of the responses

are within the first three categories, it is those categories which predominantly influence the shifts. In some cases, a higher mean scale value is not accompanied by a higher incidence of "close calls" and "caused accidents." In most cases, however, such *was* the case (recall that a correlation of .73 was found). Had the subsample sizes been larger, frequencies of "close calls" and "caused accidents" would have been sufficiently large to achieve greater stabilization or reliability and it is likely that the association between scale values and those frequencies would approach 1.0.

Table 30 presents an overview of the results obtained from the computer analysis. The 52 questions are listed in abbreviated form in the left-hand column. Actual data are presented in Appendix D. Observed functional relationships between the five-point scale and the eight demographic variables are presented in coded form in columns 2 through 9. Finally, specific automobiles which appeared to deviate from the "norm" in terms of reported percentages of near accidents (close calls), accidents, and/or mean (five-point) scale values are listed to the right of column 9.

A positive sign in a cell within columns 2 through 9 indicates a positive relationship between the five-point scale responses and a demographic variable. For example, in row 1, column 4, the positive sign means that the frequency of critical incidents of "seeing with low beam headlights" was reported by respondents to be greater, the greater a driver's height. Similarly, a negative sign refers to a negative relationship. $\cup$ and $\cap$ indicate $\cup$ -shaped and inverse $\cup$ -shaped functions, respectively, while M and F indicate the sex which reported the greatest relative frequency of critical incidents as evidenced by mean scale values.

At the outset, certain qualifications should be stated prior to discussing the general findings presented in Table 30. First, most of the relationships or differences observed should not be construed as being of large or substantial magnitude in an absolute sense. Since near accidents are relatively infrequent events, it would be expected that results obtained in this study would reflect that fact

SUMMARY OF RELATIONSHIPS BETWEEN DRIVING PROBLEMS AND SELECTED DEMOGRAPHIC VARIABLES

QUESTION/PROBLEM										CARS HAVING A HIGHER THAN AVERAGE NUMBER OF CRITICAL INCIDENTS.
	YEARS DRIVING	DRIVER AGE	DRIVER HEIGHT	DRIVER WEIGHT	VEHICLE SIZE	VEHICLE AGE	DRIVER SEX	MILES PER YEAR	SCALE VALUE	
1. Seeing with low beams	0	-	+	+	-		M	+	1.86	Pontiac LeMans; Toyota Corolla; Buick LeSabre; Ford LTD, Plymouth Valiant, Duster
2. Seeing with high beams	0	0	+	+	-		M		1.17	Toyota Corolla; Ford Maverick, Granada; Plymouth Valiant, Duster
3. Rain, snow, fog on side windows	0	-	+		-		M	+	1.89	Toyota Corolla; Chevrolet Vega; Ford Pinto, Galaxie; Plymouth Duster
4. Rain, Snow, fog on rear window	-	-	+		-	-	M	+	2.02	Chevrolet Vega, Chevelle, Camaro; Ford Pinto, Torino, Galaxie
5. Glare from oncoming vehicle	0	-	+	+	-		M	+	2.25	Pontiac LeMans; Toyota Corolla; Buick Century; Chevrolet Vega, Camaro; Chrysler Newport; Ford Mustang; Plymouth Duster
6. Glare from tail lights		0	+	0			M	+	1.35	Pontiac LeMans
7. Glare from own car	0		+		+		F	+	1.51	Buick LeSabre; Ford Torino, Mustang
8. Glare from inside mirror		-	+	0	-		F	+	1.83	Toyota Corolla; Ford Mustang
9. Glare on left mirror	0	-	+	+	-	+	M	+	1.64	Toyota Corolla; Ford Mustang
10. Inside mirror information	0	0	+	+			M	+	1.49	Toyota Corolla; VW Beetle; Buick LeSabre, Skylark; Chevrolet Vega
11. Left mirror information	0	-	+	+	-		M	+	1.47	VW Beetle; Chevrolet Camaro; Dodge Dart; Oldsmobile Delta 88; Plymouth Duster
12. Right mirror information	0	-	0	0			M	+	1.65	
13. Mirror information too long	0	0	+	+	-		M	+	1.33	Ford Torino, Mustang
14. Windshield wipers inadequate	0	-			-		M	+	1.61	Pontiac LeMans; Toyota Corolla; VW Beetle; Chevrolet Camaro
15. Windshield defogger inadequate	0	-	+		-	-	M	+	1.64	VW Beetle; Buick LeSabre; Chevrolet Camaro
16. Posts blocked visibility	-	-	0	-		0	F	+	1.63	Toyota Corolla; Buick Century; Chevrolet Monte Carlo, Malibu; Ford Torino, LTD, Galaxie, Mustang; Plymouth Valiant, Duster
17. Roofline, hood, trunk blocked visibility	-	-		-			M		1.08	Ford Torino
18. Mirrors blocked visibility	+	0	+	0			M	+	1.15	Buick Skylark; Ford Torino; Plymouth Valiant
19. Passengers blocked visibility	-	-			-		M	+	1.49	Toyota Corolla; VW Beetle; Chevrolet Vega
20. Headrests blocked visibility		0	-		-	+	F	+	1.23	VW Beetle
21. Seats cause discomfort	-	-	+	+	-		M	+	1.10	
22. Seat belt restricts vision	+	0		+		+	M	+	1.38	Pontiac LeMans; Ford Pinto, Maverick, Granada
23. Brake requires too much force	-	-	+		-	-	F		1.06	Plymouth Duster
24. Braking without power brakes		0	0	+	+	-	M	+	1.59	
25. Leg reach to foot controls	-				-		F		1.05	
26. Foot slipping off pedal	0	-	+		-		M	+	1.20	Chevrolet Vega; Ford Pinto
27. Stepping on two pedals	0	-	+	+	-		M	+	1.21	

Table 30 (continued)

QUESTION/PROBLEM										CARS HAVING A HIGHER THAN AVERAGE NUMBER OF CRITICAL INCIDENTS
	YEARS DRIVING	DRIVER AGE	DRIVER HEIGHT	DRIVER WEIGHT	VEHICLE SIZE	VEHICLE AGE	DRIVER SEX	MILES PER YEAR	SCALE VALUE	
28. Leg hitting steering column	0	-	+	+	-		M		1.07	
29. Shifting into wrong gear	-	-	-		-		F	+	1.12	
30. Steering in wind	-	-	-		-		F	+	1.49	Toyota Corolla; VW Beetle; Chevrolet Vega; Ford Maverick; Plymouth Duster
31. Steering during skid	-	-	-		-	-	F		1.39	Pontiac LeMans; Toyota Corolla; VW Beetle; Buick Skylark; Chevrolet Vega; Dodge Dart, Duster; Ford Mustang
32. Steering with blowout	-	-	+	0			M		1.65	
33. Steering without power steering	+	0	+	+	+		M	+	1.87	
34. Steering normally hard	-	-	-		-		F		1.11	
35. Steering too sensitive	0	-			-		M		1.09	
36. Difficulty seeing gauges	0		+	0	+		M	+	1.22	Chrysler Newport
37. Shifting an unfamiliar car			-	-	-		F		1.34	Not relevant
38. Controls on unfamiliar cars	-	-	+	-	-			+	1.68	Not relevant
39. Finding headlight control	0						M	+	1.07	
40. Finding climate control	+	0	+				M	+	1.18	
41. Finding dimmer control	0	0		-			F	+	1.17	Chevrolet Vega
42. Finding washer/wiper control	0	0	+				M	+	1.13	Plymouth Duster
43. Finding defogger/deicer control		0	+					+	1.19	
44. Finding emergency flasher control					-		F	+	1.14	Ford Pinto
45. Finding horn	0	0					F	+	1.14	Pontiac Catalina; Ford Maverick
46. Finding miscellaneous controls	0	-	+				M	+	1.19	
47. Reaching horn			+	+				+	1.06	
48. Reaching miscellaneous controls	0	-	+		-	+	M	+	1.17	Chevrolet Camaro, Malibu; Plymouth Duster
49. Operating dimmer control	0	-		-				+	1.14	Buick Century; Chevrolet Vega
50. Operating washer/wiper control	0	0	+					+	1.12	Plymouth Duster
51. Operating defogger/deicer control	0	-						+	1.19	
52. Operating horn	0	-	+				F	+	1.12	Ford Maverick

and, therefore, demonstrate relatively small differences. In addition, mean scale values computed from five-point scales tend to be strongly constrained away from their end points, i.e., the values 1 and 5. And, as noted above, the categories "close call" and "caused accident" were expected to be experienced by respondents relatively infrequently, most mean scale values were anticipated to be between the values 1 and 3. Such was indeed the case. Thus, small differences represent greater effects than might otherwise seem apparent. For example, consider Question 1 again, for which male respondents indicated relatively more critical incidents than females. The frequencies for each severity category are shown below as a function of sex:

	<u>No Problem</u>	<u>Annoying</u>	<u>Potential Danger</u>	<u>Close Call</u>	<u>Caused Accident</u>
Males	953	589	522	92	1
Females	585	352	264	43	3

The computed mean scale values for males and females were 1.89 and 1.82, respectively, a difference of only 0.07. Nevertheless, a χ^2 test of the two frequency distributions indicated that the difference value of 0.07 was significant beyond the .05 level of confidence.

Second, as will be noted below, despite the observed relationships, mean scale values for many of the questions so closely approached 1.0 that further analyses of these questions were considered inappropriate in view of the purpose of this study which was to focus attention on the more important driver/vehicle mismatch problems of automobiles. Nevertheless, it is useful to at least note the rather consistent trends exhibited by respondents for all questions.

Third, each of the problems described by a question is treated as though it were independent of the others. For the most part, more than one problem, at varying levels of severity, probably occur simultaneously in nearly every driving situation. Thus, even a "small" problem cannot be wholly dismissed as irrelevant or negligible. Unfortunately, the complexities involved in attempting to elicit "compound" experiences from respondents with respect to specific combinations of problems were beyond the scope of this study.

Column 2 of Table 30 describes observed relationships between the 52 problems listed and driving experience. For 26 questions, inverse U-functions were observed, meaning that relatively inexperienced and very experienced drivers had relatively fewer critical incidents due to the problem experiences than did moderately experienced drivers. For 13 questions, the greater the driving experience, the less frequent/severe the problem. A few questions resulted in positive relationships with driving experience.

Column 3 is concerned with driver age relationships. Here, 30 questions resulted in negative functions, while 15 yielded inverse U-functions. No positive relationships were observed. In general, therefore, the older the driver, the less frequent the critical incidents for the problems described.

Column 4, driver height, is almost totally dominated by positive functions. Thus, the taller the driver, the greater the critical incident frequency for the problem expressed. A few negative and U-shaped functions were observed as well.

Relatively fewer relationships were found for driver weight (column 5). Most were positive functions, indicating that heavier drivers expressed more frequent critical incidents for the problems than did lighter drivers. However, several questions resulted in negative, U-shaped and $\cap$ -shaped functions.

With few exceptions, all of which seem quite understandable, the larger the car size, the fewer the critical incidents expressed by respondents (column 6). Nearly all of the functions observed were negative relationships. Those exhibiting positive functions were associated with steering with power steering failure, braking with power brake failure, glare and seeing gauges.

Vehicle age represented the least important demographic variable in this study (column 7); only 10 functions were observed distributed almost equally between positive and negative relationships.

Column 8 of Table 30 indicates that male drivers tended to experience greater critical incident frequency for the problems described than did female drivers. Thirty one questions had a greater frequency

for males, 15 were more frequent for females, and six were equal for both sexes.

Column 9, which illustrates problem frequency/severity as a function of miles driven per year, is totally dominated by positive relationships. As expected, the more miles driven per year, the more critical incidents reported by drivers and the greater the problem severity in general. Results from this question are of interest primarily because they provide a check on the meaningfulness of questionnaire data in general. For example, failure to find positive relationships here would lead one to suspect the validity of all relationships observed. On the other hand, these results obviously do not guarantee the opposite conclusion.

This general examination of Table 30 suggests that there are probably many *real* relationships between driving problems and the demographic variables included in the study. As will be seen below, many of the relationships wash out following the application of statistical significance tests. However, it should be noted that while the overall sample of drivers in the study appeared to be more than sufficient for delineating the more important problems, it was simultaneously quite inadequate for determining the significance of problems of lesser frequency. In summary, we are convinced that a larger sample of drivers would reveal many more significant relationships.

2. Results of Significance Tests

Based on mean scale values (averaged across all variables), data from the 20 most important questions/problems were subjected to χ^2 tests. Mean scale values derived from these questions ranged from 1.38 to 2.25. Table 31 summarizes the results of this analysis which omitted the variables "years driving experience" and "miles driven per year." The relationships shown were all found to be significant beyond the 0.5 level of confidence.

Seventy-five percent of the 20 most frequent problems listed in Table 31 are visibility problems. Four are control problems related to drivers' own cars while a fifth control problem (Question 149) is concerned with controls on *unfamiliar* cars. Since there were many more

Table 31

SUMMARY OF SIGNIFICANT RELATIONSHIPS BETWEEN THE 20 MOST IMPORTANT PROBLEMS AND SIX SELECTED VARIABLES

*	**	Question/Problem	Mean Scale Value	Driver Age	Driver Height	Driver Weight	Vehicle Size	Vehicle Age	Sex
111	1	Seeing with low beams	1.86	-	+				M
113	3	Rain, snow, fog on side windows	1.89	-	+				M
114	4	Rain, snow, fog on rear windows	2.02	-				-	
115	5	Glare from oncoming vehicle	2.25	-					
117	7	Glare from own car	1.51				+		
118	8	Glare on inside mirror	1.83	-			-		
119	9	Glare on left mirror	1.64	-	+		-		M
120	10	Inside mirror information	1.49	∩	+	+			M
121	11	Left mirror information	1.47	-	+	+	-		M
122	12	Right mirror information	1.65	-	∩				M
124	14	Windshield wipers inadequate	1.61	-			-		
125	15	Windshield defogger inadequate	1.64	-			-	-	
126	16	Posts blocked visibility	1.63	-	∩				F
129	19	Passengers blocked visibility	1.49	-			-		
132	22	Seat belt restricts vision	1.38	∩					
134	24	Braking without power brakes	1.59	∩	∩		+	-	
140	30	Steering in wind	1.49	-			-		
142	32	Steering with blowout	1.65	-					
143	33	Steering without power steering	1.87				+		
149	38	Controls on unfamiliar cars	1.68	-	+		-		

* Question number on questionnaire.

** Table number in Appendix D.

questions focused on control than visibility problems in the questionnaire (37 versus 21), the observed predominance of vision related critical incidents takes on even greater significance.

Glare from oncoming vehicles resulted in the greatest relative frequency of critical incidents by far, as measured by mean scale values. The next most critical problem was rear window vision obscuration by rain, snow, or fog, followed by rain, snow, or fog on side windows. Thus, the three highest ranked problems were associated with visual blindness in the forward field-of-view, blindness in the rear field-of-view, and blindness in the side field-of-view, in that order.

a. Driver Age

With few exceptions, critical incidents decreased significantly as respondent age increased. Despite the consistency of this trend across questions, however, it appears to be more an interesting finding than it is one of importance. At first glance, there seems to be no logical explanation as to why older drivers should experience fewer critical incidents than younger drivers. In fact, one would expect the opposite trend because vision and reaction time tends to become degraded with age.

Three explanations for these observed trends can be advanced. First, the concept of man's adaptation capabilities has long been accepted as an element of learning to cope with complex environments. It is possible, therefore, that older drivers have gained so much experience across automobile types that they have adapted to "conventional" problems and indeed experience fewer incidents than do younger, inexperienced drivers. An analysis of the data in terms of driver age by driver experience might provide evidence in this regard. While the data is available, unfortunately project time and funds did not permit as complete an analysis of the data as would have been desired.

A second possible explanation, not totally unrelated to the first, is the fact that age tends to subdue criticism, i.e., the older a person becomes, the more he accepts "the way things are" and the less he is critical of his environment. It is reasonable to expect that older persons would be less critical of driving problems.

A third possible explanation is suggested by anecdotal evidence provided by some of the very old respondents who indicated that exposure, especially to high severity close call situations is less than younger drivers. Several older drivers volunteered that they no longer drove at night or in bad weather or in heavy traffic. Decreased exposure would account for the observed trend. A comparison of incident frequency by driver age with exposure, e.g., miles per year, might clarify the issue.

None of these explanations may seem totally satisfactory from a technical point of view, but they do seem to be far more satisfactory than those which would attempt to suggest, for example, that there are behavioral or physiological reasons why older persons should find glare, rain, snow, and fog to be less of a problem than do younger persons.

b. Driver Height

Table 31 indicates nine significant relationships between incident frequency and driver height. Some of these relationships were expected. For example, it was anticipated that tall drivers would encounter certain types of visibility problems, such as acquiring information from left-outside, inside, and right-outside rear-view mirrors (Questions 120, 121, and 122). The unfavorable downward viewing angle and eye-to-mirror distance of very tall persons would lead one to expect them to have greater difficulty in gaining information from conventionally placed mirrors. Further, we anticipated tall persons to be more affected by certain visibility obstructions, such as road posts (Question 126), again because of their unfavorable downward viewing angle, but not by other forms of obstructions, such as passengers (Question 129), which is perhaps obvious. It is not surprising, furthermore, to find tall persons affected more by rain, snow, and fog (Questions 113 and 114). Although this relationship for Question 114 failed to reach significance, the trend was noted in Table 31.

On the other hand, it is not exactly clear as to why taller persons should experience greater difficulty with mirror glare (see Tables 30 and 31, Questions 117, 118, and 119), seeing far enough ahead with low-beam headlights (Question 111), braking without power

brakes (Question 134) and operation of controls on unfamiliar cars (Question 149). It is conceivable that because of their relatively poorer access to mirrors, taller persons may find glare to have a greater "noise" effect than shorter drivers. Similarly, it might be reasonable to expect taller persons to experience greater difficulty with forward visibility in general, both during daytime and nighttime driving. If so, we would expect seeing with high-beams to be of equal importance. Although this trend was observed (Table 30), it did not reach significance. However, results from Questions 134 and 149 escape what might be termed reasonable explanations.

c. Driver Weight

Only two relationships between driving problems and driver weight were statistically significant, i.e., acquiring information from the inside and left-outside mirrors (Questions 120 and 121). Since weight is strongly correlated with height, it would be anticipated that the strongest functions found for the height variable would also appear for the weight variable. Somewhat weaker relationships would wash out. Thus, the two significant relationships observed are not particularly surprising. However, it *is* somewhat surprising that certain trends found with other questions (Table 31) did not achieve significance.

d. Vehicle Size

Results from the analyses of vehicle size data are, for the most part, clearly understandable and anticipated. They indicate that the larger the automobile, the less severe are many visibility problems. The single exception is glare from the driver's own car (Question 117); this significant function suggests, quite understandably, that drivers of larger cars are subjected to greater amounts of reflected glare than drivers of smaller cars simply because larger cars have larger reflective surface areas.

Explanations for the significant functions found for Questions 134, 140, and 143 are rather obvious. Braking and steering without power brakes and power steering are clearly more of a problem with larger cars than smaller cars. Conversely, steering in strong winds

is a problem unique to smaller cars. The function observed for Question 149, however, is not obvious. It suggests that the larger the driver's car, the lesser the problem of locating and operating controls in unfamiliar cars. Because larger cars (typical of most rentals) tend to have more controls than smaller cars, perhaps the explanation may lie with the concept of transfer, e.g., it is well known that it is easier to transfer from complex to simple tasks than vice versa. Thus, it would tend to follow that drivers of cars having many controls would have less difficulty in adjusting to cars with fewer controls than drivers of cars having a small array of controls.

e. Vehicle Age

Three significant relationships were found for the variable, vehicle age, and two of these are closely related. Drivers of newer cars found windshield defogging to be less of a problem than did drivers of older vehicles (Question 125). Similarly, drivers of newer cars expressed fewer critical incidents due to rain, snow, and fog on rear windows than did drivers of older vehicles. These findings are in keeping with known improvements in windshield defoggers through the last decade and with the installation of defogger systems for rear windows in newer cars.

The remaining significant relationship indicates that the newer the car, the less severe the problem of braking after power brake failure. Because we are not aware of any substantial improvements made in "back-up" brake systems during the last ten years, an explanation for this trend similar to that presented for defogger systems cannot be advanced here. However, it does appear to be a possibility.

f. Sex

An examination of sex differences for the 20 questions having the most frequently occurring critical incidents reveals little insightful or useful information. It would appear that such differences were due, at least in part, to an irrelevant biasing factor, not conceptually unlike the bias exhibited in the driver age relationships. Simply stated, it seems most likely that males were more "outspoken" with

respect to critical incidents than were females. On the other hand, the fact that males tend to drive slightly more per unit time than females may be an equally plausible explanation as to why they expressed greater concern with the problems described. In any event, there appear to be no physical factors associated with males and females, except size, which would explain why males should find the incidents more frequent and or severe than females.

3. Cars

Table 30 also lists the makes and model of specific cars which were owned by respondents who indicated the greatest severity of the problems described in the questions. For example, consider Question 1, "seeing far enough ahead with low-beam headlights." The mean scale value across all respondents was 1.86. The cars listed were operated by subgroups of respondents whose mean scale values were the highest observed within the distribution of scale values from which 1.86 was computed. For example, the Pontiac LeMans received a mean scale value of 2.21 and the Toyota Corolla received a value of 2.08.

For some questions, no cars are listed. Such was the case where the variability of the overall distribution of scale values was very small and no car received a scale value substantially greater than the overall mean value. Low variability was usually the case where overall means closely approached 1.0. However, there were a few notable exceptions, such as those computed for Questions 122, 134, 142, and 143, which had mean scale values of 1.65, 1.59, 1.65, and 1.87, respectively.

Approximately 300 different make/model cars were involved in the entire survey sample. For the present analysis, only the data for subgroups of respondents whose make/model but *not* year sample sizes were 25 or greater were selected, i.e., 25 or more drivers who owned the same make/model cars. Twenty-nine subgroups/car types were selected. From these 29, those exhibiting the highest scale values are listed in Table 30.

Because the sample size of each car type for each problem described was not large, averaging about 40, reliability is not considered

sufficient for assuming that the cars listed in the table indeed comprise the major contribution to the problems described. However, the sample sizes were considered sufficient for providing general tendencies and a starting point for further study.

As can be seen in Table 30, most of the cars listed were associated with visibility problems. Notable exceptions were those listed next to "steering in the wind" and "steering during skidding." Of the 29 cars included in this analysis, 10 appear to predominate in terms of frequency of association with the driving problems. The most frequently listed cars were the Toyota Corolla and the Plymouth Duster, followed by the Chevrolet Vega, VW Beetle, Ford Mustang, Chevrolet Camaro, Pontiac LeMans, Ford Torino, Ford Maverick, and Ford Pinto. It is to be noted that with the exceptions of the Pontiac LeMans and the Ford Torino which are intermediate size, all of these cars are compact or subcompact type vehicles. This finding is generally consistent with accident research data, i.e., smaller cars tend to be more frequently involved in accidents than do larger cars.

Extreme caution should be exercised, however, in considering the specific cars listed in Table 30. The subgroups of cars include models produced across a number of years. While some of the models have changed very little, others have quite different designs. Thus, a car listed in the table may and probably does reflect different model years. Even so, there is reason to believe that a driving problem may be related to a specific model if its frequency of association is high. If design changes occurred which eliminated a particular problem, ratings by respondents should closely approach the total sample mean scale value. Additional analysis of existing data, e.g., vehicle make/model and year by mismatch question could clarify some of the findings.

