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Driver Preferences for Secondary Controls

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16. Abstract

The report identifies driver preferences for secondary controls (headlights on/off, horn, etc.). A total of 103 drivers sat in a mockup of a sports car with a "pod like" instrument panel covered with velcro.®

Drivers designed instrument panels by placing the switches they preferred for 24 functions where they wanted them. There were 255 switch designs (stalk controls, pushbuttons, etc.) to choose among. Drivers also identified the motion that should be used to operate each control and provided comments. When the design was complete, drivers reached for each control while operating a driving simulator.

Drivers preferred the stalk position for headlight controls, front wiper and wash, and turn signals. The steering wheel was preferred for cruise controls and the horn, while the lower right dash was selected for hazard. For new controls (suspension adjust, steering adjust) driver preferences for location were not consistent.

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The collection of switches used as secondary controls in this study were crafted by Steve Goldstein, Josh Kerst, Don Ottens, and Dennis Battle. This project clearly benefited from the enormous time (nearly a year) and effort expended in the switch building process.

Don Ottens coordinated the scheduling and completed the testing of drivers and was responsible for seeing the testing completed in near record time. Josh Kerst, Sue Adams and Kris Zeltner all assisted in the data collection procedure. All assistants except Sue Adams, an engineer in the Division, were Industrial Engineering students at the University of Michigan during the study.

Paul Green and Josh Kerst collaborated in the analysis of the driver data, and jointly produced the final report with the help of Sue Adams and Steve Goldstein. Finally, we would like to offer a special word of appreciation to Kris Zeltner for her help in producing the bulk of the figures.

In addition to these, we would like to offer special thanks to John Boreczky, Todd Bos, and Kris Zeltner of the Human Factors Division at UMTRI for their assistance with the videotape demonstrating the data collection procedure.

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EXECUTIVE SUMMARY

Green, Kerst, Ottens, Goldstein, and Adams (1987). Driver Preferences for Secondary Controls (Technical Report UMTRI-87-47). Ann Arbor, Michigan: The University of Michigan Transportation Research Institute, October.

Background and Purpose

The advent of a worldwide automotive economy and increased competitiveness in the industry has forced U.S. automakers to take a hard look at how they design cars. Of particular importance is identifying what the customer wants. The Ford BIC (Best-in-Class) study and the GM Mona Lisa project both represent recent attempts to obtain customer preference data on automotive design by manufacturers. This report concerns Chrysler's effort to obtain information on driver preferences for secondary controls for their future products.

How the Data Were Collected

A total of 103 drivers participated in an experiment carried out at the University of Michigan Transportation Research Institute. Participants were evenly divided among 3 age groups: 18-29 (18 men, 17 women), 30-54 (16 men, 17 women), and 55-78 (18 men, 17 women). Drivers sat in a mockup of a 1985 Chrysler Laser whose instrument panel surface was modified to represent a sports car of the 90's. (It had a "pod-like" design.) All of the interior surfaces where controls could be mounted were covered with VELCRO®. Surrounding the driver were panels on which were mounted 255 different types of switches (stalks controls, pushbuttons, rocker switches, etc.) most of which are found in current production cars. In some cases multiple copies of each switch were provided. All surface-mounted switches had a VELCRO® backing.

Drivers selected the switches they thought should be used for 24 functions (headlights on/off, rear defrost, etc.) for a sports car of the future. Drivers also placed the switches where they thought they belonged and stated how the controls should operate. (This process of constructing a design from parts is analogous to children developing a face with the "Mr. Potatohead" toy.)

After the data were recorded by an experimenter using a computer, drivers were asked to reach for each of the controls while operating a driving simulator. Problems drivers had in using their own design were reviewed with them and drivers were allowed to change their switch preferences.

Subsequently, the process was repeated (but without the driving simulator check) for a second version of the climate control unit. (The first pass was with the current Chrysler horizontal design. The second pass was with a vertical (Berlinetta) design.)

Key Findings

The following table presents a summary of driver preferences by function. When there was no single overwhelmingly popular design, the top two or three most preferred designs are presented.

Condensed Summary of Secondary Control Preferences

FUNCTION	PREFERRED ITEM		
	Zone	Switch	Operation
Aud. Horn	center wheel hub	push surface	push forward
	rt. & left spokes	push surface	push forward
Beam Flash	left stalk	stalk	push forward
	left stalk	stalk	pull towards
Beam Select	left stalk	stalk	push forward
	left stalk	stalk	pull towards
Climate	center of console	horizontal	- not tested
Cruise On	left spoke	rocker	push forward
	left stalk	stalk	push right
Cr.Resume	right spoke	rocker	push forward
	left stalk	stalk	push right
	right spoke	push surface	push forward
Cruise Set	right spoke	rocker	push forward
	left stalk	stalk	push right
	right spoke	push surface	push forward
Dome Light	center roof	rocker	push up
	lower left dash	rocker	push forward
Frt. Wash	right stalk	stalk	push forward
Frt. Wiper	right stalk	stalk	twist left(-Ty)
Hazard Lt.	lower rt. dash	rocker	push forward
Headlights	left stalk	stalk	twist left(-Ty)
	lower left dash	push-pull	push forward
Ignition	rt. side column	- not tested	twist left(-Ty)
	lower rt. dash	- not tested	twist in(Tx)
Panel Lts.	lower left dash	rotary knob	twist in(Tx)
	lower left dash	thumb wheel	twist in(Tx)
Power Lock	forward armrest	- not tested	- not tested
Power Seat	low left seat	- not tested	- not tested
Pwr Window	forward armrest	- not tested	- not tested

FUNCTION	PREFERRED ITEM		
	Zone	Switch	Operation
Radio	top cntr console	- not tested	- not tested
Rear Defog	lower left dash	rocker	push forward
	right side pod	push button	push forward
Rear Wash	lower left dash	rocker	push forward
	right side pod	push button	push forward
Rear Wiper	right side pod	rocker	push forward
	lower left dash	rotary	twist in(Tx)
	lower left dash	push button	push forward
Steer. Adj	lower right dash	rocker	push forward
Suspn. Adj	lower right dash	rocker	push forward
Turn Signl.	left stalk	stalk	push up/down

Designers also need specific information regarding the size, shape, and manufacturer of the switches used in this study to be able to effectively pinpoint preferred design types. A table which contains these data appears later in this report.

Implications for Future Product Designs

The results of this study provide significant customer preference data on individual secondary controls. The main questions addressed by this study have been answered. However given the dynamic nature of the automobile industry and of drivers' preferences, the results may need to be updated in 5-10 years. One question not addressed in this study was why drivers had these specific preferences. By addressing this question more explicitly in subsequent studies, predictions regarding future driver preferences for secondary controls could be made. This will reduce how often exhaustive studies of driver preferences should be conducted, which in turn will reduce product-related research and development costs.

INTRODUCTION

This technical report is the third and final one in a series of three describing research being conducted at the University of Michigan Transportation Research Institute (UMTRI). The purpose of these three reports is to provide the Chrysler Corporation with human factors and other information relating to secondary controls. This information should help Chrysler design easy to use instrument panels for future cars.

A literature review of human factors and secondary controls (Turner & Green, 1987) represents part one of the series. The second report (Green, Ottens and Adams, 1987) describes the switches used in 1986 cars. This final report extends the previous work by investigating driver preferences for types and locations of secondary controls.

The initial report (Turner and Green, 1987) discussed in great detail the human factors literature concerning automobile secondary controls (e.g. headlights, windshield wiper/washer, etc.). The purpose of this literature review was to identify research methods used previously, compare the results of these different methods, and compile a list of design recommendations.

The second report (Green, Ottens, and Adams, 1987) focused on the types of secondary controls found in 1986 production year cars sold in the United States. Specifically, a survey was conducted of nearly all 1986 automobiles sold in the U.S. to gather information concerning instrument panel switch control design, location, and operation. This information proved useful in selecting controls for the preference experiment described in this report.

This final technical report on driver preferences for control types and locations represents the culmination of this series. Preferences were obtained by allowing drivers to actually design and "operate" their own simulated instrument panel. Drivers selected a switch for each function and located it within the mockup vehicle. This report describes how that experiment was carried out and pinpoints driver preferences for secondary controls. More specifically, this final report addresses the following issues:

- What kinds of switches do drivers prefer for secondary controls?
- Where should these secondary controls be located?
- How should these controls operate?
- What comments do drivers have on how controls should be designed?

The literature on driver preferences has been exhaustively reviewed in Turner and Green (1987). Because that review is recent and part of this project, the literature will not be reviewed in detail here. It should suffice to say that there are no studies in the open literature which have comprehensively examined driver preferences for secondary controls. There are, however, several that have examined particular controls or control groups. For example, Mortimer and Post (1973) examined driver preferences for three-beam switching systems. Kuechenmeister (1974) and Mourant, Moussa-Hamouda, and Howard (1977) looked at driver preferences for various stalk control designs. McCallum, Dick, and Casey (1982) looked at driver preferences for pod controls. Two related (and very important) studies are Hallen (1977) concerning what drivers consider to be comfortable reach, and the Callahan (1986a, b, c) description of the Ford Best-In-Class (BIC) research. For those unfamiliar with it, the BIC research involved having engineers and product planners evaluate a list of 400 customer satisfaction features (turn signal lever size, windshield washer switch access, etc.) to determine which cars had the best designs.

From reviewing the literature, the following ideas emerged:

1. As part of the process of identifying preferences for controls, drivers should get a chance to use them. Evidence for this comes from the comments offered in both the Kuechenmeister and Mourant et al. studies.

2. The preference research should be comprehensive, both in terms of the number of functions investigated and the number of switch options drivers can choose between. With regard to the functions investigated, there was no preference data for virtually all secondary controls, so all had to be considered. Regarding switch options, a clear lesson from the Green (1979), Turner and Green (1987), and Green, Ottens, and Adams (1987) studies is that the controls favored by manufacturers change over time. Therefore, the choices examined in an experiment should not be confined to a few switch designs popular at the time an experiment is conducted.

3. In exploring options for future products, it is important that participants in studies be given a context (by giving examples) of what the future will be like. Simply telling them to think about the future is not enough. This idea came from those involved with the BIC study.

With those ideas in mind, the experiment described in the following sections was planned and carried out.

TEST PLAN

People Tested

A total of 109 licensed drivers, 55 men and 54 women, participated in this experiment. The data from 6 people (3 men, 3 women) were not included in the analysis because their data were faulty. Some of those drivers had problems with the simulator (i.e., they didn't complete the driving task). For others the data were incomplete. (Drivers failed to select all the functions presented.) The analysis was therefore based upon the data from 103 drivers. A large majority of those tested (96%) reported they had 20/20 corrected vision. Nearly equal numbers of men and women were selected within each of the following 3 age groups: 18-29 years (18 men, 17 women), 30-54 years (16 men, 17 women), and 55-78 years (18 men, 17 women).

Most older drivers were recruited from lists generated from previous Human Factors Division studies, while some others were recruited upon completion of another on-going study at UMTRI. Many other drivers were recruited from lists generated from another Chrysler project (Schneider, 1987) that dealt with armrest locations using a computer-controlled seating buck. This latter list was especially important because it was stratified by age, sex, and stature, thus helping to assure the testing of an anthropometrically diverse population.

Most people participating in this study lived in the local Ann Arbor-Saline-Ypsilanti (Michigan) area. The combination of these areas represents a broad socio-economic mix of well-educated professionals, blue-collar factory workers, and rural residents. The majority of the participants (65%) drove American made vehicles (25% Ford, 23% General Motors, and 17% Chrysler). Only 10% of the people tested drove European made automobiles, while 25% drove Japanese cars.

The authors want to emphasize that while the experiment was conducted at the University and there were a few students within the sample, the overwhelming majority of the population was not students. The sample used in this experiment is reasonably representative of the U.S. adult population.

Finally, participants were paid $20 for a session, which typically lasted one and one-half hours. The two participants who were videotaped (to record the procedure) were paid an additional $5 since their sessions lasted a bit longer.

Test Methodology

The research described here has been referred to as the "Mr. Potatohead" experiment because of the parallel between the method employed here and the children's toy of the same name. That name has been used both by the authors and the sponsor. The general premise of the toy is to provide a large selection of facial features (eyes, ears, noses, etc.) that could be applied in any combination to an ordinary potato to create a character, Mr. Potatohead. Clever children often experiment with new pieces of their own creation and adjust the facial combinations until they reach the design they desire. The method used here replaces those facial features with switches for secondary controls (i.e., rocker switches, pushbuttons, slide switches, stalks controls, etc.) and the generic potato is now an A to B pillar metal mockup of an automobile. Furthermore, the clever children are replaced by experienced drivers who also have interesting ideas about how their design should look. Although the parallel described above is a simplification of the procedures used in this investigation, the analogy provides a memorable way to easily comprehend the investigation process. While the name may be amusing, the data were collected in a rigorous and scientific manner.

Test Equipment and Materials

The general arrangement of the equipment used in this experiment is shown in Figure 1 and described below. There was a mockup of a sports car, a collection of nearly 1000 switches, a computer system for data acquisition, another computer system to run the driving simulator, and other miscellaneous items.

1985 Chrysler Laser Mockup

All tests were conducted with the driver seated in an A to B pillar metal mockup of a 1985/86 Chrysler Laser. See Figure 2. The car had a finished interior which included a production steering wheel. It should be noted that the mockup was fitted with standard three-point restraint unit, a dome light, and three functional foot pedals. However, at Chrysler's request, a transmission shift lever was not installed. Two Sears model #3950 1/2" drill chucks were mounted one per side on the steering column to accept and allow for movement of any size stalk control. The steering wheel was linked by ropes to elastic shock cords, giving the system a spring-centered feel.

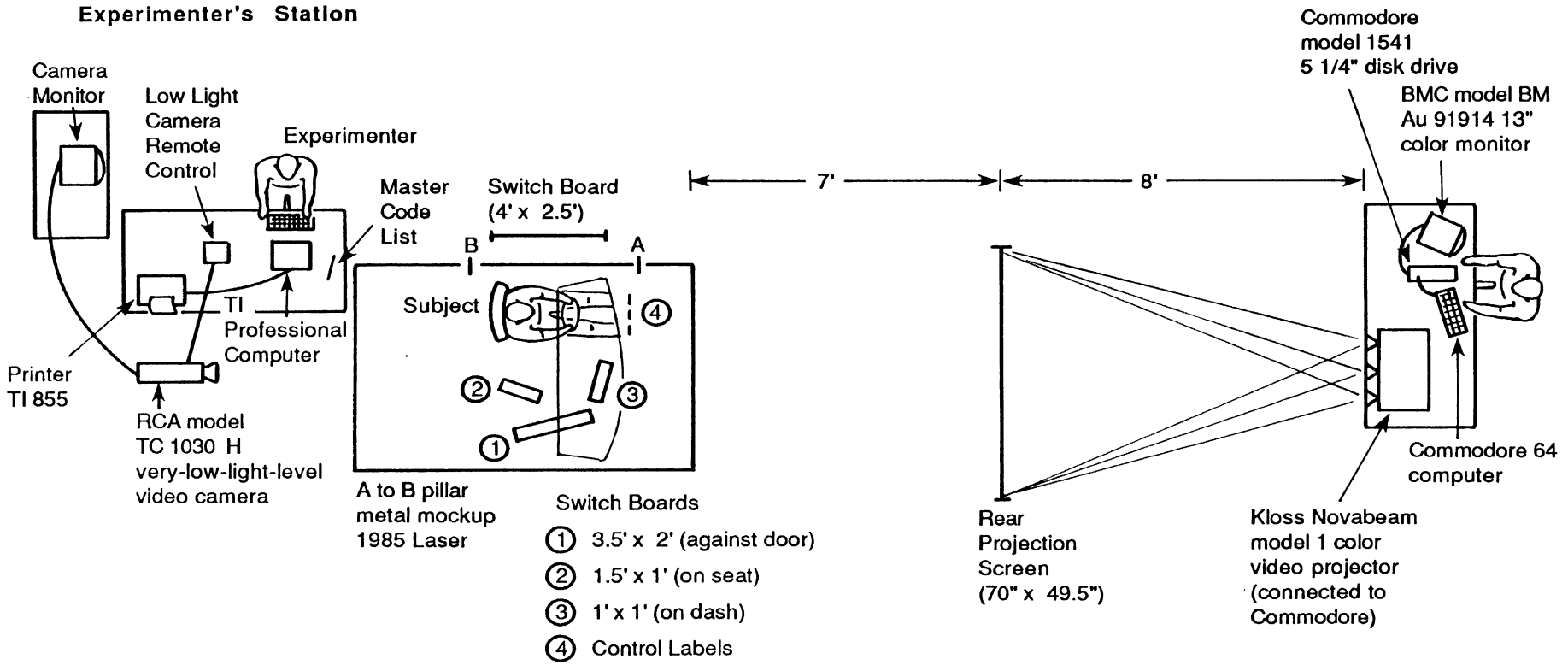


Figure 1, General Arrangement of the Test Equipment

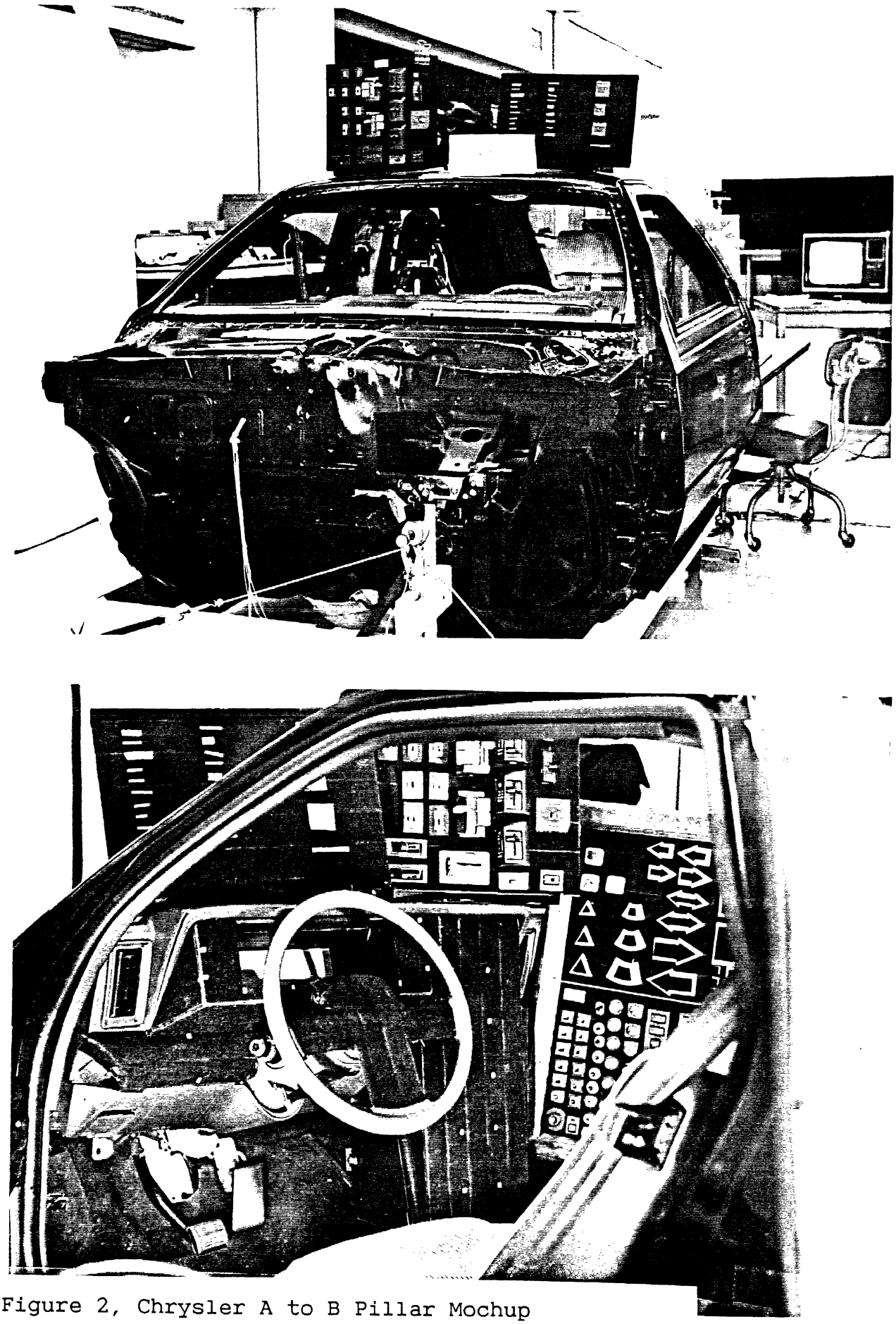


Figure 2, Chrysler A to B Pillar Mochup

Several modifications were made to the dashboard, as per Chrysler's request. These modifications simulated the general, but not specific geometry of the interior of a futuristic sports car package. Foam blocks (pods) covered with VELCRO® were added to the face of the instrument panel, thereby placing sections of the panel within fingertip reach of the 10 and 2 o'clock positions on the steering wheel. In addition, a similar block of foam was added to the center console moving the face aft about two inches on average. See Figures 3 and 4.

The interior of the mockup was partitioned into several regions, and each region was further partitioned into many zones as illustrated in Figure 5. The partitioning followed a standard method that was adopted from Malone et al. (1972). The same basic scheme has subsequently been used by Anacapa Sciences (1976) and Friedman and Schmidtz (1981). These zones are also identical to those used in the second experiment in this series, a survey of secondary controls of 1986 production cars (Green, Ottens, and Adams, 1987). The corners of each zone were marked by white dots on the VELCRO®.

The primary regions included: pods (zones 1-17); lower dashboard (zones 18-20); lower seat (21-22); steering column (24-27); console (zones 31-36, 41-53); door panel (55-58); rear dome light (61-78); and the steering wheel surfaces (81-89). All zones were covered with VELCRO® so that switches selected during the experiment could be mounted quickly and easily.

Switches

A collection of 255 different switches was painstakingly prepared for use as secondary controls. Multiple copies of some switches were provided so that the same switch design could be used for several different functions. Most of these switches were taken from interesting designs uncovered in the survey of 1986 cars (Green et al. 1987), though several were unique prototypes. For example, a collection of push surface switches were created in various shapes (arrows, squares, the arc of a wiper sweep) so as to allow drivers to chose futuristic switches. A complete switch listing appears in Appendix A.

In order to guarantee adequate hand/finger clearance between the switches and to avoid inadvertant operation, most switches were mounted on plexiglass bases. Bases were sized so that switches would have hand/finger clearances between them recommended in Military Standard 1472C (1 inch between hand-operated controls (knobs), 1/2 inch between finger-operated controls (buttons and rocker switches)). In each case it was assumed the clearance would be split between adjacent controls, so knobs had 1/2 inch skirts and buttons 1/4 inch skirts. The VELCRO® backings were glued onto those skirts so the switches could be easily placed on the VELCRO® surfaces within the vehicle mockup.

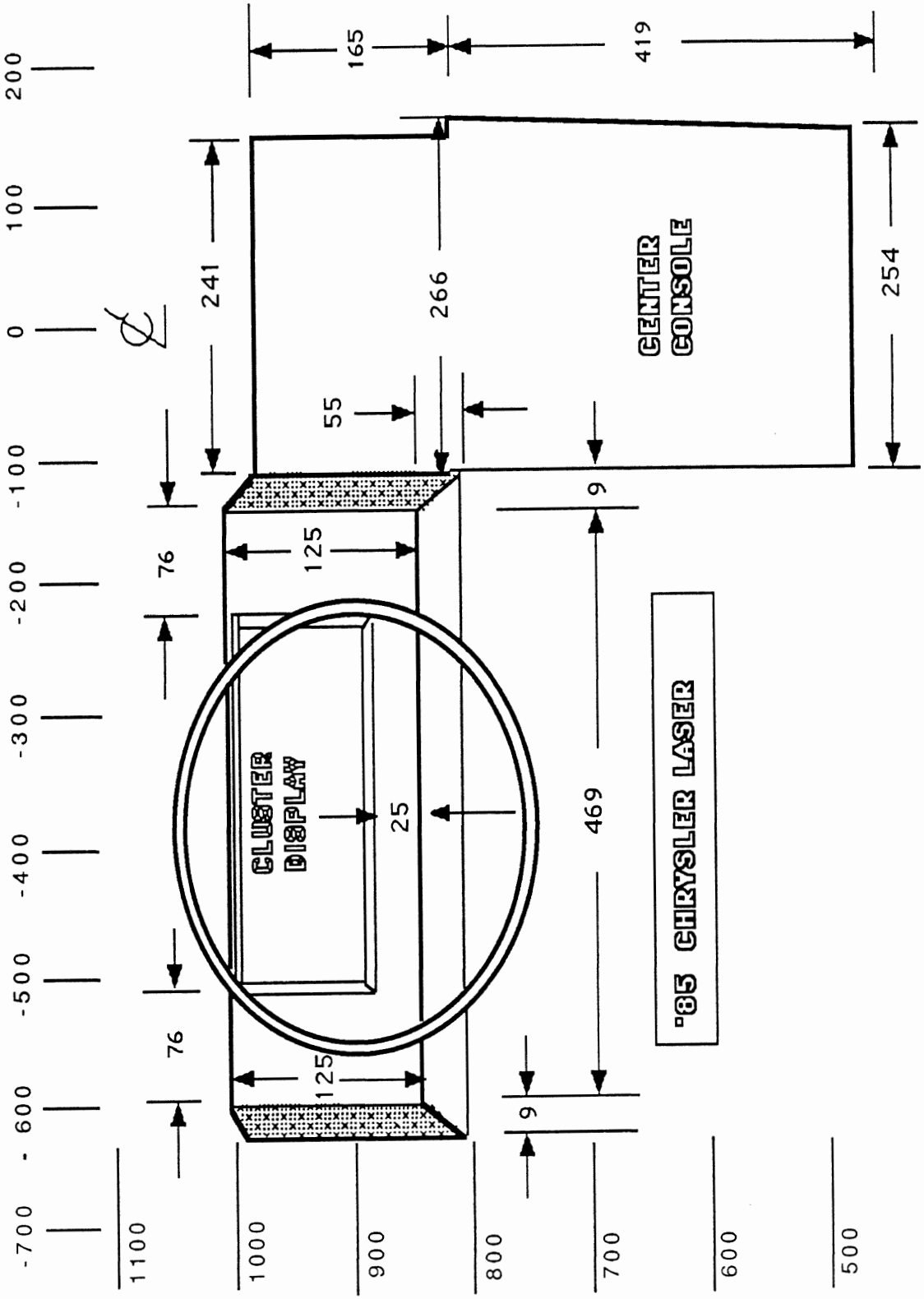


Figure 3, Front View of Instrument Panel
(All measurements in millimeters.)

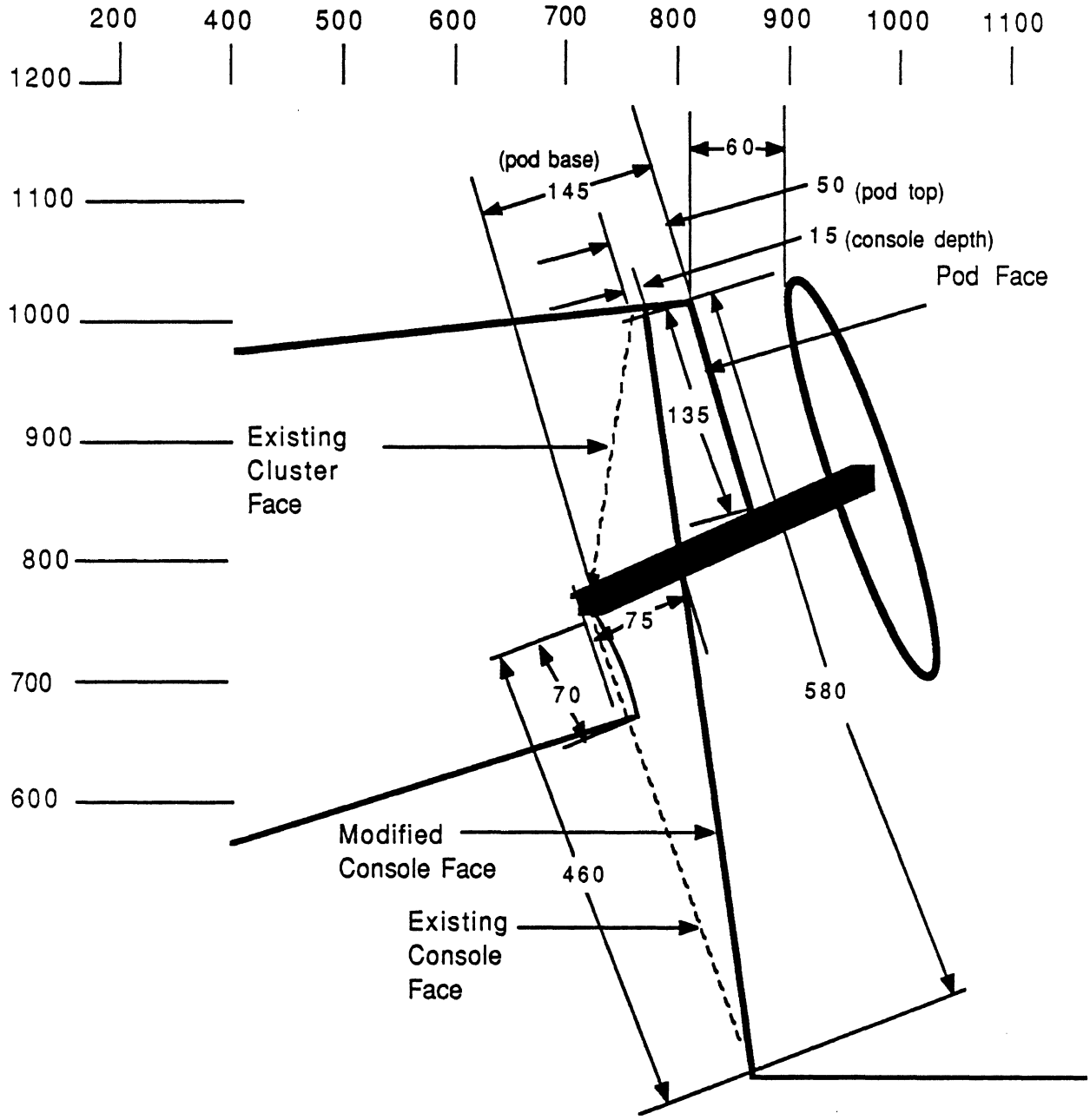


Figure 4, Side View of Instrument Panel
(All measurements in millimeters.)

