Development of Human Factors Guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO): Investigation of User Stereotypes and Preferences

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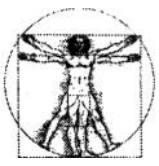

FOREWORD

This report is one of a series of reports produced as part of a contract designed to develop precise, detailed human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO). During the analytic phase of the project, research issues were identified and rated by 8 human factors experts along 14 separate criteria. The goal of the experimental phase was to examine the highest rated research issues that can be addressed within the scope of the project. The 14 experiments produced in that phase reflect the results of those ratings.

This experiment examined the stereotypes and preferences of private and commercial drivers for ATIS display information content and design. Design recommendations for ATIS displays are made on the basis of results of data collected via a survey and user clinic.

Copies of this report can be obtained through the Research and Technology Report Center, 9701 Philadelphia Court, Unit Q, Lanham, Maryland 20706, telephone: (30 1) 577-0818, fax: (30 1) 577- 1421, or the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161, telephone: (703) 605-6000, fax: (703) 605-6900.

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Director, Office of Safety
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NOTICE

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16. Abstract The presentation of in-vehicle information to the driver is an important issue for highway safety. A review of the guideline literature revealed that although attempts have been made to develop guidelines for in-vehicle information systems, few guidelines are available for practical application. The objective of this study was to generate design guidelines for Advanced Traveler Information System (ATIS) displays. To meet this objective, the following tasks were undertaken. First, information from the literature was used to develop a list of information items that are or could be made available to a driver. Second, this list was compiled into a set of logical information item groupings. Third, an analysis was conducted for each information item to assess the level of attention, comprehension, and required action for each item. This information was then filtered through the set of existing standards so that duplicate work would not be conducted. Fourth, in order to identify a subset of information items that are most suitable for standard development, trade studies were performed. Of the remaining information items, the driving population stereotypes and preferences for ATIS displays were assessed via a survey or a user clinic. The design recommendations made on the basis of the results of this study reflect both general recommendations and, where appropriate, specific recommendations.			
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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 l shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

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LIST OF ABBREVIATIONS

AAA . . . . . American Automobile Association
ATIS . . . . . Advanced Traveler Information System
ANOVA . . . . . Analysis of Variance
CTR . . . . . Center for Transportation Research
CVO . . . . . Commercial Vehicle Operations
CVSA . . . . . Commercial Vehicle Safety Alliance
FHWA . . . . . Federal Highway Administration
GID . . . . . Generic Intelligent Driver
HUD . . . . . Head-Up Display
ISIS . . . . . In-Vehicle Signing and Information Systems
ISO . . . . . International Standards Organization
IVIS . . . . . In-Vehicle Information Systems
IVSAWS . . . . . In-Vehicle Safety Advisory and Warning Systems
MUTCD . . . . . Manual of Uniform Traffic Control Devices
RROI . . . . . Re-Route Option Information
RCI . . . . . Road Construction Information
SNK . . . . . Student Newman Kuels
UMTRI . . . . . University of Michigan Transportation Research Institute

EXECUTIVE SUMMARY

The presentation of in-vehicle information to the driver is an important issue for highway safety. A review of the guideline literature revealed that although attempts have been made to develop guidelines for in-vehicle information systems (IVIS), few guidelines are available for practical application. The objective of this study was to generate design guidelines for Advanced Traveler Information System (ATIS) displays. To meet this objective, the following tasks were undertaken. First, information from the literature was used to develop a list of information items that are or could be made available to a driver. Second, this list was compiled into a set of logical information item groupings. Third, an analysis was conducted for each information item to assess the level of attention, comprehension, and required action for each item. This information was then filtered through the set of existing standards so that duplicate work would not be conducted. Fourth, in order to identify a subset of information items that are most suitable for standard development, trade studies were performed. Of the remaining information items, the driving population stereotypes and preferences for ATIS displays were assessed via a survey or a user clinic.

The survey was used to gather information from rural drivers (from Blacksburg, Virginia), urban drivers (from Seattle, Washington, and Monterey, California), and commercial vehicle operation (CVO) drivers (from a Denver, Colorado-based trucking company). The user clinic was a computer simulation designed to determine presentation comprehension and driver preferences in a dynamic driving scenario. The final list of information items that were tested in the survey and user clinic fell into the ATIS categories listed below:

The Survey:

- Motorist Service Information
- Time/Distance to Destination Information
- Time/Distance to Next Turn and Lane Suggestion Information
- Guide Sign Information
- Road Construction Information (RCI)
- Re-route Option Information (RROI)
- Stopped Vehicle Ahead Information
- Congestion Ahead Information
- Approach of Emergency Vehicle Information
- Road Surface Condition and Warning Information
- Regulatory Information
- Type of Roadway Information

The User Clinic:

- Index of Yellow Pages
- Restaurant Description and Costs
- Alternative Route Display
- Accident Alert

- Congestion Alert
- Weather Alert
- Off-route Alert

The objective of this study was to test and evaluate driver stereotypes and preferences for several ATIS information types and displays formats. As such, the design recommendations made reflect both general recommendations and, where appropriate, specific recommendations.

GENERAL RECOMMENDATIONS

- The results of both surveys showed that displays of a combined modality format are most preferred, specifically combined iconic/textual displays and combined iconic/auditory format. When available, standard icons should be used to increase the familiarity of the message. However, text-only displays are to be avoided, with the possible exception of route "lists" that allow the driver to preview the series of streets used in the route.

- Allow displays and functions that are typically used only during travel to unfamiliar destinations (e.g., Motorist Services Information) to be turned off or on as deemed necessary by the driver.

- When presenting information about an upcoming event (turn, exit, construction, etc.), present the information in terms of distance (miles) and one other parameter (preferably time); however, do not present the information in terms of time only.

- When designing displays for CVO drivers, consider that this population has the same general preferences as non-commercial drivers. The exception is for situations in which CVO drivers require information that is specific to their task, such as low clearance warnings and weight limits.

- When presenting relative location information, display the information in a format that requires the least amount of inferencing by the driver. For example, present the message "*Ambulance approaching from rear in left lane*" as opposed to "*Ambulance heading southbound on Elm Street in left lane*."

- When considering the use of maps to display location information to drivers, maintain the most detailed map scale as possible that would allow drivers to easily recognize their location in relation to the item of interest.

SPECIFIC RECOMMENDATIONS

- When presenting Time/Distance to Destination Information, display both the distance to the destination and time to the destination. If display space is at a premium, provide distance information only; however, do not display only time information.

- When presenting Time/Distance to Next Turn Information, display at least two warning messages regarding an upcoming turn, and possibly three messages. Do not display only one message just before the turn.

- When presenting Distance to Next Turn Information, display one distance parameter (e.g., the number of intersections before the turn) and one other parameter, preferably time; however, do not display time only information.

- When presenting Road Construction Information (RCI), inform the driver of how far ahead the construction lies in terms of both the distance and time to the construction. If display space is at a premium, provide only distance information; however, do not display only time information.

- Inform drivers of stopped school buses ahead and emergency vehicles approaching the driver's vehicle in every instance, if feasible.

- Inform drivers of the relative location of approaching emergency vehicles.

INTRODUCTION

The presentation of in-vehicle information to the driver is an important issue for highway safety. Since attending to the driving environment is a primary task of the driver, driver information must be displayed in a manner that will not interfere with that primary task. Advanced Traveler Information Systems (ATIS) will be state-of-the-art driver assistance devices, potentially including multiple subsystems and a variety of functions. ATIS technologies will provide drivers with a variety of traveler information, including: (1) roadway and signing information, (2) routing and navigation information, (3) safety advisory and warning information, and (4) motorist services information.

Early efforts to define driver information requirements primarily focused on in-vehicle route guidance and route navigation (Eberhard, 1968; Dudek et al., 1978). These studies are examples of early attempts to define what information is important to drivers while navigating. Substantial research has since been conducted with regard to navigational information requirements. For example, Dingus et al. (1995) analyzed a widely deployed ATIS prototype in the TravTek project. This project, conducted through a partnership of the Federal Highway Administration (FHWA), General Motors, the American Automobile Association (AAA), and others, was one of the largest operational tests of an advanced driver information system ever conducted in North America. The results are continuing to facilitate guideline and standard development.

An example of driver information system standardization on a large scale is the work of the International Standards Organization (ISO) beginning in the early 1970s, with the development of ISO 2575 - Road Vehicles. Government regulations issued by agencies in both North America and Europe mandated the use of some of these standards, especially in the area of control and display symbols in accord with ISO 2575. Green (1980), of the University of Michigan's Transportation Research Institute (UMTRI), has been involved with symbol standards development and has made many contributions to the ISO - Road Vehicles committee. His work provides a basis for driver preference and stereotype studies, especially with regard to in-vehicle signing.

In-vehicle signing may play an important role in the human factors standards efforts for ATIS. Early work on visual displays established text size, location, illumination, and color for in-vehicle applications (Boreczy, Green, Bos, and Kerst, 1988; Green, Levison, Paelke, and Serafin, 1995). Human factors design principles suggest that symbolic representations of established highway signs can be highly effective. The Manual of Uniform Traffic Control Devices (MUTCD), formerly the domain of civil engineers, is central in many symbolic signing studies. In-vehicle symbolic signing technology has also facilitated further guideline development in the area of in-vehicle status monitoring and in-vehicle safety and warning systems, both of which may benefit from a common set of international symbols. Green et al. (1995) suggest that a standard international symbol supplemented by a simple text message is the most effective way to convey vehicle conditions or common roadway hazards. Research describing the development and evaluation of the supplementary text message appears in Williams, Hoekstra, and Green (1993).

Wickens and Andre (1990) summarize their findings of compatibility in visual displays, many of which serve as guidelines in the development of ATIS displays. Wickens' and Andre's compatibility principles in visual display design have led to expanded use of head-up displays (HUDs), such as those described by Campbell and Hershberger (1988). Peacock and Karwowski (1993) dedicate two chapters of their text, *Automotive Ergonomics*, to the various in-dash signing display formats, such as head-up, that have found common use. Greenland and Doyle (1991) also demonstrate that HUD applications are desirable and successful in CVOs.

Auditory display guidelines have also emerged in the ATIS literature. Early work by Deatherage (1972) established guidelines for the use of auditory messages in information displays. Labiale (1990) looked specifically at vehicle applications and compared visual and auditory modalities. He found that when the message was simple, the auditory modality was superior. The use of auditory warning tones in vehicle applications was further expanded by Edworthy, Loxley, and Dennis (1991), who identified relationships between such sound characteristics as pitch, level, and repetition rate to perceived levels of urgency. Such studies have helped to establish warning tone guidelines. Guidelines for combining the visual with the auditory modality have been proposed by Walker, Alicandri, Sedney, and Roberts (1990), building on the work of Wickens (1987).

Inherent tradeoffs between the auditory and visual modalities and associated format options present challenges for ATIS developers who are mindful of such human factors issues as safety, usability, and user acceptance. A study by Streeter and Vitello (1986) found that self-rated poor navigators prefer verbal directions employing landmark information. They concluded that map reading is a difficult task, and that for the general population, verbal directions should be employed.

Regarding navigation systems, Antin, Dingus, Hulse, and Wierwille (1990) performed a study that was designed to evaluate the relative effectiveness and efficiency associated with the use of three navigation methods: moving map display, conventional paper map, and memorized route. One of the most important findings of this study was that, on average, the driver spent a significantly greater proportion of driving time looking at the moving map, compared with that spent looking at the paper map, implying that the selective attention abilities of subjects would be strained much more using the moving-map display. Wierwille, Hulse, Fischer, and Dingus (1990) set out to investigate this problem by monitoring drivers' reactions to salient cues or incidents while navigating with a moving-map display. They found that, when using a moving-map display to navigate under conditions of high attentional demand in the driving environment, longer glances are devoted to the forward roadway and away from the moving-map display. Wierwille et al. concluded that drivers can adapt to the changing task demands that are imposed while driving and navigating with a moving map display.

Stokes, Wickens, and Kyte (1990) have pointed out that the benefits associated with either spatial or verbal navigation aids may depend strongly on whether the navigator is in the route-planning or route-following phase of the navigation process. Although there may be a value in providing both auditory and visual navigation information during route guidance, the benefits appear to be implementation dependent. In the TravTek project, drivers preferred, and performed better with, both the visual display and voice guidance operating concurrently (Dingus et al., 1995). Green et

al. (1995) reported that ALI-SCOUT drivers make the transition from the visual display to using voice route guidance once they become familiar with the interface.

The human factors issues surrounding in-vehicle visual map displays in navigation are well documented (Antin et al., 1990; Green and Williams, 1992; Labiale, 1990; Mitchell, 1993; Wierwille et al., 1990), establishing recommendations for such parameters as map detail, orientation, perspective, heading, and line thickness. Many of these findings are summarized in the design guidelines of Green et al. (1995).

The work of Hulse et al. (1998, in press) has provided useful information on display modality allocations for non-standard information items. It has also been helpful in resolving ambiguities in display standards. Other guideline source documents include *ICE Ergonomics Design of In-vehicle Information Systems: Code of Practice and Design Guidelines* (ICE Ergonomics, 1993), which is extremely general and, for the most part, has little or no content specific for vehicles. Leiser and Carr (1991) have compiled a report analyzing input-output devices as part of the Generic Intelligent Driver (GID) project. It contains sections on tone output devices, visual displays, speech recognition devices, keyboards, touch screens, and conventional controls. While this report is more substantive than the ICE guidelines and contains useful human engineering guidelines, it is not specific enough for most applications.

Until recently, Green et al.'s (1995) *Preliminary human factors design guidelines for driver information system,* was the most exhaustive source of overall ATIS guidelines. Most recently, however, a series of experiments for FHWA have been conducted to determine appropriate guidelines for the use of ATIS displays. An experiment by Liu and Dingus (1997) evaluated the use of multi-modality displays for ATIS. Lee, Dingus, Mollenhauer, and Brown (in press) evaluated fatigued CVO drivers when using ATIS displays. Mollenhauer, Dingus, Hankey, Carney, and Neale (in press) evaluated ATIS displays for CVO drivers. Collins, Biever, Dingus, and Neale (1997) established guidelines on the use of symbolic in-vehicle signing information systems (ISIS). Lastly, Hanowski et al. (1997) established guidelines on the use of in-vehicle safety advisory and warning systems (IVSAWS). The current report is intended to supplement this latest series of experiments.

OBJECTIVE OF THE STUDY

The review of the guideline literature revealed that although attempts have been made to study IVIS, limited guidelines are available for practical application for many potential ATIS functions. The objective of this study was to determine user stereotypes and preferences in order to generate additional design guidelines for ATIS displays. To meet this objective, the following tasks were undertaken. First, information from the literature was used to develop a list of information items that are or could be made available to a driver. Second, this list was compiled into a set of logical information item groupings. Third, an analysis was conducted for each information item to assess the level of attention, comprehension, and required action for each item. This information was then filtered through the set of existing standards so that duplicate work would not be conducted. Fourth, in order to identify a subset of information items that are most suitable for standard development, trade studies were performed. Of the remaining information items, the driving

population stereotypes and preferences for ATIS displays were assessed via a survey or a user clinic. The survey was used to gather information from rural, urban, and commercial drivers. The user clinic was a computer simulation designed to determine presentation comprehension and driver preferences in a dynamic driving scenario. A detailed explanation of this process follows.

METHOD FOR DEVELOPMENT OF THE SURVEY AND USER CLINIC

A human factors research team from the University of Iowa, consisting of two human factors faculty members and two graduate students, was assembled to develop a list of ATIS information items and determine which should be evaluated via a survey or a user clinic. As depicted in figure 1, the task began with a broad literature review that resulted in the creation of a list of 86 driving-relevant ATIS information items (appendix A). From this list of items, the researchers wanted to determine which items had applicable display guidelines and which items needed additional display guidelines developed. The following sections outline this process.

ATIS INFORMATION ITEM SUBGROUPING

Under the premise that breaking the list of 86 driving-relevant information items into smaller groups would facilitate guideline and standard development, three orthogonal categories were devised and the information items were assigned to one of the three categories:

Safety-Specific Information. Those information items that tend to alert or inform the driver of potentially or clearly hazardous or dangerous situations that are developing in the vehicle or external driving environment.

Driver Assistance Information. Those information items that assist the driver with basic roadway navigation, dynamic route selection, and en-route vehicle operations, under the assumption of continuous, uninterrupted navigation from a starting point to a destination, above and beyond required regulatory stops and yields.

Driver Convenience Information. Those information items that provide the driver with otherwise additional information related to motorist services, trip planning activity, recreation, or entertainment. This is information that benefits specific driver needs, such as locating a rest stop.

All information items were definable within this structure and resulted in 14 safety-specific items, 34 driver assistance items, and 38 driver convenience items. The grouped list of items can be seen in appendix B.

INFORMATION ITEM ANALYSIS

It was the opinion of the research team that guidelines for the information items should exist relevant to applicable aspects of the driving task. Three relevant dimensions were determined: attention, comprehension, and action required for the information item. The definitions of each dimension category are:

Attention. The relative priority of the attention required for the information item. For example, does the information require immediate attention?

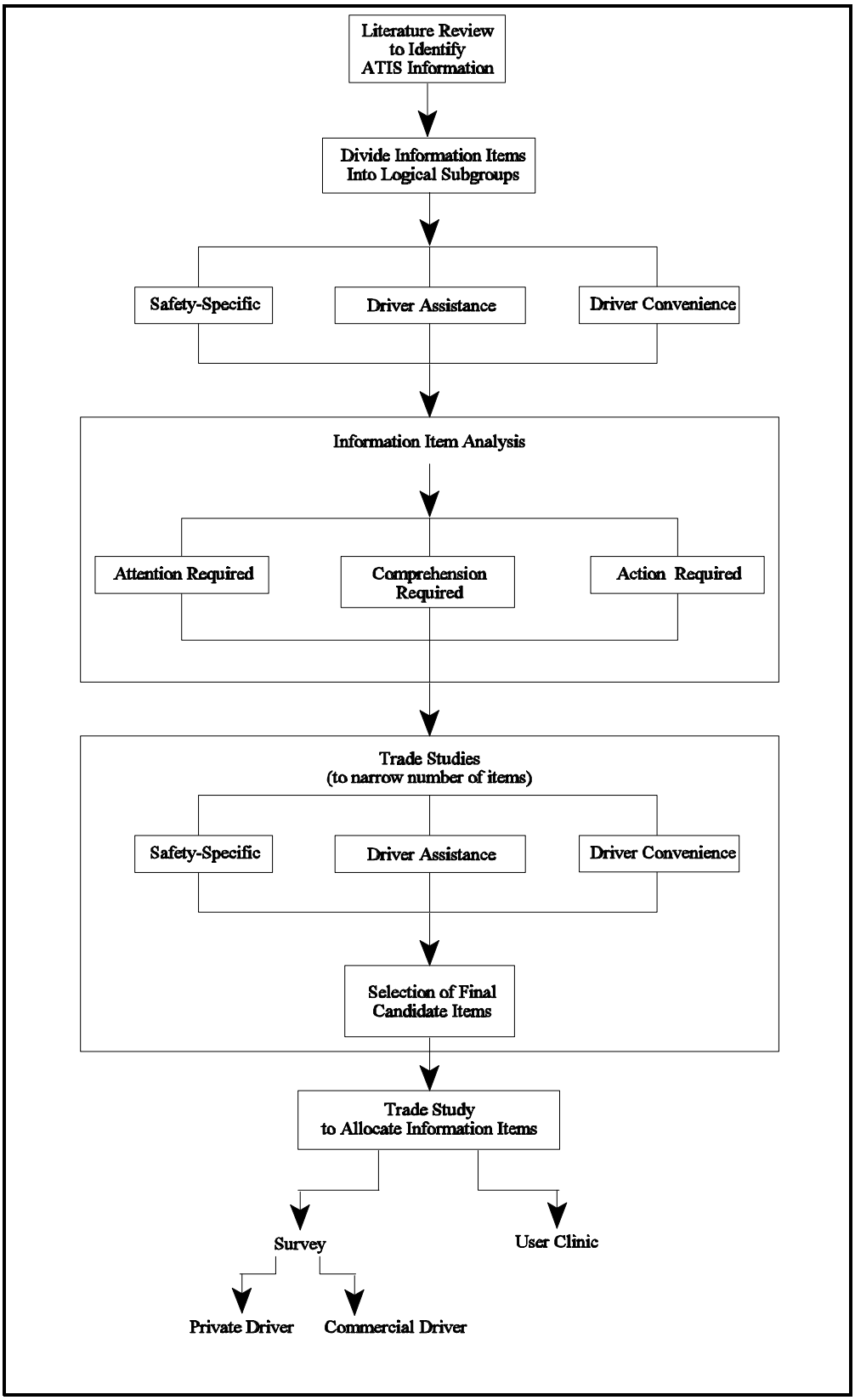


Figure 1. Process for the development of the private driver survey, the commercial driver survey, and the user clinic.

Comprehension. The information level that the driver is required to actively consider or comprehend from the presented information. As such, usability of the information is implied. For example, how well the driver comprehends the information and to what degree the driver prefers one method of presentation over another should be considered.

Action Required. The action suggested and/or required in response to the information delivered by the information item. The standards for these actions arise from driver convention, driver practice, regulatory requirements and, in some cases, legal requirements.

All information items were broken into these three dimensions, as shown in appendix C. The relative level of attention required, the type of comprehension required, and the action required were designated. At this point, it was necessary to determine if standards were already in existence for each information item. The source of any discovered standard information (as listed in appendix C) was listed, and those items that had an existing standard were filtered out. The filter resulted in 13 safety-specific items (one item was filtered), 23 driver assistance items (11 items were filtered), and 34 driver convenience items (4 items were filtered), leaving a total of 70 remaining information items. Those items that were filtered as part of this process are marked with an asterisk in appendix C.

TRADE STUDY

Because resources were not available for this study to create guidelines for 70 information items, a trade study approach was used to weight and rate relevant criteria in order to quantify the relative importance of guideline development for the remaining ATIS information items. The trade study is useful for creating an ordinal ranking of multiple items based on *a priori* criteria. The trade study was performed within each information item logical subgrouping: safety-specific information, driver assistance information, and driver convenience information. The assigned ratings and weightings were performed by two members of the research team. After each rating was made, the results were reviewed by the human factors design team as a whole. Discrepancies in the outcome were discussed until a resolution was achieved. Once the ratings were agreed upon, the information items were ranked from highest total score to lowest total score within each subgrouping. The resulting trade study and assigned rankings for the information items are shown in appendices D, E, and F. Note that these trade studies provided a systematic means to prioritize and reduce the number of items considered. Also note that in all of the trade studies, the relative weightings were derived a priori through consensus negotiations by the design team. These weightings represent the relative importance of each criterion and are applied after the ratings have been derived. A total score is then calculated by multiplying the rating by the weighting for each criterion, and then summing all of the applicable criterion scores.

Safety-Specific Information Trade Study

Again, the safety-specific information items are those that alert or inform the driver of potentially hazardous, clearly hazardous, or dangerous situations that are developing in the vehicle or in the external driving environment. The trade study for safety-specific information can be seen in

appendix D. The criteria chosen were required response time and degree of potential danger if misinterpreted, as defined below.

Required Response Time

Information items that require a rapid response time leave the driver with relatively less time to interpret the information and respond accordingly. It was determined by the research team that human factors design guidelines for items that require a rapid response time can increase overall safety because, all other factors being equal, these information items are more likely to be misinterpreted or ignored in highly time-critical situations. It was also thought that standardization of these items would encourage a faster response time. Therefore, information items that require a rapid response time were given a higher priority for standardization than items that do not require a rapid response time. As an example, the information item *icy bridge immediately ahead* requires a faster response than a *thunderstorm warning*. Therefore, assuming all other factors equal, *icy bridge immediately ahead* should be ranked higher than a *thunderstorm warning*. The following rating definitions were used for "Required response time":

4: Immediate response required (e.g., < 5 sec).
3: Urgent response required, but not necessarily immediate (e.g., 5-60 sec).
2: Priority response required (e.g., within the next 20 min. or at the next service station).
1: Non-urgent response required (e.g., at a convenient time in the near future).
0: Response not required.

Weightings were assigned on a scale of 1 to 10, with 1 being the least important and 10 being the most important. That the driver should be able to respond in a quick manner was considered critical; therefore, a weighting of 8 of 10 was assigned.

Degree of Potential Danger if Misinterpreted

This criterion includes the degree of potential danger to the driver and/or passengers, vehicle, and/or environment if the information item is misinterpreted or not conveyed. For example, if a driver misinterprets an icy bridge warning, there is a possibility of a dangerous outcome. As an example, the potentially hazardous outcome of misinterpreting a *railroad crossing ahead* message exceeds in severity the likely outcome of misinterpreting a *congestion ahead* message. All other factors being equal, overall safety can be increased through standardization of the former information item. A weighting of 10 was assigned since misinterpretation could be critical, and the following rating definitions were used for "Degree of danger if misinterpreted":

4: Misinterpretation could lead to death or permanent disability injury.
2: Misinterpretation could lead to vehicle or property damage.
0: Misinterpretation presents no danger to person or property.

Driver Assistance Information

Driver assistance information refers to those information items that assist the driver with the primary driving task, or other secondary tasks that relate to the basic requirements of driving, such as navigation and en-route vehicle operations. These information items constitute the basic information that is needed to proceed from a starting point to a destination, under the assumption of continuous, uninterrupted driving, above and beyond required regulatory stops and yields. The trade study for driver assistance information can be seen in appendix E.

Frequency of Use

It was thought by the research team that those information items that are most frequently used should be selected for standardization, since users will spend more time receiving and effectively responding to these information items than to less frequently used items. Also, with this information standardized, there would be a better transfer of knowledge when using an unfamiliar vehicle (such as a rental car). As an example, it is likely that turn-by-turn route guidance information items, such as *distance to turn*, will be used more frequently than route navigation information such as *cost to destination* or *road type*. Therefore, the former is a better candidate for standardization. A weighting of 6 was assigned and the following rating definitions were used for "Frequency of use":

4: This information item will be used very often relative to other information items (e.g., used frequently within a specified distance or time interval).
2: This information item will be used sometimes relative to other information items (i.e., average relative use).
0: This information item will rarely to never be used.

Utility of Information

Utility of information referred to the degree of assistance provided to the driver when this information is available. This was defined as the degree to which the information assists the driver with the primary driving task, as well as secondary tasks that define basic driving requirements, in achieving maximum driving efficiency. The utility of an information item was measured by the likely degree to which it could conserve time, effort, fuel, money, and mental workload (stress). As an example, the information item *list alternative possible routes*, which identifies routes based on the driver's preferred route characteristics, is likely to have significant utility for the driver with time and maneuver savings. The *name of current street* information item is likely to offer little utility to an en-route driver in most circumstances. A weighting of 8 was assigned, and the following rating definitions were used for "Utility of information":

4: Information is likely to lead to significant added utility (by conserving time, effort, fuel, or mental workload).
2: Information could lead to some added utility.
0: Information is not likely to have any utility (has no potential value).

Degree of Potential Inconvenience if Misinterpreted

This criterion included the degree of potential inconvenience to the driver and/or passengers if the information item is misinterpreted or not conveyed. Inconveniences include unnecessary driving, lost time, or lost motorist service or recreation opportunities. Since this is a very difficult metric to quantify, a two-state parameter is introduced. For example, if a driver misinterprets a *distance to exit* information item, the driver will possibly miss the turn, which leads to additional driving and time loss. For each information item, we must determine whether such an inconvenient outcome resulting from misinterpretation is likely. A weighting of 4 was assigned, and the following rating definitions were used for "Degree of potential inconvenience if misinterpreted":

4: Misinterpretation is likely to cause inconvenience (as in unnecessary driving, lost time, mental stress, or lost motorist service opportunity).
0: Misinterpretation is not likely to cause inconvenience.

Degree of Potential Danger if Misinterpreted

This criterion included the degree of potential danger to the driver and/or passengers, vehicle, and/or environment if the information item is misinterpreted or not conveyed. Note that even though "safety critical" information is not being presented, the information may still have safety implications. For example, if a driver misinterprets a *direction to turn* arrow and turns the wrong direction onto a one-way street, there is the possibility of a hazardous outcome. A weighting of 10 was assigned, and the following rating definitions were used for "Degree of potential danger if misinterpreted":

4: Misinterpretation could lead to death or permanent disability injury.
2: Misinterpretation could lead to vehicle or property damage.
0: Misinterpretation presents no danger to person or property.

Driver Convenience Information

Driver convenience information refers to those driving-related information items that are non-essential for performing the basic driving task. These are generally items that provide the driver with otherwise additional information related to motorist services, trip planning activity, recreation, or entertainment. This is information that benefits specific driver needs, such as locating a rest stop. The trade study for driver convenience information can be seen in appendix F.

Frequency of Use

It was thought that those driver convenience information items that are most frequently used should be selected for standardization. The information items that are used more often are better candidates for standardization, since users will spend more time receiving and effectively responding to these information items than less frequently used items. Frequency of use emphasis also facilitates the transfer of use knowledge from vehicle to vehicle. It is likely that *parking*

information will be utilized by the driver more frequently than *accommodation/lodging information*. Therefore, parking information is a better candidate for standardization. A weighting of 8 was assigned, and the following rating definitions were used for "Frequency of use":

4: This information item will be used very often relative to other information items (e.g., used frequently within a specified distance or time interval).
2: This information item will be used sometimes relative to other information items (i.e., average relative use).
1: This information item will rarely be used.

Level of Convenience

This is the degree of convenience provided by the information item, above and beyond basic information requirements of the driving task. Such information items typically address special driver needs, such as additional information related to motorist services, trip planning activity, recreation, or entertainment. For example, the location of *nearest rest stop* is likely to be significantly convenient to a driver who desires the information. A weighting of 10 was assigned, and the following rating definitions were used for "Level of convenience":

4: Information has potential to lead to significant added convenience (by expediting driver special needs such as parking, dining, and lodging, or facilitating recreation or entertainment pursuits).
3: Information has potential to highly increase convenience.
2: Information has potential to increase convenience.
1: Information has potential to slightly increase convenience.
0: Information does not increase convenience (has no potential value).

Degree of Potential Inconvenience if Misinterpreted

This criterion included the degree of potential inconvenience to the driver and/or passengers if the information item is misinterpreted or not conveyed. Inconveniences include unnecessary driving, lost time, or lost motorist service or recreation opportunities. For each item, we must think of the most serious, likely degree of inconvenience that could result from misinterpretation. Since this is a very difficult metric to quantify, a two-state parameter is introduced. For example, if the *location of a gas station* is misinterpreted, the driver could run out of gas en-route, elevating the situation to serious inconvenience. A weighting of 10 was assigned, and the following rating definitions were used for "Degree of potential inconvenience if misinterpreted":

4: Misinterpretation is likely to cause inconvenience (as in unnecessary driving, lost time, or lost motorist service opportunity).
0: Misinterpretation is not likely to cause inconvenience.

SELECTION OF FINAL CANDIDATE ITEMS

The next step in the process was to use the results of the trade studies to determine a suitable cut-off point for guideline and standardization development. The intentions of the cut-off justification were:

- To select a subset of information items that were representative of the diversity of potential guidelines within the subgrouping categories (i.e., safety-specific information, driver assistance information, and convenience information).

- To select a subset of information items that were feasible and reasonably standardizable with the resources of the project.

- To select subsets of information items that were given high total rankings.

The information items were listed within each subgrouping from highest rank to lowest rank. For Safety-Specific Information, 11 of 13 information items were considered. Selecting 11/13 (85 percent) of the safety items is consistent with the emphasis on safety in this study. The items excluded were vehicle condition monitoring items. It was argued that for the item "Inform the driver of current problems," a current problem would either exhibit itself in terms of an already obvious problem (flat tire, for example), or already have a type of warning associated with it (such as an oil light). For the item "Inform the driver of potential problems," it was argued that the diversity of potential vehicle status problems is so large that it could warrant a separate study.

For Driver Assistance Information, the top 16 of 23 items were selected. This appears to be a natural cut-off since there is good representation across information item functional categories. They are:

- (3) Route Guidance items
- (5) Dynamic Route Selection items
- (2) Vehicle Condition Monitoring items
- (2) In-Vehicle Signing items
- (3) Route Navigation items
- (1) In-Vehicle Safety and Warning item

For Driver Convenience Information, the 10 highest ranked information items were selected since at least one of each type of driver convenience information item is represented:

- (8) Motorist Services Information items
- (1) In-Vehicle Signing item
- (1) Trip Plan item

Once selected, the final 37 items were applied to the Survey/User Clinic Process Allocation stage that follows.

ALLOCATION OF INFORMATION ITEMS TO THE SURVEY OR USER CLINIC

To determine how to measure driver stereotypes and preferences for information items, a second trade study allocation tool was applied. The criteria used were description complexity, picture complexity, and driver familiarity with the information items. Since these items were all deemed to be of equal value in determining if the information item should be in the survey or user clinic, a weighting value was not applied. The criteria are defined in the following sections and the rating descriptions are given.

Description Complexity

This refers to those information items for which a verbal or textual elaboration is possible and reasonably expected. Such information items include traffic reports, weather forecasts, and road maintenance descriptions. The rating descriptions were:

5: The information item is simple to describe verbally or textually.
3: The item anticipates a moderately complex verbal or textual description.
1: The item anticipates a highly complex verbal or textual description.

Picture Complexity

Picture complexity refers to those information items that are best described visually with a complex picture. This type of information item most often implies a spatial relationship among its components. The pictorial aid is most commonly a map, but can also be a diagram. Information items that anticipate a complex picture include directions and views. The rating descriptions were:

5: The information item does not require a complex picture.
3: The information item anticipates a moderately complex picture.
1: The information item anticipates a highly complex picture.

Driver Familiarity

This refers to those information items that are commonly regarded as familiar concepts with drivers. The rating descriptions were:

5: The information item is commonly used and familiar to drivers.
3: The information item is not commonly used by drivers but can be expected to be understood.
1: The information item is novel, or is not generally expected to be known or understood among drivers.

Appendix G shows the results of the survey/user clinic trade study. Before creating the survey, the original list of items was reviewed to ensure that coverage and representativeness had been maintained. Based on this review, two additional items were added: road construction warning

and an off-route indication. "Road construction" was added as an information item category to the survey. "Off-route indication" was added as an item on the user clinic due to its novel nature and need for context to facilitate understanding.

One final step in the information item selection process was to eliminate items that were redundant with other items. "Redundant" in this case refers to the degree to which any guideline developed would apply virtually unchanged between items. For example, a safety-specific item was present entitled, "ISIS: Roadway Warning Signs." In addition, a driver assistance item was present entitled, "ISIS: Regulatory, Street, and Highway Information." While these two items refer to differing types of signs, their presentation would be standardized between sign types for obvious reasons. Thus, it was unnecessary to test both items. This step was particularly important to reduce the size of the survey to a manageable level. Removal of the items that contained redundancy resulted in the final information items tested, as shown in table 1.

Table 1. Final list of items included in the survey and the user clinic.

The Survey	The User Clinic
Motorist Service Information	Index of Yellow Pages
Time/Distance to Destination Information	Restaurant Description and Costs
Time/Distance to Next Turn and Lane Suggestion Information	Alternative Route Display
Guide Sign Information	Accident Alert
Road Construction Information (RCI)	Congestion Alert
Re-route Option Information (RROI)	Weather Alert
Stopped Vehicle Ahead Information	Off-route Alert
Congestion Ahead Information	
Approach of Emergency Vehicle Information	
Road Surface Condition and Warning Information	
Regulatory Information	
Type of Roadway Information	

Regarding the survey, the fact that driver needs are different for rural and urban drivers as compared with CVO drivers was considered. For example, commercial drivers cannot access fast-food drive-through windows and cannot park in parking garages. Therefore, the survey for CVO drivers required that questions regarding several aspects of ATIS information items be worded differently, have different examples, or be excluded as non-applicable. For these reasons, two surveys were developed: one for rural and urban private drivers, and one for commercial drivers.

STUDY 1—THE PRIVATE DRIVER SURVEY

METHOD FOR THE PRIVATE DRIVER SURVEY

Experimental Design for the Private Driver Survey

For the private driver survey, the independent variables were Gender, three levels of Age (18-25, 35-45, 65 and over), two levels of Environment (rural, urban), and Option, a within-subject variable that varied with each question. Option referred to the number of items that the survey respondent reviewed for each question. For example, there were *three* options for questions that asked which of *three* display types was most preferred. Similarly, there were *four* options for questions that asked which of *four* types of information was most preferred.