V. DISCUSSION AND RECOMMENDATIONS

A. GENERAL SIGNIFICANCE OF FINDINGS

Of the total sample of 3478 respondents, 1573 reported having close calls and/or 118 accidents because of specific driver/vehicle design mismatches. To comprehend the meaningfulness and significance of these summary statistics, consider first the following statements which, although not intending to be precise, are generally supported by available data. First, the average driver travels some 9000 miles per year (*Accident Facts*, 1975). Second, the ownership period of an automobile by the average driver is approximately four years.¹ Third, approximately one accident occurs, on the average, for every 40,000 miles driven (Forbes, 1970). It follows, therefore, that the average driver travels some 36,000 miles per automobile and has 0.9 accidents.

Now, close calls and accidents were reported by respondents in this study for a single vehicle. Given an average ownership period of four years, the average respondent in the sample owned his vehicle for two years, had driven his vehicle for 18,000 miles and had sustained 0.45 accidents. Multiplying the total number of respondents by the number of accidents per driver (3478×0.45) yields 1565 accidents. Since 118 accidents were reported by respondents to be due to driver/vehicle mismatches, the estimated percentage of total accidents is 7.5 percent. In other words, driver/vehicle mismatch problems are estimated to represent 7.5 percent of the causative factors of all accidents.

While 7.5 percent is substantial, amounting to approximately 1.7 million accidents per year, there is good reason to believe that it is a minimum estimate and probably a gross underestimate. In Sec. I.D, a discussion was presented which emphasized the difficulties in classifying causes of accidents. It was emphasized that traditional definitions of certain accident causations may be misleading, somewhat arbitrary and, occasionally, quite erroneous. "Driver error" or "inattention," for example, are catch-all terms which do not necessarily represent "pure"

¹Although we were unable to find published evidence to support this statement during the period of preparing this report, we believe that such evidence exists. In any event, the probable error in the estimate would have little impact on the conclusions to be reported below.

reasons for accidents. It was shown in Sec. I.D, that variations in vehicle design features can increase or decrease specific types of accidents which would ordinarily be classified as driver induced. Thus, it is likely that vehicle design factors, as well as environmental and roadway factors, are inextricably associated with driver errors in most accidents. They act as *catalysts* which influence, positively or negatively, the probability of the occurrence of a driver error. In conclusion, therefore, while it may very well be impossible to determine the exact contribution of each type of factor to accidents, it seems quite clear that the contribution of vehicle design features is much greater than the computed estimate presented above.

An additional consideration is the fact that the questionnaire employed in this study did not permit respondents to indicate the *number* of close calls or accidents which were caused by vehicle factors. Rather, they were permitted only to provide the single, worst experience associated with each factor. Therefore, the 1573 close calls and 118 accidents reported are most likely underestimates of the total number of critical incidents that were experienced, implying again that the computed estimate of 7.5 percent is also lower than the actual percentage contribution of vehicle factors to accidents.

To gain further insight into the significance of the summary statistics, consider, for example, the responses to the question involving vision obscuration via vehicles' pillars or posts. Four percent of the respondents indicated that such obscuration caused at least one close call. Since the ratio of close calls to accidents in this study was found to be about 13 to 1, the predicted average number accidents per person due to pillar or post obscuration is 0.003. Assuming the same average ownership period of two years and that the value 0.003 is associated with that period, the predicted accident rate per year per driver would be 0.0015. If this estimate is then applied to the 125,166,000 current drivers in the country, one would expect about 187,749 accidents per year, due to pillar/post obscuration. At an average cost of \$1300 per accident (*Accident Facts*, 1974), which excludes costs of police, legal awards, etc., the total bill for pillar/post obscuration accidents

per year is estimated to be about \$244,073,700. Moreover, since the accident to death ratio is about 0.0029 (*Accident Facts*, 1974), 544 deaths would be expected.

The evidence seems conclusive to these writers that the national costs of driver/vehicle mismatch caused accidents (as well as many other types of accidents identified in the study) are far from trivial and are certainly of sufficient significance to warrant serious research toward minimizing driver visual and control problems. Based on our results, the following list of 12 driver/vehicle mismatch problems appear to be the most important and should receive priority consideration with respect to NHTSA and industry efforts:

- . Oncoming headlight glare
- . Seeing with low-beam headlights
- . Vision obscuration by pillars and posts
- . Rain, fog, and snow obscuration of rear windows
- . Rain, fog, and snow obscuration of side windows
- . Information provided by left mirrors
- . Information provided by inside mirrors
- . Information provided by right mirrors
- . Braking after power brake failure
- . Steering after power steering failure
- . Steering after tire failure
- . Skidding during brake application.

B. DRIVER/VEHICLE MISMATCH COUNTERMEASURES

Design countermeasures to the driver/vehicle mismatch problems reported by survey respondents tend to follow, at least conceptually, from the nature of the questions asked. Actual engineering solutions and implementation considerations, however, are not always so obvious because of occasional design criteria conflicts. For example, improvement in low-beam headlights must be considered in relation to potential negative effects on the visibility of oncoming drivers, and reducing visual obscuration, produced by pillars and posts, must be considered in relation to possible hazards resulting from weakening the roof structure.

The 20 most important driver/vehicle mismatch problems revealed in this study (see Table 31, p. 90) clearly indicate the predominance of vision difficulties. Fifteen of the 20 problems involve some form of vision difficulty. The most severe is that of glare from oncoming vehicles. Recent headlighting research should shed more light on the possible solutions than can be presented here, although it should be noted that such solutions must be compatible with that of another significant problem, visibility with low-beam headlights. A need exists for greater forward illumination but it must not conflict with the visibility of oncoming drivers. The development of automatic dimmers and improvement in the accessibility of conventional dimmer controls also seem indicated.

Rain, snow, and fog on side and rear windows represent problems of considerable significance, as evidenced by respondents' reports. Although each of these elements is composed of water, the reduction of its obscurational effects on visibility probably requires entirely different technological solutions. Inadequate windshield wipers and defoggers are apparently major contributors to a relatively high number of critical incidents, although the trend, at least for defoggers, tends to be favorable for newer vehicles.

Rear view mirrors were the source of five of the top 20 mismatch problems. Glare on inside and left mirrors and inadequate acquisition of visual information were the difficulties experienced by respondents. Recent research literature on rear vision has provided some potential solutions, or at least improvements, to these problems, but none of the solutions, to our knowledge, has been implemented as yet. Increased mirror field of view and night mirror dimming features which eliminate glare seem clearly needed. With regard to the former, however, it is also evident that increases in the size of inside mirrors should not be accompanied by concomitant increases in obscuration of forward vision. Perhaps the only practical and effective improvement will be some form of periscope which has virtually no physical effect on forward vision at all.

Glare generated from drivers' own vehicles also remains a significant problem, despite standards established for its reduction. As

might seem intuitively obvious, glare is more severe the larger the vehicle. Solutions to this problem are clear but implementation of designs known to eliminate glare is yet to be initiated.

Blockage of vision by pillars and posts, passengers, seat belts (via torso movement restrictions), headrests and high seat backs is also a major contributor to critical incidents. While we were not able to determine which pillars and posts pose the greatest problems, the large "C" pillars appear to be the primary responsible structures because of their size. In any event, when all of these structures are considered collectively, especially with respect to small drivers, the total constraint on visual access to the driver's environment is rather enormous. Beyond the obvious need to reduce pillar size, specific design solutions to visual blockage problems are not straightforward, however. For example, a conflict exists between the desirability of smaller seats/headrests for crash prevention and of larger seats/headrests for post-crash protection.

Braking and steering emerge as significant problems when power features and tires fail. The problems are especially evident on the larger vehicles and for small drivers. A temporary back-up capability which provides power assist for a short period following engine failure may be worth exploring. Improved tire blow-out protection is an obvious solution to the other difficulties experienced by respondents.

Steering is also reported to be a significant problem in windy environments and the problem is highly related to vehicle and driver size. The smaller the vehicle or driver, the greater its severity. Since driver size is non-manipulable, handling and aerodynamic characteristics of small vehicles represent key elements for redesign consideration.

Finally, finding, reaching, and operating controls on unfamiliar cars is also a problem of no little significance. In view of trends toward increased number of vehicles per household and increased usage of rental vehicles, efforts toward standardization of controls and their placement appear necessary.

C. RECOMMENDED FURTHER STUDIES

Accident investigation is principally subjective in nature. Even the most sophisticated studies which attempt to determine accident

causations employ the same basic technique used in the present investigation. That is, drivers are *asked to describe* their accidents and/or provide information leading to a delineation of factors which may have contributed towards such accidents. However, as we observed in our focus panel studies, drivers do not typically *think* about vehicle design features unless specifically asked to consider them as possible accident causing factors. Why this is so remains an interesting question. Perhaps the most reasonable answer can be found in discussions of "fault," "relevance," and the "judicial system." The typical accident is a two car collision which is not preceded by a mechanical failure by either vehicle. The immediate reaction by both drivers is to establish fault. Insurance companies reimburse drivers on the basis of driver fault, never on vehicle design features. To both the drivers and insurance companies, vehicle design factors are irrelevant. Moreover, the judicial system seldom recognizes vehicle design factors as contributors towards accidents in cases where litigation ensues. Thus, it is not surprising that drivers tend to be oblivious of the *real* importance of such factors. From a monetary point of view, driver fault is the *only consideration that matters*. Everything else is irrelevant and, therefore, unimportant.

The present study demonstrated that when drivers are asked to relate vehicle design features to critical incidents, independent of driver fault considerations, they clearly have a great deal to say in this regard.¹ The survey results provide a relatively extensive data base that can be used to investigate a wide variety of vehicle safety and driver/vehicle mismatch problems. The existing combinations of driver and vehicle variations and the breadth of the questions asked permit the investigation of many more hypotheses than were examined here. Unfortunately, time and money limited our analyses to perhaps only 40 percent of the total number of relevant hypotheses that could be advanced.

Objectives of the study, in addition to the development of a workable scaling technique, included the (1) identification and rank-ordering driver/vehicle mismatch problems, (2) estimating the overall severity

¹It is likely, however, that these drivers would provide entirely different information were they interrogated immediately after experiencing their critical incidents, especially those which resulted in actual accidents.

of the problems, (3) examining the relations between vehicle designs and driver variables, (4) testing specific hypotheses related to mismatch problems, and (5) identifying remedial design countermeasures. Data were analyzed in sufficient detail to meet these objectives but as the analyses proceeded, it became clear that a wealth of data would necessarily remain unanalyzed and that many questions of interest would remain unanswered. While the reader may have already generated a number of his own questions, the following paragraphs offer some examples.

Do drivers, in general, purchase vehicles which match their own physical characteristics? For example, do tall and/or heavy-set drivers purchase large cars? A simple cross tab between height, weight and vehicle type would provide an answer.

The Pacer and BMW 2002 are "greenhouses," with respect to visibility, in comparison to most vehicles. Do drivers of these cars report fewer and less severe visibility problems than drivers of other cars?

The survey sample contained some 600 drivers whose ages exceeded 65. Do such drivers experience problems differently from that of younger drivers? Do they recognize their sensory-control limitations and optimize their performance by driving specific types of automobiles?

Since short drivers experience vision obscuration problems because of high seat backs and headrests, at what height do these problems become negligible? Also, do short drivers experience less severe problems in cars such as the Saab which provides see-through headrests?

Are problems related to height general across males and females? For example, do short female drivers experience the same types and severity of problems as do short male drivers?

And, very importantly, are the specific vehicles, for which respondents reported specific problems, measurably deficient with respect to those problems? Clearly, it would be of great value to objectively determine, for example, forward and rear fields of view, reaction time to the dimmer control, and surface type and area contributing to own vehicle glare.

Clearly, many more questions could be posed.

Despite the relatively large data base accumulated in this study, there appears to be considerable justification for extending the survey to a larger sample of drivers. While we do not believe the principal findings will be altered significantly as a result of conducting a larger survey, it is likely that other findings will emerge which could not surface in the present study because data points were too few in number. Moreover, much was learned in this study which could increase the cost-effectiveness of a larger survey. For example, some of the questions asked in the survey appear to be of little or no importance. They could be eliminated in future surveys, thus decreasing questionnaire length and probably increasing response rate. Additionally, the response rates from the two autoclub subsamples were so favorable that future surveys should consider the exclusive use of membership clubs.

From a sampling point of view, the overall sample employed in this study is not precisely representative of the U.S. population of drivers, although it samples the range of driver, vehicle, and environmental variables sufficiently well to enable reliable conclusions to be made.

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Appendix A

SUMMARY OF FOCUS PANEL COMMENTS

Sex: Female
Age: 32
Occupation: Housewife
Years Driving: 16

Vehicles: 1969 Ford Galaxie
1966 Ford Mustang

1. In an uncontrolled intersection I have stopped, looked both ways, and proceeded to make a left turn into the intersection at which point a car coming from the right almost hits me. My fault because I don't look to see what is coming from the right last. Instead I usually look right then left then I proceed. I have been told I should look right again. Also cars were going fast. (Mustang)
2. While driving down a street, car next lane over had stopped for a pedestrian running across the street. I didn't see him in time and I hit him. Blame was put on pedestrian because he wasn't in a crosswalk and he was also drunk. (Mustang)
3. Parked car on hill outside of home. Wheels were curbed. Emergency brake on and transmission in park. Kids got in to play cops and robbers. Turned wheel, released brake and transmission. The car rolled down hill and collided with a sports car. (Galaxie)
4. Other car's blinker was difficult to see until was right on top of him. Had to brake severely because he was coming from left to right over the off-ramp. (Mustang)
5. Lots of force needed to put emergency brake on or off. As a result it is used very little. (Galaxie)
6. I can't look in my mirror when driving on the freeway at night, because of the headlights. I turn the rear view mirror up. (Galaxie)
7. When my windows were fogged I would have to pull over to find the defog control because I didn't have a light inside. And I didn't know the layout of the controls. Only drive car about once per week. (Mustang)
8. Changing to a right lane on a freeway checked mirrors and over my shoulder--seeing it was clear moved over. However, at the same time a car two lanes over to my right made a left lane change into the same position I was changing to. I didn't notice if he had his signal on or not. (Galaxie)

Sex: Female
Age: 33
Occupation: Teacher
Years Driving: 17

Vehicle: 1964 Pinto
1976 Porsche
Anglia

1. Passing car on two way road, saw oncoming car almost too late slowed and pull back into lane. Oncoming car couldn't be seen because car was in dip, plus distortion caused by heat mirage caused the road not be seen. (Pinto)
2. High back seats cause a blind spot in the peripheral vision causing one to change body position to look around, e.g., VW's I have driven in the past.
3. Driving on freeway, cars in front had stopped for an emergency. I braked sharply which caused my car to go into oscillation - with the feeling it would almost tip over. (Anglia)
4. Driving on freeway gas pedal ceased to function, had no power. Felt panicked, pulled over to the side. (Anglia)
5. Controls jammed (accelerator linkage failure) on freeway no control of car at all. (Anglia)
6. I was crossing Pacific Coast Highway with three other people all walking bicycles. Traffic almost refused to stop. When one lane stopped the others kept moving until one car finally screeched to a stop, this repeated itself on all lanes across the highway.
7. A woman told her six year old boy to cross to the middle of the Pacific Coast Highway when there was no traffic on their side, and to wait in the middle until the traffic on the other side had stopped. The boy got confused and ran into the other side before traffic had stopped. Cars braked for him but he got even more confused and ran into the oncoming traffic only through skillful driving did we avoid hitting him. He did get to the other side.
8. While driving I was adjusting the radio on my car, causing me not to look where I was going. As a result I ran into the rear end of a stopped car. (Anglia)
9. Horn easy to push but not very loud. (Pinto)
10. Passenger front seat back doesn't lock properly, when coming to a stop the seat flops forward. (Pinto)
11. No feedback to see if my headlights are on. (Pinto)

Sex: Male
Age: 20
Occupation: Phone Operator
Years Driving: 5

Vehicle: 1967 Volkswagen

1. Driving on freeway at night. Noticed in rear view mirror car coming rapidly from behind with no headlights on. The car passed on the right, then came over to my lane - would have hit me if I hadn't yanked the wheel to the left almost hitting a truck in the left lane. Yanking the car back into the original lane to avoid hitting the truck, I came in the way of a car with its high beams on, it was apparently following the first car. To avoid hitting the car I again tucked in to where the truck was to let the car pass. Then I over reacted getting back into my lane, missed it and went one more lane over. I felt I had no control over the car.
2. When changing to a left lane I would look in the side mirror but not turn around - not seeing a car I would proceed to change lanes but a car which had been in my blind spot would beep its horn causing me not to continue the lane change.
3. Driving with friend on a wet night - over a bridge lost control and spun out. Car didn't have tail lights, windshield wipers or top. Was doing 55 in 35 zone. Turned car around and drove on.
4. I was going too fast to brake for a yellow. But it turned red unexpectedly. So I slammed on brakes and skidded through the intersection. Problem was that I misjudged my own speed and the light turned faster then expected.
5. I was crossing a crosswalk (as a pedestrian) with the walk sign when a car swerved left to avoid hitting me. It went across the street and hit a parked car. He was drunk and was arrested.
6. Driving down the street a car in front stopped to make a right turn. Other cars behind him slammed on their brakes. I slammed on mine but they didn't stop me fast enough so I ran into the car in front of me.
7. Problem with cars that have auto transmission. Travels without giving gas when foot isn't on the brake.
8. Notice driver in a new vehicle made a right turn too short, driver panicked tried to brake but instead accelerated went up on curb, hit a signpost and a tree.
9. Blow out in rear tire causes car to be uncontrollable. (1967 VW)

Sex: Female
Age: 29
Occupation: Housewife
Years Driving: 13

Vehicle: 1965 Mustang

1. I was driving down a street, not paying attention. I almost drove into a parked car, swerved at the last moment.
2. I was getting off the freeway at an off-ramp when a truck on my left started coming over to the off-ramp. I was forced onto the shoulder to avoid being hit by the truck.
3. Fell asleep on freeway. Woke up because car wandered over lane divider bumps.
4. Driving west in the afternoon. Can't see brake lights because of the glare and high ambient lighting, I compensate by driving slower.
5. In making a left turn onto a through street, I usually misjudge the speed of the traffic. Proceeding onto the through street, I cause cars to brake suddenly to avoid hitting me.
6. I had stopped behind two cars at a red light when the light turned green. I went forward but the car in front of me didn't. As a result I ran into her rear end.
7. While making a left turn at an intersection, I went into a fishtail spin because of water running into the road from an adjacent car wash.
8. Saw car coming towards me on the wrong side of the street. Pulled over to the side, turned off the headlights and let him pass by.
9. Have trouble backing up because of large rear panel, obscures view.
10. Problem going from gas pedal to brake. Shoe catches on brake pedal when lifting off of gas. Gas pedal is lower than brake.
11. Emergency brake on wrong side. Brake handle is on the left side. When getting out of car have caught it with knee causing it to release.
12. Headlights degrade my driving behavior by temporarily blinding me.
13. With respect to knobs and dials, the fewer the better.
14. Multipurpose controls confusing.
15. No feedback to see if lights are on.

Sex: Male
Age: 32
Occupation: Engineer
Years Driving: 10

Vehicle: 1968 Toyota

1. Many times looking into the rear view mirror it has not showed me cars that are there when I go to make a lane change.
2. Fell asleep on freeway, drifted into other lanes. Woke up just in time because of bumps between lanes.
3. I had stopped for traffic light. Car driving up from behind swerved over to parking lane to pass because light just turned green. If I were to have turned right as I had planned, I would have hit him.
4. Car had stopped at an intersection in a different lane. Light was green for my direction. I was passing car when I saw pedestrian (boy) crossing in front of the other car. I braked hard and swerved in order to miss him.
5. Coming back from a party I fell asleep at the wheel went through bushes and landed in a ditch. I then woke up after the car came to a stop.
6. On two occasions while driving, the rear of the seat went all the way back to recline.

Sex: Female
Age: 28
Occupation: Law Journal Editor
Years Driving: 12

Vehicle: 1971 Vega

1. Stopped in a freeway jam, car coming up from behind slammed brakes on causing it to skid would have hit my rear end if it hadn't swerved onto emergency shoulder. There was no where for me to go so I stayed where I was.
2. Bumper to bumper traffic on freeway car slid into my rear end.
3. Braked to let a tumbleweed pass. Car behind braked while in a puddle and slid into me.
4. Cars in front had slowed down to a stop, car in front didn't have brake lights so I didn't notice him stopping. Seeing he had stopped I jammed on my brakes. Slid into his rear at the same time a car behind me slid into my rear.
5. To operate horn requires extreme force. Had dealer check. They said it was o.k. Actually sprained wrist one time trying to use it.

Sex: Female
Age: 27
Occupation: Cost Analyst
Years Driving: 5

Vehicle: 1971 Toyota Corolla

1. Driving on freeway during morning rush hours. Large car in front signalled for right lane change. Began merging very slowly. Car from two lanes over pulled into same lane as merging car forcing merging car to whip back into original lane as Jean was about to speed up and pass.
2. Glare from headlights on car behind is so bad, she'll change lanes to remove it. No dimmer on mirror.
3. When windows get fogged or steamed up, drives with windows open.
4. Has to take foot completely off accelerator before moving to brake pedal because brake pedal is higher than accelerator. Worries about this when she is on a hill.
5. Passengers on right block side vision.

Sex: Male
Age: 29
Occupation: Military
Years Driving: 12 years

Vehicle: 1970 Plymouth Duster

1. Coming down freeway off-ramp and didn't notice a stop sign as ramp reached an intersection. Continued into intersection then noticed car on his left. Other driver swerved out of way. Gill applied his brakes. Said he was fatigued, not paying attention. Occurred at dusk (7 pm)
2. Fell asleep at wheel in fast lane. Hit lane reflectors which woke him up and he regained control.
3. Can't adjust outside (left) mirror to cover "blind" spot.
4. Back window stays fogged; front defroster has no effect on back. Side windows also cause problems when they are fogged up.

Sex: Male
Age: 27
Occupation: Unemployed
Years Driving: 10

Vehicle: 1967 M.G. Midget
1961 Mercury

1. Car is small and low to ground which limits his vision during lane changes, especially campers and vans. Other cars tend to cut in front of him presumably because they don't see him. (1967 MG)
2. Approaching intersection with red light. Brakes failed, but fortunately light turned green before he reached intersection. (1961 Mercury)
3. Winds from passing trucks cause car to waver. Windshield wiper switch is inconveniently located on far right side of dash. (1961 Mercury)
4. Bright headlamps seem to dim. (1961 Mercury)

Sex: Male
Age: 29
Occupation: U.S. Government
Years Driving: 14

Vehicles: 1963 Falcon Truck
1971 Gremlin

1. Raining, traveling 50 mph. Heard an explosion, lost control of car, spinning at least twice. Came to stop off the road. Apparently hit a rock or chuckhole with left rear tire causing a blow out. Didn't check mirrors or look around while trying to regain control. (Falcon)
2. Can never adjust the left outside mirror and inside rear view mirror to eliminate blind spot. Can't trust the mirrors. (Falcon)
3. Glare, won't drive without wearing sunglasses. Glare from rear view mirror with car behind with headlights is very bad. (Gremlin)
4. Horn breaks frequently, works intermittently. (Falcon)
5. Turn signal won't turn off automatically. Never uses parking brake because always forgets to release it later.
6. Didn't realize that in snow country, where there is a shade on road there is probably ice. Was driving fast and spun out when hit ice. (Falcon)

Sex: Female
Occupation: Housewife

Vehicle: 1972 Torino Stationwagon

1. Kid on left side of street riding a skateboard pulled across in front of her. She slammed on brakes, didn't check rear mirrors. Car braked smoothly.
2. Head rests on front seat block part of right rear vision. When her kids are in back seat, they sit partially blocking rear view.