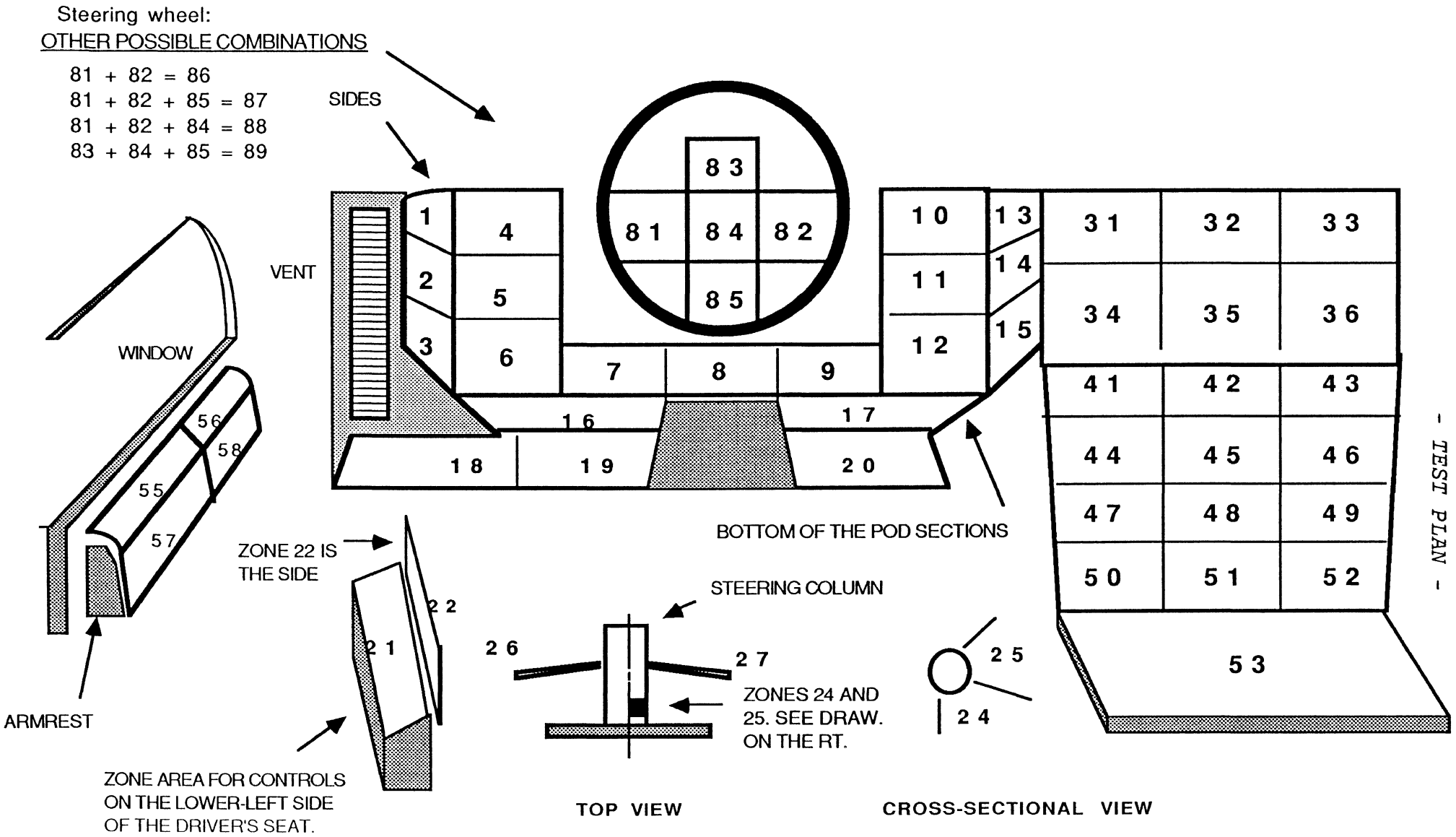
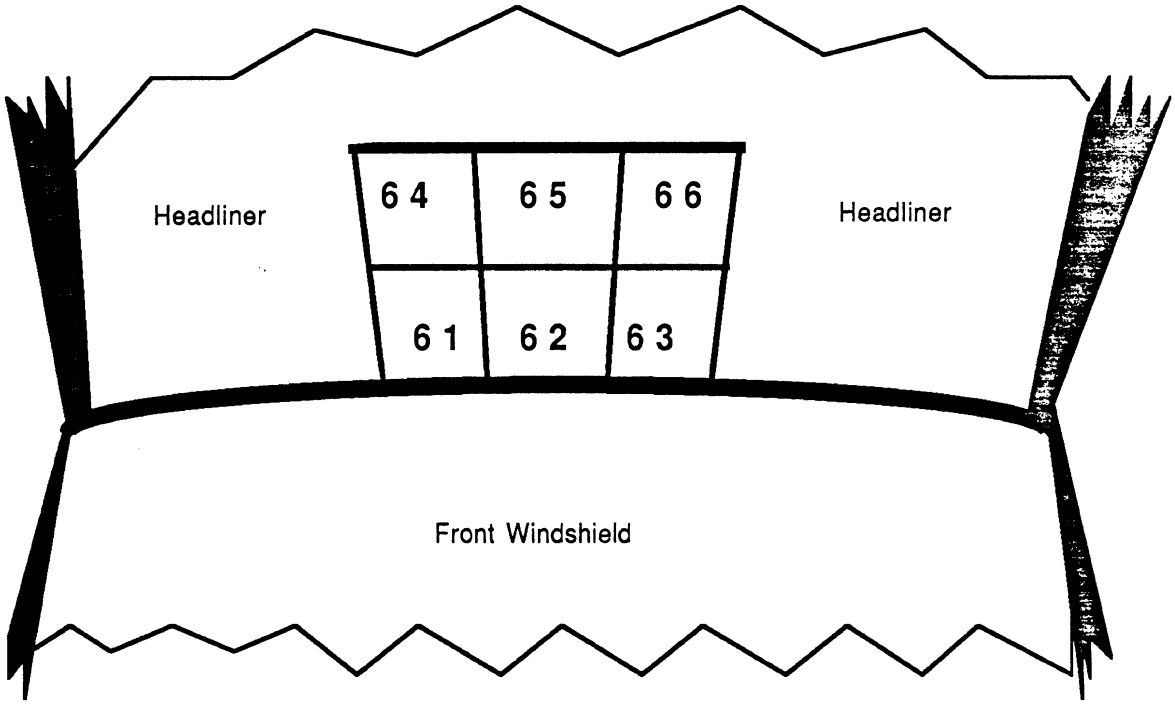


Figure 5, Secondary Controls Zone Chart

The Front Dome Light Switch Locations



The Rear Dome Light Switch Locations

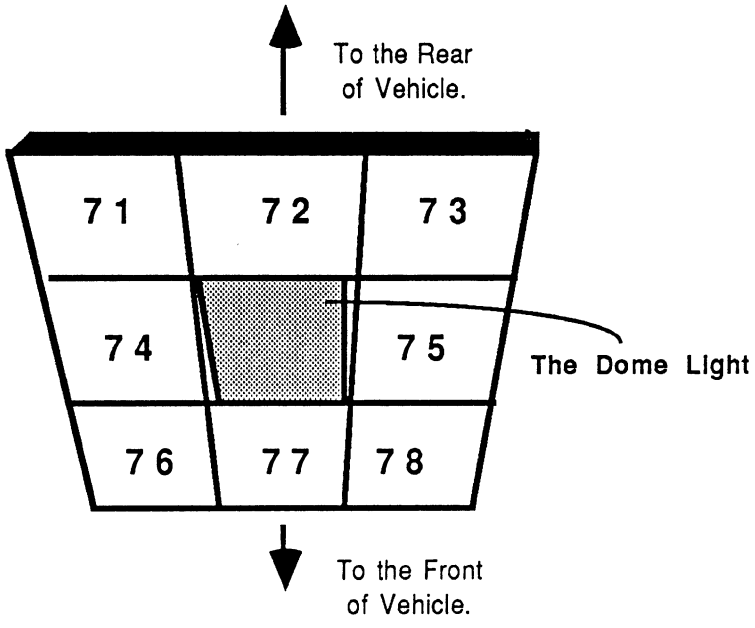


Figure 5, Secondary Controls Zone Chart

Four large boards were used to hold the switches. The boards were positioned in and around the vehicle interior so that the participant could have easy access to the entire collection of approximately 1000 switches. The driver got the feeling of being surrounded by what looked liked a jumbo jet airplane cockpit. See Figure 6. The largest switch board (Figure 7), located by the driver's door, had an extensive collection of rocker switches, thumbwheels, knobs, and stalks. The medium sized switch board (Figure 8), positioned on the passenger seat and leaning against the passenger's door, contained a large collection of push surfaces, and push buttons, as well as two styles of climate controls. Two smaller boards (on the seat and on the instrument panel above the console (Figure 9) contained other miscellaneous switches. A fifth board containing the secondary control function labels was located directly in front of the participant.

Figure 6, Driver Surrounded by Switches

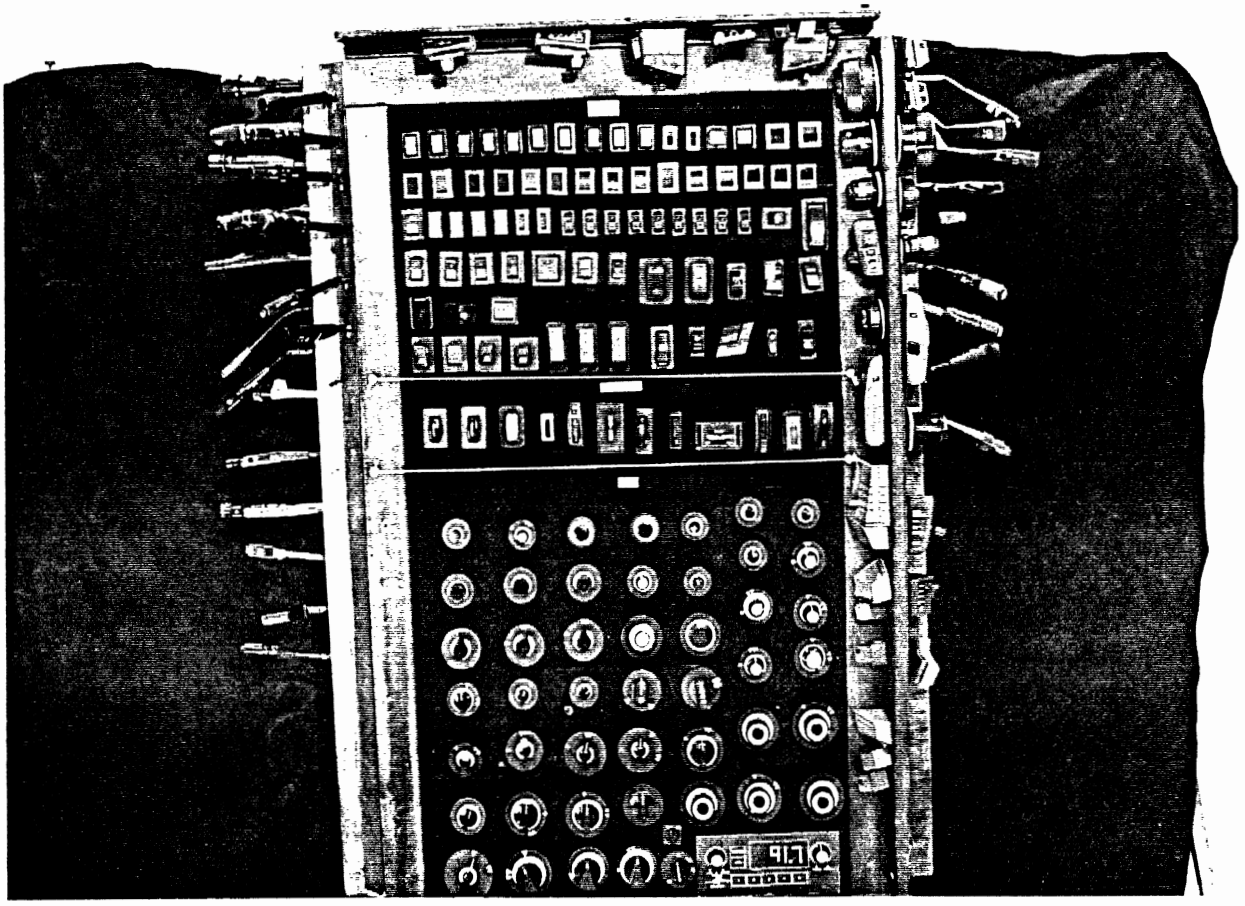


Figure 7, Large Switch Board

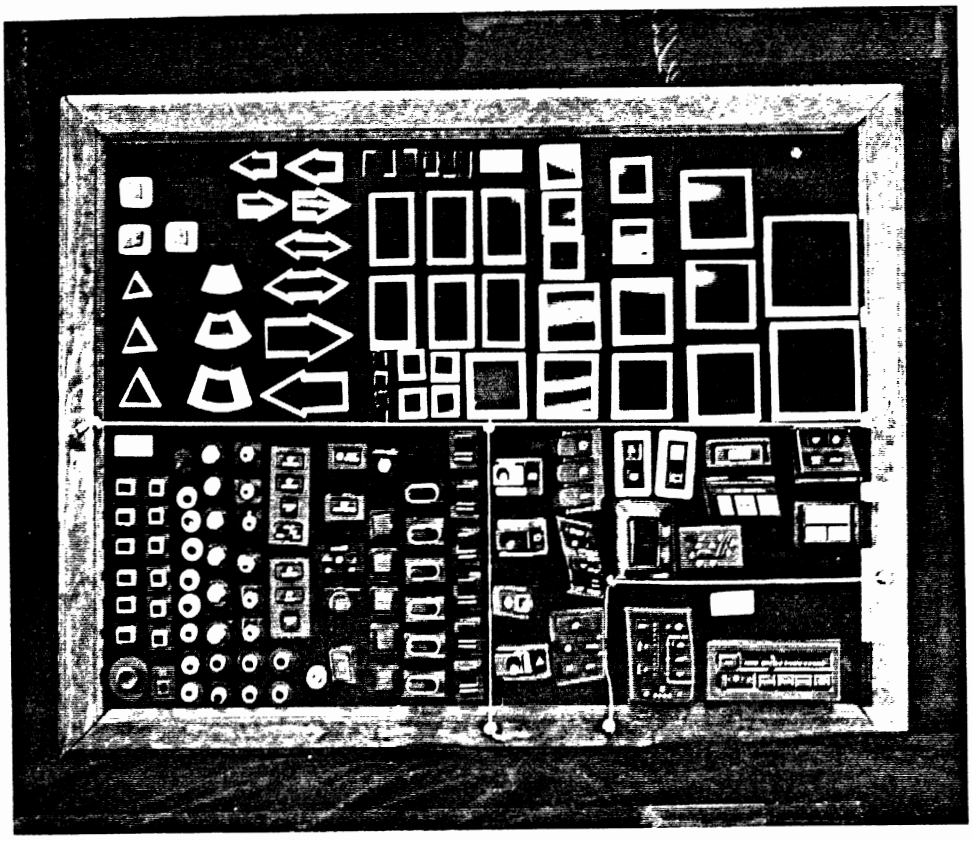


Figure 8, Medium Switch Board

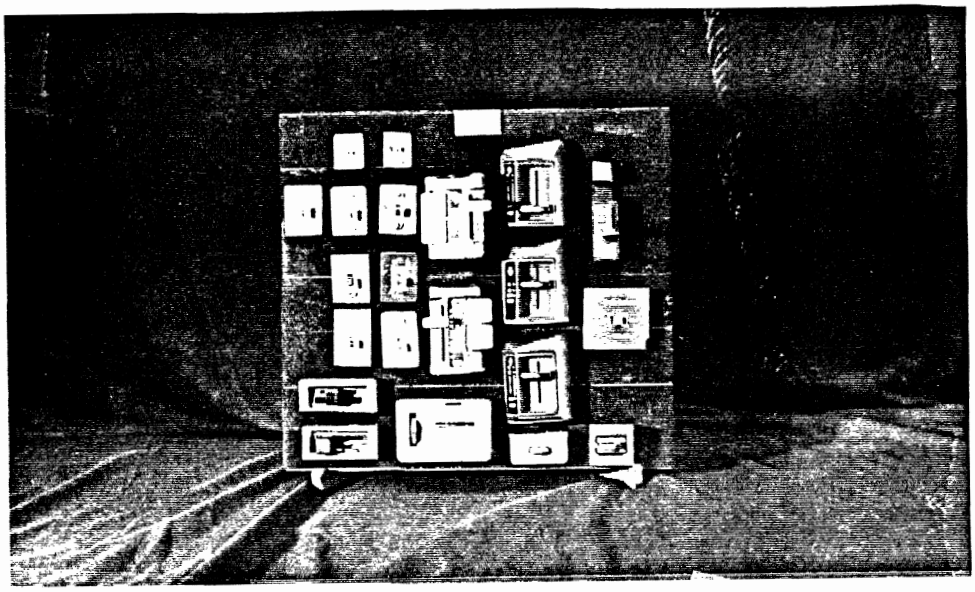


Figure 9, Small Switch Board

Computer for Recording Preferences

The experimenter recorded the participant responses (comments, preferences for switch, location, and method of operation) on a Texas Instruments Professional Computer (shown in Figure 10) using a custom data collection routine written in BASIC by the first author. In real time, the software caught many errors made by the experimenter (entering nonexistent zone numbers and method of operation codes, mismatches between switch type and number, etc.) This quality control procedure reduced the data entry error rate to far below what it would have been had the data been collected using paper and pencil.

Coding Forms

A Master Code List was placed next to the Texas Instruments computer to help in the data entry procedure. This Master Code List consisted of a Switch Number List, a Zone Diagram, and a Method of Operation Table.

The Switch Number List identified both the type (rocker, pod, etc.) and identification number of each of the 255 switches available. See Appendix A.

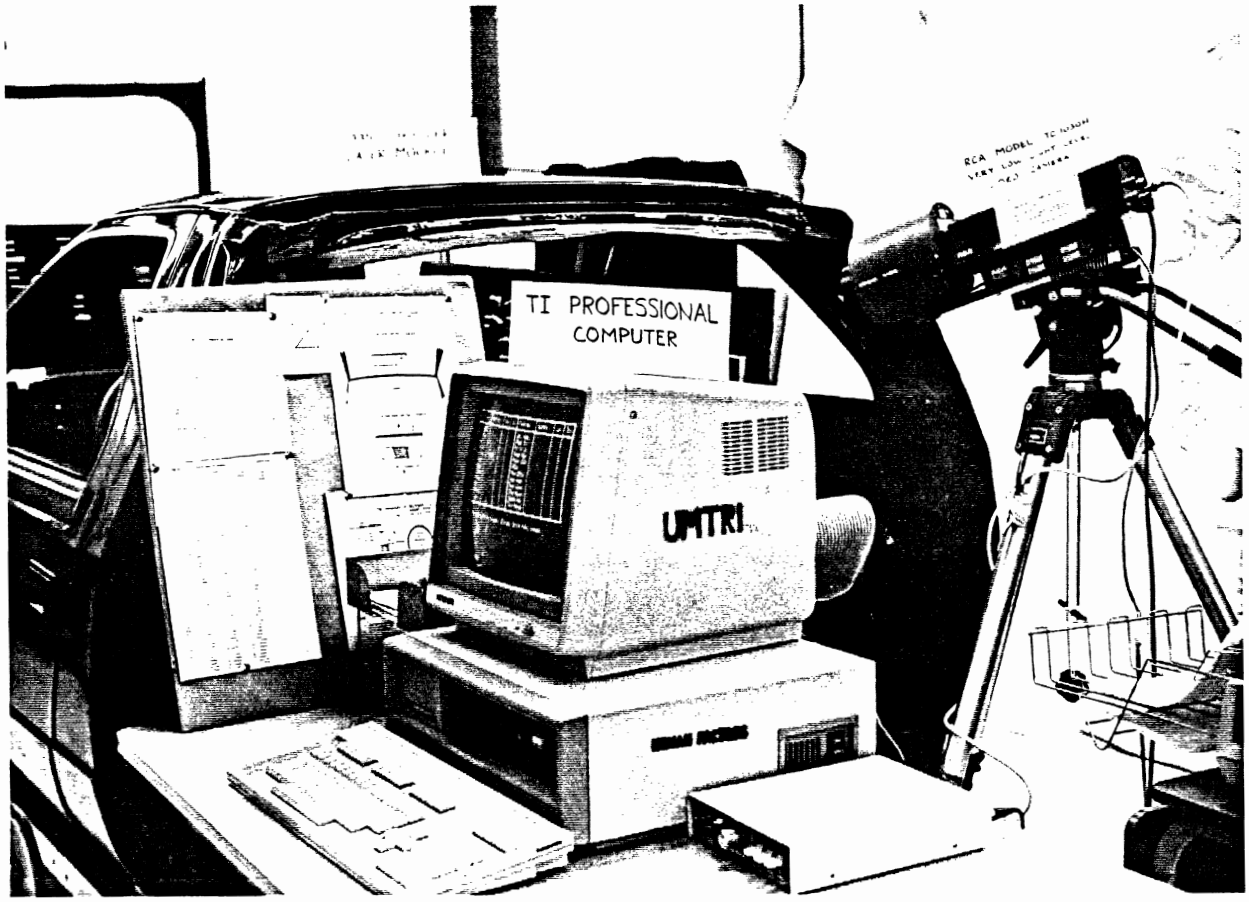


Figure 10, Texas Instruments Computer System Hardware

The Zone Diagram, described in the mockup section, assigned zone numbers to specific regions where secondary controls could have been placed within the mockup vehicle. The Method of Operation Table identified the direction of the force or torque participants used to operate a control. It should be noted that all directions were relative to the vehicle and not the specific surface on which a control was to be mounted. The Method of Operation Table and figure below apply to a driver comfortably seated in the mockup applying the right-hand rule.

Table 1, Method of Operation Codes

#	Vector	Motion Name	#	Vector	Motion Name
1	Fx	push in	13	Tx	twist in
2	Fy	push right	14	Ty	twist right
3	Fz	push up	15	Tz	twist up
4	-Fx	pull out	16	-Tx	twist out
5	-Fy	push left	17	-Ty	twist left
6	-Fz	push down	18	-Tz	twist down
7	+/-Fx	push in/pull out	19	+/-Tx	twist in/out
8	+/-Fy	push right/left	20	+/-Ty	twist right/left
9	+/-Fz	push up/down	21	+/-Tz	twist up/down
10	Fx&y	push/pull in/out, left/rt.	22	Tx&y	twist in/out, left/rt.
11	Fx&z	push/pull in/out, up/down	23	Tx&z	twist in/out, up/down
12	Fy&z	push/pull left/rt., up/down	24	Ty&z	twist left/rt.,up/down

25 force not along axis
26 torque not along axis
27 multiple (twist & push)
99 not fitted

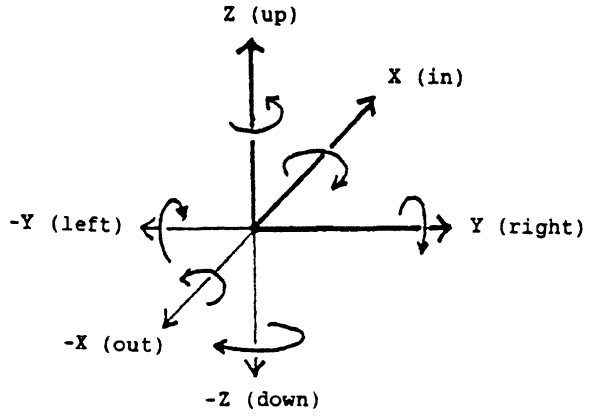


Figure 11, Method of Operation Vectors and Torques

Driving Simulator

A Commodore 64 computer was connected to a Kloss Novabeam Model 1 color video projector to generate the simulated road scene. An UMTRI-developed proprietary assembly language program loaded by a BASIC language I/O program generated the road image. A color monitor used with the Commodore computer displayed a duplicate copy of the road scene to the experimenter. Figure 12 shows this arrangement.

Figure 12, Driving Simulator Equipment

The road scene was projected onto a four foot by six foot screen in front of the vehicle. Six pairs of rectangles simulated road edge markers for a single-lane road as it would appear at night. See Figure 13. The tests were conducted in a windowless room with the lights off to simulate night driving. Some illumination was provided by two fluorescent lamps located at each door of the mockup, the experimenter's worklight located behind the screen, and the scatter from the projection video display.

Miscellaneous

An RCA model TC1030 low light-level video camera was located behind the driver's seat and was connected to Panasonic 13 inch color video monitor (model CT-1320M) and a camera control box. The monitor was positioned so that the experimenter could clearly see the actions of the driver, because the experimenter's vision of the right side of the instrument panel was normally blocked by the back of the vehicle. In addition, the box was used to remotely control the camera zoom and focus.

Experimenters were provided with a complete set of instructions to ensure uniformity in the testing process. This instruction set included a sample experimenter dialogue and the experimental procedure. A copy appears in Appendix B. Upon conclusion of the testing, a 35mm camera was used to photograph the driver's design. A rear view and a right side shot were taken with a driver nameplate (name, run number, and date) in clear view so the design could be later identified. Photos for two typical and two unusual designs appear in the Appendix C.

Test Activities and Their Sequence

Each driver was recruited either by phone or in person using the instructions in Appendix D. One test session was conducted for each driver. Test session durations typically ranged from 1 to 2 hours with a mean of 1.5 hours. This would appear to be a prohibitively long period of time to be seated in a vehicle; however, drivers spent much of the time thinking and positioning the switches. There was little idle time to allow the driver to be bored, and in fact, most people said it was an interesting and enjoyable experience.

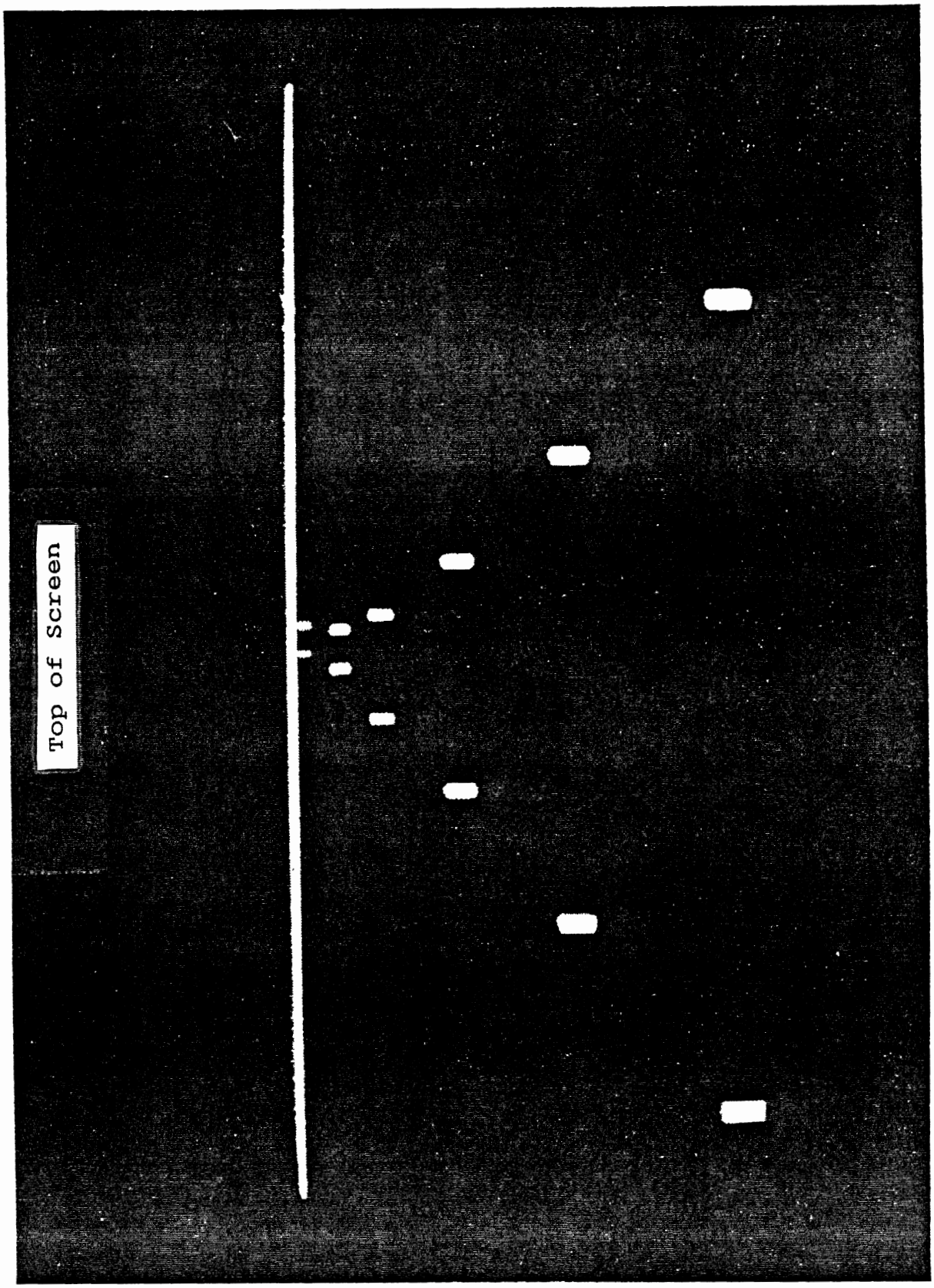


Figure 13, Picture of the Simulated Road

The experimenter began by outlining the experimental procedure. The participant then provided the background information requested on the standard form found in Appendix E. This information was useful in identifying the participant's driving experience, eyesight, types of secondary controls used, and vehicle driven most often. A listing of the vehicles people reported they drove appears in Appendix F.

The participant then adjusted the driver's seat of the mockup vehicle and fastened the seatbelt. Next, the experimenter explained the list of 24 functions (Table 2) by giving examples of how each control was operated. (The 24 functions tested were selected by Chrysler.) Two alternative configurations of the climate control function were used, horizontal (standard Chrysler cluster) and vertical ('85 Berlinetta), in two separate phases of the experiment. During phase 1, the participant used the horizontal climate control in the development of an instrument panel design. In phase 2 the participant replaced the horizontal design with the vertical climate control and modified the instrument panel design where necessary. This procedure tested a hypothesis that drivers would position the vertical climate control on the right side pod. This hypothesis was not supported by the data.

Table 2. List of the Secondary Controls Tested

1. Auditory Horn	13. Optical Horn
2. Beam Select	14. Panel Brightness
3. Climate Control	15. Power Door Lock
4. Cruise Control On/Off	16. Power Seat
5. Cruise Control Resume	17. Power Window
6. Cruise Control Set	18. Radio
7. Dome Light	19. Rear Defrost
8. Front Washer	20. Rear Windshield Wash
9. Front Windshield Wiper	21. Rear Windshield Wiper
10. Hazard Lights	22. Steering Adjustment
11. Headlights	23. Suspension Adjust
12. Ignition	24. Turn Signal

The experimenter described the various switches available, both verbally and by demonstration. Participants were instructed not to feel restricted to select certain switches due to switch labeling or color (i.e. a red switch labeled "hazard") but to select switches based on their shape and functionality (i.e., a round push button). Additionally, multiple switches were allowed for one function (i.e., one switch to turn a control on and one to turn it off) and multiple functions were allowed for one switch.

Furthermore, participants were told that they would be designing a dashboard for cars of the 1990's. To put them in the proper frame of mind, participants were then told about some of the technology that would be available during this period. "Anti-lock braking systems and 4-wheel steering will be available on all American built automobiles." "Compact disc players for cars will be old-fashioned." This method indeed helped drivers to think in a future context and they frequently commented so (e.g."Future cars require a better location for this control."). Furthermore, the method was highly recommended by the research team at Ford that conducted the BIC study (Callahan, 1986a, b, c).

With these preliminary steps completed, the participant proceeded to select switches for the function labels in any order and to place them on the VELCRO ® surfaces within the mockup. The type, location, and the method of operation of the switch selected were recorded on the Texas Instruments Personal Computer. The experimenter also recorded the participants' comments on any special features that they might desire in such a futuristic automobile. For example, "The seek-and-scan features of the radio should be on the wheel."

After the participant had completed this procedure it was explained that they would perform a driving task while reaching for specific controls when asked to do so by the experimenter. The driving task, utilizing participant designs, represented a critical step never employed before in secondary control preference experiments. This step forced drivers to realize that aesthetically appealing designs may not be easy to use. Further, one can't make a good judgement about a design's ease-of-use without first using it, a position supported by the data.

The experimenter then conducted a trial run of the driving simulation task. The participant completed as many one-minute practice trials as needed to feel comfortable with the driving simulator. During these trials, the driver was given feedback by the experimenter as to how well he or she was steering. When participants had difficulty, the experimenter stood next to the car and told the participant which way to turn the wheel.

After the participant felt comfortable with the driving simulator, he or she participated in one ten minute driving trial. A ten-minute time period was selected because it was sufficient to cover the entire list of secondary control activities. During this session, the participant was asked to operate each of the secondary controls he or she had selected. Although there was no formal error collection, the experimenter made note of any difficulties the participant may have had operating or locating the switches. The order in which these controls were operated appears in the instructions in Appendix B.

After the driving session, participants were encouraged to discuss any problems they experienced while using any of the controls. The experimenter used the list of problems to probe drivers if there were any changes to be made in the design. This discussion typically led to modification of the original dashboard design. Quite often those changes involved replacement of similarly shaped and spaced switches which had caused mistakes while driving. Changes were also made because some controls were hard to reach, awkward to operate, or people had forgotten where they put them. All changes were recorded by the experimenter using the software running on the Texas Instruments computer.

The participant was then instructed to remove the horizontal climate control and replace it with the vertical climate control. The participant was allowed to place the climate control in any of the permitted zones, and was also allowed to change the position or type of any of the other controls. These changes were also recorded by the experimenter on the Texas Instruments computer. Since the basic design was typically not greatly modified, and to save time, no driving session was conducted using this new configuration.

Upon completion of the test session, the driver was paid and thanked for his or her contribution to the research.

Exact text of the instructions given can be found in Appendix B.

RESULTS AND DISCUSSION

The material in this section is grouped into three sections: an examination of the differences in control preferences due to age and sex of those responding, the detailed preferences for each control, and a more global view of control preferences. Most of the preference data are grouped by control with a four page subsection containing both the descriptive figures and explanatory text. In each case preferences for location, switch type, and method of operation are provided.

Response Differences Due to Age and Sex

A major question in this study was if the age or sex of those people in the sample had an effect on the results of this experiment. (Did men want controls in different places than women? Did older people have different preferences than middle-aged or younger drivers?) These issues were only examined for preferences for control location. It was assumed that if the preferences for location were identical, then the preferences for switch type, etc., would be also.

To examine these issues, Chi-square statistics were computed for the location preferences for each control. Comparisons were made for men versus women, the three age groups (18-29 versus 30-54 versus 55-78) and the six cells formed by all possible combinations of those two factors (e.g., young women, etc.). In all, 72 Chi-square statistics were computed (24 controls times 3 dimensions). Typically in these analyses a finding is "significant" if the probability the of the outcome being chance was less than .05 (1 out of 20). Here, with 72 tests one would expect that to occur almost four times on average. Somewhat less common is use of the .1 or "engineering" level of significance.

Shown in Table 3 are all those instances where significance was achieved at the .1 level or less (1 out of 10 by chance) for at least one of the three tests for each control. Only 12 of the 72 tests showed significance, just slightly above the seven one would expect by chance. In brief, the results of this analysis show very clearly that there were very few deviations in positional preferences due to sex, age, or the combination of both. Most of those represent chance occurances.

Table 3, Significant Variations Due to Sex, Age or Both

Control Type	- Chi-Square Significance - Sex	Age	Age*Sex
Climate Control	.135	.211	.067 +
Cruise Control On	.184	.139	.064 +
Cruise Resume	.407	.080 +	.235
Ignition	.640	.095 +	.167
Radio	.312	.009 **	.046 *
Rear Defrost	.019 *	.077 +	.010 *
Rear Washer	.140	.229	.047 *
Rear Wiper	.027 *	.277	.090 +

Key: + $p < .1$ - Possibly Significant
* $p < .05$ - Statistically Significant
** $p < .01$ - Very Significant

For four controls (radio, rear defroster and rear wiper and rear washer), age, sex, or both affect the preferences people have for those controls. For four other controls it is possible those factors affect driver preferences but the outcome of the statistical tests is unclear.