As can be seen in table 2, the cell sizes for the between-subject factors were unequal. Therefore, for each question, three separate analyses were conducted: each between-subject factor (Age, Gender, Environment) was analyzed with Option. Questions required either a forced choice between two or more items, or a ranking of two or more items. For the forced choice questions, the Chi-square Test for Independent Samples was conducted for possible interactions, and a Chi-square Goodness-of-Fit test was conducted for a possible main effect of Option. For the ranking questions, an Analysis of Variance (ANOVA) was conducted except in cases in which there were only two items to rank; in these cases, the question was considered a forced choice, and a chi-square test was used. Also for the ranking questions, simple effects tests were run as appropriate utilizing a one-way ANOVA. The Student Neuman Kuels (SNK) test was selected for main effect post-hoc tests. The dependent variable was either Frequency or Rank as appropriate.

Table 2. The number of rural and urban survey respondents per cell.

R = Rural U = Urban	Age (18-25)				Age (35-45)				Age (65 and over)			
	Male		Female		Male		Female		Male		Female	
	R	U	R	U	R	U	R	U	R	U	R	U
No. of Respondents	13	23	7	11	10	11	10	16	16	6	13	14

Participants for the Private Driver Survey

The number of participants per experimental cell can be seen in table 2. Although 75 drivers were solicited from a rural setting (Blacksburg, Virginia) and 75 drivers were solicited from an urban setting (Seattle, Washington, and Monterey, California) to participate in the experiment, six of the rural drivers reported that they did most of their driving in a suburban, city, or highway/freeway setting (as opposed to rural or small town). These six drivers were therefore categorized as urban, setting the total number of participants categorized as rural at 69, and the total number of participants categorized as urban at 81. There were 54 participants aged 18 to 25 years, 47 participants aged 35 to 45 years, and 49 participants aged 65 and over. Seventy-nine men and 71 women participated in the study. Eighteen participants reported driving under 2,000 miles per

year, 43 reported driving 2,000 to 7,999 miles per year, 48 reported driving 8,000 to 12,999 miles per year, 30 reported driving 13,000 to 19,999 miles per year, and 11 reported driving 20,000 or more miles per year.

Apparatus for the Private Driver Survey

After a first draft of the private driver survey was completed, several iterations were performed to clarify content, wording, and grammar. At this stage, the survey was pre-tested by three non-technical individuals to ensure readability and to determine the time necessary to respond to the survey. After minor revisions were made to the survey, recruitment of drivers began. The survey for rural and urban drivers can be seen in appendix H. The first page of the survey was designed to collect demographic information. The remaining pages of the survey covered the topics listed for inclusion in the survey as shown in table 1.

Procedure for the Private Driver Survey

For the drivers solicited from a rural setting, the surveys were disseminated to individuals who responded to advertisements by calling the Virginia Tech Center for Transportation Research (CTR) in Blacksburg, Virginia. If the caller had a current valid driver's license and fell into one of the age categories, then an informed consent form and survey were mailed out to the individual. The caller was asked to fill in the survey, which would take between 30 to 45 minutes, and then mail the survey back to the CTR in a pre-addressed, postage-paid envelope. After the survey was returned, the participant was mailed a check in the amount of $10.00.

For the drivers solicited from the urban settings, the surveys were disseminated by research assistants at Battelle (Seattle) and Monterey Technologies to drivers who were on site to take part in other transportation-related studies. At the participant's completion of the non-related study, the participant was asked if he/she would like to fill out a survey for an additional $10.00. If the participant agreed, he/she was given the survey and paid $10.00 in cash after completing the survey.

RESULTS AND DISCUSSION OF THE PRIVATE DRIVER SURVEY

For the questions with the dependent variable of Rank, ANOVAs were completed using SAS software (SAS Institute, Inc., 1995), using the General Linear Model for unequal sample sizes. The post-hoc test chosen was an SNK. As previously stated, three separate analyses were conducted for each between-subject factor (Age, Gender, and Environment) with Option. When a simple effects test was appropriate, it was conducted in SAS by isolating the data and running one-way ANOVAs, followed by SNKs to find significant differences between the options.

Although Option was an independent variable for each of the three separate analyses conducted, the p value is reported only once as it is given for the Age by Option interaction. It should be noted that the final p value for Option was the same for each of the four analyses, even though the sums of square values and mean square values differed slightly due to different degrees of

freedom for each of the three analyses. The ANOVA tables and SNK tables for the private driver survey are shown in appendix I.

For the survey questions in which a ranking of items was requested, respondents were asked to rank from 1 to the number of options available, with 1 being the best ranking and the final number being the worst ranking. Therefore, the lowest mean value for a given option is the best ranked item.

Motorist Services Information

Motorist Services Information—Question 1

This was a forced-choice question asking respondents if they would like to receive motorist services information automatically, only by request, or either automatically or by request. A chi-square test for independent samples revealed no significant interactions of Age, Gender, or Environment by Option. For this question, 27 respondents (18 percent) replied that they would like to receive this type of information automatically, 26 (17 percent) replied that they would like to receive the information only when requested, and 97 (65 percent) replied either automatically or when requested. A significant chi-square test, X^2=66.20, df=2, p<0.001, shows the disproportionate frequencies to be a reliable indicator of the preference for the option of having the information displayed either automatically or upon request.

Motorist Services Information—Question 2

This question requested a ranking of six types of restaurant information based on importance. The six types of information were:

- Restaurant name.
- Drive-through vs. sit-down.
- Type of food served.
- Price.
- Location.
- Seating availability/waiting time.

There were no significant interactions. An SNK on the significant main effect of Option, F(5, 735)=31.67, p=0.0001 (tables 34 and 35), shows that respondents thought that *location* was the most important piece of information that they needed when choosing a restaurant while driving.

The *type of food served* and *restaurant name* received the second best rankings, which were not significantly different from each other.

Motorist Services Information—Question 3

This question requested a ranking of eight types of lodging information based on importance. The eight types of information were:

- Lodging name.
- Closest lodging with a vacancy.
- All lodging with vacancies in the area.
- Specific lodging location.
- Special features.
- Price.
- Quality.
- What is nearby.

There was a significant interaction of Age by Option, F(14,1028)=3.73, p=0.0001 (table 36). A simple effects test and SNKs conducted for Option at each level of Age (table 37) showed that the 18-25 age group thought that *price* was the most important piece of information. For the 35-45 age group, *closest lodging with vacancy*, *price*, *all lodgings with vacancies in the area*, *specific lodging location*, and *quality* were assigned the best mean rankings, but were not ranked as significantly different from each other. For the 65 and over age group, *lodging name*, *quality*, *all lodgings with vacancies in the area*, and *closest lodging with vacancies in the area* were assigned the lowest mean rankings, but were not significantly different from each other. An SNK on the significant main effect of Option, F(7, 1028)=26.66, p=0.0001 (tables 38 and 39), shows that, for all respondents combined, *price* and *closest lodging with vacancy* were assigned the best rankings.

Motorist Services Information—Question 4

This question requested that respondents rank seven pieces of information regarding selection of a gas station. The seven information items were:

- Service name.
- Cost of gasoline.
- Restrooms.
- Hours of operation.
- Location.
- Other services.
- Payment methods.

There was a significant Age by Option interaction, F(12, 876)=3.13, p=0.0002 (table 40). A simple effects test and SNKs conducted for Option by each level of Age (table 41) showed that the 18-25 age group thought *cost of gasoline* and *payment methods* were the most important items of information, and were not ranked significantly different from each other. The 35-45 age group thought *location* was the most important piece of information. For the 65 and over age group, *location*, *cost of gasoline*, *hours of operation*, *service name*, and whether there were *restrooms* were assigned the best mean rankings, but were not significantly different from each other. An SNK performed for the significant main effect of Option, F(6, 876)=42.66, p=0.0001 (tables 42 and 43), showed that, overall, *location* and *cost of gasoline* were considered to be the most important pieces of information.

Motorist Services Information—Question 5

This question asked respondents to rank three display formats (iconic only, textual only, or combined iconic/textual) for the presentation of lodging accommodations. There were no significant interactions, revealing that there were no significant disagreements among the respondents. An SNK conducted for the significant main effect of Option, $F(2, 292)=69.21$, $p=0.0001$ (tables 44 and 45), showed that respondents most preferred the combined iconic/textual display format.

Motorist Services Information—Question 6

This question asked respondents to rank three display formats (iconic only, textual only, or combined iconic/textual) for the presentation of parking information. There were no significant interactions, revealing that there were no significant disagreements among the respondents. An SNK conducted for the significant main effect of Option, $F(2, 288)=83.67$, $p=0.0001$ (tables 46 and 47), showed that most respondents preferred the combined iconic/textual format.

Discussion of Response to Motorist Services Information Survey Questions

It appears that, overall, since the majority of respondents prefer to receive Motorist Services Information either automatically or when requested, the respondents would like to be able to toggle between two levels of system function. This seems logical since Motorist Services Information is mostly applicable when traveling long distances and not during everyday travel. When searching for a restaurant, the respondents, regardless of age, gender, or environment, agreed that knowing the location of the restaurant was the most important factor. However, the age groups did not agree on the most important information when choosing lodging or a gas station, suggesting that for lodging and fuel information, Motorist Services Information may need to provide several types of information to provide the best service to all drivers. There was general agreement for display formats, as shown by the significant difference in preference for the combined iconic/textual display format.

Time/Distance to Destination Information

Time/Distance to Destination Information—Question 1

This question asked respondents to rank whether they preferred to receive time/distance to destination information every so many miles, all the time, or only when requested. There was a significant Age by Option interaction, $F(4, 294)=2.99$, $p=0.0191$ (table 48). A simple effects test and SNKs (table 49) revealed that all three age groups preferred the information to be displayed only when requested; however, there were differences in preference for the lower ranked options. In agreement with these findings, an SNK conducted for the significant main effect of Option, $F(2, 294)=39.16$, $p=0.0001$ (tables 50 and 51), showed that, overall, respondents want the information displayed only when requested.

Time/Distance to Destination Information—Question 2

This was a forced-choice question asking respondents to select one of three display formats for time/distance to destination information. A chi-square revealed no significant interactions. Overall, a display showing the distance remaining to the destination was preferred by 36 respondents (24 percent), a display showing the time to the destination was preferred by 8 respondents (5 percent), and a display with both the time and the distance to the destination was preferred by 105 respondents (70 percent). One person (less than 1 percent) did not answer the question. A significant chi-square test, X^2=100.36, df=2, p<.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Time/Distance to Destination Information—Question 3

This was a forced-choice question asking the respondents how they would like trip distance or travel time information updated. A chi-square revealed no significant interactions. Overall, 110 respondents (74 percent) said they would like the information updated based upon a percentage of the total trip or travel time, while 39 (26 percent) respondents reported that they would like the information updated every so many miles or minutes. Note that one person (less than 1 percent) did not answer the question. A significant chi-square test, X^2=35.58 , df=1, p>.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Time/Distance to Destination Information—Question 4

This was a forced-choice question asking the respondents what type of time and distance information they would like to receive half-way through a short trip. There was a significant Gender by Option interaction, X^2=10.227, df=2, p=0.0060. Based on this result and the information presented in table 3, it appears that both men and women prefer both distance and time to destination information, and women do not want time to destination information. A significant chi-square test for Option, X^2=80.44 , df=2, p>.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Table 3. Time/Distance to Destination Information Question 4 frequency distribution for the significant Gender by Option interaction.

Question: You have driven about half way to your destination, and you would like to know how much farther you have to go. What information would you most prefer to receive?			
		Gender	
Option	**Frequency (%)**	**Male**	**Female**
Distance to Destination	40 (27%)	16	24
Time to Destination	11 (7%)	10	1
Both Distance and Time to Destination	99 (66%)	53	46

Time/Distance to Destination Information—Question 5

This was a forced-choice question asking the respondents what type of information they would like to receive for automatically updated Time/Distance to Destination Information. There were no significant interactions. For this question, 63 respondents (42 percent) preferred information given every so many miles or minutes, 21 (14 percent) preferred information based on a percentage of total trip distance or travel time, and 66 (44 percent) preferred information based on both amount of miles or minutes and on a percentage of total trip time. A significant chi-square test, X^2=25.32, df=2, p>.001, shows the frequencies to be significantly different from the expected values.

Discussion of Response to Time/Distance to Destination Information Survey Questions

Overall, the respondents surveyed prefer to have time/distance to destination information displayed only when requested. Since most day-to-day trips may be perceived as familiar and the time and distance to the destination are known, this type of information is useful only for special trips. Also, the general results point toward a trend in which respondents prefer to have more information rather than less, wanting both time and distance information instead of one or the other. Lastly, most respondents indicated that they would like time/distance information updated based upon both amount of miles or minutes and on a percentage of total trip time.

Time/Distance to Next Turn and Lane Suggestion Information

Time/Distance to Next Turn and Lane Suggestion Information—Question 1

This question asked respondents to rank in terms of preference whether they prefer to receive one, two, or three messages regarding an upcoming turn. There was a significant Age by Option interaction, F(4, 268)=5.96, p=0.0001 (table 52). The simple effects test and SNKs (table 53) show that the 18-25 age group and the 35-45 age group thought that receiving two messages was preferable. The 65 and over age group ranked the options of receiving three or two messages the best, but not significantly different from each other. There was also a significant interaction for Gender by Option, F(2, 270)=3.98, p=0.0198 (table 54). The simple effects test and SNKs show that the men ranked the option of receiving two messages about an upcoming turn as most preferable, while the women ranked the options of receiving two or three messages about an upcoming turn (table 55) the best, but not significantly different from each other. Further analysis on the significant main effect of Option, F(2, 268)=69.09, p=0.001 (tables 56 and 57), revealed that respondents most prefer to receive two messages regarding an upcoming turn.

Time/Distance to Next Turn and Lane Suggestion Information—Question 2

This was a forced-choice question asking respondents to specify whether they would prefer to receive distance to turn information, time to turn information, or both distance and time to turn information when driving in a city. There were no significant interactions. Seventy-four respondents (50 percent) indicated that they prefer to receive distance to turn information, 69 (46 percent) preferred both time and distance to turn information, and 6 (4 percent) preferred to

receive only time to turn information. One respondent chose not to answer the question. A chi-square Goodness-of-Fit test, X^2=25.32, df=2, p>.001, shows the frequencies to be significantly different from the expected values. Note, however, that two options received very close response frequencies.

Time/Distance to Next Turn and Lane Suggestion Information—Question 3

This was a forced-choice question asking respondents to specify the type of information they would prefer to receive about an upcoming turn. There were no significant interactions. One-hundred and fifteen respondents (77 percent) indicated that they prefer to know the number of intersections they are from their turn, while 19 (13 percent) preferred to know the number of city blocks to the turn, and 16 (10 percent) preferred to know how many tenths of a mile to the turn. A chi-square Goodness-of-Fit test, X^2=126.84, df=2, p>.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Time/Distance to Next Turn and Lane Suggestion Information—Question 4

This was a forced-choice question asking respondents to specify what type of information they would prefer to receive regarding what exit to take if traveling on a highway. There were no significant interactions. Fifty-eight respondents (39 percent) replied that they preferred to know the number of exits that they would pass before coming to their exit, while 41 respondents (27 percent) replied they would prefer to know the distance to the exit, 46 (31 percent) would prefer to know both distance and time to the exit, and 5 (3 percent) would prefer to know time to the exit. A chi-square Goodness of Fit test, X^2=41.62, df=3, p>.001, shows the frequencies to be significantly different from the expected values. Note, however, that two options had very close response frequencies.

Time/Distance to Next Turn and Lane Suggestion Information—Question 5

This was a forced-choice question asking respondents what type of distance to exit information (number of exits away, number of miles away, both number of exits and miles) they would prefer. There was a significant Environment by Option interaction, X^2=6.494, df=3, p=0.0389. Table 4 shows that, although both groups preferred to receive information on both the number of exits and miles before the exit, there were differences in preferences for the other two options. A significant chi-square test for the main effect of Option, X^2=67.09, df=2, p<0.001, shows that the disproportionate frequencies are a reliable indication of preference.

Table 4. Time/Distance to Next Turn and Lane Suggestion Information Question 5 frequency distribution for Environment by Option interaction.

Question: For the following question, please assume that this information will be presented to you in terms of distance. Which type of information would you most prefer to receive about your upcoming exit?			
		Environment	
Option	**Frequency (%)***	**Rural**	**Urban**
Number of Exits Away	19 (13%)	4	15
Number of Miles Away	34 (23%)	19	15
Both Number of Exits and Miles	96 (64%)	45	51

* One person (less than 1 percent) chose not to answer the question.

Time/Distance to Next Turn and Lane Suggestion Information—Question 6

This question asked respondents whether they would prefer an iconic only, textual only, or combined iconic/textual display regarding which lane to be in before an upcoming exit. There were no significant main effects. An SNK performed for the significant main effect of Option, $F(2, 290)=129.74$, $p=0.0001$ (tables 58 and 59), revealed that respondents most prefer the combined iconic and textual display.

Time/Distance to Next Turn and Lane Suggestion Information—Question 7

This question asked respondents whether they would prefer an iconic only, textual only, or combined iconic/textual display regarding navigation information. There was a significant Age by Option interaction, $F(4, 290)=6.02$, $p=0.0001$ (table 60). The simple effects test and SNKs (table 61) show that all three age groups thought that the combined iconic and textual display was most preferable. The 18-25 age group and the 35-45 age group thought that the all-text message was least preferable, while the 65 and over age group thought that the iconic only message was least preferable. An SNK on the significant main effect of Option, $F(2, 290)=114.26$, $p=0.0001$ (tables 62 and 63), showed the combined iconic/textual display to be the most preferred.

Discussion of Response to Time/Distance to Next Turn and Lane Suggestion Information Survey Questions

For time/distance to next turn information, the results were not specific as to whether two or three upcoming turn messages were most preferred; however, it is clear that drivers prefer to have advance warning and want more than one message given immediately preceding the turn. When distance to turn or distance to exit information is displayed, there is disagreement as to whether information is best displayed in terms of distance (miles), time and distance, number of exits, or other; however, respondents do not want time only information under any circumstances. Again, respondents indicated that they prefer to have a combined iconic/textual display format.

Guide Sign Information

Guide Sign Information—Question 1

This forced-choice question asked respondents how they would prefer to see guide sign information displayed in their vehicle. Forty-seven respondents (31 percent) replied that they would always like the guide sign information posted, 51 (34 percent) replied that they would like the information posted only when relevant, and 45 (30 percent) replied that they would like the information posted only when requested. There were no significant interactions or a main effect by Option. The respondents had no significant preference for when the guide sign information should be posted. Note that seven people (5 percent) chose not to answer the question.

Guide Sign Information—Question 2

This question asked respondents to rank three display types for guide sign information. There was a significant Age by Option interaction, $F(4, 292)=3.22$, $p=0.0131$ (table 64). A simple effects test and SNKs (table 65) showed that, although all three age groups preferred the combined iconic and textual format, there was disagreement for the other options. An SNK for the significant main effect of Option, $F(2, 292)=145.40$, $p=0.0001$ (tables 66 and 67), supported the interaction results.

Discussion of Response to Guide Sign Information Survey Questions

The results for Guide Sign Information Question 1 show that respondents did not agree when they would prefer to have guide sign information posted, implying that an on/off toggle feature for this information would be appropriate. It could be that some respondents felt that guide signs posted on the roadway are adequate and not truly necessary for an in-vehicle system. Perhaps if the question was worded to consider poor visibility conditions, the respondents would have a different opinion. Note that for the display format question, respondents again prefer to have a combined iconic/textual display format.

Road Construction Information

Road Construction Information—Question 1

This question asked respondents to rank eight pieces of information about road construction information (RCI) from least to most important. The eight items were:

- How far ahead the construction lies.
- The type of construction.
- Any shift in road alignment.
- Whether there are workers or other people in the vicinity.
- Speed limit in the construction zone.
- Indication that there are slow-moving vehicles in the area.
- Uneven or bumpy pavement.

! Information about merging traffic into your lane, or you merging into another lane.

There was a significant Age by Option interaction, F(14, 1027)=2.38, p=0.0029 (table 68). A simple effects test and SNKs (table 69) show that all three age groups preferred *how far ahead the construction lies* as the most important piece of information, although there was some disagreement as to the order of importance for the other options. Although there was a significant Gender by Option interaction, F(7, 1034)=2.18, p=0.0339 (table 70), both men and women agreed that *how far ahead the construction lies* was the most important item of information (table 71); however, men and women differed significantly in their ranking of lesser preferred items. An SNK on the significant main effect of Option, F(7, 1027)=78.37, p=0.0001 (tables 72 and 73), supported the interaction results.

Road Construction Information—Question 2

This was a forced-choice question asking respondents when they would like to receive information about how far away construction lies. There were no significant interactions. Eighty respondents (53 percent) replied that they would prefer to receive information in terms of both the distance and time to the construction. Distance only information was preferred by 67 respondents (45 percent), and time away was preferred by two respondents (1 percent). One person chose not to answer the question. A significant chi-square test for the main effect of Option, X^2=69.86, df=2, p<0.001, shows the frequencies to be significantly different from the expected values; however, the frequencies for the two most preferred options are close.

Road Construction Information—Question 3

This was a forced-choice question asking respondents whether they would prefer to receive a warning about road construction more than 2 miles in advance. There was a significant interaction of Age by Option, X^2=9.715, df=2, p=0.0078. As seen in table 5, the 18-25 age group and the 35-45 age group tended to prefer to receive the information more than 2 miles in advance. However, the 65 and over age group was roughly divided in their responses. Note that two people chose not to answer the question.

Table 5. Road Construction Information Question 3 frequency distribution for the significant Age by Option interaction.

Question: In general, do you want to receive information about upcoming road construction sooner than 2 miles before the area?				
		Age		
Option	**Freq. Count**	**18-25**	**35-45**	**65 +**
Want information more than 2 miles in advance	95	36	36	23
Do not want information more than 2 miles in advance	53	18	10	25

There was also a significant Environment by Option interaction, X^2=11.973, df=1, p=0.0005. The frequencies shown in table 6 indicate that, although the urban group prefers to receive a construction warning more than 2 miles in advance, the rural group did not have a clear preference. A chi-square test for the main effect of Option, X^2=11.92, df=1, p<0.001, shows that overall, most people prefer to receive a warning more than 2 miles in advance.

Table 6. Road Construction Information Question 3 frequency distribution for the significant Environment by Option interaction.

Question: In general, do you want to receive information about upcoming road construction sooner than 2 miles before the area?			
		Environment	
Option	**Frequency (%)***	**Rural**	**Urban**
Want information more than 2 miles in advance	95 (63%)	33	62
Do not want information more than 2 miles in advance	53 (35%)	34	19

* Two people (1 percent) chose not to respond to the question.

Discussion of Response to Road Construction Information Survey Questions

Regardless of age or gender, respondents tended to agree that knowing how far ahead road construction was located was an important item of information. When asked how they would like the RCI displayed, the respondents were approximately divided as to whether they wanted to know time and distance information or just distance, but clearly they did not want time only information. Although most respondents wanted to know about construction more than 2 miles in advance, there was an interesting age effect that showed that older respondents were not in agreement as to whether this information was useful. This result might indicate that an older driver would be less likely to re-route. Also, rural drivers did not show a clear preference to receive RCI more than 2 miles in advance. This result may indicate that rural drivers do not tend to find road construction delays as much of an inconvenience, or they do not have to deal with the problems of road construction very often and consider infrequent delays acceptable. It may also be the case that alternate routes are significantly longer in rural areas, in which case the drivers may prefer the shorter wait of road construction delays to longer driver times.

Re-route Option Information

Re-route Option Information—Question 1

This question asked respondents to rank 10 options from least to most important pertaining to choosing a new route. The items were:

- Convenience.
- Least amount of traffic.
- Shortest route (distance).
- Fastest route (time).

- Most inexpensive route.
- Particular road type.
- Fewest turns.
- Scenery.
- Attractions and landmarks along route.
- State/regions that the route will travel through.

There was a significant Age by Option interaction, F(18, 1323)=2.62, p=0.0002 (table 74). A simple effects test and subsequent SNKs (table 75) show that the 18-25 age group thought *fastest route* was the most important item of information. The 35-45 age group thought *fastest route*, *least amount of traffic*, and *shortest route* were the most important, but not significantly different from each other. The 65 and over age group thought that *shortest route* and *least amount of traffic* were the most important items of information, but not significantly different from each other.

There was also a significant Gender by Option interaction, F(9, 1332)=2.34, p=0.0129 (table 76). A simple effects test and subsequent SNKs (table 77) show that both men and women ranked *fastest route*, *shortest route*, and *least amount of traffic* as the most important, but not significantly different from each other; however, the two groups showed significant disagreement on the importance of lesser ranked options. An SNK for the significant main effect of Option, F(9, 1323)=120.51, p=0.0001 (tables 78 and 79), shows that, overall, respondents ranked *least amount of traffic, fastest route,* and *shortest route* as the most important items and not significantly different from each other.

Re-route Option Information—Question 2

This question asked respondents to rank nine options from least to most important when trying to avoid particular kinds of routes. The nine options were:

- Type of roadway.
- Complex intersections.
- Number of traffic lights/stop signs.
- Toll ways.
- High crime regions/localities.
- Railroad crossings.
- Congestion/traffic.
- Poor road quality.
- The number of turns.

There was a significant Age by Option interaction, F(16, 1175)=4.79, p=0.0001 (table 80). A simple effects test and SNKs (table 81) show that the 18-25 age group and the 35-45 age group ranked *congestion/traffic* as the most important piece of information. For the 65 and over age group, *congestion/traffic*, *high crime regions*, *poor road quality*, and *complex intersections* have the best means, but are not significantly different from each other. An SNK for the significant main effect of Option, F(8, 1175)=75.24, p=0.0001 (tables 82 and 83), shows that, overall,

respondents ranked *high crime regions*, *poor road quality*, and *number of traffic lights/stop lights* as the most important and not significantly different from each other.

Re-route Option Information—Question 3

This forced-choice question asked respondents whether they would like an in-vehicle system to automatically suggest an alternative route in the event of a traffic delay or only if requested. There were no significant interactions. A chi-square test showed a significant main effect of Option, X^2=3.89, df=1, p<0.05. Most (86) respondents prefer to receive the information automatically, while 62 prefer to receive the information when requested.

Re-route Option Information—Question 4

This question asked respondents to rank three re-routing information display designs in terms of preference. The options were a text list of directions, a full route map display, or a turn-by-turn display. There were no significant interactions and no significant main effect of Option.

Discussion of Response to Re-route Option Information Survey Questions

It is interesting to note that when considering re-route options, the 18-25 and the 35-45 age groups agreed that congestion is the most important piece of information, yet the elderly were concerned with several factors, one of which is being re-routed through a high crime region. The lack of agreement in the 65 and older age group shows that this population has many concerns when being re-routed and will likely need more information than the younger groups to feel comfortable with accepting re-routing information. For question 3, there was a significant difference in the number of responses for each option, although the actual number of respondents preferring one method over another is fairly close. Furthermore, for question 4, there were no significant results. These results taken together suggest that more consideration should be given to the appropriate display of Re-route Option Information (RROI) for in-vehicle systems.

Stopped Vehicle Ahead Information

Stopped Vehicle Ahead Information—Question 1

This forced-choice question asked respondents to choose whether they would like to have stopped vehicle ahead information presented in their vehicle. There were no significant interactions. A chi-square test for the main effect of Option was significant, X^2=80.66, df=1, p<0.001, and shows clearly that most respondents (130) want stopped vehicle ahead information in their vehicle as opposed to those who do not (20).

Stopped Vehicle Ahead Information—Question 2

This question asked respondents to rank five items from least to most desirable in terms of receiving stopped vehicle ahead information in the vehicle. The five items were:

- School bus.
- Public transit.
- Emergency vehicle such as an ambulance or police car.
- Delivery vehicle such as a mail or UPS truck.
- Utility vehicle such as a telephone repair vehicle.

There was a significant Age by Option interaction, F(8, 588)=3.82, p=0.0002 (table 84). A simple effects test and SNKs (table 85) show that the 18-25 age group and the 35-45 age group ranked *emergency vehicle such as an ambulance or police car* as the most desirable information item, and *school bus* as the second most desirable factor. However, for the 65 and over age group, *emergency vehicle such as ambulance or police car* and *school bus* were ranked the most desirable, but not significantly different from each other. The significant Environment by Option interaction, F(4, 592)=4.80, p=0.0008 (table 86), shows that the rural group ranked *school bus* and *emergency vehicle such as ambulance or police car* as most desirable, but not significantly different from each other, while the urban group thought *emergency vehicle such as ambulance or police car* was the most important option (table 87). An SNK on the significant main effect of Option, F(4, 588)=130.65, p=0.0001 (tables 88 and 89), shows that, overall, *emergency vehicle such as ambulance or police car* was given the most desirable ranking, and *delivery vehicle* was given the least desirable ranking.

Stopped Vehicle Ahead Information—Question 3

Although this question requested the respondents to rank the options, there were only two options. Therefore, the decision was made to analyze this question as a forced-choice type using the chi-square test. The question asked respondents to decide if they prefer to receive a textual message or a combined iconic/textual message regarding a stopped vehicle. There were no significant interactions. A significant test for the main effect of Option, X^2=42.66, df=1, p<0.001, shows that 115 respondents (77 percent) prefer to receive a combined iconic/textual message, while 35 (23 percent) prefer to see a text-only message.

Stopped Vehicle Ahead Information—Question 4

This forced-choice question asked respondents whether they would prefer to receive a suggestion for action as they approach a stopped vehicle. There was a significant Age by Option interaction, X^2=25.608, df=2, p<0.0001 (see table 7). Subsequent chi-square tests revealed that for the 18-25 age group and the 35-45 age group, there was not a significant difference in the number of respondents who did or did not prefer to receive a suggested action. However, the 65 and over age group did prefer to receive a suggested action, X^2=30.44, df=1, p<0.001. A test for the main effect of Option shows that, overall, respondents did prefer to receive a suggested course of action when a stopped vehicle was ahead, X^2=14.10, df=1, p<0.001.

Table 7. Stopped Vehicle Ahead Information Question 4 frequency distribution for Age by Option interaction.

Question: It is possible that an in-vehicle system will be able to provide you with a recommended driver action to take as you approach a stopped vehicle ahead (e.g., "School bus ahead. Prepare to stop."). Do you want to receive this information?				
		Age		
Option	**Freq. Count**	**18-25**	**35-45**	**65 +**
Want suggested action	98	24	30	44
Do not want suggested action	52	30	17	5

Discussion of Response to Stopped Vehicle Ahead Information Survey Questions

The results clearly indicate that most respondents would like to have *stopped vehicle ahead* information presented to them in their vehicles. Although there were some differences in rankings of importance for the type of stopped vehicle for which respondents would like information, in general, respondents thought it most important to know about school buses and emergency vehicles. This is logical since these types of vehicles denote a time when increased awareness of the driving environment is of primary importance. Respondents again indicated that a combined iconic/textual display format is preferred. When asked if they would prefer to receive a suggested course of action when a stopped vehicle was ahead, only the older age group showed a significant preference for receiving this type of information. This result may mean that the younger and middle-aged groups felt more confident in their ability to analyze and respond to a stopped vehicle in the roadway, whereas the older group was more comfortable with an aid.

Congestion Ahead Information

Congestion Ahead Information—Question 1

This question asked respondents to rank four items regarding congestion information from least to most important. The four items were:

- Distance/time to congested area.
- Average traveling speed of congestion.
- The cause of the congestion.
- The duration of the delay due to congestion.

There was a significant Age by Option interaction, $F(6, 438)=2.59$, $p=0.0178$ (table 90). A simple effects test and SNK (table 91) show that the 18-25 age group ranked *distance/time to congested area*, *duration of delay*, and *average traveling speed of congestion* as most important, but not as significantly different from each other. The 35-45 age group ranked *duration of delay* and *distance/time to congested area* as the most important items of information. The 65 and over age group ranked *distance/time to congested area* as the most important piece of information.

The main effect of Option was also significant, F(3, 438)=54.05, p=0.0001 (table 92), and an SNK (table 93) revealed that, overall, respondents thought *distance/time to congested area* was the most important item of information, and the *cause of the congestion* was the least important item of information.

Congestion Ahead Information—Question 2

This was a forced-choice question asking respondents to specify how far traffic would have to be backed up before they would consider taking an alternate route. There were no significant interactions. The results are listed in table 8 (one person chose not to answer the question). A significant main effect of Option was shown, X^2=12.17, df=4, p<0.02. Note, however, that the two options chosen most often have relatively close response frequencies.

Table 8. Congestion Ahead Information Question 2 frequency distribution for responses.

Question: How far does traffic have to be backed up before you would consider taking an alternate route?	
Option	**Frequency (%)***
Less than ¼ mile	20 (13%)
¼ to ½ mile	43 (29%)
½ to ¾ mile	36 (24%)
¾ to 1 mile	23 (15%)
Greater than 1 mile	27 (18%)

* One person chose not to answer the question.

Congestion Ahead Information—Question 3

This was a forced-choice question asking respondents how long traffic would have to be backed up before they would consider taking an alternate route. There was a significant Age by Option interaction, X^2=20.114, df=8, p=0.0093. As can be seen in table 9, more older respondents said they would be willing to wait longer before taking another route. A significant test for the main effect of Option, X^2=36.86, df=4, p<0.001, shows that the observed frequencies are significantly different from those expected.

Table 9. Congestion Ahead Information Question 3 frequency distribution for the significant Age by Option interaction.

Question: How long does traffic have to be backed up before you would consider taking an alternate route?				
		Age		
Option	**Frequency (%)**	**18-25**	**35-45**	**65 +**
Less than 5 minutes	15 (10%)	4	9	2
Between 5 and 10 minutes	48 (32%)	22	16	10
Between 10 and 15 minutes	48 (32%)	18	14	16
Between 15 and 20 minutes	22 (15%)	8	4	10
Greater than 20 minutes	17 (11%)	2	4	11

Congestion Ahead Information—Question 4

This forced-choice question asked respondents whether they would prefer to receive information about the distance to a traffic jam in terms of how many minutes ahead, miles ahead, or both. There were no significant interactions. Eighty-two respondents (55 percent) specified that they would like to know both miles and minutes, 60 (40 percent) specified miles ahead, and 8 (5 percent) specified minutes ahead. A significant test for the main effect of Option, X^2=57.76, df=2, p<0.001, shows that the observed frequencies are significantly different from those expected.

Congestion Ahead Information—Question 5

This forced-choice question asked respondents how they would prefer to receive information regarding the duration of a traffic jam. There was a significant interaction of Gender by Option, X^2=7.491, df=2, p=0.0236, as shown in table 10. Although most men and women prefer to know both miles and minutes delayed, there was no consensus in the second most preferred option. A significant main effect of Option, X^2=91.00, df=2, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Table 10. Congestion Ahead Information Question 5 frequency distribution for the significant Gender by Option interaction.

Question: Would you prefer to receive information about the duration of a traffic jam in terms of how many minutes delayed, how many miles delayed, or in terms of both minutes and miles delayed?			
		Gender	
Option	**Frequency (%)**	**Male**	**Female**
Minutes the traffic is delayed	25 (17%)	19	6
Miles the traffic is delayed	20 (13%)	8	12
Both minutes and miles delayed	105 (70%)	52	53

Discussion of Response to Congestion Ahead Information Survey Questions

In general, respondents consider congestion information in terms of how it will affect the length of their trip. For question 1, it is intuitive that respondents would want to know the distance or time to a congested area so that they may re-route. However, according to question 2, respondents vary considerably in their response to how far and how long traffic would have to be backed up before they would take an alternate route, with older individuals showing more tolerance for waiting. This may be indicative of the fact that those over age 65 may have more flexibility in travel time and have the option not to travel during rush hour traffic. Regarding how they would like information displayed, most respondents prefer to have the most information possible, opting to receive both miles and minutes information for the distance to a traffic jam and the duration of a traffic jam.

Approach of Emergency Vehicle Information

Approach of Emergency Vehicle Information—Question 1

This question asked respondents to rank five items from least important to most important regarding the approach of an emergency vehicle. The five items were:

- The destination of the emergency vehicle relative to you.
- Relative location of the approaching emergency vehicle.
- Speed of the approaching emergency vehicle.
- Type of emergency vehicle (e.g., police, ambulance, fire truck).
- The number of emergency vehicles approaching.

There was a significant Age by Option interaction, $F(8, 588)=3.55$, $p=0.0005$ (table 94). The simple effects test and SNKs (table 95) show that the 18-25 age group and the 35-45 age group considered *relative location of the approaching vehicle* to be the most important item of information. The 65 and over age group gave *relative location of the approaching vehicle* and *type of emergency vehicle* the best rankings. An SNK on the significant main effect for Option, $F(4, 588)=33.27$, $p=0.0001$ (tables 96 and 97), shows *relative location of the approaching emergency vehicle* to be considered the most important item of information.