Appendix B

PILOT STUDY, QUESTIONNAIRE FORMS, AND RESULTS

FORM I AND RESPONSES (PERCENT)
NATIONWIDE VEHICLE SAFETY SURVEY

In answering the questions in this questionnaire, please consider only the car you drive most often. Before answering, please be sure to read the instructions given below.

INSTRUCTIONS

This questionnaire consists mostly of questions which ask you to select one of five possible answers. The answers are (1) NO PROBLEM, (2) ANNOYING, (3) POTENTIAL DANGER, (4) CLOSE CALL, and (5) CAUSED ACCIDENT.

EXAMPLE (Check only one):

<u>PROBLEM</u>	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
My vision has been <u>limited</u> because of: fog, rain or snow on my side or rear windows.	[]	[]	[]	[]	[]

If your vision has never been limited because of fog, rain or snow on your side or rear windows, you would place a check in the box under "NO PROBLEM." If your vision has been limited and caused you to be annoyed but never seemed to be a danger, you would place a check in the box under "ANNOYING." If your vision has been limited and it placed you in a potentially dangerous position, you would check the box labeled "POTENTIAL DANGER." If your vision has been limited and it almost resulted in an accident, you would check the box labeled "CLOSE CALL." Finally, if your vision has been limited and it resulted in an actual accident, you would check the box labeled "CAUSED ACCIDENT."

For each question, please select the one answer which best describes the worst situation you had with the problem. For example, if the same problem resulted in you having a near accident or "close call" on one occasion and an actual accident on another occasion, you would check only the box labeled "CAUSED ACCIDENT."

Remember, check only one box per item.

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
I HAVE HAD DIFFICULTY SEEING:					
Vehicles to the left or right of me	% [] 57	% [] 17	% [] 13	% [] 13	% [] 0
Vehicles in back of me in my lane or in the two lanes next to mine	[] 33	[] 30	[] 23	[] 13	[] 0
That another vehicle ahead of me was stopping	[] 73	[] 17	[] 3	[] 3	[] 0
That another vehicle ahead of me was already stopped	[] 73	[] 20	[] 0	[] 3	[] 3
That another vehicle ahead of me was turning	[] 67	[] 13	[] 13	[] 3	[] 0

(Continued on Page 2)

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
Far enough ahead to detect pedestrians, cyclists or curves in the road using my <u>low-beam</u> headlights	[] 43	[] 27	[] 30	[] 0	[] 0
Far enough ahead to detect pedestrians, cyclists or curves in the road using my <u>high-beam</u> headlights	[] 73	[] 23	[] 3	[] 0	[] 0
How far my own car's front or rear fenders or bumpers stick out	[] 77	[] 13	[] 10	[] 0	[] 0
Other _____ . . .	[]	[]	[]	[]	[]
MY VISION HAS BEEN <u>LIMITED</u> BECAUSE:					
Of fog, rain or snow on my side or rear windows	[] 30	[] 30	[] 27	[] 13	[] 0
Of glare at night from another vehicle's headlights or taillights	[] 17	[] 43	[] 47	[] 0	[] 0
Of sun glare reflected from parts of my car or parts of another vehicle	[] 7	[] 53	[] 40	[] 0	[] 0
Of headlight glare at night on my inside, left or right outside mirrors from cars behind me . .	[] 13	[] 50	[] 37	[] 0	[] 0
Mirrors did not give enough information to the rear or side of my car or did not give that information quickly enough . . .	[] 20	[] 47	[] 23	[] 13	[] 0
Windshield wipers or defogger didn't clear my front window quickly or completely of fog, rain or snow	[] 20	[] 57	[] 20	[] 3	[] 0
Other _____ . . .	[]	[]	[]	[]	[]
MY VISION HAS BEEN <u>BLOCKED</u> BY :					
One of the posts supporting my car's roof	[] 57	[] 23	[] 13	[] 6	[] 0
The roofline, hood or trunk . .	[] 70	[] 17	[] 10	[] 0	[] 0
The inside, left or right outside mirrors	[] 73	[] 20	[] 0	[] 0	[] 0
Passengers in the front or rear seats	[] 43	[] 40	[] 13	[] 0	[] 0
The front seat or front seat head rests	[] 67	[] 20	[] 13	[] 0	[] 0
Other _____ . . .	[]	[]	[]	[]	[]

(Continued on Page 3)

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
<u>SEEING AND READING INSTRUMENTS</u> AND GAUGES:					
I have had difficulty seeing other gauges or warning lights (temperature, oil, fuel, etc.) . .	[] 77	[] 23	[] 3	[] 0	[] 0
The steering wheel blocks my view of the speedometer or other gauges or controls	[] 63	[] 37	[] 0	[] 0	[] 0
Other _____ . . .	[]	[]	[]	[]	[]
<u>SEATING IN MY CAR:</u>					
The driver's seat forced me to sit in an uncomfortable or unsafe posture	[] 87	[] 13	[] 0	[] 0	[] 0
The seat or chest belt restricted body and head movements to see over my shoulder	[] 67	[] 17	[] 10	[] 3	[] 0
Other _____ . . .	[]	[]	[]	[]	[]
<u>BRAKING AND SHIFTING OF MY CAR:</u>					
The brake or clutch pedals or parking brake required too much force to operate	[] 93	[] 0	[] 3	[] 3	[] 0
My legs didn't comfortably reach brake, clutch or gas pedals . . .	[] 93	[] 6	[] 0	[] 0	[] 0
My foot slipped off brake pedal or caught side of pedal when moving from gas pedal	[] 93	[] 6	[] 0	[] 0	[] 0
I stepped on more than one pedal or the wrong pedal (brake, clutch, gas) because they were too close together	[] 93	[] 6	[] 0	[] 0	[] 0
My leg hit steering wheel or column while moving foot to brake pedal	[] 87	[] 13	[] 0	[] 0	[] 0
I sometimes shifted into wrong gear because I couldn't tell which gear the shift was in	[] 90	[] 7	[] 3	[] 0	[] 0
When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the gear shift pattern was different than in my car	[] 67	[] 23	[] 7	[] 3	[] 0
Other _____ . . .	[]	[]	[]	[]	[]

(Continued on Page 4)

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
STEERING WAS DIFFICULT:					
When driving in strong winds . . .	[] 47	[] 40	[] 13	[] 0	[] 0
When I tried to stop quickly and skidded	[] 53	[] 23	[] 13	[] 6	[] 3
When a tire blew out	[] 53	[] 23	[] 17	[] 3	[] 3
When power steering was lost . . .	[] 60	[] 13	[] 23	[] 3	[] 0
Because steering wheel was some- times very hard to turn	[] 80	[] 13	[] 6	[] 0	[] 0
Because normal steering wheel movements caused car to change direction too quickly or not quickly enough	[] 90	[] 6	[] 0	[] 3	[] 0
Other _____ . . .	[]	[]	[]	[]	[]
CONTROLS AND SWITCHES - I HAVE HAD DIFFICULTY FINDING, REACHING, OR OPERATING ONE OR MORE OF THE FOLLOW- ING SWITCHES OR CONTROLS:					
Headlights, turn signals, headlight dimmer, window washer or wiper, defogger, deicer, emergency flasher, mirror dimmer, horn.	<u>Finding</u> . . .	[] 80 [] 17	[] 3	[] 0	[] 0
	<u>Reaching</u> . .	[] 87 [] 13	[] 0	[] 0	[] 0
	<u>Operating</u> . .	[] 87 [] 13	[] 0	[] 0	[] 0
Radio knobs, ashtray, lighter, vent, climate controls, interior lights, dash lights	<u>Finding</u> . . .	[] 87 [] 13	[] 0	[] 0	[] 0
	<u>Reaching</u> . .	[] 87 [] 13	[] 0	[] 0	[] 0
	<u>Operating</u> . .	[] 90 [] 10	[] 0	[] 0	[] 0
When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the location or operation of the controls (horn, lights, climate adjust- ments, etc.) was different than in my car	[] 30	[] 63	[] 6	[] 0	[] 0

(Continued on Page 5)

Most close calls or near accidents are believed to be partly caused by a number of factors. Estimate the number of close calls you have had in the past two months which were in part due to each factor below.

Vehicle break downs (motor stalled, flat tire, brake or steering failure, ...) -

None ☐ 93 1 or 2 ☐ 3 3 or 4 ☐ 3 More than 4 ☐ 0

Poor design of my vehicle (bad visibility, poor steering or braking, confusing control location/operation, ...)

None ☐ 75 1 or 2 ☐ 21 3 or 4 ☐ 3 More than 4 ☐ 0

Environmental factors (bad weather, ice, rain, bad roads, poor signs, ...)

None ☐ 73 1 or 2 ☐ 27 3 or 4 ☐ 0 More than 4 ☐ 0

Another car or driver so I don't know what the problem was

None ☐ 40 1 or 2 ☐ 57 3 or 4 ☐ 3 More than 4 ☐ 0

My own driving errors (day dreaming, not looking, speeding or ignoring driving rules, ...)

None ☐ 76 1 or 2 ☐ 23 3 or 4 ☐ 0 More than 4 ☐ 0

Try to forget about specific design features of cars that you are familiar with and tell us what you would really like to see built into the car you buy -- something that you think would reduce driver errors. If you cannot define what that "something" might be, try to describe what it might do.

Please describe the vehicle you drive most often.

Vehicle Make
(Ford, Chevy, etc.)

Model
(Pinto, Vega, etc.)

Year

19__

What is the body style of the above vehicle? (Check all appropriate boxes)

☐ 2 Door

☐ Station Wagon

☐ Pickup

☐ 4 Door

☐ Hard Top

☐ Other _____

☐ Convertible

☐ Van

Which of the following equipment do you have on your vehicle? (Check all appropriate boxes)

☐ Air Conditioner

☐ Automatic Transmission

☐ Rear Window De-ice/

☐ Power Brakes

☐ Right Outside Mirror

Defog System

☐ Power Steering

☐ Cruise Control

(Continued on Page 6)

Has the vehicle's standard equipment been modified in any way?

☐ Yes

☐ No

If yes, please describe: _____

What is the approximate total number of miles you have driven this car?

☐ Under 1,000

☐ 5,001 - 10,000

☐ 1,001 - 5,000

☐ Over 10,000

How many months have you been driving this car?

☐ Less than one

☐ 13 - 18

☐ 1 - 6

☐ More than 18

☐ 7-12

Finally, for purposes of comparing your answers with others in the survey, would you please give the following information about yourself:

Your sex: ☐ Male or ☐ Female

What is your present age? _____ years

Your total years of driving experience. _____ years

About how tall are you? _____ feet _____ inches

What is your approximate weight? _____ lbs

If you had any difficulty understanding the instructions or particular questions, please describe them below so that we can improve the survey in the future.

Criticism of Questionnaire (if any) _____

Would you be willing to give further information on a confidential basis by telephone?

If so, please call Mr. John Queen at (213) 674-1301 between 9 a.m. and 5:30 p.m.

Please place the completed questionnaire in the enclosed pre-stamped envelope and mail it at your earliest convenience.

Thank you for your cooperation.

FORM II AND RESPONSES (PERCENT)
NATIONWIDE VEHICLE SAFETY SURVEY

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EXAMPLE (Check only one):

<u>PROBLEM</u>	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
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My vision has been limited

because of: fog, rain or

snow on my side or rear windows.

[]	[]	[]	[]	[]
-----	-----	-----	-----	-----

If your vision has never been limited because of fog, rain or snow on your side or rear windows, you would place a check in the box under "NO PROBLEM." If your vision has been limited and caused you to be annoyed but never seemed to be a danger, you would place a check in the box under "ANNOYING." If your vision has been limited and it placed you in a potentially dangerous position, you would check the box labeled "POTENTIAL DANGER." If your vision has been limited and it almost resulted in an accident, you would check the box labeled "CLOSE CALL." Finally, if your vision has been limited and it resulted in an actual accident, you would check the box labeled "CAUSED ACCIDENT."

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Remember, check only one box per item.

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Vehicles to the left or right of me	%	%	%	%	%
	[] 30	[] 13	[] 33	[] 23	[] 0
Vehicles in back of me in my lane or in the two lanes next to mine	[] 47	[] 13	[] 30	[] 7	[] 3
That another vehicle ahead of me was stopping	[] 73	[] 7	[] 13	[] 7	[] 0
That another vehicle ahead of me was already stopped	[] 60	[] 10	[] 27	[] 7	[] 0
That another vehicle ahead of me was turning	[] 63	[] 13	[] 13	[] 10	[] 0

(Continued on Page 2)

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
Far enough ahead to detect pedestrians, cyclists or curves in the road using my <u>low-beam</u> headlights	[] 50	[] 13	[] 30	[] 7	[] 0
Far enough ahead to detect pedestrians, cyclists or curves in the road using my <u>high-beam</u> headlights	[] 90	[] 3	[] 7	[] 0	[] 0
How far my own car's front or rear fenders or bumpers stick out	[] 70	[] 17	[] 10	[] 0	[] 3
Other _____ . . .	[]	[]	[]	[]	[]
MY VISION HAS BEEN <u>LIMITED</u> BECAUSE:					
Of fog, rain or snow on my side or rear windows	[] 27	[] 23	[] 40	[] 7	[] 3
Of glare at night from another vehicle's headlights or taillights	[] 10	[] 40	[] 47	[] 3	[] 0
Of sun glare reflected from parts of my car or parts of another vehicle	[] 10	[] 47	[] 40	[] 3	[] 0
Of headlight glare at night on my inside, left or right outside mirrors from cars behind me . .	[] 10	[] 47	[] 43	[] 0	[] 0
Mirrors did not give enough information to the rear or side of my car or did not give that information quickly enough . . .	[] 23	[] 17	[] 43	[] 17	[] 0
Windshield wipers or defogger didn't clear my front window quickly or completely of fog, rain or snow	[] 43	[] 20	[] 37	[] 0	[] 0
Other _____ . . .	[]	[]	[]	[]	[]
MY VISION HAS BEEN <u>BLOCKED</u> BY :					
One of the posts supporting my car's roof	[] 47	[] 23	[] 17	[] 13	[] 0
The roofline, hood or trunk . .	[] 17	[] 10	[] 10	[] 0	[] 3
The inside, left or right outside mirrors	[] 80	[] 10	[] 7	[] 3	[] 0
Passengers in the front or rear seats	[] 43	[] 40	[] 7	[] 0	[] 0
The front seat or front seat head rests	[] 70	[] 10	[] 20	[] 0	[] 0
Other _____ . . .	[]	[]	[]	[]	[]

(Continued on Page 3)

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
<u>SEEING AND READING INSTRUMENTS</u> <u>AND GAUGES:</u>					
I have had difficulty seeing other gauges or warning lights (temperature, oil, fuel, etc.) . . .	[] 60	[] 40	[] 0	[] 0	[] 0
The steering wheel blocks my view of the speedometer or other gauges or controls	[] 77	[] 13	[] 7	[] 0	[] 0
Other _____ . . .	[]	[]	[]	[]	[]
<u>SEATING IN MY CAR:</u>					
The driver's seat forced me to sit in an uncomfortable or unsafe posture	[] 80	[] 13	[] 3	[] 0	[] 0
The seat or chest belt restricted body and head movements to see over my shoulder	[] 57	[] 37	[] 3	[] 0	[] 0
Other _____ . . .	[]	[]	[]	[]	[]
<u>BRAKING AND SHIFTING OF MY CAR:</u>					
The brake or clutch pedals or parking brake required too much force to operate	[] 90	[] 3	[] 3	[] 0	[] 0
My legs didn't comfortably reach brake, clutch or gas pedals . . .	[] 93	[] 3	[] 0	[] 0	[] 0
My foot slipped off brake pedal or caught side of pedal when moving from gas pedal	[] 67	[] 17	[] 13	[] 0	[] 0
I stepped on more than one pedal or the wrong pedal (brake, clutch, gas) because they were too close together	[] 87	[] 3	[] 3	[] 3	[] 0
My leg hit steering wheel or column while moving foot to brake pedal	[] 100	[] 0	[] 0	[] 0	[] 0
I sometimes shifted into wrong gear because I couldn't tell which gear the shift was in	[] 90	[] 7	[] 0	[] 0	[] 0
When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the gear shift pattern was different than in my car	[] 60	[] 27	[] 10	[] 0	[] 0
Other _____ . . .	[]	[]	[]	[]	[]

(Continued on Page 4)

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
STEERING WAS DIFFICULT:					
When driving in strong winds . . .	[] 40	[] 43	[] 17	[] 0	[] 0
When I tried to stop quickly and skidded	[] 67	[] 7	[] 27	[] 0	[] 0
When a tire blew out	[] 67	[] 10	[] 27	[] 0	[] 0
When power steering was lost . . .	[] 37	[] 7	[] 57	[] 0	[] 0
Because steering wheel was some- times very hard to turn	[] 70	[] 23	[] 7	[] 0	[] 0
Because normal steering wheel movements caused car to change direction too quickly or not quickly enough	[] 73	[] 17	[] 7	[] 0	[] 0
Other _____ . . .	[]	[]	[]	[]	[]
CONTROLS AND SWITCHES - I HAVE HAD DIFFICULTY FINDING, REACHING, OR OPERATING ONE OR MORE OF THE FOLLOW- ING SWITCHES OR CONTROLS:					
Headlights, turn signals, headlight dimmer, window washer or wiper, defogger, deicer, emergency flasher, mirror dimmer, horn.	<u>Finding</u> . . .	[] 80 [] 17	[] 3	[] 0	[] 0
	<u>Reaching</u> . .	[] 80 [] 17	[] 3	[] 0	[] 0
	<u>Operating</u> . .	[] 60 [] 37	[] 3	[] 0	[] 0
Radio knobs, ashtray, lighter, vent, climate controls, interior lights, dash lights	<u>Finding</u> . . .	[] 83 [] 17	[] 0	[] 0	[] 0
	<u>Reaching</u> . .	[] 83 [] 17	[] 0	[] 0	[] 0
	<u>Operating</u> . .	[] 83 [] 17	[] 0	[] 0	[] 0
When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the location or operation of the controls (horn, lights, climate adjust- ments, etc.) was different than in my car	[] 37	[] 53	[] 10	[] 0	[] 0

(Continued on Page 5)

Most close calls or near accidents are believed to be partly caused by a number of factors. Estimate the number of close calls you have had in the past two months which were in part due to each factor below.

Vehicle break downs (motor stalled, flat tire, brake or steering failure, ...)

None [] 1 or 2 [] 3 or 4 [] More than 4 []

Poor design of my vehicle (bad visibility, poor steering or braking, confusing control location/operation, ...)

None [] 1 or 2 [] 3 or 4 [] More than 4 []

Environmental factors (bad weather, ice, rain, bad roads, poor signs, ...)

None [] 1 or 2 [] 3 or 4 [] More than 4 []

Another car or driver so I don't know what the problem was

None [] 1 or 2 [] 3 or 4 [] More than 4 []

My own driving errors (day dreaming, not looking, speeding or ignoring driving rules, ...)

None [] 1 or 2 [] 3 or 4 [] More than 4 []

Try to forget about specific design features of cars that you are familiar with and tell us what you would really like to see built into the car you buy -- something that you think would reduce driver errors. If you cannot define what that "something" might be, try to describe what it might do.

Please describe the vehicle you drive most often.

<u>Vehicle Make</u>	<u>Model</u>	<u>Year</u>
(Ford, Chevy, etc.)	(Pinto, Vega, etc.)	
_____	_____	19____

What is the body style of the above vehicle? (Check all appropriate boxes)

☐ 2 Door	☐ Station Wagon	☐ Pickup
☐ 4 Door	☐ Hard Top	☐ Other _____
☐ Convertible	☐ Van	

Which of the following equipment do you have on your vehicle? (Check all appropriate boxes)

☐ Air Conditioner	☐ Automatic Transmission	☐ Rear Window De-ice/Defog System
☐ Power Brakes	☐ Right Outside Mirror	
☐ Power Steering	☐ Cruise Control	

(Continued on Page 6)

Has the vehicle's standard equipment been modified in any way?

☐ Yes

☐ No

If yes, please describe: _____

What is the approximate total number of miles you have driven this car?

☐ Under 1,000

☐ 5,001 - 10,000

☐ 1,001 - 5,000

☐ Over 10,000

How many months have you been driving this car?

☐ Less than one

☐ 13 - 18

☐ 1 - 6

☐ More than 18

☐ 7-12

Finally, for purposes of comparing your answers with others in the survey, would you please give the following information about yourself:

Your sex: ☐ Male or ☐ Female

What is your present age? _____ years

Your total years of driving experience. _____ years

About how tall are you? _____ feet _____ inches

What is your approximate weight? _____ lbs

If you had any difficulty understanding the instructions or particular questions, please describe them below so that we can improve the survey in the future.

Criticism of Questionnaire (if any) _____

Would you be willing to give further information on a confidential basis by telephone?
If so, please call Mr. John Queen at (213) 674-1301 between 9 a.m. and 5:30 p.m.

Please place the completed questionnaire in the enclosed pre-stamped envelope and mail it at your earliest convenience.

Thank you for your cooperation.

FORM III AND RESPONSES (PERCENT)

NATIONWIDE VEHICLE SAFETY SURVEY

In answering the questions in this questionnaire, please consider only the car you drive most often. Before answering, please be sure to read the instructions given below.

INSTRUCTIONS

This questionnaire consists mostly of questions which ask you to select one of five possible answers. The answers are (1) NO PROBLEM, (2) ANNOYING, (3) POTENTIAL DANGER, (4) CLOSE CALL, and (5) CAUSED ACCIDENT.

EXAMPLE (Check only one):

PROBLEM	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
My vision has been <u>limited</u> because of: fog, rain or snow on my side or rear windows	☐	☐	☐	☐	☐

If your vision has never been limited because of fog, rain or snow on your side or rear windows, you would place a check in the box under "NO PROBLEM." If your vision has been limited and caused you to be annoyed but never seemed to be a danger, you would place a check in the box under "ANNOYING." If your vision has been limited and it placed you in a potentially dangerous position, you would check the box labeled "POTENTIAL DANGER." If your vision has been limited and it almost resulted in an accident, you would check the box labeled "CLOSE CALL." Finally, if your vision has been limited and it resulted in an actual accident, you would check the box labeled "CAUSED ACCIDENT."

For each question, please select the one answer which best describes the worst situation you had with the problem. For example, if the same problem resulted in you having a near accident or "close call" on one occasion and an actual accident on another occasion, you would check only the box labeled "CAUSED ACCIDENT."

Remember, check only one box per item.