The location of the radio represents one item that was clearly affected by differences in age and also by the joint interaction of age and sex. For the radio, both the age dimension ($p < .009$) and the age by sex interaction ($p < .046$) were significant. Further analysis of these data indicated that young people (18-29) preferred to have the radio positioned as high as possible on the center console (zone 32) probably because younger people are observed to change between radio stations more frequently than older people. In comparison, middle aged and older people placed the radio much lower on the center console (zone 42 and 35). Drivers commented that this high placement of the radio made it easier for them to operate the radio and still concentrate on the road ahead. It was suggested that the lower placement of the radio by the older participants was due to vision problems (i.e. bifocals), however the researchers observed that the placement of the radio was primarily determined by reach. Unlike the difference due to age, the age by sex interaction is difficult to interpret.

For the rear window defrost and rear wiper controls (and almost for the rear washer) there were statistically significant differences between men and women. Men typically wanted these controls on the right pod or floor console (zones 11, 53) while women wanted them on the lower left dash. The authors have no idea why this difference occurred.

There were four other controls that did show some possibly significant differences due to sex, age, or a combination of both (climate control, ignition, cruise control on and cruise

resume functions). There was a tendency for younger drivers to want the cruise control functions mounted on the steering wheel while the older drivers wanted them mounted on the left stalk. This tendency may reflect expectancies drivers have; expectancies based upon what they drive now. A listing of those vehicles for each participant sex appears in Appendix F.

Because so few tests were significant, it appears that there were very few variations in preferences between men and women or those associated with their age. For that reason all of the data were pooled across age and sex for further analysis. It is important that the reader not be confused by these findings. People of different ages and sexes have pronounced preferences for different car types (for example, younger people gravitate to sports cars while luxury cars are preferred by older individuals) but when preferences are confined to the location of controls in a particular vehicle body style, there are very few differences.

Results by Control

Because there were so few differences between groups in the sample, the data were pooled for further analysis. In this section results are grouped by control. Each group of four pages contains the following:

1. Text which briefly describes the results of interest for the given switch type, including relevant driver comments.

2. A figure which displays the percent of the participants who placed a switch for a given switch type in a certain zone by a scaled dot.

3. A table displaying the percent of the participants who chose a specific switch type (i.e., push button, toggle switch) for a given instrument panel function.

4. A table displaying the percent of the participants who chose a given method of operation (i.e., push in, turn right) for a given instrument panel function.

The instrument panel zones referenced in the "Results and Discussion" section can be found in Figure 3. A list of the Method of Operation Codes is presented in Table 1. Figures and tables are grouped so that the text is always on the left side of a pair of pages and the figures are always on the right.

The results are presented in easy to use figures that utilize varying sizes of dots to indicate preference levels. The dots shown in Figure 14 represent the percent of switches in a given location. The larger the size of the dot, the larger the percentage it represents. To help pinpoint preferred locations, the highest percentage area is represented

by an encircled block "M" called the "M dot" (as in Maximum (or Michigan)).

A brief explanation of how to read the figures and tables effectively will be presented by walking through the summary statistics for the dome light control.

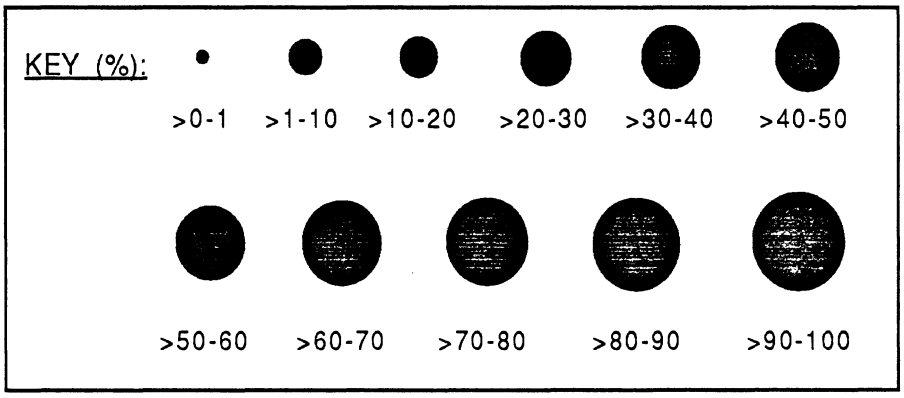


Figure 14, Dot Percentages Scaling Key

Dome Light

The dome light figure indicates the forward center zone (zone 77) of the roof region that surrounds the dome light as the location most frequently chosen (17.6%) for the dome light switch and is therefore identified by the "M" dot. The second most preferred location is the lower left dash position (zone 18) which accounted for 14.7% of the total.

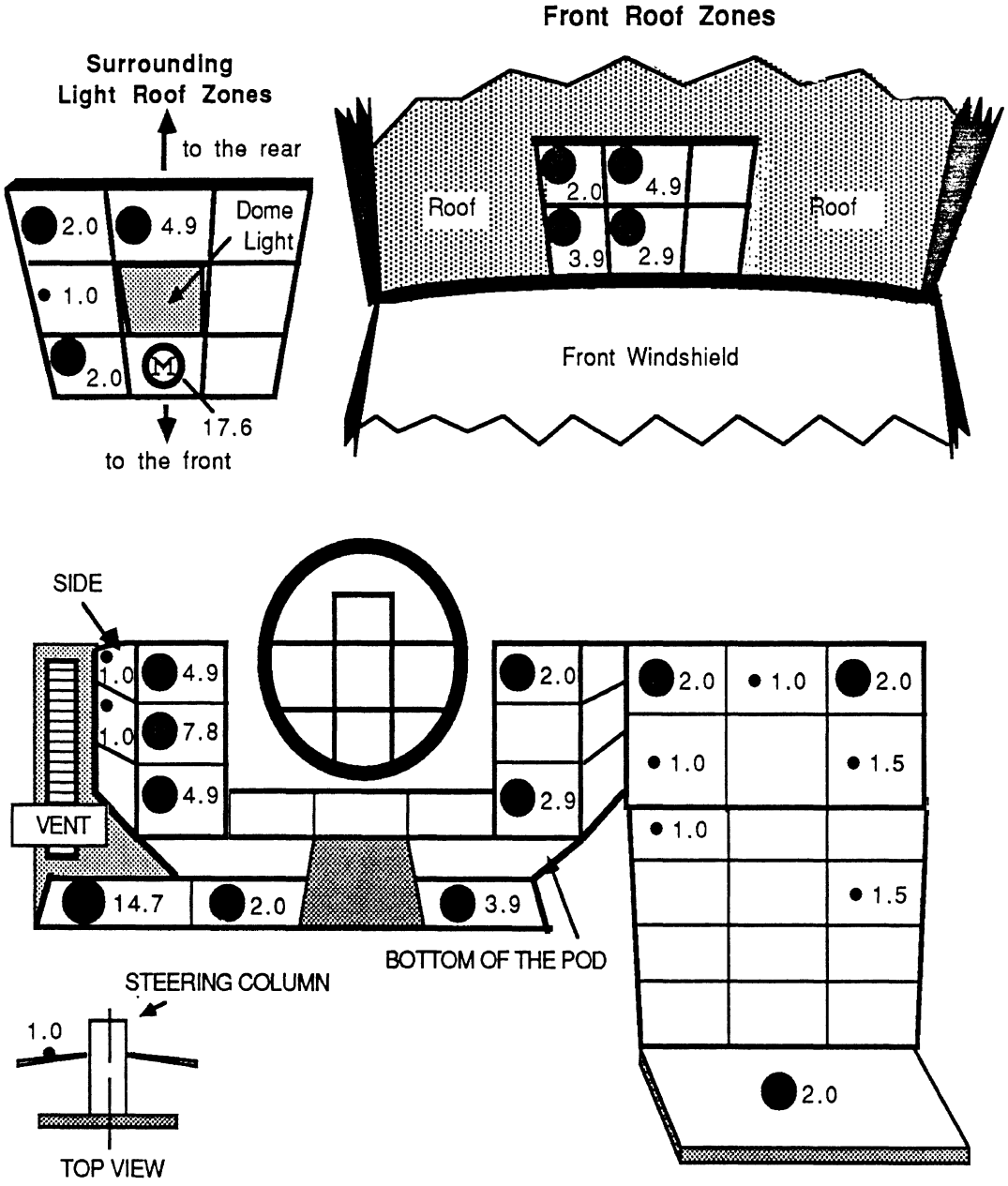
As can be seen, most drivers (41.2%) preferred to control the dome light using a two-position rocker switch. The second most selected switch type was a push button (14.7%), while a push-pull switch (10.8%), typically associated with the headlight control,was third.

The Method of Operation table indicates the directions preferred for operating secondary controls. Two preferred methods of operation stand out for the dome light control: pushing in (41.2%) which was typically associated with the control mounted on the instrument panel, as well as pushing up (36.3%) which was used with the dome light control located in the roof position.

Relevant comments for this switch included: four people who suggested that the dome light switch click before the light turns on. One person felt that he should be able to "push the switch to the desired brightness," and another felt that the dome light should automatically dim within five seconds of activation.

DOME LIGHT

Location (% of switches in given location)



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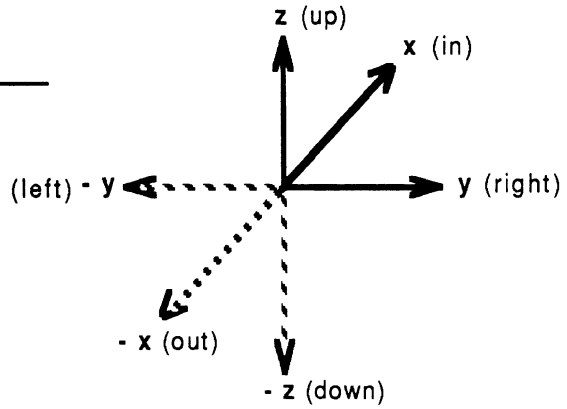
DOME LIGHT

Switch Type (% of switches that are a given type)

%	Switch Type
41.2	two-way rocker
14.7	push button switch
10.8	push-pull switch
9.8	slide switch
8.8	rotary knob
4.9	push surface switch
3.9	thumbwheel switch
2.9	toggle switch
2.0	combination switch
1.0	stalk

Method of Operation (% of switches operated using given method)

%	Method of Operation
36.6	Fx
29.7	Fz
11.9	Tx
7.9	Fy
5.9	-Tx
3.0	-Fx
2.0	+/-Fy
2.0	Tz
1.0	-Fz



(axes relative to driver)

Auditory Horn

Preferred locations for the auditory horn were consistently centered around the steering wheel. In fact, 98% of those tested put the auditory horn somewhere on the steering wheel, with the single most preferred location (37.3%) directly on the center hub (zone 84). This position was followed closely by a combination of the left and right spokes (zones 81 + 82, 26.5%). Only one person put the horn on the stalk mechanism. Further, many drivers indicated without prompting that a very unfavorable position for the horn switch was a stalk mounting.

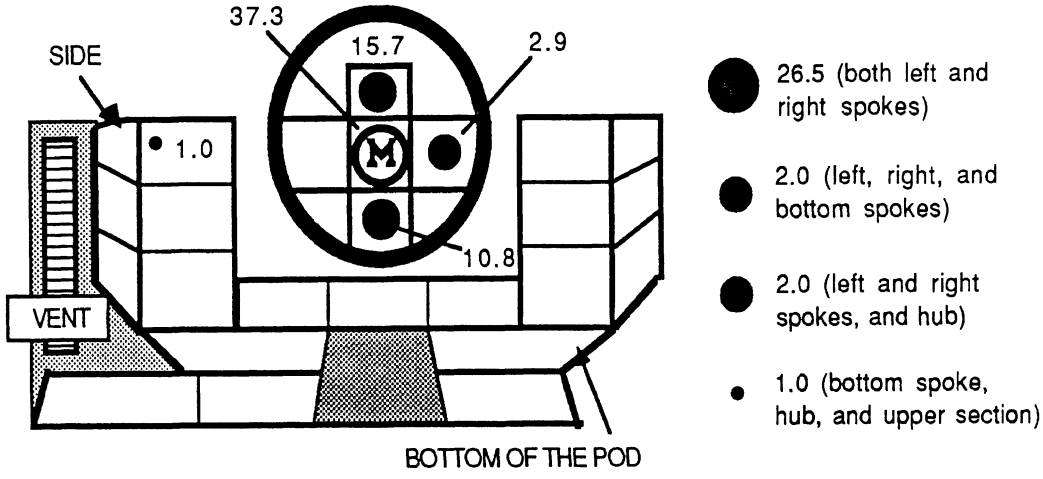
The type of switch that was consistently selected to operate the horn was a large (see Appendix G) push surface (90.2%). A small percentage (8.8%) preferred push buttons and only one person liked a stalk mechanism.

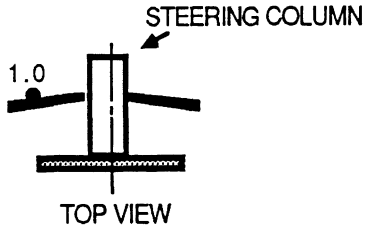
Virtually all the drivers preferred to operate the horn control by pushing in (forward).

Comments for the auditory horn included five people who felt that there should be two push surface switches for this function, and three who commented that the horn switch should be flush with the wheel. Further, five drivers commented regarding the size of the auditory horn switch. Three chose a small switch to avoid accidentally hitting the horn, while two others chose large switches so that they would be easy to find and hit.

AUDITORY HORN

Location (% of switches in given location)





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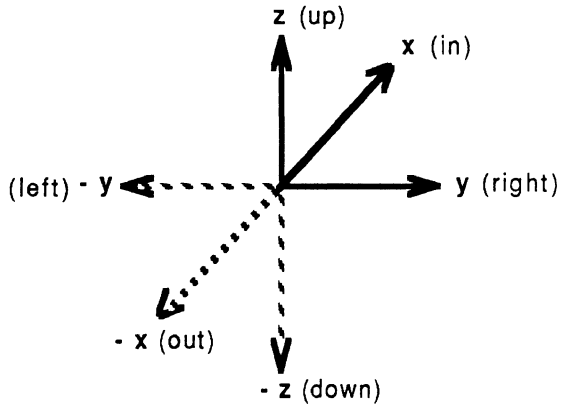
AUDITORY HORN

Switch Type (% of switches that are a given type)

%	Switch Type
90.2	push surface
8.8	push button
1.0	stalk

Method of Operation (% of switches operated using given method)

%	Method of Operation
99.0	Fx
1.0	Fy



(axes relative to driver)

Beam Select

The location most preferred (60.8%) for the headlight beam select control was the left stalk position (zone 26). Further, the results indicate that 81.3% of the people tested wanted the beam select in zones to the left of the steering column.

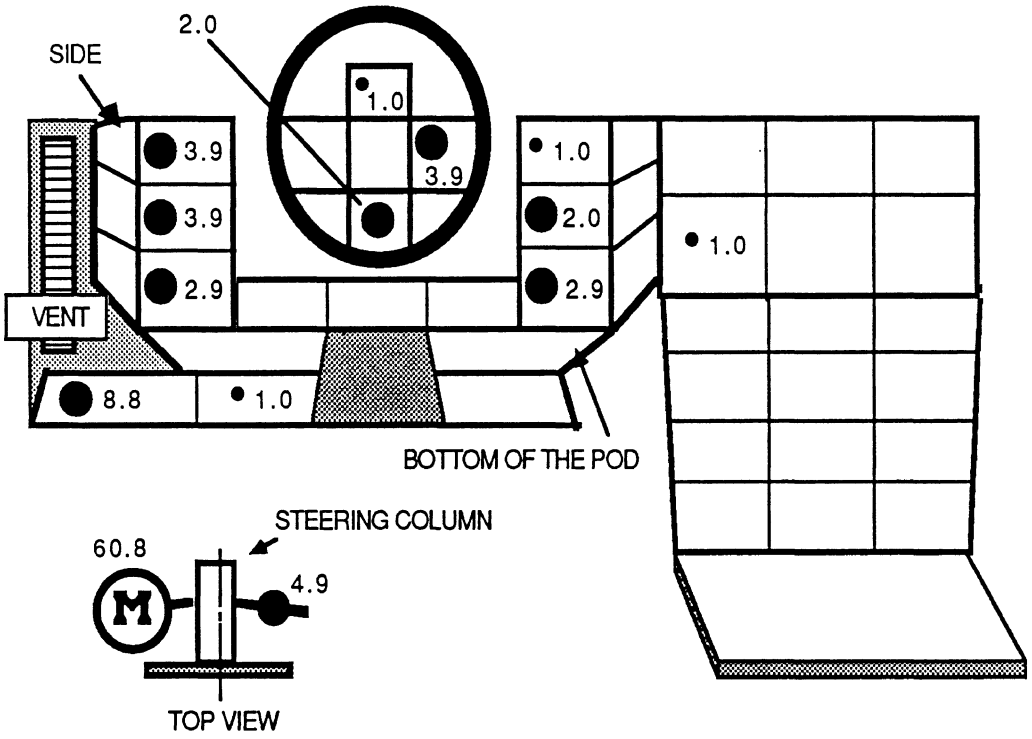
The vast majority of the drivers (65.7%) requested that a stalk mechanism be used to operate the beam select control. Two-position rocker switches (10.8%) and push buttons (6.9%) were also occasionally chosen as beam select switch types.

The most selected (41.2%) method of operation for the beam select control was to push in (forward); pull out (rearward) was selected almost as frequently (36.3%). These two motions accounted for 77.5% of the response concerning how to operate the beam select. This represents an interesting dilemma for designers, who will inevitably confuse at least one of these two groups of drivers unless both methods of operation are allowed.

Relevant comments for this function centered around the variations of stalk mechanisms which should be used to control the beam select switch. To select the beam position, eight people suggested using a stalk where the entire stalk pushes forward, three people suggested a push button on the end of the stalk, and one person suggested a knob on the end of the stalk.

BEAM SELECT

Location (% of switches in given location)



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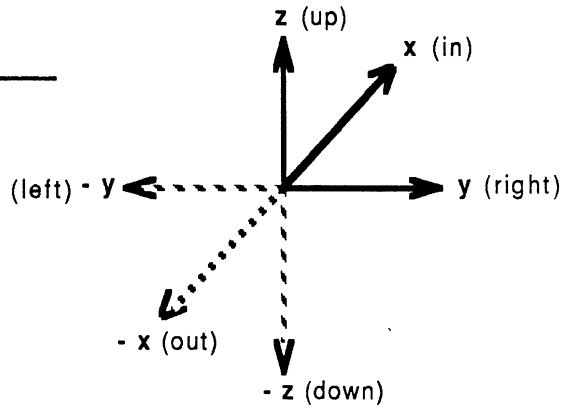
BEAM SELECT

Switch Type (% of switches that are a given type)

%	Switch Type
65.7	stalk
10.8	two-way rocker
6.9	push button
4.9	rotary knob
3.9	pull-push knob
3.9	push surface switch
2.0	combination switch
1.0	rotary handgrip
1.0	slide switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
41.2	Fx
36.3	-Fx
6.9	-Ty
3.9	Tx
2.9	Fy
2.9	Ty
2.0	+/-Fx
2.0	-Tx
1.0	Fz
1.0	+/-Fz



(axes relative to driver)

Climate Control

For the climate control, location was the only variable under examination during this experiment. No data regarding method of operation and switch type preferred were collected.

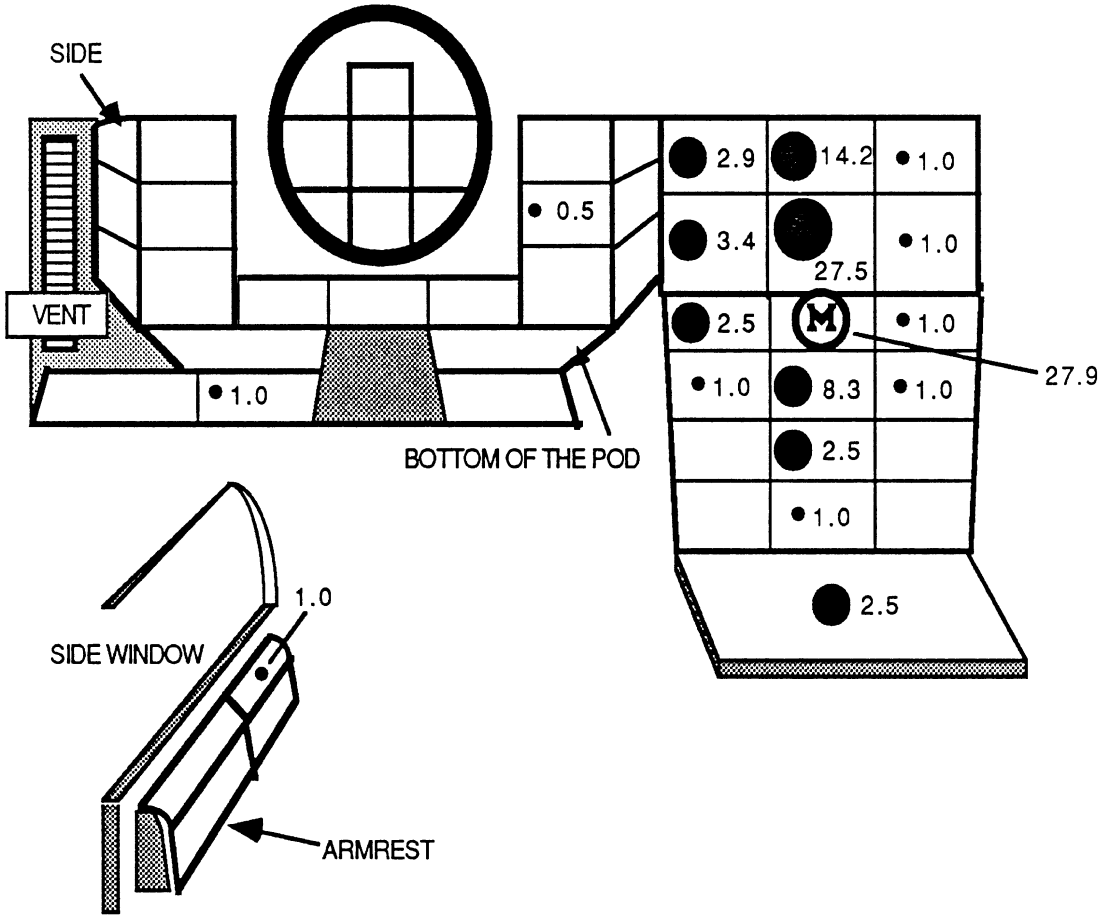
The positioning of the climate control in the upper center four zones (zones 32, 35, 42, and 45) of the console region middle column accounted for 77.9% of all areas tested. The two most frequently preferred locations for this function were zone 42 (27.9%) and zone 35 (27.5%). Variations within these four regions probably resulted from differences in the driver's ability to reach the climate control. Furthermore, people indicated that they preferred the center zones both for quick and easy recognition of the control settings, as well as for passenger access to the climate control.

Horizontal climate controls were preferred over vertical climate controls by the vast majority of drivers. Drivers stated that the vertical climate control was harder to operate and set accurately than the horizontal control.

Relevant comments for the climate control revolved around making sure that this control would be easily visible to the driver. Another interesting comment by one person was that on future climate controls, one should be able to select the desired temperature for the interior of the car.

CLIMATE CONTROL

Location (% of switches in given location)



Cruise Control On/Off

Drivers selected the left spoke of the steering wheel (zone 81) as the most preferred position for the cruise on/off control (18.6%). Further, the pooled steering wheel area (zones 81 - 85) was chosen a total of 44.6% of the time, while the combination of the two steering column positions (zones 26 - 27) was the preferred locations of 19.1% of the test participants. These data indicate that the steering wheel and column area was highly favored by the test participants (a combined preference percentage of 63.7%) as the location for the cruise control on/off switch.

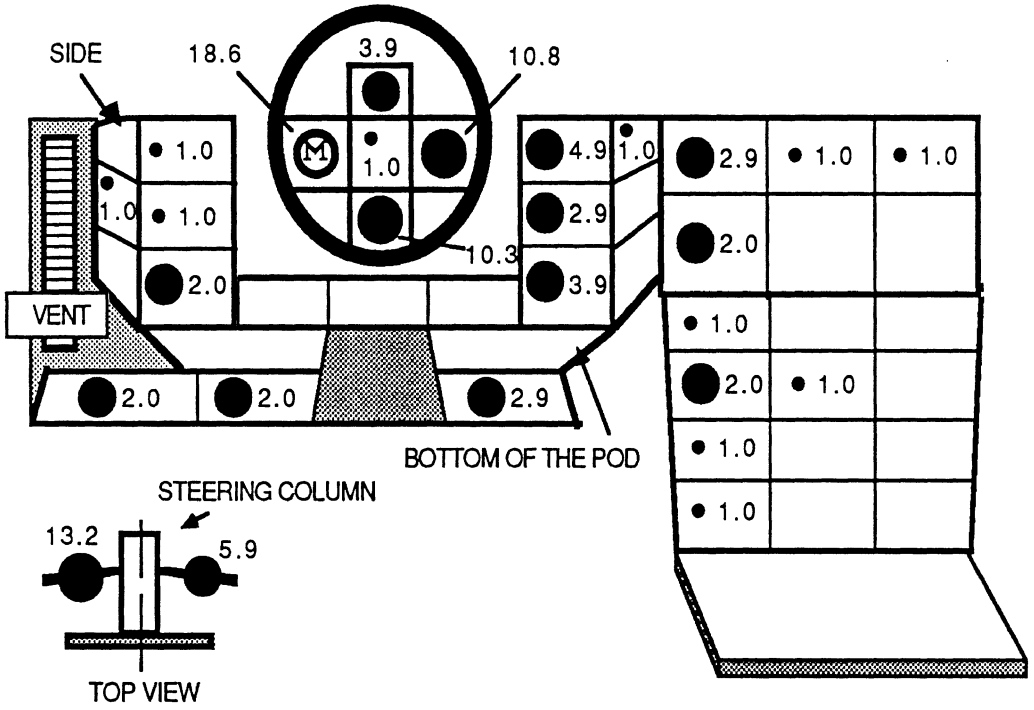
The two-position rocker switch was most selected (34.3%) switch type to operate the cruise on/off control. The stalk was also a popular switch type choice for the cruise control on/off (19.1%). This is most likely due to the frequency in which the steering column zones were selected. In addition, the push button (15.2%), the push surface (12.7%) and the slide switch (11.8%) were also occasionally selected.

The most preferred method of operation was to push in (forward) (67.2%). Another less popular method was to push right (18.1%).

Driver comments for this function included six people who suggested that the cruise on/off switch should light up when activated. When drivers commented on a color for this illumination, green and blue were the suggested colors. Others commented that the three cruise functions should be clustered together in the same general region. Further, many people commented that the cruise set and cruise on/off functions should be included in a single two-function switch, while others felt that all three cruise function switches be included in a single three-function switch.

CRUISE CONTROL ON/OFF

Location (% of switches in given location)



This page is reserved for the reader's notes.

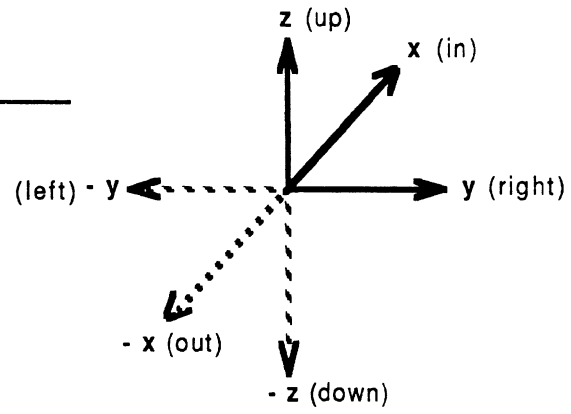
CRUISE CONTROL ON/OFF

Switch Type (% of switches that are a given type)

%	Switch Type
34.3	two-way rocker
19.1	stalk
15.2	push button switch
12.7	push surface switch
11.8	slide switch
2.0	lever switch
1.0	combination switch
1.0	pod
1.0	toggle switch
1.0	rotary knob

Method of Operation (% of switches operated using given method)

%	Method of Operation
67.2	Fx
18.1	Fy
3.9	-Ty
2.9	-Fy
2.0	-Fz
2.0	+/-Fy
1.0	Fz
1.0	-Fx
1.0	Tx
1.0	Ty



(axes relative to driver)

Cruise Control Resume

The right spoke of the steering wheel (zone 82) was the most preferred location for the cruise control resume function (18.6%). Again, the steering wheel and steering column zones (zones 81 - 85, 26 - 27) were quite popular (combined total of 48.5%). These data suggest that drivers would like to have the cruise control located in a position near the steering wheel to allow for quick and easy manipulation.

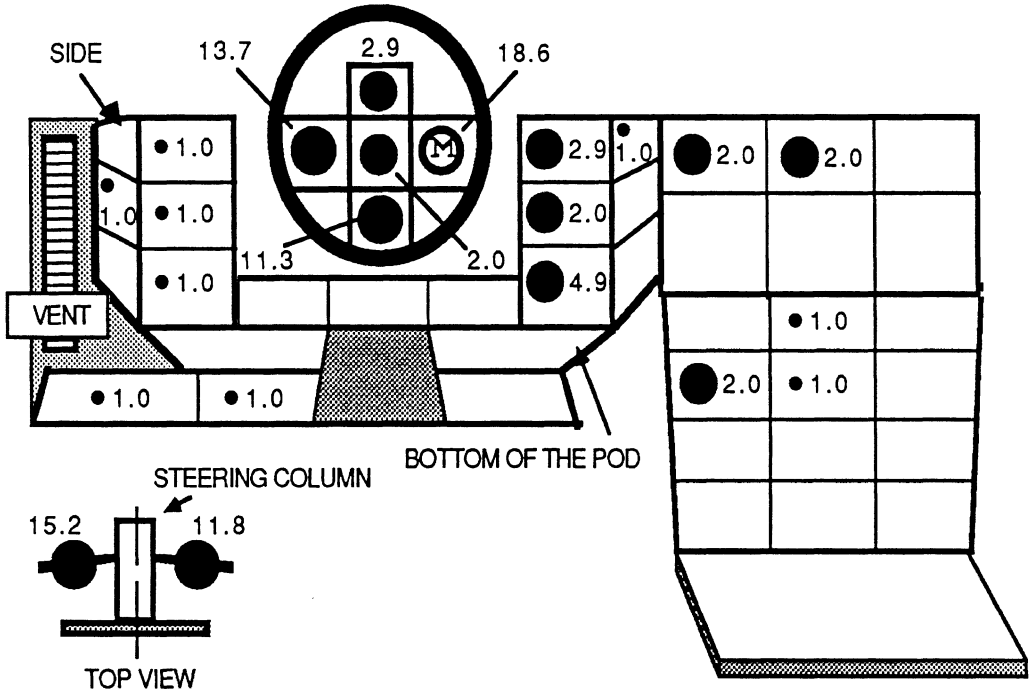
The switch type selected most often for the cruise control resume was the stalk. Two-position rocker switches were the next most popular, followed by push surfaces and push buttons. The combination of these four switch types accounted for 86.1% of the switches chosen.

Most drivers preferred to operate the cruise control resume switch by pushing in (forward). A somewhat smaller percent (17.1%) of the people indicated that pushing either right or left was desirable.

Many comments for the cruise control resume centered around avoiding accidentally engaging this function. Four people commented that the cruise resume switch should be small to avoid accidentally hitting it. Further, two drivers felt that the cruise resume switch should be hit twice before the cruise resume is engaged. This setup can most likely be attributed to minimizing the chance of accidental activation of the cruise control resume. Also, three drivers who included the cruise control switches in a cluster placed the resume switch below the cruise on and cruise set switches. Again, this placement was probably to minimize accidental activation of the cruise resume, as well as making it readily accessible. Others commented that the three cruise functions should be clustered together in the same general region, or be included in a single three-function switch. This is consistent with the overall preference data.

CRUISE CONTROL RESUME

Location (% of switches in given location)



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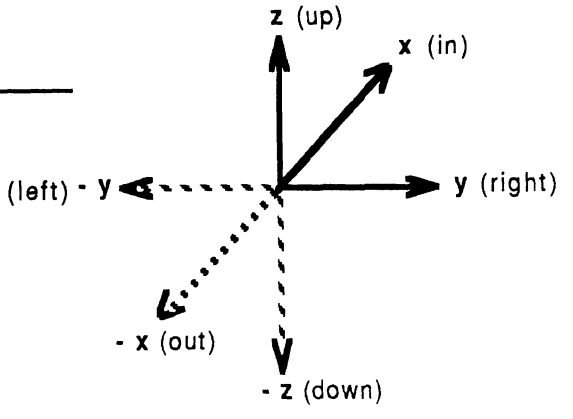
CRUISE CONTROL RESUME

Switch Type (% of switches that are a given type)

%	Switch Type
27.0	stalk
21.6	two-way rocker
19.1	push surface switch
18.6	push button switch
5.9	slide switch
2.0	rotary knob
2.0	lever switch
2.0	paddle switch
1.0	pod
1.0	combination switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
64.2	Fx
9.3	Fy
7.8	-Fy
5.9	Ty
4.9	-Ty
2.9	-Fx
2.0	-Fz
2.0	Tx
1.0	Fz



(axes relative to driver)

Cruise Control Set

Results for the cruise control set switch type and method of operation paralleled those for the cruise control resume function. The cruise control set had the exact same preferred zone as did the cruise control resume, (zone 82) the right spoke of the steering wheel. The positional relationship between the cruise set and resume function is clearly visible given these data. A total of 48.6% of the switches were placed on the steering wheel. This number is only 0.1% more than the total for the cruise control resume switch. These results further indicate the need for grouping the resume and set function together. The combination of the right and left stalks accounted for 28% of the cruise set placement. This figure is identical to the resume percentage, and also supports the notion of grouping the two controls (resume & set).