Approach of Emergency Vehicle Information—Question 2

This question asked respondents which of two auditory messages they would prefer to hear regarding the approach of an ambulance. There were no significant interactions. One-hundred and thirty-four respondents (89 percent) specified that they would prefer to hear the message, "*Ambulance approaching from rear in left lane*," while 16 (11 percent) specified that they would prefer to hear the message, "*Ambulance heading southbound on Elm Street in left lane*." A significant test for the main effect of Option, $X^2=92.83$, $df=1$, $p<0.001$, shows the disproportionate responses to be a reliable indicator of preference.

Approach of Emergency Vehicle Information—Question 3

This forced-choice question asked respondents to consider whether they would prefer to receive a suggested course of action in the event that an emergency vehicle approaches if they are traveling in the right lane. A significant Age by Option interaction was revealed, X^2=23.510, df=2, p<0.0001 (table 11). It appears that as age increases, more respondents preferred to receive a suggested course of action. A significant Environment by Option interaction also exists, X^2=3.845, df=1, p=0.0499, as shown in table 12. A significant main effect of Option, X^2=9.62, df=1, p<0.001, shows the disproportionate responses to be a reliable indicator of preference.

Table 11. Approach of Emergency Vehicle Information Question 3 frequency distribution for the significant Age by Option interaction.

Question: Do you want an in-vehicle system to recommend a driver action in response to the approach of the emergency vehicle?				
		Age		
Option	**Frequency (%)**	**18-25**	**35-45**	**65 +**
Want to receive suggestion	94 (63%)	22	30	42
Do not want to receive suggestion	56 (37%)	32	17	7

Table 12. Approach of Emergency Vehicle Information Question 3 frequency distribution for the significant Environment by Option interaction.

Question: Do you want an in-vehicle system to recommend a driver action in response to the approach of the emergency vehicle?			
		Environment	
Option	**Frequency (%)**	**Rural**	**Urban**
Want to receive suggestion	94 (63%)	49	45
Do not want to receive suggestion	56 (37%)	20	36

Approach of Emergency Vehicle Information—Question 4

This forced-choice question asked respondents to consider whether they would prefer to receive a suggested course of action in the event that an emergency vehicle approaches if they are traveling in the left lane (as opposed to the right lane in the previous question). There is a significant Age by Option interaction, X^2=29.707, df=2, p<0.0001 (table 13), which again shows that as age increases, more respondents would like to receive a suggested course of action. There are also significant Gender by Option, X^2=4.664, df=1, p<0.0308 (table 14), and Environment by Option, X^2=3.833, df=1, p<0.0386 (table 15), interactions. The significant main effect of Option, X^2=29.04, df=1, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Table 13. Approach of Emergency Vehicle Information Question 4 frequency distribution for the significant Age by Option interaction.

Question: Do you want an in-vehicle system to recommend a driver action as an emergency vehicle approaches your vehicle?				
		Age		
Option	**Frequency (%)**	**18-25**	**35-45**	**65 +**
Want to receive suggestion	108 (72%)	25	38	45
Do not want to receive suggestion	42 (28%)	29	9	4

Table 14. Approach of Emergency Vehicle Information Question 4 frequency distribution for the significant Gender by Option interaction.

Question: Do you want an in-vehicle system to recommend a driver action as an emergency vehicle approaches your vehicle?			
		Gender	
Option	**Frequency (%)**	**Male**	**Female**
Want to receive suggestion	108 (72%)	51	57
Do not want to receive suggestion	42 (28%)	28	14

Table 15. Approach of Emergency Vehicle Information Question 4 frequency distribution for the significant Environment by Option interaction.

Question: Do you want an in-vehicle system to recommend a driver action as an emergency vehicle approaches your vehicle?			
		Environment	
Option	**Frequency (%)**	**Rural**	**Urban**
Want to receive suggestion	108 (72%)	55	53
Do not want to receive suggestion	42 (28%)	14	28

Approach of Emergency Vehicle Information—Question 5

This forced-choice question asked respondents to indicate if they prefer to know how far away an approaching ambulance is. One-hundred and thirty drivers (87 percent) replied that they would want to know how far away an approaching ambulance is, while 19 (13 percent) replied that they would not want to know. Note that one person (less than 1 percent) chose not to answer the question. There were no significant interactions. The significant main effect of Option, X^2=40.33, df=1, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Approach of Emergency Vehicle Information—Question 6

This question asked respondents to rank seven methods for displaying an ambulance's distance information. The seven options were:

- Tenths of a mile away.
- Seconds away.
- City blocks away.
- Both tenths of a mile and seconds away.
- Both tenths of a mile and blocks away.
- Both seconds and blocks away.
- Tenths of a mile, seconds, and blocks away.

There was a significant Age by Option interaction, $F(12, 870)=1.77$, $p=0.0484$ (table 98), Gender by Option interaction, $F(6, 876)=2.36$, $p=0.0286$ (table 100), Environment by Option interaction, $F(6, 876)=4.38$, $p=0.0002$ (table 102), and a significant main effect of Option, $F(6, 870)=2.67$, $p=0.0143$ (table 104). However, inspection of the SNKs performed for each interaction and the main effect (tables 99, 101, 103, and 105) shows that, overall, respondents did not agree on what information was most important.

Discussion of Response to Approach of Emergency Vehicle Information Survey Questions

For the display of Approach of Emergency Vehicle Information, the respondents prefer to know the relative location of the approaching vehicle (question 1) and want this type of information presented as it pertains to their current location (question 2). As with the construction information, older respondents were more likely to want suggested course of action information than the younger and middle-aged drivers. Although respondents want to know the distance of the approaching emergency vehicle, there is not agreement on the format for displaying that type of information.

Road Surface Condition and Warning Information

Road Surface Condition and Warning Information—Question 1

This was a forced-choice question asking respondents whether they prefer to receive distance, time, or both distance and time information regarding road surface condition. There were no significant interactions. Eighty respondents (53 percent) prefer to receive both time and distance information, while 64 (43 percent) prefer distance only, and 5 (3 percent) prefer time only (one person did not answer the question). A significant test of the main effect of Option, $X^2=62.42$, $df=2$, $p<0.001$, shows the disproportionate frequencies to be a reliable indicator of preference.

Road Surface Condition and Warning Information—Question 2

This was a forced-choice question asking respondents whether they prefer an in-vehicle system to recommend an action when approaching a potentially dangerous area. There was a significant

Age by Option interaction, X^2=21.300, df=2, p<0.0001. The frequency counts are shown in table 16, and indicate that the number of respondents who wanted a recommended action increased as age increased (note that one person chose not to answer the question). A significant test of the main effect of Option, X^2=43.74, df=1, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Table 16. Road Surface Condition and Warning Information Question 2 frequency distribution for the significant Age by Option interaction.

Question: Would you like to receive information about recommended actions to take when approaching potentially hazardous areas?				
		Age		
Option	**Frequency (%)***	**18-25**	**35-45**	**65 +**
Want to receive suggestion	115 (77%)	31	38	46
Do not want to receive suggestion	34 (23%)	23	8	3

* One person chose not to answer the question.

Road Surface Condition and Warning Information—Question 3

This question asked respondents to rank three possible methods to present warning information to drivers (iconic only, textual only, and combined iconic/textual). There were no significant interactions. An SNK on the significant main effect of Option, F(2, 292)=161.60, p=0.0001 (tables 106 and 107), shows that the combined iconic/textual message was most preferred.

Discussion of Response to Road Surface Condition and Warning Information Survey Questions

Once again, respondents prefer to have more information displayed rather than less, as shown by the number of respondents who prefer to receive both time and distance information. As with previous types of information, as age increased, more respondents wanted to receive a suggested course of action. Again, respondents preferred a combined iconic/textual display format.

Regulatory Information

Regulatory Information—Question 1

This question asked respondents to rank two options for displaying regulatory information. Although this was a ranking question, since there were only two options, the data were analyzed with a chi-square test. There were no significant interactions. One hundred and thirty-four respondents (89 percent) preferred to see the standard warning sign displayed, while 16 (11 percent) preferred the text-only message. A significant test of the main effect of Option, X^2=92.82, df=1, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Regulatory Information—Question 2

This forced-choice question asked respondents to choose whether they would want the speed limit displayed at all times (chosen by 61 respondents or 41 percent), only when it changes and then for a short time (44 or 29 percent), or only when requested (43 or 29 percent). Note that two people (1 percent) chose not to answer the question. There were no significant interactions or main effects.

Discussion of Response to Regulatory Information Survey Questions

For the display of regulatory information, most respondents prefer to see an icon of the standard warning sign displayed as opposed to a text message. This may be due to the respondents wanting to see the more familiar presentation of information. When asked when they would like the speed limit displayed, the responses were split approximately evenly between the three possible options, implying that strong agreement does not exist.

Type of Roadway Information

Type of Roadway Information—Question 1

This question asked respondents to rank seven items of information from most to least important when looking at a road map if trying to find a new route to follow before starting a trip. The seven items were:

- The type of road: interstate, U.S. highway, county road, etc.
- The speed limits of roads and states.
- The surface conditions of roads and interstates.
- A road or interstate's typical/historical traffic flow.
- The number of intersections along a road or interstate.
- Whether there is construction on a particular road or interstate.
- Whether a road or interstate is a toll way.

There was a significant Age by Option interaction, $F(12, 882)=4.39$, $p=0.0001$ (table 108). A simple effects test and SNKs (table 109) show that the 18-25 age group gave *the type of road* and *the speed limits of roads* the best ranking. The 35-45 age group and the 65 and over age group thought that *the type of road* was the most important item of information. An SNK on the significant main effect of Option, $F(6, 882)=75.64$, $p=0.0001$ (tables 110 and 111), shows that, overall, respondents ranked *the type of road* as the most important item of information.

Type of Roadway Information—Question 2

This question asked respondents to rank seven pieces of information from most to least important when looking at a road map if trying to determine how much farther they need to travel. The seven options were the same as those for Type of Roadway Information Question 1. There was a significant Age by Option interaction, $F(12, 876)=4.00$, $p=0.0001$ (table 112). A simple effects

test and SNKs (table 113) show that the 18-25 age group and the 35-45 age group gave *the type of road* and *the speed limits of roads* the best ranking. The 65 and over age group thought *the type of road* was the most important piece of information. An SNK on the significant main effect of Option, F(6, 876)=68.15, p=0.0001 (tables 114 and 115), shows that, overall, respondents ranked *the type of road* as the most important piece of information.

Type of Roadway Information—Question 3

This question asked respondents to rank seven pieces of information from most to least important when looking at a road map if looking at a road map to change routes. The seven options were the same as those for Type of Roadway Information Question 1. The rankings were very similar to the previous two questions. There was a significant Age by Option interaction, F(12, 876)=3.51, p=0.0001 (table 116). A simple effects test and SNKs (table 117) show that the 18-25 age group gave *the type of road* and the *speed limits of roads* the best ranking. The 35-45 age group and the 65 and over age group thought that *the type of road* was the most important item of information.

There was a significant Environment by Option interaction, F(6, 882)=2.41, p=0.0257 (table 118). Both the rural and urban groups thought the type of road was the most important factor; however, there were some differences in preference between the lesser preferred options (table 119). An SNK on the significant main effect of Option, F(6, 876)=63.82, p=0.0001 (tables 120 and 121), shows that, overall, respondents ranked *the type of road* as the most important item of information.

Discussion of Response to Type of Roadway Information Survey Questions

Whether trying to find a new route, trying to determine how much farther to travel, or trying to change routes, the type of roadway is considered an important item of information by all respondents. In some cases, an effect of age was found because the 18-25 or 35-45 age groups thought that in some situations, speed limit was also an important piece of information, presumably to determine the fastest route to get to their destination. However, the 65 and over age group was less concerned with speed limit. This may indicate that the 65 and over age group is generally less concerned with getting to their destination quickly.

STUDY 2—COMMERCIAL VEHICLE DRIVER SURVEY

METHOD FOR THE COMMERCIAL VEHICLE DRIVER SURVEY

Experimental Design for the Commercial Vehicle Driver Survey

For the commercial driver survey, the independent variables analyzed were three levels of Age (18-25, 35-45, and 55 and over), two levels of Type of driver ("local" meaning hauling within a 100-mile radius, or "over-the-road" meaning hauling in more than a 100-mile radius), and Option, a within-subjects variable. Again, Option referred to the number of items that the survey respondent reviewed for each question. For example, there were *three* options for questions that asked which of *three* display types was most preferred. Similarly, there were *four* options for questions that asked which of *four* types of information was most preferred.

As can be seen in table 17, the cell sizes for the between-subject factors were unequal. Therefore, for each question, two separate analyses were conducted: each between-subject factor (Age and Environment) was analyzed with Option. Questions required either a forced choice between two or more items, or a ranking of two or more items. For the forced-choice questions, the Chi-square Test for Independent Samples was conducted for possible interactions, and a Chi-square Goodness-of-Fit test was conducted for a possible main effect of Option. For the ranking questions, an ANOVA was conducted except in cases in which there were only two items to rank; in these cases, the question was considered a forced choice, and a Chi-square test was used. For the ranking questions, simple effects tests were run as appropriate as a one-way ANOVA. The SNK test was selected for post-hoc tests. The dependent variable was either Frequency or Rank as appropriate.

Table 17. The number of CVO driver survey respondents per cell.

	Age (18-25)		Age (35-45)		Age (55 and over)	
	Local	**Over-the-Road**	**Local**	**Over-the-Road**	**Local**	**Over-the-Road**
No. of Respondents	5	1	21	10	4	5

Participants for the Commercial Vehicle Driver Survey

The commercial drivers were solicited from a Denver, Colorado-based trucking company that hauls general commodities. Fifty drivers were asked to participate; however, four drivers did not respond to the survey questions appropriately and their data were discarded. Of the 46 drivers who completed the survey correctly, all had a current Class A commercial license. Forty-three responded that they were typically city or freeway drivers, one was a small-town driver, and two were suburban drivers. Two of the 46 drivers were women.

Apparatus for the Commercial Vehicle Driver Survey

Using the private driver survey as a template, the commercial vehicle driver survey was developed. Individuals from Commercial Vehicle Safety Alliance (CVSA), who were very

familiar with commercial drivers and their needs while driving, reviewed the draft. Based upon this review, revisions were made to the survey. The survey for commercial drivers can be seen in appendix J. The first page of the survey was designed to collect demographic information. The remaining pages of the survey covered the topics listed for the survey as shown in table 1.

Procedure for the Commercial Vehicle Driver Survey

The survey for the commercial vehicle drivers was administered by a representative of CVSA in cooperation with the Denver-based trucking company previously mentioned. CVO drivers were asked to volunteer as they were either leaving for or returning from a drive. Four to 10 drivers were gathered at a time, and they filled out the survey in a meeting room on the trucking company premises. Drivers were paid $20.00 for their time.

RESULTS AND DISCUSSION FOR THE COMMERICAL VEHICLE DRIVER SURVEY

The procedures to analyze the commercial vehicle driver survey were similar to those used for the private driver survey, except for the analysis of the variable Option. To analyze Option, we first attempted to use the same procedure as that used to analyze Option for the private driver survey, which was to simply report any main effect of Option as it appeared with the analysis for Age by Option. However, we noticed that because of the small number of subjects in some of the experimental cells, it was necessary to increase statistical power for the analysis of Option. Therefore, a separate within-factor ANOVA was performed for the main effect of Option. The ANOVA tables and SNK tables for the commercial vehicle driver survey are shown in appendix K.

For the survey questions in which a ranking of items was requested, respondents were asked to rank from 1 to the number of options available, with 1 being the best ranking and the final number being the worst ranking. Therefore, the lowest mean value for a given option is the most preferred item.

Motorist Services Information

Motorist Services Information—Question 1

This was a forced-choice question asking respondents if they would like to receive motorist services information automatically, only by request, or either automatically or by request. The chi-square test showed no significant interactions. For this question, 10 respondents (22 percent) replied that they would like to receive this type of information automatically, 11 (7 percent) replied that they would like to receive the information only when requested, and 25 (54 percent) replied either automatically or when requested. A significant test for the main effect of Option, X^2=9.17, df=2, p<0.02, shows the disproportionate frequencies to be a reliable indicator of the preference for the option of having the information presented either automatically or when requested.

Motorist Services Information—Question 2

This question requested a ranking of four types of restaurant information from least to most important. The four information items were:

- Truck stop/restaurant name.
- Type of food served.
- Price.
- Location.

There was a significant Age by Option interaction, $F(6, 129)=2.25$, $p=0.0422$ (table 122). A simple effects test and SNKs (table 123) show that the 18-25 age group and the 55 and over age group did not give statistically different rankings for the options. The 35-45 age group ranked *location* and *truck stop/restaurant name* the best, but not significantly different from each other. An SNK on the significant main effect of Option, $F(3, 135)=4.96$, $p=0.0027$ (tables 124 and 125), shows that *location* was ranked the best, and *price*, *type of food served*, and *truck stop/restaurant name* were not ranked significantly different from each other.

Motorist Services Information—Question 3

This question asked CVO drivers to rank seven items of fuel stop/re-fueling information based on importance. These were:

- Service name.
- Cost of fuel.
- Restrooms.
- Hours of operation.
- Location.
- Other services.
- Payment methods.

An SNK on the significant main effect for Option, $F(6, 270)=8.88$, $p=0.0001$ (tables 126 and 127), shows that, overall, respondents gave *location*, *cost of fuel*, and *hours of operation* the best rankings, but these were not significantly different from each other.

Motorist Services Information—Question 4

This question asked drivers to rank three formats (iconic only, textual only, combined iconic/textual) in order of preference. An SNK on the significant main effect of Option, $F(2, 90)=40.23$, $p=0.0001$ (tables 128 and 129), shows that drivers preferred option 3, the combined iconic/textual format.

Discussion of Responses to Motorist Services Information Survey Questions

Most CVO drivers specified that they would prefer to have the choice to receive motorist services information displayed either automatically or when requested, implying that the ability to toggle between levels of system function would be suitable. For question 2, significant main effect of Option shows that the 18-25 age group and the 55 and over age group showed a lack of agreement as to which item of information was most important. The 35-45 age group did consider location and restaurant name to be more important than the other options. Overall, respondents thought that location was the most important piece of information. It may be noted that the significant interaction shown for this question is the only significant interaction shown for any of the ranking questions throughout the CVO driver survey, implying that, in most instances, drivers do agree on what types of information they need. For question 3, the drivers ranked four of seven items of information similar to each other. The lack of agreement for a most important option for questions 2 and 3 implies that drivers vary considerably on the type of information they consider important. The format of the display should be a combined iconic/textual format.

Time/Distance to Destination Information

Time/Distance to Destination Information—Question 1

This question asked drivers to rank whether they preferred to receive time/distance to destination information at specified intervals, continuously, or only when requested. An SNK on the significant main effect of Option, $F(2, 90)=18.83$, $p=0.0001$ (tables 130 and 131), shows that drivers preferred to receive the information only when requested.

Time/Distance to Destination Information—Question 2

This was a forced-choice question asking drivers whether they would prefer to have a display showing distance to destination, time to the destination, or both time and distance. Thirty-two drivers (70 percent) replied that they would like both time and distance information, while 13 (28 percent) preferred distance only, and 1 (2 percent) preferred time only.

Time/Distance to Destination Information—Question 3

This was a forced-choice question asking drivers whether they would prefer time/distance information updated by miles or minutes, or as a percentage of the total trip. Thirty-one drivers (67 percent) responded that they would like the information in terms of miles or minutes, while 15 (33 percent) responded that they would like the information presented as a percentage of the total trip. A significant main effect of Option, $X^2=5.56$, $df=1$, $p<0.02$, shows the disproportionate frequencies to be a reliable indicator of preference.

Time/Distance to Destination Information—Question 4

This was a forced-choice question asking drivers whether they would prefer to have a display showing distance to destination, time to the destination, or both time and distance if they were making a short trip (about 25 miles in the city). Thirty drivers (65 percent) replied that they would like both time and distance information, while 13 (28 percent) preferred distance only, and 3 (7 percent) preferred time only. A significant main effect of Option, X^2=24.30, df=2, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Time/Distance to Destination Information—Question 5

This was a forced-choice question asking drivers which type of time/distance information they would most prefer to receive on a short trip. Twenty-two drivers (48 percent) replied that they would like updated information based on both amount of miles or minutes and on a percentage of the total trip distance, while 18 (39 percent) chose information based on amount of miles or minutes, and 6 (13 percent) chose information based on a percentage of the total trip. A significant main effect of Option, X^2=9.04, df=2, p<0.02, shows the disproportionate frequencies to be a reliable indicator of preference.

Discussion of Responses to Time/Distance to Destination Information Survey Questions

Taking the results of the responses to the questions together, it would appear that drivers prefer more information rather than less for Time/Distance to Destination Information. Drivers prefer both time and distance information, and, when given the option, prefer information based on miles or minutes and percentage of trip distance. However, drivers would like this information presented only when requested.

Time/Distance to Next Turn and Lane Suggestion Information

Time/Distance to Next Turn and Lane Suggestion Information—Question 1

This question asked drivers to rank, in terms of preference, whether they would want to receive one, two, or three messages as they approach a turn. An SNK on the significant main effect of Option, F(2, 90)=27.40, p=0.0001 (tables 132 and 133), shows that the option of receiving two messages and the option of receiving three messages were given the best rankings.

Time/Distance to Next Turn and Lane Suggestion Information—Question 2

This forced-choice question asked drivers to choose whether they would prefer distance to turn information, time to turn information, or both while driving in the city. Twenty-five drivers (54 percent) responded that they prefer distance to the turn information, while 0 chose time to the turn, and 21 (46 percent) chose both time and distance to the turn. A significant main effect of Option, X^2=23.52, df=2, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Time/Distance to Next Turn and Lane Suggestion Information—Question 3

This forced-choice question asked drivers to choose in what method they would like to have distance to turn information presented. Thirty-two respondents (70 percent) chose to know the number of intersections/turns from the upcoming turn, while nine (20 percent) wanted to know how many tenths of a mile, and five (11 percent) wanted to know how many city blocks. A significant main effect of Option, X^2=27.70, df=2, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Time/Distance to Next Turn and Lane Suggestion Information—Question 4

This forced-choice question asked drivers to choose what type of information they would want regarding an upcoming exit if traveling on a highway. Sixteen drivers (35 percent) chose to know the number of exits and miles from the upcoming exit, while 15 (33 percent) preferred to know distance and time to the exit, 1 (2 percent) preferred time to the exit, and 14 (30 percent) preferred distance to the exit. A significant main effect of Option, X^2=12.95, df=3, p<0.01, shows the disproportionate frequencies to be a reliable indicator of preference; however, the results do not show a strong preference for one type of information over another.

Time/Distance to Next Turn and Lane Suggestion Information—Question 5

This forced-choice question asked drivers to choose in what method they would like to have distance to an upcoming exit information presented. Thirty-two drivers (70 percent) preferred to know how many exits and miles away their exit was, while 10 (22 percent) drivers preferred to know the number of miles from an upcoming exit, and 4 (9 percent) drivers wanted to know how many exits away the exit was. A significant main effect of Option, X^2=28.34, df=2, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Time/Distance to Next Turn and Lane Suggestion Information—Question 6

This question asked drivers to rank three displays (iconic only, textual only, combined iconic/textual) for an upcoming exit in terms of preference. An SNK on the significant main effect of Option, F(2, 90)=79.47, p=0.0001 (tables 134 and 135), shows the combined iconic/textual format to be the most preferred.

Time/Distance to Next Turn and Lane Suggestion Information—Question 7

This question asked drivers to rank three displays (iconic only, textual only, combined iconic/textual) for navigation information in terms of preference. An SNK on the significant main effect of Option, F(2, 90)=70.14, p=0.0001 (tables 136 and 137), shows the combined iconic/textual format to be the most preferred.

Discussion of Responses to Time/Distance to Next Turn and Lane Suggestion Information Survey Questions

Although drivers did not agree whether they would want two or three messages before an upcoming turn, drivers did tend to agree that one message was not enough. For question 2, regarding an upcoming turn, and question 4, regarding an upcoming exit, the response frequencies do not indicate a clear preference for the preferred type of information. However, if drivers were receiving distance to an upcoming turn information, they would prefer to know how many intersections until their turn. If they were receiving distance to an exit information, they would prefer to know both how many exits and how many miles until their exit. A combined iconic/textual format is most preferred. In general, it can be concluded that CVO drivers have varied preferences for the display of this type of information, indicating that selectable options may be desirable if feasible.

Guide Sign Information

Guide Sign Information—Question 1

This forced-choice question asked drivers to choose whether they would prefer guide sign information to be displayed always, only when relevant to the route, or only when requested. Twenty-two drivers (48 percent) said they would prefer to receive guide sign information only when requested, while 7 (15 percent) would prefer to receive the information only when it is relevant to the route, and 17 (37 percent) would prefer to always receive the information. A significant main effect of Option, X^2=7.60, df=2, p<0.05, shows the disproportionate frequencies to be a reliable indicator of preference.

Guide Sign Information—Question 2

This question asked drivers to rank three display formats (iconic only, textual only, combined iconic/textual) for guide sign information in terms of preference. An SNK on the significant main effect of Option, F(2, 90)=79.87, p=0.0001 (tables 138 and 139), shows the combined iconic/textual format to be the most preferred.

Discussion of Responses to Guide Sign Information Survey Questions

Although a significant main effect of Option was found, the results do not indicate a clear preference for the display of guide sign information except that considerably fewer people prefer receiving information only when it is relevant to the route. Since some individuals want the information only when requested and others want the information always presented, it may be plausible to make this an optional function. Again, the combined iconic/textual format is the most preferred.

Road Construction Information

Road Construction Information—Question 1

This question asked drivers to rank eight items of RCI from least to most important. These were:

- How far ahead the construction lies.
- The type of construction.
- Any shift in road alignment.
- Whether there are workers or other people in the vicinity.
- Speed limit in the construction zone.
- Indication that there are slow-moving vehicles.
- Uneven or bumpy pavement.
- Information about merging traffic into your lane, or you merging into another lane.

An SNK on the significant main effect of Option, $F(7, 315)=18.26$, $p=0.0001$ (tables 140 and 141), shows that *how far ahead the construction lies* is the most preferred item of information, and *speed limit in the construction zone* is the second most preferred item of information.

Road Construction Information—Question 2

This forced-choice question asked drivers to choose what information they would prefer to receive regarding distance to a construction zone. Twenty-four respondents (52 percent) replied that they would prefer to know the distance and time to the construction zone, while 22 (48 percent) would prefer to know the distance, and 0 would prefer to know the time. A significant main effect of Option, $X^2=23.13$, df=2, $p<0.001$, shows the disproportionate frequencies to be a reliable indicator of preference.

Road Construction Information—Question 3

This forced-choice question asked drivers to choose whether they prefer to receive information about road construction 2 miles in advance. Thirty-two drivers (70 percent) replied that they prefer to receive the information 2 miles in advance, while 14 (30 percent) replied that they did not. A significant main effect of Option, $X^2=7.04$, df=1, $p<0.01$, shows the disproportionate frequencies to be a reliable indicator of preference.

Discussion of Responses to Road Construction Information Survey Questions

For RCI, drivers first want to know how far ahead the construction lies, and secondly, the speed limit in the construction zone. Presumably, knowing the speed limit will tell the driver if it is worth re-routing to avoid construction or will allow the driver to plan ahead regarding speed. Drivers show varied preference for wanting to know only the distance or the distance and time, but most tend to want to know about construction at least 2 miles in advance.

Re-route Option Information

Re-route Option Information—Question 1

This question asked drivers to rank 10 re-routing pieces of information based on importance for choosing a new route. These were:

- Convenience.
- Least amount of traffic/congestion.
- Shortest route (distance).
- Fastest route (time).
- Most expensive route.
- Particular road type.
- Fewest turns.
- Weather conditions along route.
- Road conditions along route.
- Appropriate truck clearance along route.

An SNK on the significant main effect of Option, $F(9, 405)=21.19$, $p=0.0001$ (tables 142 and 143), shows that CVO drivers gave *appropriate truck clearance along route* and *shortest route* the best rankings, but these rankings were not significantly different from each other.

Re-route Option Information—Question 2

This question asked drivers to rank nine options in terms of importance when trying to avoid a particular kind of route. These were:

- Type of roadway.
- Complex intersections.
- Number of traffic lights/stop signs.
- Toll ways.
- Poor clearance.
- Number of rest areas.
- Congestion/traffic.
- Poor road quality.
- The number of turns.

An SNK on the significant main effect of Option, $F(8, 360)=24.41$, $p=0.0001$ (tables 144 and 145), shows that CVO drivers gave *poor clearance* and *congestion/traffic* the best rankings.

Re-route Option Information—Question 3

This forced-choice question asked drivers to choose whether they would like an in-vehicle system to automatically suggest an alternate route or give the information only when requested. There was no significant main effect of Option. Twenty-eight drivers (61 percent) replied that they

would like the system to automatically suggest an alternate route, while 17 (37 percent) replied that they would like the information only when requested. One person (2 percent) chose not to answer the question.

Re-route Option Information—Question 4

This question asked drivers to rank a text list of directions, a full route map display, or a turn-by-turn display for preference in presenting navigation information. There was no significant main effect of Option.

Discussion of Responses to Re-route Option Information Survey Questions

When considering re-routing, drivers are concerned with ensuring proper vehicle clearance on the route and selecting a short route. Drivers want to avoid congestion or heavy traffic. For question 3, the response frequencies indicated that most drivers would prefer a system to suggest an alternate route; however, the response frequencies did not indicate strong agreement. This may indicate that drivers do not have trust in a system to weigh the alternatives appropriately. For three possible re-routing navigation configurations, the drivers did not show a clear preference.

Stopped Vehicle Ahead Information

Stopped Vehicle Ahead Information—Question 1

This forced-choice question asked drivers to decide whether they would want stopped vehicle ahead information presented to them in their vehicle. Forty drivers (87 percent) replied that they would like this information, and 6 (13 percent) replied that they would not. A significant main effect of Option, X^2=25.130, df=1, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Stopped Vehicle Ahead Information—Question 2

This forced-choice question asked drivers to rank five vehicle types from least to most desirable in terms of receiving stopped vehicle information in the vehicle. The five vehicle types were:

- School bus.
- Public transit vehicle, such as a city bus or a taxi.
- Emergency vehicle such as an ambulance or police car.
- Delivery vehicle such as a mail or UPS truck.
- Utility vehicle such as a telephone repair vehicle.

An SNK on the significant main effect of Option, F(4, 180)=72.74, p=0.0001 (tables 146 and 147), shows that drivers gave *school bus* and *emergency vehicle* the best rankings.

Stopped Vehicle Ahead Information—Question 3

This forced-choice question asked drivers to rank two display formats in terms of preference when receiving stopped vehicle ahead information. Because there were only two options, the question was analyzed with a chi-square test. Thirty-three drivers (72 percent) responded that they would want the combined iconic/textual format, and 13 (28 percent) drivers responded that they would want the text-only display. A significant main effect of Option, X^2=8.70, df=1, p<0.01, shows the disproportionate frequencies to be a reliable indicator of preference.

Stopped Vehicle Ahead Information—Question 4

This was a forced-choice question that asked drivers to choose whether they would like the in-vehicle system to suggest an action if coming upon a stopped vehicle. Thirty-one drivers (67 percent) replied that they would like to receive a suggestion, while 15 (33 percent) replied that they would not. A significant main effect of Option, X^2=5.56, df=1, p<0.02, shows the disproportionate frequencies to be a reliable indicator of preference.

Discussion of Responses to Stopped Vehicle Ahead Information Survey Questions

Most CVO drivers would want to receive Stopped Vehicle Ahead Information in their vehicles. Overall, respondents thought it most important to know about school buses and emergency vehicles. This is logical since these types of vehicles denote a time when increased awareness of the driving environment is of primary importance. As is the trend, most drivers prefer a combined iconic/textual format display. For this question, most drivers indicated that they would like to receive a suggested course of action when receiving Stopped Vehicle Ahead Information.

Congestion Ahead Information

Congestion Ahead Information—Question 1

This question asked drivers to rank four types of congestion information in terms of preference to receive in their trucks. These were:

- Distance/time to congested area.
- Average traveling speed of congestion.
- The cause of the congestion.
- The duration of the delay due to congestion.

An SNK on the significant main effect of Option, F(3, 135)=14.21, p=0.0001 (tables 148 and 149), revealed that drivers thought *distance/time to congested area* was the most important item of information to receive.

Congestion Ahead Information—Question 2

This forced-choice question asked respondents to specify how far traffic would have to be backed up before they would take an alternate route. The results are shown in table 18. A significant main effect of Option, X^2=19.64, df=4, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Table 18. Congestion Ahead Information Question 2 response frequency distribution.

Question: How far does traffic have to be backed up before you would consider taking an alternate route?	
Option	**Frequency (%)**
Less than ¼ mile	2 (4%)
¼ to ½ mile	10 (22%)
½ to ¾ mile	6 (13%)
¾ to 1 mile	8 (17%)
Greater than 1 mile	20 (43%)

Congestion Ahead Information—Question 3

This forced-choice question asked respondents to specify how long traffic would need to be backed up before they would consider taking an alternate route. The results are shown in table 19. A significant main effect of Option, X^2=24.43, df=4, p<0.02, shows the disproportionate frequencies to be a reliable indicator of preference.

Table 19. Congestion Ahead Information Question 3 response frequency distribution.

Question: How long does traffic have to be backed up before you would consider taking an alternate route?	
Option	**Frequency (%)**
Less than 5 minutes	1 (2%)
Between 5 and 10 minutes	7 (15%)
Between 10 and 15 minutes	6 (13%)
Between 15 and 20 minutes	11 (24%)
Greater than 20 minutes	21 (46%)

Congestion Ahead Information—Question 4

This forced-choice question asked respondents to specify whether they would prefer to receive information about a traffic jam in terms of minutes ahead, miles ahead, or both minutes and miles ahead. Twenty-five drivers (54 percent) responded that they would like the information in terms of both minutes and miles, 21 (46 percent) responded miles ahead, and 0 responded minutes only.

A significant main effect of Option, X^2=23.53, df=2, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Congestion Ahead Information—Question 5

This forced-choice question asked respondents to specify whether they would prefer to receive information about the duration of a traffic jam in terms of minutes delayed, miles delayed, or both minutes and miles delayed. Thirty-seven drivers (80 percent) prefer to know both miles and minutes delayed, 7 (15 percent) prefer to know miles delayed, and 2 (4 percent) prefer to know minutes delayed. A significant main effect of Option, X^2=46.748, df=2, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Discussion of Responses to Congestion Ahead Information Survey Questions

CVO drivers think that distance/time to congestion is the most important information. Drivers vary as to how long in terms of distance traffic has to be backed up before they will re-route, however, most drivers will wait for traffic that is backed up a mile or more, or wait 15 minutes or longer. Although drivers did not differ considerably in their choice between receiving information about a traffic jam in terms of miles or both miles and minutes, none of the drivers wanted minutes only. Regarding the duration of a traffic jam, most prefer to know both miles and minutes.

Approach of Emergency Vehicle Information

Approach of Emergency Vehicle Information—Question 1

This question asked individuals to rank Approach of Emergency Vehicle Information items in terms of display preference. These were:

- The destination of the emergency vehicle relative to you.
- Relative location of the approaching emergency vehicle.
- Speed of the approaching emergency vehicle.
- Type of emergency vehicle.
- The number of emergency vehicles approaching.

An SNK on the significant main effect of Option, F(4, 180)=10.77, p=0.0001 (tables 150 and 151), shows *relative location of the approaching emergency vehicle* to be considered the most preferred item of information to be displayed.

Approach of Emergency Vehicle Information—Question 2

This forced-choice question asked drivers which of two auditory messages they would prefer to hear regarding the approach of an ambulance. There was a significant Environment by Option interaction, X^2=4.802, df=1, p<0.0284. The frequency distribution is shown in table 20, which shows the interaction to be of limited value for indicating any practical differences between the local and over-the-road drivers. Most respondents (37) specified that they would prefer to hear

the message *"Ambulance approaching from rear in left lane,"* while nine specified that they would prefer to hear the message *"Ambulance heading southbound on Elm Street in left lane*." A significant test for the main effect of Option, X^2=17.04, df=1, p<0.001, shows the disproportionate responses to be a reliable indicator of preference.

Table 20. Approach of Emergency Vehicle Information question 2 frequency distribution for the significant Environment by Option interaction.