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
MY VISION HAS BEEN LIMITED BECAUSE:					
Of fog, rain or snow on my side windows	☐ 24	☐ 24	☐ 42	☐ 7	☐ 0
Of fog, rain or snow on my rear window	☐ 11	☐ 31	☐ 53	☐ 2	☐ 0
Of sun glare reflected from parts of another vehicle	☐ 18	☐ 44	☐ 31	☐ 4	☐ 0
Of windshield glare at night from another vehicle's headlights	☐ 18	☐ 36	☐ 40	☐ 4	☐ 0
Of windshield glare at night from another vehicle's taillights	☐ 56	☐ 31	☐ 9	☐ 2	☐ 0

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
MY VISION HAS BEEN LIMITED BECAUSE (continued)					
Of glare at night on my left outside mirror from cars behind me	[] 36	[] 44	[] 20	[] 0	[] 0
Of glare at night on my inside mirror from cars behind me	[] 33	[] 49	[] 18	[] 0	[] 0
Mirrors did not give me enough information to the rear or side of me	[] 33	[] 16	[] 38	[] 13	[] 0
Mirrors did not give me the information I needed quickly enough	[] 42	[] 16	[] 33	[] 4	[] 2
Windshield wipers did not clear my window quickly or completely enough of rain or snow	[] 42	[] 24	[] 33	[] 0	[] 0
Windshield defogger did not clear my window quickly or completely enough of fog	[] 38	[] 22	[] 48	[] 2	[] 0
CONTROLS AND SWITCHES - I HAVE HAD DIFFICULTY FINDING, REACHING, OR OPERATING ONE OR MORE OF THE FOLLOW- ING SWITCHES OR CONTROLS:					
Headlights, turn signals, headlight dimmer, window washer or wiper, defogger, deicer, emergency flasher, mirror dimmer, horn	<u>Finding</u> . .	[] 71 [] 9	[] 7	[] 0	[] 0
	<u>Reaching</u> . .	[] 73 [] 20	[] 4	[] 0	[] 0
	<u>Operating</u> .	[] 80 [] 11	[] 7	[] 0	[] 0
Radio knobs, ashtray, lighter, vent, climate controls, interior lights, dash lights	<u>Finding</u> . .	[] 84 [] 13	[] 0	[] 0	[] 0
	<u>Reaching</u> . .	[] 78 [] 18	[] 22	[] 0	[] 0
	<u>Operating</u> .	[] 84 [] 13	[] 0	[] 0	[] 0
CIRCLE THE PARTICULAR CONTROL ABOVE THAT CAUSED THE PROBLEM					

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
BRAKING OF MY CAR					
The brake pedal required too much force to operate	☐ 80	☐ 13	☐ 2	☐ 2	☐ 2
The clutch pedal required too much force to operate	☐ 100	☐ 0	☐ 0	☐ 0	☐ 0
The parking brake required too much force to operate	☐ 89	☐ 9	☐ 2	☐ 0	☐ 0
My legs didn't comfortably reach a pedal	☐ 9	☐ 4	☐ 2	☐ 2	☐ 0
My foot slipped off the brake pedal	☐ 89	☐ 7	☐ 2	☐ 2	☐ 0
My foot caught the side of the brake pedal when moving it from the gas pedal to the brake . . .	☐ 78	☐ 13	☐ 4	☐ 4	☐ 0
My leg hit the steering wheel while moving foot to the brake pedal	☐ 9	☐ 4	☐ 4	☐ 0	☐ 0
My leg hit the steering column while moving foot to the brake pedal	☐ 95	☐ 2	☐ 2	☐ 0	☐ 0
Please describe the vehicle you drive most often.					
<u>Vehicle Make</u> (Ford, Chevy, etc.)	<u>Model</u> (Pinto, Vega, etc.)	<u>Year</u> 19__			
What is the body style of the above vehicle? (Check all appropriate boxes)					
☐ 2 Door	☐ Station Wagon	☐ Pickup			
☐ 4 Door	☐ Hard Top	☐ Other _____			
☐ Convertible	☐ Van				
Which of the following equipment do you have on your car? (Check all appropriate boxes)					
☐ Air Conditioner	☐ Automatic Transmission	☐ Rear Window De-ice/Defog System			
☐ Power Brakes	☐ Right Outside Mirror				
☐ Power Steering	☐ Cruise Control				

Has the car's standard equipment been modified in any way?

☐ Yes

☐ No

If yes, please describe: _____

What is the approximate total number of miles you have driven this car

☐ Under 1,000

☐ 5,001 - 10,000

☐ 1,001 - 5,000

☐ Over 10,000

How many months have you been driving this car?

☐ Less than one

☐ 13 - 18

☐ 1 - 6

☐ More than 18

☐ 7 - 12

Finally, for purposes of comparing your answers with others in the survey, would you please give the following information about yourself:

Your sex:

☐ Male

or

☐ Female

What is your present age? _____ years

Your total years of driving experience. _____ years

About how tall are you? _____ feet _____ inches

What is your approximate weight? _____ lbs

If you had any difficulty understanding the instructions or particular questions, please describe them below so that we can improve the survey in the future.

Criticism of Questions (if any) _____

Would you be willing to give further information on a confidential basis by telephone? If so, please call Mr. John Queen at (213) 674-1301 between 9 a.m. and 5:30 p.m.

Please place the completed questionnaire in the enclosed pre-stamped envelope and mail it at your earliest convenience.

Thank you for your cooperation.

FORM IV AND RESPONSES (PERCENT)
NATIONWIDE VEHICLE SAFETY SURVEY

In answering the questions in this questionnaire, please consider only the car you drive most often. Before answering, please be sure to read the instructions given below.

INSTRUCTIONS

This questionnaire consists mostly of questions which ask you to select one of five possible answers. The answers are (1) NO PROBLEM, (2) ANNOYING, (3) POTENTIAL DANGER, (4) CLOSE CALL, and (5) CAUSED ACCIDENT.

EXAMPLE (Check only one):

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
<u>PROBLEM</u>					

The seat or chest belt restricted body and head movements to see over my shoulder.

☐ ☐ ☐ ☐ ☐

If your head or body movements have never been restricted by your car's seat belts or chest harness, you would place a check in the box under "NO PROBLEM". If your movement has been restricted and caused you to be annoyed but never seemed a danger, you would place a check in the box under "ANNOYING". If your movement has been restricted and it placed you in potentially dangerous position, you would check the box labeled "POTENTIAL DANGER". If your movement was restricted and it almost resulted in an accident, you would check the box labeled "CLOSE CALL". Finally, if your movement had been restricted and it resulted in an actual accident, you would check the box labeled "CAUSED ACCIDENT".

For each question, please select the one answer which best describes the worst situation you had with the problem. For example, if the same problem resulted in you having a near accident or "close call" on one occasion and an actual accident on another occasion, you would check only the box labeled "CAUSED ACCIDENT."

Remember, check only one box per item.

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
<u>SEATING IN MY CAR:</u>					
The driver's seat forced me to sit in an uncomfortable or unsafe posture	☐ 83	☐ 10	☐ 3	☐ 0	☐ 0
The seat or chest belt restricted body and head movements to see over my shoulder	☐ 63	☐ 23	☐ 13	☐ 0	☐ 0
Other _____ . . .	☐	☐	☐	☐	☐

(Continued on Page 2)

	No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
<u>BRAKING AND SHIFTING OF MY CAR:</u>					
The brake or clutch pedals or parking brake required too much force to operate	☐ 93	☐ 7	☐ 0	☐ 0	☐ 0
My legs didn't comfortably reach brake, clutch or gas pedals	☐ 87	☐ 10	☐ 3	☐ 0	☐ 0
My foot slipped off brake pedal or caught side of pedal when moving from gas pedal	☐ 77	☐ 10	☐ 3	☐ 3	☐ 0
I stepped on more than one pedal or the wrong pedal (brake, clutch, gas) because they were too close together	☐ 100	☐ 0	☐ 0	☐ 0	☐ 0
My leg hit steering wheel or column while moving foot to brake pedal	☐ 83	☐ 13	☐ 3	☐ 0	☐ 0
I sometimes shifted into wrong gear because I couldn't tell which gear the shift was in	☐ 87	☐ 0	☐ 10	☐ 0	☐ 0
When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the gear shift pattern was different than in my car	☐ 53	☐ 33	☐ 10	☐ 0	☐ 0
Other _____ . . .	☐	☐	☐	☐	☐
<u>STEERING WAS DIFFICULT:</u>					
When driving in strong winds . .	☐ 53	☐ 40	☐ 7	☐ 0	☐ 0
When I tried to stop quickly and skidded	☐ 77	☐ 3	☐ 10	☐ 10	☐ 0
When a tire blew out	☐ 73	☐ 0	☐ 7	☐ 3	☐ 0
When power steering was lost . .	☐ 47	☐ 13	☐ 26	☐ 3	☐ 0
Because steering wheel was sometimes very hard to turn	☐ 80	☐ 13	☐ 3	☐ 0	☐ 0
Because normal steering wheel movements caused car to change direction too quickly or not quickly enough	☐ 77	☐ 10	☐ 10	☐ 3	☐ 0
Other _____ . . .	☐	☐	☐	☐	☐

(Continued on Page 3)

		No Problem 1	Annoying 2	Potential Danger 3	Close Call 4	Caused Accident 5
<u>CONTROLS AND SWITCHES</u> - I HAVE HAD DIFFICULTY FINDING, REACHING, OR OPERATING ONE OR MORE OF THE FOLLOWING SWITCHES OR CONTROLS:						
Headlights, turn signals, headlight dimmer, window washer or wiper, defogger, deicer, emergency flasher, mirror dimmer, horn.	<u>Finding</u> . .	[] 83	[] 13	[] 0	[] 3	[] 0
	<u>Reaching</u> .	[] 77	[] 20	[] 0	[] 3	[] 0
	<u>Operating</u> .	[] 83	[] 13	[] 0	[] 3	[] 0
Radio knobs, ashtray, lighter, vent, climate controls, interior lights, dash lights	<u>Finding</u> . .	[] 80	[] 13	[] 7	[] 0	[] 0
	<u>Reaching</u> .	[] 77	[] 13	[] 7	[] 0	[] 0
	<u>Operating</u> .	[] 83	[] 10	[] 7	[] 0	[] 0
When driving an unfamiliar car (rented, borrowed, etc.) I was confused because the location or operation of the controls (horn, lights, climate adjustments, etc.) was different than in my car		[] 23	[] 57	[] 20	[] 0	[] 0
<u>SEEING AND READING OF INSTRUMENTS AND GAUGES:</u>						
I have had difficulty seeing other gauges or warning lights (temperature, oil, fuel, etc.)		[] 83	[] 10	[] 10	[] 0	[] 0
The steering wheel blocks my view of the speedometer or other gauges or controls . . .		[] 73	[] 23	[] 7	[] 0	[] 0
Other _____ . . .		[]	[]	[]	[]	[]
Please describe the vehicle you drive most often.						
<u>Vehicle Make</u> (Ford, Chevy, etc.)	<u>Model</u> (Pinto, Vega, etc.)	<u>Year</u>				
_____	_____	19 _____				

(Continued on Page 4)

What is the body style of the above vehicle? (Check all appropriate boxes)

- | | | |
|--------------------------------------|--|--------------------------------------|
| ☐ 2 Door | ☐ Station Wagon | ☐ Pickup |
| ☐ 4 Door | ☐ Hard Top | ☐ Other _____ |
| ☐ Convertible | ☐ Van | |

Which of the following equipment do you have on your car? (Check all appropriate boxes)

- | | | |
|--|---|--|
| ☐ Air Conditioner | ☐ Power Steering | ☐ Right outside mirror |
| ☐ Power Brakes | ☐ Automatic Transmission | ☐ Rear window de-ice/defog system |

Has the car's standard equipment been modified in any way?

- ☐ Yes ☐ No

If yes, please describe: _____

What is the approximate total number of miles you have driven this car?

- | | |
|--|---|
| ☐ Under 1,000 | ☐ 5,001 - 10,000 |
| ☐ 1,001 - 5,000 | ☐ Over 10,000 |

How many months have you been driving this car?

- | | |
|--|---------------------------------------|
| ☐ Less than one | ☐ 13 - 18 |
| ☐ 1 - 6 | ☐ More than 18 |
| ☐ 7 - 12 | |

Finally, for purposes of comparing your answers with others in the survey, would you please give the following information about yourself:

Your sex: ☐ Male or ☐ Female

What is your present age? _____ years

Your total years of driving experience. _____ years

About how tall are you? _____ feet _____ inches

What is your approximate weight? _____ lbs

If you had any difficulty understanding the instructions or particular questions, please describe them below so that we can improve the survey in the future.

Criticism of Questions (if any) _____

(Continued on Page 5)

Would you be willing to give further information on a confidential basis by telephone? If so, please call Mr. John Queen at (213) 674-1301 between 9 a.m. and 5:30 p.m.

Please place the completed questionnaire in the enclosed pre-stamped envelope and mail it at your earliest convenience.

Thank you for your cooperation.

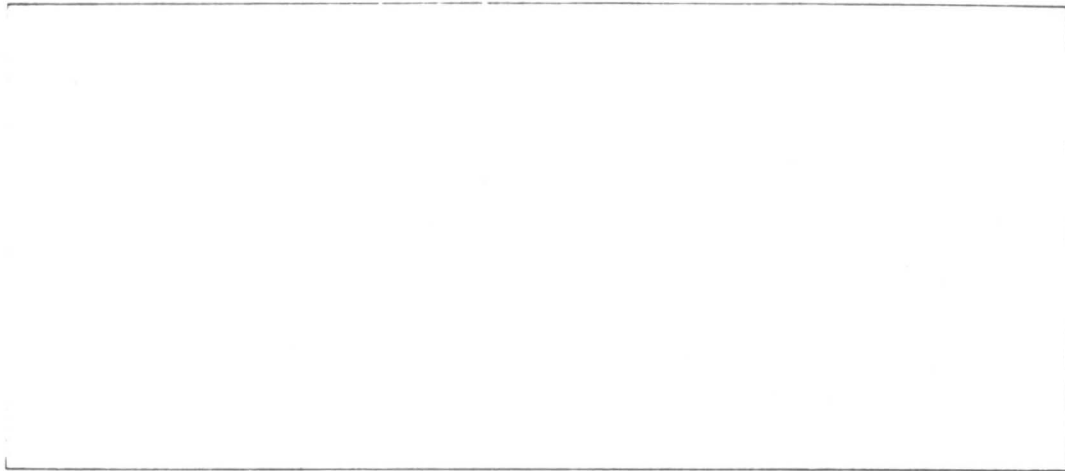
FORM V AND RESPONSES (PERCENT)
NATIONWIDE VEHICLE SAFETY SURVEY

Most of the questions in this survey are about near accident situations in which you have been involved while driving your car. A near accident is a situation in which you narrowly missed being involved in a collision with another vehicle, pedestrian, cyclist or whatever.

In answering the questions in this questionnaire, please consider only the car you drive most often. The information we obtain will be given to the National Highway Traffic Safety Administration which develops and enforces automobile design standards. Your participation will be of great assistance in designing better cars for the future.

1. In your own words, give a brief description of a near accident or close call in which you were involved. Remember, a near accident is a situation in which you almost had a collision but somehow an accident did not occur. (A space is provided below for a simple diagram of the situation.)

If possible, please draw diagram of near accident situation below.



2. In your opinion, what was the primary reason the near accident did not become an actual accident? What did you or somebody else do? Slam on brakes? Turn steering wheel?

(Continued on Page 2)

3. Would you please give suggestions on how changes in the features of your car, roadways, signs, other cars, etc., might prevent the near accident that you had from occurring again?

4. If you were to lend your car to a friend, what would you tell him about it to make sure he would drive it safely? Would you tell him about a blind spot, the brakes, dashboard controls or what?

5. The following are believed to be possible factors in the cause of accidents. Which of them have played a part in any near accidents you can think of in which you were involved? Also, how much did the factors contribute to the near accidents?

	<u>Played No</u> <u>Part</u>	<u>Contributed</u> <u>Somewhat</u>	<u>Contributed</u> <u>Greatly</u>
<u>Vehicle Factors</u>			
Blocked vision from car	[] 28	[] 32	[] 40
Steering difficulties	[] 86	[] 14	[] --
Seating difficulties	[] 100	[] --	[] --
Braking difficulties	[] 76	[] 19	[] 5
Gear-shift difficulties	[] 84	[] 16	[] --
Finding and using dashboard controls	[] 75	[] 25	[] 0
Visibility of other vehicles, pedestrians, signs, etc.	[] 23	[] 23	[] 54
Other _____	[]	[]	[]
<u>Driver Factors</u>			
Fatigue	[] 39	[] 39	[] 22
Alcohol/drugs	[] 89	[] 11	[] --
Disregarding driving rules	[] 26	[] 39	[] 35
Inattention	[] 18	[] 33	[] 48
Lack of driving skill	[] 58	[] 26	[] 16
Other _____	[]	[]	[]

(Continued on Page 3)

	<u>Played No</u> <u>Part</u>	<u>Contributed</u> <u>Somewhat</u>	<u>Contributed</u> <u>Greatly</u>
<u>Environmental Factors</u>			
Darkness	[] 42	[] 42	[] 16
Rain/snow/ice	[] 56	[] 22	[] 22
Fog	[] 40	[] 30	[] 30
Sun glare	[] 24	[] 48	[] 29
Other _____	[]	[]	[]

<u>Roadway Factors</u>			
Poor signs (location/readability)	[] 35	[] 35	[] 30
Poor road conditions	[] 68	[] 28	[] 4
Bumps/holes	[] 84	[] 11	[] 5
Poor street markings	[] 47	[] 37	[] 16
Other _____	[]	[]	[]

Don't know []

Please describe the vehicle you drive most often.

<u>Vehicle Make</u> (Ford, Chevy, etc.)	<u>Model</u> (Pinto, Vega, etc.)	<u>Year</u>
_____	_____	19____

What is the body style of the above vehicle? (Check all appropriate boxes)

[] 2 Door	[] Station Wagon	[] Pickup
[] 4 Door	[] Hard Top	[] Other
[] Convertible	[] Van	

Which of the following equipment do you have on your car? (Check all appropriate boxes)

[] Air Conditioner	[] Power Steering	[] Right Outside Mirror
[] Power brakes	[] Automatic Transmission	[] Rear window de-ice/defog system

Has the car's standard equipment been modified in any way?

[] Yes [] No

If yes, please describe: _____

What is the approximate total number of miles you have driven this car?

[] Under 1,000	[] 5,001 - 10,000
[] 1,001 - 5,000	[] Over 10,000

(Continued on Page 4)

How many months have you been driving this car?

☐ Less than one
☐ 1 - 6
☐ 7 - 12

☐ 13 - 18
☐ More than 18

Finally, for purposes of comparing your answers with others in the survey would you please give the following information about yourself:

Your sex: ☐ Male or ☐ Female

What is your present age? _____ years

Your total years of driving experience. _____ years

About how tall are you? _____ feet _____ inches

What is your approximate weight? _____ lbs

If you had any difficulty understanding the instructions or particular questions, please describe them below so that we can improve the survey in the future.

Criticisms of Questions (if any) _____

Would you be willing to give further information on a confidential basis by telephone? If so, please call Mr. John Queen at (213) 674-1301 between 9 a.m. and 5:30 p.m.

Please return the completed questionnaire in the enclosed pre-stamped envelope at your earliest convenience.

Thank you for your cooperation.

FORM II

NATIONWIDE VEHICLE SAFETY SURVEY

In answering the questions in this questionnaire, please consider only the car you drive most often. Before answering, please be sure to read the instructions given below.

INSTRUCTIONS

This questionnaire consists mostly of questions which ask you to select one of five possible answers: (1) NO PROBLEM, (2) ANNOYING, (3) POTENTIAL DANGER, (4) CLOSE CALL, and (5) CAUSED ACCIDENT

EXAMPLE

1 = NO PROBLEM • 2 = ANNOYING • 3 = POTENTIAL DANGER • 4 = CLOSE CALL
5 = CAUSED ACCIDENT

MY VISION HAS BEEN <u>LIMITED</u> BECAUSE OF . .	
Fog, rain or snow on my side or rear windows	1

If your vision has never been limited because of fog, rain or snow on your side or rear windows, you would write "1" in the box, as shown above. If your vision has been limited and caused you to be annoyed but never seemed to be a danger, you would write "2" in the box. If your vision has been limited and it placed you in a potentially dangerous position, you would write "3" in the box. If your vision has been limited and it almost resulted in an accident, you would write "4" in the box. Finally, if your vision has been limited and it resulted in an actual accident, you would write "5" in the box.

For each question, please select the one answer which best describes the worst situation you had with the problem.

1 = NO PROBLEM • 2 = ANNOYING • 3 = POTENTIAL DANGER • 4 = CLOSE CALL
5 = CAUSED ACCIDENT

I HAVE HAD DIFFICULTY SEEING ...		6. Far enough ahead to detect pedestrians, cyclists or curves in the road using my <u>low-beam</u> headlights	
1. Vehicles to the left or right of me		7. Far enough ahead to detect pedestrians, cyclists or curves in the road using my <u>high-beam</u> headlights	
2. Vehicles in back of me in my lane or in the two lanes next to mine		8. How far my own car's front or rear fenders or bumpers stick out	
3. That another vehicle ahead of me was stopping		9. Other _____	
4. That another vehicle ahead of me was already stopped			
5. That another vehicle ahead of me was turning			

(Continued on Page 2)

1 = NO PROBLEM • 2 = ANNOYING • 3 = POTENTIAL DANGER • 4 = CLOSE CALL
5 = CAUSED ACCIDENT

MY VISION HAS BEEN <u>LIMITED</u> BECAUSE ...		2. The steering wheel blocks my view of the speedometer or other gauges or controls.	
1. Of fog, rain or snow on my side or rear windows		<u>SEATING IN MY CAR ...</u>	
2. Of glare at night from another vehicle's headlights or taillights		1. The driver's seat forced me to sit in an uncomfortable or unsafe posture	
3. Of sun glare reflected from parts of my car or parts of another vehicle		2. The seat or chest belt restricted body and head movements to see over my shoulder.	
4. Of headlight glare at night on my inside, left or right outside mirrors from cars behind me		3. Other _____	
5. Mirrors did not give enough information to the rear or side of my car or did not give that information quickly enough		<u>BRAKING AND SHIFTING OF MY CAR ...</u>	
6. Windshield wipers or defogger didn't clear my front window quickly or completely of fog, rain or snow		1. The brake or clutch pedals or parking brake required too much force to operate	
7. Other _____		2. My legs didn't comfortably reach brake, clutch or gas pedals.	
MY VISION HAS BEEN <u>BLOCKED</u> BY ...		3. My foot slipped off brake pedal or caught side of pedal when moving from gas pedal	
1. One of the posts supporting my car's roof		4. I stepped on more than one pedal or the wrong pedal (brake, clutch, gas) because they were too close together	
2. The roofline, hood or trunk		5. My leg hit steering wheel or column while moving foot to brake pedal	
3. The inside, left or right outside mirrors		6. I sometimes shifted into wrong gear because I couldn't tell which gear the shift was in.	
4. Passengers in the front or rear seats		7. When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the gear shift pattern was different than in my car.	
5. The front seat or front seat head rests		8. Other _____	
6. Other _____		<u>SEEING AND READING INSTRUMENTS AND GAUGES ...</u>	
1. I have had difficulty seeing other gauges or warning lights (temperature, oil, fuel, etc.)			

1 = NO PROBLEM • 2 = ANNOYING • 3 = POTENTIAL DANGER • 4 = CLOSE CALL
5 = CAUSED ACCIDENT

STEERING WAS DIFFICULT ...		CONTROLS AND SWITCHES - I HAVE HAD DIFFICULTY FINDING, REACHING, OR OPERATING ONE OR MORE OF THE FOLLOWING SWITCHES OR CONTROLS ...	
1. When driving in strong winds		1. Headlights, turn signals, headlight dimmer, window washer or wiper, defogger, deicer, emergency flasher, mirror dimmer, horn Finding Reaching Operating	
2. When I tried to stop quickly and skidded			
3. When a tire blew out			
4. When power steering was lost			
5. Because steering wheel was sometimes very hard to turn			
6. Because normal steering wheel movements caused car to change direction too quickly or not quickly enough		2. Radio knobs, ashtray, lighter, vent, climate controls, interior lights, dash lights Finding Reaching Operating	
7. Other _____			
		3. When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the location or operation of the controls (horn, lights, climate adjustments, etc.) was different than in my car.	