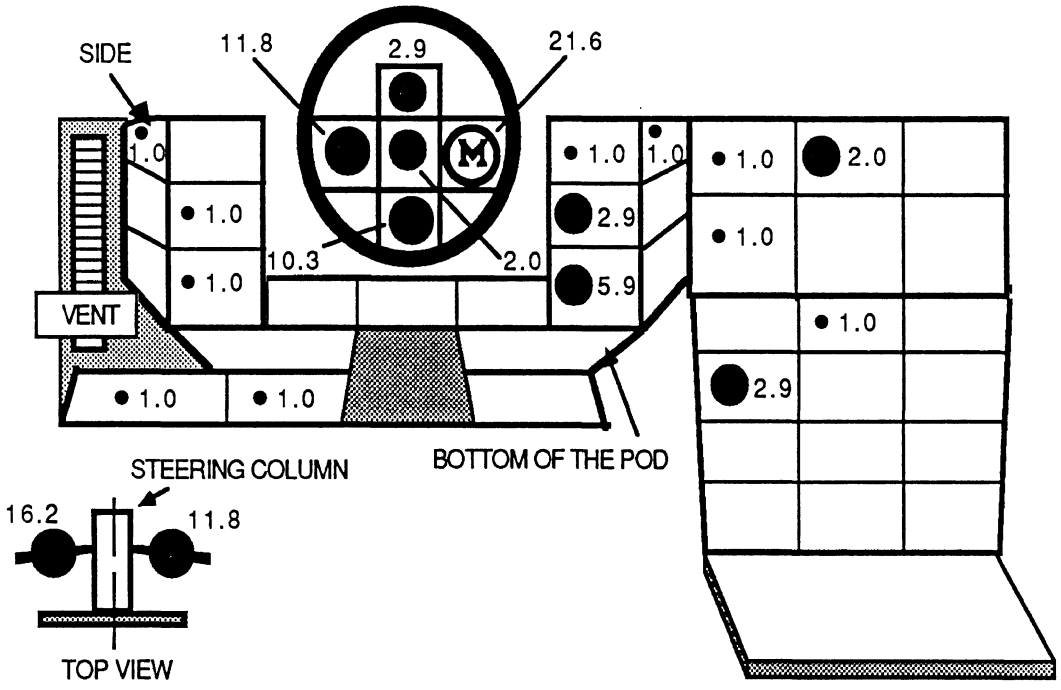
Again the stalk was the preferred switch type for the cruise control set feature. Push surfaces, two-position rocker switches and push buttons remained the other most frequently selected switch types, paralleling the cruise set function.

The majority of drivers (62.3%) selected the push in (forward) motion as the best method for controlling the cruise set. The push right motion was the second most preferred method of operation (17.2%). Further, these two motions were the only ones to receive more than 5%.

Interesting comments for this function included: two people who suggested that the cruise control switch should be held until the desired speed is attained, and one person who felt that one should be able to key in the desired cruising speed. Others commented that the three cruise functions should be clustered together in the same general region. Further, many drivers commented that the cruise set and cruise on/off functions should be included in a single two-function switch, while others felt that all three cruise function switches be included in a single three-function switch.

CRUISE CONTROL SET

Location (% of switches in given location)



This page is reserved for the reader's notes.

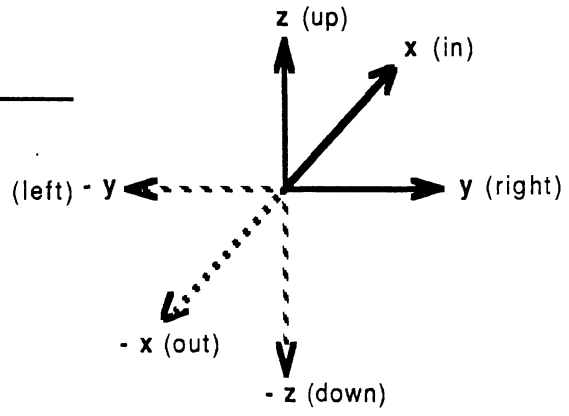
CRUISE CONTROL SET

Switch Type (% of switches that are a given type)

%	Switch Type
27.9	stalk
22.1	push surface switch
19.6	two-way rocker
13.7	push button switch
7.8	slide switch
2.9	rotary knob
2.0	lever switch
2.0	paddle switch
1.0	pod
1.0	combination switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
62.3	Fx
17.2	Fy
8.8	-Ty
4.9	-Fy
2.9	Tx
2.0	Ty
1.0	-Fx
1.0	-Fz



(axes relative to driver)

Front Windshield Washer

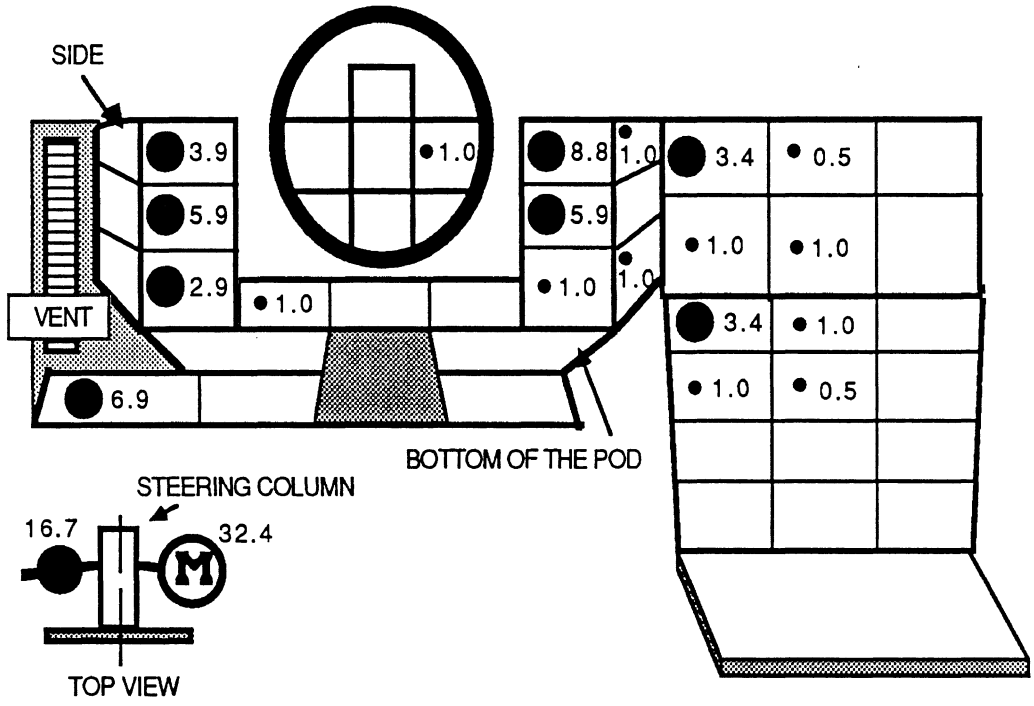
The preferred location for the front windshield washer was the steering column, with 32.4% of the participants choosing the right stalk, and 16.7% choosing the left stalk. Other popular zone locations were the upper right and the lower left pod positions (zones 10 and 18 respectively). An interesting result was that one percent of those tested wanted the front windshield washer control on the steering wheel, although the majority of people wanted the control just below on the steering column stalk control.

Paralleling the steering column location preference, the stalk was the choice as the best switch type for the front washer. This switch type was chosen 49.0% of the time. Furthermore, the method of operation most preferred was to push the stalk in (forward). Other switch types consistently selected included the slide switch, push button, rotary, and two way rocker. These switch types were typically operated by pushing in (forward) or pulling out (rearward), or by pushing right or left.

There were no significant driver comments regarding the front windshield washer function.

FRONT WINDSHIELD WASHER

Location (% of switches in given location)



This page is reserved for the reader's notes.

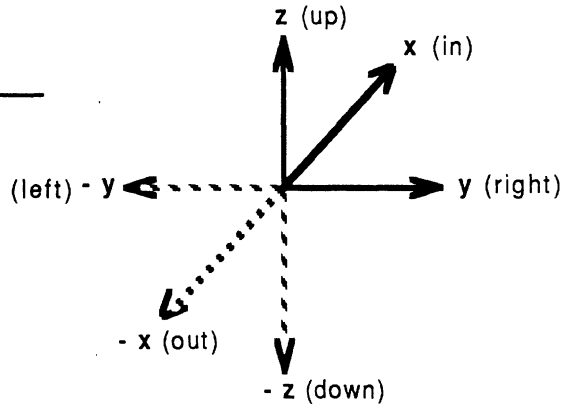
FRONT WINDSHIELD WASHER

Switch Type (% of switches that are a given type)

%	Switch Type
49.0	stalk
10.8	slide switch
9.8	push button switch
8.8	rotary knob
7.4	two-way rocker
6.9	combination switch
5.9	push surface switch
1.0	thumb wheel switch
0.5	paddle switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
45.6	Fx
17.6	-Fy
13.7	-Fx
11.8	Fy
2.9	Ty
2.0	Fz
2.0	+/-Fx
2.0	-Tx
1.0	-Ty
1.0	Twist & Push
0.5	-Fz



(axes relative to driver)

Front Windshield Wipers

The preferred locations for the front windshield wiper control were nearly identical to those for the front windshield washer: right stalk (32.4%), left stalk (16.7%), upper right pod (8.8%). These results are not surprising given the functional relationship these two controls maintain.

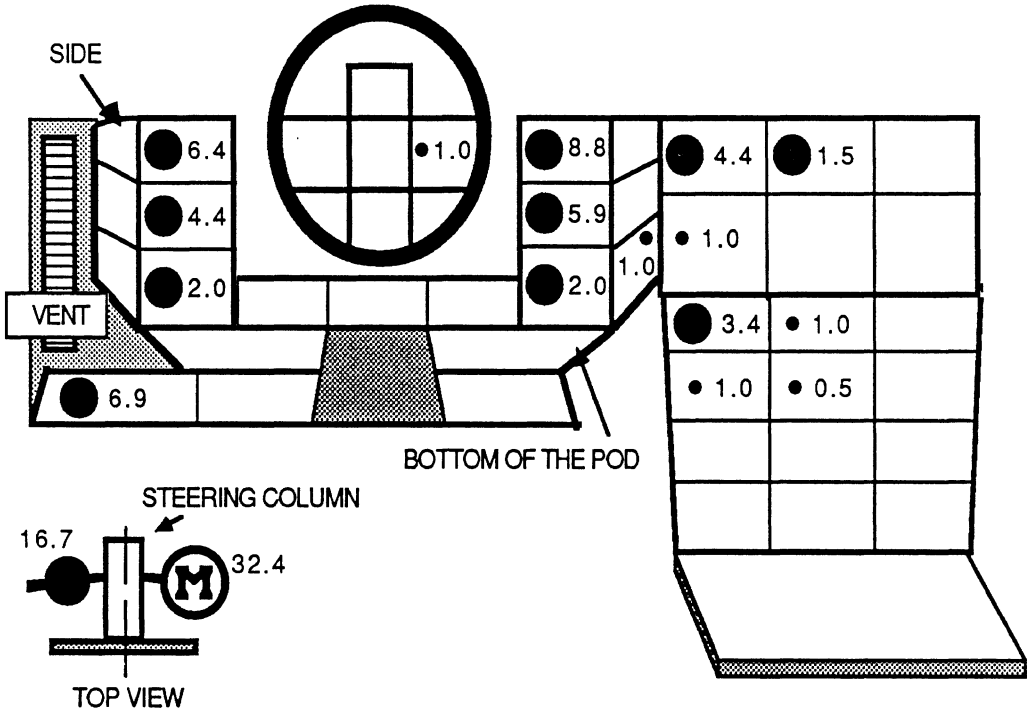
The stalk was chosen about half the time (49.0%) as the best switch type for the front wipers. Four other switch types were each selected about 10% of the time. These types included slide switches, rotary knobs, rocker switches, and combination switches. In addition, the combination switches were used more often for the front windshield wipers than for any other control tested.

The method of operation most selected for the front windshield wipers was twist left (torque about the -y axis). Other frequently chosen methods include push up and push down, as well as push in (forward).

Comments for this function were concerned with wiper speed selection. Eleven drivers commented that there should be a setting for intermittent wiping, where the front wiper would come on intermittently rather than continuously. Also, they commented that there should be between three and five speed settings. Specifically, four drivers felt that there should be three speed settings, three felt that there should be four speed settings, and one commented that there should be five speed settings.

FRONT WINDSHIELD WIPERS

Location (% of switches in given location)



This page is reserved for the reader's notes.

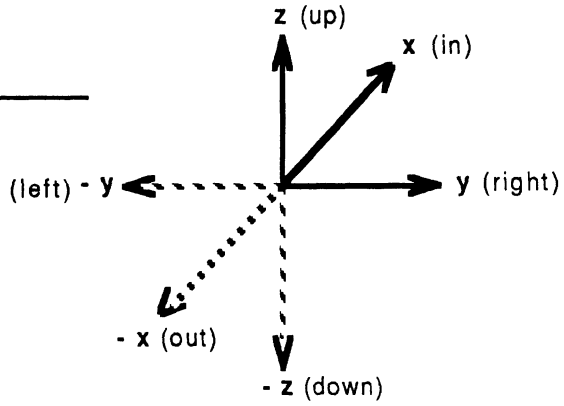
FRONT WINDSHIELD WIPER

Switch Type (% of switches that are a given type)

%	Switch Type
49.0	stalk
11.8	slide switch
10.8	rotary knob
9.3	two-way rocker
9.3	combination switch
3.9	push surface switch
2.9	push button switch
2.0	thumb wheel switch
1.0	paddle switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
26.5	-Ty
18.1	Fz
17.6	Fx
10.8	-Fz
10.3	+/-Fz
9.8	Fy
2.9	-Fy
1.0	+/-Fy
1.0	-Tx
1.0	+/-Ty



(axes relative to driver)

Hazard Lights

There was a fairly significant trend to place the hazard switch in the lower dashboard region. Zone 20 was the most preferred location (15.7%), and zone 18 the second most preferred (9.8%). As can be seen from the figure, a significant number of participants placed the hazard switch directly on the steering column.

Nearly half of the participants (41.7%) chose rocker switches, 28.4% chose push buttons.

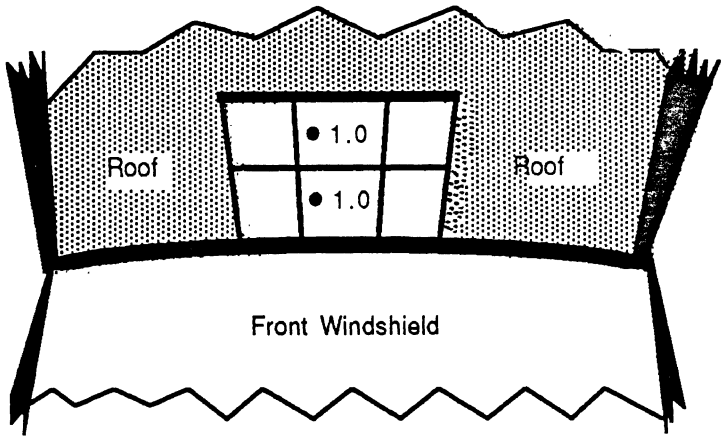
By far the most requested method of operation was to push in (forward). This motion typically accompanied the selection of one of the lower dashboard positions. The push down motion was the second most frequently chosen method of operation. This method of operation was typically chosen for a switch mounted on the floor console.

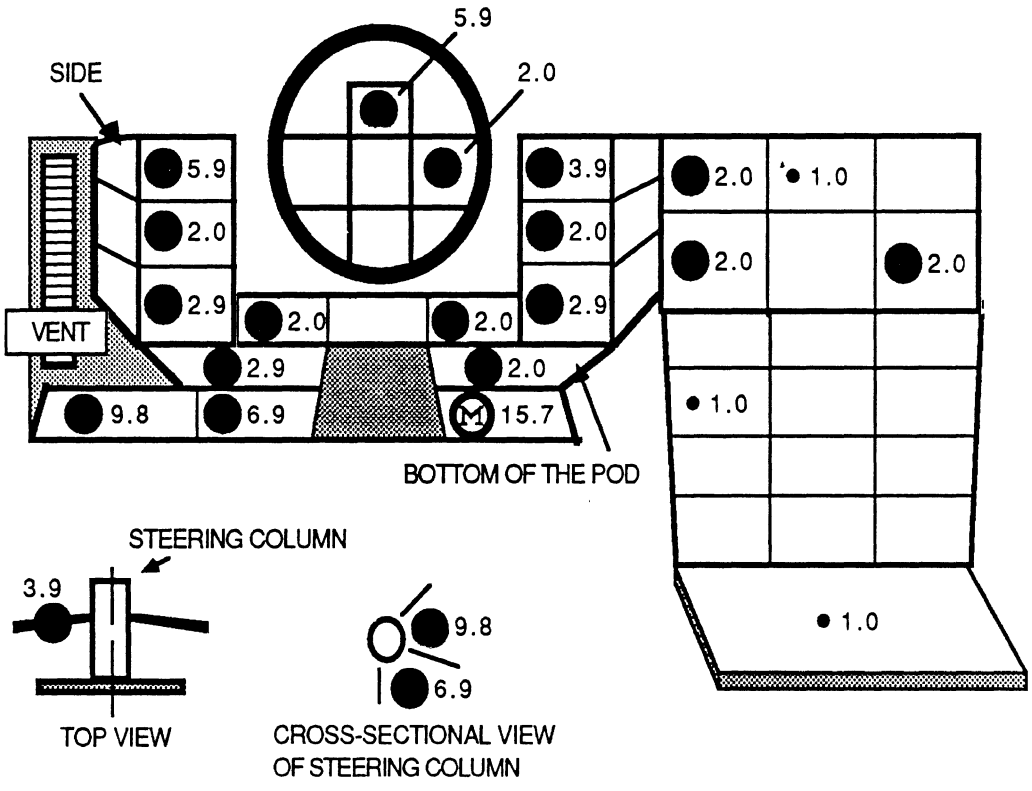
Comments for this function included 16 drivers who felt that the hazard switch should be illuminated when activated. Of these people, eight felt that the illumination color should be red, while three felt that the switch light should blink when the hazard lights are activated.

HAZARD LIGHTS

Location (% of switches in given location)

Front Roof Zones





This page is reserved for the reader's notes.

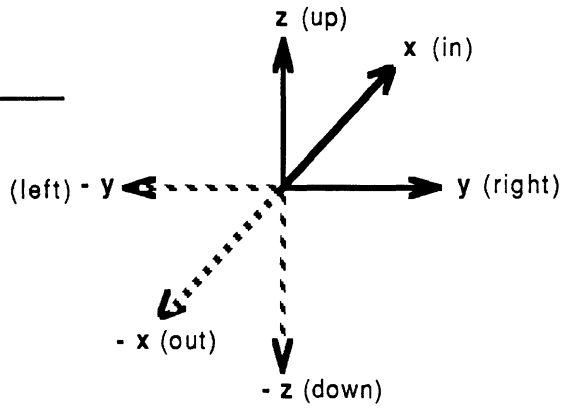
HAZARD LIGHTS

Switch Type (% of switches that are a given type)

%	Switch Type
47.1	two-way rocker
28.4	push button switch
5.9	push surface switch
4.9	push-pull switch
3.9	stalk
3.9	rotary knob
2.9	slide switch
1.0	rotary handgrip
1.0	paddle switch
1.0	toggle switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
58.8	Fx
10.8	-Fz
6.9	Fy
6.9	Fz
6.9	-Fy
2.9	-Fx
2.0	Tx
2.0	-Ty
1.0	+/-Fx
1.0	Fx&y
1.0	Fx&z



(axes relative to driver)

Headlights/Parking Lights

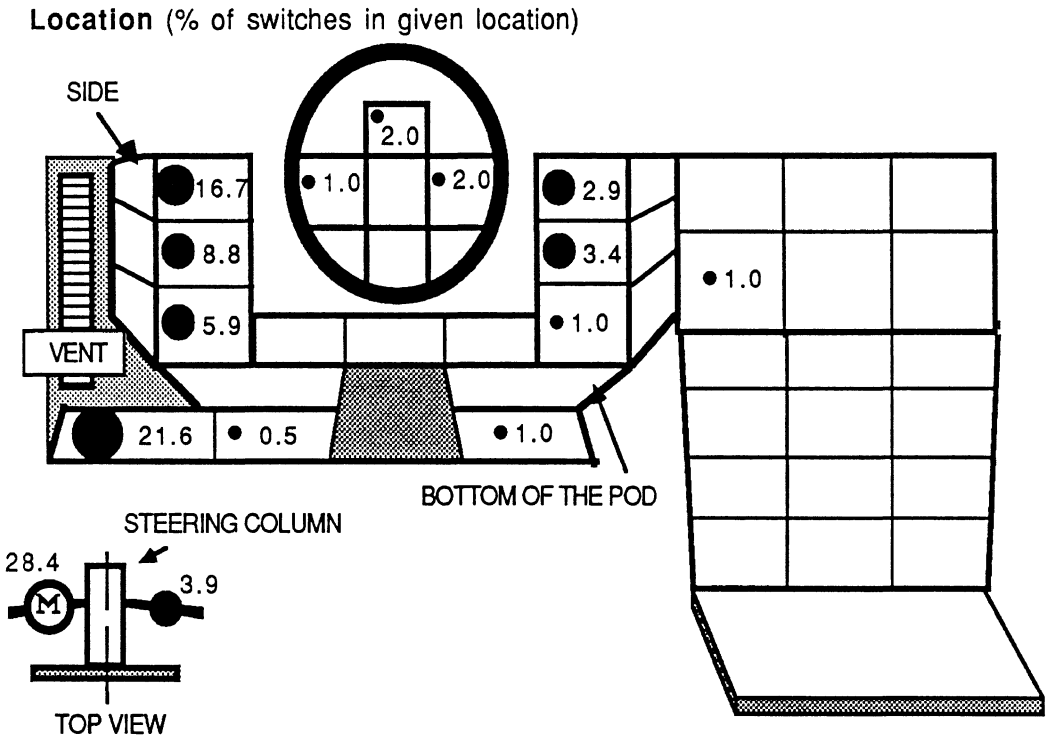
The left side stalk (28.4%) and lower left pod (21.6%) positions were selected exactly 50% of the time as the preferred location for the headlight switch. Two other popular choices for this function were the upper left and middle left pods, accounting for an additional 25% of the preferred locations.

The stalk was used 32.4% of the time for headlights. Following closely was the push-pull switch preferred by 23.5% of those responding. Two other popular switch types were two-position rocker switches and pushbuttons.

Once again the push in (forward) motion was selected as the desired method of operation. Twisting the switch left (torque about the -y axis) was also frequently chosen. This motion was frequently used with a stalk.

Interesting comments regarding the headlight function included the following: people wanted this function to be included in a single multifunction switch, usually in combination with the parking lights; one driver felt that the ISO symbol for this function should light up when the headlights are on.

HEADLIGHTS/PARKING LIGHTS



This page is reserved for the reader's notes.

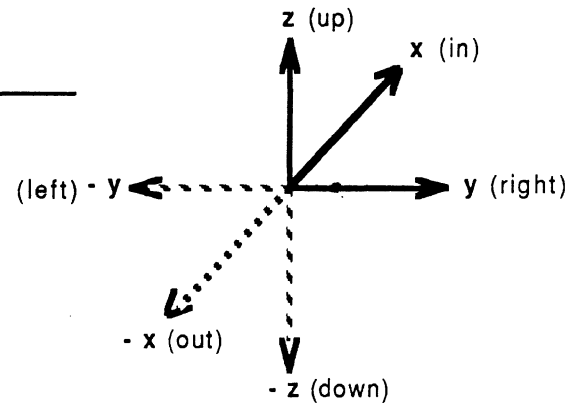
HEADLIGHTS/PARKING LIGHTS

Switch Type (% of switches that are a given type)

%	Switch Type
32.4	stalk
23.5	push-pull switch
14.7	two-way rocker
11.8	push button switch
6.9	rotary knob
4.9	combination switch
2.9	push surface switch
1.0	rotary handgrip
1.0	paddle switch
1.0	slide switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
34.3	Fx
22.5	-Ty
21.6	-Fx
7.8	Tx
4.9	Ty
3.9	+/-Fx
2.0	Fy
2.0	-Tx
1.0	Fz



(axes relative to driver)

Ignition

For the ignition switch, location and method of operation were the only variables under examination during this experiment. No data on switch type preferred were collected.

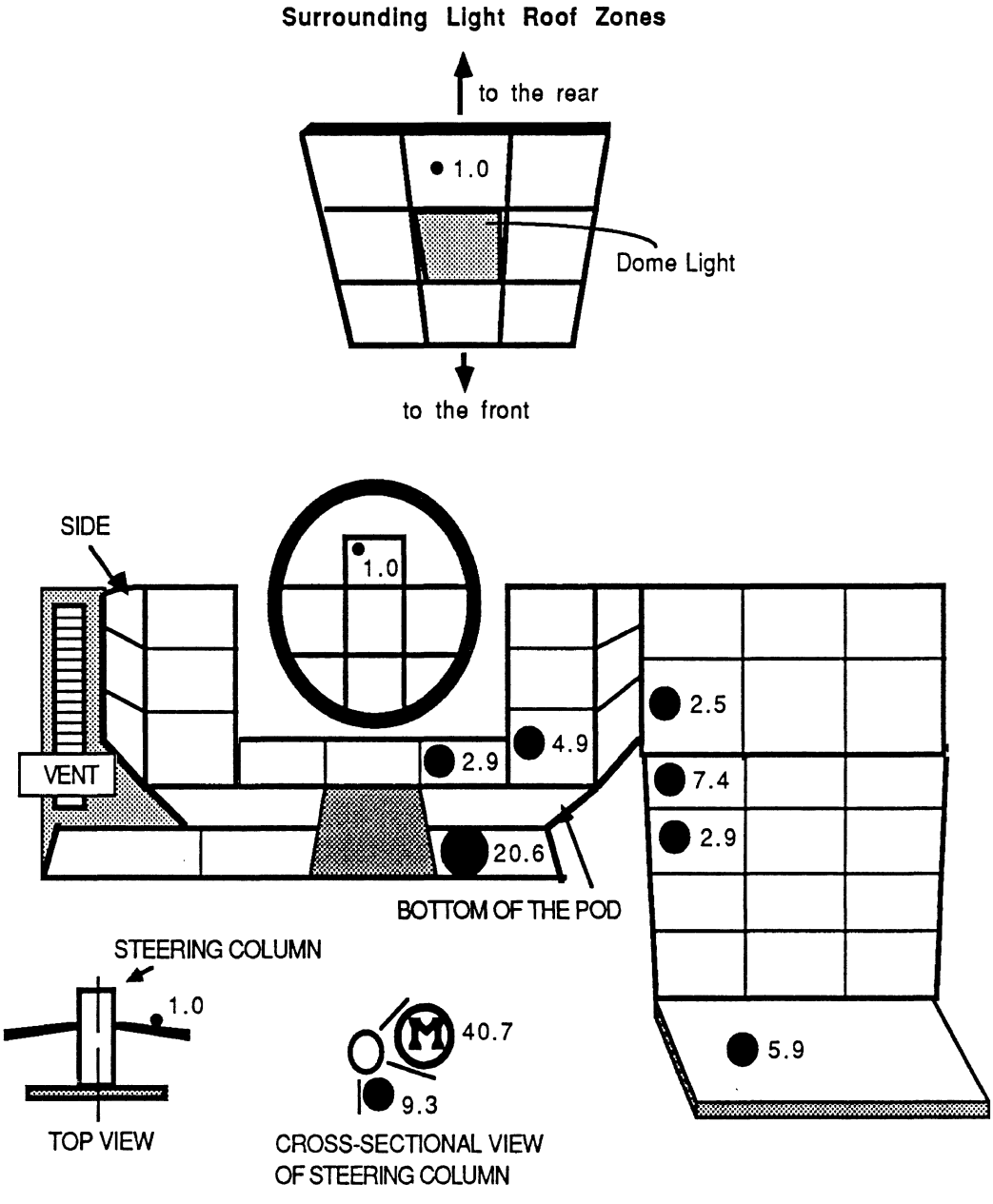
The most preferred zone for the ignition switch was the upper right side of the steering column 40.7%. Other locations preferred by many of the test participants include the bottom right pod area (20.6%) and the lower right side of the steering column (9.3%). There were some people who even placed the ignition in unexpected locales, such as the end of the stalk, the roof liner, and the steering wheel. Although not reflective of the majority of the test participants, these results do require some mention.

The majority (51.8%) preferred to turn on the ignition with a twist in (torque about the +x axis). A significant number (37.5%), however, preferred a twist left (torque about the -y axis).

One interesting comment for this function was that the switch should light up for 15 seconds each time a door is opened, presumably to make it easier to insert the key during night driving. Further, one driver strongly indicated that there should be no ignition key release switch, citing that they are "a pain to use."

IGNITION

Location (% of switches in given location)

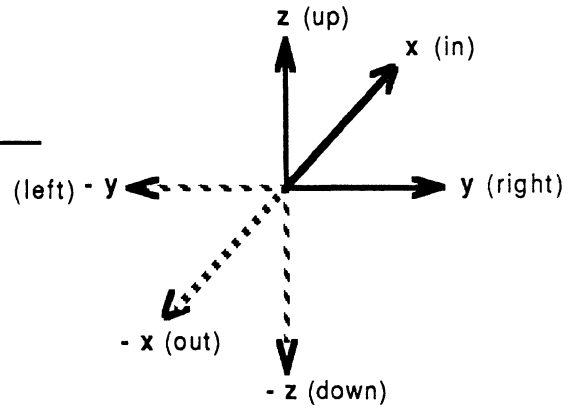


This page is reserved for the reader's notes.

IGNITION

Method of Operation (% of switches operated using given method)

%	Method of Operation
51.8	Tx
37.5	-Ty
3.6	Fx
3.6	Tz
3.6	-Tz



(axes relative to driver)

Optical Horn (High Beam Flash)

Over half of the people (52.9%) wanted the switch controlling the optical horn (or beam flasher) on the left hand stalk. Other positions chosen for this function typically accounted for less than 5% of the total and were distributed on or closely around the steering wheel.

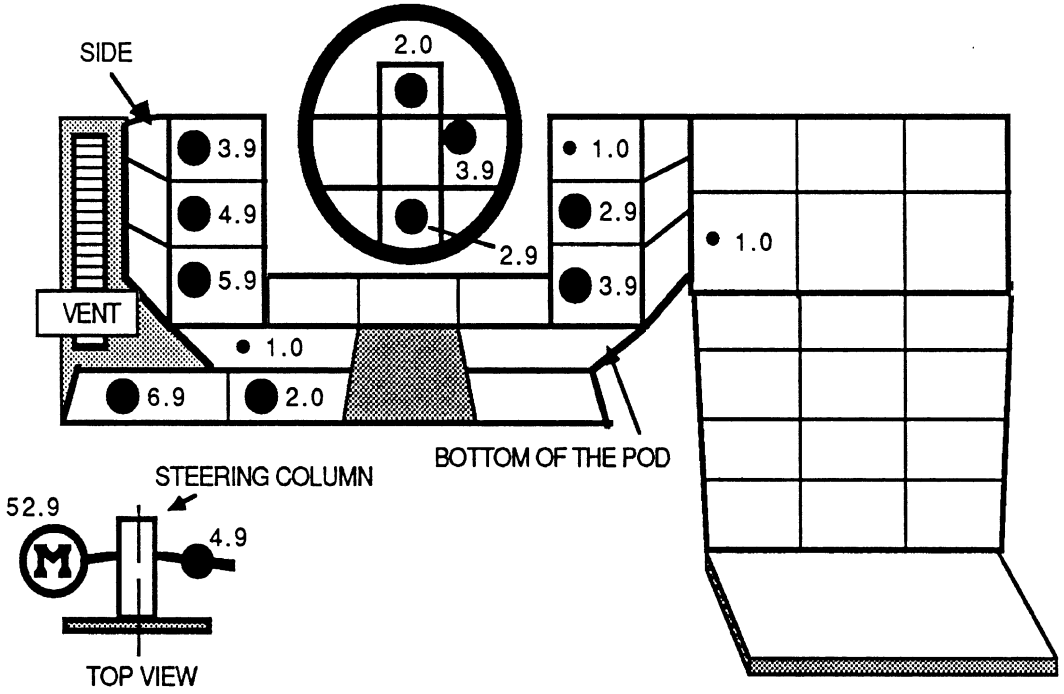
The stalk was the overwhelming choice (57.8%) for the optical horn switch type. Push buttons and two position rocker switches were also frequently chosen (13.7% and 12.7%, respectively).

The majority of participants preferred one of two operation methods, either a push in (43.1%), or a pull out (40.2%). Given this split in results, it is hard to make a recommendation for a method of operation. Designers should weigh the possibilities of allowing both motions.

The only relevant comment for this function was that five drivers stated that they did not want the optical horn switch to click when activated.

OPTICAL HORN (HIGH BEAM FLASH)

Location (% of switches in given location)



This page is reserved for the reader's notes.

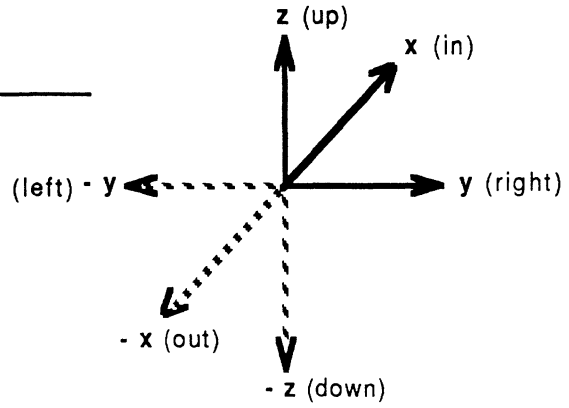
OPTICAL HORN (HIGH BEAM FLASH)

Switch Type (% of switches that are a given type)

%	Switch Type
57.8	stalk
13.7	push button switch
12.7	two-way rocker
7.8	push surface switch
2.9	push-pull switch
2.0	combination switch
1.0	rotary knob
1.0	rotary handgrip
1.0	slide switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
43.1	Fx
40.2	-Fx
8.8	Fy
2.0	+/-Fx
1.0	Fz
1.0	Tx



(axes relative to driver)

Panel Brightness

The lower left portion of the instrument panel (zone 18) was selected as the most preferred locale for the panel brightness control (27.5%). Three locations directly above this zone (zones 4-6) were also frequently chosen. In addition, the lower right underside of the dash (zone 20) was a popular position (7.8%).