Question: Imagine that you are traveling on a two-lane street named Elm, heading south. Which auditory description do you prefer?			
		Environment	
Option	**Frequency (%)**	**Local**	**Over the Road**
"Ambulance approaching from rear in left lane."	37 (80%)	27	10
"Ambulance heading southbound on Elm Street in left lane."	9 (20%)	3	6

Approach of Emergency Vehicle Information—Question 3

This forced-choice question asked drivers to consider whether they would prefer to receive a suggested course of action in the event that an emergency vehicle approaches if they are traveling in the right lane. A test for the main effect of Option was not significant. Twenty-five drivers (54 percent) replied that they would like to receive a suggested course of action, and 21 (46 percent) replied that they would not.

Approach of Emergency Vehicle Information—Question 4

This forced-choice question asked drivers to consider whether they would prefer to receive a suggested course of action in the event that an emergency vehicle approaches if they are traveling in the left lane. A significant test for the main effect of Option was not significant. Twenty-five drivers (54 percent) replied that they would like to receive a suggested course of action, and 21 (46 percent) replied that they would not.

Approach of Emergency Vehicle Information—Question 5

This forced-choice question asked drivers to consider whether they would want to know how far away the approaching emergency vehicle is. Forty-three drivers (93 percent) replied that they would want to know, and 3 (7 percent) replied that they would not want to know. A significant test for the main effect of Option, X^2=34.78, df=1, p<0.001, shows the disproportionate responses to be a reliable indicator of preference.

Approach of Emergency Vehicle Information—Question 6

This question asked drivers to rank seven different styles of presenting approaching vehicle distance. These were:

- Tenths of a mile away.
- Seconds away.
- City blocks away.
- Both tenths of a mile and seconds away.
- Both tenths of a mile and blocks away.
- Both seconds and blocks away.
- Tenths of a mile, seconds, and blocks away.

There was no significant main effect of Option.

Discussion of Responses to Approach of Emergency Vehicle Information Survey Questions

When driving, most CVO drivers want to know the relative location of an approaching emergency vehicle. Although there is a significant Environment by Option interaction, indicating some difference in preference, most drivers want to know the relative location of an approaching emergency vehicle as it relates to their position instead of as it relates to the roadways in general, presumably to make it easier to locate the emergency vehicle and determine if they need to pull over to the shoulder. Drivers also specified that they would like to know how far away the emergency vehicle is; again, this would help the drivers determine if they need to pull over to the shoulder. Drivers did not agree on whether they would like to receive a suggested course of action. When asked to rank the style of the Approach of Emergency Vehicle Information presented to them, the drivers did not show agreement as to the best method of presentation.

Road Surface Condition and Warning Information

Road Surface Condition and Warning Information—Question 1

This forced-choice question asked drivers whether they prefer to receive distance, time, or both distance and time information regarding road surface condition. There were no significant interactions. Twenty-seven drivers (59 percent) prefer to receive both time and distance information, while 19 (41 percent) prefer distance only, and 0 prefer time only. A significant test of the main effect of Option, X^2=25.09, df=2, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Road Surface Condition and Warning Information—Question 2

This was a forced-choice question asking drivers whether they prefer an in-vehicle system to recommend an action when approaching a potentially dangerous area. Most drivers (34) replied that they would like a suggested action, while 12 replied that they would not. A significant test of the main effect of Option, X^2=10.52, df=1, p<0.01, shows the disproportionate frequencies to be a reliable indicator of preference.

Road Surface Condition and Warning Information—Question 3

This question asked respondents to rank three possible methods (iconic only, textual only, combined iconic and textual) to present warning information to drivers. An SNK on the significant main effect of Option, $F(2, 90)=65.24$, $p=0.0001$ (tables 152 and 153), shows that the combined iconic/textual message was most preferred.

Discussion of Responses to Road Surface Condition and Warning Information Survey Questions

Once again, CVO drivers indicated that they do not want time-only information as it pertains to the presence of poor road surface conditions. A relatively close number of drivers want either distance only, or both time and distance information. Most CVO drivers would like a suggested action when approaching poor road surface conditions. Also, most prefer a combined iconic/textual message.

Regulatory Information

Regulatory Information—Question 1

This question asked respondents to rank two options for displaying regulatory information. Since there were only two options, the data were analyzed with a chi-square test. All 46 drivers (100 percent) specified that they would prefer the regulatory symbol format as opposed to the textual format.

Regulatory Information—Question 2

This forced-choice question asked respondents to choose whether they would want the speed limit displayed at all times, only when it changes and then for a short time, or only when requested. There was no significant main effect of Option. Twenty-two drivers (48 percent) reported that they would prefer the speed limit posted at all times, 11 (24 percent) reported that they would like the speed limit posted only when it changes, and 12 (26 percent) reported that they would like the speed limit posted only when requested. One driver (2 percent) chose not to respond.

Discussion of Responses to Regulatory Information Survey Questions

Interestingly, there was complete agreement among the CVO drivers that the regulatory symbol format is the best method for presenting regulatory information, presumably because this is a familiar format. For speed limit information, roughly half of the drivers thought the speed limit should be displayed at all times, while the other half thought the speed limit should be displayed only at specific times (when requested or when the speed limit changes). This indicates that the time for displaying the speed limit should be a function set by the driver.

Type of Roadway Information

Type of Roadway Information—Question 1

This question asked drivers to rank 11 pieces of information from most to least important regarding use of a road map to find a new route to follow before starting a trip. The 11 items were:

- The type of road.
- The speed limits of roads and interstates.
- The surface conditions of roads and interstates.
- A road or interstate's typical/historical traffic flow.
- The number of intersections along a road or interstate.
- Whether there is construction on a particular road or interstate.
- Whether a road or interstate is a toll way.
- Low overpasses.
- Allowable vehicle weight.
- Allowable vehicle length.
- Uphill/downhill grade.

An SNK on the significant main effect of Option, $F(10, 450)=19.50$, $p=0.0001$ (tables 154 and 155), shows that, overall, drivers gave *low overpasses*, *the type of road*, and *allowable vehicle length* the best rankings.

Type of Roadway Information—Question 2

This question asked drivers to rank the same 11 items of information as presented in the previous question from most to least important regarding using a road map to determine how much farther they must travel. An SNK on the significant main effect of Option, $F(10, 450)=9.75$, $p=0.0001$ (tables 156 and 157), shows that, overall, drivers gave *the type of road*, *low overpasses*, *allowable vehicle weight*, and *allowable vehicle length* the best rankings.

Type of Roadway Information—Question 3

This question asked drivers to rank the same 11 items of information as presented in the previous 2 questions from most to least important regarding using a road map to change routes. An SNK on the significant main effect of Option, $F(10, 450)=8.82$, $p=0.0001$ (tables 158 and 159), shows that, overall, drivers gave *low overpasses*, *the type of road*, *allowable vehicle weight*, and *allowable vehicle length* the best ranking.

Discussion of Responses to Type of Roadway Information Survey Questions

For this type of information, drivers did not agree on the most important piece of information, but the SNKs performed show that three or four options were consistently selected. Drivers are concerned with low overpasses, the type of road, and allowable vehicle length for all three hypothetical situations. Allowable vehicle weight was a concern for two of the three scenarios.

STUDY 3—THE USER CLINIC

METHOD FOR THE USER CLINIC

Experimental Design for the User Clinic

The purpose of the user clinic was to obtain subjective driver opinion regarding the comprehension and preference of ATIS display formats. For the experimental design, the independent variables were Gender and Option. Again, Option, a within-subject variable, referred to the number of display types that the respondent reviewed for each question. For example, there were *three* options for questions that asked which of *three* display types was most preferred. The Chi-square Test for Independent Samples was conducted for a possible interaction, and a Chi-square Goodness-of-Fit test was conducted for a possible main effect of Option. The dependent variable was Frequency.

Participants for the User Clinic

Forty participants were recruited from the Virginia Tech campus in Blacksburg, Virginia. Of the 40 participants aged 18-55 years who participated, 19 were male and 21 were female. Two stated that they drive less than 2,000 miles per year, 7 stated that they drive between 2,000 and 7,999 miles per year, 10 stated that they drive between 8,000 and 7,999 miles per year, 16 stated that they drive between 13,000 and 19,999 miles per year, and 5 stated that they drive 20,000 miles or more per year.

Apparatus for the User Clinic

The user clinic computer simulation was modeled on a Macintosh Powerbook 2300 laptop computer. The software-based interface simulation was written in Macromedia Authorware. The screen images are shown in appendix L.

Procedure for the User Clinic

Each participant completed the user clinic individually. Participants were first asked to read and sign an informed consent form. They were then presented with the laptop computer with the User Clinic Survey set at the start. Participants were then given detailed instructions regarding how the simulation worked, and were encouraged to ask questions regarding the use of the computer and simulation. After any questions were answered, the participants reviewed a series of potential ATIS display designs and were asked to subjectively indicate which of three formats would be: 1) easiest to quickly comprehend, and 2) most preferred in their own automobile. The User Clinic Survey took approximately 20 minutes to complete, for which the participant was paid $5.00.

RESULTS AND DISCUSSION OF THE USER CLINIC

First-Level Yellow Pages

Respondents were asked to choose which of three top-level yellow page display formats was the easiest to comprehend and which was most preferred. The three top-level yellow page displays are shown in appendix L, figure 2.

Comprehension

There were no significant interactions. Eighteen respondents (45 percent) chose the text-only format, 20 (50 percent) chose the combined iconic/textual format, and 2 (5 percent) chose the iconic-only format. A significant main effect of Option, X^2=14.60, df=2, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Preference

There were no significant interactions. Seventeen respondents (43 percent) chose the text-only format, 17 (43 percent) chose the combined iconic/textual format, and 6 (15 percent) chose the iconic-only format. A significant main effect of Option, X^2=6.05, df=2, p<0.05, shows the disproportionate frequencies to be a reliable indicator of preference.

Second-Level Yellow Pages

Respondents were asked to choose which of two second-level yellow page formats was the easiest to comprehend and which was the most preferred. The two display formats are shown in appendix L, figure 3.

Comprehension

There were no significant interactions. Five respondents (13 percent) chose the text-only display, and 35 (88 percent) chose the iconic-only display. A significant main effect of Option, X^2=22.50, df=1, p<0.001, shows the disproportionate frequencies to be a reliable indicator of drivers' subjective evaluation of ease of comprehension.

Preference

There were no significant interactions. Seven respondents chose the text-only display (18 percent), and 33 (83 percent) chose the iconic-only display. A significant main effect of Option, X^2=16.90, df=1, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Alternate Route Display

Respondents were asked to choose which of two alternate route display formats they found the easiest to comprehend and which was the most preferred. The two display formats are shown in appendix L, figure 4.

Comprehension

There were no significant interactions. Overall, 16 (40 percent) respondents chose the list format, and 24 (60 percent) chose the map format. The main effect of Option was not significant.

Preference

There was a significant Gender by Option interaction, X^2=4.290, df=1, p=0.0481. Table 21 shows the frequency distribution. More of the men chose the map directions than did the women. Overall, 10 respondents (25 percent) chose the list format, and 30 (75 percent) chose the map format. A significant main effect of Option, X^2=10, df=1, p<0.01, shows the disproportionate frequencies to be a reliable indicator of preference.

Table 21. Alternate route display preference frequency distribution for Gender by Option interaction.

		Gender	
Option	**Frequency (%)**	**Male**	**Female**
List directions	10 (25%)	2	8
Map directions	30 (75%)	17	13

Accident Alert

Respondents were asked to choose which of four head-up accident-alerting display formats they thought would be the easiest to comprehend, and which would be the most preferred. The four display formats are shown in appendix L, figure 5.

Comprehension

There were no significant interactions. Four respondents chose the crash icon only (without an audio alert), 22 (55 percent) chose the crash icon with audio, 3 (8 percent) chose the crash text only (without audio), and 11 (28 percent) chose the crash text with audio. A significant main effect of Option, X^2=23, df=3, p<0.001, shows the disproportionate frequencies to be a reliable indicator of drivers' subjective evaluation of ease of comprehension.

Preference

There were no significant interactions. Five respondents (13 percent) chose the crash icon without an audio alert, 19 (48 percent) chose the crash icon with audio, 4 (10 percent) chose the crash text without audio, and 12 (30 percent) chose the crash text with audio. A significant main effect of Option, X^2=14.6, df=3, p<0.01, shows the disproportionate frequencies to be a reliable indicator of preference.

Congestion Alert

Respondents were asked to choose which of two congestion-alerting display formats they thought to be the easiest to comprehend, and which would be the most preferred. The two display formats are shown in appendix L, figure 6.

Comprehension

There were no significant interactions or main effects. Eighteen respondents (45 percent) chose the textual alert, and 22 (55 percent) chose the map alert.

Preference

There were no significant interactions or main effects. Twenty-one respondents (53 percent) chose the textual alert, and 19 (48 percent) chose the map alert.

Weather Alert

Respondents were asked to choose which of two weather-alerting display formats they thought to be the easiest to comprehend, and which would be the most preferred. The two display formats are shown in appendix L, figure 7.

Comprehension

There were no significant interactions. Five respondents (13 percent) chose a map display that pointed out the geographic location of the weather alert, and 35 (88 percent) chose a textual message. A significant main effect of Option, X^2=22.50, df=1, p<0.001, shows the disproportionate frequencies to be a reliable indicator of drivers' subjective evaluation of ease of comprehension.

Preference

There were no significant interactions. Five respondents (13 percent) chose a map display that pointed out the geographic location of the weather alert, and 35 (88 percent) chose a textual message. A significant main effect of Option, X^2=22.50, df=1, p<0.001, shows the disproportionate frequencies to be a reliable indicator of preference.

Off-route Alert

Respondents were asked to choose which of two off-route alerting display formats they thought would be the easiest to comprehend and which would be the most preferred. The two display formats are shown in appendix L, figure 8.

Comprehension

There were no significant interactions or main effects. Sixteen respondents (40 percent) chose the textual alert, and 24 (60 percent) chose the map alert.

Preference

There were no significant interactions. Twelve respondents (30 percent) chose a textual format display, and 28 (70 percent) chose the map display. A significant main effect of Option, X^2=6.4, df=1, p<0.02, shows the disproportionate frequencies to be a reliable indicator of preference.

Discussion of Responses to the User Clinic

For the yellow page displays, respondents chose the combined iconic and textual format display when given the option. Otherwise, respondents chose the iconic-only display (as opposed to text-only). This is consistent with preferences shown for both the rural and urban survey, and the CVO survey.

For the alternate route display, proportionately more men than women indicated that they prefer a map display. This may indicate a greater ability to read maps (greater spatial ability) on the part of men (Maccoby & Jacklin, 1974). When asked about the accident alert display, more respondents indicated that they could better comprehend and preferred a combined iconic/audio display format. For the congestion alert display, there was no significant difference in comprehension or preference for the display. Perhaps a combined modality display would have garnered more favor. For the weather alert display, most respondents thought a simple textual message would be easier to comprehend and more preferred than a map display. This is interesting in light of the fact that for the alternate route display and the off-route display, more respondents thought a map would be preferable. The difference may be due to the fact that weather maps are generally of a larger geographic area than a route map, and drivers believe that the larger scale weather map would be more difficult to associate with their own position.

CONCLUSIONS

PRIVATE DRIVER SURVEY

Reviewing the answers of those who responded to the rural/urban survey, some interesting response patterns emerge. With regard to age, younger drivers tend to be clearly concerned with issues of cost, whereas the middle-aged and older drivers consider cost, but also consider several other factors (as shown by the motorist services information responses). With regard to travel time, younger and middle-aged drivers tend to be concerned with reducing travel time, whereas older drivers do not consider travel time to be as much of a concern (as shown by the responses to the re-routing, construction, congestion, and type of roadway questions). With regard to receiving a suggested course of action, older individuals are more interested in receiving such information than their younger and middle-age driving counterparts in the case of stopped vehicles or the approach of emergency vehicles. Also, older individuals appear to have concern with issues such as being routed through a high crime region.

There were relatively few significant Gender by Option and Environment by Option interactions. The results of the survey show that there were no significant Gender by Option differences for most preferred option. That is, both males and females tended to select the same option as their first choice, but showed differences for second, third, and other options. The significant Environment by Option interactions were centered around the theme of efficient travel time. For example, in response to RCI question 3, fewer rural drivers were concerned with being warned about construction well ahead of time. As previously stated, this result may indicate that rural drivers do not tend to find road construction delays as much of an inconvenience, or they do not have to deal with the problems of road construction very often and consider infrequent delays acceptable.

There were also three interesting patterns to emerge from the data. One pattern is that drivers tended to prefer to have a combined iconic/textual display format as opposed to an iconic-only or text-only display. It is interesting to note that the format of the preferred combined iconic/textual formats were similar; that is, the icon was simple (standard symbols were used when available) and the text was shown directly below the icon. Furthermore, older individuals tended to dislike the text-only display, implying that they may find such a display difficult to read.

A second pattern to emerge was the tendency of respondents to want more information instead of less. For example, if asked whether they prefer time information, distance information, or both time and distance information, most respondents would choose to have both time and distance information. A third pattern to emerge was the tendency of respondents to choose to have control of when information was displayed. For example, when asked if they would like to receive motorist services information automatically, when requested, or either automatically or when requested, respondents would choose to have the option available to them.

Taken together, these results suggest the following:

- Men and women tend to agree on what type of information they most prefer to receive.

- Rural and urban drivers tend to agree on what type of information they most prefer to receive; however, rural drivers are less concerned with possible time delays while driving.

- Older drivers are more likely to want to receive a suggested course of action when near stopped or emergency vehicles.

- Older drivers have a number of concerns when traveling that their younger and middle-aged counterparts do not, including being comfortable with the area they must navigate, as well as issues of safety.

- Drivers prefer combined iconic/textual display formats the most.

COMMERCIAL DRIVER SURVEY

The CVO drivers responded to survey questions similarly, as indicated by the fact that there was only one significant interaction for all the survey questions; that is, regardless of age or whether the driver was a "local" or "over-the-road" driver, drivers tended to prefer the same types of ATIS information. Interestingly, if reviewing responses for the questions that were the same for both the rural/urban survey and the CVO driver survey, one might notice that responses for commercial and non-commercial drivers were often similar. For example, both populations tended to want more information instead of less as indicated by, for example, wanting both time and distance information or both miles and minutes information. Also, both populations tended to want control over when information was displayed, such as wanting information displayed either automatically or when requested, suggesting that an on/off feature would be suitable.

The similarities in responses from the commercial and non-commercial drivers would suggest that many ATIS displays can be designed to provide the same information/features. However, CVO driver responses did reflect that this population of drivers has specific concerns. For example, regarding type of roadway information, CVO drivers must first be concerned with low overpasses and allowable vehicle weight before they can consider issues of speed limit and possible pot holes. Therefore, some ATIS systems will need to have information specific to CVO drivers.

USER CLINIC

Mimicking the survey responses, the respondents for the user clinic most preferred the combined iconic/textual format displays. However, for the accident alert display, most respondents indicated that they could better comprehend and preferred a combined iconic/audio display format. Interestingly, most respondents chose not to read text when they had another option. A shortcoming of this study was that, because of resource constraints, more combined iconic/auditory displays were not tested against combined iconic/textual displays.

Regarding the display of maps, the preference for maps would appear to depend on the use of the display. For the alternate route display, most preferred the map as opposed to list directions. However, for the weather alert display, most respondents thought a simple textual message would be easier to comprehend and more preferred than a map display. As previously stated, the

difference may be due to the fact that weather maps are generally of a larger geographic area than a route map, and drivers believe that the larger scale weather map would be more difficult to associate with their own location. Note, of course, that for the alternate route display, preference for the map depended to some degree on gender.

For the congestion alert display, there were no significant interactions or main effects; however, the only display types tested were a textual format and a map format. In fact, the responses between the two display types are roughly divided. Perhaps if a combined modality display had been tested, more respondents would have shown a preference for such a display.

RECOMMENDATIONS FOR ATIS DISPLAY DESIGN

The objective of this study was to test and evaluate driver stereotypes and preferences for several ATIS information types and display formats. As such, the following design recommendations reflect both general recommendations and, where appropriate, specific recommendations.

General Recommendations

- The results of both surveys showed that displays of a combined modality format are most preferred, specifically combined iconic/textual displays and combined iconic/auditory format. When available, standard icons should be used to increase the familiarity of the message. However, text-only displays are to be avoided, with the possible exception of route "lists" that allow the driver to preview the series of streets used in the route.

- Allow displays and functions that are typically used only during travel to unfamiliar destinations (e.g., Motorist Services Information) to be turned off or on as deemed necessary by the driver.

- When presenting information about an upcoming event (turn, exit, construction, etc.), present the information in terms of distance (miles) and one other parameter (preferably time); however, do not present the information in terms of time only.

- When designing displays for CVO drivers, consider that this population has the same general preferences as non-commercial drivers. The exception is for situations in which CVO drivers require information that is specific to their task, such as low clearance warnings and weight limits.

- When presenting relative location information, display the information in a format that requires the least amount of inferencing by the driver. For example, present the message "*Ambulance approaching from rear in left lane*" as opposed to "*Ambulance heading southbound on Elm Street in left lane*" (Approach of Emergency Vehicle Information—Question 2).
- When considering the use of maps to display location information to drivers, maintain the most detailed map scale as possible that would allow drivers to easily recognize their

location in relation to the item of interest (e.g., construction, severe weather; User Clinic—Weather Alert).

Specific Recommendations

- When presenting Time/Distance to Destination Information, display both the distance to the destination and time to the destination. If display space is at a premium, provide distance information only; however, do not display only time information (Time/Distance to Destination Information—Question 4).

- When presenting Time/Distance to Next Turn Information, display at least two warning messages regarding an upcoming turn, and possibly three messages. Do not display only one message just before the turn (Time/Distance to Next Turn and Lane Suggestion Information—Question 1).

- When presenting Distance to Next Turn Information, display one distance parameter (e.g., the number of intersections before the turn) and one other parameter, preferably time; however, do not display time only information (Time/Distance to Next Turn and Lane Suggestion Information—Question 3).

- When presenting RCI, inform the driver of how far ahead the construction lies in terms of both the distance and time to the construction. If display space is at a premium, provide only distance information; however, do not display only time information (Road Construction Information—Question 1).

- Inform drivers of stopped school buses ahead and emergency vehicles approaching the driver's vehicle in every instance, if feasible (Stopped Vehicle Ahead Information—Question 2).

- Inform drivers of the relative location of approaching emergency vehicles (Approach of Emergency Vehicle Information—Question 1).

APPENDIX A: ORIGINAL LIST OF 86 ATIS INFORMATION ITEMS

ISIS: Standard roadway warning signs (yellow and orange)
ISIS: Temporary or dynamic conditions (road closures, road maintenance, or road construction)
ISIS: Regulatory, street, and highway sign information
ISIS: Guide signs
ISIS: Distance to toll
ISIS: Cost of toll
ISIS: Recreational and cultural interest signs
ISIS: Parking arrow
IVSAWS: Approach of emergency vehicles
IVSAWS: Road surface condition (i.e., broken pavement ahead, water flowing in the road)
IVSAWS: Bridge information (lane narrows, raised, ice, etc.)
IVSAWS: Weather conditions alert (rain, fog, sleet, snow, cross winds, precipitation, etc.)
IVSAWS: Reduced visibility warning
IVSAWS: Reduced traction warning
IVSAWS: Roadway obstruction warning
IVSAWS: Congestion ahead
IVSAWS: Accident immediately ahead
IVSAWS: Stopped bus ahead
IVSAWS: Guidance to hospital
IVSAWS: Emergency contact police or fire
IVSAWS: Emergency road service or aid request
VCM: Inform the driver of current problems
VCM: Inform the driver of potential problems
VCM: Inform the driver of current status
VCM: Fuel level
VCM: Inform driver of routine service/maintenance
VCM: Provide more detailed information at the drivers request
DRS: List alternative possible routes
DRS: Updated congestion information that might affect drivers route
DRS: Updated weather information that might affect drivers route
DRS: Off-route recovery
DRS: Vehicle current position
RG: Distance to next turn
RG: Time to next turn (at current speed)
RG: Name of current street
RG: Name of street to turn on
RG: Lane suggestion for turn
RG: Direction to turn
RG: Diagram of next intersection
RG: Type of roadway (interstate, two-lane, rural, etc.)
RG: Location of major landmarks along route
RG: Type of turn (turn detail)
RN: Initiate requests and input parameters

RN: Distance to destination
RN: Time to destination
RN: Cost to get to destination
RN: Road type (e.g., highway, interstate, etc.)
RN: Directional heading information
RN: States, regions, locales, and communities along route
RN: Landmarks or topographical features along route
RN: Re-route options
RN: Compare current and alternative routes
Optimum accelerator for fuel economy
Optimum gear for engine efficiency
Trip Plan: Initiate requests and input parameters
Trip Plan: Diagram of route
Trip Plan: Time to get to each destination from previous destination
Trip Plan: Toll charges along the trip
Trip Plan: Total time for trip
Trip Plan: Estimates of mileage
Trip Plan: Location of attractions and points of interest
Trip Plan: Forecast weather information
Trip Plan: Historical traffic information
Trip Plan: Distance to each destination from previous destination
IMSIS: Index of yellow pages
IMSIS: Service description and costs (Fuel prices, etc.)
IMSIS: List of service hours of operation
IMSIS: Closest service
IMSIS: Restaurant description and costs
IMSIS: Restaurant reservation availability
IMSIS: Restaurant reservation establishment
IMSIS: Attraction description and costs
IMSIS: Attraction hours of operation
IMSIS: Attraction restrictions
IMSIS: Attraction ticket availability
IMSIS: Attraction ticket purchase
IMSIS: Transportation from parking to attraction
IMSIS: Accommodation descriptions and costs
IMSIS: Accommodation reservation availability
IMSIS: Accommodation reservation establishment
IMSIS: Distance to service/attraction
IMSIS: Service/attraction parking availability
IMSIS: Service/attraction directions from parking to service/attraction
IMSIS: Service/attraction payment methods supported
IMSIS: Rest area facilities available
IMSIS: Motorist services signs

APPENDIX B: ORIGINAL LIST OF 86 ATIS INFORMATION ITEMS IN SUBGROUPINGS

SAFETY SPECIFIC INFORMATION

ISIS: Standard roadway warning signs (yellow and orange)
ISIS: Temporary or dynamic conditions (road closures, road maintenance, or road construction)
IVSAWS: Approach of emergency vehicles
IVSAWS: Road surface condition (i.e., broken pavement ahead, water flowing in the road)
IVSAWS: Bridge information (lane narrows, raised, ice, etc.)
IVSAWS: Weather conditions alert (rain, fog, sleet, snow, cross winds, precipitation, etc.)
IVSAWS: Reduced visibility warning
IVSAWS: Reduced traction warning
IVSAWS: Roadway obstruction warning
IVSAWS: Congestion ahead
IVSAWS: Accident immediately ahead
IVSAWS: Stopped bus ahead
VCM: Inform the driver of current problems
VCM: Inform the driver of potential problems

DRIVER ASSISTANCE INFORMATION

ISIS: Regulatory, street, and highway sign information
ISIS: Guide signs
DRS: List alternative possible routes
DRS: Updated congestion information that might affect drivers route
DRS: Updated weather information that might affect drivers route
DRS: Off-route recovery
DRS: Vehicle current position
RG: Distance to next turn
RG: Time to next turn (at current speed)
RG: Name of current street
RG: Name of street to turn on
RG: Lane suggestion for turn
RG: Direction to turn
RG: Diagram of next intersection
RG: Type of roadway (interstate, two-lane, rural, etc.)
RG: Location of major landmarks along route
RG: Type of turn (turn detail)
RN: Initiate requests and input parameters
RN: Distance to destination
RN: Time to destination
RN: Cost to get to destination
RN: Road type (e.g., highway, interstate, etc.)
RN: Directional heading information

RN: States, regions, locales, and communities along route
RN: Landmarks or topographical features along route
RN: Re-route options
RN: Compare current and alternative routes
VCM: Inform the driver of current status
VCM: Fuel level
VCM: Inform driver of routine service/maintenance
VCM: Provide more detailed information at the drivers request
Optimum accelerator for fuel economy
Optimum gear for engine efficiency
IVSAWS: Guidance to hospital

DRIVER CONVENIENCE INFORMATION

Trip Plan: Initiate requests and input parameters
Trip Plan: Diagram of route
Trip Plan: Time to get to each destination from previous destination
Trip Plan: Toll charges along the trip
Trip Plan: Total time for trip
Trip Plan: Estimates of mileage
Trip Plan: Location of attractions and points of interest
Trip Plan: Forecast weather information
Trip Plan: Historical traffic information
Trip Plan: Distance to each destination from previous destination
IMSIS: Index of yellow pages
IMSIS: Service description and costs (Fuel prices, etc.)
IMSIS: List of service hours of operation
IMSIS: Closest service
IMSIS: Restaurant description and costs
IMSIS: Restaurant reservation availability
IMSIS: Restaurant reservation establishment
IMSIS: Attraction description and costs
IMSIS: Attraction hours of operation
IMSIS: Attraction restrictions
IMSIS: Attraction ticket availability
IMSIS: Attraction ticket purchase
IMSIS: Transportation from parking to attraction
IMSIS: Accommodation descriptions and costs
IMSIS: Accommodation reservation availability
IMSIS: Accommodation reservation establishment
IMSIS: Distance to service/attraction
IMSIS: Service/attraction parking availability
IMSIS: Service/attraction directions from parking to service/attraction
IMSIS: Service/attraction payment methods supported
IMSIS: Rest area facilities available

IMSIS: Motorist services signs
ISIS: Distance to toll
ISIS: Cost of toll
ISIS: Recreational and cultural interest signs
ISIS: Parking arrow
IVSAWS: Emergency contact police or fire
IVSAWS: Emergency road service or aid request

APPENDIX C: INFORMATION ITEM ANALYSIS

Table 22. Information item analysis for the safety specific information items.

Safety Specific Information	Attention Mechanism	Comprehension	Standard Source (if available)	Required Actions
Warning Signs				
ISIS: Standard roadway warning signs (yellow and orange)	As Noticed	sign	MUTCD 2C, UMTRI NAV G17	action implicit
		distance to sign		
Emergency Vehicle				
IVSAWS: Approach of emergency vehicles	2—Urgent	direction	UMTRI IVSAWS	pull off to side of road
		distance to emergency vehicle		stop
		type of emergency vehicle	UMTRI IVSAWS	
Roadway				
* ISIS: Temporary or dynamic conditions (road clos., road maint., or road const.)	3—Priority	description of condition	MUTCD 6B-12	proceed with caution
		distance to condition	MUTCD 6B-15	re-route required
		length of condition	MUTCD 6B-36	
IVSAWS: Road surface condition (i.e. broken pave ahead, water flow in the road)	2—Urgent	description of condition		slow
		distance to condition		proceed with caution
		length of condition		do not proceed
IVSAWS: Bridge information (lane narrows, raised, ice, etc.)	2—Urgent	bridge status (raised, open)		proceed with caution
		bridge hazards (slippery)		stop ahead
		bridge width		do not cross
		bridge weight limit		
Environmental Hazard				
IVSAWS: Weather conditions alert (rain, fog, sleet, snow, cross winds, precip, etc.)	4—Non-Urgent	type of weather conditions		proceed with caution
		distance to condition		
		magnitude of condition		
IVSAWS: Reduced visibility warning	2—Urgent	visibility distance		slow
		distance to reduced visibility		
IVSAWS: Reduced traction warning	1—Immediate	percent reduction in traction		slow
		distance to reduction in		

Safety Specific Information	Attention Mechanism	Comprehension	Standard Source (if available)	Required Actions
		traction		
		slide warning		
IVSAWS: Roadway obstruction warning	1—Immediate	type of obstruction		proceed with caution
		distance to obstruction		do not proceed
Traffic Flow				
IVSAWS: Congestion ahead	As Noticed	congestion indication		yield
		distance to congestion		
		avg speed		
		reason for congestion	UMTRI IVSAWS	
IVSAWS: Accident Immediately ahead	1—Immediate	indication of accident		proceed with caution
		distance to accident		
IVSAWS: Stopped bus ahead	2—Urgent	indication of bus		yield
		distance to bus		prepare to stop
Vehicle Condition Warning				
VCM: Inform the driver of current problems	2—Urgent	type of problem	UMTRI VEH MON G1,G8,G9	proceed with caution to nearest service
		potential outcome		pull off to the side of the roadway
VCM: Inform the driver of potential problems	4—Non-Urgent	type of problem	UMTRI G1,G4-G6	service at nearest convenience
		potential outcome		
		mean-time-to-failure		

Table 23. Information item analysis for the driver assistance information items.

Driver Assistance Information	Attention Mechanism	Comprehension	Standard Source (if available)	Required Actions
Regulatory Signs				
ISIS: Regulatory, street, and highway sign information	As Noticed	sign	MUTCD 2B, UMTRI NAV G17	action implicit
		distance to sign		
ISIS: Guide signs	As Noticed	sign	MUTCD 2D, UMTRI NAV G17	action implicit
		distance to sign		
Dynamic Route Selection Information				
RS: List alternative possible routes	As Noticed	presentation of routes		no action required
DRS: Updated congestion information that might affect driver's route	4—Non-Urgent	indication of congestion	UMTRI TRAFFIC G2	action implicit
		location of congestion		
		distance to congestion		
		avg. speed of congestion		
		reason for congestion		
DRS: Updated weather information that might affect driver's route	4—Non-Urgent	type of weather		action implicit
		distance to weather		
		magnitude of weather conditions		
		span of weather condition		
DRS: Off-route recovery	2—Urgent	off-route indication	UMTRI TRAFFIC G2	follow guidance instructions
		maneuvers required		
		distance to route		
DRS: Vehicle current position	As Noticed	vehicle current position		action implicit
Route Guidance				
* RG: Distance to next turn	As Noticed	distance to next turn	UMTRI NAV G13	action implicit
RG: Time to next turn (at current speed)	As Noticed	time to next turn		action implicit
* RG: Name of current street	As Noticed	name of current street	UMTRI NAV G20,G21	no action required
* RG: Name of street to turn on	As Noticed	name of street to	UMTRI NAV	action implicit

Driver Assistance Information	Attention Mechanism	Comprehension	Standard Source (if available)	Required Actions
		turn on	G20,G21	
RG: Lane suggestion for turn	As Noticed	lane suggestion for turn		no action required
* RG: Direction to turn	As Noticed	direction to turn	UMTRI NAV G2	action implicit
* RG: Diagram of next intersection	As Noticed	diagram of next intersection	UMTRI NAV G3,G15,G20	no action required
RG: Type of roadway (interstate, two-lane, rural, etc.)	As Noticed	type of roadway		no action required
RG: Location of major landmarks along route	As Noticed	landmark description	UMTRI NAV G7	no action required
		location of landmark		
		distance to landmark		
RG: Type of turn (turn detail)	As Noticed	type of turn	UMTRI NAV G9,G27	no action required
Route Navigation Information				
* RN: Initiate requests and input parameters	n/a	Initiate requests / input parameters	UMTRI INTEGRATION G1,G2,UMTRI MAN CONTROL G1-G9, UMTRI NAV INP G1-G6,TRAVTEK	Initiate requests / input parameters
RN: Distance to destination	As Noticed	distance to destination		no action required
RN: Time to destination	As Noticed	time to destination		no action required
RN: Cost to get to destination	As Noticed	cost to destination		no action required
RN: Road type (e.g., highway, interstate, etc.)	As Noticed	road type		no action required
* RN: Directional heading information	As Noticed	compass heading	UMTRI NAV G11	no action required
* RN: States, regions, locales, and communities along route	As Noticed	name of current state, region, locale, or comm	UMTRI NAV G10,G20	no action required
* RN: Landmarks or topographical features along route	As Noticed	name of feature	UMTRI NAV G10,G20	no action required
		type of feature	UMTRI NAV G10,G20	
RN: Re-route options	n/a	list of options		action implicit
RN: Compare current and alternative routes	n/a	distance comparison		select desired route
		time comparison		
		cost comparison		
		road type comparison		
		regional traversal comparison		

Driver Assistance Information	Attention Mechanism	Comprehension	Standard Source (if available)	Required Actions
Vehicle Condition Monitoring				
VCM: Inform the driver of current status	n/a	name component	UMTRI MON G2,G3	no action required
		status component	UMTRI MON G4,G5	
VCM: Fuel level	As Noticed	fuel level		action implicit
		low fuel		
VCM: Inform driver of routine service/maintenance	As Noticed	type of service	UMTRI MON G10-G13	action implicit
		distance/miles to service		
VCM: Provide more detailed information at the drivers request	n/a	Initiate request / input parameters		Initiate request / input parameters
		name component		action implicit
		elaborated description		
Vehicle Efficiency / Performance				
Optimum accelerator for fuel economy	As Noticed	accelerator rate		no action required
Optimum gear for engine efficiency	As Noticed	gear		no action required
Special Assistance				
IVSAWS: Guidance to hospital	n/a	initiate request / input parameters	TRAVTEK	initiate request / input parameters
		indication of condition		follow guidance instructions
		est. time to hosp.		
		est. distance to hosp.		