Most close calls or near accidents are believed to be partly caused by a number of factors. Estimate the number of close calls you have had in the past two months which were in part due to each factor below.

Vehicle break downs (motor stalled, flat tire, brake or steering failure, ...)

None [] 1 or 2 [] 3 or 4 [] More than 4 []

Poor design of my vehicle (bad visibility, poor steering or braking, confusing control location/operation, ...)

None [] 1 or 2 [] 3 or 4 [] More than 4 []

Environmental factors (bad weather, ice, rain, bad roads, poor signs, ...)

None [] 1 or 2 [] 3 or 4 [] More than 4 []

Another car or driver so I don't know what the problem was

None ☐ 1 or 2 ☐ 3 or 4 ☐ More than 4 ☐

My own driving errors (day dreaming, not looking, speeding or ignoring driving rules, ...)

None ☐ 1 or 2 ☐ 3 or 4 ☐ More than 4 ☐

Try to forget about specific design features of cars that you are familiar with and tell us what you would really like to see built into the car you buy -- something that you think would reduce driver errors. If you cannot define what that "something" might be, try to describe what it might do.

Please describe the vehicle you drive most often.

<u>Vehicle Make</u>	<u>Model</u>
(Ford, Chevy, etc.)	(Pinto, Vega, etc.)

19 _____

What is the body style of the above vehicle? (Check all appropriate boxes)

☐ 2 Door	☐ Station Wagon	☐ Pickup
☐ 4 Door	☐ Hard Top	☐ Other _____
☐ Convertible	☐ Van	

Which of the following equipment do you have on your vehicle? (Check all appropriate boxes)

☐ Air Conditioner	☐ Automatic Transmission	☐ Rear Window De-ice/Defog System
☐ Power Brakes	☐ Right Outside Mirror	
☐ Power Steering	☐ Cruise Control	

Has the vehicle's standard equipment been modified in any way?

☐ Yes ☐ No

If yes, please describe: _____

What is the approximate total number of miles you have driven this car?

- | | |
|--|---|
| ☐ Under 1,000 | ☐ 5,001 - 10,000 |
| ☐ 1,001 - 5,000 | ☐ Over 10,000 |

How many months have you been driving this car?

- | | |
|--|---------------------------------------|
| ☐ Less than one | ☐ 13 - 18 |
| ☐ 1 - 6 | ☐ More than 18 |
| ☐ 7 - 12 | |

Finally, for purposes of comparing your answers with others in the survey, would you please give the following information about yourself:

Your sex: ☐ Male or ☐ Female

What is your present age? ____ year

Your total years of driving experience. years

About how tall are you? ____ feet ____ inches

What is your approximate weight? ____ lbs

If you had any difficulty understanding the instructions or particular questions, please describe them below so that we can improve the survey in the future.

Criticism of Questionnaire (if any) _____

Would you be willing to give further information on a confidential basis by telephone? If so, please call Mr. John Queen at (213) 674-1301 between 9 a.m. and 5:30 p.m.

Please place the completed questionnaire in the enclosed pre-stamped envelope and mail it at your earliest convenience.

Thank you for your cooperation.

Appendix C

COVER LETTERS



Automobile Club of Southern California

November 23, 1976

Dear Member:

Would you please do us a favor?

Your Auto Club is conducting a survey regarding certain features of automobiles and driving safety. While past controlled experiments have provided us with valuable information, we are anxious to find out what you as a motorist believe to be safety hazards.

Some aspects of automobiles may endanger your safety. This survey focuses on those features which are believed to be possible safety problems.

Of course, your individual answers will be held in strictest confidence. They only will be combined with answers from others in the survey in order to get an overall picture of members' opinions and experiences.

Please complete and return the questionnaire as soon as possible. Most questions can be answered quickly with a simple check mark. A postage-paid return envelope is enclosed for your convenience.

Many thanks for your help.

Sincerely,

A handwritten signature in cursive script that reads "Harry V. Cheshire, Jr." with a horizontal line at the end.

Harry V. Cheshire, Jr.
President

HVC:ic

American Automobile Association

NEW HAMPSHIRE DIVISION • 70 Queen City Ave. Manchester, N.H. 03105 • 603-669-0101

Dear AAA Member:

Would you please help us reduce accidents?

Each year 15.6 million auto accidents occur nationally. Of these, about 46,000 end in deaths and almost 4.5 million end in disabling injuries. We don't believe all of these accidents are due to driver negligence and are trying to find out what other factors are involved.

The New Hampshire Division of the AAA is participating in a national survey to learn more about driver problems with vehicle components such as mirrors and controls that could prevent accidents from occurring if designed better. The results will be analyzed and given to the U.S. Department of Transportation to help design better cars in the future.

Will you help us find out about vehicle safety problems by taking a few minutes to complete the enclosed questionnaire? Because you are one of only 3,000 members selected for the survey in New Hampshire, your response is very important to the success of the study.

Please complete and return the enclosed questionnaire (in the postage paid envelope) at your earliest convenience to our research group in California for analysis. To acquire and maintain your trust, we ask that you do not put your name on the questionnaire.

Many thanks for your help.



Gerald W. Connolly
Club Manager

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BRANCH OFFICES

Portsmouth Parade Mall
Portsmouth, New Hampshire 03801

223A Main Street
Nashua, New Hampshire 03060

38 School Street
Concord, New Hampshire 03301



CONSUMER NEWSLETTER

Dear California Driver:

Would you do us a favor?

Each year 15.6 million auto accidents occur nationally. Of these, about 46,000 end in deaths and almost 4.5 million end in disabling injuries. We don't believe all of these accidents are due to driver negligence and are trying to find out what other factors are involved.

The Consumer Newsletter is an organization devoted to consumers and their well being. We are participating in a national survey to learn more about driver problems with vehicle components such as mirrors, controls and brakes that could prevent accidents if designed better. The results will be given to the National Highway Traffic Safety Administration for subsequent use in designing safer cars.

Will you help us find out about vehicle safety problems by taking a few minutes to complete the enclosed questionnaire? Because you are one of only 2,000 California drivers randomly selected for the survey, your response is important to the success of the study. And women drivers are every bit as important in our survey as men.

Please complete and return the enclosed questionnaire (in the postage paid envelope) at your earliest convenience. To acquire your trust and maintain confidentiality, we ask that you do not put your name on the questionnaire.

Many thanks for your help.

Russell L. Smith, Ph.D.
Editor, Consumer Newsletter

Dear California Driver:

Last week you received a questionnaire as part of a national survey on vehicle safety. Since you were one of a sample selected to represent California, your response is very important to the study. If you have already completed and returned the questionnaire, consider this card a thank you for your cooperation. If you haven't as yet returned the questionnaire, we hope you will do so at your earliest convenience.

Once again, thank you for your help.

Dear New Hampshire Driver:

Last week you received a questionnaire as part of a national survey on vehicle safety. Since you were one of a sample selected to represent New Hampshire, your response is very important to the study. If you have already completed and returned the questionnaire, consider this card a thank you for your cooperation. If you haven't as yet returned the questionnaire, we hope you will do so at your earliest convenience.

Once again, thank you for your help.

Appendix D

QUESTIONNAIRE ANALYSIS RESULTS

This appendix consists of computer printed tables of cross tabulations of the responses to the questionnaire items by the following factors: driver age, sex, miles/year, years driving, height, weight, vehicle type, and vehicle age. It is available for viewing purposes in the NHTSA Technical Reference Service, 400 Seventh St. S.W. Washington, D.C.

Appendix E

SAMPLE VEHICLE MANUFACTURER/MODEL FREQUENCIES

001	<u>AMERICAN MOTORS</u>	0
002	Gremlin	9
003	Pacer	6
004	Hornet	42
005	Matador	17
006	Ambassador Brough.	10
007	Javelin	3
008	Rambler	16
009	Rebel	6
010	American	2
011	Classic	2
012	AMX	0

375	<u>AUDI</u>	2
376	Fox	6
377	100 GL/LS	9
378		0
379	7300 LS	0
380	S90	1

401	<u>BMW</u>	1
402	2002	9
403	Bavaria	4
404	530 I	1
405	1600	1

020	<u>BUICK</u>	24
021	Appollo	4
022	Century	27
023	Le Sabre	30
24	Le Sabre Custom	1
025	Electra 225	20
026	Estate SW	1
027	Skyhawk	0
028	Riviera	4
029	Le Sabre Luxus	2
030	Centurion	1
031	Skylark	38
032	Sport Wagon	1
033	Special	6
034	Regal	12
035	Mantar	0
036	Limited	3
037	Wildcat	2

050	<u>CADILLAC</u>	29
051	Calais	4
052	De Ville	38
053	Fleetwood	5
054	Fleetwood Eldorado	10
055	Seville	8
056	Fleetwood Brough.	4

060	<u>CHEVROLET</u>	54
061	Vega	39
062	Nova	56
063	Chevy II	2
064	Chevelle	56
065	Monte Carlo	35
066	Laguna	3
067	Bel Air	9
068	Impala	92
069	Caprice	49
070	Camaro	35
071	Monza	6
072	Corvette	10
073	Biscayne	0
074	Brookwood	0
075	Townsmen	2
076	Kingswood	8
077	El Camino	9
078		0
079	Corvair	4
080	Concourse (Nova)	7
081	Pick-up Truck	48
082	Van	10
083	Malibu	55
084	Cheyenne	0
085	Chevette	5

090	<u>CRYSLER</u>	28
091	Newport	27
092	Newport Custom	2
093	New Yorker	17
094	Town & Country	6
095	Imperial Lebaron	2
096	Cordoba	8
097	Cricket	1
098		0
099	300	3

110	<u>DATSUN</u>	15
111	240 Z	13
112	260 Z	4
113	280 Z	6
114	B 210	19
115	510	16
116	610	13
117	710	6
118	1200	11
119	1600	2
120	Pick-up Truck	21

125	<u>DODGE</u>	11
126	Dart	80
127	Dart Swinger	13
128	Dart Sport	3
129	Coronet	22
130	Charger	6
131	Monaco	18
132	Challenger	3
133	Polara	22
134	Demon	3
135	Colt	12
136	Aspen	17
137	Van	21
138	Pick-up Truck	5

360	<u>FIAT</u>	1
361	124 Sedan	2
362	124 Coupe	4
363	128 Sedan	3
364	128 Coupe	0
365	131 Sedan	0
366	X 19	2
367	850 Spider	2
368	1300	1

150	<u>FORD</u>	54
151	Pinto	80
152	Maverick	53
153	Granada	25
154	Torino	46
155	Elite	3
156	LTD	87
157	Custom	6
158	Custom Ranch SW	2
159	Mustang II	20
160	T Bird	20
161	Galaxie 500	31
162	Country Squire SW	12
163	Custom	0
164	Cortina	0
165	Fairlane	10
166		0
167	Mach I	2
168	Mustang	38
169		0
170	Ranchero	7
171	Pick-up Truck	47
172	Van	9
173	Falcon	15

486	<u>HONDA</u>	0
487	Civic	9
488	600 Sedan	1
489	Accord	3

480	<u>JAGUAR</u>	1
481	XKE	2
482	XJS	2

440	<u>LEYLAND</u>	1
441	Midget	0
442	MGB	4
443	MGB GT	0
444	MGB GF	0

180	LINCOLN	3
181	Continental	9
182	Mark IV	11

350	MAZDA	4
351	RX 2	6
352	RX 3	3
353	RX 4	5
354	808	0
355	1200	1
356	Pick-up Truck	1
357	1600	2

190	MERCURY	11
191	Bobcat	3
192	Comet	16
193	Monarch	11
194	Montego	16
195	Monterey	5
196	Marquis	15
197	Brougham	4
198	Cougar	17
199	Capri	27
200	Cyclone	0

385	MERCEDES	4
386	200	0
387	220	8
388	230	3
389	240	5
390	250	5
391	280	10
392	300	4
393	440	0
394	450	4
395	530	0
396	190	2
397	210	1

210	OLDSMOBILE	25
211	Omega	7
212	Cutlass Colonade	4
213	Cutlass	71
214	Vista Cruiser SW	3
215	Delta 88	35
216	98	12
217	Custom Cruiser	2
218	Starfire	3
219	Toronado	10
220	Jet Star	0
221	Skyhawk	0
222	442	0
223	Royal	4
224	F 85	3
225	Del Monte	1

450	OPEL	3
451	Kadett	4
452	1900 GT	4
453	Manta	4
454	Manta Luxus	0
455	65 E	0

235	PLYMOUTH	19
236	Valiant	33
237	Valiant Scamp	8
238	Valiant Duster	2
239	Fury	15
240	Gran Fury	3
241	Satellite	25
242	Fury I	1
243	Fury II	5
244	Fury III	18
245	Fury Gran Coup	2
246	Baracuda	4
247	Suburban SW	3
248	Belvedere	2
249	Duster	26
250	GTX	1
251	Volare	14

260	<u>PONTIAC</u>	20
261	Astre	3
262	Ventura	12
263	Le Mans	34
264	Gran Am	1
265	Catalina	31
266	Safari	2
267	Bonneville	8
268	Grand Safari	1
269	Granville	7
270	Firebird	15
271	Grand Prix	19
272	GTO	1
273	Ventura II	5
274	Tempest	3
275	Sunbird	3
276	Chief	1

285	<u>PORSCHE</u>	1
286	911	5
287	912	0
288	914	7
289	929	1

470	<u>PUEGOT</u>	0
471	403	1
472	404	1
473	504	5

460	<u>RENAULT</u>	1
461	10	0
462	12	4
463	16	1

420	<u>SAAB</u>	5
421	99 LE	13
422	96	1

430	<u>SUBARU</u>	6
431	GL Coupe	3
432	DL	3
433	GF	1

300	<u>TOYOTA</u>	12
301	Corolla	36
302	Corolla/600	2
303	Delica	18
304	Corona	15
305	Mark II	15
306	Crown	1
307		0
308	Pick-up Truck	9
309	Corolla 1200	1

410	<u>TRIUMPH</u>	0
411	TR 4	0
412	TR 6	0
413	TR 7	1
414	Spitfire	1
415	GT 6	0
416	TR 250	2

315	<u>V.W.</u>	22
316	Bug/Beetle	65
317	Dasher	15
318	Rabbit	14
319	Scirocco	0
320	Karmann Ghia	5
321	412 Sedan/Wagon	2
322	Type 3 Fastback	2
323	Type 3 Squareback	15
324	411	1
325	Micro Bus/Camp/Va	34
326	113	1

335	<u>VOLVO</u>	3
336	144	12
337	145	8
338	142	7
339	164	5
340	244	4
341	1800	3
342	165	0
343	245	6
344	265	2
345	122	1

<u>500 NO VEHICLE</u>	52
-----------------------	----

<u>501 TWO VEHICLES</u>	85
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<u>504 INTERNATIONAL PICK/UP</u>	2
505 GMC Pick-up	13
506 GMC Van	3
507 All Purpose	44

Appendix F

RESPONSE FREQUENCY FOR TOTAL SAMPLE

RESPONSE FREQUENCY FOR TOTAL SAMPLE
NATIONWIDE VEHICLE SAFETY SURVEY

In answering the questions in this questionnaire, **please consider only the car you drive most often.** Before answering, please be sure to read the instructions given below.

INSTRUCTIONS

This questionnaire consists mostly of questions which ask you to select one of five possible answers. The answers are (1) NO PROBLEM, (2) ANNOYING, (3) POTENTIAL DANGER, (4) CLOSE CALL, and (5) CAUSED ACCIDENT.

EXAMPLE (Check only one)

PROBLEM	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
My vision has been limited because of: fog, rain or snow on my side or rear windows	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

If your vision has never been limited because of fog, rain or snow on your side or rear windows, you would place a check in the box under "NO PROBLEM". If your vision has been limited and caused you to be annoyed but never seemed to be a danger, you would place a check in the box under "ANNOYING". If your vision has been limited and it placed you in a potentially dangerous position, you would check the box labeled "POTENTIAL DANGER". If your vision has been limited and it almost resulted in an accident, you would check the box labeled "CLOSE CALL". Finally, if your vision has been limited and it resulted in an actual accident, you would check the box labeled "CAUSED ACCIDENT".

For each question, please select the one answer which best describes the worst situation you had with the problem. For example, if the same problem resulted in you having a near accident or "close call" on one occasion and an actual accident on another occasion, you would check only the box labeled "CAUSED ACCIDENT".

Remember, check only one box per item. And **only** for the **one** car you drive most often.

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
I HAVE HAD DIFFICULTY SEEING:					
Far enough ahead to detect pedestrians, cyclists, or curves in the road using my low-beam headlights	1 5 4 2 1 ☐	9 4 4 2 ☐	7 8 9 3 ☐	1 3 6 4 ☐	4 5 ☐ 111
Far enough ahead to detect pedestrians, cyclists or curves in the road using my high beam headlights.	2 8 8 1 1 ☐	3 0 4 2 ☐	9 4 3 ☐	1 9 4 ☐	1 5 ☐ 112
MY VISION HAS BEEN LIMITED BECAUSE:					
Of rain, snow or fogging on my side windows.	1 2 5 3 1 ☐	1 2 7 5 2 ☐	7 1 7 3 ☐	7 7 4 ☐	7 5 ☐ 113
Of rain, snow or fogging on my rear window	1 0 4 3 1 ☐	1 2 9 8 2 ☐	8 6 6 3 ☐	9 8 4 ☐	1 1 5 ☐ 114
Of glare at night from an oncoming vehicle's headlights	2 4 2 7 1 ☐	8 5 8 2 ☐	1 0 9 1 3 ☐	1 6 4 4 ☐	5 5 ☐ 115

MY VISION HAS BEEN LIMITED BECAUSE:

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Of glare at night from another vehicle's taillights	2427 1 ☐	858 2 ☐	122 3 ☐	14 4 ☐	0 5 ☐ 116
Of sun glare reflected from parts of my car.	2039 1 ☐	1018 2 ☐	329 3 ☐	21 4 ☐	2 5 ☐ 117
Of headlight glare at night on my inside mirror from cars behind me.	1131 1 ☐	1766 2 ☐	494 3 ☐	23 4 ☐	1 5 ☐ 118
Of headlight glare at night on my left outside mirror from cars behind me . . .	1568 1 ☐	1222 2 ☐	311 3 ☐	13 4 ☐	0 5 ☐ 119
Inside mirror did not give enough information directly to the rear of my car . .	2375 1 ☐	514 2 ☐	413 3 ☐	106 4 ☐	4 5 ☐ 120
Left mirror did not give enough information to the left side of my car.	2377 1 ☐	545 2 ☐	350 3 ☐	108 4 ☐	5 5 ☐ 121
Right mirror did not give enough information to the right side of my car (Check here if you don't have a right outside mirror ☐) . . . 1731	707 1 ☐	261 2 ☐	179 3 ☐	51 4 ☐	3 5 ☐ 122
It took too long to get information from my mirrors so I was distracted from looking ahead of me	2595 1 ☐	492 2 ☐	255 3 ☐	29 4 ☐	5 5 ☐ 123
Windshield wipers didn't clear my front window quickly or completely of fogging, rain or snow.	1911 1 ☐	986 2 ☐	470 3 ☐	46 4 ☐	1 5 ☐ 124
Windshield defogger didn't clear the front window quickly or completely of fogging	1817 1 ☐	1008 2 ☐	502 3 ☐	47 4 ☐	2 5 ☐ 125

MY VISION HAS BEEN BLOCKED BY:

One of the front, side or back posts supporting my car's roof.	2068 1 ☐	702 2 ☐	510 3 ☐	132 4 ☐	8 5 ☐ 126
The front roofline, hood or trunk.	3184 1 ☐	137 2 ☐	41 3 ☐	11 4 ☐	1 5 ☐ 127
The inside, left or right outside mirrors. . .	3025 1 ☐	210 2 ☐	92 3 ☐	31 4 ☐	3 5 ☐ 128
Passengers in the front or rear seats. . .	2071 1 ☐	1024 2 ☐	278 3 ☐	21 4 ☐	1 5 ☐ 129
The front seat or front seat head rests. .	2776 1 ☐	443 2 ☐	139 3 ☐	16 4 ☐	0 5 ☐ 130

SEATING IN MY CAR:

The driver's seat forced me to sit in an uncomfortable or unsafe posture.	3150 1 ☐	249 2 ☐	37 3 ☐	2 4 ☐	0 5 ☐ 131
The seat or chest belt restricted body and head movements to see over my shoulder	2352 1 ☐	769 2 ☐	224 3 ☐	16 4 ☐	0 5 ☐ 132

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT	
BRAKING AND SHIFTING OF MY CAR:						
The brake required too much force to operate.	3268 1[]	115 2[]	39 3[]	5 4[]	0 5[]	133
Braking was difficult when power brakes failed (Check here if power brakes never failed *1[]). 1.638	720 1[]	76 2[]	189 3[]	47 4[]	4 5[]	134
My legs didn't comfortably reach brake, clutch or gas pedals.	3284 1[]	111 2[]	26 3[]	0 4[]	0 5[]	135
My foot slipped off brake pedal or caught side of pedal when moving from gas pedal.	2937 1[]	307 2[]	141 3[]	20 4[]	19 5[]	136
I stepped on more than one pedal or the wrong pedal (brake, clutch, gas) because they were too close together . .	3171 1[]	157 2[]	79 3[]	8 4[]	3 5[]	137
My leg hit steering wheel or column while moving foot to brake pedal	3299 1[]	152 2[]	35 3[]	3 4[]	0 5[]	138
I sometimes shifted into wrong gear because I couldn't tell which gear the shift was in	3020 1[]	330 2[]	38 3[]	4 4[]	1 5[]	139
STEERING WAS DIFFICULT:						
When driving in strong winds.	2063 1[]	1029 2[]	283 3[]	28 4[]	1 5[]	140
When I tried to stop quickly and skidded.	2542 1[]	437 2[]	294 3[]	74 4[]	16 5[]	141
When a tire blew out (check here if you never had a blow out *1[]). 1.889.	644 1[]	180 2[]	188 3[]	36 4[]	4 5[]	142
When power steering was lost (check here if power steering never went out *1[]). 1.731	468 1[]	194 2[]	277 3[]	33 4[]	1 5[]	143
Because steering wheel is normally sometimes very hard to turn	3090 1[]	235 2[]	47 3[]	11 4[]	0 5[]	144
Because normal steering wheel movements caused car to change direction too quickly or not quickly enough . . .	3162 1[]	173 2[]	52 3[]	10 4[]	1 5[]	145
SEEING AND READING INSTRUMENTS AND GAUGES:						
I have had difficulty seeing gauges or warning lights (temperature, oil, fuel, etc.).	2782 1[]	535 2[]	100 3[]	4 4[]	0 5[]	146

Have you ever driven an unfamiliar car, that is, a rented or borrowed car:

Yes 2847 1 ☐ 147

No 578 2 ☐

→ Skip the two questions in the box below

PLEASE ANSWER THESE QUESTIONS

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the gear shift pattern was different than in my car . .	1911 1 ☐	734 2 ☐	95 3 ☐	7 4 ☐	0 5 ☐ 148
When driving an unfamiliar car (rented, borrowed, etc.), I was confused because the location or operation of the controls (horn, lights, climate adjustments, etc.) was different in my car	1133 1 ☐	1368 2 ☐	238 3 ☐	9 4 ☐	0 5 ☐ 149

In this section, we are concerned with how well you can find, reach and operate the controls and switches in the car you drive most.