The rotary switch was chosen most frequently by the test participants (35.3%). This was followed closely by the thumb wheel (27.5%). In addition, push-pull switches were chosen 13.7% of the time.

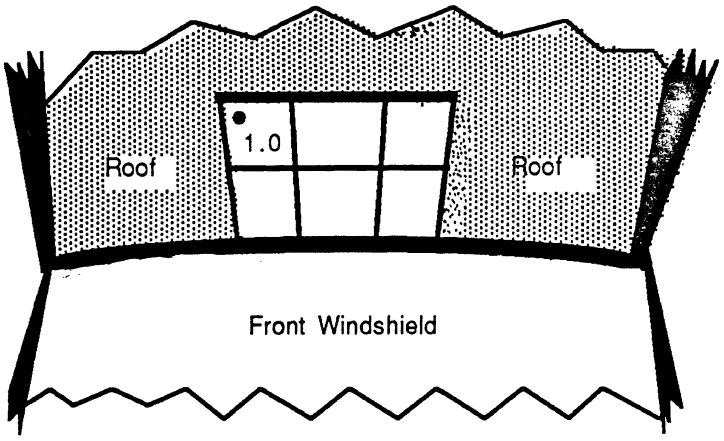
The preferred method of increasing instrument panel brightness was to twist in (torque about the +x axis), suggesting the use of a knob on the instrument panel.

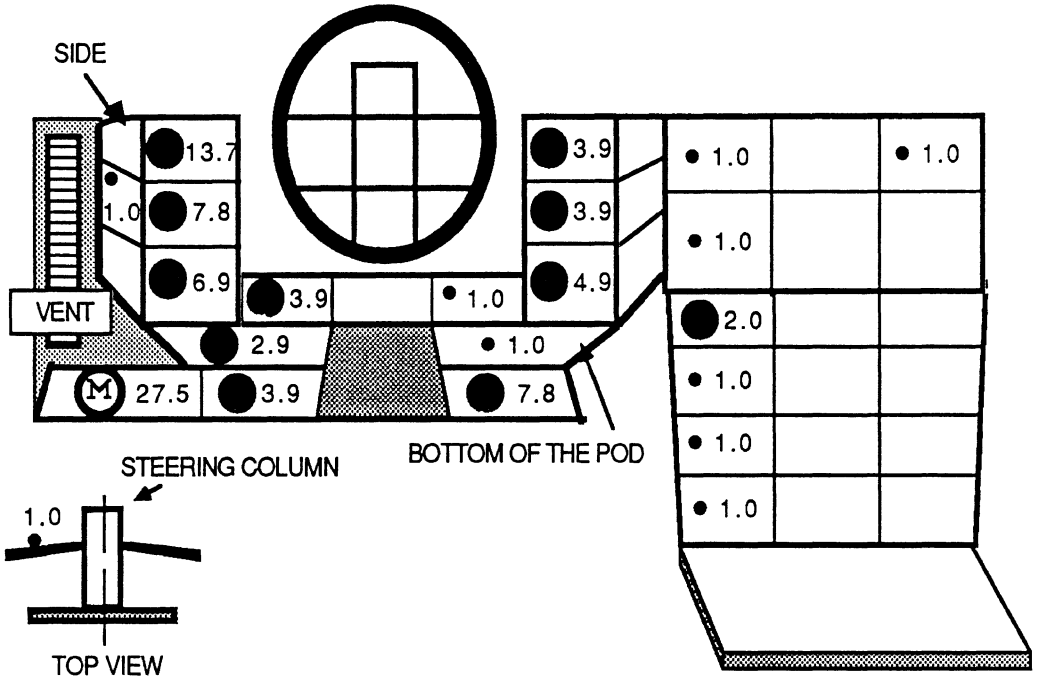
Relevant comments for the panel brightness function were as follows. Five people commented that they would like the panel brightness to be proportional to either how far the switch is pushed in or how long the switch is held on. Two others felt that this function should be included with the dome light control in a two-function switch, while one person felt that the panel brightness control should be included with the headlight control in a two-function switch.

PANEL BRIGHTNESS

Location (% of switches in given location)

Front Roof Zones





This page is reserved for the reader's notes.

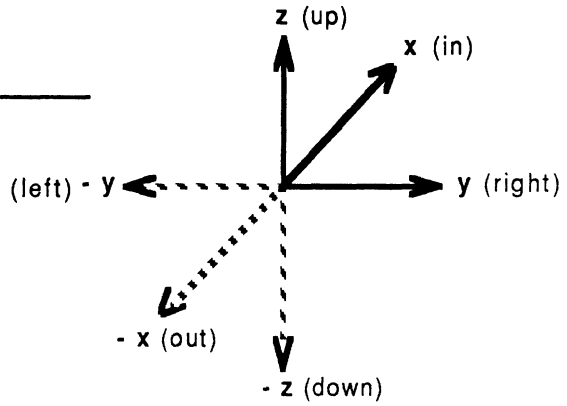
PANEL BRIGHTNESS

Switch Type (% of switches that are a given type)

%	Switch Type
35.3	rotary knob
27.5	thumb wheel switch
13.7	push-pull switch
5.9	slide switch
3.9	push surface switch
3.9	combination switch
2.9	push button switch
2.9	two-way rocker
1.0	paddle switch
1.0	stalk
1.0	toggle switch
1.0	rotary handgrip

Method of Operation (% of switches operated using given method)

%	Method of Operation
46.1	Tx
12.7	Fy
10.8	Fx
9.8	Fz
4.9	-Ty
3.9	Tz
2.9	+/-Fy
2.9	-Tx
1.0	-Fx
1.0	-Fz
1.0	+/-Fz
1.0	Ty
1.0	-Tz
1.0	Tx&y



(axes relative to driver)

Power Door Lock

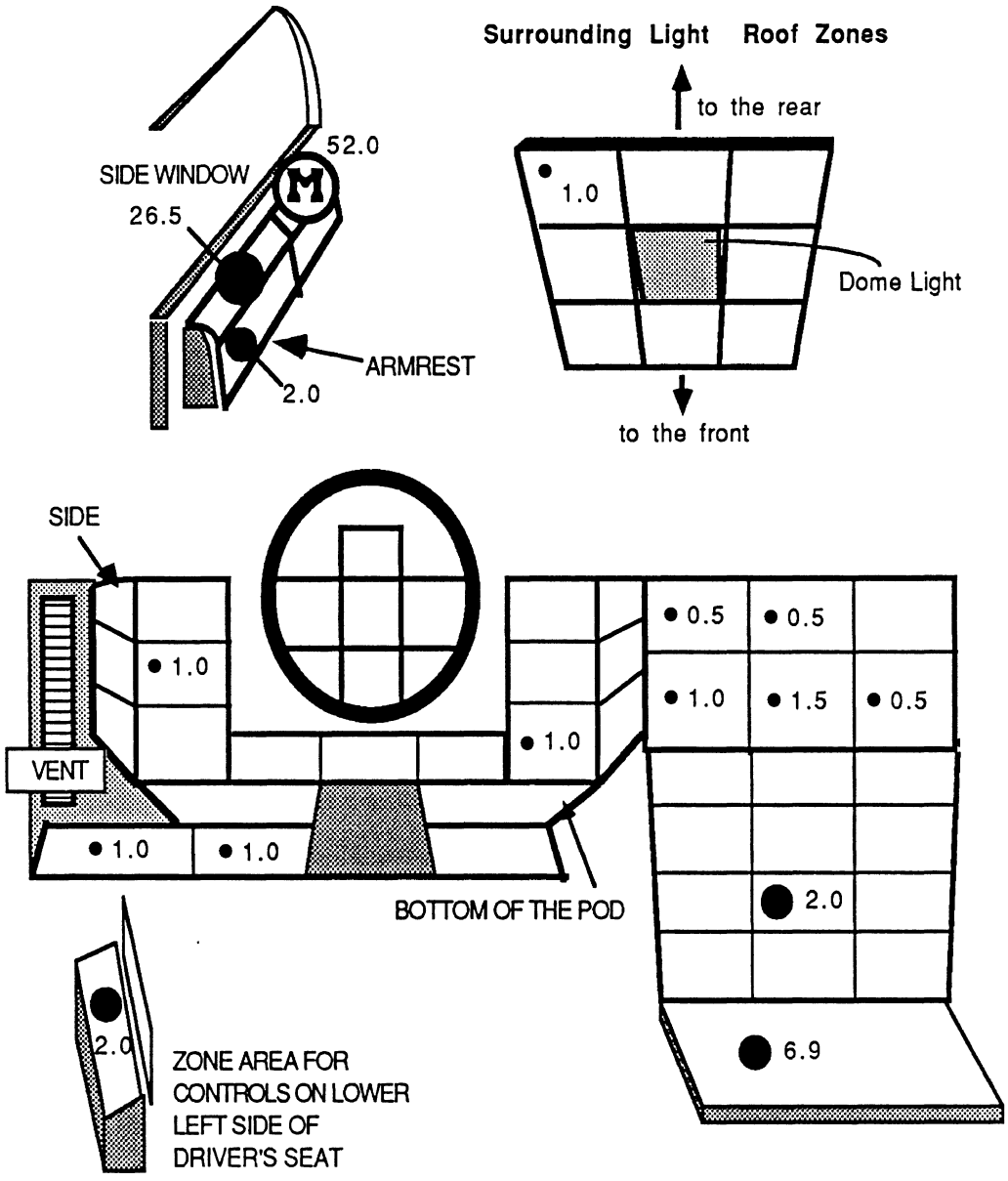
For the power door lock, location was the only variable under examination during this experiment. No data regarding method of operation and switch type preferred were collected.

The location for the power door lock control most often selected was the left front armrest, zone 56 (52.0%). This position is located directly beneath the side window and approximately one forearms length from where the driver is normally seated (given his arm is on the armrest). The second most popular position (26.5%) for this function was in zone 55, located directly behind zone 56. This location was likely chosen by drivers with shorter forearms than those who preferred zone 56. The most popular non-armrest position was the floor console between the two front seats (zone 53). This zone was selected 6.9% of the time. It should be noted that the three most preferred zones for this control are the same as those chosen for the power window control.

The only relevant comment made by three people concerned the power door locks' accessibility to the passengers. These drivers felt there should be some way to allow all passengers to operate the locks.

POWER DOOR LOCK

Location (% of switches in given location)



Power Seat

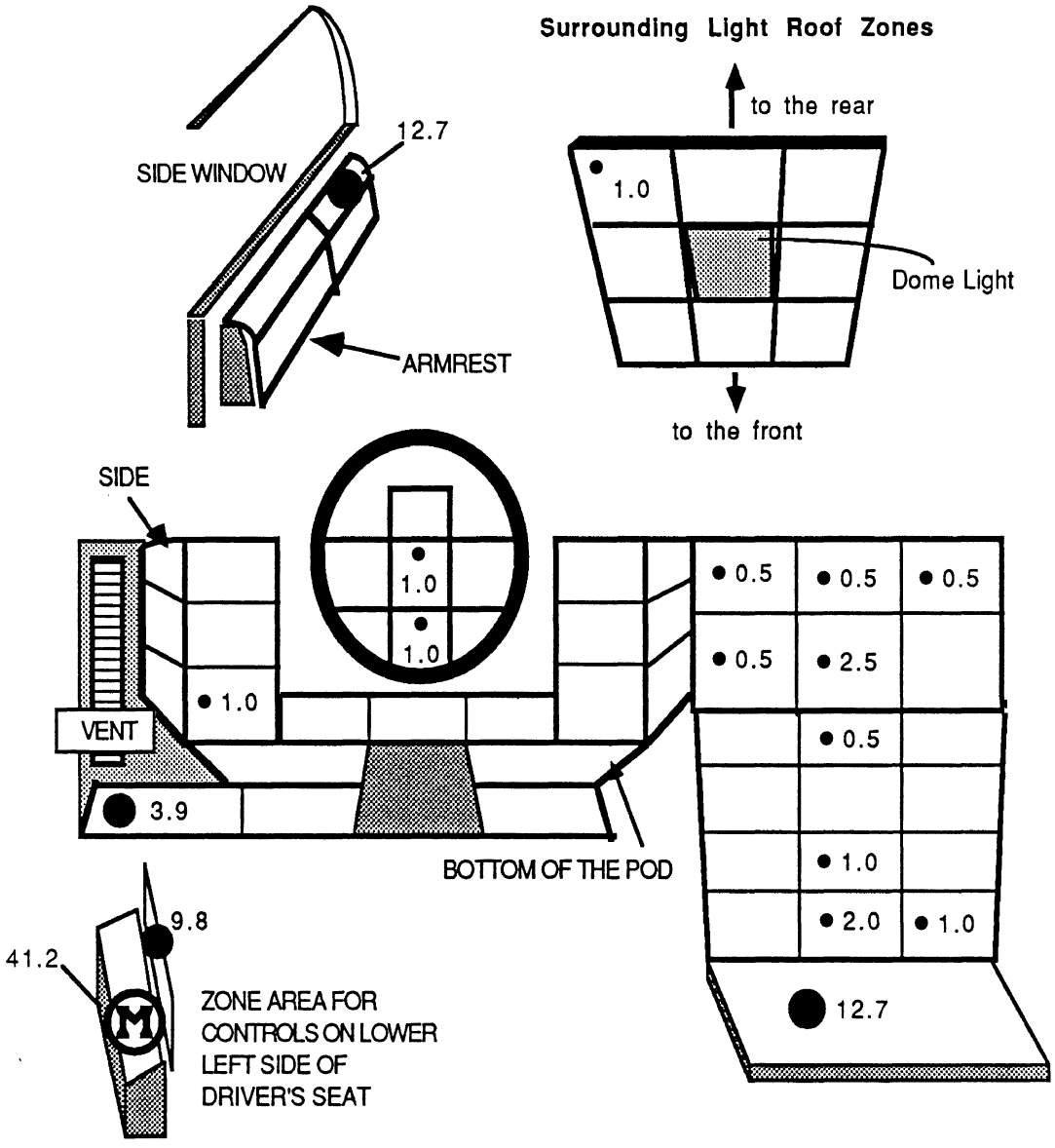
For the power seat control, location was the only variable under examination during this experiment. No data regarding method of operation and switch type preferred were collected.

The lower left side of the driver's seat (zone 21) was selected as the most preferred location (41.2%) for the power seat control. Two other zones chosen by 12.7% of the test participants were zone 53 in the console region and zone 56 in the door panel region.

There were no relevant comments concerning the power seat control.

POWER SEAT

Location (% of switches in given location)



Power Windows

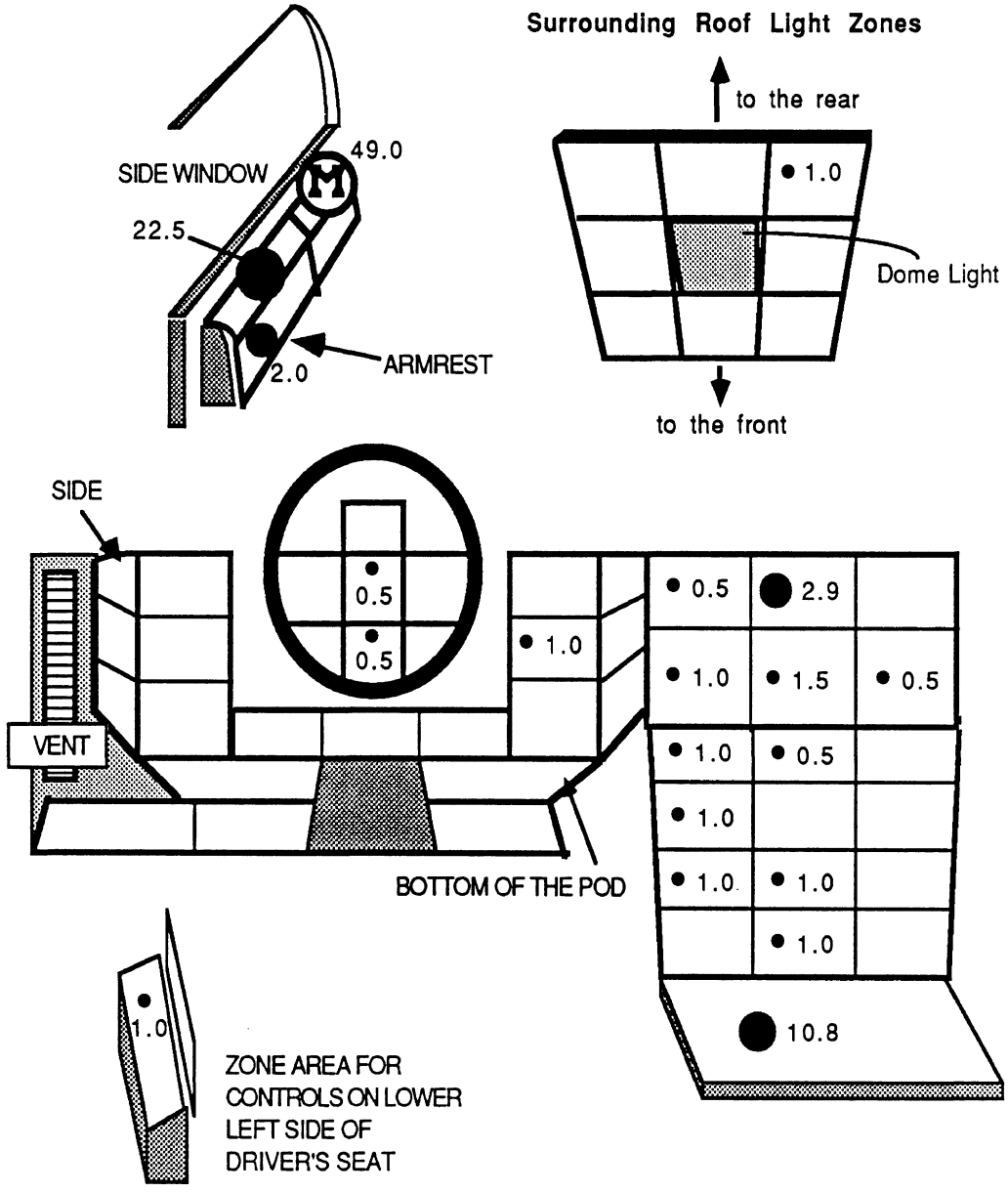
For the power window control, location was the only variable under examination during this experiment. No data regarding method of operation and switch type preferred were collected.

The front half of the driver's armrest was the most frequently chosen area to place the power window control switch (zone 56, 49.0%). The zone directly behind this was the second most popular location (22.5%). As with the power door locks, the split in preference between zones 55 and 56 was most likely due to variations in drivers' ability to easily reach these two zones. The third most selected position (10.8%) was the floor console between the driver and passenger seat (zone 53). It should be noted that the three most preferred zone preferences for this control are the same as those chosen for the power door lock control.

As was the case with the power door lock function, three people felt that all passengers should have access to a power window switch.

POWER WINDOWS

Location (% of switches in given location)



Radio

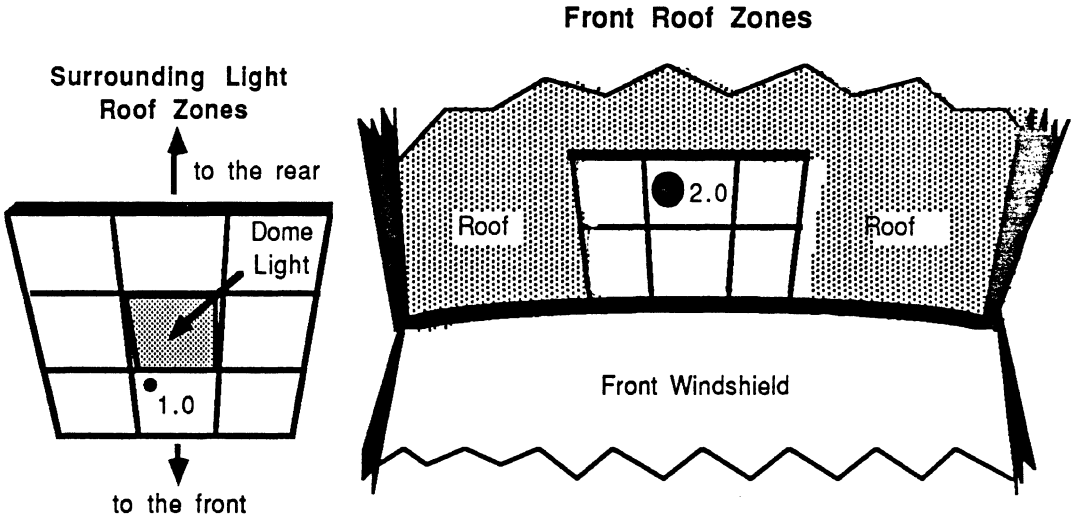
For the radio, location was the only variable under examination during this experiment. No data regarding method of operation and switch type preferred were collected.

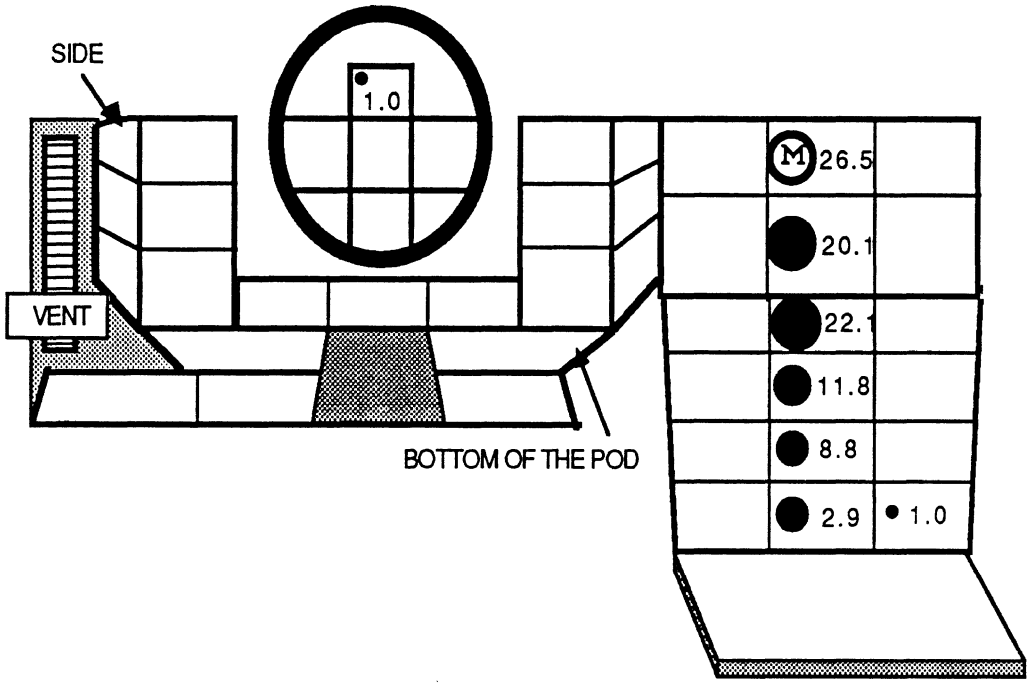
The upper center of the console region (zone 32) was selected most frequently for the radio location (26.5%). In addition, the two zones directly below (zones 35 and 42) were also frequently chosen (20.1% and 22.1% respectively). Many drivers commented that the radio should be placed high on the console because it is constantly adjusted and that the higher positioning allows for better vision of the road while tuning the radio. Finally, two drivers said the radio should be located on the car roof zones (roof light and front roof).

Relevant comments regarding the radio included two participants who wanted placement of the radio high on the dashboard so that the driver could maximize the time that his/her eyes are fixated on the road while adjusting the radio. Another interesting comment from one person was that the radio seek and scan buttons should be located on the steering wheel to facilitate easier access, and also to reduce the time spent fixating on the radio while adjusting.

RADIO

Location (% of switches in given location)





Rear Window Defrost

There was no location which was an overwhelming choice for the rear defrost. The lower left dashboard surface (zone 18) was the most preferred location (9.8%). Two other moderately preferred locations, zones 11 and 12 to the right of the pod were each chosen 7.8% of the time.

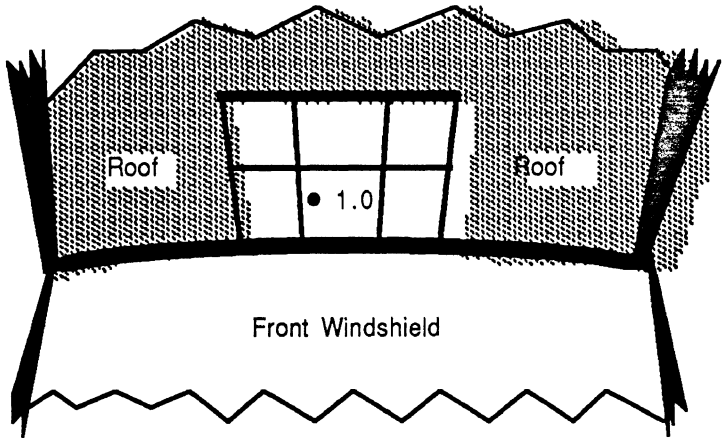
An overwhelming majority chose to operate the rear defrost control by pushing in (forward).

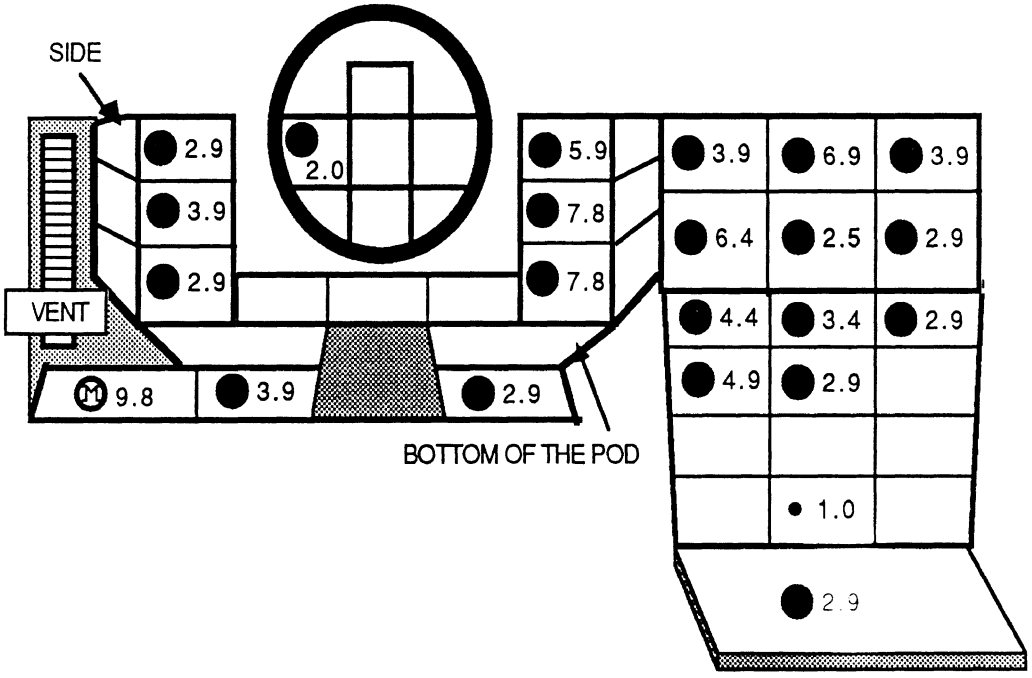
There were many interesting comments regarding the rear window defrost control. In fact, there were more comments regarding that control than any other. Considering that the rear defrost control is not a high priority item, this was a surprise to the experimenters. First, 17 drivers indicated that they wanted a light to be on when the rear window defrost was activated. The three people who commented on a color for this light said that the color should be either amber or orange. Second, two others suggested that the rear defrost have a timer or heat sensor so that it turns off automatically and to avoid a fire or electrical hazard. Third, two drivers felt that this control should be incorporated within the climate control cluster. Fourth, two people commented that the rear window defrost control should have separate settings for ice and defrost, or alternatively, it should have a way to set an exact rear defrost temperature.

REAR WINDOW DEFROST

Location (% of switches in given location)

Front Roof Zones





This page is reserved for the reader's notes.

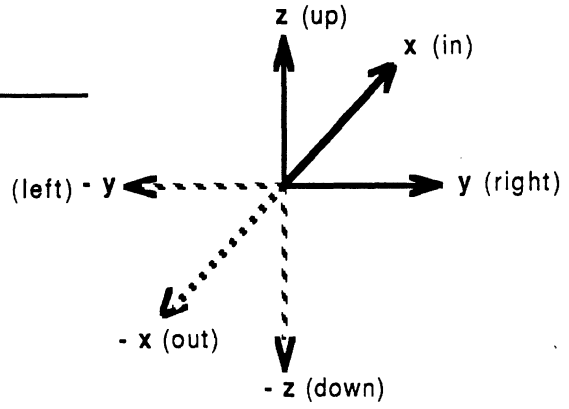
REAR WINDOW DEFROSTER

Switch Type (% of switches that are a given type)

%	Switch Type
49.5	two-way rocker
34.8	push button switch
7.8	push surface switch
2.9	slide switch
2.0	rotary knob
1.0	push-pull switch
1.0	paddle switch
1.0	toggle switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
89.2	Fx
3.9	Fy
2.9	-Fz
1.0	Fz
1.0	-Fx
1.0	+/-Fz
1.0	Tx



(axes relative to driver)

Rear Window Washer

The two locations most frequently chosen for the rear washer control switch were the lower left dashboard location (zone 18, 11.3%), and the middle right pod position (zone 11, 10.3%). An interesting point is that these two zones were the most frequently preferred location for both the rear defrost and rear wiper controls. In addition, the right stalk position (zone 27) was frequently chosen (7.8%) to control the rear washer.

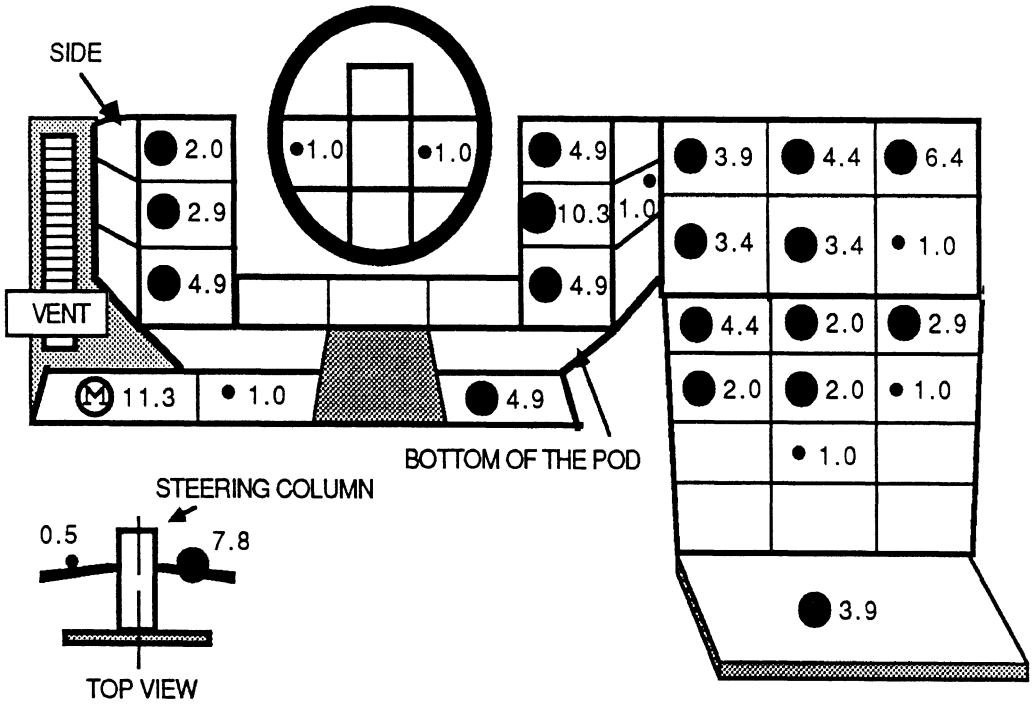
Two types of switches chosen over half (54.4%) of the time for the rear window washer switch were two position rockers (34.3%) and push buttons (20.1%). Other less frequently chosen switch types included rotary knobs (11.8%) and stalks (8.3%).

Similar to the rear defrost control, a push in (forward) was the most frequently chosen method of operation (78.9%).

The only relevant comment concerning the rear window washer function was that some drivers wanted this function to be incorporated with the rear window wiper function in a single multifunction switch.