Table 24. Information item analysis for the driver convenience information items.

Driver Convenience Information	Attention Mechanism	Comprehension	Standard Source (if available)	Required Actions
Trip Planning				
* Trip Plan: Initiate requests and input parameters	n/a	Initiate requests/ input parameters	UMTRI INTEGRATION G1,G2,TRAVTEK	Initiate requests / input parameters
* Trip Plan: Diagram of route		Diagram of route	UMTRI G29	
Trip Plan: Time to get to each destination from previous destination	As Noticed	time		no action required
Trip Plan: Toll charges along the trip	As Noticed	total toll charges		no action required
Trip Plan: Total time for trip	As Noticed	total time		no action required
Trip Plan: Estimates of mileage	As Noticed	estimates of mileage		no action required
Trip Plan: Location of attractions and points of interest	As Noticed	name of attraction		no action required
		location of attraction		no action required

Driver Convenience Information	Attention Mechanism	Comprehension	Standard Source (if available)	Required Actions
Trip Plan: Forecast Weather Information	As Noticed	type of weather		action implicit
		day / hour of forecast		
		type of weather		
		location of weather		
Trip Plan: Historical traffic information	As Noticed	weekday/weekend		no action required
		time of day		
		avg. speed		
Trip Plan: Distance to each destination from previous destination	As Noticed	time to get to each destination		no action required
Motorist Services				
IMSIS: Index of yellow pages	n/a	format of listings		initiate requests / input parameters
IMSIS: Service description and costs (Fuel prices, etc.)	n/a	service name		no action required
		service location		
		service description and costs		
IMSIS: List of service hours of operation	n/a	service hours of operation		no action required
IMSIS: Closest service	n/a	location of service		
		distance to service		
IMSIS: Restaurant description and costs	n/a	restaurant name		no action required
		restaurant location		
		restaurant description and costs		
IMSIS: Restaurant reservation availability	n/a	restaurant reservation availability		no action required
IMSIS: Restaurant reservation establishment	n/a	confirmation of reservation		no action required
IMSIS: Attraction description and costs	n/a	attraction location		no action required
		attraction description and costs		
IMSIS: Attraction hours of operation	n/a	attraction hours of operation		no action required
IMSIS: Attraction restrictions	n/a	attraction restrictions		no action required
IMSIS: Attraction ticket availability	n/a	attraction ticket		no action required

Driver Convenience Information	Attention Mechanism	Comprehension	Standard Source (if available)	Required Actions
		availability		
IMSIS: Attraction ticket purchase	n/a	payment and purchase confirmation		no action required
IMSIS: Transportation from parking to attraction	n/a	type of transportation		no action required
		schedule of transportation		
IMSIS: Accommodation descriptions and costs	n/a	accommodation description and costs		no action required
IMSIS: Accommodation reservation availability	n/a	accommodation reservation availability		no action required
IMSIS: Accommodation reservation establishment	n/a	confirmation of reservation		no action required
IMSIS: Distance to service/attraction	As Noticed	distance to service / attraction		no action required
IMSIS: Service/attraction parking availability	n/a	service / attraction parking availability		no action required
		location of parking		
IMSIS: Service/attraction directions from parking to service/attraction	n/a	directions		no action required
IMSIS: Service/attraction payment methods supported	n/a	payment and order verification		no action required
IMSIS: Rest area facilities available	n/a	rest area facilities available		no action required
ISIS: Distance to toll	3—Priority	distance to toll		no action required
ISIS: Cost of toll	3—Priority	cost of toll		no action required
* IVSAWS: Emergency contact police or fire	n/a	verify request	TRAVTEK	initiate request / input parameters
* IVSAWS: Emergency road service or aid request	n/a	verify request	TRAVTEK	initiate request / input parameters
Driver Convenience Signs				
IMSIS: Motorist services signs	As Noticed	sign	MUTCD 2G	no action required
		distance to sign		
ISIS: Recreational and cultural interest signs	As Noticed	sign	MUTCD 2H	no action required
		distance to sign		
ISIS: Parking Arrow	As Noticed	arrow		no action required
		distance to parking		
* Filtered information items (standards in place for each level of comprehension).				

APPENDIX D: SAFETY TRADE STUDY

Table 25. Safety specific information item trade study.

Safety Specific Information	Required Response Time Rating	R ate × Weight (8)	Potential Danger if Misinterpreted Rating	Rate × Weight (10)	Total of Rates × Weights
Warning Signs					
ISIS: Standard roadway warning signs (yellow and orange)	4	32	4	40	72
Emergency Vehicle					
IVSAWS: Approach of emergency vehicles	3	24	4	40	64
Roadway					
IVSAWS: Road surface condition (i.e. broken pavement ahead, water in the road)	4	32	2	20	52
IVSAWS: Bridge information (lane narrows, raised, ice, etc.)	3	24	4	40	64
Environmental Hazard					
IVSAWS: Weather conditions alert (rain, fog, sleet, snow, cross winds, precip, etc.)	2	16	2	20	36
IVSAWS: Reduced visibility warning	3	24	4	40	64
IVSAWS: Reduced traction warning	4	32	4	40	72
IVSAWS: Roadway obstruction warning	4	32	4	40	72
Traffic Flow					
IVSAWS: Congestion ahead	3	24	2	20	44
IVSAWS: Accident immediately ahead	4	32	4	40	72
IVSAWS: Stopped bus ahead	4	32	4	40	72
Vehicle Condition Warning					
VCM: Inform the driver of current problems	2	16	2	20	36
VCM: Inform the driver of potential problems	1	8	2	20	4

Table 26. Rank ordering of safety specific information items based on safety trade study.

Safety Specific Information	Total
ISIS: Standard roadway warning signs (yellow and orange)	72
IVSAWS: Reduced traction warning	72
IVSAWS: Roadway obstruction warning	72
IVSAWS: Accident immediately ahead	72
IVSAWS: Stopped bus ahead	72
IVSAWS: Approach of emergency vehicles	64
IVSAWS: Bridge information (lane narrows, raised, ice, etc.)	64
IVSAWS: Reduced visibility warning	64
IVSAWS: Road surface condition (i.e. broken pavement ahead, water flow in the road)	52
IVSAWS: Congestion ahead	44
IVSAWS: Weather conditions alert (rain, fog, sleet, snow, cross winds, precip, etc.)	36
VCM: Inform the driver of current problems	36
VCM: Inform the driver of potential problems	8

APPENDIX E: DRIVER ASSISTANCE INFORMATION TRADE STUDY

Table 27. Driver assistance information item trade study.

Driver Assistance Information	Freq. of Use Rating	Rate × Weight (6)	Utility of Info. Rating	Rate × Weight (8)	Potential Inconven. if Misinter. Rating	Rate × Weight (4)	Danger if Misinter. Rating	Rate × Weight (10)	Total of Rates × Weights
Regulatory Signs									
ISIS: Regulatory, street, and highway sign information	4	24	4	32	4	16	4	40	112
ISIS: Guide signs	2	12	2	16	4	16	0	0	44
Dynamic Route Selection Information									
DRS: List alternative possible routes	2	12	4	32	0	0	0	0	44
DRS: Updated congestion information that might affect drivers route	2	12	4	32	4	16	0	0	60
DRS: Updated weather information that might affect drivers route	2	12	2	16	4	16	4	40	84
DRS: Off-route recovery	0	0	4	32	4	16	0	0	48
DRS: Vehicle current position	2	12	2	16	4	16	0	0	44
Route Guidance									
RG: Time to next turn (at current speed)	2	12	2	16	4	16	2	20	64
RG: Lane suggestion for turn	4	24	2	16	4	16	2	20	76
RG: Type of roadway (interstate, two-lane, rural, etc.)	2	12	2	16	0	0	2	20	48
RG: Location of major landmarks along route	0	0	2	16	0	0	0	0	16
Route Navigation Information									
RN: Distance to destination	4	24	2	16	4	16	0	0	56
RN: Time to destination	4	24	0	0	4	16	0	0	40
RN: Cost to get to destination	2	12	0	0	4	16	0	0	28
RN: Road type (e.g., highway, interstate, etc.)	2	12	0	0	0	0	0	0	12
RN: Re-route options	2	12	2	16	4	16	0	0	44
RN: Compare current and alternative routes	2	12	4	32	0	0	0	0	44

Driver Assistance Information	Freq. of Use Rating	Rate × Weight (6)	Utility of Info. Rating	Rate × Weight (8)	Potential Inconven. if Misinter. Rating	Rate × Weight (4)	Danger if Misinter. Rating	Rate × Weight (10)	Total of Rates × Weights
Vehicle Condition Monitoring									
VCM: Fuel level	4	24	2	16	4	16	0	0	56
VCM: Inform driver of routine service/maintenance	2	12	2	16	0	0	0	0	28
VCM: Provide more detailed information at the drivers request	0	0	2	16	4	16	2	20	52
Vehicle Efficiency / Performance									
Optimum accelerator for fuel economy	0	0	2	16	0	0	0	0	16
Optimum gear for engine efficiency	0	0	0	0	0	0	2	20	20
Special Assistance									
IVSAWS: Guidance to hospital	2	12	2	16	4	16	0	0	44

Table 28. Rank ordering of driver assistance information items based on driver assistance trade study.

Driver Assistance Information	Total
ISIS: Regulatory, street, and highway sign information	112
DRS: Updated weather information that might affect drivers route	84
RG: Lane suggestion for turn	76
RG: Time to next turn (at current speed)	64
DRS: Updated congestion information that might affect drivers route	60
RN: Distance to destination	56
VCM: Fuel level	56
VCM: Provide more detailed information at the driver's request	52
DRS: Off-route recovery	48
RG: Type of roadway (interstate, two-lane, rural, etc.)	48
DRS: List alternative possible routes	44
DRS: Vehicle current position	44
ISIS: Guide signs	44
RN: Re-route options	44
RN: Compare current and alternative routes	44
IVSAWS: Guidance to hospital	44
RN: Time to destination	40
RN: Cost to get to destination	28
VCM: Inform driver of routine service/maintenance	28
Optimum gear for engine efficiency	20
RG: Location of major landmarks along route	16
Optimum accelerator for fuel economy	16

APPENDIX F: DRIVER CONVENIENCE INFORMATION TRADE STUDY

Table 29. Driver convenience information item trade study.

Driver Convenience Information	Freq. of Use Rating	Rate × Weight (8)	Level of Conven. Rating	Rate × Weight (10)	Potential Inconven-ience if Misinter. Rating	Rate × Weight (5)	Total of Rates × Weights
Trip Planning							
Trip Plan: Time to get to each destination from previous destination	0	0	2	20	0	0	20
Trip Plan: Toll charges along the trip	0	0	3	30	4	20	50
Trip Plan: Total time for trip	2	16	2	20	4	20	56
Trip Plan: Estimates of mileage	2	16	2	20	4	20	56
Trip Plan: Location of attractions and points of interest	2	16	2	20	4	20	56
Trip Plan: Forecast weather information	0	0	2	20	4	20	40
Trip Plan: Historical traffic information	0	0	3	30	4	20	50
Trip Plan: Distance to each destination from previous destination	0	0	2	20	4	20	40
Motorist Services							
IMSIS: Index of yellow pages	2	16	4	40	4	20	76
IMSIS: Service description and costs (Fuel prices, etc.)	4	32	2	20	0	0	52
IMSIS: List of service hours of operation	0	0	2	20	4	20	40
IMSIS: Closest service	2	16	4	40	4	20	76
IMSIS: Restaurant description and costs	4	32	2	20	4	20	72
IMSIS: Restaurant reservation availability	2	16	2	20	4	20	56
IMSIS: Restaurant reservation establishment	0	0	3	30	4	20	50
IMSIS: Attraction description and costs	0	0	2	20	4	20	40
IMSIS: Attraction hours of operation	0	0	2	20	4	20	40
IMSIS: Attraction restrictions	0	0	2	20	4	20	40
IMSIS: Attraction ticket availability	0	0	3	30	4	20	50
IMSIS: Attraction ticket purchase	2	16	4	40	4	20	76
IMSIS: Transportation from parking to attraction	0	0	1	10	4	20	30
IMSIS: Accommodation descriptions and costs	0	0	2	20	4	20	40
IMSIS: Accommodation reservation availability	0	0	2	20	4	20	40
IMSIS: Accommodation reservation	2	16	2	20	4	20	56

Driver Convenience Information	Freq. of Use Rating	Rate × Weight (8)	Level of Conven. Rating	Rate × Weight (10)	Potential Inconven-ience if Misinter. Rating	Rate × Weight (5)	Total of Rates × Weights
establishment							
IMSIS: Distance to service/attraction	2	16	3	30	4	20	66
IMSIS: Service/attraction parking availability	2	16	3	30	4	20	66
IMSIS: Service/attraction directions from parking to service/attraction	2	16	3	30	4	20	66
IMSIS: Service/attraction payment methods supported	0	0	2	20	4	20	40
IMSIS: Rest area facilities available	0	0	2	20	4	20	40
ISIS: Distance to toll	0	0	2	20	0	0	20
ISIS: Cost of toll	2	16	2	20	4	20	56
Driver Convenience Signs							
IMSIS: Motorist services signs	2	16	3	30	4	20	66
ISIS: Recreational and cultural interest signs	0	0	2	20	0	0	20
ISIS: Parking arrow	2	16	3	30	4	20	66

Table 30. Rank ordering of driver convenience information items based on driver convenience item trade study.

Driver Convenience Information	Total
IMSIS: Index of yellow pages	76
IMSIS: Closest service	76
IMSIS: Attraction ticket purchase	76
IMSIS: Restaurant description and costs	72
IMSIS: Distance to service/attraction	66
IMSIS: Service/attraction parking availability	66
IMSIS: Service/attraction directions from parking to service/attraction	66
IMSIS: Motorist services signs	66
ISIS: Parking arrow	66
Trip Plan: Total time for trip	56
Trip Plan: Estimates of mileage	56
Trip Plan: Location of attractions and points of interest	56
IMSIS: Restaurant reservation availability	56
IMSIS: Accommodation reservation establishment	56
ISIS: Cost of toll	56
IMSIS: Service description and costs (Fuel prices, etc.)	52
IMSIS: Restaurant reservation establishment	50
Trip Plan: Toll charges along the trip	50
Trip Plan: Historical traffic information	50
IMSIS: Attraction ticket availability	50
Trip Plan: Forecast weather information	40
Trip Plan: Distance to each destination from previous destination	40
IMSIS: List of service hours of operation	40
IMSIS: Attraction description and costs	40
IMSIS: Attraction hours of operation	40
IMSIS: Attraction restrictions	40
IMSIS: Accommodation descriptions and costs	40
IMSIS: Accommodation reservation availability	40
IMSIS: Service/attraction payment methods supported	40
IMSIS: Rest area facilities available	40
IMSIS: Transportation from parking to attraction	30
Trip Plan: Time to get to each destination from previous destination	20
ISIS: Distance to toll	20
ISIS: Recreational and cultural interest signs	20

APPENDIX G: SURVEY OR USER CLINIC TRADE STUDY

Table 31. Survey vs. user clinic trade study for safety specific information items.

Safety Specific Information	Description Complexity	Picture Complexity	Familiarity	Given a Rating of 1?	Survey or Clinic
ISIS: Standard roadway warning signs	3	5	5	n	Survey
IVSAWS: Reduced traction warning	5	5	5	n	Survey
IVSAWS: Roadway obstruction warning	5	5	1	y	Clinic
IVSAWS: Accident Immediately Ahead	5	3	1	y	Clinic
IVSAWS: Stopped bus ahead	5	5	3	n	Survey
IVSAWS: Approach of emergency vehicles	5	3	3	n	Survey
IVSAWS: Bridge information (lane narrows, raised, ice, etc.)	3	3	5	n	Survey
IVSAWS: Reduced visibility warning	5	5	1	y	Clinic
IVSAWS: Road surface condition (i.e. broken pavement ahead, water flow in the road)	3	5	3	n	Survey
IVSAWS: Congestion ahead	3	5	5	n	Survey
IVSAWS: Weather conditions alert (rain, fog, sleet, snow, cross winds, precip, etc.)	1	5	5	y	Clinic

Table 32. Survey vs. user clinic trade study for driver assistance information items.

Driver Assistance Information	Description Complexity	Picture Complexity	Familiarity	1 Rating?	Survey or Clinic
ISIS: Regulatory, street, and highway sign information	5	3	5	n	Survey
DRS: Updated weather information that might affect driver's route	3	1	3	y	Clinic
RG: Lane suggestion for turn	5	5	5	n	Survey
RG: Time to next turn (at current speed)	5	5	5	n	Survey
DRS: Updated congestion information that might affect driver's route	1	3	3	y	Clinic
RN: Distance to destination	5	3	5	n	Survey
VCM: Fuel level	5	5	5	n	Survey
VCM: Provide more detailed information at the drivers request	1	3	3	y	Clinic
DRS: Off-route recovery	1	1	1	y	Clinic
RG: Type of roadway (interstate, two-lane, rural, etc.)	5	3	3	n	Survey
ISIS: Guide signs	5	3	5	n	Survey
DRS: List alternative possible routes	1	1	1	y	Clinic
DRS: Vehicle current position	3	3	3	n	Survey
RN: Re-route options	3	5	3	n	Survey
RN: Compare current and alternative routes	3	5	3	n	Survey
IVSAWS: Guidance to hospital	1	1	1	y	Clinic

Table 33. Survey vs. user clinic trade study for driver convenience information items.

Driver Convenience Information	Description Complexity	Picture Complexity	Familiarity	1 Rating?	Survey or Clinic
IMSIS: Index of yellow pages	1	5	5	y	Clinic
IMSIS: Closest service	5	3	3	n	Survey
IMSIS: Attraction ticket purchase	3	5	3	n	Survey
IMSIS: Restaurant description and costs	1	5	3	y	Clinic
IMSIS: Distance to service/attraction	5	5	3	n	Survey
IMSIS: Service/attraction parkavailabilitylity	3	3	5	n	Survey
IMSIS: Service/attraction directions from parking to service/attraction	1	1	5	y	Clinic
IMSIS: Motorist services signs	5	3	3	n	Survey
ISIS: Parking arrow	5	5	5	n	Survey
Trip Plan: total time for trip	5	5	5	n	Survey

APPENDIX H: SURVEY OF IN-VEHICLE INFORMATION SYSTEMS (PRIVATE DRIVERS)

Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061-0536

Thank you for volunteering to participate in the following survey. Please fill out the information below. This will be used as a receipt for Virginia Tech's accounting purposes, so carefully fill in each item. This receipt will not remain with your survey answer sheet, in order to ensure your responses are kept anonymous. When you finish all of the sections, place the survey and the receipt in the enclosed self addressed envelope. Three to four weeks after you return the survey, you will receive a check for $10.00 in the mail. Thank you for participating in this research project. If you have any questions at all, please call the number listed on the receipt below.

DOCUMENTATION OF PARTICIPATION AND PAYMENT

In-Vehicle Information Systems Survey
Principle Investigator: Tom Dingus
Telephone: (540) 231-8831

Participant Information

Your Name:_____
City:_____
State:_____
Zip Code:_____
Phone Number:_____
Social Security Number: _____

Acknowledgment

I expect to receive a check in the amount of $10.00 for completing the attached survey to the best of my ability.

Signature of Participant_____

INTRODUCTION

The purpose of this survey is to identify some of the issues involved in providing drivers with information that is not currently available to them in their vehicles. For example, detailed information on existing restaurants and lodging accommodations could be provided during a trip to aid drivers in choosing where to eat or stop for the night. Additional information (that will soon be available inside vehicles) will include navigational help to a destination, advanced warnings when there is traffic congestion ahead, and more specific information about existing roadway hazards and conditions. It is important to note, though, that providing drivers with in-vehicle information will not replace roadside signs and postings; rather, it will be an addition to that information.

The results of this information will be used to answer academic research questions involved with designing safer and more usable in-vehicle information systems. This is <u>not</u> market research.

This survey is separated into sections. The first section asks about your driving background. This information helps us identify trends in information preferences. For example, drivers in Washington may want different information than drivers in Virginia or North Carolina. Younger drivers may desire different information than older drivers. Following the background section, there are a number of specific sections that ask questions about distinct pieces of information that will be provided in-vehicle in the near future.

There are several types of questions asked in the survey. These include multiple choice questions where you will select the most appropriate option(s); and preference questions where you will be asked to select one option from among several choices, or to rank a series of options based on your preferences for the options. Directions are provided for each question.

If you have any questions while you are completing the survey, feel free to contact Dr. Tom Dingus at (540) 231-8831.

All of your responses will be kept anonymous. There is no right answer to a given question; different people will want different pieces of information presented to them in-vehicle. This survey is meant to serve as a starting point for incorporating driver information into vehicles; your participation is important because it will help us to determine what types of information will best be presented in-vehicle, and the best way to display it.

BACKGROUND INFORMATION

1) What is your birth date? _____/_____/_____
Month / Date / Year

2) Are you:
- ❑ Male
- ❑ Female

3) Approximately how many miles do you drive per year? (Check only one)
- ❑ Under 2,000
- ❑ 2,000 - 7,999
- ❑ 8,000 - 12,999
- ❑ 13,000 - 19,999
- ❑ 20,000 or more

4) How often do you drive? (Check only one)
- ❑ At least once daily
- ❑ At least once weekly
- ❑ Less than once weekly

5) Is any driving you do work-related? (Check only one)
- ❑ Yes
- ❑ No (skip to question #7)

6) If you answered yes to the above question (question #5), how many work-related miles do you drive per year? (Check only one)
- ❑ Under 2,000
- ❑ 2,000 - 7,999
- ❑ 8,000 - 12,999
- ❑ 13,000 - 19,999
- ❑ 20,000 or more

7) In which environment do you most typically drive? (Check only one)
- ❑ Rural area
- ❑ Small town (Less than 50,000)
- ❑ Suburban
- ❑ City
- ❑ Highway/freeway (e.g., Interstate 81)

8) What type of automobile do you drive most often?

Make (e.g., Ford, Toyota): _____
Model (e.g., Escort, Celica): _____
Year: _____

Motorist Service Information

Motorist service information includes food, lodging and gas information, camping and picnic information, and parking information. Drivers currently get most of their motorist service information from commercial billboards and signs along roadsides and highways. Signs with parking arrows are currently provided in major cities near large public parking lots. Providing parking lot information to drivers in-vehicle may reduce the stress of finding parking in unfamiliar areas, and will help the driver prepare to turn into a lot by informing them well in advance of the lot's entrance.

1. An in-vehicle display may present motorist service information to drivers several ways. One method would be to automatically present the information in a timely fashion before the exit or turn necessary to get to the advertised restaurant or gas station. This is currently what you see as you drive on highways, where billboards and signs are posted just before the exits, or several miles before the exit. Another method of in-vehicle presentation is for drivers to request information about a service. Then, and only then, will this information be presented. Please tell us your preference for receiving information about motorist services such as parking lots, lodging, and restaurants by checking **one** of the boxes below.

- ❑ I would like to receive this information automatically as I approach each motorist service.
- ❑ I would like to receive this information only when I request it.
- ❑ I would like the option of receiving this information automatically or when I request it.

2. Imagine that you are driving along a highway and want to stop to get something to eat. Please rank the following pieces of information (from 1 to 6) based on how important each is to your selection of a restaurant. A '1' indicates the most important factor, and a '6' indicates the least important factor when searching for a restaurant.

_____ Restaurant name (e.g., McDonald's)
_____ Drive-through vs. sit-down
_____ Type of food served
_____ Price
_____ Location (e.g., 25 miles away)
_____ Seating availability / waiting time

3. Imagine that you are driving along a highway and want to stop for the night. Please rank the following pieces of information (from 1 to 8) based on how important each is to your selecting a place to stay for the night. A ‘1' indicates the most important factor, and an ‘8' indicates the least important factor when searching for a place to stay .

_____ Lodging name (e.g., Days Inn)
_____ Closest lodging with vacancy
_____ All lodging with vacancies in the area
_____ Specific lodging location (e.g., Best Western, 25 miles away).
_____ Special features (e.g., HBO, swimming pool)
_____ Price
_____ Quality (e.g., AAA ratings)
_____ What is nearby (e.g., gas stations, restaurants, stores, etc.)

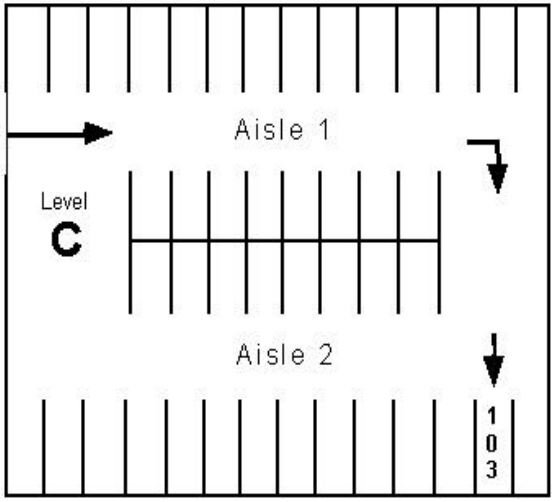
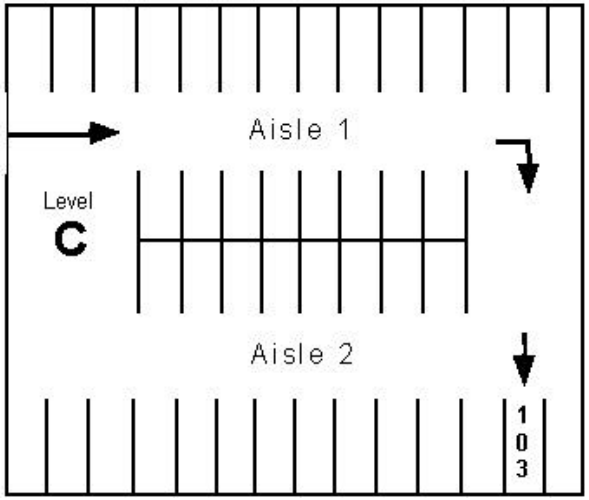
4. Imagine that you are driving along a highway and are in need of gas. Please rank the following pieces of information (from 1 to 7) based on how important each is to your selection of a gas station to re-fuel. A ‘1' indicates the most important factor, and a ‘7' indicates the least important factor when searching for a gas station.

_____ Service name (e.g., Amoco, Shell)
_____ Cost of gasoline
_____ Restrooms
_____ Hours of operation
_____ Location (e.g., 25 miles away)
_____ Other services (e.g., snacks, drinks, convenience items, ATM machine, etc.
_____ Payment methods (e.g., MasterCard, Visa)

5. Now imagine that you are traveling on an interstate and want to stop for the night. Listed below are several possible display types for lodging accommodations. Please remember that these displays will be presented to you in your vehicle. Please rank (from 1 to 3) the displays in order of your preference, where a ‘1' indicates the most preferred display, a ‘2' indicates the 2nd most preferred display, and a ‘3' indicates the least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

		**Lodging Next Right**	
What is your preference for each display?			

6. Now imagine that you have found a parking lot and need to find a parking space. There are several ways to provide you with this information in-vehicle: as a text message, where you are provided with a location in the lot; as a picture, which shows you a diagram of the parking lot and an available parking space; or as a combination of both text and picture. Below you will find an example of each type of presentation. Please rank the 3 displays in order of your preference, where a '1' indicates the most preferred display, a '2' indicates the 2nd most preferred display, and a '3' indicates the least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

	Parking: Level C Aisle 2 # 103 		**Parking**: Level C Aisle 2 # 103
What is your prefer-ence for each display?			

Time/Distance to Destination Information

Time/distance to destination information includes more general navigational information and will entail the driver programming an in-vehicle system so that the system "knows" where the driver is going. Throughout the survey there will be references made to this aspect of in-vehicle systems in which it will be referred to generally as *"pre-planned routes."* A pre-planned route consists of the driver entering a beginning point and an end destination into the in-vehicle system, and the system then guiding the driver to the destination through a series of directions.

The advantage of these pre-planned route systems is that they will be capable of providing the driver with specific information pertaining to the distance and time involved with their chosen path of travel. Such systems will be useful to drivers at the beginning of their trip, as they will provide the driver with exact information as to how long the trip will take and the distance to their destination. So too will these systems be useful to drivers during the course of their trip, as they will allow the driver to know how much time remains until they reach their destination, and how far away their destination lies.

1. Distance/time to destination information can be presented in a variety of fashions. For example, it can be presented after a specified time (e.g., every 30 minutes) or after a specified distance (e.g., every 50 miles). The information can also be presented constantly, in which the driver may look at the display at any time to receive information about the distance/time to the destination. Another alternative would be to display the information only when the driver requests it, such as by pressing a button (on the steering wheel, for example). Please rank (from 1 to 3) these options based upon your preference for displaying this information, where a '1' indicates the most preferred mode of display, a '2' indicates the 2nd most preferred mode of display, and a '3' indicates the least preferred mode of display.

_____ Information is displayed every × amount of miles or minutes.
_____ Information is displayed all the time.
_____ Information is displayed only when requested.

2. Imagine that you are on a 300-mile trip, and you expect to be driving about 5 hours. As you approach your destination, you may receive information on how much time remains of your trip or on how many miles you have remaining yet to travel. Suppose that you have driven about half-way to your destination, and you would like to know how much farther you have to go. Which display do you prefer? (Please check **one**):

- ❑ A display showing the distance to the destination (e.g., 150 miles remaining).
- ❑ A display showing the time to the destination (e.g., 2 hours 30 minutes remaining).
- ❑ A display with both the time and distance to the destination.

3. Imagine that you are using a pre-planned route system that updates your distance or time to destination automatically. Given a long trip, how would you like the information to be updated? (Please check **one**)**:**

- ❑ Updated information based on × amount of miles or minutes (e.g., every 100 miles or
- ❑ 60 minutes).
- ❑ Updated information based on a percentage of your total trip distance or travel time (e.g., you will receive updated information when your trip is 25%, 50%, and 75% complete, by time or distance).

4. Now imagine that you are on a shorter trip, about 25 miles in the city, which should take you about 45 minutes. You have driven about half way to your destination, and you would like to know how much farther you have to go. What information would you most prefer to receive? (Please check **one**):

- ❑ Distance to destination (e.g., 12 miles remaining).
- ❑ Time to destination (e.g., 20 minutes remaining).
- ❑ Both distance and time to destination.

5. Given a short trip with automatically updated information, which type of information would you most prefer to receive? (Please check **one**):

- ❑ Updated information based on × amount of miles or minutes (e.g., every 5 miles or 10 minutes).
- ❑ Updated information based on a percentage of your total trip distance or travel time (e.g., you will receive updated information when your trip is 25%, 50%, and 75% complete, by time or distance).
- ❑ Updated information based on both × amount of miles or minutes AND on a percentage of your total trip distance or travel time.

Time/Distance to Next Turn and Lane Suggestion Information

An in-vehicle system will be capable of giving a driver turn-by-turn directions to their destination, based on a route that the driver has entered into the in-vehicle system before the start of the trip. *Time/distance to next turn information* will tell the driver how far away the next turn is or how much time the driver has before they need to turn. Furthermore, the system will be able to suggest a lane to be in for the upcoming turn. This information may be helpful to drivers when they find themselves in unfamiliar areas, or at complicated intersections. We want to know how to best present this information to drivers in their vehicles.

1. Different drivers want different amounts of information about when to turn next. For example, some drivers may only want to be told about an upcoming turn just before they encounter the intersection. Others may want some kind of forewarning to prepare them for the turn and to help reduce anxiety about where to turn. Imagine that you are driving and there is a turn coming up. Examine the 3 options below and rank them based on how you would like to be told about an upcoming turn. A '1' indicates your most preferred, a '2' indicates your 2nd most preferred, and a '3' indicates your least preferred option.

_____ I only want to receive one message about how far away my turn is – just before the intersection where I will be turning (e.g., "Turn, next right").

_____ I want to receive two messages – one message as I approach my turn, and another message when I get close to my turn (e.g., "Turn right, ½ mile", then closer to the intersection: "Turn, next right").

_____ I want to receive three messages as I approach my turn. I want one message that reminds me to prepare for my turn far in advance of the turn (e.g., "Turn right, 2 miles"); I also want to receive a second message as I approach my turn (e.g., "Turn right, ½ mile"); and finally I want to receive a message when I get closer to the intersection (e.g., "Turn, next right").

2. Now imagine that you have programmed a route to your destination into your in-vehicle navigation system. You are driving in a city, and you are using the navigation system to tell you where to turn next. Which type of information would you most prefer to receive about how far ahead an upcoming turn is? Please check **one**. (Please remember that this information is about your next turn, not how far away your final destination is).

- ❑ Distance to the turn.
- ❑ Time to the turn.
- ❑ Both distance and time to the turn.

3. For the following question, assume that this information will be presented to you in terms of distance away. Which type of information would you most prefer to receive about an upcoming turn? (Please check **one**):

- ❑ The number of city blocks away.
- ❑ How many tenths of a mile away.
- ❑ The number of intersections / turns away (e.g., "Take your 2nd right").

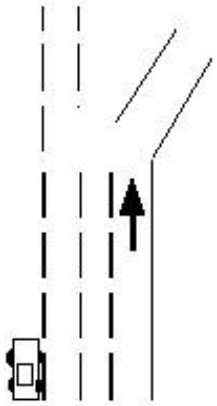
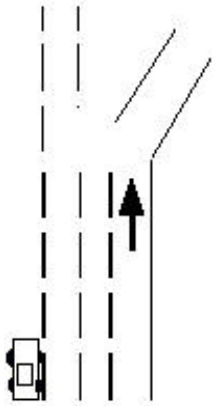
4. Now imagine that you are traveling on a highway, and you are using the navigation system to tell you what exit to take. Which type of information would you most prefer to receive about how far ahead an upcoming exit is on a highway? Please check **one**. (Please remember that this information is about your next exit, not how far away your final destination is).

- ❑ Distance to the exit.
- ❑ Time to the exit.
- ❑ Both distance and time to the exit.
- ❑ The number of exits that you will pass before coming to your exit.

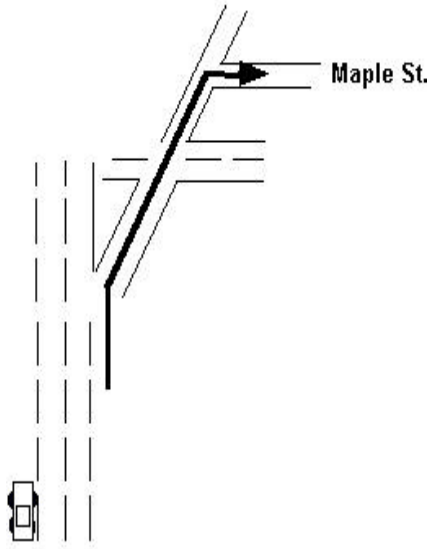
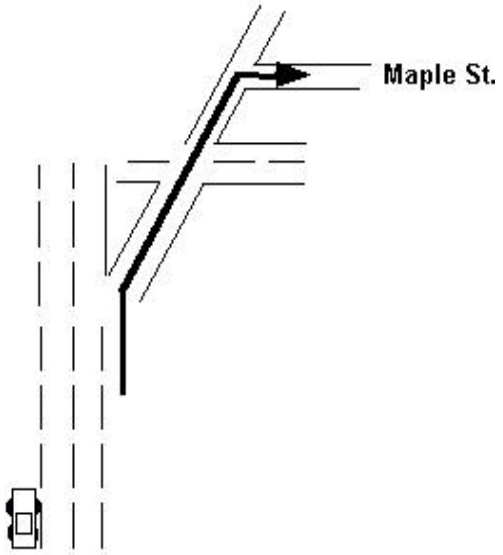
5. For the following question, please assume that this information will be presented to you in terms of distance. Which type of information would you most prefer to receive about your upcoming exit? (Please check **one**):

- ❑ Number of exits away.
- ❑ Number of miles away from upcoming exit.
- ❑ Both the number of exits and miles away from upcoming exit.

6. Imagine driving down a large interstate – 4 lanes per direction – and the speed limit is 65 mph. You are in the far left lane. Beside the road ahead of you is a sign for your exit, which is 2 miles away. You then check your in-vehicle display to determine which lane you need to be in. Please rank the following 3 displays in order of your preference. Assign a '1' to your most preferred display, a '2' to your 2nd most preferred display, and a '3' to your least preferred display. Consider the style of each display as well as the information conveyed by each display as you rank them.