Please indicate whether any delays or confusion in **finding** a control has presented a difficulty and to what degree it caused a hazard. Check **NO PROBLEM** if a finding difficulty has never occurred.

FINDING CONTROLS AND SWITCHES:

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Headlights	3219 1 ☐	184 2 ☐	20 3 ☐	3 4 ☐	0 5 ☐ 150
Climate Control	2722 1 ☐	531 2 ☐	34 3 ☐	0 4 ☐	2 5 ☐ 151
Headlight Dimmer	2926 1 ☐	407 2 ☐	78 3 ☐	2 4 ☐	2 5 ☐ 152
Window Washer or Wiper	3033 1 ☐	321 2 ☐	53 3 ☐	5 4 ☐	0 5 ☐ 153
Defogger/De-Icer	2801 1 ☐	490 2 ☐	59 3 ☐	6 4 ☐	1 5 ☐ 154
Emergency Flasher	2905 1 ☐	378 2 ☐	48 3 ☐	3 4 ☐	0 5 ☐ 155
Horn	3052 1 ☐	277 2 ☐	74 3 ☐	16 4 ☐	1 5 ☐ 156

Have you had any difficulty **finding** any of the controls or switches listed below:

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Radio Knobs					
Ashtray					
Lighter					
Vent	2879 1 ☐	478 2 ☐	78 3 ☐	2 4 ☐	0 5 ☐ 157
Mirror Dimmer					
Interior Lights					
Dash Lights					
Turn Signal					

Now indicate whether **reaching** has presented a difficulty and to what degree it caused a hazard. Check **NO PROBLEM** if a reaching difficulty has never occurred.

REACHING CONTROLS AND SWITCHES

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Headlights	3 3 7 8 1 ☐	5 2 2 ☐	1 0 3 ☐	0 4 ☐	0 5 ☐ 158
Climate Control	2 9 9 5 1 ☐	3 0 1 2 ☐	3 1 3 ☐	0 4 ☐	1 5 ☐ 159
Headlight Dimmer	3 0 7 3 1 ☐	2 6 9 2 ☐	5 7 3 ☐	0 4 ☐	0 5 ☐ 160
Window Washer or Wiper	3 2 2 3 1 ☐	1 5 9 2 ☐	2 4 3 ☐	1 4 ☐	0 5 ☐ 161
Defogger/De-Icer	3 0 1 6 1 ☐	2 9 3 2 ☐	4 5 3 ☐	2 4 ☐	1 5 ☐ 162
Emergency Flasher	3 1 4 6 1 ☐	1 8 3 2 ☐	1 9 3 ☐	2 4 ☐	0 5 ☐ 163
Horn	3 2 5 3 1 ☐	1 2 5 2 ☐	3 3 3 ☐	5 4 ☐	1 5 ☐ 164

Have you had any difficulty **reaching** any of the controls or switches listed below:

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Radio Knobs					
Ashtray					
Lighter	2 9 3 9 1 ☐	3 8 7 2 ☐	9 2 3 ☐	8 4 ☐	0 5 ☐ 165
Vent					
Mirror Dimmer					
Interior Lights					
Dash Lights					
Turn Signal					

Now indicate whether any delays or confusion in **operating** a control has presented a difficulty and to what degree it caused a hazard. Check **NO PROBLEM** if an operating difficulty has never occurred.

OPERATING CONTROLS & SWITCHES

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Headlights	3 3 3 2 1 ☐	6 6 2 ☐	2 1 3 ☐	2 4 ☐	0 5 ☐ 211
Climate Control	2 7 9 4 1 ☐	4 5 8 2 ☐	5 1 3 ☐	3 4 ☐	1 5 ☐ 212
Headlight Dimmer	3 0 1 9 1 ☐	2 8 4 2 ☐	8 3 3 ☐	5 4 ☐	0 5 ☐ 213
Window Washer or Wiper	3 0 5 6 1 ☐	2 6 7 2 ☐	5 8 3 ☐	6 4 ☐	0 5 ☐ 214
Defogger/De-Icer	2 8 1 4 1 ☐	4 1 8 2 ☐	9 3 3 ☐	8 4 ☐	1 5 ☐ 215
Emergency Flasher	3 0 5 9 1 ☐	2 1 6 2 ☐	4 3 3 ☐	3 4 ☐	0 5 ☐ 216
Horn	3 1 0 1 1 ☐	2 0 8 2 ☐	7 6 3 ☐	1 1 4 ☐	2 5 ☐ 217

Have you had any difficulty **operating** any of the switches or controls listed below:

	NO PROBLEM	ANNOYING	POTENTIAL DANGER	CLOSE CALL	CAUSED ACCIDENT
Radio Knobs					
Ashtray					
Lighter	2973	390	53	2	0
Vent	☐	☐	☐	☐	☐ 218
Mirror Dimmer					
Interior Lights					
Dash Lights					
Turn Signal					

The following are believed to be possible factors in the cause of accidents. Which of them have played a part in any **near accidents** or **close calls** you can think of in which you were involved? Also, how much did the factors contribute to the near accidents?

	PLAYED NO PART	CONTRIBUTED SOMEWHAT	CONTRIBUTED GREATLY
Vehicle Factors (your car only)			
Poor vision from car	2196 1 ☐	692 2 ☐	261 3 ☐ 219
Steering or braking difficulties	2738 1 ☐	271 2 ☐	83 3 ☐ 220
Gear shift difficulties	2989 1 ☐	83 2 ☐	8 3 ☐ 221
Finding and using controls	2792 1 ☐	246 2 ☐	126 3 ☐ 222
Visibility of other vehicles, pedestrians, signs, etc.	1777 1 ☐	974 2 ☐	266 3 ☐ 223
Driver Factors (yourself only)			
Fatigue	2045 1 ☐	883 2 ☐	190 3 ☐ 224
Alcohol/Drugs	2788 1 ☐	176 2 ☐	81 3 ☐ 225
Disregarding driving rules	2584 1 ☐	410 2 ☐	72 3 ☐ 226
Inattention	1900 1 ☐	1014 2 ☐	212 3 ☐ 227
Lack of driving skills	2899 1 ☐	125 2 ☐	26 3 ☐ 228
Environmental Factors			
Darkness	1876 1 ☐	998 2 ☐	197 3 ☐ 229
Rain/snow/ice	1366 1 ☐	1260 2 ☐	472 3 ☐ 230
Fog	1521 1 ☐	1247 2 ☐	309 3 ☐ 231
Sun glare	1617 1 ☐	1211 2 ☐	252 3 ☐ 232
Roadway Factors			
Poor signs (location/readability)	1630 1 ☐	1144 2 ☐	294 3 ☐ 233
Poor road conditions	1753 1 ☐	999 2 ☐	285 3 ☐ 234
Poor street markings	1638 1 ☐	1084 2 ☐	283 3 ☐ 235

How many close calls or near accidents have you had due to all reasons in the last two months.

(Write number in box) 236/237

Could you tell us what you would really like to see built into the next car you buy — something that you think would reduce driver errors. If you cannot define what that "something" might be, try to describe what it might do.

3630 Responses

Please complete the following questions **carefully** and **completely** so we can relate problems to vehicle designs and driver characteristics.

Describe the vehicle you drive most often.

Vehicle Manufacturer (Ford, Chrysler, V.W., etc.)

Model (Pinto, Vega, 240Z, etc.)

Year

242/244

245/246

What is the body style of the above vehicle? (Check all appropriate boxes) ²⁴⁷

- | | | |
|---|--|---|
| ☐ 1 2 Door 1712 | ☐ 4 Station Wagon 449 | ☐ 7 Pickup 245 |
| ☐ 2 4 Door 1231 | ☐ 5 Hard Top 1027 | ☐ Other (Specify) 41 |
| ☐ 3 Convertible 72 | ☐ 6 Van 99 | |

Which of the following equipment do you have on your vehicle? (Check all appropriate boxes) ²⁴⁸

- | | | |
|--|--|--|
| ☐ 1 Air Conditioning 1731 | ☐ 4 Automatic Transmission 2613 | ☐ 7 Rear Window De-ice/Defogger 952 |
| ☐ 2 Power Brakes 2114 | ☐ 5 Right Outside Mirror 1200 | ☐ 8 Cruise Control 321 |
| ☐ 3 Power Steering 2349 | ☐ 6 Rear Window Wiper 163 | |

Has the vehicle's standard equipment been modified in any way?

²⁴⁹

- Yes ☐ 1 301
No ☐ 2 3074

If yes, please describe: _____

250/252

How many miles do you drive this car per year? ²⁵³

- | | |
|--|--|
| ☐ 1 Under 1,000 88 | ☐ 3 5,001-10,000 1237 |
| ☐ 2 1,000-5,000 608 | ☐ 4 Over 10,000 1500 |

Finally, for purposes of comparing your answers with others in the survey, would you please give the following information about yourself:

Your sex:

- Male ☐ 1 2189
Female ☐ 2 1277

What is your present age? _____ years ^{255/256}

Your total years of driving experience? _____ years ^{257/258}

About how tall are you? _____ feet _____ inches ^{259/260}

What is your approximate weight? _____ pounds ²⁶¹

Please place the completed questionnaire in the enclosed pre-stamped envelope and mail it at your earliest convenience.

Thank you for your cooperation.

Appendix G

DETAILED ANALYSIS OF SELECTED QUESTIONS

A. INTRODUCTION

This appendix was prepared as a follow-on to the main study under DOT Purchase Order NHTSA-7-3421. The purpose was to conduct additional analyses of the data which could not be accomplished within the time and budget constraints of the main study.

Despite pleas to potential respondents of questionnaires to submit their returns prior to an established deadline, approximately 10 percent (363) nevertheless sent in their returns late. These returns were therefore coded and keypunched and added to the main pool of data before the analyses described below were performed.

The present study was designed to answer the following questions of interest to NHTSA:

1. Are car body shell types related to visibility problems?
2. Do drivers of cars with multifunction controls report more problems than those without these controls?
3. Are driver height and vehicle size correlated? What does this relationship imply about the fit between drivers and their vehicles?
4. How do the types of problems that drivers of vans and other special vehicles are having compare to those for passenger vehicle drivers?
5. How do the visibility problems in cars with rear window wipers and defoggers compare to those in cars without these devices?
6. How do braking and steering problems compare for vehicles of the same size which have and which do not have power steering and braking?
7. A number of specific vehicle makes/models were identified in the main study as having a higher than average number of critical incidents. Can the specific design features of these cars causing some of these incidents be identified?

In addition, we elected to add an eighth question which would supplement Question No. 3 and, hopefully, provide clarifying information, namely,

8. Are driver weight and vehicle size correlated? What does this relationship imply about the fit between drivers and their vehicles?

All of these questions were straightforward in the sense that, given the appropriate classifications of the independent variables, dependent measures are readily generated from the data bank of responses.

B. RESULTS

1. Driver Height and Vehicle Size

Figure G-1 shows mean driver heights of males and females as a function of car size: subcompact (SC), compact (C), intermediate (I), and full size (F). These data suggest that taller drivers tend to drive smaller cars, regardless of sex. The trend shown for females, however, is weak and non-significant. The height differences between the largest three car sizes for males are also not significant. Chi square tests matching subcompact male drivers against compact, intermediate, and full-size male drivers reveal that significantly more taller males drive subcompact cars than would be expected by chance ($\chi^2 = 7.36, p < .01$). These tests were based on two categories of height; less than 64 inches and greater than 64 inches.

Despite the facts that the overall trends were not substantial and that only one category (subcompact drivers) yielded significant differences, the data nevertheless suggest mismatches between driver height and vehicle size. This is so because one would expect significant trends opposite to those observed here. Thus, no significant differences at all would indicate that a relatively large percentage of tall males and females drive very small cars, while a relatively large percentage of short males and females drive very large cars. For example, 33 percent of the sample of male drivers of subcompact cars were 6 feet or taller. Similarly, 28 percent of the sample of female drivers of full-size cars were 5'2" or shorter. Interestingly, we did not observe abnormal numbers of tall females and short males driving subcompact and full-size cars, respectively. In effect, these data indicate that the height/vehicle size mismatches were principally tall male drivers and subcompact cars, and short female drivers with full-size cars.

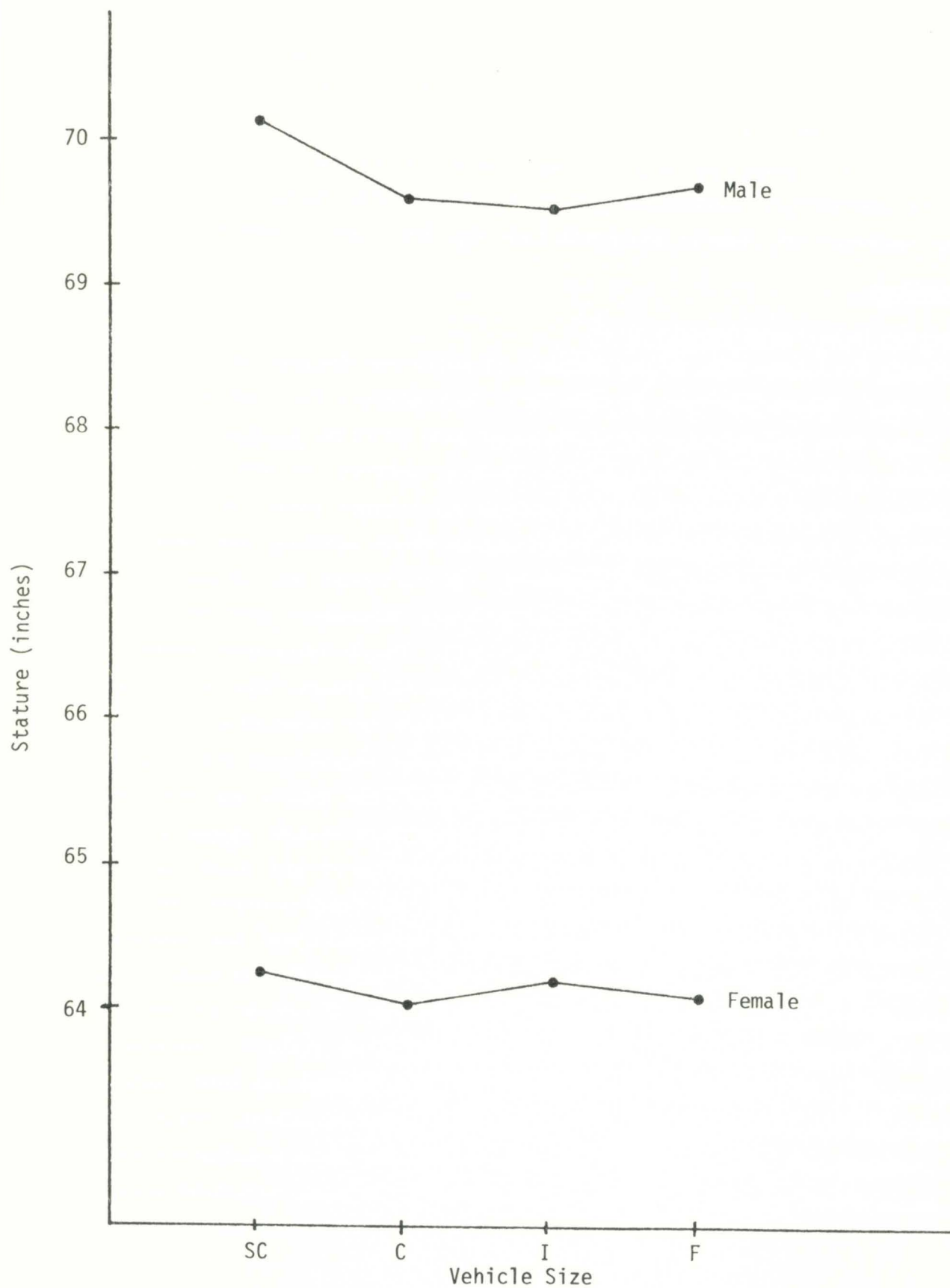


Fig. G-1--Driver height as a function of vehicle size

2. Driver Weight and Vehicle Size

Figure G-2 presents the plotted relationship between driver weight and vehicle size. The weight scale was based on responses to the following weight categories: <100, 101-125, 126-150, 151-175, 176-200, 201-225, 226-250, and >250. Thus, the points plotted were calculated by multiplying the midpoints of these categories with their respective driver frequencies and then dividing the sum by the total number of drivers.

As can be seen, the trends exhibited by males and females were almost exact mirror images of those observed for the driver height/vehicle size functions. Thus, for example, the greater the weight of the female driver, the larger the car employed. For male drivers, no differences in weight occurred between subcompact, compact, and intermediate size cars, but a relatively large increase in driver weight was found for full-size cars. A χ^2 test of the significance of the differences between subcompact and full-size car female drivers revealed a significance beyond the .01 level of confidence ($\chi^2 = 13.05$). A χ^2 test for male drivers indicated a similar level of significance ($\chi^2 = 17.84$, $p < .01$).

To illustrate somewhat more dramatically the differences observed, 24 percent of the male drivers of full-size cars weighed 201 or more pounds, while only 8 percent of the drivers of the other car sizes were 201 or more. On the other hand, we did not observe the opposite "imbalance" for drivers at the lower end of the weight spectrum, i.e., 21, 20, 20, and 22 percent of the drivers of subcompact, compact, intermediate, and full-size cars, respectively, had weights of 150 pounds or less.

The opposite findings were observed for female drivers. No substantial differences between car sizes were found for females weighing 201 or more pounds, but weights of 120 pounds or less ranged from 29 percent for full-size cars to 49 percent for subcompact cars. In effect, the distribution structures for the driver weight/vehicle size relationships were essentially identical to those of driver height/vehicle size except that, as noted, they were mirror images of one another.

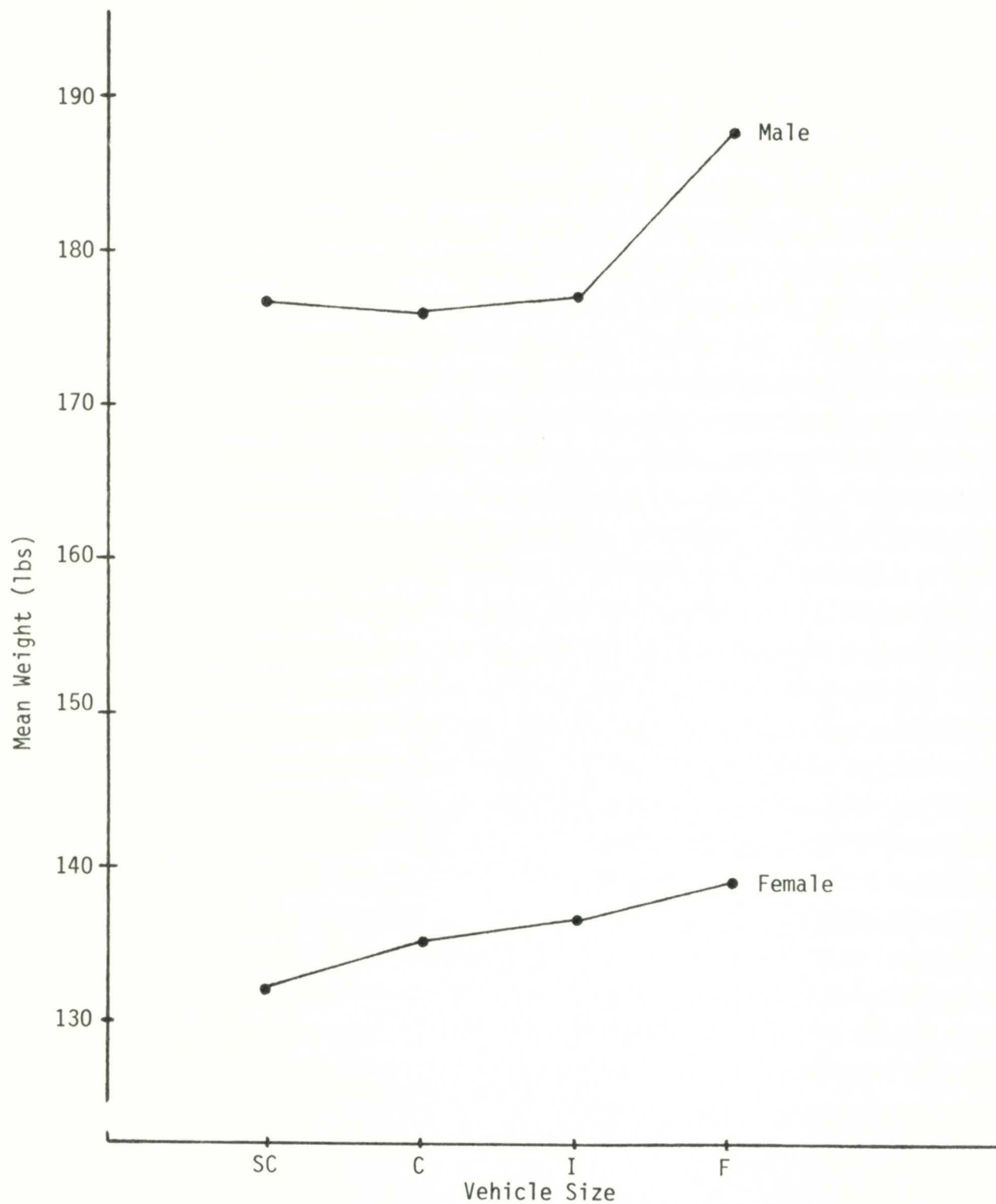


Fig. G-2--Driver weight as a function of vehicle size

3. Rear Window Wipers and Defoggers

An analysis was made to segregate drivers of vehicles with and without rear window wipers and with and without rear window defoggers and to then calculate the differences between these subgroups with respect to the question, "My vision has been limited because of rain, snow or fogging on my rear window." The response frequencies to the five categories of problem criticality were:

	No Problem	Annoying	Potential Danger	Close Call	Caused Accident	Mean Scale Value
Wipers	67	58	29	4	0	1.81
No wipers	1079	1375	939	106	13	2.03
Defogger	461	297	187	21	5	1.78
No defogger	685	1136	781	89	8	2.11

A X^2 test of the differences between the wiper/no wiper frequency distributions revealed that the distributions were indeed significantly different ($X^2 = 13.20$, $df = 4$, $p < .02$). As can be seen in the table, mean scale values of 1.81 and 2.03 were computed for the two classes of vehicles. The X^2 test indicates that the difference between these scale values is significant.

A second X^2 test was performed on the defogger/no defogger distributions. This test revealed that these distributions were also significantly different, yielding a relatively large chi square of 165.23, well beyond the .01 level of confidence. The mean scale values of 1.78 (defogger) and 2.11 (no defogger) were, therefore, significantly different.

The shapes of the wiper /no wiper and defogger/no defogger distribution are shown in Fig. G-3. It can be clearly seen that the no wiper and no defogger distributions were quite different from their counterparts. The value of wipers and defoggers to respondents is evident. Rear window defoggers and/or wipers appear to be design features with substantial accident reduction potential for a relatively low cost.