REAR WINDOW WASHER

Location (% of switches in given location)



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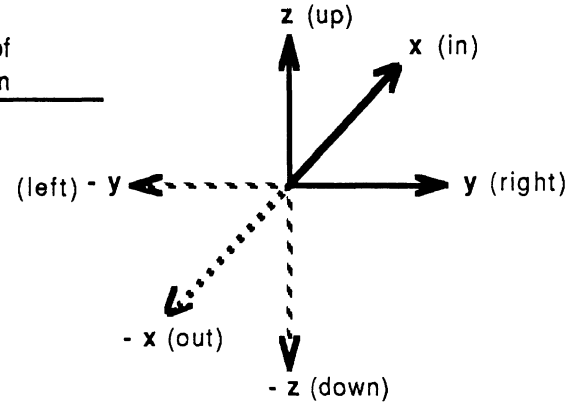
REAR WINDOW WASHER

Switch Type (% of switches that are a given type)

%	Switch Type
34.3	two-way rocker
20.1	push button switch
11.8	rotary knob
8.3	stalk
7.8	combination switch
7.8	slide
6.9	push surface switch
1.0	push-pull switch
1.0	pod
1.0	rotary handgrip

Method of Operation (% of switches operated using given method)

%	Method of Operation
78.9	Fx
6.9	-Fy
4.4	-Fz
2.9	Tx
2.5	Fy
2.5	Fz
1.0	-Fx
1.0	+/-Fx



(axes relative to driver)

Rear Wiper

Zone 11 in the middle of the right side pod was the most preferred location (13.2%) to house the rear wiper control. The lower left most zone of the dashboard (zone 18) continued its popularity for rear window controls. This zone was the second most preferred location for rear wiper control.

Two position rocker switches were the most frequently selected (37.3%) rear wiper switch type. Rotary and push button switches were the next two most preferred types, but their combined selection percentage (28.9%) is still less than that of the rocker type switches.

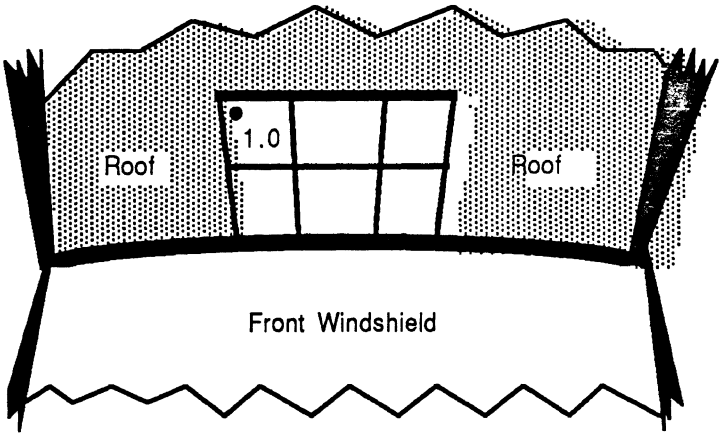
Paralleling the other rear window functions, the majority of drivers (54.4%) preferred to activate the rear wiper with a push in (forward). A significantly smaller percentage of the drivers wanted to operate the rear wiper control by twisting in.

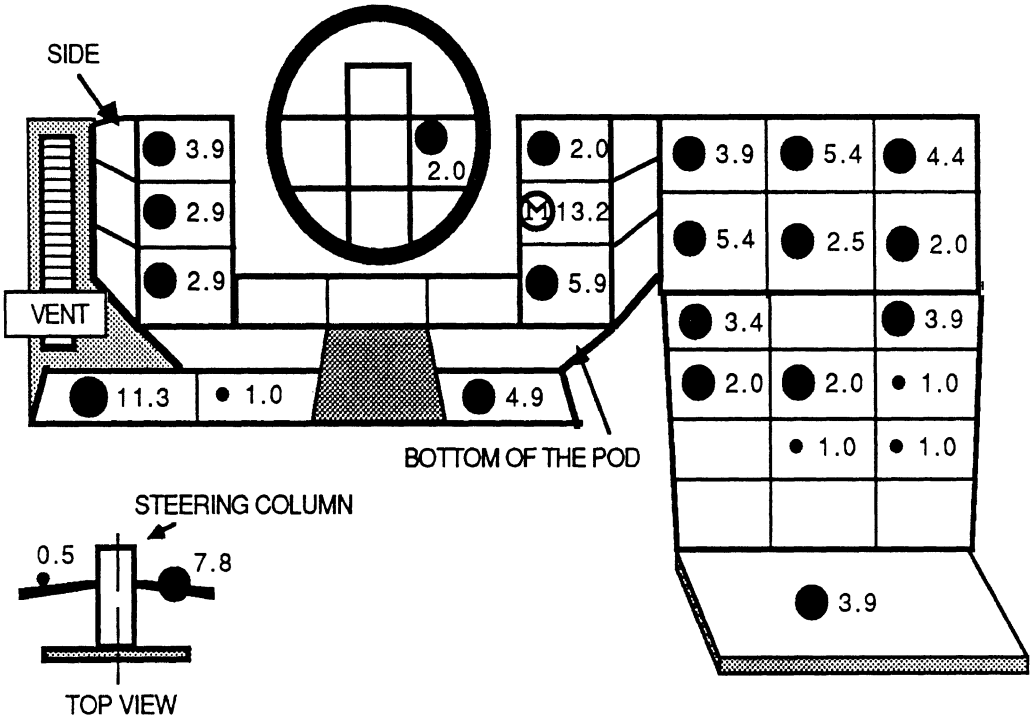
A number of people wanted all the rear wiper controls to be similar in terms of functionality and operation to the front wiper control. Further, as was previously stated, many drivers wanted this function to be incorporated with the rear window washer function as part of a single multi-functional switch.

REAR WINDOW WIPER

Location (% of switches in given location)

Front Roof Zones





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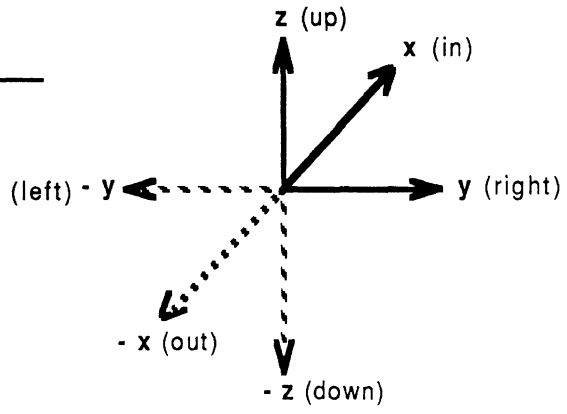
REAR WINDOW WIPER

Switch Type (% of switches that are a given type)

%	Switch Type
37.3	two-way rocker
14.7	rotary knob
14.2	push button switch
8.8	slide
8.3	stalk
7.8	combination switch
3.9	push surface switch
1.0	push-pull switch
1.0	pod
1.0	rotary handgrip
1.0	toggle switch
1.0	thumb wheel switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
54.4	Fx
13.7	Tx
7.4	-Fz
5.4	+/-Fz
4.4	Fy
4.4	Fz
3.9	-Ty
2.0	Ty
1.0	-Fx
1.0	+/-Fx
1.0	+/-Fy
1.0	-Tx
0.5	Tx&y



(axes relative to driver)

Steering Adjustment

The steering adjust function represented a unique control since none of the drivers tested had ever even heard of such a function. Drivers were therefore not affected by their previous experience in locating this control. The lower right side of the dashboard (zone 20) was the most preferred zone (15.7%) for placement of the steering adjustment control. Remarkably, this location is the same as the most popular position for the suspension adjustment control. This relationship may have arisen because participants typically positioned these two controls at nearly same time during the experiment. No other singular location was clearly preferred for operating this control. The unfamiliarity with the steering adjust function most likely played a role in the random distribution of locations for this control.

The two-position rocker was the test participants' overwhelming choice (58.3%) as the switch type for the steering adjustment control. Push buttons were also a moderately popular choice (16.7%).

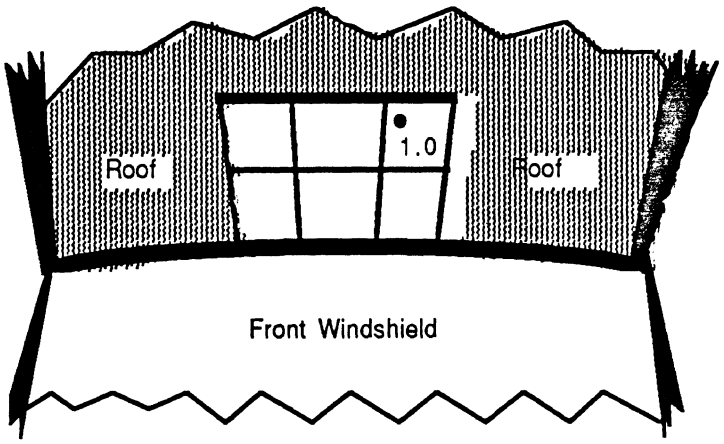
The push in (forward) motion was most frequently chosen to operate the power mode of the steering adjust control (77.9%). This is certainly the result of the control being frequently located on the face of the instrument panel.

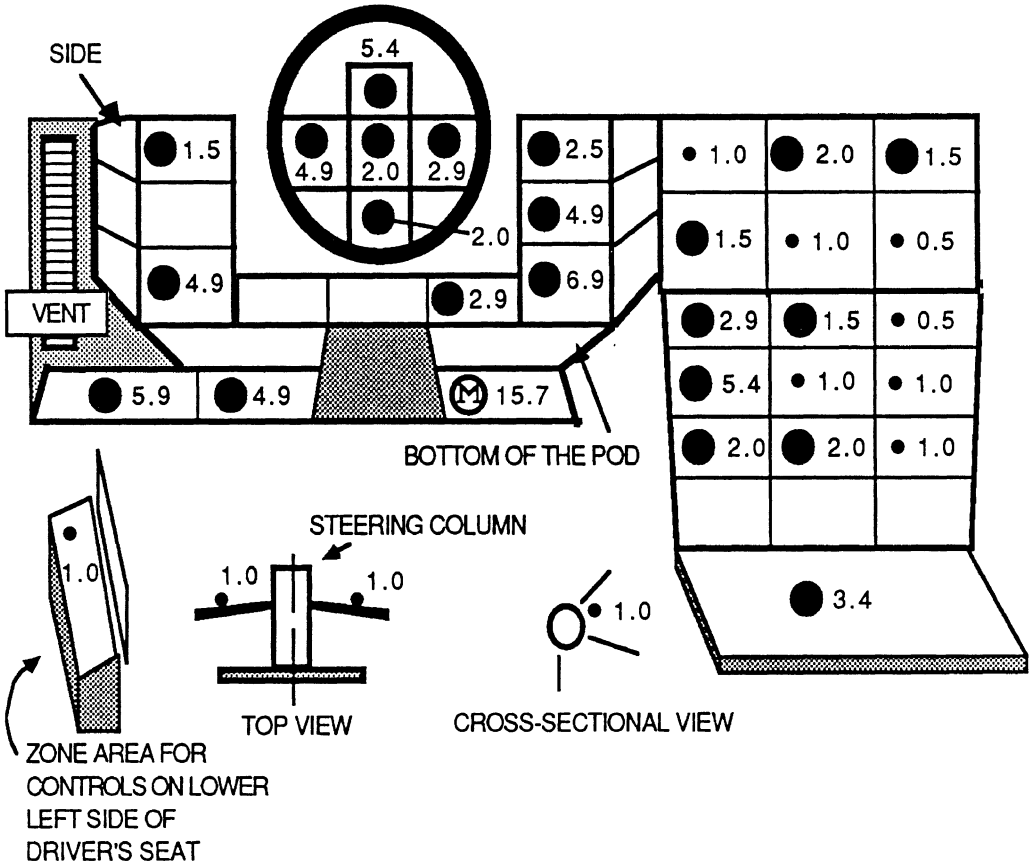
Interesting comments regarding the steering adjust control included the idea of incorporating lights on the switch to help indicate whether the steering is in manual or power mode. Colors suggested to be used for this purpose included green, yellow, and blue. Further, two participants felt that the steering wheel should automatically default to the power steering setting when the car is started.

STEERING ADJUSTMENT

Location (% of switches in given location)

Front Roof Zones





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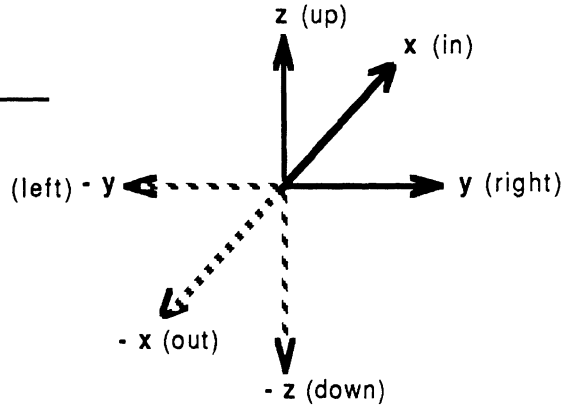
STEERING ADJUSTMENT

Switch Type (% of switches that are a given type)

%	Switch Type
58.3	two-way rocker
16.7	push button switch
6.9	toggle switch
6.9	slide
5.4	push surface switch
2.9	rotary knob
2.0	stalk paddle switch
1.0	

Method of Operation (% of switches operated using given method)

%	Method of Operation
77.9	Fx
5.9	+/-Fz
4.4	-Fz
3.9	+/-Fy
2.0	+/-Fx
1.0	Fy
1.0	Fz
1.0	-Fy
1.0	Tx
1.0	+/-Tx
1.0	+/-Ty



(axes relative to driver)

Suspension Adjustment

As can be seen from the percent of switches in a given location figure, there was no single location chosen an overwhelming majority of the time. Driver unfamiliarity with the suspension adjust function, (as with the steering adjust) clearly played a role in this random distribution of locations for this control. However, drivers most often (13.7%) selected the lower right side of the instrument panel (zone 20) as their preferred location for the suspension adjustment control. This location is the same as the most selected position for the steering adjustment control. Some other popular locations included the lower left dash zones (18-19) which accumulated 6.9% and 5.9% respectively. This relationship may have arisen because drivers positioned these two controls at nearly same time during the experiment (often last).

The two-position rocker was the overwhelming choice (61.3%) by drivers to control the suspension adjust. Drivers noted that the rocker should in some way identify and control the default setting (firm, soft) for their ride.

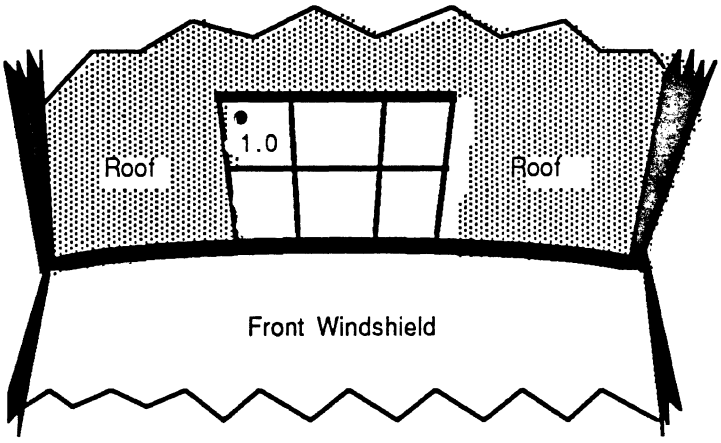
The majority of the participants tested (73.0%) operated the suspension adjust luxury or soft ride mode by using a push in (forward).

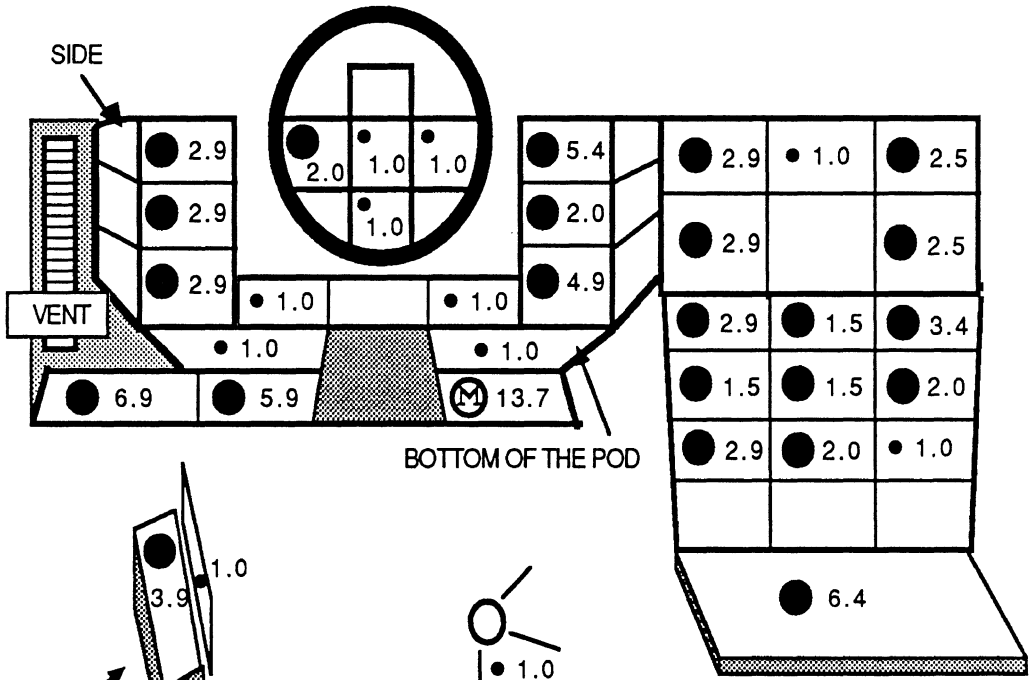
As was the case for the steering adjust function, comments concerning this function included having lights incorporated on the switch to help indicate the current suspension adjust setting.

SUSPENSION ADJUSTMENT

Location (% of switches in given location)

Front Roof Zones





ZONE AREA FOR CONTROLS ON LOWER LEFT SIDE OF DRIVER'S SEAT

CROSS-SECTIONAL VIEW OF STEERING COLUMN

This page is reserved for the reader's notes.

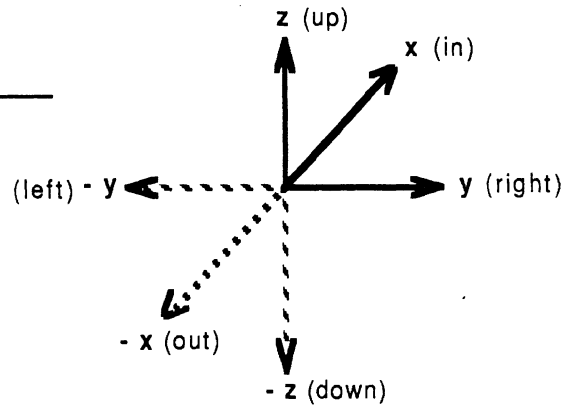
SUSPENSION ADJUSTMENT

Switch Type (% of switches that are a given type)

%	Switch Type
61.3	two-way rocker
15.2	push button switch
6.9	push surface switch
5.9	slide
5.9	toggle switch
2.9	rotary knob
1.0	thumb wheel switch
1.0	paddle switch

Method of Operation (% of switches operated using given method)

%	Method of Operation
73.0	Fx
7.4	-Fz
4.9	+/-Fy
3.9	+/-Fz
2.9	Fz
2.0	Fy
2.0	+/-Fx
1.0	Tx
1.0	-Ty
1.0	+/-Tx
1.0	+/-Ty



(axes relative to driver)

Turn Signal

As seen in the figure, the most preferred location (76.5%) for the turn signal control was the left side stalk position (zone 26). Surprisingly, the second most preferred positions for the left and right turn signal was the combination of the left and right wheel spoke positions (8.8%) (zones 81 and 82, respectively). Considering the strength of the turn signal stereotype, this represented an incredible finding since no such design has ever existed. The design was truly a novel idea; however, when the steering wheel was rotated 180 degrees, orientation-related errors such as pushing the left spoke for a right turn were observed. It should be noted that in normal driving situations it is unlikely a driver would need to signal a turn when the steering wheel is rotated 180 degrees.

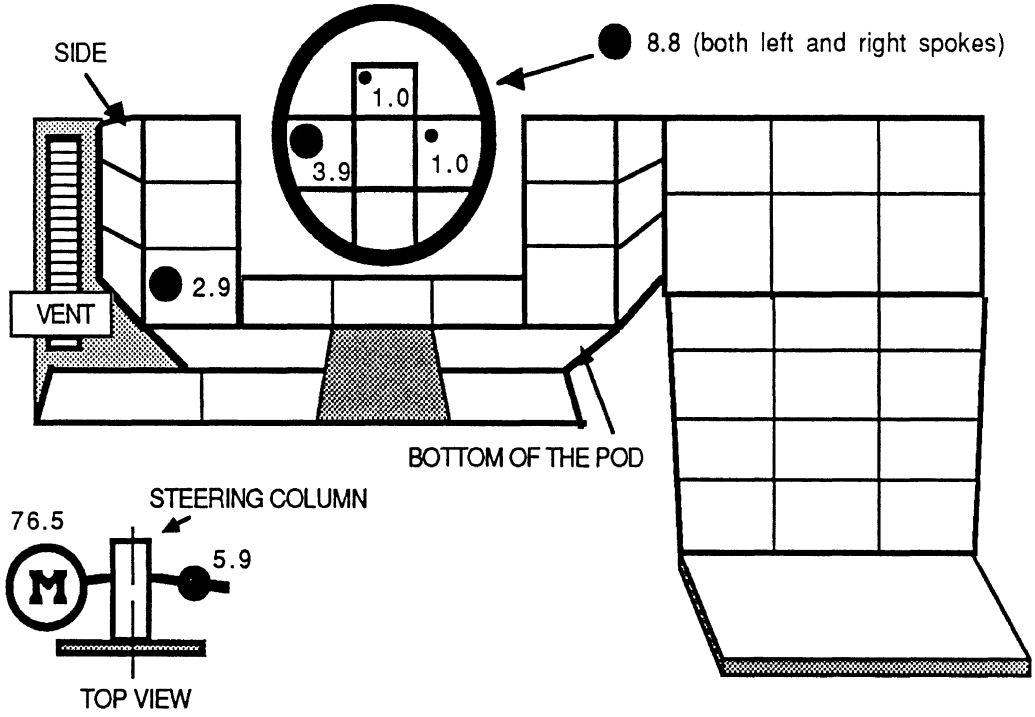
As can be seen in the method of operation table, the overwhelming preference (84.1%) was to operate the turn signal by pushing up or down. An occasionally chosen (16.7%) method of operation was to push in (forward).

The switch type that was overwhelmingly preferred was the stalk (82.5%). The push surface arrows to signal for a turn were preferred by 12.6% of the drivers. This result was totally unanticipated.

Relevant comments regarding the turn signal function concerned the frequent desire to use arrow-shaped push surfaces for the turn signal. This indicated that a visual direction cue, such as an arrow shape, was desired by many of the drivers. When they were asked about the rotational problem they experienced, a typical comment was that "The engineers will figure out how to design the arrows so I don't make mistakes in turning."

TURN SIGNAL

Location (% of switches in given location)



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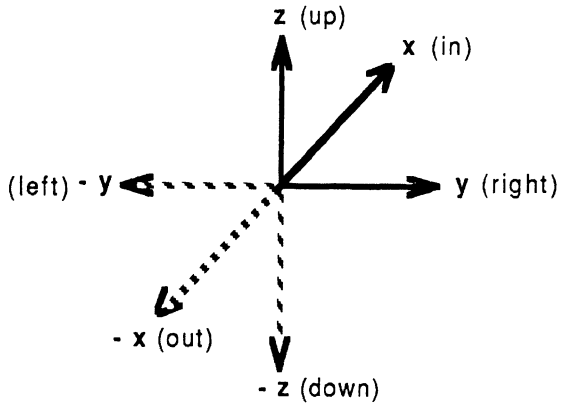
TURN SIGNAL

Switch Type (% of switches that are a given type)

%	Switch Type
82.5	stalk
12.6	push surface switch
3.9	two-way rocker
1.0	lever

Method of Operation (% of switches operated using given method)

%	Method of Operation
81.4	+/-Fz
16.7	Fx
1.0	-Fz
1.0	+/-Fy



(axes relative to driver)

Pooling of Zones

The third and final section of the "Results and Discussion" concerns a more global view of where secondary controls should be located. An analysis of pooled (closely associated) zones was conducted so that general positional preferences could be mapped. Designers need not always pinpoint the exact location of a specific control. Instead, they may desire to vary the specific location of a control within a general area. Thus the pooled data may be sufficient for identifying driver preferences for the location of secondary controls.

Presented below are the summary data for pooled zones. The reference point used in these pooled zones was a person comfortably seated in the driver's seat. Zones were pooled for analysis based upon logical break points in the dashboard layout. For example, the left side of the pod is clearly different from the right side pod, as is the steering wheel, from the lower dash. (See Table 4.)

Table 4. Names and Numbers of Pooled Zones

Zone # Range	Description of the New Pooled Zone
(1-3)	Left pod (side)
(4-6)	Left pod (facing)
(7-9)	Lower center pod (facing)
(10-12)	Right pod (facing)
(13-15)	Right pod (side)
(16-17)	Lower center pod (underside)
(18-20)	Lower dash under pods (facing)
(21-22)	Lower left side of drivers seat
(24-25)	Right side steering column
(26)	Left stalk
(27)	Right stalk
(31-36)	Upper area of the main console
(41-52)	Lower area of main console
(53)	Floor console between seats
(55-58)	Driver's side door and armrest
(61-66)	Forward ceiling area
(71-78)	Aft ceiling area near dome light
(81-89)	Steering wheel zones

Shown in Table 5 are the preference percentages for each control and the associated pooled zones. When no clear cut pooled zone was preferred, the top two or three are presented.

Table 5, Pooled Zone Preferences for Secondary Controls

Control Type	(% preferring)	Pooled Zone
Auditory Horn	(98.1)	Steering wheel zones
Beam Select	(61.2)	Left stalk
Climate	(50.2)	Upper area of center console
	(45.6)	Lower area of center console
Cruise On	(44.4)	Steering wheel zones
Cruise Resume	(48.5)	Steering wheel zones
Cruise Set	(48.5)	Steering wheel zones
Dome Light	(28.2)	Ceiling zones near Dome light
	(20.4)	Lower dash zones under pods
Front Washers	(33.0)	Right stalk
	(16.5)	Left stalk
	(15.5)	Right pod zone
Front Wipers	(33.0)	Right stalk
	(16.5)	Left stalk
	(16.5)	Right pod
Hazard	(33.0)	Lower dash zones under pods
Headlights	(31.1)	Left pod
	(29.1)	Left stalk
	(23.3)	Lower dash zones under pods
Ignition	(49.5)	Right side of steering column
Optical Horn	(53.4)	Left stalk
Panel Brightness	(38.8)	Lower dash zones under pod
	(28.2)	Left pod
Power Door Lock	(80.6)	Driver's armrest on door
Power Seat	(50.5)	Low left side of driver's seat
Power Windows	(73.8)	Driver's armrest on door
Radio	(46.6)	Lower area of center console
	(45.6)	Upper area of center console
Rear Defrost	(27.2)	Upper area of center console
	(21.4)	Right pod
	(16.5)	Lower dash zones under pod
Rear Washer	(21.4)	Upper area of center console
	(20.4)	Right pod
	(16.5)	Lower dash zones under pod
Rear Wiper	(22.3)	Upper area of center console
	(21.4)	Right pod
	(16.5)	Lower dash zones under pod
Steering Adjust	(26.2)	Low dash zones underneath pod
	(17.5)	Steering wheel zones
	(16.5)	Lower area of center console
Suspension Adjust	(26.2)	Low dash zones underneath pod
	(17.5)	Lower area of center console
Turn Signal	(76.7)	Left side stalk

An interesting point associated with these data is that some controls did not match their most preferred location with the most preferred pooled zone. For example, the unpooled results may have indicated a right side stalk control as the most preferred zone, however the pooled data has indicated that two adjacent pod positions were more popular when their data was pooled.

CONCLUSIONS

If driver preferences are the only criterion by which designers select secondary controls locations, switches, and operation methods, then the following are **highly recommended** by the results:

1. Auditory horns should use large push surfaces (at least 2 inches by 2 inches) mounted on the the center hub of the steering wheel.

2. The beam flash and beam select ("high beams") control should be located on the left stalk mechanism. In line with current design practice, this stalk should be about 5 inches long and should use either a push forward or pull back method of operation.

3. The turn signal should be located on the left stalk and operate by pushing it up and down. The stalk should be about 5 inches long from the column.

4. The radio should be positioned high on the center console so that it is easy to adjust from the driver's seat. The climate control should be a horizontal design that is located below the radio on the center console.

5. The cruise functions (on/off, set, and resume) should be located on the steering wheel. These cruise controls should all be two-position rocker switches.

6. The front washer and wiper functions should be located on the right stalk, which should be about 5 inches long. There should be at least three speed settings, including an intermittent function. The stalk should push up to increase the speed setting and pull toward the driver for wash.

7. The power window and lock functions should be positioned on the driver's side armrest with the window control in front of the lock control. Further, the power seat control should be on the lower left side of the driver's seat.

- *CONCLUSIONS* -

There were some designs that can only be partially supported by the findings. These design schemes are classified as **suggestions**, that is they were not clear cut recommendations from the drivers tested in this experiment.

The following appear to be preferred:

1. The ignition should be mounted on the right side of the steering column. This control should also contain a small light that operates for 10-15 seconds after the driver's door is opened to help drivers find the ignition in the dark.

2. The panel light switch, a rotary knob, should be located on the lower left dashboard.

3. The dome light control should be located on the headliner near the front edge of the light itself. This control should use a three position rocker switch (door activated, light on, light off).

4. The hazard switch is preferred on the lower right dashboard position near the ignition. Further, it should flash during operation.

There were some controls for which a recommended location cannot be given because no consistent preferences were found among drivers. These controls include: suspension adjust, steering adjust, rear defrost, rear wiper and wash. For these secondary controls, designers may want to use the results detailed within this report to identify the possible locations.

Three factors significantly contributed to the quality of the results obtained within this investigation. First, the extensive collection of switches (nearly 1000) enabled drivers to select from a variety of current and generic switch designs. Although this collection required nearly a year to purchase and fabricate, the study clearly benefited from the extensive effort. It should be noted that a significant amount of this production time was spent waiting for switch donations to be processed. Consequently, one way to reduce this production time would be to purchase the switches needed and not to rely on donations for any similar studies.

A second factor which was critical to the quality of the results was to incorporate the use of a simulated driving task using the instrument panel which the participant had just designed. This was critical because drivers have no idea how usable the instrument panel is until they have had a chance to use them under "real" driving conditions. This represents a unique addition in the determination of driver preferences for secondary controls.

A third key factor which directly contributed to the quality of the results was the automated data collection procedure. This on-line, real-time quality control process eliminated numerous errors by flagging many inconsistencies which would have likely gone unnoticed using paper and pencil collection methods. Some of these inconsistencies included mismatches between switch type and switch number, illegal zones, and control type.

Thus, this report identifies very specifically which types of switches drivers want for various secondary controls, where they should go, and how they should operate. But designers should apply these data with some care for the following reasons. First, there were a number of cases where pod locations (which are easy to reach and label) were second choices (but not by much) behind more conventional locations. Few drivers have driven cars with pod controls, and even though told to think about the future, drivers may still be bound by previous experience. Second, this research did not explicitly address why drivers had certain preferences for location, switch type, and operation method. Over time driver preferences will change and without an understanding of the reasons for decision, it is difficult to say when the results of this experiment no longer apply. How and when manufacturers should follow popular opinion (as expressed by drivers here) and when the manufacturers should take the initiative to reshape it is a very difficult decision.