		**Exit** **Right lane** **2 miles**	 **Exit** **Right lane** **2 miles**
What is your preference for this display?			

7. Now imagine that you have a more complicated set of turns off the highway. You are still driving down a large interstate – 4 lanes per direction – and the speed limit is 65 mph. You are still in the far left lane. Your exit is 2 miles away, but immediately after you exit the highway, you will have to go straight through the first intersection, and then take a sharp right at the second intersection, onto Maple Street. In other words, you have a series of directions to follow to exit the highway and find Maple street. Please rank the following 3 displays in order of your preference for instructions on how to get to Maple Street. Assign a '1' to the most preferred display, a '2' to the 2nd most preferred display, and a '3' to the least preferred display. Consider the style of each display as well as the information conveyed by each display as you rank them.

		**Exit right lane 2 miles. Continue straight through first intersection. Turn right on Maple St.**	**Exit right lane 2 miles. Continue straight through first intersection. Turn right on Maple St.** 
What is your preference for this display?			

Guide Sign Information

Guide sign information helps direct drivers to their destination. Guide sign information includes route markers – specifically shaped signs with the highway or route number displayed (e.g., Interstate I-75, 2 Miles), destination signs (e.g., Atlanta 100 miles), exit signs along freeways, and mile markers. Guide signs in cities also include motorist service signs (e.g., a blue sign with a white 'H' indicating a hospital is in the area).

1. Guide signs are currently seen posted along roads and highways, regardless of whether drivers "use" the information they display or not. The guide signs provided by an in-vehicle display, however, may be displayed only when they are relevant to a driver's pre-planned route, or they may be displayed only when the driver requests the information. Which mode of display would you most prefer in displaying this information? (Please check **one**):

- ❑ Always display guide sign information.
- ❑ Display guide sign information only when it is relevant to my route.
- ❑ Only display guide sign information when I request it.

2. Below are 3 examples of possible guide sign displays. Please rank the following 3 guide signs in order of your preference. Assign a '1' to your most preferred display, a '2' to your 2nd most preferred display, and a '3' to your least preferred display. Consider the style of each display as well as the information conveyed by each display as you rank them.

		**I-74** **Next Right**	 **I-74** **Next Right**
What is your preference for this display?			

Road Construction Information

Many car accidents occur in construction zones every year. *RCI* will allow in-vehicle systems to provide drivers with advanced notification of potentially hazardous areas, as well as provide more detailed information about construction areas. However, in order for in-vehicle information systems to be effective, they must be able to present information that drivers will both want and use. Below are several questions that seek to determine driver preferences to help designers develop effective in-vehicle systems.

1. To begin, it is essential to identify what pieces of information drivers want about road construction. Below are listed items of information related to road construction. Please rank these items (from 1 to 8) based on their importance to you in receiving information about road construction. A '1' indicates the most important item of information, and an '8' indicates the least important item of information pertaining to road construction. (Please be sure to rank all the options, and remember that we are asking about what information is important to you).

_____ How far ahead the construction lies.
_____ The type of construction.
_____ Any shift in road alignment (e.g., both lanes shift slightly to the right).
_____ Whether there are workers or other people in the vicinity.
_____ Speed limit in the construction zone.
_____ Indication that there are slow-moving vehicles (e.g., dump trucks) in the area.
_____ Uneven or bumpy pavement.
_____ Information about merging traffic into your lane, or you merging into another lane.

2. Would you like to receive information about how far away the road construction is in terms of a distance away (10 miles ahead), a time away (8 minutes ahead), or both a distance and a time? (Please check **one**):

❑ I would like to receive information in terms of a distance away.
❑ I would like to receive information in terms of a time away.
❑ I would like to receive information in terms of both distance and time away.

3. Road construction signs currently provide drivers with information about distance to the construction area. Typically there are a series of signs posted, and as you drive closer to the construction, the distance on the signs also reduces. For example, the first sign that you encounter might read, "Road construction 2 miles ahead." Further down the road, you may encounter a sign that reads, "Road construction, 1500 ft," then "Road construction, 1000 ft," etc. In-vehicle information systems are capable of providing this information to drivers even earlier than currently posted signs. In general, do you want to receive information about upcoming road construction sooner than 2 miles before the area? (Please check **one**):

- ❑ I want to receive information about upcoming road construction more than 2 miles in advance.
- ❑ I do not want to receive information about upcoming road construction more than 2 miles in advance.

Re-route Option Information

Re-route options information may be useful when traveling long distances along main roads or highways by providing options to the driver when problems (such as traffic delays) arise along the current pre-planned route. For example, imagine that you are driving along an interstate, and have over 5 hours remaining of your trip. Soon traffic begins to build up ahead. An in-vehicle system can help you find an alternate route to your destination, thereby avoiding the traffic congestion ahead.

1. There are a number of ways that drivers may choose a new route to get them to their destination. Some may want to avoid toll roads, while others may want to travel along a route with as few turns as possible. We are interested in how drivers choose new routes. Below you will find a list of ways that drivers may choose routes. Please rank these options (from 1 to 10) based on their importance to you in choosing a new route. A '1' indicates the most important item of information, and a '10' indicates the least important item of information pertaining to choosing a new route. (Please be sure to rank all the options, and remember that we are asking about what information is important to you).

_____ Convenience (e.g., multiple restaurants and gas stations available).
_____ Least amount of traffic.
_____ Shortest route (distance).
_____ Fastest route (time).
_____ Most inexpensive route (e.g., no toll booths).
_____ Particular road type (e.g., all back roads).
_____ Fewest turns.
_____ Scenery (e.g., through a national park or mountains).
_____ Attractions and landmarks along route (i.e., things to do such as historical monuments, amusement parks, and city parks).
_____ States/regions through which the route travels.

2. We are also interested in learning what kinds of routes drivers typically try to avoid when trying to get to a destination. Below you will find a list of problems that people typically try to avoid when choosing a route to follow. Please rank these options (from 1 to 9) based on their importance to you when avoiding a particular route. A '1' indicates the most important item to be avoided, and a '9' indicates the least important item to be avoided. (Please be sure to rank all the options, and remember that we are asking about what information is important to you).

_____ Type of roadway
_____ Complex intersections
_____ Number of traffic lights/stop signs
_____ Toll ways
_____ High crime regions/localities
_____ Railroad crossings
_____ Congestion/traffic
_____ Poor road quality (e.g., potholes, dips in the road)
_____ The number of turns

3. Imagine that you are driving on a freeway and a traffic accident has just occurred ahead. Traffic begins to back up. Would you like an in-vehicle system to automatically suggest an alternative route for you, or would you like to receive this information only when you request it? (Please check **one**):

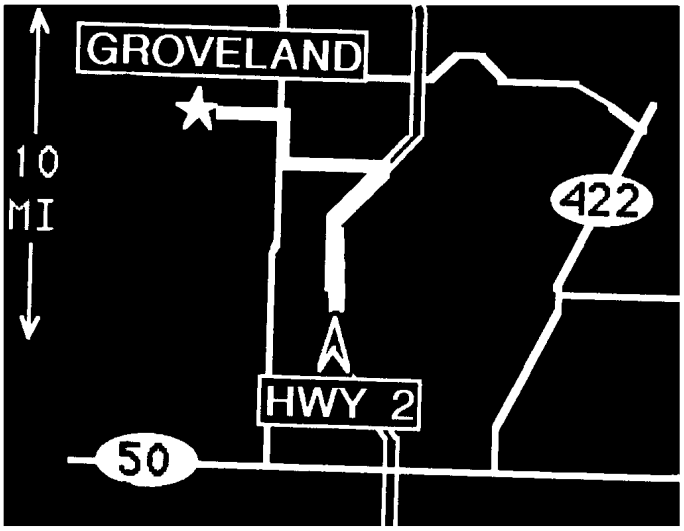
- ❑ I would like an in-vehicle system to automatically suggest an alternative route when I come across a traffic delay.
- ❑ I would like to receive this information only when I request it.

4. Imagine that you are about to go on a trip and have chosen a route to follow, but you would like to compare this route with another one recommended by the computer. There are several ways to compare the two routes, depending on the presentation of each route format. Three such formats include: a list of text instructions on how to get to the destination (e.g., "Go down Main Street. Turn left at Mayberry. Turn right at Walnut St."); a bird's-eye view of the route, similar to paper maps you see today; and a series of "turn-by-turn" directions presented graphically on the in-vehicle display. See examples of all 3 displays below:

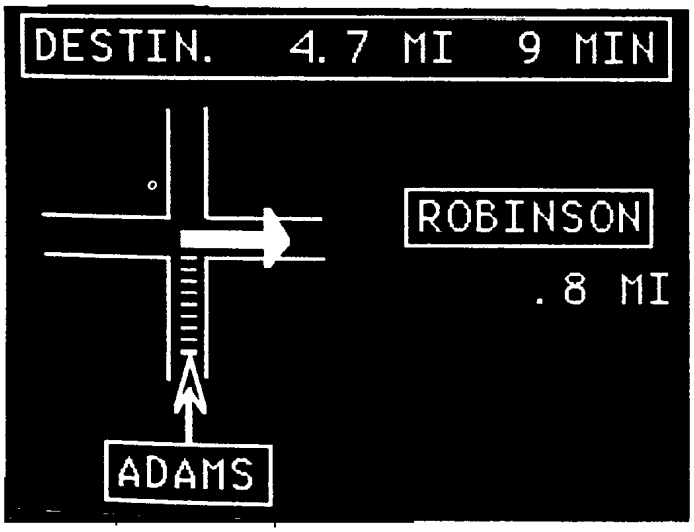
Directions to 1648 Pine Rd.:

1. Take Main Street 6 blocks to Walnut Street.
2. Turn right onto Walnut Street. Go 2 blocks to Hankey Avenue.
3. Turn left onto Hankey Avenue. Go 1 block to Pine Road.
4. Turn right onto Pine Road.
5. House is about 5 blocks up.

Example of a list of text directions.



Example of a full map route guidance display.



Example of <u>one</u> screen of a turn-by-turn route guidance display.

Drivers will be able to compare sets of text instructions with one another; or they may be able to compare birds' eye view maps; or they will be able to compare routes in the turn-by-turn format, where drivers can preview the drive by stepping through all of the turns in a trip.
Which display format do you prefer when comparing alternate routes? When ranking the displays, think about how you will compare the two routes: do you want to see the entire route, the turns involved in a route, or the number of steps involved in a drive? Please rank the 3 displays in order of your preference, where a '1' indicates your most preferred display, a '2' indicates your 2nd most preferred display, and a '3' indicates your least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

	Text list of directions	Full route map display	Turn-by-turn display
What is your preference for each display?			

Stopped Vehicle Ahead Information

In-vehicle systems will be able to tell drivers when there is a stopped vehicle ahead in their lane (such as a school bus or police car) well in advance of when the driver may be able to see the vehicle. Drivers may use this *stopped vehicle ahead information* to prepare to slow down well in advance of the stopped vehicle, or perhaps may even choose to take an alternate route if the delay is going to take a while.

1. Do you want to have this information presented to you in your vehicle? (Please check **one**):

- ❑ I do want this information presented to me in my vehicle.
- ❑ I do not want this information presented to me in my vehicle.

2. There are a number of different vehicles that stop in the road for short periods, such as taxis and buses picking up or dropping off passengers, or a police car blocking traffic in one lane. Please rank these items (from 1 to 5) based on how desirable it is to receive this information about each type of vehicle. A '1' indicates the most important vehicle that you would like to know has stopped, and a '5' indicates the least important vehicle that you would like to know has stopped. (Please be sure to rank all the options, and remember that we are asking about what information is important to you).

_____ School bus.
_____ Public transit vehicle, such as a city bus or a taxi.
_____ Emergency vehicle such as an ambulance or police car.
_____ Delivery vehicle such as a mail or UPS truck.
_____ Utility vehicle such as a telephone repair vehicle.

3. There are several possible ways to present stopped vehicle information to drivers. Below are 2 options for displaying a stopped ambulance ahead. Please rank the 2 displays in order of your preference, where a '1' indicates the most preferred display, and a '2' indicates the least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

	Ambulance Stopped Ahead	 **Stopped Ahead**
What is your preference for each display?		

4. It is possible that an in-vehicle system will be able to provide you with a recommended driver action to take as you approach a stopped vehicle ahead (e.g., “School bus ahead. Prepare to stop.”). Do you want to receive this information? (Please check **one**):

- ❑ I do want the system to suggest an action for me to take as I approach a stopped vehicle.
- ❑ I do not want the system to suggest an action for me to take as I approach a stopped vehicle.

Congestion Ahead Information

Congestion ahead information refers to a slowdown of traffic ahead of you in your direction of travel (a 'traffic jam'). The cause may be an accident, rush hour, road construction, or some other problem. Currently, drivers receive this information from traffic reports on the radio and CB radios. Immediately providing this information to drivers by in-vehicle systems may relieve congestion by encouraging drivers to take an alternate route, or it may make the congested area a safer place by encouraging slower driving around the congested area.

1. There is a lot of information that can be given to drivers about traffic congestion. We want to know which pieces of information drivers consider to be most important. Please rank these items (from 1 to 4) based on how important each piece of traffic congestion information is to you. A '1' indicates the most important item to know about traffic congestion, and a '4' indicates the least important item to know about traffic congestion. (Please be sure to rank all the items, and remember that we are asking about what information is important to you).

_____ Distance/time to congested area.
_____ Average traveling speed of congestion.
_____ The cause of the congestion.
_____ The duration of the delay due to congestion.

2. Different people have different opinions on what they consider to be a traffic jam. For some, any delay is a traffic jam, while for others, the backup must be over ½ mile to be considered a traffic jam. How far does traffic have to be backed up before you would consider taking an alternate route? Please **check** the most appropriate distance:

- ❑ Less than 1/4 mile.
- ❑ 1/4 to ½ mile.
- ❑ ½ to 3/4 mile.
- ❑ 3/4 to 1 mile.
- ❑ More than 1 mile.

3. How long does traffic have to be backed up before you would consider taking an alternate route? (Please check **one**):

- ❑ Less than 5 minutes.
- ❑ Between 5 and 10 minutes.
- ❑ Between 10 and 15 minutes.
- ❑ Between 15 and 20 minutes.
- ❑ Greater than 20 minutes.

4. Would you prefer to receive information about the distance to a traffic jam in terms of how far ahead it is (miles), how many minutes ahead it is, or in terms of both miles and minutes ahead? (Please check **one**):

- ❑ Minutes ahead (e.g., “traffic jam ahead 10 minutes....”).
- ❑ Miles ahead (e.g., “traffic jam ahead 5 miles....”).
- ❑ Both minutes and miles ahead.

5. Would you prefer to receive information about the duration of a traffic jam in terms of how many minutes it is delayed, how many miles it is delayed, or in terms of both minutes and miles delayed? (Please check **one**):

- ❑ Minutes delayed (e.g., “traffic is backed up about 10 minutes....”)
- ❑ Miles delayed (e.g., “traffic is backed up about 5 miles....”)
- ❑ Both minutes and miles delayed.

Approach of Emergency Vehicle Information

Approach of emergency vehicle information is currently conveyed to drivers by the siren and horn of an emergency vehicle (e.g., police car, ambulance, fire truck) as it nears your vehicle on the way to an emergency. Drivers typically use sound cues to determine the direction from which the emergency vehicle is coming, and the emergency vehicle's estimated speed. It is possible that this information, as well as more explicit information, may be displayed in-vehicle to the driver. It is important to note that this information is about the approach of the emergency vehicle; information about a stopped emergency vehicle in your lane was addressed earlier in the survey.

1. The approach of an emergency vehicle involves several pieces of information, such as the kind of vehicle (police car, ambulance, etc.), its direction of approach, and perhaps a recommended action for the driver (e.g., to pull over to the side of the road). We want to know which pieces of information drivers think are most important. Please rank these items (from 1 to 5) based on how important each piece of information about the approach of emergency vehicles is to you. A '1' indicates the most important item to know about the approaching emergency vehicle, and a '5' indicates the least important item to know about the approaching emergency vehicle. (Please be sure to rank all the items, and remember that we are asking about what information is important to you).

_____ The destination of the emergency vehicle relative to you (if it is driving to the scene of an accident).
_____ Relative location of the approaching emergency vehicle.
_____ Speed of the approaching emergency vehicle.
_____ Type of emergency vehicle (e.g., police, ambulance, fire truck).
_____ The number of emergency vehicles approaching (e.g., sometimes both a fire truck and an ambulance will respond to the same emergency and travel along the same route, one vehicle after the other).

2. There are several ways that a driver can be told about the approach of an emergency vehicle such as an ambulance. Most likely the information will be conveyed through speakers in a car. Below are two descriptions of how the approach of an ambulance may be conveyed. Imagine that you are traveling on a two lane street named Elm, heading south. Which auditory description do you prefer? Remember that this information will be presented to you through your speakers. Think about being in the driver's seat when you receive the information. (Please check **one**):

❑ "Ambulance approaching from rear in left lane."
❑ "Ambulance heading southbound on Elm street in left lane."

3. An in-vehicle system will also be able to provide you with information about what to do as the emergency vehicle approaches (e.g., 'Pull over to shoulder'). There are several situations a driver can be in when an emergency vehicle approaches. One situation might be where you are traveling in the right lane of a 2-lane road. In this circumstance, do you want an in-vehicle system to recommend a driver action in response to the approach of the emergency vehicle? (Please check **one**):

- ❑ I want an in-vehicle system to suggest a driver action in this situation.
- ❑ I do not want an in-vehicle system to suggest a driver action in this situation.

4. Sometimes you may find yourself in more complicated situations. For example, imagine that you are driving in the far left lane of a road that has 3 lanes in your direction. A message about a recommended action may be useful here, since it is not clear what the proper response is (i.e., remain in the lane or try to pull over to the shoulder). In situations such as this one, do you want an in-vehicle system to recommend a driver action as an emergency vehicle approaches your vehicle? (Please check **one**):

- ❑ I want an in-vehicle system to suggest a driver action in these situations.
- ❑ I do not want an in-vehicle system to suggest a driver action in these situations.

5. When you receive a message about the approach of an emergency vehicle, do you want to know how far away it is (e.g., "Ambulance approaching, ½ mile"), or simply that it is approaching (e.g., "Ambulance approaching")? (Please check **one**):

- ❑ I want to know how far away the approaching emergency vehicle is to me when I receive the message.
- ❑ I do not want to know how far away the approaching emergency vehicle is to me when I receive the message.

6. Assume now that you will receive distance information. Please rank these items (from 1 to 7) based on how you would like to receive distance information about the approach of emergency vehicles. A '1' indicates your most preferred distance style, and a '7' indicates your least preferred distance style.

_____ Tenths of a mile away.
_____ Seconds away.
_____ City blocks away.
_____ Both tenths of a mile and seconds away.
_____ Both tenths of a mile and blocks away.
_____ Both seconds and blocks away.
_____ Tenths of a mile, seconds, and blocks away.

Road Surface Condition and Warning Information

Road surface condition and warning information is used to alert drivers to potentially hazardous conditions on streets and highways. This information informs drivers of hazardous areas or conditions and indicates that caution should be taken when approaching the area. A driver may also have to reduce their speed and/or perform some vehicle maneuver. Some common examples of warning information include a message that a driver is approaching a railroad crossing or a warning that there is a tight curve, or intersection, ahead. Other information may warn the driver of a narrow bridge or pedestrian crossing ahead, or that the right lane ends. Some warning information is also found in construction areas. Warning signs are currently posted by the side of the road near (and ahead of) the potentially hazardous area.

1. In-vehicle systems will be capable of presenting this warning information to drivers in one of three ways: as a distance ahead (such as 1/4 mile), as a time ahead (such as 20 seconds), or as a combination of both distance and time ahead. In which format do you prefer to receive this information? (Please check **one**):

- ❑ Distance ahead (e.g., 1/4 mile ahead).
- ❑ Time ahead (e.g., 20 seconds ahead).
- ❑ Both time and distance ahead.

2. In-vehicle systems will be "smart" enough to provide drivers with recommended actions to take to avoid hazardous areas, such as recommending an advised speed when approaching a curve (e.g., "Right curve ahead, reduce speed to 35 mph"). Would you like to receive information about recommended actions to take when approaching potentially hazardous areas? (Please check **one**):

- ❑ I would like an in-vehicle system to recommended an appropriate action when approaching potentially dangerous areas.
- ❑ I would not like an in-vehicle system to recommended an appropriate action when approaching potentially dangerous areas.

3. There are several possible ways to present warning information to drivers. Below are 3 options for displaying a hazardous road condition ahead. Please rank the 3 displays in order of your preference, where a ‘1' indicates the most preferred display, a ‘2' indicates the 2nd most preferred display, and a ‘3' indicates the least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

		**Slippery When Wet**	 **Slippery When Wet**
What is your preference for this display?			

Regulatory Information

Regulatory information informs drivers about traffic regulations and laws. This information includes speed limits, stop signs, 'do not enter' information, information about where drivers can and cannot park (e.g., 'emergency parking only'), and information about traffic flow (such as turn-only lanes). This information is currently conveyed by signs posted along the roadway. Examples of current signs and their information include: speed limit, stop and yield information, and 'do not pass,' 'keep right,' 'left turn only,' and 'do not enter' signs.

1. Below are 2 options for displaying regulatory information. Please rank the 2 displays in order of your preference, where a '1' indicates the most preferred display, and a '2' indicates the least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

	DO NOT ENTER	
What is your preference for this display?		

2. Everyone can think of a time where they were driving on a road on which they did not know the speed limit. In-vehicle systems would be capable of providing speed limit information to drivers at any time. Speed limit information provided by an in-vehicle display may be displayed all the time, only when the speed limit changes, or only when the driver requests it. Which mode of display would you most prefer in displaying this information? (Please check **one**):

- ❑ I would like the speed limit displayed in my vehicle all the time.
- ❑ I would like the speed limit displayed in my vehicle only when it changes from the current speed limit, and then, I only want it temporarily displayed.
- ❑ I would like to receive this information only when I request it .

Type of Roadway Information

Paper road maps provide drivers with information about how to get from point A to point B, but they also provide drivers with information about the roads and highways themselves. Road maps tell drivers whether a highway is divided, whether there are tolls along a particular route, as well as the type of roadway it is: interstate, state highway, or county road, for example. In-vehicle systems will be able to provide drivers with this same *type of roadway information* on a computer screen, as well as new information about roads along a route.

1. We are interested in determining what information is most important to drivers when looking at a road map. Of course, the information that is important depends on why the driver is looking at the road map in the first place. Imagine that you are **trying to find a new route to follow before starting on a trip**. Below, there is a list of different pieces of information about roads and interstates. Please rank these items (from 1 to 7) based on how important each piece of information is to you when looking at a road map. A '1' indicates the most important item when looking at a road map, and a '7' indicates the least important item when looking at a road map. (Please be sure to rank all the items, and remember that we are asking about what information is important to you).

_____ The type of road: interstate, U.S. highway, county roads, etc.
_____ The speed limits of roads and interstates.
_____ The surface conditions of roads and interstates (e.g., icy, slippery, potholes).
_____ A road or interstate's typical/historical traffic flow.
_____ The number of intersections along a road or interstate.
_____ Whether there is construction on a particular road or interstate.
_____ Whether a road or interstate is a toll way.

2. Now imagine that you are on your way to a destination and you want to find out how much farther you have to go until you reach your destination. Please rank the following items (from 1 to 7) based on how important each piece of information is to you **when looking at a road map to determine how much farther you must travel**. A '1' indicates the most important item of information, and a '7' indicates the least important item of information. (Please be sure to rank all the items, and remember that we are asking about what information is important to you).

_____ The type of road: interstate, U.S. highway, county roads, etc.
_____ The speed limits of roads and interstates.
_____ The surface conditions of roads and interstates (e.g., icy, slippery, potholes).
_____ A road or interstate's typical/historical traffic flow.
_____ The number of intersections along a road or interstate.
_____ Whether there is construction on a particular road or interstate.
_____ Whether a road or interstate is a toll way.

3. Now imagine that you are on your way to a destination, but you have decided to change routes due to congestion or some other reason. Please rank the following items (from 1 to 7) based on how important each piece of information is to you **when looking at a road map to change routes**. A '1' indicates the most important item of information, and a '7' indicates the least important item of information. (Please be sure to rank all the items, and remember that we are asking about what information is important to you).

_____ The type of road: interstate, U.S. highway, county roads, etc.
_____ The speed limits of roads and interstates.
_____ The surface conditions of roads and interstates (e.g., icy, slippery, potholes).
_____ A road or interstate's typical/historical traffic flow.
_____ The number of intersections along a road or interstate.
_____ Whether there is construction on a particular road or interstate.
_____ Whether a road or interstate is a toll way.

Thank you for your participation!

APPENDIX I: ANOVA TABLES AND SNK TABLES FOR THE PRIVATE DRIVER SURVEY DATA ANALYSIS

Table 34. Motorist Services Information Question 2 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	5	402.958	80.592	31.67	0.0001
S*Option(Age)	735	1870.270	2.545		

Table 35. Motorist Services Information Question 2 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
6--Seating availability/waiting time	4.3067	A
2--Drive through vs. sit-down	4.2067	A
4--Price	3.6067	B
1--Restaurant name (e.g., McDonald's)	3.1600	C
3--Type of food served	2.8733	C
5--Location	2.4733	D

Table 36. Motorist Services Information Question 3 ANOVA table for the Age x Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	14	224.189	16.014	3.73	0.0001
S*Option(Age)	1028	4413.692	4.293		

Table 37. Motorist Services Information Question 3 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
5--Special features (e.g., Days Inn)	6.0741	A
8--What is nearby (e.g., gas stations, restaurants, stores, etc.)	5.9623	A
3--All lodging with vacancies in the area	4.4815	B
4--Specific lodging location (e.g., Best Western, 25 miles).	4.3704	B
7--Quality (e.g., AAA ratings)	4.2407	B
1--Lodging name (e.g., Days Inn)	4.2222	B
2--Closest lodging with vacancy	3.8148	B
6--Price	2.5185	C

(Age 35-45)

Option	Mean	SNK Grouping
5--Special features (e.g., Days Inn)	6.1915	A
8--What is nearby (e.g., gas stations, restaurants, stores, etc.)	5.2553	B
1--Lodging name (e.g., Days Inn)	4.9362	B
7--Quality (e.g., AAA ratings)	4.3191	B C
4--Specific lodging location (e.g., Best Western, 25 miles).	4.2766	B C
3--All lodging with vacancies in the area	4.0000	B C
6--Price	3.4834	C
2--Closest lodging with vacancy	3.3617	C

(Age 65 and Over)

Option	Mean	SNK Grouping
5--Special features (e.g., Days Inn)	6.0816	A
8--What is nearby (e.g., gas stations, restaurants, stores, etc.)	4.8980	B
6--Price	4.3878	B C
4--Specific lodging location (e.g., Best Western, 25 miles).	4.3061	B C
2--Closest lodging with vacancy	4.1429	B C D
3--All lodging with vacancies in the area	4.1224	B C D
7--Quality (e.g., AAA ratings)	3.7551	C D
1--Lodging name (e.g., Days Inn)	3.1633	D

Table 38. Motorist Services Information Question 3 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	7	801.398	114.485	26.66	0.0001
S*Option(age)	1028	4413.692	4.293		

Table 39. Motorist Services Information Question 3 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
5--Special features (e.g., Days Inn)	6.1133	A
8--What is nearby (e.g., gas stations, restaurants, stores, etc.)	5.3893	B
4--Specific lodging location (e.g., Best Western, 25 miles).	4.3200	C
3--All lodging with vacancies in the area	4.2133	C
7--Quality (e.g., AAA ratings)	4.1067	C
1--Lodging name (e.g., Days Inn)	4.1000	C
2--Closest lodging with vacancy	3.7800	C D
6--Price	3.4333	D

Table 40. Motorist Services Information Question 4 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	12	118.056	9.838	3.13	0.0002
S*Option(Age)	876	2753.156	3.143		

Table 41. Motorist Services Information Question 4 SNK results for Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
6--Other services(e.g., snacks, drinks, convenience items, ATM machines, etc.)	5.3704	A
7--Payment methods (e.g., MasterCard, Visa)	4.8519	A B
4--Hours of operation	4.4074	B C
3--Restrooms	4.3704	B C
1--Service name (e.g., Amoco, Shell)	3.8333	C
5--Location (e.g., 25 miles away)	2.7407	D
2--Cost of gasoline	2.3889	D

(Age 35-45)

Option	Mean	SNK Grouping
6--Other services(e.g., snacks, drinks, convenience items, ATM machines, etc.)	5.5000	A
7--Payment methods (e.g., MasterCard, Visa)	5.0000	A
1--Service name (e.g., Amoco, Shell)	4.1304	B
3--Restrooms	4.0870	B

(Age 35-45)

Option	Mean	SNK Grouping
4--Hours of operation	3.3913	B
2--Cost of gasoline	3.3261	B
5--Location (e.g., 25 miles away)	2.4043	C

(Age 65 and Over)

Option	Mean	SNK Grouping
6--Other services(e.g., snacks, drinks, convenience items, ATM machines, etc.)	5.4286	A
7--Payment methods (e.g., MasterCard, Visa)	5.0204	A
3--Restrooms	4.0204	B
2--Cost of gasoline	3.6735	B
4--Hours of operation	3.3878	B
1--Service name (e.g., Amoco, Shell)	3.2245	B
5--Location (e.g., 25 miles away)	3.1224	B

Table 42. Motorist Services Information Question 4 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	6	804.438	134.073	42.66	0.0001
S*Option (Age)	876	2753.156	3.143		

Table 43. Motorist Services Information Question 4 SNK for the main effect of Option.

Option	Mean	SNK Grouping
6--Other services	5.4295	A
7--Payment method	4.9530	B
3--Restrooms	4.1678	C
4--Hours of operation	3.7584	C
1--Service name	3.7248	C
2--Cost of gasoline	3.1007	D
5--Location	2.7600	D

Table 44. Motorist Services Information Question 5 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	92.741	46.371	69.21	0.0001
S*Option (Age)	292	195.652	0.670		

Table 45. Motorist Services Information Question 5 SNK for the main effect of Option.

Option	Mean	SNK Grouping
2--Textual	2.36913	A
1--Iconic	2.26000	A
3--Combined Iconic/Textual	1.34899	B

Table 46. Motorist Services Information Question 6 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	106.242	53.121	83.67	0.0001
S*Option (Age)	288	182.836	0.635		

Table 47. Motorist Services Information Question 6 SNK for the main effect of Option.

Option	Mean	SNK Grouping
3--Textual	2.45270	A
2--Iconic	2.22449	B
1--Combined Iconic/Textual	1.31293	C

Table 48. Time/Distance to Destination Information Question 1 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	4	9.377	2.344	2.99	0.0191
S*Option(Age)	294	230.129	0.783		

Table 49. Time/Distance to Destination Information Question 1 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
1--Information is displayed every × amount of miles or minutes.	2.4074	A
2--Information is displayed all the time.	2.000	B
3--Information is displayed only when requested.	1.5926	C

(Age 35-45)

Option	Mean	SNK Grouping
1--Information is displayed every × amount of miles or minutes.	2.4468	A
2--Information is displayed all the time.	2.1702	A
3--Information is displayed only when requested.	1.3830	B

(Age 65 and Over)

Option	Mean	SNK Grouping
2--Information is displayed all the time.	2.4286	A
1--Information is displayed every × amount of miles or minutes.	2.1020	A
3--Information is displayed only when requested.	1.4694	B

Table 50. Time/Distance to Destination Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	61.299	30.649	39.16	0.0001
S*Option(Age)	294	230.129	0.783		

Table 51. Time/Distance to Destination Information Question 1 SNK for the main effect of Option.

Option	Mean	SNK Grouping
1--Information is displayed every × amount of miles or minutes	2.3200	A
2--Information is displayed all the time	2.1933	A
3--Information is displayed only when requested	1.4867	B

Table 52. Time/Distance to Next Turn Question 1 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	4	15.264	3.816	5.96	0.0001
S*Option(Age)	268	171.481	0.639		

Table 53. Time/Distance to Next Turn Question 1 SNK results for Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
1--I only want to receive one message	2.4038	A
3--I want to receive three messages as I approach my turn	2.1569	A
2--I want to receive two messages	1.3962	B

(Age 35-45)

Option	Mean	SNK Grouping
1--I only want to receive one message	2.5333	A
3--I want to receive three messages as I approach my turn	2.0435	B
2--I want to receive two messages	1.3913	C

(Age 65 and Over)

Option	Mean	SNK Grouping
1--I only want to receive one message	2.8095	A
2--I want to receive two messages	1.5814	B
3--I want to receive three messages as I approach my turn	1.4889	B

Table 54. Time/Distance to Next Turn Question 1 ANOVA table for the Gender × Option interaction.

Source	DF	SS	MS	F	Pvalue
Gender*Option	2	5.347	2.674	3.98	0.0198
S*Option(Gender)	270	181.397	0.672		

Table 55. Time/Distance to Next Turn Question 1 SNK results for the Gender × Option interaction. (Male)

Option	Mean	SNK Grouping
1--I only want to receive one message	2.4605	A
3--I want to receive three messages as I approach my turn	2.0658	B
2--I want to receive two messages	1.4286	C

(Female)

Option	Mean	SNK Grouping
1--I only want to receive one message	2.6984	A
3--I want to receive three messages as I approach my turn	1.7273	B
2--I want to receive two messages	1.4769	B

Table 56. Time/Distance to Next Turn Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	88.413	44.207	69.09	0.001
S*Option(Age)	268	171.481	0.639		

Table 57. Time/Distance to Next Turn Question 1 SNK for main effect of Option.

Option	Mean	SNK Grouping
1--I only want to receive one message	2.56835	A
3--I want to receive three messages as I approach my turn	1.90845	B
2--I want to receive two messages	1.45070	C

Table 58. Time/Distance to Next Turn Question 6 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	135.843	67.921	129.74	0.0001
S*Option(Age)	290	151.823	0.524		

Table 59. Time/Distance to Next Turn Question 6 SNK for main effect of Option.

Option	Mean	SNK Grouping
1--Sign alone	2.58108	A
2--Words alone	2.16216	B
3--Words and sign	1.24667	C

Table 60. Time/Distance to Next Turn Question 7 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	4	13.010	3.253	6.02	0.0001
S*Option(Age)	290	156.787	0.5406		

Table 61. Time/Distance to Next Turn Question 7 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
2--Words only	2.6111	A
1--Sign only	2.1667	B
3--Sign and words	1.2222	C

(Age 35-45)

Option	Mean	SNK Grouping
2--Words only	2.4894	A
1--Sign only	2.1277	B
3--Sign and words	1.3830	C

(Age 65 and Over)

Option	Mean	SNK Grouping
1--Sign only	2.6383	A
2--Words only	2.2128	B
3--Sign and words	1.1633	C

Table 62. Time/Distance to Next Turn Question 7 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	123.546	61.773	114.26	0.0001
S*Option(Age)	290	156.787	0.5406		

Table 63. Time/Distance to Next Turn Question 7 SNK for the main effect of Option.

Option	Mean	SNK Grouping
2--Textual	2.44595	A
1--Iconic	2.30405	A
3--Combined Iconic/Textual	1.25333	B

Table 64. Guide Sign Information Question 2 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	4	6.419	1.605	3.22	0.0131
S*Option(Age)	292	145.527	0.498		

Table 65. Guide Sign Information Question 2 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
2--Words only	2.6481	A
1--Sign only	2.1667	B
3--Sign and words	1.1852	C

(Age 35-45)

Option	Mean	SNK Grouping
1--Sign only	2.3830	A
2--Words only	2.3404	A
3--Sign and words	1.2766	B

(Age 65 and Over)

Option	Mean	SNK Grouping
1--Sign only	2.5000	A
2--Words only	2.3750	A
3--Sign and words	1.1224	B

Table 66. Guide Sign Information Question 2 ANOVA table for the main effect Option.

Source	DF	SS	MS	F	Pvalue
Option	2	144.926	72.463	145.40	0.0001
S*Option(Age)	292	145.527	0.498		

Table 67. Guide Sign Information Question 2 SNK for the main effect of Option.