4. Steering and Braking

Several specific mismatch questions regarding steering and braking were analyzed in detail to determine whether or not problem frequency/

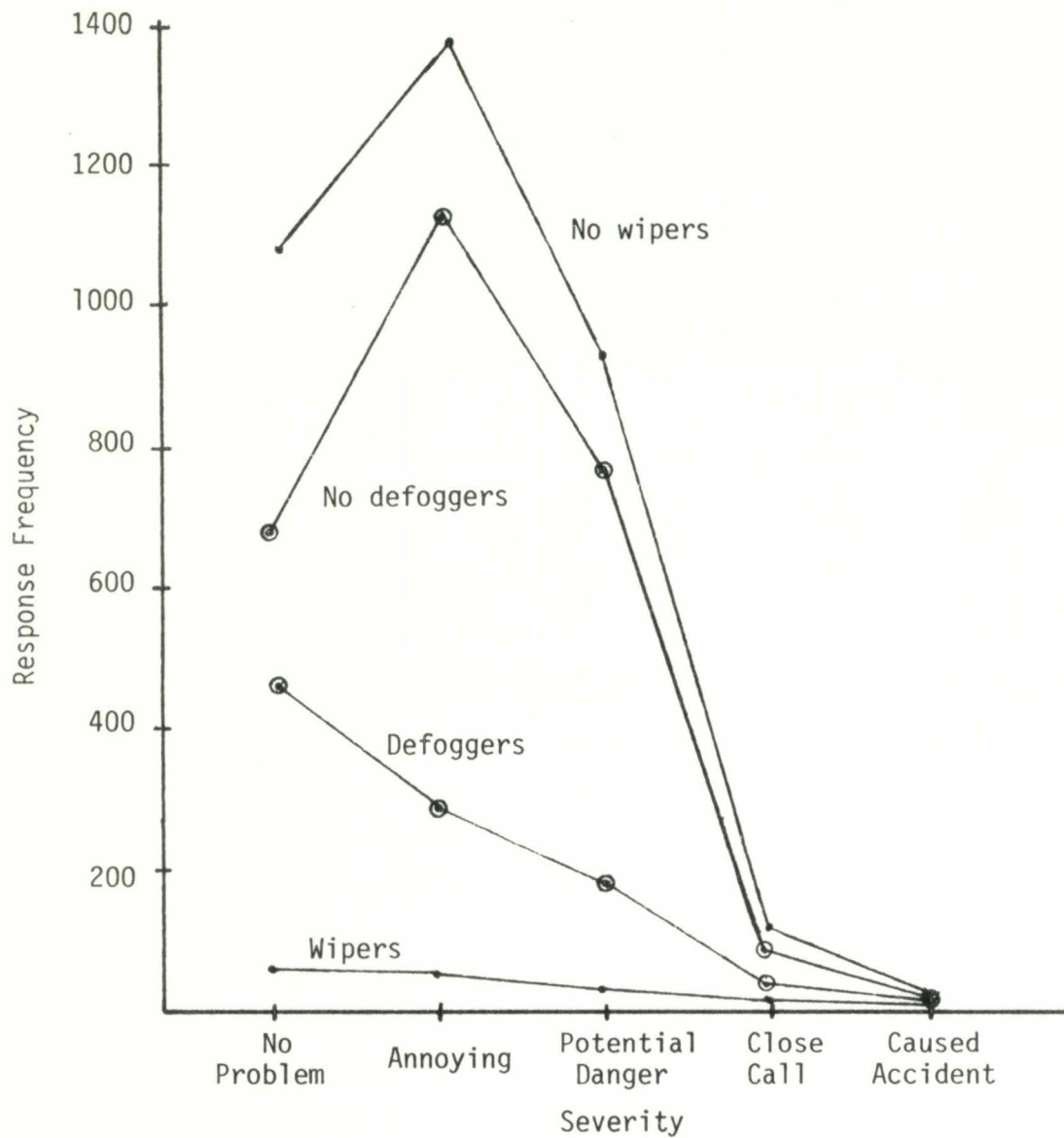


Fig. G-3--Frequency of responses as a function of level of severity for wiper/defogger analysis

severity reports were different across vehicle size and for vehicles having and not having power steering and/or power brakes.

a. Vehicle Size and Braking

Power brake failures at the component level are relatively infrequent, however, when engine power is lost due to stalling, power features are also lost. Responses, then, reflect the loss of power brakes due to whatever reasons.

Responses to Question No. 134, "Braking was difficult when power brakes failed," were examined by vehicle size to determine differential effects between braking with and without power failure.

1) Power Brake Failure. Response frequency to each of the five severity categories and mean scale value are shown below.

Vehicle Size	Total Responses	Severity					$\bar{x}$
		1	2	3	4	5	
SC	33	24	0	8	1	0	1.58
C	76	42	12	19	3	0	1.76
I	136	81	11	34	9	1	1.81
F	199	106	25	58	10	0	1.86

The data clearly illustrate a positive relation between vehicle size and braking problems after a power brake failure--the larger the vehicle the greater the difficulty. It is also clear that when such problems occurred, they were more than simply annoying (category 2), and tended to fall into the potential danger (3) category.

2) Brake Force. Responses to Question No. 133, "The brake required too much force to operate," were analyzed by vehicle size for vehicles with and without power brakes. Data are shown below by vehicle size and brake type.

Vehicles without power brakes exhibited slightly more problems than those with power brakes, but severity generally was relatively low. Only 4 of the 1120 responses were in the "close call" category and all were for non-power brake vehicles. One would anticipate that vehicle size would make little difference for power brake equipped vehicles and that was in fact the case. However, one would also anticipate that larger vehicles would have

greater difficulty than small ones when not power-brake equipped. This expectation, however, was not supported by the data as the mean scale values (1.09 - 1.10) were virtually identical across vehicle sizes. A significance test was therefore not performed.

	Vehicle Size	Responses	Severity					$\bar{x}$
			1	2	3	4	5	
POWER BRAKES	SC	135	130	4	1	0	0	1.04
	C	276	262	9	5	0	0	1.07
	I	471	460	9	2	0	0	1.03
	F	662	654	6	2	0	0	1.02
	Total	1544	1506	28	10	0	0	1.03
NO POWER BRAKES	SC	568	528	25	13	2	0	1.10
	C	330	306	17	6	1	0	1.10
	I	156	146	7	2	1	0	1.09
	F	66	61	4	1	0	0	1.09
	Total	1120	1041	53	22	4	0	1.10

3) Steering During Skid - Power Vs. No Power Brakes. Responses to Question No. 141, "Steering was difficult when I tried to stop quickly and skidded," were analyzed by vehicle size for vehicles with and without power brakes and/or power steering. Data are shown below for vehicles with and without power brakes.

	Vehicle Size	Responses	Severity					$\bar{x}$
			1	2	3	4	5	
POWER BRAKES	SC	136	101	16	13	5	1	1.45
	C	268	198	45	16	9	0	1.39
	I	466	351	71	30	12	1	1.38
	F	645	506	73	55	10	1	1.34
	Total	1515	1156	205	114	16	3	1.36
NO POWER BRAKES	SC	563	409	79	55	15	4	1.45
	C	323	255	42	43	11	2	1.52
	I	154	110	26	16	2	0	1.42
	F	61	43	5	10	3	0	1.56
	Total	1101	817	152	124	31	6	1.50

Vehicles without power brakes had significantly more skidding problems during quick braking than those with power brakes ($p < .01$), with full-size/

power brake vehicles having the fewest ($\bar{x} = 1.34$) and full-size/no power brake vehicles having the most ($\bar{x} = 1.56$). Interestingly, there was a small but consistent trend within the power brake equipped vehicle classification for smaller vehicles to have greater problems than larger vehicles. Means ranged from 1.45 to 1.36 for small (SC) and large (F) size vehicles, respectively. No clear or consistent trend was apparent for non-power brake equipped vehicles.

4) Steering During Skid - Power Vs. No Power Steering. Responses to the same question (No. 141) were examined relative to vehicles with and without power steering. One would anticipate that power steering equipped vehicles might have less of a problem with skidding while braking quickly than with non-power steering equipped vehicles. Also, one might expect small vehicles to have less of a problem than large vehicles. The response frequencies are shown below.

	Vehicle Size	Responses	Severity					$\bar{x}$
			1	2	3	4	5	
POWER STEERING	SC	66	46	13	7	0	0	1.41
	C	401	285	65	40	9	2	1.45
	I	581	433	92	40	14	1	1.38
	F	689	534	77	64	13	1	1.36
	Total	1737	1298	247	151	36	4	1.39
NO POWER STEERING	SC	663	464	82	61	20	5	1.45
	C	190	138	22	19	11	0	1.49
	I	39	28	5	6	0	0	1.44
	F	17	15	1	1	0	0	1.18
	Total	909	645	110	87	31	5	1.40

The data clearly illustrate that there was no difference in problems of skidding between power and non-power steering equipped vehicles as a whole. Mean scale values were 1.39 vs. 1.40, respectively. Also, there were no consistent or clear trends across vehicle size with or without power steering. Eliminating the mean value of 1.18 for full size vehicles without power steering, for which there were only 17 responses, the mean for all vehicle/steering combinations ranged only from 1.36 to 1.49. Power steering and vehicle size, therefore, appear to have little effect on skidding problems during quick braking.

b. Vehicle Size and Steering

The relationship between vehicle size and power steering vs. no power steering equipped vehicles relative to steering in strong winds, understeering/oversteering, steering after a blowout and upon power steering failure are presented in the following subsections.

1) Steering in Winds. Responses to Question No. 140, "Steering was difficult when driving in strong winds," were classified by vehicle size and power steering vs. no power steering. Anecdotal evidence and general experience leads one to believe that small vehicles have far more difficulty in strong winds than larger vehicles and that power steering may reduce these problems. Responses are presented below..

	Vehicle Size	Responses	Severity					$\bar{x}$
			1	2	3	4	5	
POWER STEERING	SC	66	40	21	5	0	0	1.47
	C	404	229	147	24	4	0	1.51
	I	580	390	165	21	4	0	1.38
	F	700	509	160	29	1	1	1.32
	Total	1750	1168	493	79	9	1	1.39
NO POWER STEERING	SC	640	296	221	112	11	0	1.75
	C	196	109	68	17	2	0	1.55
	I	40	20	16	3	1	0	1.63
	F	18	11	7	0	0	0	1.39
	Total	894	436	312	132	14	0	1.69

The effectiveness of power steering was clearly indicated by the difference in mean scores and a comparison of distributions using the χ^2 test. The distributions were found to be significantly different ($p < .01$). In addition, the mean score for power steering equipped vehicles at each level of vehicle size was lower than that of equivalent size non-power steering equipped vehicles (1.47 vs. 1.75, 1.51 vs. 1.55, 1.38 vs. 1.63, and 1.32 vs. 1.39).

Vehicle size was also clearly and consistently related to steering difficulties in strong winds. For both power and non-power equipped

vehicles, the smaller the vehicle the greater the problem. Therefore, while smaller vehicles are more adversely affected by strong winds, power steering reduces the problem for all vehicle sizes.

2) Steering Response. Responses to Question No. 145, "Steering was difficult because normal steering wheel movements caused car to change direction too quickly or not quickly enough," were examined by vehicle size and power vs. no power steering. Response data are presented below.

	Vehicle Size	Responses	Severity					$\bar{x}$
			1	2	3	4	5	
POWER STEERING	SC	66	58	3	3	2	0	1.23
	C	402	373	22	7	0	0	1.09
	I	587	550	25	11	1	0	1.09
	F	700	666	23	10	1	0	1.07
	Total	1755	1647	73	31	4	0	1.08
NO POWER STEERING	SC	635	587	38	7	2	1	1.10
	C	194	176	11	6	1	0	1.13
	I	39	34	3	2	0	0	1.18
	F	18	16	0	1	0	1	1.33
	Total	886	813	52	16	3	2	1.11

Vehicles equipped with power steering were affected only slightly less by "too quick/slow" steering problems than non-power steering equipped vehicles. Means were 1.08 vs. 1.11 and the distributions did not differ significantly. An unusual trend was observed for the power vs. no power steering groups across vehicle types. For vehicles having power steering, the smaller the vehicle the greater the problem, but for non-power steering vehicles, the smaller the vehicle the smaller the problem.

Since separate responses were not recorded with regard to whether the specific problem was one of steering too quickly or not quickly enough, interpretation of the above finding is difficult. Perhaps subcompacts with power steering steer too quickly while full-size vehicles without power steering do not respond quickly enough, thus causing the relatively greater problem responses by these vehicle drivers.

3) Power Steering Failure. Responses to Question No. 143, "Steering was difficult when power steering was lost," are shown below for vehicles equipped with that feature.

Vehicle Type	Responses	Severity					$\bar{x}$
		1	2	3	4	5	
SC	13	6	2	5	0	0	2.08
C	102	32	26	39	5	0	2.17
I	169	63	39	60	7	0	2.07
F	235	83	58	88	5	1	2.08

Differences between vehicle sizes were small, with means ranging from 2.07 to 2.17. Responses for compact vehicles resulted in the highest mean scale value but the response distribution was not statistically significant from that of the other vehicle sizes. Therefore, when power steering failed, for whatever reason, drivers of one vehicle size did not seem to have more of a problem than drivers of any other size vehicle.

4) Steering After Tire Blowout. Responses to Question No. 142, "Steering was difficult when a tire blew out," were analyzed by vehicle size and power steering feature to determine whether vehicle size and/or power steering resulted in more frequent/severe problems. The relative frequency of the "blowout" experience reported by drivers is shown below by vehicle size:

Subcompact	28.2%
Compact	31.8
Intermediate	35.5
Full size	40.6

Apparently, the larger the vehicle the greater the frequency or at least reported frequency of blowouts experienced. If one assumes that respondents of one vehicle group do not remember more "blowouts" than another, which seems tenable enough, the trend appears "real". Unfortunately, there was no time-base upon which to establish a blowout rate, which would be of considerable interest.

Responses by individuals who experienced blowouts are shown below:

	Vehicle Size	Responses	Severity					$\bar{x}$
			1	2	3	4	5	
POWER STEERING	SC	15	7	3	5	0	0	1.87
	C	111	64	18	18	4	0	1.53
	I	177	101	32	37	7	0	1.72
	F	245	152	38	48	5	2	1.64
	Total	548	324	91	108	16	2	1.65
NO POWER STEERING	SC	153	93	34	24	2	0	1.58
	C	54	31	8	12	3	0	1.76
	I	14	8	2	2	2	0	1.86
	F	10	8	2	0	0	0	1.50
	Total	231	140	46	38	7	0	1.62

Overall mean scores for the power steering vs. no power steering classification were 1.65 vs. 1.62, respectively; the overall distributions accordingly were not significantly different. Power steering apparently was of no benefit in reducing steering difficulty subsequent to a tire blowout. Also, there were no clear trends accompanying vehicle size for either group. However, the sample sizes were very small for some combinations (e.g., 10, 14, and 15).

5. "Special" Vehicle Problems

a. Introduction

Vans, pickup trucks, and other multipurpose passenger vehicles (e.g., jeeps, carry-all wagons) differ in fundamental ways from more conventional passenger vehicles. Drivers of these "special" vehicles, therefore, might be expected to be involved in unique and/or more severe driver/vehicle mismatch problems than passenger vehicle drivers. One would anticipate more frequent critical incidents in the areas of vision (especially indirect vision), braking, and perhaps steering.

Responses to the questionnaire by 300 respondents who reported one of these "special" vehicles to be their primary vehicle were analyzed in order to identify unique or over-represented mismatch problems relative to passenger vehicle drivers. Responses to the 52 most important questions (see Table 30) were analyzed and contrasted with responses by all passenger

vehicle drivers combined. Overall mean scale values, which represent the overall frequency/severity of mismatch problems, were used initially to identify questions to which "special" vehicle drivers' responses appeared more severe than passenger vehicle drivers. Response distributions for passenger vehicle drivers were then tested against those for "special" vehicle drivers for statistical significance using the X^2 test.

b. Results

"Special" vehicle drivers reported significantly more frequent/severe incidents for 5 of the 52 mismatch questions analyzed. Three of these were vision related, while the remaining two were braking and steering related. They were:

- 1) Vision limited because of rain, snow or fog on my side window (Q. 113)
- 2) It took too long to get information from my mirrors, so I was distracted from looking ahead of me (Q. 123)
- 3) Vision has been blocked by inside, left or right outside mirrors (Q. 128)
- 4) The brake required too much force to operate (Q. 133)
- 5) Steering was difficult when driving in strong winds (Q. 140).

Figure G-4 illustrates the mean scale value for (1) each passenger vehicle type (subcompact, compact, intermediate, and full size), (2) the average for all passenger vehicles, and (3) the mean for "special" vehicles as a group, for each of the five questions. The level of significance (X^2) is also shown.

"Special" vehicle drivers, as shown, reported a significantly greater mismatch problem frequency/severity for these questions than did drivers of other vehicle types. Interestingly, subcompacts are second in problem frequency and severity for four of the five mismatch questions.

Design improvement suggestion responses (see Table 28) were also analyzed to identify desired improvements more frequently cited by "special" vehicle drivers. Suggestions which were cited one percent more often and one percent less often or more by "special" vehicle drivers are shown in Table G-1. Those more frequently cited by "special" vehicle drivers involved

Question Code

1 - Vision limited; by rain, snow, fog on side windows

2 - Vision limited; distracted too long by mirrors

3 - Vision blocked by mirror(s)

4 - Brake required too much force

5 - Steering difficult in wind

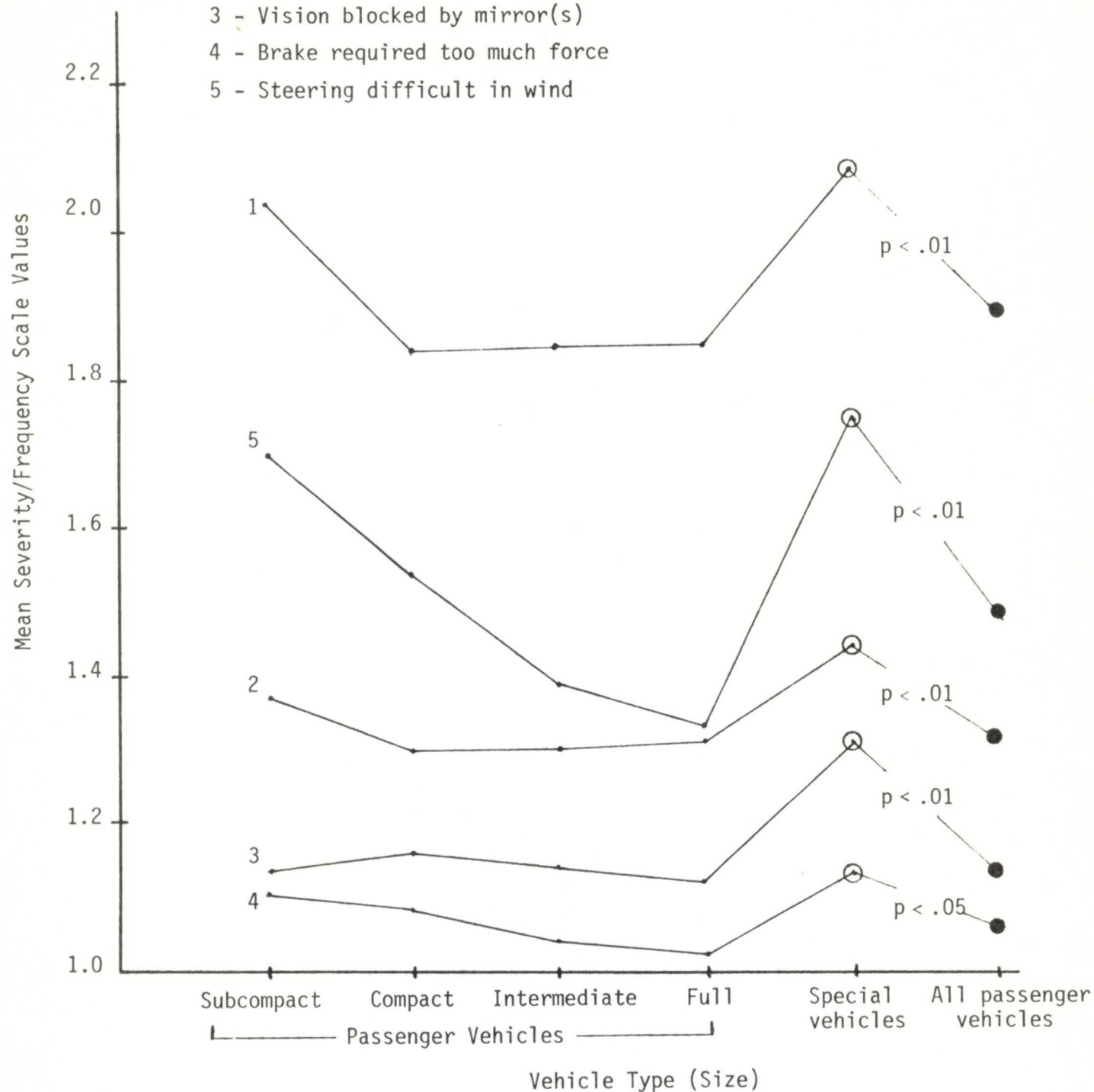


Fig. G-4--Relation between frequency/severity mean scale value and vehicle type for "mismatch" questions where special vehicles were significantly higher

Table G-1

DESIRED DESIGN IMPROVEMENTS FOR SPECIAL AND PASSENGER VEHICLES

Design Suggestion	Percent of Respondents	
	Special Vehicles	Passenger Vehicles
Better rear view mirrors	12.9	9.8
Reduce oncoming glare	9.4	6.7
Better brakes	5.9	2.6
Better signalling between cars	4.5	3.6
Better handling/suspension	4.2	2.2
Defog other (than windshield) windows	8.7	10.2
Better vision in general	5.2	6.8
Better hand controls	3.8	5.5
Standardize dash	3.8	5.0
Better malfunction monitoring systems	2.8	4.0
Rear window wiper	1.4	3.6
Smaller posts	1.4	2.9
Headrests that don't block vision	0.4	1.5
Total sample n	287	2663

(1) better rear view mirrors, (2) reduction of oncoming headlight glare, (3) better brakes, (4) better handling/suspension, and (5) better signalling between cars. Better handling/suspension and better brakes were suggested by twice as many special vehicle than passenger vehicle drivers.

c. Discussion

Special vehicle drivers apparently do have unique mismatch problems causing or contributing to more frequent/severe critical incidents and accidents. Some of these are certainly predictable. The need and/or desire for improved rear view mirrors, mirrors which do not block the forward field of view, mirrors which do not require extensive time to gain needed information, steering, handling, and braking are clearly obvious to anyone who has operated these vehicles. The greater frequency/severity of incidents due to (1) rain, snow, and fog on side windows, and (2) greater desire for better signalling between cars is probably related to the generally degraded visibility from such vehicles. On the other hand, it is not clear why special vehicle drivers desire to have oncoming glare reduced more often than do passenger vehicle drivers. Perhaps such drivers are relatively overexposed to night driving situations since many such vehicles are used for recreational purposes.

The foregoing analysis and results should be considered an under-representation of the magnitude of the problems associated with van and pickup vehicle drivers. Such a position is due to the fact that 20 percent of the "special" vehicle category is composed of jeep and carry-all type vehicles which are perhaps more like station wagons than they are like vans or trucks in design. Consequently, if van and truck mismatch problem severity/frequency were considered separate from these vehicles, the 12.9 percent "special" vehicle drivers desiring better rear view mirrors, for example, as well as other improvements, would likely be substantially greater.

6. Vehicle Upper Body Shell and Visibility Problems

a. Background

It has been implied by many investigators in automotive visibility research that there is a relation between (1) direct visibility obscurations due to vehicle pillars or posts and accidents, and (2) indirect visibility, i.e., mirror field of view and accidents. To the writers' knowledge, this implication, however, has never been verified empirically.