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APPENDIX A - LIST OF SWITCHES TESTED

#	SWITCH TYPE	FUNCTION	SIZE	SOURCE (WxH)	MODEL
1	rocker		11/16x1	Littelfuse	780865BP
2	rocker		.75x1	Littelfuse	780601BP
3	rocker		7/8x11/16	Littelfuse	780765BP
4	rocker		.75x13/16	Littelfuse	780693BP
5	rocker		5/8x7/8	Littelfuse	780646BP
6	rocker		3/8x5/8	Littelfuse	780609BP
7	rocker		.75x9/16	GC Electr	35-620
8	rocker		.6x.75	GC Electr	35-632
9	paddle		.5x9/16	GC Electr	35-316
10	knob		1 7/16 dia	GC Electr	37-576
11	knob		1 1/8 dia	GC Electr	37-574
12	knob		7/8 dia	Augat	92012
13	knob		11/16 dia	Augat	92007
14	thumb		1/16x.75	GC Electr	35-850
15	toggle		3/16x.5	GC Electr	35-854
16	slide		.25x.25	GC Electr	35-240
17	slide		.25x5/16	GC Electr	35-242
18	slide		.25x.25	GC Electr	35-210
19	slide		1/8x1/8	GC Electr	35-202
20	pshbtn		3/8x.5	GC Electr	35-413
21	pshbtn		3/8 dia	GC Electr	35-411
22	pshpll		.5 dia	Littelfuse	145701BP
23	pshpll		7/16 dia	Littelfuse	145702BP
24	pshpll		7/8 dia	General	18110
25	rotary		3/16x3/8	Leviton	
26	pshbtn		.75x.75	GC Electr	35-484
27	pshbtn		3/16x3/8	Leviton	800-575
28	thumb		1/16x.75	Leviton	801-413
29	knob		9/16 dia	GC Electr	37-578
30	rocker	crs control	5/8x1	85 Berlinetta	14084303
31	knob		9/16 dia	GC Electr	37-584
32	rocker		11/16x7/8	Littelfuse	780692BP
33	knob		.75 dia	GC Electr	37-572
34	knob		1 dia	GC Electr	37-544
35	rocker	hazard	1x1.75	84 VW Golf	
36	pshbtn		3/8 dia	GC Electr	35-406
37	pshbtn		.5 dia	GC Electr	35-422
38	pshbtn		.25 dia	GC Electr	35-453
40	pshbtn		3/8 dia	GC Electr	35-408
41	pshbtn		3/8x3/8	GC Electr	35-412
42	pshbtn		3/8 dia	GC Electr	35-852
43	rocker		5/16x11/16	GC Electr	35-662
44	pshbtn	wipe/wash	7/8x2	83 Honda Civic Wagon	
45	pshbtn	rear defrost	7/8x2	83 Honda Civic Wagon	
47	knob	panel bright	.5 dia	84 Honda Civic Wagon	
48	poddel	wipe/wash	2.5x2	85 Camaro Berlinetta	

49	pod	climate ctrl	3x3.5		
50	rocker	headlt/dim	2.25x2	84 Ford Tempo	
51	rocker	headlight	.5x1.5	87 Ford Aerostar	
52	paddle	headlt/foglt	3x2.25	87 Ford Mustang	
53	slide	crs. control	1/16x.25	87 Cadillac CDV	
54	slide	del wash/wipe	2.5x4	87 Chev Beretta	
55	slide	wash/wipe	1.25x3.25	87 Chev Corvette	
56	slide	wash/wipe	2.5x3	87 Chev Beretta	
57	slide	del wash/wipe	2.5x3	87 Chev Beretta	
58	combo	headlight	2.25x2.75	87 Pontiac GrandAm	
59	combo	del wash/wipe	2x4.5	87 Pontiac GrandAm	
60	touch	climate ctrl	6x2.25	87 Buick LeSabre	
61	stalk	del wipe/cru	4.25x1	86 Toyota Camry	465239405
62	stalk	del wipe/cru	5x1	86 Mazda 626	BG6766120C
63	lever	wiper	2.75x1.25	86 Toyota MR2	8465117020
64	lever	headlight	2.75x1.25	86 Toyota MR2	8411117021
66	pshbtn	rear defog	1 dia	86 Toyota MR2	8479017020
67	rocker	headlt/parklt	1x1.5	86 Pontiac Fiero	
68	rocker	heater	1x1.75	86 VW Jetta	
69	rocker	hazard	1x2	86 VW Jetta	
70	knob	headlight	2 dia	86 Saab 9000	
71	stalk	crs/turn/brt	6x.5	86 VW Golf	
72	stalk	wipe/wash	4x.5	86 VW Golf	
73	knob	headlight	1.5 dia	86 Mercedes	2015400183/64
74	stalk	del wipe/cru	4.5x7/8	86 Pontiac 6000	
75	stalk	headlt/turn	5x.75	86 Mazda 626	BG6766120C
76	pshbtn	hazard	1 dia	86 Mazda RX7	FB01661840
77	pshbtn	rear defrost	1 dia	86 Mazda RX7	FB01661740
78	rotary	del wipe/wash	2 dia	86 Mazda RX7	FB01661810
79	rotary	headlight	2 dia	86 Mazda RX7	FB01661710
80	knob	panel light	1 dia	86 Mazda RX7	FB01661730
81	paddle	del wipe	2.75x1.5	85 Mazda 626	GA9766170H00
82	stalk	trn/wash/wipe	5x1	87 Ford Taurus	
83	combo	lights	2x2.75	85 Chev Berlinetta	
85	combo	del wiper	1x3.5	86 VW Golf	
86	thumb	light dim	.25x1	86 VW Golf	
87	stalk	lights	5x.75	82 Mazda 626	
88	stalk	del wipe/wash	2.25x.75	83 Honda Civic Wagon	
89	stalk	del wipe/wash	3x.75	82 Mazda 626	
90	rocker		3/8x1	Chrysler	
91	combo	del wipe/wash	1.75x40	86 Buick Somerset	25517587
92	stalk	del wipe/wash	5x1	86 Dodge Conquest	MB183952
93	pshbtn		1.75x5.5	86 Buick Somerset	22534143
94	combo	wipers	1.5x3	86 Chev Cavalier	14078936
95	rocker	lights	1.75x1.75	86 Chev Cavalier	1995289
96	slide	del wipe	1.75x2	86 Chev Spectrum	94134825
97	pod		2.25x3.25	86 Chev Spectrum	94134821
98	rocker	headlight	7/8x1.25	86 Nissan Maxima SE	2598001L60
99	rocker	rear defrost	5/8x1 5/8	86 Chev Cavalier	14086670
100	stalk	del wipe/crs	4.75x1	86 Chev Caprice	25031456
101	rocker	headlt	.75x5	86 Nissan 300ZX	2598017P01
102	pshbtn		1x1.25	86 Chev Cavalier	14057590
103	paddle	rear wipe	2x1.5	86 Nissan 300ZX	2521017P15
104	paddle	cruise	2x1.5	86 Nissan 300ZX	2521501P09

106	stalk	del wipe/wash			1995290
105	thumb		.25x1.5	86 Chev Cavalier	2556019P00
107	stalk	del wiper	5x1	86 Honda Civic CRX	2556019P00
108	stalk	headlt	5x1	86 Honda Civic CRX	2556019P00
109	knob		1.25 dia	86 Volvo 740 GLE	13233762
110	stalk	wiper	7x1	86 Mercedes 300D	1245450424
111	stalk	crs control	6x.5	86 Mercedes 300D	1245450924
112	stalk	turn signal	5.5x1	86 BMW 635 CSI	61311377071
113	stalk	crs control	6x1	86 BMW 500	61311377979
114	pod			86 Subaru XT	83001LA351
115	paddle	lights	2.5x1.5	85 Mazda 626	GA9766180K00
116	rotary	del wipe/wash	1 7/8x1 1/8	86 Isuzu Impulse	8941204190
117	rotary	headlight	1.25x1 1/8	86 Isuzu Impulse	8941204020
118	rocker	headlight	1 3/8x.25	86 Mercury Sable	E64Y11654A
119	thumb	panel dim	1.5x.25	86 Mercury Sable	E64Y11691A
120	pshbtn	rear defrost	2 1/8x1.25	86 Mercury Sable	E64Y18C621A
121	stalk	del wipe/wash	5x7/8	86 Merc Cougar XR7	E5SZ17A553B
122	stalk	headlight	6x.75	86 Merc Cougar XR7	E5SZ13305A
123	rocker	r. wipe/wash	5/8x1	83 Mercury Lynx	E1FZ17A553C
124	combo	del wipe/wash	3x1.5	86 Ford Tempo GL	E63Z17A553B
125	pshbtn	lights	1x3	86 Dodge Conquest	MB337938
127	pshbtn	headlts	2x1.5	86 Cadillac Seville	1635565
128	rocker	wipe/wash	1.5x.25	Chrysler	
129	rocker	wipe/wash	5/8x1.75	Chrysler	
130	rocker	trunk	1.5x.25	Chrysler	
131	pshbtn	trunk	.5x.5	Chrysler	
132	rocker	rear defrost	1.5x1.25	Chrysler	
133	rocker	rear defrost	5/8x1 5/8	Chrysler	
134	rocker	on/off	1x1	Chrysler	
135	knob	on/off	3/4 dia	Chrysler	
136	rocker	on/off	1.25x3/8	Chrysler	
138	toggle			Chrysler	
139	toggle			Chrysler	
140	pshbtn		1/8 dia	Chrysler	
141	pshbtn	open rear	1/8 dia	Chrysler	
142	stalk	headlight	5.5x1	87 Subaru GL Hatch	83113GA370
143	stalk	wipe/wash	5.25x1	87 Subaru GL Hatch	83113GA370
144	stalk	headlight	5.5x.75	87 Toyota Corolla SR5	8411219505
145	stalk	wipe/wash	5/75x.75	87 Toyota Corolla SR5	8465280006
146	rotary	headlight	1.75x1.5	87 Dodge Colt	MB327203
147	rotary	wipe/wash	1.75x1.5	87 Dodge Colt	MB357876
148	rocker	hazard	2.25x7/8	87 Audi 500	855941509012
149	rocker	rear defr	2.25x7/8	87 Audi 500	
150	rocker	headlt/dimmer	2.25x1 7/8	87 Audi 500	855941531B/01Z
151	paddle	wash/wipe	3x2.5	85 Mazda 626	GA9766170H00
152	paddle	fr defr/haz	3x2.5	85 Mazda 626	GA9766170H00
153	slide	panel lights	1 1/8x.5	86 Buick Somerset	25517587
154	pshbtn	rear defrost	1 1/8x.5	86 Buick Somerset	22534143
155	thumb	dimmer	5/16x7/8	87 Audi 500	
156	stalk	lights	5x5/8	86 Honda Civic CRX	2556019P00
157	slide	climate	5.5x2.25	LCI	
158	stalk	wipe/wash/crs	5.5x7/8	Chrysler	
159	combo	wipe/wash	2x3.5	LCI	
160	pshbtn	hazard	.75x.25	Ford Escort	

161	push	square	3.5		
162	push	square	2.5		
163	push	square	2		
164	push	square	1.25		
165	push	square	.75		
166	push	square	.5		
167	push	rectangle	2 3/8x1.5		
168	push	rectangle	1x.5		
169	push	triangle	1.25		
170	push	triangle	1		
171	push	triangle	.75		
172	push	trapezoid	1.5 base		
173	push	trapezoid	1 1/8 base		
174	push	trapezoid	5/8 base		
175	push	arrow	3 long		
176	push	arrow	2.5 long		
177	rotary	headlt/dimm	2x1.75	87 Subaru GL Hatch	783011270
178	rotary	wipe/wash	2x1.75	87 Subaru GL Hatch	783021520
179	knob	fan	1 5/8 dia	87 Ford Mustang	E6DZ18519-C
180	knob	temperature	1 5/8 dia	87 Ford Mustang	E6DZ18519-B
181	knob	select	1 5/8 dia	87 Ford Mustang	E6DZ18519-A
182	slide	int wipe	2.25x.75	86 Subaru XT	
183	slide	panel dimm	2.25x.75	86 Subaru XT	
184	pshbtn	hdlt/dimm	2.5x3	87 Chevy Beretta	
185	stalk	headlt	1 1/8x5	83 Honda Civic Wgn	
186	thumb	dimmer	1 3/8x1/4	87 Chevy Beretta	
187	rocker	rear wash	5/8x1 1/8	86 Chevy Cavalier	
188	pshbtn	hazard	7/8x.25	86 Cadillac Seville	
189	thumb	dimmer	1.25x.25	86 Cadillac Seville	
190	thumb	dimmer	1.25x.25	86 Cadillac Seville	
191	pshbtn	front wash	1x.5	86 Buick Somerset	
192	pshbtn	turn signal	1 1/8x.25	85 Chevy Berlinetta	
193	pshbtn		1x3/8	86 Subaru XT	
194	pshbtn	crs set/reset	2.75x1.5	85 Mazda 929	
195	slide		3x2	85 Mazda 929	
196	rocker	fr. wipe/wash	1x4.75	85 Mazda 929	
197	rocker	headlights	1x4.75	85 Mazda 929	
198	knob		1.5 dia	GC Electric	
199	knob		7/8 dia	GC Electric	
200	knob		1.5x3/8	GC Electric	
201	knob		7/8x1.25	GC Electric	
202	knob		.5x2	GC Electric	
203	knob		.75 dia	GC Electric	
204	knob		1 1/8 dia	GC Electric	
205	knob		5/8 dia	GC Electric	
206	knob		3/4 dia	GC Electric	
207	rocker		5/16x7/8	GC Electric	
208	pshbtn	foglights	2x1.25	86 Nissan 300ZX	
209	pshbtn	rear defr	2x1.5	86 Nissan 300ZX	
210	thumb	rear defr	2.5x1	87 Chevy Beretta	
211	pshbtn	hazard	2x1.25	86 Nissan 300ZX	
212	pshbtn	beam adjust	2x1.5	86 Nissan 300ZX	
213	thumb	rear defr	2.5x.75	87 Chevy Beretta	
214	slide	panel bright	2 7/8x1.75	85 Mazda 929	

215	pshbtn	front wash	2.25x1.25	86 Chevy Spectrum
216	combo	headlights	3x2	83 Citroen CX
217	pshbtn	rear defr	3.75x1.5	83 Citroen GSA
218	pshbtn	hazard	4x1.5	83 Citroen GSA
219	pshbtn		3.75x1.5	83 Citroen GSA
220	pshbtn		3.5x1.5	83 Citroen GSA
221	rocker		1.5x2	85 Citroen BX
222	rocker	turn signal	1.5x2	85 Citroen BX
223	rocker		5/8x1	87 Jaguar
224	slide		2.25x1 1/8	87 Jaguar
225	rocker		.75x1	87 Jaguar
226	rocker	fog lts	.75x1	87 Jaguar
227	rocker	hazard	.75x1	87 Jaguar
228	rocker	heat seat	.75x1	87 Jaguar
229	rocker		1.25x1.25	87 Jaguar
230	rotary	headlts	2x3	87 Jaguar
231	lever	cruise	1.5x3	87 Jaguar
232	pshbtn	seat adjust	2 5/8x2	87 Jaguar
233	rocker	turn signal	2.5x1	83 Citroen CX
234	pshbtn	horn	1.5x1.5	85 Citroen BX
235	slide	wipe/wash	1.5x3	85 Citroen BX
236	combo	wipe/wash	3x2.5	83 Citroen CX
237	rocker	turn signal	2.25x1	83 Citroen CX
238	pshbtn	hazard	3/8x3/4	83 Citroen CX
239	pshbtn	hazard	1x1.25	85 Mazda 929
240	push		.75x5/8	85 Mazda 929
241	push	rear defr	5/8x5/8	85 Mazda 929
242	push	beam adjust	5/8x7/8	85 Mazda 929
243	pshbtn		7/8x1	83 Citroen GSA
244	pshbtn	foglights	7/8x1	83 Citroen GSA
245	pshbtn	oil	7/8x1	83 Citroen GSA
246	pshbtn	hazard	7/8x1	83 Citroen GSA
247	pshbtn	rear defr	7/8x1	83 Citroen GSA
248	combo	lights	1.5x4.5	85 Citroen BX
249	combo	lights	2.5 dia	83 Citroen GSA
250	combo	wipe/wash	2.5 dia	83 Citroen GSA
251	pshbtn	wipe/wash	3.5x4	Subaru XT
252	pshbtn	lights	3.5x4	Subaru XT
253	push	arrow	3 3/8	
254	push	arrow	1.75	
255	push	arrow	1.5	

- APPENDIX A - LIST OF SWITCHES TESTED -

APPENDIX B - EXPERIMENTAL PROCEDURE

THE UNIVERSITY OF MICHIGAN
TRANSPORTATION RESEARCH INSTITUTE
HUMAN FACTORS DIVISION

DRIVER PREFERENCES FOR SECONDARY CONTROLS INSTRUCTIONS TO EXPERIMENTERS AND PARTICIPANTS

Before the experiment begins...

1. Make sure the TI Computer is on, the Input4A program is running, and you have a data disk in drive A. To start the Input4 program, cd to \SURVEY and type BASIC INPUT4A. Data filenames for each subject should correspond to the subject number, i.e. S1 for subject 1, S2 for subject 2, etc. Fill in as much of the biographical information as you can before the subject arrives.

2. Make sure the Commodore computer is on and the driving simulation program is running and ready for a 1 minute trial (instructions are next to the Commodore computer). Use the file "DATA" for the road pattern input.

3. Make sure the camera control box, camera, and monitor are turned on (turn the equipment on in that order, turn off in reverse order).

4. Make sure there are blank copies of all of the forms (Consent, Biographical, Backup Data Collection) on hand along with a Support Voucher (for paying participants).

5. Make sure you have money to pay participants. (If you need more, ask Flora or Paul Olson.)

6. Complete as much of the Biographical form as you can before the participant arrives (participant number, phone, sex, experimenter, date, time, etc.). Also print the participant's name on the Support Voucher and related information on the Master Participant List.

When the participant arrives ...

ARE YOU ___ ? *(Use their name.)* **HELLO, MY NAME IS ___ AND I AM ONE OF THE EXPERIMENTERS WORKING ON THE INSTRUMENT PANEL STUDY.** *(Don't say test.)* **BEFORE WE GET GOING, I WOULD LIKE TO NOTE THIS EXPERIMENT TAKES APPROXIMATELY 2**

HOURS AND YOU WILL BE PAID 20 DOLLARS FOR YOUR TIME. IF YOU WOULD LIKE TO VISIT THE REST ROOM, NOW WOULD BE A GOOD TIME TO DO SO. I SHOULD ALSO NOTE THAT SMOKING IS PROHIBITED IN THIS BUILDING, SO PLEASE REFRAIN FROM DOING SO.

Take them into the long lab and sit them down across the table from you near the mockup. **THE PURPOSE OF THIS EXPERIMENT IS TO DETERMINE WHAT KINDS OF SWITCHES PEOPLE PREFER FOR CONTROLLING THE HEADLIGHTS, WINDSHIELD WIPER, AND SO FORTH. THE RESULTS OF THIS STUDY WILL BE USED TO SELECT CONTROLS FOR FUTURE VEHICLES. SINCE YOU WILL BE DRIVING THOSE VEHICLES, YOUR OPINION IS IMPORTANT.**

BEFORE WE GET TO THAT, THERE IS SOME PAPERWORK TO COMPLETE. FIRST, YOU NEED TO SIGN THIS OFFICIAL CONSENT FORM THE UNIVERSITY REQUIRES US TO GIVE YOU, WHICH BASICALLY REPEATS IN WRITING WHAT I JUST SAID. *Have the participant sign the consent form.*

NEXT, WE NEED TO KNOW A LITTLE MORE ABOUT YOU. *You should fill out the form, so the information is legible. You should already have their name recorded.* **WHAT IS YOUR HOME ADDRESS?** *Be sure to get their zip code. If the participant is a student, just get their local address, not their permanent address.*

WHAT DO YOU DO FOR A LIVING? *Focus on how they spend most of their time. If the person is retired, note that along with their former occupation. If the person is a student, also list their major and level (junior, Ph.D. candidate, etc.) as well. If the person is a student with a part time job, ignore the job.*

You should already have their home phone. Also record their sex.

ARE YOU RIGHTHANDED, LEFTHANDED, OR AMBIDEXTROUS?

DO YOU NORMALLY WEAR GLASSES WHEN DRIVING? CONTACTS? TO THE BEST OF YOUR KNOWLEDGE, WHAT IS YOUR VISUAL ACUITY WHEN YOU DRIVE? IT'S 20 SOMETHING OR OTHER. IF YOU WEAR GLASSES OR CONTACTS WHEN DRIVING, WE WANT TO KNOW HOW WELL YOU SEE WITH THEM ON.

WHAT KIND OF VEHICLE DO YOU DRIVE MOST OFTEN? *If they are employed as a driver (e.g., truck driver), then ask about their "personal vehicle" as well. In any case, make sure you get the make model and year. If they are unsure, you might want to look at their vehicle after the experiment is over, if they drove it to UMTRI. If you still can't tell, take a look at the owner's manual, if they have one.*

ABOUT HOW MANY MILES DO YOU DRIVE IN A YEAR? *If they don't know, then ask them for a weekly average and multiply by 52. Tell them what it would work out to be.*

DOES THAT VEHICLE HAVE A CRUISE CONTROL? A POWER SEAT? POWER DOOR LOCKS? POWER WINDOWS? A REAR DEFROSTER? A REAR WIPER?

WITH REGARDS TO THAT OR ANY OTHER VEHICLE, HAVE YOU EVER USED THE CRUISE CONTROL? A POWER SEAT? POWER DOOR LOCKS? POWER WINDOWS? A REAR DEFROSTER? A REAR WIPER?

HOW OLD ARE YOU? *Some people, especially women, may be reluctant to give you their age. Tell them the information is used for statistical purposes only and you will not tell anyone their age. If they are still reluctant, start out by asking for their age decade* (**ARE YOU BETWEEN 41 AND 50?**) *and then go from there. If it takes some effort to pry it out, offer a positive comment to put them at ease if it seems reasonable.* (**GEE, YOU CERTAINLY DON'T LOOK ... **).

TODAY WE ARE GOING TO DETERMINE WHERE YOU THINK A NUMBER OF CONTROLS, SUCH AS THE LIGHTS AND WIPER, SHOULD BE LOCATED. WE WILL ALSO FIND OUT WHAT KIND OF SWITCHES YOU PREFER FOR THESE FUNCTIONS. DON'T WORRY IF YOU DON'T KNOW MUCH ABOUT HOW SWITCHES WORK, IT DOESN'T MATTER. A GOOD DESIGN IS ONE WHICH IS EASY FOR YOU TO USE, SO THERE IS NO RIGHT OR WRONG ANSWER.

FROM A LARGE COLLECTION OF KNOBS, PUSH BUTTONS, AND STALK CONTROLS, YOU WILL SELECT THE SWITCHES YOU PREFER AND PUT THEM ON THE INSTRUMENT PANEL OF A CAR. THE SWITCHES HAVE VELCRO ON THE BACK, SO THEY SHOULD STICK FAIRLY EASILY TO THE VELCRO COVERED SURFACES IN THE CAR.

AFTERWARDS, I WILL TURN ON THE DRIVING SIMULATOR AND SHOW YOU HOW TO OPERATE IT. ONCE YOU UNDERSTAND THAT, I WILL DIM THE LIGHTS AND YOU WILL GO FOR A SIMULATED SHORT DRIVE. DURING THAT DRIVE YOU WILL BE ASKED TO TOUCH THE CONTROLS YOU PLACED ON THE INSTRUMENT PANEL TO HELP YOU DETERMINE IF THE CHOICES YOU MADE ARE GOOD ONES FOR YOU.

ONCE THE SIMULATION HAS STOPPED, YOU CAN CHANGE YOUR CHOICES FOR SWITCHES AND THEIR LOCATIONS IF YOU WISH.

LET'S HEAD OVER TO THE CAR AND BEGIN. ADJUST THE SEAT SO YOU ARE COMFORTABLE AND FASTEN YOUR SAFETY BELT. *Show the participant the alphabetical listing of labels.* **IN THIS EXPERIMENT WE ARE INTERESTED IN APPROXIMATELY 20 FUNCTIONS. LET ME TELL YOU WHAT THEY ARE. IF AT ANY TIME YOU HAVE A QUESTION, FEEL FREE TO ASK.**

THERE ARE A NUMBER OF FUNCTIONS WHOSE PURPOSE I ASSUME I DON'T HAVE TO EXPLAIN. IF I AM WRONG LET ME KNOW. I ASSUME

YOU UNDERSTAND THE HORN, THE POWER DOOR LOCKS, POWER SEAT, AND POWER WINDOW CONTROLS, THE RADIO, THE TURN SIGNAL, AND THE WIPER AND WASHER. IS THAT CORRECT? *(If they say no, then explain the function they don't understand.)* I SHOULD NOTE THAT FOR THE POWER DOOR LOCKS, POWER SEAT, AND POWER WINDOW CONTROLS, AS WELL AS THE RADIO AND CLIMATE CONTROLS, WE ONLY WANT TO KNOW WHERE THEY SHOULD GO, NOT WHAT THEY SHOULD LOOK LIKE.

THE BEAM FLASHER IS USED TO FLASH YOUR HEADLAMPS. THIS IS USED ON TWO LANE ROADS TO SIGNAL ANOTHER DRIVER YOU ARE GOING TO PASS THEM. IT IS ALSO USED TO SIGNAL ONCOMING DRIVERS THEY FORGOT TO TURN THEIR HEADLIGHTS ON, OR THAT THEY ARE DRIVING WITH THEIR BRIGHT LIGHTS ON WHEN THEY SHOULDN'T BE.

THE BEAM SELECT IS USED TO TURN ON YOUR BRIGHT HEADLIGHTS.

THE CLIMATE CONTROL PANEL IS USED TO CONTROL THE HEAT, FAN, AND AIR CONDITIONER. FOR THIS ITEM WE ONLY WANT TO KNOW WHERE IT SHOULD GO. WE WILL BE EXAMINING TWO DESIGNS, A HORIZONTAL ONE LIKE THIS *(point to it)* AND A VERTICAL ONE LIKE THIS *(point to it)*.

THE CRUISE CONTROL SETS THE VEHICLE TO DRIVE AT A FIXED SPEED WHEN YOUR FOOT IS OFF THE ACCELERATOR. USUALLY THERE ARE SWITCHES TO TURN THE CRUISE SYSTEM ON AND OFF, TO SET THE DESIRED SPEED, AND TO RETURN TO A PREVIOUSLY SET SPEED (SOMETIMES CALLED THE RESUME FEATURE).

THE DOME OR INTERIOR LIGHT, THIS LIGHT, *(point to it)* ILLUMINATES THE PASSENGER COMPARTMENT.

THE HAZARD SWITCH, SOMETIMES CALLED THE FOUR-WAY FLASHER CAUSES ALL OF THE PARKING LIGHTS, BOTH FRONT AND REAR TO BLINK ON AND OFF. IF SOMETHING GOES WRONG WITH YOUR CAR AND YOU PULL OFF TO THE SIDE OF THE ROAD, YOU MIGHT TURN IT ON.

THE HEADLAMP OR HEADLIGHT SWITCH IS USED TO TURN YOUR HEADLIGHTS, TAILLIGHTS, AND PARKING LIGHTS ON.

THE IGNITION SWITCH, WHICH REQUIRES A KEY, IS USED TO START YOUR CAR.

THE PANEL BRIGHTNESS ALLOWS YOU TO ADJUST THE BRIGHTNESS OF THE INSTRUMENT PANEL AT NIGHT. IT ONLY WORKS WHEN THE HEADLIGHTS OR PARKING LIGHTS ARE ON.

THE REAR DEFROSTER IS USED TO REMOVE ICE FROM THE REAR WINDSHIELD.

THE REAR WASHER AND WIPER SERVE THE SAME PURPOSE AS THE FRONT WINDSHIELD WIPER AND WASHER, BUT ARE USED ON THE REAR WINDOW.

THE STEERING ADJUST SWITCH ALLOWS YOU TO CHANGE HOW HARD YOU HAVE TO TURN THE STEERING WHEEL TO TURN THE CAR. SOME PEOPLE LIKE POWER STEERING AND OTHERS LIKE MANUAL STEERING. THIS SWITCH WILL ALLOW YOU TO SELECT EITHER ONE. THIS FUNCTION IS NOT PROVIDED ON MOST CARS NOW BEING MADE. I WANT TO EMPHASIZE THAT THIS IS NOT USED TO ADJUST THE POSITION OF THE STEERING WHEEL (SUCH AS TILT WHEEL), BUT RATHER HOW HARD IT IS TO TURN THE STEERING WHEEL.

THE SUSPENSION ADJUST SWITCH ALLOWS YOU TO CHANGE HOW SOFT OR HOW HARD THE CAR RIDES. WHILE A SOFT RIDE IS MORE COMFORTABLE, A HARD RIDE MAKES THE CAR EASIER TO HANDLE. I WANT TO EMPHASIZE THIS ADJUSTS THE CAR'S SUSPENSION, NOT THE SEAT. THIS FUNCTION IS NOT PROVIDED ON MOST CARS NOW BEING MADE.

DO YOU HAVE ANY QUESTIONS ABOUT WHAT ANY OF THESE FUNCTIONS ARE?

I ALSO NEED TO SAY A FEW WORDS ABOUT THE SWITCHES YOU CAN CHOOSE FROM. ON THIS PANEL ARE A LARGE NUMBER OF POSSIBLE SWITCHES THAT MIGHT BE USED FOR THESE FUNCTIONS. SOME OF THEM ARE ACTUALLY FOUND IN CARS NOW AND OTHERS ARE JUST PROPOSALS FOR FUTURE CARS. FOR EXAMPLE THERE ARE PUSHBUTTONS *(point to an example and show how it works)*, ROCKER SWITCHES *(point and demonstrate for this and all other examples)*, TOGGLE SWITCHES, SLIDE SWITCHES, KNOBS, TOUCH SURFACES, STALKS, PADDLE SWITCHES, LEVERS, THUMB WHEELS, ROTARY SWITCHES, AND OTHERS. YOU MAY NOTICE THAT THERE ARE SEVERAL COPIES OF EACH SWITCH IN CASE YOU WANT TO USE THE SAME SWITCH DESIGN FOR SEVERAL FUNCTIONS, FOR EXAMPLE IF YOU WANTED THE HEADLIGHTS AND WIPER CONTROLS TO BE THE SAME TYPE OF KNOB. THE SWITCHES ALL HAVE VELCRO ON THE BACK SO THEY WILL STICK TO THE VELCRO COVERED SURFACES IN THE CAR. THESE SURFACES ARE LOCATED . . .*(point out locations of velcro)*.

I ALSO WANT TO EMPHASIZE THAT YOUR SELECTIONS ARE NOT RESTRICTED BY THE LABELLING ON THE SWITCHES. THAT IS, IF A SWITCH IS LABELED "HAZARD" BUT YOU WOULD LIKE TO USE IT FOR THE DOME LIGHT, THAT'S OK. IN ADDITION, IF YOU WOULD LIKE A CERTAIN SWITCH TO BE A DIFFERENT COLOR, THAT'S OK TOO, JUST TELL ME AND I'LL MAKE A NOTE OF IT.

Show the subject the small board with the function labels.
ON THIS SMALL BOARD ARE THE LABELS FOR ALL OF THE FUNCTIONS I JUST DESCRIBED. THEY ALSO HAVE VELCRO ON THE BACK.

NOW I AM GOING TO EXPLAIN WHAT YOU WILL DO DURING THE EXPERIMENT SO PLEASE LISTEN CAREFULLY.

BEGINNING WITH THE CONTROLS YOU CONSIDER TO BE MOST IMPORTANT, YOU WILL SELECT A FUNCTION LABEL AND PLACE IT ON

ANY OF THE VELCRO COVERED SURFACES INSIDE THE CAR WHERE YOU THINK THE ASSOCIATED CONTROL BELONGS. NEXT YOU WILL SELECT A SWITCH OR A STALK AND PLACE IT NEXT TO THE LABEL. YOU WILL CONTINUE TO PLACE FUNCTION LABELS AND SWITCHES WHERE YOU THINK THEY BELONG. IF YOU WISH TO CHANGE EITHER THE LOCATION OR TYPE OF A SWITCH, YOU MAY DO SO AT ANYTIME. ALSO, IF YOU WOULD LIKE TO CHOOSE MULTIPLE SWITCHES FOR ONE FUNCTION, FOR EXAMPLE, TWO PUSHBUTTONS TO TURN SOMETHING ON AND OFF, THAT'S ALLOWED.

I SHOULD REMARK THAT INSTALLING THE STALKS IS A BIT TRICKY. IF YOU WANT A STALK ON THE LEFT OR RIGHT SIDE, INSERT THE SHAFT IN THIS DRILL CHUCK AND TURN IT TO TIGHTEN IT *(show them how to do this)*.

BEFORE YOU BEGIN, I WOULD LIKE TO RE-EMPHASIZE THAT THE SWITCHES YOU SELECT ARE FOR A FULLY EQUIPPED CAR TO BE PRODUCED IN THE 1990's. IN MAKING YOUR DECISIONS ABOUT WHICH SWITCHES TO CHOOSE, TRY TO IMAGINE WHAT CARS WILL BE LIKE IN THE 1990's AND WHAT YOU WOULD EXPECT FROM THIS TYPE OF CAR. TO PLACE THINGS IN PERSPECTIVE, LIFE IN THE 1990's WILL BE SOMETHING LIKE THIS:

> MARIO CUOMO IS FINISHING HIS FIRST TERM AS PRESIDENT OF THE UNITED STATES.
>
> THE AVERAGE AMERICAN BUILT PASSENGER CAR COSTS $13,800.
>
> A CURE FOR AIDS HAS BEEN FOUND AND THE DISEASE HAS BEEN VIRTUALLY ELIMINATED.
>
> COMPACT DISC PLAYERS FOR CARS ARE OLD-FASHIONED.
>
> MOST AMERICAN HOMES NOW HAVE STEREO TELEVISION SETS.
>
> THE PRICE OF UNLEADED GASOLINE IS $1.35 PER GALLON.
>
> THE CHICAGO CUBS WIN THE WORLD SERIES.
>
> ANTI-LOCK BRAKING SYSTEMS AND 4-WHEEL STEERING ARE AVAILABLE ON ALL AMERICAN BUILT AUTOMOBILES.

AGAIN, THE REASON FOR MENTIONING THESE THINGS IS TO GIVE YOU A SENSE OF WHAT LIFE WILL BE LIKE IN THE 1990'S, TRY TO MAINTIN THIS PERSPECTIVE WHEN MAKING YOUR SELECTIONS. *Make sure that the computer program is ready, the zone chart is in front of you, you have a data sheet for comments next to you, and the switchboard is close to the subject.* IF YOU HAVE NO FURTHER QUESTIONS, YOU MAY GO AHEAD AND BEGIN YOUR SELECTIONS.

- APPENDIX B - EXPERIMENTAL PROCEDURE -

Enter into the computer the switch number, its name, location, method of operation, and any comments the subject may have. For the climate controls, ignition, power door locks, power seat, power windows, and the radio, enter "0" for the switch number, "-" for its name, and "0" for it's method of operation code since we are interested in location only.

The method of operation axes are relative to the instrument panel surface, not individual switch surfaces. Therefore if a subject places a push button switch on the door, the method of operation would be along the -Fy axis.

When entering comments do NOT use commas.

Repeat the process of selecting labels and switches until there are no more labels left. As they go through the process, offer encouragement. (**THAT'S FINE. OK. GOOD.**) *Encourage them indirectly to say why they chose a particular location or switch and enter those thoughts in the comments field for each switch. Avoid engaging in a discussion.*

If for some reason you lose the subject's data file (power outage, flood, famine, locusts, etc.) create a new file called S1A (for subject #1).