Option	Mean	SNK Grouping
2--Textual	2.46309	A
1--Iconic	2.34228	A
3--Combined Iconic/Textual	1.19333	B

Table 68. Road Construction Information Question 1 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	14	120.488	8.606	2.38	0.0029
S*Option(Age)	1027	3718.098	3.620		

Table 69. Road Construction Information Question 1 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
2--Type of construction	6.3519	A
4--Workers or other people in the area	6.2222	A
7--Uneven or bumpy pavement	5.3333	B
6--Indication of slow-moving vehicles	5.1111	B
3--Any shift in road alignment	4.1296	C
8--Info about merging traffic into your lane or you merging into another lane	3.2963	D
5--Speed limit in the construction zone	3.2407	D
1--Haw far ahead the construction lies	2.3333	E

(Age 35-45)

Option	Mean	SNK Grouping
2--Type of construction	6.6596	A
4--Workers or other people in the area	5.6809	B
7--Uneven or bumpy pavement	5.2766	B
6--Indication of slow-moving vehicles	4.8511	B C
3--Any shift in road alignment	4.1915	C
5--Speed limit in the construction zone	4.0652	C
8--Info about merging traffic into your lane or you merging into another lane	3.1277	D
1--Haw far ahead the construction lies	1.7609	E

(Age 65 and Over)

Option	Mean	SNK Grouping
7--Uneven or bumpy pavement	5.7143	A
2--Type of construction	5.4286	A
4--Workers or other people in the area	5.3469	A
6--Indication of slow-moving vehicles	4.7551	A B
3--Any shift in road alignment	4.6531	A B
8--Info about merging traffic into your lane or you merging into another lane	3.9592	B C
5--Speed limit in the construction zone	3.4694	C
1--Haw far ahead the construction lies	2.0204	D

Table 70. Road Construction Information Question 1 ANOVA table for the Gender × Option interaction.

Source	DF	SS	MS	F	Pvalue
Gender*Option	7	55.7644	7.966	2.18	0.0339
S*Option(Gender)	1034	3782.822	3.658		

Table 71. Road Construction Information Question 1 SNK results for the Gender × Option interaction. (Male)

Option	Mean	SNK Grouping
2--Type of construction	5.9367	A
4--Workers or other people in the area	5.8101	A
7--Uneven or bumpy pavement	5.3671	A B
6--Indication of slow-moving vehicles	4.8481	B
3--Any shift in road alignment	4.2152	C
8--Info about merging traffic into your lane or you merging into another lane	3.9747	C
5--Speed limit in the construction zone	3.5256	C
1--How far ahead the construction lies	2.0253	D

(Female)

Option	Mean	SNK Grouping
2--Type of construction	6.3803	A
4--Workers or other people in the area	5.7183	B
7--Uneven or bumpy pavement	5.5211	B C
6--Indication of slow-moving vehicles	4.9859	C D
3--Any shift in road alignment	4.4366	D
5--Speed limit in the construction zone	3.6197	E
8--Info about merging traffic into your lane or you merging into another lane	2.8873	F
1--How far ahead the construction lies	2.0857	G

Table 72. Road Construction Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	7	1986.152	283.736	78.37	0.0001
S*Option(Age)	1027	3718.098	3.620		

Table 73. Road Construction Information Question 1 SNK for the main effect of Option.

Option	Mean	SNK Grouping
2--Type of construction	6.1467	A
4--Workers or other people in the area	5.7667	A B
7--Uneven or bumpy pavement	5.4400	B
6--Indication of slow-moving vehicles	4.9133	C
3--Any shift in road alignment	4.3200	D
5--Speed limit in the construction zone	3.5705	E
8--Info about merging traffic into your lane or you merging into another lane	3.4600	E
1--Haw far ahead the construction lies	2.0537	F

Table 74. Re-route Option Information Question 1 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	18	219.074	12.171	2.62	0.0002
S*Option(Age)	1323	6150.009	4.65		

Table 75. Re-route Option Information Question 1 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
10--State/regions that the route will travel through	8.4444	A
9--Attractions and landmarks along route	7.7222	A B
7--Fewest turns	7.2963	B C
8--Scenery	6.6852	C D
6--Particular road type	6.0370	D E
5--Most inexpensive route	5.6296	E F
1--Convenience	4.9444	F
3--Shortest route (distance)	3.0370	G
2--Least amount of traffic	3.0000	G
4--Fastest route (time)	2.0185	H

(Age 35-45)

Option	Mean	SNK Grouping
10--State/regions that the route will travel through	8.2766	A
9--Attractions and landmarks along route	7.3404	B
7--Fewest turns	6.5319	B C
8--Scenery	6.5106	B C
5--Most inexpensive route	6.4255	B C
6--Particular road type	5.9574	C
1--Convenience	5.0426	D
3--Shortest route (distance)	3.1277	E
2--Least amount of traffic	2.7447	E
4--Fastest route (time)	2.6383	E

(Age 65 and over)

Option	Mean	SNK Grouping
10--State/regions that the route will travel through	7.7551	A
9--Attractions and landmarks along route	7.0408	A B
7--Fewest turns	6.5510	B
5--Most inexpensive route	6.3469	B
8--Scenery	5.9592	B
6--Particular road type	5.9184	B
1--Convenience	4.6122	C
4--Fastest route (time)	4.2245	C
2--Least amount of traffic	3.0204	D
3--Shortest route (distance)	2.8367	D

Table 76. Re-route Option Information Question 1 ANOVA table for the Gender × Option interaction.

Source	DF	SS	MS	F	Pvalue
Gender*Option	9	99.084	11.009	2.36	0.0129
S*Option(Gender)	1332	6269.999	4.707		

Table 77. Re-route Option Information Question 1 SNK results for the Gender × Option interaction. (Male)

Option	Mean	SNK Grouping
10--State/regions that the route will travel through	8.4937	A
9--Attractions and landmarks along route	7.6582	B
7--Fewest turns	6.7975	C
8--Scenery	6.5823	C D
5--Most inexpensive route	6.0886	C D
6--Particular road type	5.8608	D
1--Convenience	5.0380	E
2--Least amount of traffic	2.9494	F
3--Shortest route (distance)	2.7215	F
4--Fastest route (time)	2.4304	F

(Female)

Option	Mean	SNK Grouping
10--State/regions that the route will travel through	7.8028	A
9--Attractions and landmarks along route	7.0704	A B
7--Fewest turns	6.8310	B
8--Scenery	6.1831	B
5--Most inexpensive route	6.1408	B
6--Particular road type	6.0986	B
1--Convenience	4.6761	C
4--Fastest route (time)	3.4930	D
3--Shortest route (distance)	3.3099	D
2--Least amount of traffic	2.9014	D

Table 78. Re-route Option Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	9	5041.617	560.180	120.51	0.0001
S*Option(Age)	1323	6150.008	4.648		

Table 79. Re-route Option Information Question 1 SNK for the main effect of Option.

Option	Mean	SNK Grouping
10--State/regions that the route will travel through	8.1667	A
9--Attractions and landmarks along route	7.3800	B
7--Fewest turns	6.8133	C
8--Scenery	6.3933	C D
5--Most inexpensive route	6.1133	D
6--Particular road type	5.9733	D
1--Convenience	4.8667	E
3--Shortest route (distance)	3.0000	F
4--Fastest route (time)	2.9333	F
2--Least amount of traffic	2.9267	F

Table 80. Re-route Option Information Question 2 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	16	343.599	21.475	4.79	0.0001
S*Option(Age)	1175	5268.902	4.484		

Table 81. Re-route Option Information Question 2 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
6--Railroad crossings	7.2407	A
9--The number of turns	7.0556	A
1--Type of roadway	6.2963	A
2--Complex intersections	4.9074	B
5--High crime regions/localities	4.6481	B C
4 -Toll ways	4.5926	B C
8--Poor road quality	4.4630	B C
3--Number of traffic lights/stop signs	3.6111	C
7--Congestion/traffic	2.1852	D

(Age 35-45)

Option	Mean	SNK Grouping
6--Railroad crossings	7.4783	A
9--The number of turns	6.4894	B
4 -Toll ways	6.4894	B
1--Type of roadway	6.2766	B
2--Complex intersections	4.5745	C
3--Number of traffic lights/stop signs	4.4468	C
8--Poor road quality	3.8723	C D
5--High crime regions/localities	3.1064	D
7--Congestion/traffic	2.0426	E

(Age 65 and Over)

Option	Mean	SNK Grouping
6--Railroad crossings	7.0000	A
9--The number of turns	6.8367	A
4 -Toll ways	5.7959	B
1--Type of roadway	5.0204	B C
3--Number of traffic lights/stop signs	4.7755	B C D
2--Complex intersections	4.4490	C D E
8--Poor road quality	3.8163	D E
5--High crime regions/localities	3.7551	D E
7--Congestion/traffic	3.5306	E

Table 82. Re-route Option Information Question 2 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	8	2699.135	337.392	75.24	0.0001
S*Option(Age)	1175	5268.902	4.484		

Table 83. Re-route Option Information Question 2 SNK for the main effect of Option.

Option	Mean	SNK Grouping
6--Railroad crossings	7.2349	A
9--The number of turns	6.8067	A
1--Type of roadway	5.8733	B
4--Toll ways	5.5800	B
2--Complex intersections	4.6533	C
3--Number of traffic lights/stop signs	4.2533	C D
8--Poor road quality	4.0667	D
5--High crime regions/localities	3.8733	D

Table 84. Stopped Vehicle Ahead Information Question 2 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	8	37.498	4.687	3.82	0.0002
S*Option(Age)	588	720.881	1.226		

Table 85. Stopped Vehicle Ahead Information Question 2 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
5--Utility vehicle	4.0370	A
4--Delivery vehicle	3.9630	A
2--Public transit vehicle	3.1852	B
1--School bus	2.2963	C
3--Emergency vehicle	1.5185	D

(Age 35-45)

Option	Mean	SNK Grouping
4--Delivery vehicle	4.0000	A
5--Utility vehicle	3.3830	B
2--Public transit vehicle	3.3617	B
1--School bus	2.5957	C
3--Emergency vehicle	1.5745	D

(Age 65 and Over)

Option	Mean	SNK Grouping
4--Delivery vehicle	4.3878	A
5--Utility vehicle	3.7347	B
2--Public transit vehicle	3.2245	C
3--Emergency vehicle	1.8367	D
1--School bus	1.7551	D

Table 86. Stopped Vehicle Ahead Information Question 2 ANOVA table for the Environment × Option interaction.

Source	DF	SS	MS	F	Pvalue
Env*Option	4	23.828	5.957	4.80	0.0008
S*Option(Env)	592	734.551	1.241		

Table 87. Stopped Vehicle Ahead Information Question 2 SNK results for the Environment × Option interaction. (Rural)

Option	Mean	SNK Grouping
4--Delivery vehicle	4.4203	A
5--Utility vehicle	3.7101	B
2--Public transit vehicle	3.2609	C
1--School bus	1.9130	D
3--Emergency vehicle	1.6812	D

(Urban)

Option	Mean	SNK Grouping
4--Delivery vehicle	3.8519	A
5--Utility vehicle	3.7531	A
2--Public transit vehicle	3.2469	B
1--School bus	2.4691	C
3--Emergency vehicle	1.6049	D

Table 88. Stopped Vehicle Ahead Information Question 2 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	4	640.718	160.179	130.65	0.0001
S*Option(Age)	588	720.881	1.226		

Table 89. Stopped Vehicle Ahead Information Question 2 SNK results for the main effect of Option.

Options	Mean	SNK Grouping
4--Delivery vehicle	4.1133	A
5--Utility vehicle	3.7333	B
2--Public transit vehicle	3.2533	C
1--School bus	2.2133	D
3--Emergency vehicle	1.6400	E

Table 90. Congestion Ahead Information Question 1 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	6	17.954	2.992	2.59	0.0178
S*Option(Age)	438	505.979	1.155		

Table 91. Congestion Ahead Information Question 1 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
3--The cause of the congestion	3.3019	A
2--Average traveling speed of congestion	2.4340	B
4--The duration of the delay due to congestion	2.3019	B
1--Distance/time to congested area	1.9245	B

(Age 35-45)

Option	Mean	SNK Grouping
3--The cause of the congestion	3.3830	A
2--Average traveling speed of congestion	2.7234	B
1--Distance/time to congested area	1.9362	C
4--The duration of the delay due to congestion	1.8723	C

(Age 65 and Over)

Option	Mean	SNK Grouping
3--The cause of the congestion	3.1429	A
2--Average traveling speed of congestion	2.9184	A
4--The duration of the delay due to congestion	2.449	B
1--Distance/time to congested area	1.5306	C

Table 92. Congestion Ahead Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	3	187.328	62.443	54.05	0.0001
S*Option(Age)	438	505.979	1.155		

Table 93. Congestion Ahead Information Question 1 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
3--The cause of the congestion	3.2752	A
2--Average traveling speed of congestion	2.6846	B
4--The duration of the delay due to congestion	2.1477	C
1--Distance/time to congested area	1.7987	D

Table 94. Approach of Emergency Vehicle Information Question 1 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	8	53.772	6.721	3.55	0.0005
S*Option(Age)	588	1113.321	1.893		

Table 95. Approach of Emergency Vehicle Information Question 1 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
1--The destination of the emergency vehicle relative to you	3.4444	A
3--Speed of the approaching emergency vehicle	3.3333	A
4--Type of emergency vehicle	3.2593	A
5--The number of emergency vehicles approaching	3.2222	A
2--Relative location of the approaching emergency vehicle	1.7407	B

(Age 35-45)

Option	Mean	SNK Grouping
4--Type of emergency vehicle	3.7660	A
3--Speed of the approaching emergency vehicle	3.3404	A B
1--The destination of the emergency vehicle relative to you	3.1915	A B
5--The number of emergency vehicles approaching	3.0426	B
2--Relative location of the approaching emergency vehicle	1.5532	C

(Age 65 and Over)

Option	Mean	SNK Grouping
1--The destination of the emergency vehicle relative to you	3.7755	A
3--Speed of the approaching emergency vehicle	3.3061	A B
5--The number of emergency vehicles approaching	2.9796	B
4--Type of emergency vehicle	2.6531	B C
2--Relative location of the approaching emergency vehicle	2.2857	C

Table 96. Approach of Emergency Vehicle Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	4	251.988	62.997	33.27	0.0001
S*Option(Age)	588	1113.321	1.893		

Table 97. Approach of Emergency Vehicle Information Question 1 SNK results for main effect of Option.

Option	Mean	SNK Grouping
1--The destination of the emergency vehicle relative to you	3.4733	A
3--Speed of the approaching emergency vehicle	3.3267	A
4--Type of emergency vehicle	3.2200	A
5--The number of emergency vehicles approaching	3.0867	A
2--Relative location of the approaching emergency vehicle	1.8600	B

Table 98. Approach of Emergency Vehicle Information Question 6 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	12	91.196	7.599	1.77	0.0484
S*Option(Age)	870	3730.141	4.288		

Table 99. Approach of Emergency Vehicle Information Question 6 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
7--Tenths of mile, seconds, and blocks away	4.8679	A
5--Both tenths of mile and blocks away	4.3019	A B
6--Both seconds and blocks away	4.1698	A B
1--Tenths of a mile away	3.8704	A B
2--Seconds away	3.6792	B
3--City blocks away	3.5849	B
4--Both tenths of a mile and seconds away	3.3585	B

(Age 35-45)

Option	Mean	SNK Grouping
7--Tenths of mile,seconds,and blocks away	4.6170	A
3--City blocks away	4.1915	A
5--Both tenths of mile and blocks away	4.1277	A
6--Both seconds and blocks away	3.8723	A
2--Seconds away	3.7660	A
4--Both tenths of a mile and seconds away	3.6596	A
1--Tenths of a mile away	3.6170	A

(Age 65 and Over)

Option	Mean	SNK Grouping
2--Seconds away	4.6250	A
6--Both seconds and blocks away	4.1667	A B
1--Tenths of a mile away	4.0625	A B
7--Tenths of mile,seconds,and blocks away	4.0417	A B
3--City blocks away	4.0208	A B
4--Both tenths of a mile and seconds away	3.7292	A B
5--Both tenths of mile and blocks away	3.3061	B

Table 100. Approach of Emergency Vehicle Information Question 6 ANOVA table for the Gender × Option interaction.

Source	DF	SS	MS	F	Pvalue
Gender*Option	6	60.849	10.142	2.36	0.0286
S*Option(Gender)	876	3760.488	4.293		

Table 101. Approach of Emergency Vehicle Information Question 6 SNK results for the Gender × Option interaction. (Male)

Option	Mean	SNK Grouping
7--Tenths of mile,seconds,and blocks away	4.6883	A
6--Both seconds and blocks away	4.3636	A B
3--City blocks away	4.1429	A B C
5--Both tenths of mile and blocks away	4.0000	A B C
2--Seconds away	3.8182	A B C
1--Tenths of a mile away	3.5897	B C
4--Both tenths of a mile and seconds away	3.2468	C

(Female)

Option	Mean	SNK Grouping
7--Tenths of mile,seconds,and blocks away	4.3380	A
2--Seconds away	4.2254	A
1--Tenths of a mile away	4.1408	A
4--Both tenths of a mile and seconds away	3.9296	A
5--Both tenths of mile and blocks away	3.8310	A
6--Both seconds and blocks away	3.7606	A
3--City blocks away	3.6761	A

Table 102. Approach of Emergency Vehicle Information Question 6 ANOVA table for the Environment × Option interaction.

Source	DF	SS	MS	F	Pvalue
Env*Option	6	111.381	4.38	1.034	0.0002
S*Option(Env)	876	3709.957	4.235		

Table 103. Approach of Emergency Vehicle Information Question 6 SNK results for the Environment × Option interaction. (Rural)

Option	Mean	SNK Grouping
3--City blocks away	4.5652	A
2--Seconds away	4.1739	A B
6--Both seconds and blocks away	4.1534	A B
7--Tenths of mile, seconds, and blocks away	4.0290	A B
1--Tenths of a mile away	3.9855	A B
5--Both tenths of mile and blocks away	3.7681	A B
4--Both tenths of a mile and seconds away	3.2174	B

(Urban)

Option	Mean	SNK Grouping
7--Tenths of mile, seconds, and blocks away	4.9494	A
5--Both tenths of mile and blocks away	4.0500	B
6--Both seconds and blocks away	4.0000	B
4--Both tenths of a mile and seconds away	3.8861	B
2--Seconds away	3.8734	B
1--Tenths of a mile away	3.7375	B
3--City blocks away	3.3544	B

Table 104. Approach of Emergency Vehicle Information Question 6 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	6	68.662	11.444	2.67	0.0143
S*Option(Age)	870	3730.141	4.288		

Table 105. Approach of Emergency Vehicle Information Question 6 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
7--Tenths of mile, seconds, and blocks away	4.5203	A
6--Both seconds and blocks away	4.0743	A B
2--Seconds away	4.0135	A B
5--Both tenths of mile and blocks away	3.9195	A B
3--City blocks away	3.9189	A B
1--Tenths of a mile away	3.8523	A B
4--Both tenths of a mile and seconds away	3.5743	B

Table 106. Road Surface Condition Question 3 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	152.663	76.332	161.6	0.0001
S*Option(Age)	292	137.927	0.472		

Table 107. Road Surface Condition Question 3 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
2--Textual	2.59732	A
1--Iconic	2.18667	B
3--Combined Iconic/Textual	1.20134	C

Table 108. Type of Roadway Information Question 1 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	12	147.106	12.259	4.39	0.0001
S*Option(Age)	882	2463.631	2.793		

Table 109. Type of Roadway Information Question 1 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
5--Number of intersections along road or interstate	5.1585	A
7--Whether a road or interstate is a toll way	4.9630	A B
3--The surface conditions of road or interstate	4.5926	B C
6--Whether there is construction on a particular road or interstate	4.0556	C D
4--A road or interstate's typical/ historical traffic flow	3.7407	D
2--Speed limits of roads/ interstates	2.5741	E
1--Type of road	2.4259	E

(Age 35-45)

Option	Mean	SNK Grouping
5--Number of intersections along road or interstate	5.6809	A
7--Whether a road or interstate is a toll way	5.2128	A
4--A road or interstate's typical/ historical traffic flow	4.3617	B
3--The surface conditions of road or interstate	3.7234	B C
6--Whether there is construction on a particular road or interstate	3.5319	B C
2--Speed limits of roads/ interstates	3.4043	C
1--Type of road	1.8936	D

(Age 65 and Over)

Option	Mean	SNK Grouping
7--Whether a road or interstate is a toll way	5.3878	A
5--Number of intersections along road or interstate	5.3469	A
4--A road or interstate's typical/ historical traffic flow	4.8367	A
2--Speed limits of roads/ interstates	3.7755	B
6--Whether there is construction on a particular road or interstate	3.4898	B
3--The surface conditions of road or interstate	3.3265	B
1--Type of road	1.6735	C

Table 110. Type of Roadway Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	6	1267.717	211.286	75.64	0.0001
S*Option(Age)	882	2463.631	2.793		

Table 111. Type of Roadway Information Question 1 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
5--Number of intersections along road or interstate	5.5133	A
7--Whether a road or interstate is a toll way	5.1800	A
4--A road or interstate's typical/ historical traffic flow	4.2933	B
3--The surface conditions of road or interstate	3.9067	C
6--Whether there is construction on a particular road or interstate	3.7067	C
2--Speed limits of roads/ interstates	3.2267	D
1--Type of road	2.0133	E

Table 112. Type of Roadway Information Question 2 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	12	141.941	11.828	4.00	0.0001
S*Option(Age)	876	2588.696	2.955		

Table 113. Type of Roadway Information Question 2 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
7--Whether a road/interstate is a toll way	5.5741	A
5--Number of intersections along a road or interstate	5.1296	A
3--The surface conditions of road or interstate	4.4259	B
6--Whether there is construction on a particular road or interstate	4.0000	B
4--A road or interstate's typical/ historical traffic flow	3.7037	B
1--Type of road	2.8333	C
2--Speed limits of roads/ interstates	2.2407	C

(Age 35-45)

Option	Mean	SNK Grouping
7--Whether a road/interstate is a toll way	5.6739	A
5--Number of intersections along a road or interstate	5.4565	A
4--A road or interstate's typical/ historical traffic flow	4.3478	B
6--Whether there is construction on a particular road or interstate	3.7174	B
3--The surface conditions of road or interstate	3.6739	B
2--Speed limits of roads/ interstates	2.7391	C
1--Type of road	2.2391	C

(Age 65 and Over)

Option	Mean	SNK Grouping
7--Whether a road/interstate is a toll way	5.4082	A
5--Number of intersections along a road or interstate	5.1224	A
4--A road or interstate's typical/ historical traffic flow	4.8980	A
2--Speed limits of roads/ interstates	3.5510	B
6--Whether there is construction on a particular road or interstate	3.5102	B
3--The surface conditions of road or interstate	3.3673	B
1--Type of road	2.0204	C

Table 114. Type of Roadway Information Question 2 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	6	1208.435	201.406	68.15	0.0001
S*Option(Age)	876	2588.696	2.955		

Table 115. Type of Roadway Information Question 2 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
7--Whether road or interstate is a toll way	5.5503	A
5--Number of intersections along road or interstate	5.2282	A
4--Road or interstate's typical / historical traffic flow	4.2953	B
3--Surface conditions of road / interstate	3.8456	C
6--Whether there is construction on a particular road/ interstate	3.7517	C
2--Speed limits of roads/ interstates	2.8255	D
1--Type of road	2.3826	E

Table 116. Type of Roadway Information Question 3 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	12	126.796	10.566	3.51	0.0001
S*Option(Age)	876	2639.131	3.013		

Table 117. Type of Roadway Information Question 3 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
7--Whether a road/interstate is a toll way	5.3704	A
5--Number of intersections along a road or interstate	5.2778	A
3--The surface conditions of road or interstate	4.5000	B
6--Whether there is construction on a particular road or interstate	4.0556	B C
4--A road of interstate's typical/ historical traffic flow	3.5000	C
2--Speed limits of roads/ interstates	2.6296	D
1--Type of road	2.5370	D

(Age 35-45)

Option	Mean	SNK Grouping
7--Whether a road/interstate is a toll way	5.8298	A
5--Number of intersections along a road or interstate	5.2979	A
4--A road of interstate's typical/ historical traffic flow	4.1064	B
6--Whether there is construction on a particular road or interstate	3.8936	B
3--The surface conditions of road or interstate	3.5532	B C
2--Speed limits of roads/ interstates	3.0426	C
1--Type of road	2.1277	D

(65 and Over)

Option	Mean	SNK Grouping
7--Whether a road/interstate is a toll way	5.6042	A
5--Number of intersections along a road or interstate	5.0208	A B
4--A road of interstate's typical/ historical traffic flow	4.6042	B
2--Speed limits of roads/ interstates	3.7917	C
3--The surface conditions of road or interstate	3.5000	C
6--Whether there is construction on a particular road/interstate	3.3125	C
1--Type of road	2.1667	D

Table 118. Type of Roadway Information Question 3 ANOVA table for the Environment × Option interaction.

Source	DF	SS	MS	F	Pvalue
Env*Option	6	44.629	7.438	2.41	0.0257
S*Option(Env)	882	2721.298	3.085		

Table 119. Type of Roadway Information Question 3 SNK results for the Environment × Option interaction. (Rural)

Option	Mean	SNK Grouping
5--Number of intersections along a road or interstate	5.5147	A
7--Whether a road/interstate is a toll way	5.3824	A
4--A road of interstate's typical/ historical traffic flow	4.1912	B
3--The surface conditions of road or interstate	3.8529	B C
6--Whether there is construction on a particular road/ interstate	3.3676	C
2--Speed limits of roads/ interstates	3.1912	C
1--Type of road	2.4706	D

(Urban)

Option	Mean	SNK Grouping
7--Whether a road/interstate is a toll way	5.7654	A
5--Number of intersections along a road or interstate	4.9383	B
6--Whether there is construction on a particular road or interstate	4.0988	C
4--A road of interstate's typical/ historical traffic flow	3.9259	C
3--The surface conditions of road or interstate	3.9012	C
2--Speed limits of roads/ interstates	3.0864	D
1--Type of road	2.1358	E

Table 120. Type of Roadway Information Question 3 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	6	1153.618	192.269	63.82	0.0001
S*Option(Age)	876	2639.131	3.013		

Table 121. Type of Roadway Information Question 3 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
7--Whether a road/interstate is a toll way	5.5906	A
5--Number of intersections along a road or interstate	5.2013	A
4--Road or interstate's typical/ historical traffic flow	4.0470	B
3--Surface conditions of roads and interstates	3.8792	B
6--Whether there is construction on a particular road/interstate	3.7651	B
2--Speed limits of road/interstate	3.1342	C
1--Type of road	2.2886	D

APPENDIX J: SURVEY OF IN-VEHICLE INFORMATION SYSTEMS (COMMERCIAL DRIVERS)

Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061-0536

Thank you for volunteering to participate in the following survey. Please fill out the information below. This will be used as a receipt for accounting purposes, so carefully fill in each item. This receipt will not remain with your survey answer sheet, in order to ensure your responses are kept anonymous. When you finish all of the sections, please return the survey to the _____. Thank you for participating in this research project. If you have any questions at all, please call the number listed on the receipt below.

DOCUMENTATION OF PARTICIPATION AND PAYMENT

In-Vehicle Information Systems Survey
Principle Investigator: Tom Dingus
Telephone: (540) 231-8831

Participant Information

Your Name:_____
Address:_____
City: _____ State: _ Zip Code: _____
Phone Number: ( )_____ – _____
Social Security Number: _____ – _____ – _____

Acknowledgment

I expect to receive a check in the amount of $20.00 for completing the attached survey to the best of my ability.

Signature of Participant: _____

INTRODUCTION

The purpose of this survey is to identify some of the issues involved in providing commercial vehicle operators with information that is not currently available to them in their vehicles. For example, detailed information on existing restaurants and lodging accommodations could be provided during a trip to aid drivers in choosing where to eat or stop for the night. Additional information (that will soon be available inside vehicles) will include navigational help to a destination, advanced warnings when there is traffic congestion ahead, and more specific information about existing roadway hazards and conditions. It is important to note, though, that providing drivers with in-vehicle information will not replace roadside signs and postings; rather, it will be an addition to that information.

The results of this information will be used to answer academic research questions involved with designing safer and more usable in-vehicle information systems. This is not market research.

This survey is separated into sections. The first section asks about your driving background. This information helps us identify trends in information preferences. (For example, drivers in Washington may want different information than drivers in Virginia or North Carolina. Younger drivers may desire different information than older drivers.) Following the background section, there are a number of specific sections that ask questions about distinct pieces of information that will be provided in-vehicle in the near future.

There are several types of questions asked in the survey. These include multiple choice questions where you will select the most appropriate option(s); and preference questions where you will be asked to select one option from among several choices, or to rank a series of options based on your preferences for the options. Directions are provided for each question.

If you have any questions while you are completing the survey, feel free to contact Dr. Tom Dingus at (540) 231-8831 or ask the research assistant who handed out the survey.

All of your responses will be kept anonymous. There is no right answer to a given question; different people will want different pieces of information presented to them in-vehicle. This survey is meant to serve as a starting point for incorporating driver information into vehicles; your participation is important because it will help us to determine what types of information will best be presented in-vehicle, and the best way to display it.

BACKGROUND INFORMATION

1) What is your birth date? _____/_____/_____
Month / Date / Year

2) Are you:

- ❑ Male
- ❑ Female

3) Are you a commercial vehicle driver? (Check only one)

- ❑ Yes
- ❑ No (Please stop and contact the person handing out the survey.)

4) If you answered yes to the above question (question #3), are you a local driver or an "over-the-road" driver? (Check only one)

- ❑ Local
- ❑ Over-the-road

5) What level of commercial driver's license (CDL) do you currently maintain?

- ❑ Class A
- ❑ Class B
- ❑ Class C

6) How many work-related miles do you drive per year? (Check only one)

- ❑ Under 20,000
- ❑ 20,000 - 49,999
- ❑ 50,000 - 99,000
- ❑ 100,000 - 149,999
- ❑ 150,000 or more

7) In which environment do you <u>most</u> <u>typically</u> drive while working? (Check only one)

- ❑ Rural area
- ❑ Small town (Less than 50,000)
- ❑ Suburban
- ❑ City
- ❑ Highway/freeway/interstate

8) What type of commercial vehicle do you drive most often?

Make: _____
Model:
Year: _____

Motorist Service Information

Motorist service information includes nearest truck stop, nearest rest area, and diesel fuel information. Drivers currently get most of their motorist service information from commercial billboards and signs along roadsides and highways.

1. An in-vehicle display may present motorist service information to drivers several ways. One method would be to automatically present the information in a timely fashion before the exit or turn necessary to get to the advertised truck stop. This is currently what you see as you drive on highways, where billboards and signs are posted just before the exits, or several miles before the exit. Another method of in-vehicle presentation is for drivers to request information about a service. Then, and only then, will this information be presented. Please tell us your preference for receiving information about motorist services such as truck stop, rest area, and fuel information.

- ❑ I would like to receive this information automatically as I approach each motorist service along a route.
- ❑ I would like to receive this information only when I request it.
- ❑ I would like the option of receiving this information automatically or when I request it.

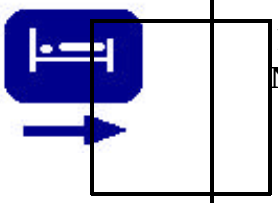
2. Imagine that you are driving along a highway and want to stop to get something to eat. Please rank the following pieces of information (from 1 to 4) based on how important each is to your selection of a truck stop. A ‘1' indicates the most important factor, and a ‘4' indicates the least important factor when searching for a restaurant.

_____ Truck stop/Restaurant name (e.g., McDonald’s)
_____ Type of food served
_____ Price
_____ Location (e.g., 25 miles away)

3. Imagine that you are driving along a highway and are in need of fuel. Please rank the following pieces of information (from 1 to 7) based on how important each is to your selection of a fuel stop to re-fuel. A ‘1' indicates the most important factor, and a ‘7' indicates the least important factor when searching for a fuel stop.

_____ Service name (e.g., Amoco, Shell)
_____ Cost of fuel
_____ Restrooms
_____ Hours of operation
_____ Location (e.g., 25 miles away)
_____ Other services (e.g., snacks, drinks, convenience items, ATM machine, etc.
_____ Payment methods (e.g., MasterCard, Visa)

4. Now imagine that you are traveling on an interstate and want to stop for the night. Listed below are several possible display types for showing an upcoming rest area. Please remember that these displays will be presented to you in your vehicle. Please rank (from 1 to 3) the displays in order of your preference, where a ‘1' indicates the most preferred display, a ‘2' indicates the 2nd most preferred display, and a ‘3' indicates the least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

			
What is your preference for each display?			

Time/Distance to Destination Information

Time/distance to destination information includes more general navigational information and will entail the driver programming an in-vehicle system so that the system "knows" where the driver is going. Throughout the survey there will be references made to this aspect of in-vehicle systems in which it will be referred to generally as *"pre-planned routes."* A pre-planned route consists of the driver entering a beginning point and an end destination into the in-vehicle system, and the system then guiding the driver to the destination through a series of directions.

The advantage of these pre-planned route systems is that they will be capable of providing the driver with specific information pertaining to the distance and time involved with their chosen path of travel. Such systems will be useful to drivers at the beginning of their trip, as they will provide the driver with exact information as to how long the trip will take and the distance to their destination. So too will these systems be useful to drivers during the course of their trip, as they will allow the driver to know how much time remains until they reach their destination, and how far away their destination lies.

1. *Distance/time to destination information* can be presented in a variety of fashions. For example, it can be presented after a specified time (e.g., every 30 minutes) or after a specified distance (e.g., every 50 miles). The information can also be presented constantly, in which the driver may look at the display at any time to receive information about the distance/time to the destination. Another alternative would be to display the information only when the driver requests it, such as by pressing a button (on the steering wheel, for example). Please rank (from 1 to 3) these options based upon your preference for displaying this information, where a '1' indicates the most preferred mode of display, a '2' indicates the 2nd most preferred mode of display, and a '3' indicates the least preferred mode of display.

_____ Information is displayed every × amount of miles or minutes.
_____ Information is displayed all the time.
_____ Information is displayed only when requested.

2. Imagine that you are on a 300 mile trip, and you expect to be driving about 5 hours. As you approach your destination, you may receive information on how much time remains of your trip or on how many miles you have remaining yet to travel. Suppose that you have driven about half-way to your destination, and you would like to know how much farther you have to go. Which display do you prefer? (Please check **one**):

- ❑ A display showing the distance to the destination (e.g., 150 miles remaining).
- ❑ A display showing the time to the destination (e.g., 2 hours 30 minutes remaining).
- ❑ A display with both the time and distance to the destination.

3. Imagine that you are using a pre-planned route system that updates your distance or time to destination automatically. Given a long trip, how would you like the information to be updated? (Please check **one**)**:**

- ❑ Updated information based on × amount of miles or minutes (e.g., every 100 miles or 60 minutes).
- ❑ Updated information based on a percentage of your total trip distance or travel time (e.g., you will receive updated information when your trip is 25%, 50%, and 75% complete, by time or distance).

4. Now imagine that you are on a shorter trip, about 25 miles in the city, which should take you about 45 minutes. You have driven about half way to your destination, and you would like to know how much farther you have to go. What information would you most prefer to receive? (Please check **one**):

- ❑ Distance to destination (e.g., 12 miles remaining).
- ❑ Time to destination (e.g., 20 minutes remaining).
- ❑ Both distance and time to destination.

5. Given a short trip with automatically updated information, which type of information would you most prefer to receive? (Please check **one**):

- ❑ Updated information based on × amount of miles or minutes (e.g., every 5 miles or 10 minutes).
- ❑ Updated information based on a percentage of your total trip distance or travel time (e.g., you will receive updated information when your trip is 25%, 50%, and 75% complete, by time or distance).
- ❑ Updated information based on both × amount of miles or minutes AND on a percentage of your total trip distance or travel time.

Time/Distance to Next Turn and Lane Suggestion Information

An in-vehicle system will be capable of giving a driver turn-by-turn directions to their destination, based on a route that the driver has entered into the in-vehicle system before the start of the trip. *Time/distance to next turn information* will tell the driver how far away the next turn is or how much time the driver has before they need to turn. Furthermore, the system will be able to suggest a lane to be in for the upcoming turn. This information may be helpful to drivers when they find themselves in unfamiliar areas, or at complicated intersections. We want to know how to best present this information to drivers in their vehicles.

1. Different drivers want different amounts of information about when to turn next. For example, some drivers may only want to be told about an upcoming turn just before they encounter the intersection. Others may want some kind of forewarning to prepare them for the turn and to help reduce anxiety about where to turn. Imagine that you are driving and there is a turn coming up. Examine the 3 options below and rank them based on how you would like to be told about an upcoming turn. A '1' indicates your most preferred, a '2' indicates your 2nd most preferred, and a '3' indicates your least preferred option.