The results section of this report showed that visibility obscurations due to posts were a significant problem to drivers, along with difficulties of obtaining information from mirrors. Both caused or contributed to critical incidents and accidents, as reported by drivers. While it was of great interest to examine specific vehicle model/year groups to determine whether or not one "style" had a greater frequency of near accidents, sample sizes were generally too small for meaningful comparisons.

From year to year and across a manufacturer's line, some vehicles are identical with respect to their "superstructure" and consequently their visibility. A good example is the 1973-1977 General Motors Chevrolet Camaro and Pontiac Firebird, both of which are identical. In addition, vehicles were identical from 1970-1972 and changed only slightly from 1972 to 1973. Thus, similarity of models appeared to be a method of increasing sample sizes for visibility analyses by grouping vehicles which were identical across model and year with regard to pillar size and location.

This seemingly simple task proved to be most difficult for several reasons. First, data permitting accurate grouping according to "superstructure" apparently is unpublished. Second, while such data exist within manufacturer records, it is pre-production information which is treated by manufacturers as company-classified and is therefore difficult to obtain. Finally, construction of groupings of identical vehicles on the basis of available photographs was impossible because of the inaccuracies inherent in that method.

With the assistance of General Motors, we were able to identify eight different groups of 1970-1977 vehicle model/years, each of which was unique.¹

¹We are indebted to Mr. Ron Roe of General Motors for his hours of research and assistance in providing guidance for establishing groupings.

These groups are shown in Table G-2. In addition to the groupings, it seemed desirable to include the BMW 2002 because of its apparently good direct visibility and the AMC Pacer because of its unique overall visibility design. Unfortunately, some groups were relatively small, but others provided reasonable sample sizes of between 40 and 50.

b. Analysis

Groups were formed on the basis of questionnaire vehicle model code numbers, vehicle year, and 2- or 4-door specification by drivers. Responses to the four most important vision (direct and indirect) questions were examined for each group. These were:

- . Q. 126--My vision has been blocked by one of the front, side, or back posts supporting my car's roof,
- . Q. 127--My vision has been blocked by the front roofline, hood or trunk,
- . Q. 120--My vision has been limited because inside mirror did not give enough information directly to the rear of my car, and
- . Q. 121--My vision has been limited because left mirror did not give enough information to the left side of my car.

c. Results

The mean scale values are illustrated for each vehicle grouping for each question in Table G-3. A χ^2 test was performed to test distribution differences for significance. While many relatively large differences in mean scores are apparent in the table, none between specific individual vehicle groups was found to be significant, undoubtedly because of the small sample sizes. Several findings are noteworthy, however; when the data were examined in combination, strong trends emerged.

First, with respect to pillar/post obscuration (Q. 126), it is observed that the vehicle hypothesized to have the smallest obscuration, the BMW 2002, indeed had the lowest score. Also, 2-door coupes, which tended to have larger "sail" pillars than did 4-door sedans, in every instance had a higher score. In fact, a comparison of all 2-door vs. all 4-door groups indicate a significant difference in response distribution ($p < .05$). The

Table G-2
BODY SHELL GROUPING DESCRIPTION

Body Shell Grouping	Vehicle (year)	N
1. "A" Body Opera Window Coupe	Monte Carlo (73-76) Grand Prix (73,74) Regal (73,76,77)	28 8 10
2. "A" Body 2-Door	Chevelle (73-76) Lemans (73-76) Cutlass (73-76) Century (73-76)	17 9 14 14
3. "A" Body 4-Door	Chevelle (73-76) Lemans (73-76) Cutlass (73-76) Century (73-76)	9 10 17 10
4. "B-C" Body 2-Door	Delta 88 (70-73) Toronado (70-74) Catalina (70-73)	6 4 2
5. "B-C" Body 4-Door	Delta 88 (70-74) Bonneville (70-74)	13 1
6. "X" Body 2-Door	Nova (71-74) Ventura (73,74) Omega (73,74) Apollo (73,74)	26 6 2 2
7. "H" Body 2-Door	Starfire (75,76) Monza (75,76)	3 7
8. "F" Body 2-Door	Firebird (70-77) Camaro (70-77)	10 15

Table G-3

SUMMARY OF MEAN SCALE VALUES BY VEHICLE GROUPING AND VISION QUESTION

Vehicle Grouping	Q126	Q127	Q120	Q121	Total	N
G1 - "A" Body Opera Window 2-Door	1.70	1.20	1.27	1.23	1.35	46
G2 - "A" Body 2-Door	1.78	1.04	1.54	1.46	1.45	54
G3 - "A" Body 4-Door	1.41	1.02	1.57	1.50	1.38	46
G4 - "B-C" Body 2-Door	1.83	1.00	1.45	1.25	1.38	12
G5 - "B-C" Body 4-Door	1.36	1.00	1.21	1.29	1.22	14
G6 - "X" Body 2-Door	1.50	1.06	1.42	1.67	1.41	36
G7 - "H" Body 2-Door	1.50	1.10	1.50	2.00	1.55	10
G8 - "F" Body 2-Door	1.60	1.08	1.52	2.00	1.55	25
G9 - BMW 2002	1.30	1.00	1.50	1.80	1.40	10
G10 - AMC Pacer	1.67	1.17	1.83	2.20	1.72	6
G1 + G2 + G4	1.75	1.10	1.42	1.35	1.40	
G3 + G5	1.40	1.00	1.39	1.45	1.34	
G6 + G7 + G8	1.53	1.08	1.47	1.85	1.48	

Q126 - Post obscuration

Q120 - Inside mirror information

Q127 - Roof, etc. obscuration

Q121 - Left mirror information

"X", "F", and "H" body vehicles were all clustered between the 2- and 4-door vehicle means. Therefore, there appears to be a clear trend for drivers of vehicles with larger "sail" pillars to report a greater frequency and severity of incidents due to post/pillar obscuration. In addition, the "A" body "opera-window" vehicles, which have small openings of various sizes and shapes in the "sail" area, appeared to have only slightly, if at all, lower scores than other two-door coupes.

Second, obscuration due to roofline, hood, or trunk (Q. 127) was apparently a far less severe problem across all vehicle groupings. For group 4 and 5, the "B-C" body 2- and 4-door vehicles, drivers reported no problems at all, as was also the case with all BMW 2002 drivers. "A" body-opera window coupe drivers reported the highest incidence (mean score of 1.20).

Third, responses to the adequacy of inside mirror information (Q. 120) did not reveal consistent trends. The "A" body "opera window" 2-door and the "B-C" body 4-door vehicles received the lowest scores (1.21 and 1.27, respectively), while all other groups were highly similar, ranging from 1.42 to 1.57. Adequacy of inside mirror information appeared to be approximately equivalent across vehicle groupings.

Fourth, responses to left-side mirror information adequacy (Q. 121) appeared to be quite different across vehicle groups. The "H", "X", and "F" body vehicles received the highest (poorest) scores, averaging 1.85, as opposed to a mean of 1.35 for 2-door and 1.45 for 4-door vehicles overall. A χ^2 test revealed that the problem was significantly more severe/frequent for these "F", "X", and "H" body vehicles than for the 2-door groups ($p < .05$) but not for the 4-door groupings. Detailed examination of left mirror field of view for these groups might illuminate the cause of these observed differences.

Analysis of reported driver direct and indirect visibility problems in terms of vehicle body shell design characteristics appear promising. While statistical significance was not observed in any but the coarsest groupings because of sample size constraints, certain trends were observed, as anticipated. Drivers of 4-door vehicles having relatively small rear post obscurations reported fewer problems than those of 2-door vehicles having relatively large rear post obscurations. The BMW 2002, which appears to

have the best direct visibility, had the fewest obscuration problems. "H", "F" and, to a lesser extent, "X" body 2-doors had the worst indirect vision through mirrors, but an explanation for this finding is not evident.

The analysis could readily be extended by surveying particular vehicle model/year owners to increase sample size. Significant differences could then be related to visibility differences identified through precise measurement of direct and indirect field of view.

7. Finding and Operating Horns

The Essex Corporation (1974) study showed that the operating response times of drivers unfamiliar with stalk-mounted horns was significantly poorer than for other horn designs.¹ Also, the percentage of respondents citing problems in operating stalk controls was second highest. Six different horn control designs were evaluated in that study.

In order to test the validity of those findings relative to drivers who regularly operate vehicles with stalk mounted, as well as other types of horn control designs, horn finding and operating responses were analyzed by horn type. Four horn types were considered:

- 1) Two spoke lever/Oldsmobile Cutlass
- 2) Three spoke pushbutton/BMW 2002
- 3) Center/Fiat 124
- 4) Stalk/Capri.

Responses by drivers of these vehicles to Questions 156 and 217 (Finding and Operating Horn) were analyzed by vehicle (horn) type. The results are shown in Table G-4. The data generally supported the findings of that earlier study. Operating problems were most frequent/severe for the stalk-mounted horn on the Capri ($\bar{x} = 1.27$) and lowest on the Fiat 124 ($\bar{x} = 1.00$). Had the Essex study not included a "rim" horn (not represented in the current analysis) the Capri stalk-mounted horn would have been the worst and the Fiat center-horn would have been the best.

It should be noted that finding and operating problems are different for different vehicles. While more drivers had problems finding the Cutlass and Fiat horn, more people had difficulty operating the Capri horn.

¹Essex Corporation, *Effects of Passive Restraint System Design on Horn Control Location and the Location and Operability of Stalk-Mounted Controls*, 1974 (DOT-HS-801-232).

Table G-4

COMPARISON OF HORN FINDING AND OPERATING PROBLEMS FOR SELECTED HORN TYPES

Vehicle (year)	Severity Category						Type Horn
	$\bar{X}$	1	2	3	4	5	
<u>FINDING HORN</u>							
Cutlass (72,73)	1.24	20	4	1	-	-	2-spoke lever
BMW 2002 (A11)	1.10	9	1	-	-	-	3-spoke pushbutton
Fiat 124 (A11)	1.25	6	2	-	-	-	center
Capri (A11)	1.07	28	2	-	-	-	stalk
<u>OPERATING HORN</u>							
Cutlass (72,73)	1.16	21	4	-	-	-	2-spoke lever
BMW 2002 (A11)	1.10	9	1	-	-	-	3-spoke pushbutton
Fiat 124 (A11)	1.00	8	-	-	-	-	center
Capri (A11)	1.27	25	3	1	1	-	stalk

8. Number of Functions on a Stalk

The hypothesis that the greater the number of control functions on a single stalk the greater will be the frequency/severity of problems reported in control operation was advanced on the basis of Essex Corporation (1974) data. They showed that the frequency of reported difficulty in locating or activating controls increased as the number of controls on a stalk increased from one to three.

A sample of vehicles from our data base was selected to represent those having from 2 to 6 functions on a single left stalk. These vehicles and sample sizes were:

<u>Number of Functions</u>	<u>Vehicle/Year</u>	<u>N</u>
2	Datsun B-210/74, 75, 76	20
	Datsun 510/72	10
	Toyota Corolla/71, 72, 73, 74	21
	Toyota Celica/73, 75	9
3	Volvo 145/71	1
	Capri/71, 72, 76	13
4	Granada/75, 76	25
	Capri/ 73, 74	15
	Mustang II/75, 76	8
5	None	
6	Colt/72, 74	7
	Chevette/76	4

Responses to all control finding, reaching, and operating questions were tabulated for each of the above groups and mean scale values were computed. These scale values are shown in Fig. G-5 as a function of the number of stalk control functions. The figure generally supports the results of Essex in that finding, reaching, and operating problem frequency/severity increased as the number of controls on a single stalk increased from 2 to 6. The trend was marked by a large increase for the 3-function sample which was represented almost exclusively by the 1971, 1972, and 1976 Capri; 13 of 14 vehicles in the sample were Capris. A review of responses to individual questions indicated clearly that while responses to most questions were relatively high in severity, the excessively large scale value for the Capri was primarily due to difficulty with the horn.

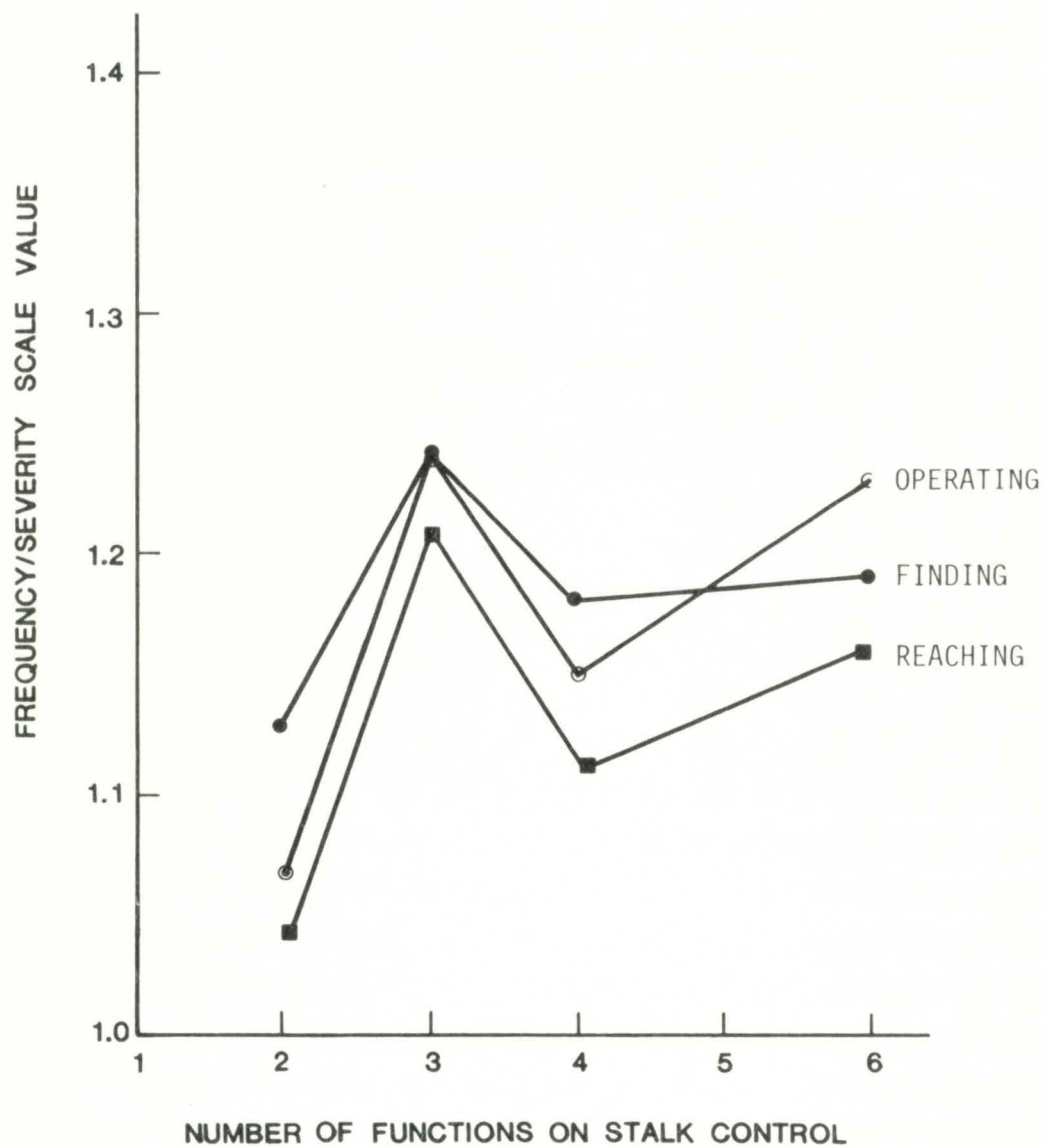


Fig. G-5--Control problems as a function of the number of functions on a stalk

9. Unique Vehicle Model/Year Mismatch Problems

a. Introduction

The purpose of this analysis was to (1) relate specific vehicle model/year(s) to responses for specific questionnaire items, (2) identify low and high severity vehicle/problem combinations, and (3) identify actual design features of those vehicles, where possible, which might account for a particular high or low problem frequency.

b. Data Analysis

Fifteen model/year combinations were selected to be analyzed in terms of responses to 20 survey questions which were selected on the basis of overall severity, interest, and potential feasibility of relating problem with actual hardware design. The 15 model/year combinations and sample size are shown below:

<u>Model</u>	<u>Years</u>	<u>N</u>
Dart	72, 74	31
Aspen	76	16
Pinto	72, 73, 74, 76	76
Maverick	70, 73	25
Granada	75, 76	25
Torino	71, 73	21
LTD	70, 71, 72, 73, 76	71
Mustang II	74	10
Cutlass	72, 73	25
Volare	76	10
Hornet	74	12
Vega	73, 74	22
Nova	71, 72, 73, 74, 76	37
Chevelle	73, 74, 76	25
Monte Carlo	73, 74, 75, 76	23

Only 1970 or newer vehicles and those having a respondent frequency of at least 10 per year were included. Thus, the focus was on newer vehicles which are of greater interest and those having "reasonably" large sample sizes.

The 20 questions were selected using prior analytic results on the basis of (1) overall severity, i.e., those which received the greatest number of problem severity responses, (2) interest or relevance to the overall goals of the study, and (3) potential feasibility of relating problem description to vehicle hardware.

Mean scale values and response distributions to the five category scale for each question were tabulated. Vehicle model/year combinations having a high mean score or a low mean score on each question relative to the overall mean per question were identified. Generally, the lowest and highest two or three scoring vehicles on a question were identified, although occasionally four or five had virtually the same value or only one vehicle was obviously far above or below the others.

c. Results

The results are shown in Table G-5 which illustrates for each question the vehicle model/year having the highest and lowest mean scale value. The higher the score the more severe/frequent the vehicle driver responses to the question. A score of 1.0, for example, means that all respondents checked the "no problem" response category.

1) Overall Model Scores. Model/year(s) most frequently occurring in the "low" score column across the 20 potential mismatch problem questions were the Aspen (nine times), Monte Carlo, and Nova (eight times each) and the Vega and Chevelle (five each). Other vehicles appeared from zero to three times. The Aspen achieved one of the lowest scores on eight of the eleven vision related questions but on none of the six control questions. The low scores of the Monte Carlo and Nova were distributed across all questions. The Aspen, therefore, appeared to be the best model with regard to direct and indirect visibility of those in the sample analyzed.

Model/year(s) most frequently occurring in the "high" score column (indicating poor design) were the Torino (15 times out of a possible 20) and the Mustang II and Hornet (six times each). The Torino obtained one of the highest scores on nine of the eleven vision questions and five of six control questions. The Torino is discussed in greater detail below.

2) Specific Design Problems. The process of relating specific designs of vehicle components which interface with drivers, e.g., mirrors, headlighting, steering, is a very time consuming process, often requiring detailed measurement of the driver/vehicle interaction. With respect to controls, a design problem can be quite obvious even upon superficial inspection of the vehicle. For others, simple inspection is not satisfactory since the interface is complex. This is typical of vision problems. No

Table G-5

VEHICLE MODEL/YEAR RECEIVING HIGHEST AND LOWEST SCALE VALUES
ON TWENTY SURVEY QUESTIONS

Question		Low Values	High Values
111.	Had difficulty seeing far enough ahead with low beam headlights	Aspen (1.50) Cutlass (1.64)	Volare (2.30) Torino (2.14)
115.	Vision limited because of glare from oncoming vehicle headlights	Monte Carlo (1.93) Nova (2.03)	Torino (2.52) Mustang II (2.30)
117.	Vision limited because of sunglare reflected from parts of my car	Aspen (1.25) Hornet (1.33)	Torino (1.76) Volare (1.70)
118.	Vision limited because of glare on my inside mirror	Aspen (1.63) Vega (1.64) Monte Carlo (1.64)	Mustang II (2.20) Torino (2.10)
120.	Vision limited because inside mirror did not give me enough information	Mustang II (1.20) Nova (1.24) Vega (1.27)	Torino (1.81) Hornet (1.83)
121.	Vision limited because left mirror did not give me enough information	Aspen (1.13) Monte Carlo (1.14)	Volare (1.67) Nova (1.59)
123.	Vision limited because it took too long to get information from my mirrors	Aspen (1.13) Vega (1.14) Nova (1.16) Maverick (1.16)	Torino (1.76)
124.	Windshield wipers did not clear quickly or completely	Hornet (1.18)	Vega (1.77) Chevelle (1.68) Torino (1.67) Dart (1.67)
125.	Windshield defogger did not clear quickly or completely	Pinto (1.19)	LTD (1.83) Vega (1.82) Chevelle (1.76) Hornet (1.73)
126.	Vision blocked by post(s)	Volare (1.20) Granada (1.21) Aspen (1.31)	Torino (2.29) LTD (1.88) Maverick (1.84) Hornet (1.83)

Table G-5 (continued)

Question	Low Values	High Values
128. Vision has been blocked by mirrors	Aspen (1.00) Mustang II (1.00)	Torino (1.33) Hornet (1.27) Cutlass (1.24) Dart (1.23)
130. Vision blocked by front seat or front seat head rests	Aspen (1.00) Nova (1.16) Monte Carlo (1.14)	Volare (1.44) Hornet (1.42) Pinto (1.40) Torino (1.38)
140. Steering difficult in strong winds	Aspen (1.13) Cutlass (1.16)	Mustang II (1.70) Vega (1.68)
141. Steering difficult when I tried to stop quickly and skidded	Torino (1.10) Vega (1.14) Monte Carlo (1.14)	Dart (1.53) Mustang II (1.50)
152. Difficulty finding headlight dimmer	Nova (1.05) Chevelle (1.08) Maverick (1.08)	Aspen (1.60) Hornet (1.50)
154. Difficulty finding defogger/de- icer	Vega (1.05) Volare (1.10) Mustang II (1.10)	LTD (1.32) Torino (1.29)
156. Difficulty finding horn	Volare (1.00) Chevelle (1.04)	Torino (1.43) Dart (1.44)
213. Difficulty operating headlight dimmer	Nova (1.03) Monte Carlo (1.07) Chevelle (1.08)	Pinto (2.15) LTD (2.06) Torino (2.05) Granada (2.00)
215. Difficulty operating defogger/ de-icer	Monte Carlo (1.15) Chevelle (1.16) Nova (1.19)	Torino (2.52) Mustang II (2.30) Torino (2.25)
217. Difficulty operating horn	Chevelle (1.00) Monte Carlo (1.00) Nova (1.08)	Torino (1.76) Volare (1.70) Mustang II (1.60)

Aspen driver reported a mirror-blocked vision problem, for example, yet Aspen mirrors appear very similar to those on other vehicles. Thus, if the responses of Aspen drivers truly reflect differences in forward visibility related to mirrors, verification will require complex measurements, beyond the scope of this study.

Aspen drivers (n = 16) reported no problems whatsoever with high headrests and/or seatbacks blocking vision while several Pinto drivers did. The Aspen has a relatively small adjustable headrest which is low when not in use and represents a small obstruction when raised. The Pinto, on the other hand, tends to have a relatively high and wide seatback which is not adjustable.

It would be of considerable interest to compare headrest-blocked vision responses of newer Volvo and Saab drivers since those vehicles have "see-through" headrests.

The Torino obtained the worst scores for finding and operating the horn and the Torino and LTD nearly the worst for operating the headlight dimmer. Inspection of these vehicles clearly indicates the problem. The horn is embedded in a heavily padded horizontal bar across the steering wheel. If it is not depressed in the proper place with sufficient force it simply does not operate.

The headlight dimmer on the Torino and LTD are strategically placed in the far left upper corner of the floor precluding rapid access, and perhaps access whatsoever to short-legged drivers.

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