When they have placed all the labels and switches on the panel ask them the following. **WOULD YOU LIKE TO CHANGE ANY OF THE LOCATIONS OR SWITCH TYPES YOU HAVE CHOSEN? IF SO, FEEL FREE TO MAKE CHANGES NOW.** *After they have completed their changes, remove the label board from in front of them. Do not save the data until after they have completed the driving simulation!!*

NEXT I WOULD LIKE TO SHOW YOU HOW OUR DRIVING SIMULATOR WORKS. ON THE SCREEN WILL APPEAR A SERIES OF SMALL BLOCKS THAT RESEMBLE ROAD EDGE MARKERS. THINK OF YOURSELF AS DRIVING ON A ONE LANE EXPRESSWAY RAMP AND THOSE MARKERS AS INDICATING THE SIDES OF THE ROAD. YOUR TASK IS TO DO THE BEST YOU CAN TO STEER DOWN THE CENTER OF THE ROAD. WHEN YOU ARE DOING A GOOD JOB STEERING, THE EDGE MARKERS CLOSEST TO YOU WILL DISAPPEAR IN THE CORNERS OF THE SCREEN *(use a flashlight to point to the corners of the screen).* **TRY TO ANTICIPATE THE CURVES AND STEER THE SIMULATOR JUST AS YOU WOULD A REAL VEHICLE. TURNING THE WHEEL CLOCKWISE MAKES THE CAR GO TO THE RIGHT, COUNTERCLOCKWISE MAKES IT GO LEFT.**

LET'S BEGIN WITH A ONE MINUTE PRACTICE RUN. *Turn on the lamps and turn off the overhead lights.* **READY? ... OK, HERE IT COMES.** *Start the driving simulator. If they have problems during the practice run, give them feedback right away* (**TURN TO THE RIGHT**). *Don't wait until the end of the trial.*

Repeat the one minute trials until they understand how to steer and their performance stabilizes.

Reset the simulator for a ten minute run. **OK, NOW YOU SEEM TO HAVE IT. NEXT I AM GOING TO ASK YOU TO STEER AND AT THE SAME TIME, HAVE YOU PRETEND YOU ARE OPERATING THE INSTRUMENT PANEL CONTROLS. THE PURPOSE OF THIS TASK IS TO HELP YOU DETERMINE IF THE SWITCHES YOU SELECTED AND/OR THEIR LOCATIONS SHOULD BE CHANGED. AFTER I RESTART THE SIMULATOR, I WILL TELL YOU WHICH CONTROLS TO OPERATE. WHEN ASKED TO DO SO, REACH FOR THE CONTROL ON THE INSTRUMENT PANEL AND SHOW ME THE MOTION YOU WOULD MAKE TO OPERATE IT. IN DOING SO TAKE YOUR TIME AND MAKE SURE THAT YOU DON'T NEGLECT TO STEER. I AM ONLY INTERESTED IN IDENTIFYING PROBLEMS IN LOCATING AND OPERATING CONTROLS, NOT THE TIME REQUIRED OR ERRORS MADE. IF YOU HAVE PROBLEMS, TELL ME ABOUT THEM AND I'LL NOTE THEM DOWN. AFTER THIS RUN IS OVER, YOU CAN GO BACK AND CHANGE EITHER THE TYPES OF SWITCHES USED OR THEIR LOCATIONS.**

Have a simulator survey sheet ready on a clipboard so you can write down any problems the subject may have. **READY? OK, HERE IT GOES.** *Stand by the driver's door and watch what they do. Read the requests off so that 5-10 seconds elapses between when they finish showing you one request and you begin to read off the next one. Make sure they are on the road before you read a request. Make a note of those switches where the subject fumbles, forgets the location, or goes off the road.*

SIGNAL A LEFT TURN.

HONK THE HORN.

TURN ON THE IGNITION.

REACH FOR THE RADIO. DON'T WORRY ABOUT TURNING IT ON.

REACH FOR THE CLIMATE CONTROLS SUCH AS THE HEATER OR AIR CONDITIONER. DON'T WORRY ABOUT TURNING THEM ON.

TURN ON YOUR HEADLIGHTS.

TURN ON THE WINDSHIELD WIPER.

TURN ON THE WINDSHIELD WASHER.

FLASH YOUR HEADLIGHTS TO SIGNAL ANOTHER DRIVER.

TURN UP THE PANEL BRIGHTNESS.

TOUCH THE POWER DOOR LOCK CONTROL. DON'T OPERATE IT.

TURN ON THE REAR DEFROSTER.

- APPENDIX B - EXPERIMENTAL PROCEDURE -

TURN ON THE REAR WIPER.

TURN ON THE REAR WASHER.

TOUCH THE POWER SEAT CONTROL.

TOUCH THE POWER WINDOWS CONTROL.

TURN ON THE CRUISE CONTROL.

SET THE CRUISE CONTROL.

OPERATE THE CRUISE CONTROL TO RESUME THE PREVIOUSLY SET SPEED.

TURN ON THE DOME LIGHT.

TURN ON THE HAZARD SWITCH, THAT IS THE FOUR-WAY FLASHER.

ADJUST THE STEERING SYSTEM SO THE WHEEL IS EASIER TO TURN. *(For even number subjects say* **HARDER TO TURN.** *)*

ADJUST THE SUSPENSION SO THE RIDE IS HARDER.
(For even number subjects say **SOFTER.** *)*

At this point, stop the simulation. If the simulation has ended before the list is complete, restart it for a few more minutes.

THAT'S JUST FINE. I'M GOING TO TURN THE LIGHTS BACK ON, SO YOU MIGHT WANT TO COVER YOUR EYES. *Turn them on.* **I NOTICED YOU HAD SOME DIFFICULTY LOCATING/OPERATING THE _____ SWITCHES** *(list one at a time if many).* **WOULD YOU LIKE TO CHANGE EITHER THE LOCATIONS OR THE TYPES OF SWITCHES USED? OK, THEN PLEASE DO SO.** *Enter the revisions into the computer program. At this point save the data by hitting the F10 key and then <RETURN>.*

DO YOU HAVE ANY FINAL COMMENTS? *Enter them into the computer.*

NOW, I WOULD LIKE YOU TO REPLACE THE HORIZONTAL CLIMATE CONTROL UNIT WITH THIS VERTICAL UNIT, LOCATE IT WHEREVER YOU WISH. YOU WILL PROBABLY FIND IT NECESSARY TO REARRANGE SOME OF THE OTHER SWITCHES OR EVEN SELECT DIFFERENT SWITCH TYPES, THAT'S OK. *Record all switch changes on the computer.* **HAVE YOU FINISHED MAKING YOUR CHANGES?** *Save the data at this point by hitting the F10 key and then <RETURN>.*

DO YOU HAVE ANY FINAL COMMENTS? *Enter them into the computer.*

THE LAST THING TO BE DONE IS FOR YOU TO BE PAID. HERE IS $20.00 AS PROMISED. *Pay them, then give them the support voucher.* **PLEASE PRINT YOUR NAME, STREET ADDRESS, CITY, AND ZIP CODE ON THIS FORM ALONG WITH YOUR SOCIAL SECURITY NUMBER, THE UNIVERSITY REQUIRES ALL OF THIS INFORMATION. ALSO SIGN YOUR NAME HERE INDICATING THAT YOU WERE PAID.**

THANK YOU FOR YOUR TIME!

Take pictures of the interior of the car after the subject leaves.

APPENDIX C - SAMPLE INSTRUMENT PANEL DESIGNS

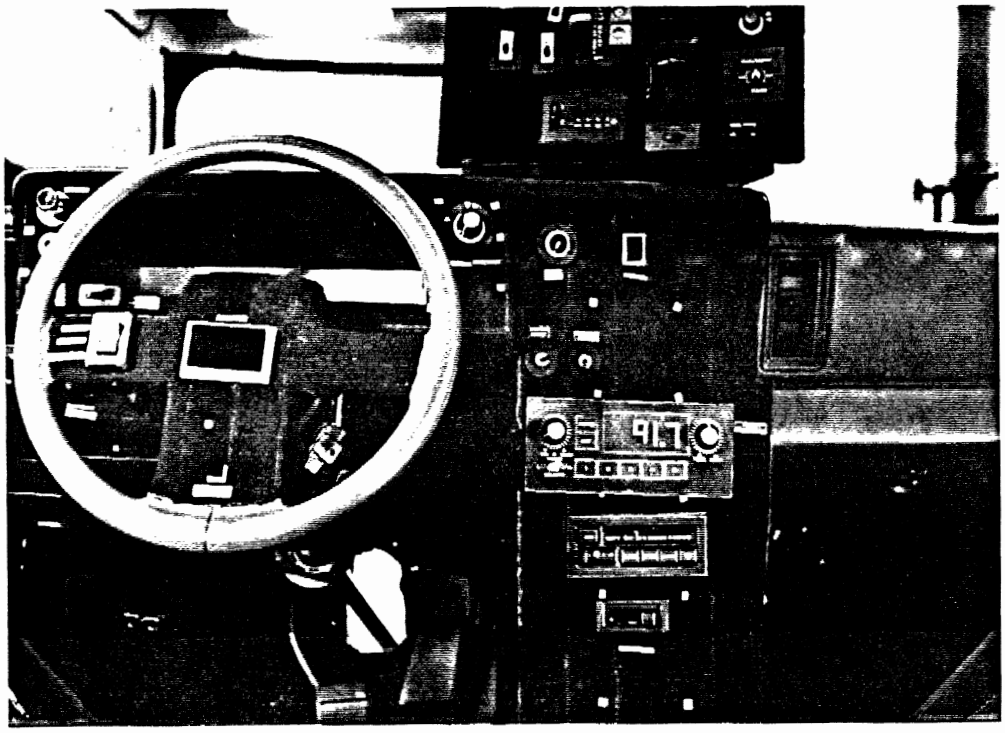

Figure C-1, Typical Design of Laser Instrument Panel (Subject #75)

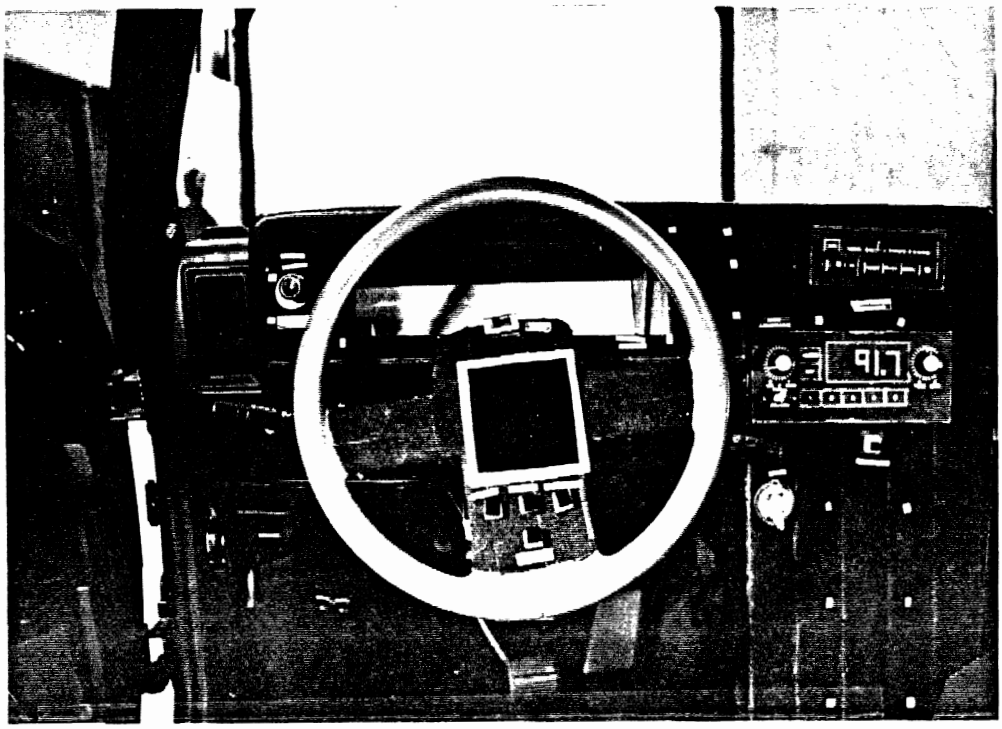

Figure C-2, Typical Design of Laser Instrument Panel (Subject #98)

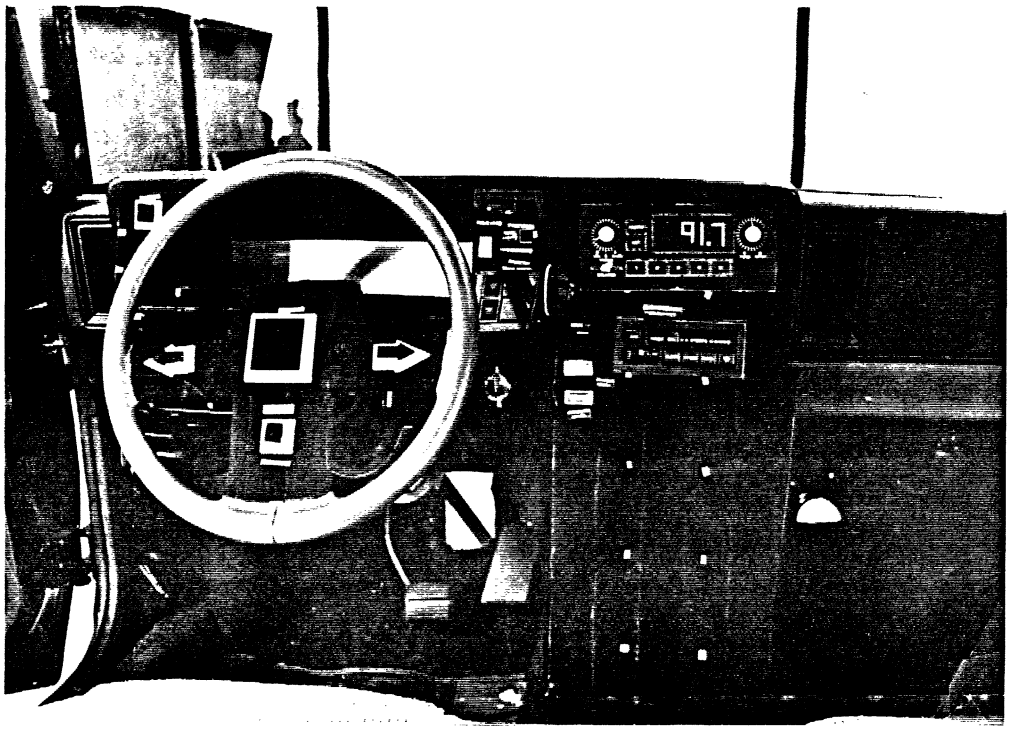

Figure C-3, Unusual Design of Laser Instrument Panel (Subject #93)

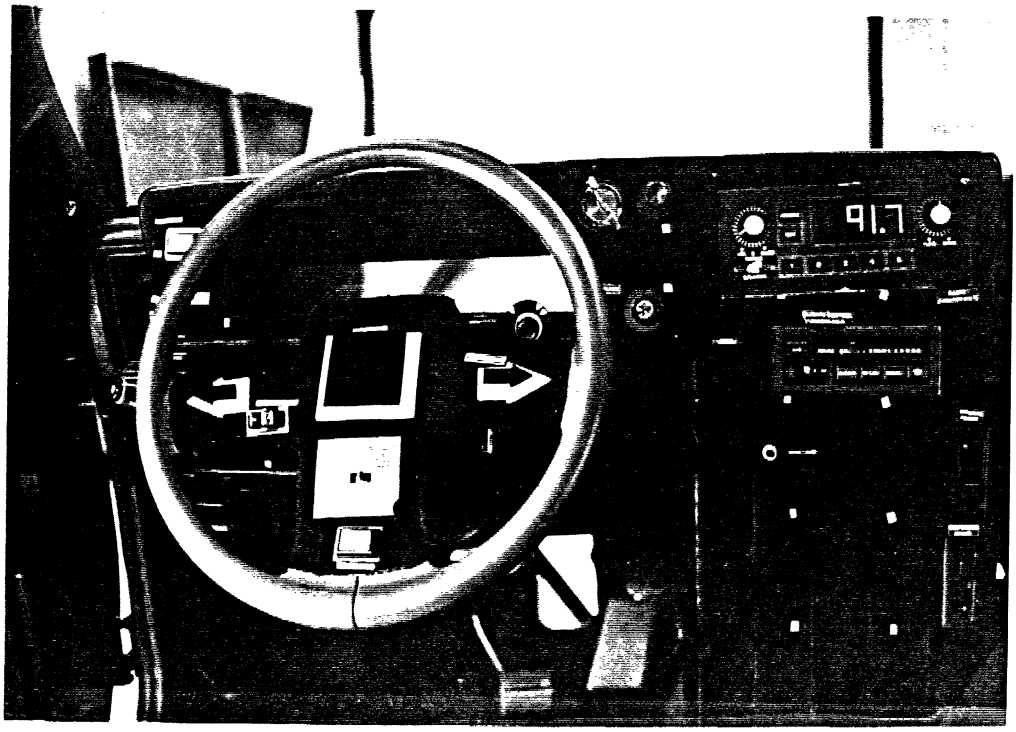

Figure C-4, Unusual Design of Laser Instrument Panel (Subject #74)

APPENDIX D - RECRUITING INSTRUCTIONS

RECRUITING SUBJECTS BY PHONE FOR THE CONTROLS STUDY

One of the responsibilities of the experimenters in this experiment is to recruit subjects. One way to recruit participants is to call them on the telephone. The following points and dialogue should be followed when contacting subjects by phone.

1. First, get the phone number of the prospective subject. (Use the lists in the folder labeled , "Subjects.")

2. Please be sure to examine the name on the list(s) that you are using to see if there is any past indication this individual has been contacted before.

3. Check the Subject Age List, which is behind the door of Room 341, to make sure that you know what age categories still have available openings.

4. Dial the person's phone number and begin you opening conversation somewhat like the following:

Hello, may I speak with Mr./Ms._____, please?

Hi, Mr./Ms._____. My name is _____ and I am calling you from the University of Michigan Transportation Research Institute, about participating in a study of automobile instrument panel controls.

This study concerns how instrument panel controls should be designed for future cars. It takes about an hour and a half, and you will be paid $20.00 for participating. This study takes place in our laboratory.

NOTE: If you are looking for individuals within certain age categories (see the Subject Age List), conclude the above opening statement by mentioning the age restrictions. For example, you may state:

Currently, we are looking for participants from the age groups of _____ years to _____ years old.

Do you qualify and would you like to participate?

If he or she says YES, then continue. If NO is the answer, then politely say,

O.K. Thank you for your time. Bye!

IMPORTANT: If NO was the answer, please note this on the subject list, so that others will not call him or her again.

If YES was the answer, then continue in this manner.....

Great! Lets get the following information.....

I have the following time slots open _____. Which would you prefer? _____.

Now get the following information and record it on the appointment sheet. Also, ask the subject to get a pencil and paper to take down important information, such as the appointment date and directions.

- Appointment date

NOTE: Be sure to consult the Subject Appointment Sheet. Also, please ask the participant in what age category he/she belongs. The age categories are 18-29, 30-55, and 56-up. You should word you question like the following:

Our age categories for this study are 18-29 years, 30-55, and 56 and up. We need to know in which age category you belong.

If for some reason you have to cancel or will be delayed in arriving, please call us at 764-4158.

- Full name
- Phone number

When you have all of this information, please ask the subject if he/she knows how to get to our building.

Do you know how to get here?

If they do not, then try to direct the subject best as you can. (Hint: try to determine a main street that they are familiar with, such as Washtenaw, Huron Pkwy, or Plymouth Rd. A map of Ann Arbor will be available on the wall next to Don's desk, just in case things get complicated).

Once you get to the main floor of the building, please go to the elevators. Go to the 3rd floor, and down the left-most hallway to room 341. State that you are here as a subject for the controls study.

Now that you have all the information that you need, and your recruited subject has all that he/she needs, ask the subject if he/she has any questions.

Do you have questions?

If the subject has no further questions, then politely remind hem/her that we will meet on the designated day and time, in room 341, at the UMTRI building. Then say good bye.

Ok....then we will see you on _____ (date) at _____ (time) in room 341 at the UM Transportation Research Institute. Bye!

- APPENDIX D - RECRUTING INSTRUCTIONS -

APPENDIX E - PARTICIPANT BACKGROUND FORM

The University of Michigan
Transportation Research Institute Participant
#_____
Human Factors Divison
Dr. Paul Green, project director
Experimenter_____
February 18, 1987 Date & Time _____

Driver Preferences for Controls - Biographical Form

Name:_____

Address:_____

Occupation:
_____
(If retired or student note such & former occupation/major)

Home Phone:_____

	(circle one)
Sex:	male female
Handedness:	right left ambidextrous
	(circle one or more)
Eyewear when driving	nothing glasses contacts
Vision when driving:	20/___ don't know

Vehicle You Drive Most Often:_____
(include year, make, model)

Total Miles Driven/Year: _____

		(circle one)		
Does that vehicle have a	cruise control?	yes	no	unsure
	a power seat?	yes	no	unsure
	power door locks?	yes	no	unsure
	power windows?	yes	no	unsure
	a rear defroster?	yes	no	unsure
	a rear wiper?	yes	no	unsure
With regards to that or any other vehicle, have you ever used the	cruise control?	yes	no	unsure
	a power seat?	yes	no	unsure
	power door locks?	yes	no	unsure
	power windows?	yes	no	unsure

a rear defroster? yes no unsure
a rear wiper? yes no unsure

Age:_____

Comments:

APPENDIX F - VEHICLES PARTICIPANTS DROVE

Vehicle			Participant	
Manufacturer	Year	Model	Sex	Age
Buick	1986	Century	M	Old
Buick	1985	Skylark	M	Old
Buick	1982	Skylark	M	Middle
Buick	1981	Le Sabre	F	Middle
Cadillac	1987	Sedan DeVille	M	Old
Chevrolet	1987	Chevette	M	Middle
Chevrolet	1985	Blazer S-10	M	Middle
Chevrolet	1985	Camaro	M	Middle
Chevrolet	1985	Cavalier RS	M	Middle
Chevrolet	1982	Celebrity	M	Middle
Chevrolet	1981	Citation	F	Young
Chevrolet	1979	Caprice	F	Old
Chevrolet	1978	Blazer K-5	M	Young
Chevrolet	1978	Nova	F	Middle
Chevrolet	1977	Malibu	M	Middle
Chevrolet	1976	Camaro	M	Young
Chevrolet	1972	Corvette	M	Middle
Chrysler	1986	New Yorker	F	Young
Dodge	1987	Daytona	M	Middle
Dodge	1987	Aries	F	Middle
Dodge	1985	Colt	F	Young
Dodge	1984	Daytona	M	Young
Dodge	1983	Colt	M	Middle
Dodge	1983	Colt	M	Old
Dodge	1982	Aries	M	Young
Dodge	1981	Aries	F	Young
Dodge	1981	Aries	F	Young
Dodge	1975	Monaco	F	Young
Ford	1987	Taurus	F	Old
Ford	1987	Taurus	F	Young
Ford	1987	E-150 Van	M	Young
Ford	1986	Ranger Pickup	M	Young
Ford	1985	Tempo	F	Middle
Ford	1985	E-150 Van	M	Old
Ford	1982	Escort Wagon	F	Old
Ford	1982	Escort	M	Young
Ford	1982	Escort	M	Middle

Ford	1982	Mustang	M	Young
Ford	1982	E-150 Van	F	Middle
Ford	1982	Granada	M	Old
Ford	1981	Fairmont	M	Middle
Ford	1981	LTD	M	Young
Ford	1980	Fiesta	M	Middle
Ford	1980	Ranger Pickup	M	Middle
Ford	1977	Ranger Pickup	M	Middle
Ford	1976	Maverick	M	Young
Ford	1971	Station Wagon	M	Old
Ford	1970	Maverick	M	Young
Honda	1987	Civic CRX SI	F	Young
Honda	1987	Accord	F	Middle
Honda	1986	Accord	F	Old
Honda	1986	Civic CRX	M	Middle
Honda	1985	Accord	F	Old
Honda	1985	Civic CRX	F	Young
Honda	1984	Accord	M	Young
Honda	1982	Accord	F	Middle
Lincoln-Mercury	1987	Topaz	F	Old
Lincoln-Mercury	1985	Marquis	M	Old
Lincoln-Mercury	1984	Marquis	M	Old
Lincoln-Mercury	1982	Lynx	M	Middle
Lincoln-Mercury	1980	Capri	F	Middle
Lincoln-Mercury	1972	Monterey	M	Middle
Mazda	1986	B-2000 SE-5	M	Young
Mazda	1980	GLC	F	Middle
Nissan	1987	Stanza	F	Old
Nissan	1984	Stanza	F	Middle
Nissan	1983	Stanza	M	Old
Nissan	1982	Stanza	F	Young
Pontiac	1986	Boneville	F	Young
Pontiac	1980	Trans Am	M	Middle
Oldsmobile	1986	Cutlass	F	Middle
Oldsmobile	1981	Cutlass	M	Middle
Oldsmobile	1981	Cutlass	M	Middle
Oldsmobile	1981	LS	F	Old
Oldsmobile	1978	Omega	F	Young
Plymouth	1987	Reliant	F	Middle
Plymouth	1985	Reliant	F	Old
Plymouth	1985	Voyager	F	Middle
Plymouth	1984	Reliant	F	Young
Plymouth	1984	Horizion	M	Old
Plymouth	1982	Reliant	M	Old
Plymouth	1979	Horizion	M	Young
Renault	1984	Encore	M	Middle

- APPENDIX F - VEHICLES PARTICIPANTS DROVE -

Renault	1984	Encore	M	Young
Subaru	1982	GL Station Wagon	M	Old
Toyota	1987	Celica GT	M	Young
Toyota	1986	Corolla	M	Middle
Toyota	1986	Corolla	F	Middle
Toyota	1986	Corolla	F	Middle
Toyota	1986	Camry	F	Middle
Toyota	1984	Corolla	F	Middle
Toyota	1984	Tercel	F	Middle
Toyota	1982	Corolla	M	Middle
Toyota	1981	Tercel	F	Young
Toyota	1980	Tercel	M	Old
Toyota	1978	Corolla	M	Middle
Volkswagon	1984	Golf	M	Young
Volkswagon	1983	Vanagon Bus	F	Middle
Volkswagon	1980	Rabbit	F	Young
Volkswagon	1973	Beetle	F	Middle
Volvo	1984	640 DL	F	Old

- APPENDIX F - VEHICLES PARTICIPANTS DROVE -

APPENDIX G - SUMMARY OF SWITCHES PREFERRED

Table G-1, Summary of Preferred Switches

Control Type	Switch Type (% preferred)	Size (in)	Manufacturer
Aud Horn	(22.3)push surface	2 3/8x1.5	UMTRI-fabricated
	(21.4)push surface	2x2	UMTRI-fabricated
	(11.7)push surface	2.5x2.5	UMTRI-fabricated
	(10.7)push surface	3.5x3.5	UMTRI-fabricated
	(10.7)push surface	1.25x1.25	UMTRI-fabricated
Beam Selec	(7.8) stalk	5x.75	'86 Mazda 626
	(5.8) stalk	5.5x1	'87 Subaru GL
	(5.8) stalk	7x1	'86 Mercedes 300
	(5.8) stalk	5x1	'86 Honda Civic
Beam Flash	(6.8) stalk	5x.75	'86 Mazda 626
	(6.8) stalk	7x1	'86 Mercedes 300
	(5.8) stalk	5x1	'86 Honda Civic
	(3.9) push button	3/8x.5	GC Elec. #35-413
Cruise On	(8.7) push surface	.5x.5	UMTRI-fabricated
	(6.8) rocker	.75x9/16	GC Elec. #35-620
	(6.8) slide	1/16x.25	'87 Cadillac CDV
	(5.8) rocker	5/8x1	'85 Berlinetta
	(4.9) push button	3/8 dia	GC Electric
	(4.9) push button	2.75x1.5	'85 Mazda 929
	(3.9) push button	3/4 dia	GC Elec. #35-484
Cr. Resume	(11.7)push surface	.5x.5	UMTRI-fabricated
	(5.8) push surface	1x.5	UMTRI-fabricated
	(5.8) stalk	4.25x1	'86 Toyota Camry
	(4.9) push button	3/8 dia	GC Elec. #35-412
	(4.9) push button	2.75x1.5	'85 Mazda 929
	(3.9) stalk	4.5x7/8	'86 Pontiac 6000
Cruise Set	(12.6)push surface	.5x.5	UMTRI-fabricated
	(6.8) push surface	1x.5	UMTRI-fabricated
	(5.8) stalk	4.25x1	'86 Toyota Camry
	(4.9) push button	2.75x1.5	'85 Mazda 929
	(4.9) push button	3/8 dia	GC Elec. #35-412
	(3.9) stalk	4.5x7/8	'86 Pontiac 6000
Dome Light	(9.7) push-pull	7/8 dia	General #18110
	(6.8) rocker	.75x9/16	GC Elec. #35-620
	(3.9) push surface	.5x.5	UMTRI-fabricated

	(3.9)	push button	3/8 dia	GC Elec. #35-412
	(3.9)	rocker	3/8x5/8	L'fuse #780609BP
	(3.9)	rocker	.6x.75	GC Elec. #35-632
	(3.9)	rocker	3/8x1	Chrysler
Fr Wash	(6.8)	stalk	5x1	'86 Honda Civic
	(5.8)	stalk	2.25x.75	'83 Honda Civic
	(3.9)	stalk	7x1	'86 Mercedes 300D
	(3.9)	knob	7/8 dia	GC Elec. #37-544
Fr Wipers	(6.8)	stalk	5x1	'86 Honda Civic
	(5.8)	stalk	2.25x.75	'83 Honda Civic
	(3.9)	stalk	7x1	'86 Mercedes 300D
	(3.9)	knob	7/8 dia	GC Elec. #37-544
Hazard	(8.7)	rocker	11/16x1	L'fuse #780865BP
	(8.7)	rocker	5/16x11/16	GC Elec. #35-622
	(6.8)	rocker	.75x9/16	GC Elec. #35-620
	(5.8)	push button	3/8 dia	GC Elec. #35-484
	(5.8)	push button	3/4 dia	GC Elec. #35-412
	(4.9)	push pull	1/2 dia	L'fuse #145701BP
	(4.9)	push button	3/4x1/4	'86 Ford Escort
	(3.9)	rocker	3/8x5/8	L'fuse #780609BP
Headlights	(19.4)	push-pull	7/8 dia	General #18110
	(6.8)	stalk	5x1	'86 Honda Civic
	(5.8)	push button	1.75x5.5	'86 Buick Somrset
	(3.9)	push pull	.5 dia	L'fuse #145701BP
Panel Lts.	(15.5)	thumb wheel	.25x1	'86 VW Golf
	(12.6)	push-pull	7/8 dia	General #18110
	(5.8)	knob	9/16 dia	GC Elec. #37-584
	(4.9)	knob	3/4 dia	GC Elec. #37-599
	(4.9)	knob	3/4 dia	GC Elec. #37-572
	(3.9)	knob	1/2 dia	'86 Honda Civic
Rear Defog	(8.7)	rocker	3/8 dia	GC Elec. #35-622
	(7.8)	push button	2.125x1.25	'86 Mercury Sable
	(6.8)	push button	1 1/8x.5	'86 Buick Somrset
	(6.8)	rocker	.75x9/16	GC Elec. #35-620
	(4.9)	push button	3/8x.5	GC Elec. #35-413
	(3.9)	rocker	5/16x7/8	GC Elec. #35-412
	(3.9)	push button	3/8 dia	GC Elec. #35-408
Rear Wash	(8.7)	rocker	5/8x1	'86 Ford Tempo
	(4.9)	push button	3/8 dia	GC Elec. #35-622
	(4.9)	rocker	.6x.75	GC Elec. #35-632
	(3.9)	push surface	.5x.5	UMTRI-fabricated
	(3.9)	combo	1x3.5	'86 VW Golf
	(3.9)	push button	3/8x.5	GC Elec. #35-413
Rear Wipers	(9.7)	rocker	5/8x1	'86 Ford Tempo
	(5.8)	rocker	.6x.75	GC Elec. #35-632
	(3.9)	knob	9/16 dia	GC Elec. #37-584

Steer Adj	(9.7) rocker	5/8x1	'87 Jaguar XJ16
	(6.8) rocker	.75x13/16	L'fuse 780693BP
	(5.8) rocker	5/8x7/8	L'fuse 780646BP
	(5.8) rocker	.6x.75	GC Elec. #35-632
	(4.9) pushbutton	.75 dia	GC Elec. #35-484
	(3.9) rocker	5/16x11/16	GC Elec. #35-662
	(3.9) rocker	.75x9/16	GC Elec. #35-620
	(3.9) toggle	3/16x.5	GC Elec. #35-854
Suspn Adj	(13.6) rocker	5/8x1	'87 Jaguar XJ16
	(5.8) rocker	.75x13/16	L'fuse #780693BP
	(5.8) rocker	5/8x7/8	L'fuse #780646BP
	(4.9) rocker	5/16x11/16	GC Elec. #35-662
	(4.9) rocker	.6x.75	GC Elec. #35-632
	(3.9) rocker	5/8x1	'85 Berlinetta
	(3.9) stalk	5.5x1	'87 Subaru GL
Turn Lts.	(8.7) stalk	5x.75	'86 Mazda 626
	(7.8) stalk	7x1	'86 Mercedes 300D
	(7.8) stalk	5x.75	'82 Mazda 626
	(6.8) stalk	5x1	'86 Honda Civic
	(5.8) stalk	3x.75	'82 Mazda 626
	(4.9) push arrow	1.5	UMTRI-fabricated
	(4.9) stalk	5.25x1	'87 Subaru GL
	(3.9) stalk	5.5x1	'86 BMW 635 CSi

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