_____I only want to receive one message about how far away my turn is – just before the intersection where I will be turning (e.g., "Turn, next right").

_____I want to receive two messages – one message as I approach my turn, and another message when I get close to my turn (e.g., "Turn right, ½ mile", then closer to the intersection: "Turn, next right").

_____I want to receive three messages as I approach my turn. I want one message that reminds me to prepare for my turn far in advance of the turn (e.g., "Turn right, 2 miles"); I also want to receive a second message as I approach my turn (e.g., "Turn right, ½ mile"); and finally I want to receive a message when I get closer to the intersection (e.g., "Turn, next right").

2. Now imagine that you have programmed a route to your destination into your in-vehicle navigation system. You are driving in a city, and you are using the navigation system to tell you where to turn next. Which type of information would you most prefer to receive about how far ahead an upcoming turn is? Please check **one**. (Please remember that this information is about your next turn, not how far away your final destination is).

- ❑ Distance to the turn.
- ❑ Time to the turn.
- ❑ Both distance and time to the turn.

3. For the following question, assume that this information will be presented to you in terms of distance away. Which type of information would you most prefer to receive about an upcoming turn? (Please check **one**):

- ❑ The number of city blocks away.
- ❑ How many tenths of a mile away.
- ❑ The number of intersections / turns away (e.g., "Take your 2nd right").

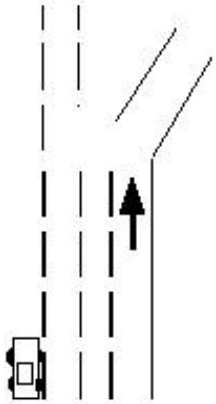
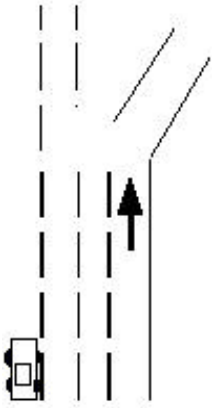
4. Now imagine that you are traveling on a highway, and you are using the navigation system to tell you what exit to take. Which type of information would you most prefer to receive about how far ahead an upcoming exit is on a highway? Please check **one**. (Please remember that this information is about your next exit, not how far away your final destination is).

- ❑ Distance to the exit.
- ❑ Time to the exit.
- ❑ Both distance and time to the exit.
- ❑ The number of exits that you will pass before coming to your exit.

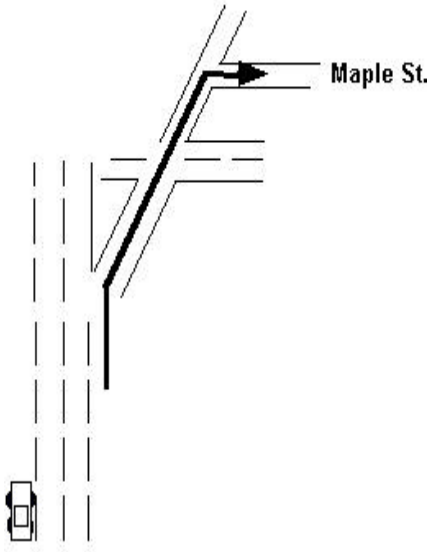
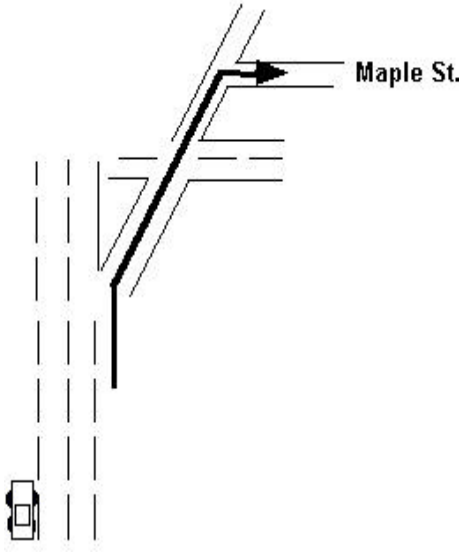
5. For the following question, please assume that this information will be presented to you in terms of distance. Which type of information would you most prefer to receive about your upcoming exit? (Please check **one**):

- ❑ Number of exits away.
- ❑ Number of miles away from upcoming exit.
- ❑ Both the number of exits and miles away from upcoming exit.

6. Imagine driving down a large interstate – 4 lanes per direction – and the speed limit is 65 mph. You are in the far left lane. Beside the road ahead of you is a sign for your exit, which is 2 miles away. You then check your in-vehicle display to determine which lane you need to be in. Please rank the following 3 displays in order of your preference. Assign a '1' to your most preferred display, a '2' to your 2nd most preferred display, and a '3' to your least preferred display. Consider the style of each display as well as the information conveyed by each display as you rank them.

		**Exit Right lane 2 miles**	 **Exit Right lane 2 miles**
What is your preference for this display?			

7. Now imagine that you have a more complicated set of turns off the highway. You are still driving down a large interstate – 4 lanes per direction – and the speed limit is 65 mph. You are still in the far left lane. Your exit is 2 miles away, but immediately after you exit the highway, you will have to go straight through the first intersection, and then take a sharp right at the second intersection, onto Maple Street. In other words, you have a series of directions to follow to exit the highway and find Maple street. Please rank the following 3 displays in order of your preference for instructions on how to get to Maple Street. Assign a '1' to the most preferred display, a '2' to the 2nd most preferred display, and a '3' to the least preferred display. Consider the style of each display as well as the information conveyed by each display as you rank them.

		**Exit right lane 2 miles.** **Continue straight through first intersection.** **Turn right on Maple St.**	 **Exit right lane 2 miles.** **Continue straight through first intersection.** **Turn right on Maple St.**
What is your preference for this display?			

Guide Sign Information

Guide sign information helps direct drivers to their destination. Guide sign information includes route markers – specifically shaped signs with the highway or route number displayed (e.g., Interstate I-75, 2 Miles), destination signs (e.g., Atlanta 100 miles), exit signs along freeways, and mile markers. Guide signs in cities also include motorist service signs (e.g., a blue sign with a white 'H' indicating a hospital is in the area).

1. Guide signs are currently seen posted along roads and highways, regardless of whether drivers "use" the information they display or not. The guide signs provided by an in-vehicle display however, may be displayed only when they are relevant to a driver's pre-planned route, or they may be displayed only when the driver requests the information. Which mode of display would you most prefer in displaying this information? (Please check **one**):

- ❑ Always display guide sign information.
- ❑ Display guide sign information only when it is relevant to my route.
- ❑ Only display guide sign information when I request it.

2. Below are 3 examples of possible guide sign displays. Please rank the following 3 guide signs in order of your preference. Assign a '1' to your most preferred display, a '2' to your 2nd most preferred display, and a '3' to your least preferred display. Consider the style of each display as well as the information conveyed by each display as you rank them.

		**I-74** **Next Right**	 **I-74** **Next Right**
What is your preference for this display?			

Road Construction Information

Many accidents occur in construction zones every year. *Road construction information* will allow in-vehicle systems to provide drivers with advanced notification of potentially hazardous areas, as well as provide more detailed information about construction areas. However, in order for in-vehicle information systems to be effective, they must be able to present information that drivers will both want and use. Below are several questions that seek to determine driver preferences to help designers develop effective in-vehicle systems.

1. To begin, it is essential to identify what pieces of information drivers want about road construction. Below are listed items of information related to road construction. Please rank these items (from 1 to 8) based on their importance to you in receiving information about road construction. A '1' indicates the most important item of information, and an '8' indicates the least important item of information pertaining to road construction. (Please be sure to rank all the options, and remember that we are asking about what information is important to you).

_____ How far ahead the construction lies.
_____ The type of construction.
_____ Any shift in road alignment (e.g., both lanes shift slightly to the right).
_____ Whether there are workers or other people in the vicinity.
_____ Speed limit in the construction zone.
_____ Indication that there are slow-moving vehicles (e.g., dump trucks) in the area.
_____ Uneven or bumpy pavement.
_____Information about merging traffic into your lane, or you merging into another lane.

2. Would you like to receive information about how far away the road construction is in terms of a distance away (10 miles ahead), a time away (8 minutes ahead), or both a distance and a time? (Please check **one**):

- ❑ I would like to receive information in terms of a distance away.
- ❑ I would like to receive information in terms of a time away.
- ❑ I would like to receive information in terms of both distance and time away.

3. Road construction signs currently provide drivers with information about distance to the construction area. Typically there are a series of signs posted, and as you drive closer to the construction, the distance on the signs also reduces. For example, the first sign that you encounter might read, "Road construction 2 miles ahead." Further down the road, you may encounter a sign that reads, "Road construction, 1500 ft," then "Road construction, 1000 ft," etc. In-vehicle information systems are capable of providing this information to drivers even earlier than currently posted signs. In general, do you want to receive information about upcoming road construction sooner than 2 miles before the area? (Please check **one**):

- ❑ I want to receive information about upcoming road construction more than 2 miles in advance.
- ❑ I do not want to receive information about upcoming road construction more than 2 miles in advance.

Re-route Option Information

Re-route options information may be useful when traveling long distances along main roads or highways by providing options to the driver when problems (such as traffic delays) arise along the current pre-planned route. For example, imagine that you are driving along an interstate, and have over 5 hours remaining of your trip. Soon traffic begins to build up ahead. An in-vehicle system can help you find an alternate route to your destination, thereby avoiding the traffic congestion ahead.

1. There are a number of ways that drivers may choose a new route to get them to their destination. Some may want to avoid toll roads, while others may want to travel along a route with as few turns as possible. We are interested in how drivers choose new routes. Below you will find a list of ways that drivers may choose routes. Please rank these options (from 1 to 10) based on their importance to you in choosing a new route. A '1' indicates the most important item of information, and a '10' indicates the least important item of information pertaining to choosing a new route. (Please be sure to rank all the options, and remember that we are asking about what information is important to <u>you</u> as a commercial driver).

_____ Convenience (e.g., multiple rest areas, restaurants, and gas stations available).
_____ Least amount of traffic/congestion.
_____ Shortest route (distance).
_____ Fastest route (time).
_____ Most inexpensive route (e.g., no toll booths).
_____ Particular road type (e.g., all back roads).
_____ Fewest turns.
_____ Weather condition along route.
_____ Road conditions along route.
_____ Appropriate truck clearance along route.

2. We are also interested in learning what kinds of routes drivers typically try to avoid when trying to get to a destination. Below you will find a list of problems that people typically try to avoid when choosing a route to follow. Please rank these options (from 1 to 9) based on their importance to you when avoiding a particular route. A '1' indicates the most important item to be avoided, and a '9' indicates the least important item to be avoided. (Please be sure to rank all the options, and remember that we are asking about what information is important to you as a commercial driver).

_____ Type of roadway (e.g., interstate, back roads, city)
_____ Complex intersections
_____ Number of traffic lights/stop signs
_____ Toll ways
_____ Poor clearance
_____ Number of rest areas
_____ Congestion/traffic
_____ Poor road quality (e.g., potholes, dips in the road)
_____ The number of turns

3. Imagine that you are driving on a freeway and a traffic accident has just occurred ahead. Traffic begins to back up. Would you like an in-vehicle system to automatically suggest an alternative route for you, or would you like to receive this information only when you request it? (Please check **one**):

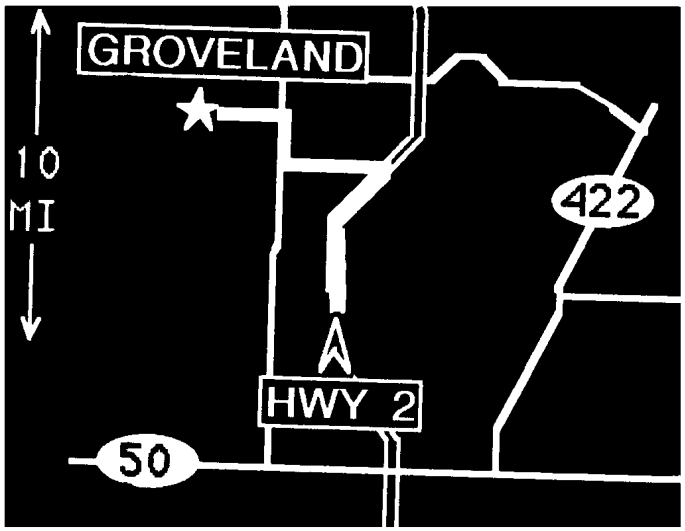
- ❑ I would like an in-vehicle system to automatically suggest an alternative route when I come across a traffic delay.
- ❑ I would like to receive this information only when I request it.

4. Imagine that you are about to go on a trip and have chosen a route to follow, but you would like to compare this route with another one recommended by the computer. There are several ways to compare the two routes, depending on the presentation of each route format. Three such formats include: a list of text instructions on how to get to the destination (e.g., "Go down Main Street. Turn left at Mayberry. Turn right at Walnut St."); a bird's-eye view of the route, similar to paper maps you see today; and a series of "turn-by-turn" directions presented graphically on the in-vehicle display. See examples of all 3 displays below:

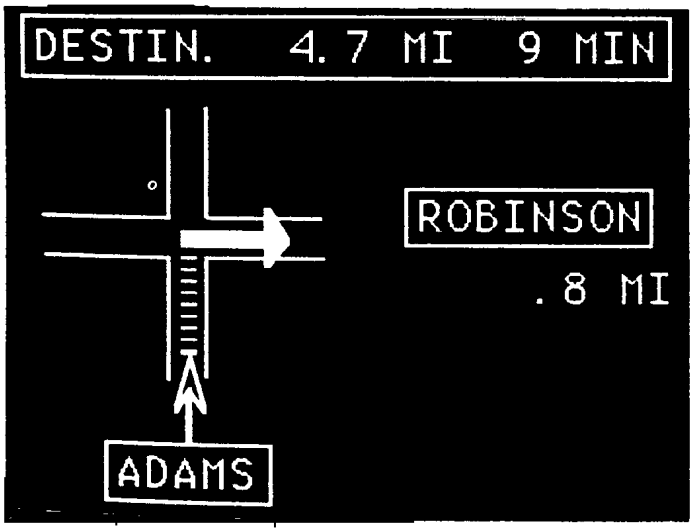
Directions to 1648 Pine Rd.:

1. Take Main Street 6 blocks to Walnut Street.
2. Turn right onto Walnut Street. Go 2 blocks to Hankey Avenue.
3. Turn left onto Hankey Avenue. Go 1 block to Pine Road.
4. Turn right onto Pine Road.
5. House is about 5 blocks up.

Example of a list of text directions.



Example of a full map route guidance display.



Example of <u>one</u> screen of a turn-by-turn route guidance display.

Drivers will be able to compare sets of text instructions with one another; or they may be able to compare birds' eye view maps; or they will be able to compare routes in the turn-by-turn format, where drivers can preview the drive by stepping through all of the turns in a trip.

Which display format do you prefer when comparing alternate routes? When ranking the displays, think about how you will compare the two routes: do you want to see the entire route, the turns involved in a route, or the number of steps involved in a drive? Please rank the 3 displays in order of your preference, where a '1' indicates your most preferred display, a '2' indicates your 2nd most preferred display, and a '3' indicates your least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

	Text list of directions	Full route map display	Turn-by-turn display
What is your preference for each display?			

Stopped Vehicle Ahead Information

In-vehicle systems will be able to tell drivers when there is a stopped vehicle ahead in their lane (such as a school bus or police car) well in advance of when the driver may be able to see the vehicle. Drivers may use this *stopped vehicle ahead information* to prepare to slow down well in advance of the stopped vehicle, or perhaps may even choose to take an alternate route if the delay is going to take a while.

1. Do you want to have this information presented to you in your vehicle? (Please check **one**):

- ❑ I do want this information presented to me in my vehicle.
- ❑ I do not want this information presented to me in my vehicle.

2. There are a number of different vehicles that stop in the road for short periods, such as taxis and buses picking up or dropping off passengers, or a police car blocking traffic in one lane. Please rank these items (from 1 to 5) based on how desirable it is to receive this information about each type of vehicle. A '1' indicates the most important vehicle that you would like to know has stopped, and a '5' indicates the least important vehicle that you would like to know has stopped. (Please be sure to rank all the options, and remember that we are asking about what information is important to you).

_____ School bus.
_____ Public transit vehicle, such as a city bus or a taxi.
_____ Emergency vehicle such as an ambulance or police car.
_____ Delivery vehicle such as a mail or UPS truck.
_____ Utility vehicle such as a telephone repair vehicle.

3. There are several possible ways to present stopped vehicle information to drivers. Below are 2 options for displaying a stopped ambulance ahead. Please rank the 2 displays in order of your preference, where a '1' indicates the most preferred display, and a '2' indicates the least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

	Ambulance Stopped Ahead	 **Stopped Ahead**
What is your preference for each display?		

4. It is possible that an in-vehicle system will be able to provide you with a recommended driver action to take as you approach a stopped vehicle ahead (e.g., “School bus ahead. Prepare to stop.”). Do you want to receive this information? (Please check **one**):

- ❑ I do want the system to suggest an action for me to take as I approach a stopped vehicle.
- ❑ I do not want the system to suggest an action for me to take as I approach a stopped vehicle.

Congestion Ahead Information

Congestion ahead information refers to a slowdown of traffic ahead of you in your direction of travel (a 'traffic jam'). The cause may be an accident, rush hour, road construction, or some other problem. Currently, drivers receive this information from traffic reports on the radio and CB radios. Immediately providing this information to drivers by in-vehicle systems may relieve congestion by encouraging drivers to take an alternate route, or it may make the congested area a safer place by encouraging slower driving around the congested area.

1. There is a lot of information that can be given to drivers about traffic congestion. We want to know which pieces of information drivers consider to be most important. Please rank these items (from 1 to 4) based on how important each piece of traffic congestion information is to you. A '1' indicates the most important item to know about traffic congestion, and a '4' indicates the least important item to know about traffic congestion. (Please be sure to rank all the items, and remember that we are asking about what information is important to <u>you</u> as a commercial driver).

Distance/time to congested area.
_____ Average traveling speed of congestion.
_____ The cause of the congestion.
_____ The duration of the delay due to congestion.

2. Different people have different opinions on what they consider to be a traffic jam. For some, any delay is a traffic jam, while for others, the backup must be over ½ mile to be considered a traffic jam. How far does traffic have to be backed up before you would consider taking an alternate route? Please **check** the most appropriate distance:

- ❑ Less than 1/4 mile.
- ❑ 1/4 to ½ mile.
- ❑ ½ to 3/4 mile.
- ❑ 3/4 to 1 mile.
- ❑ More than 1 mile.

3. How long does traffic have to be backed up before you would consider taking an alternate route? (Please check **one**):

- ❑ Less than 5 minutes.
- ❑ Between 5 and 10 minutes.
- ❑ Between 10 and 15 minutes.
- ❑ Between 15 and 20 minutes.
- ❑ Greater than 20 minutes.

4. Would you prefer to receive information about the distance to a traffic jam in terms of how far ahead it is (miles), how many minutes ahead it is, or in terms of both miles and minutes ahead? (Please check **one**):

- ❑ Minutes ahead (e.g., “traffic jam ahead 10 minutes....”).
- ❑ Miles ahead (e.g., “traffic jam ahead 5 miles....”).
- ❑ Both minutes and miles ahead.

5. Would you prefer to receive information about the duration of a traffic jam in terms of how many minutes it is delayed, how many miles it is delayed, or in terms of both minutes and miles delayed? (Please check **one**):

- ❑ Minutes delayed (e.g., “traffic is backed up about 10 minutes....”)
- ❑ Miles delayed (e.g., “traffic is backed up about 5 miles....”)
- ❑ Both minutes and miles delayed.

Approach of Emergency Vehicle Information

Approach of emergency vehicle information is currently conveyed to drivers by the siren and horn of an emergency vehicle (e.g., police car, ambulance, fire truck) as it nears your vehicle on the way to an emergency. Drivers typically use sound cues to determine the direction from which the emergency vehicle is coming, and the emergency vehicle's estimated speed. It is possible that this information, as well as more explicit information, may be displayed in-vehicle to the driver. It is important to note that this information is about the approach of the emergency vehicle; information about a stopped emergency vehicle in your lane was addressed earlier in the survey.

1. The approach of an emergency vehicle involves several pieces of information, such as the kind of vehicle (police car, ambulance, etc.), its direction of approach, and perhaps a recommended action for the driver (e.g., to pull over to the side of the road). We want to know which pieces of information drivers think are most important. Please rank these items (from 1 to 5) based on how important each piece of information about the approach of emergency vehicles is to you. A '1' indicates the most important item to know about the approaching emergency vehicle, and a '5' indicates the least important item to know about the approaching emergency vehicle. (Please be sure to rank all the items, and remember that we are asking about what information is important to you).

_____ The destination of the emergency vehicle relative to you (if it is driving to the scene of an accident).
_____ Relative location of the approaching emergency vehicle.
Speed of the approaching emergency vehicle.
Type of emergency vehicle (e.g., police, ambulance, fire truck).
The number of emergency vehicles approaching (e.g., sometimes both a fire truck and an ambulance will respond to the same emergency and travel along the same route, one vehicle after the other).

2. There are several ways that a driver can be told about the approach of an emergency vehicle such as an ambulance. Most likely the information will be conveyed through speakers in a car. Below are two descriptions of how the approach of an ambulance may be conveyed. Imagine that you are traveling on a two-lane street named Elm, heading south. Which auditory description do you prefer? Remember that this information will be presented to you through your speakers. Think about being in the driver's seat when you receive the information. (Please check **one**):

❑ "Ambulance approaching from rear in left lane."
❑ "Ambulance heading southbound on Elm street in left lane."

3. An in-vehicle system will also be able to provide you with information about what to do as the emergency vehicle approaches (e.g., 'Pull over to shoulder'). There are several situations a driver can be in when an emergency vehicle approaches. One situation might be where you are traveling in the right lane of a 2-lane road. In this circumstance, do you want an in-vehicle system to recommend a driver action in response to the approach of the emergency vehicle? (Please check **one**):

- ❑ I want an in-vehicle system to suggest a driver action in this situation.
- ❑ I do not want an in-vehicle system to suggest a driver action in this situation.

4. Sometimes you may find yourself in more complicated situations. For example, imagine that you are driving in city traffic in the far left lane of a road that has 3 lanes in your direction. A message about a recommended action may be useful here, since it is not clear what the proper response is (i.e., remain in the lane or try to pull over to the shoulder). In situations such as this one, do you want an in-vehicle system to recommend a driver action as an emergency vehicle approaches your vehicle? (Please check **one**):

- ❑ I want an in-vehicle system to suggest a driver action in these situations.
- ❑ I do not want an in-vehicle system to suggest a driver action in these situations.

5. When you receive a message about the approach of an emergency vehicle, do you want to know how far away it is (e.g., "Ambulance approaching½/2 mile"), or simply that it is approaching (e.g., "Ambulance approaching")? (Please check **one**):

- ❑ I want to know how far away the approaching emergency vehicle is to me when I receive the message.
- ❑ I do not want to know how far away the approaching emergency vehicle is to me when I receive the message.

6. Assume now that you will receive distance information. Please rank these items (from 1 to 7) based on how you would like to receive distance information about the approach of emergency vehicles. A '1' indicates your most preferred distance style, and a '7' indicates your least preferred distance style.

_____ Tenths of a mile away.
_____ Seconds away.
_____ City blocks away.
_____ Both tenths of a mile and seconds away.
_____ Both tenths of a mile and blocks away.
_____ Both seconds and blocks away.
_____ Tenths of a mile, seconds, and blocks away.

Road Surface Condition and Warning Information

Road surface condition and warning information is used to alert drivers to potentially hazardous conditions on streets and highways. This information informs drivers of hazardous areas or conditions and indicates that caution should be taken when approaching the area. A driver may also have to reduce their speed and/or perform some vehicle maneuver. Some common examples of warning information include a message that a driver is approaching a railroad crossing or a warning that there is a tight curve, or intersection, ahead. Other information may warn the driver of a narrow bridge or low clearance ahead, or that the right lane ends. Some warning information is also found in construction areas. Warning signs are currently posted by the side of the road near (and ahead of) the potentially hazardous area.

1. In-vehicle systems will be capable of presenting this warning information to drivers in one of three ways: as a distance ahead (such as 1/4 mile), as a time ahead (such as 20 seconds), or as a combination of both distance and time ahead. In which format do you prefer to receive this information? (Please check **one**):

- ❑ Distance ahead (e.g., 1/4 mile ahead).
- ❑ Time ahead (e.g., 20 seconds ahead).
- ❑ Both time and distance ahead.

2. In-vehicle systems will be "smart" enough to provide drivers with recommended actions to take to avoid hazardous areas, such as recommending an advised speed when approaching a curve (e.g., "Right curve ahead, reduce speed to 35 mph"). Would you like to receive information about recommended actions to take when approaching potentially hazardous areas? (Please check **one**):

- ❑ I would like an in-vehicle system to recommended an appropriate action when approaching potentially dangerous areas.
- ❑ I would not like an in-vehicle system to recommended an appropriate action when approaching potentially dangerous areas.

3. There are several possible ways to present warning information to drivers. Below are 3 options for displaying a hazardous road condition ahead. Please rank the 3 displays in order of your preference, where a ‘1' indicates the most preferred display, a ‘2' indicates the 2nd most preferred display, and a ‘3' indicates the least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

		**Slippery When Wet**	 **Slippery When Wet**
What is your preference for this display?			

Regulatory Information

Regulatory information informs drivers about traffic regulations and laws. This information includes speed limits, stop signs, 'do not enter' information, information about where drivers can and cannot park (e.g., 'emergency parking only'), and information about traffic flow (such as turn-only lanes). This information is currently conveyed by signs posted along the roadway. Examples of current signs and their information include: speed limit, stop and yield information, and 'do not pass,' 'keep right,' 'left turn only,' and 'do not enter' signs.

1. Below are 2 options for displaying regulatory information. Please rank the 2 displays in order of your preference, where a '1' indicates the most preferred display, and a '2' indicates the least preferred display. Consider the style of each display, as well as the information conveyed by each display, as you rank them.

	DO NOT ENTER	
What is your preference for this display?		

2. Everyone can think of a time where they were driving on a road on which they did not know the speed limit. In-vehicle systems would be capable of providing speed limit information to drivers at any time. Speed limit information provided by an in-vehicle display may be displayed all the time, only when the speed limit changes, or only when the driver requests it. Which mode of display would you most prefer in displaying this information? (Please check **one**):

- ❑ I would like the speed limit displayed in my vehicle all the time.
- ❑ I would like the speed limit displayed in my vehicle only when it changes from the current speed limit, and then, I only want it temporarily displayed.
- ❑ I would like to receive this information only when I request it .

Type of Roadway Information

Paper road maps provide drivers with information about how to get from point A to point B, but they also provide drivers with information about the roads and highways themselves. Road maps tell drivers whether a highway is divided, whether there are tolls along a particular route, as well as the type of roadway it is: interstate, state highway, or county road, for example. In-vehicle systems will be able to provide drivers with this same *type of roadway information* on a computer screen, as well as new information about roads along a route.

1. We are interested in determining what information is most important to drivers when looking at a road map. Of course, the information that is important depends on why the driver is looking at the road map in the first place. Imagine that you are **trying to find a new route to follow before starting on a trip**. Below is a list of different pieces of information about roads and interstates. Please rank these items (from 1 to 7) based on how important each piece of information is to you when looking at a road map. A '1' indicates the most important item when looking at a road map, and a '7' indicates the least important item when looking at a road map. (Please be sure to rank all the items, and remember that we are asking about what information is important to you).

_____ The type of road: interstate, U.S. highway, county roads, etc.
_____ The speed limits of roads and interstates.
_____ The surface conditions of roads and interstates (e.g., icy, slippery, potholes).
_____ A road or interstate's typical/historical traffic flow.
_____ The number of intersections along a road or interstate.
_____ Whether there is construction on a particular road or interstate.
_____ Whether a road or interstate is a toll way.
_____ Low overpasses.
_____ Allowable vehicle weight.
_____ Allowable vehicle length.
_____ Uphill/downhill grade.

2. Now imagine that you are on your way to a destination and you want to find out how much farther you have to go until you reach your destination. Please rank the following items (from 1 to 7) based on how important each piece of information is to you **when looking at a road map to determine how much farther you must travel**. A '1' indicates the most important item of information, and a '7' indicates the least important item of information. (Please be sure to rank all the items, and remember that we are asking about what information is important to you).

_____ The type of road: interstate, U.S. highway, county roads, etc.
_____ The speed limits of roads and interstates.
_____ The surface conditions of roads and interstates (e.g., icy, slippery, potholes).
_____ A road or interstate's typical/historical traffic flow.
_____ The number of intersections along a road or interstate.
_____ Whether there is construction on a particular road or interstate.
_____ Whether a road or interstate is a toll way.
_____ Low overpasses.
_____ Allowable vehicle weight.
_____ Allowable vehicle length.
_____ Uphill/downhill grade.

3. Now imagine that you are on your way to a destination, but you have decided to change routes due to congestion or some other reason. Please rank the following items (from 1 to 7) based on how important each piece of information is to you **when looking at a road map to change routes**. A '1' indicates the most important item of information, and a '7' indicates the least important item of information. (Please be sure to rank all the items, and remember that we are asking about what information is important to you).

_____ The type of road: interstate, U.S. highway, county roads, etc.
_____ The speed limits of roads and interstates.
_____ The surface conditions of roads and interstates (e.g., icy, slippery, potholes).
_____ A road or interstate's typical/historical traffic flow.
_____ The number of intersections along a road or interstate.
_____ Whether there is construction on a particular road or interstate.
_____ Whether a road or interstate is a toll way.
_____ Low overpasses.
_____ Allowable vehicle weight.
_____ Allowable vehicle length.
_____ Uphill/downhill grade.

Thank you for your participation!

APPENDIX K: ANOVA TABLES AND SNK TABLES FOR THE CVO DRIVER SURVEY DATA ANALYSIS

Table 122. CVO Motorist Services Information Question 2 ANOVA table for the Age × Option interaction.

Source	DF	SS	MS	F	Pvalue
Age*Option	6	15.592	2.599	2.25	0.0422
Subjects*Option(Age)	129	148.778	1.1533		

Table 123. CVO Motorist Services Information Question 2 SNK results for the Age × Option interaction. (Age 18-25)

Option	Mean	SNK Grouping
1--Truck stop/Restaurant name	3.0000	A
2--Type of food served	3.0000	A
3--Price	2.6667	A
4--Location	1.6667	A

(Age 35-45)

Option	Mean	SNK Grouping
3--Price	2.8710	A
2--Type of food served	2.7419	A
1--Truck stop/Restaurant name	2.2581	A B
4--Location	1.8065	B

(Age 65 and Over)

Option	Mean	SNK Grouping
1--Truck stop/Restaurant name	2.7778	A
4--Location	2.6667	A
3--Price	2.6667	A
2--Type of food served	1.8889	A

Table 124. CVO Motorist Services Information Question 2 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	3	18.130	6.04	4.96	0.0027
Subjects	45	9.152	0.203		
Subjects*Option	135	164.369	1.218		

Table 125. CVO Motorist Services Information Question 2 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
3--Price	2.8043	A
2--Type of food served	2.6087	A
1--Truck stop/Restaurant name	2.4565	A
4--Location	1.9565	B

Table 126. CVO Motorist Services Information Question 3 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	6	174.0801	29.013	8.88	0.0001
Subjects	45	0.401	0.0089		
Subjects*Option	270	882.491	3.268		

Table 127. CVO Motorist Services Information Question 3 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
6--Other services	4.9565	A
1--Service name	4.7174	A
3--Restrooms	4.5652	A
7--Payment methods	4.0870	A B
4--Hours of operation	3.4783	B C
2--Cost of fuel	3.1304	C
5--Location	3.000	C

Table 128. CVO Motorist Services Information Question 4 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	42.797	21.399	40.23	0.0001
Subjects	45	0.3261	0.0072		
Subjects*Option	90	47.869	0.532		

Table 129. CVO Motorist Services Information Question 4 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
1--Sign only	2.5	A
2--Text only	2.2609	A
3--Sign and text	1.2174	B

Table 130. CVO Time/Distance to Destination Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	25.957	12.978	18.83	0.0001
Subjects	45	0.0000	0.0000		
Subjects*Option	90	62.043	0.689		

Table 131. CVO Time/Distance to Destination Information Question 1 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
2--Information displayed all the time	2.3696	A
1--Information displayed every × amt	2.2391	A
3--Information displayed when requested	1.3913	B

Table 132. CVO Time/Distance to Next Turn Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	32.797	16.399	27.40	0.0001
Subjects	45	0.326	0.0072		
Subjects*Option	90	53.869	0.599		

Table 133. CVO Time/Distance to Next Turn Question 1 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
1--One message	2.6957	A
3--Three messages	1.6957	B
2--Two messages	1.6304	B

Table 134. CVO Time/Distance to Next Turn Question 6 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	58.739	29.369	79.47	0.0001
Subjects	45	0.0000	0.0000		
Subjects*Option	90	33.261	0.369		

Table 135. CVO Time/Distance to Next Turn Question 6 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
1--Sign only	2.6522	A
2--Text only	2.2391	B
3--Sign and text	1.1087	C

Table 136. CVO Time/Distance to Next Turn Question 7 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	54.826	27.413	70.14	0.0001
Subjects	45	0.0000	0.0000		
Subjects*Option	90	35.174	0.391		

Table 137. CVO Time/Distance to Next Turn Question 7 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
2--Text only	2.4565	A
1--Sign only	2.4348	A
3--Sign and text	1.1087	B

Table 138. CVO Guide Sign Information Question 2 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	57.565	28.783	79.87	0.0001
Subjects	45	0.0000	0.0000		
Subjects*Option	90	32.435	0.360		

Table 139. CVO Guide Sign Information Question 2 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
2--Text only	2.4783	A
1--Sign only	2.4348	A
3--Sign and text	1.0870	B

Table 140. CVO Road Construction Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	7	483.193	69.028	18.26	0.0001
Subjects	45	11.905	0.265		
Subjects*Option	315	1190.682	3.779		

Table 141. CVO Road Construction Information Question 1 SNK results for the main effect of Option.

Option	Mean	SNK Grouping		
7--Uneven or bumpy pavement	5.5896	A		
6--Slow-moving vehicles	5.5000	A	B	
2--Type of construction	5.4565	A	B	
4--Workers of others in the vicinity	4.6087		B	C
3--Shift in road alignment	4.4783		B	C
8--Information about merging traffic	4.2826			C
5--Speed limit in construction zone	3.4783			D
1--How far ahead construction is	2.1304			E

Table 142. CVO Re-route Option Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	9	1056.609	117.401	21.19	0.0001
Subjects	45	14.783	0.329		
Subjects*Option	405	2243.391	5.539		

Table 143. CVO Re-route Option Information Question 1 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
5--Most inexpensive route	7.5652	A
7--Fewest turns	7.3478	A
1--Convenience	6.9130	A
6--Particular road type	6.8261	A
8--Weather condition along route	5.4130	B
9--Road condition along route	5.0870	B C
4--Fastest route	4.5000	B C
2--Least of amount of traffic	4.1957	B C
3--Shortest route	3.9130	C D
10--Appropriate truck clearance	3.0217	D

Table 144. CVO Re-route Option Information Question 2 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	8	843.251	105406	24.41	0.0001
Subjects	45	0.213	0.005		
Subjects*Option	360	1554.527	4.318		

Table 145. CVO Re-route Option Information Question 2 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
6--Number of rest areas	8.0435	A
9--Number of turns	6.1087	B
4--Toll ways	5.9348	B
1--Type of roadway	4.8696	C
3--Number of traffic lights/stop signs	4.8043	C
8--Poor road quality	4.4565	C
2--Complex intersections	4.1739	C D
7--Congestion/traffic	3.4130	D E
5--Poor clearance	3.1522	E

Table 146. CVO Stopped Vehicle Ahead Information Question 2 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	4	259.478	64.869	72.74	0.0001
Subjects	45	0.0000	0.0000		
Subjects*Option	180	160.522	0.892		

Table 147. CVO Stopped Vehicle Ahead Information Question 2 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
4--Delivery vehicle	4.1739	A
5--Utility vehicle	4.0652	A
2--Public transit vehicle	3.2391	B
3--Emergency vehicle	1.7609	C
1--School bus	1.7609	C

Table 148. CVO Construction Ahead Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	3	51.587	17.196	14.21	0.0001
Subjects	45	2.804	0.0623		
Subjects*Option	135	163.413	1.210		

Table 149. CVO Construction Ahead Information Question 1 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
3--Cause of congestion	3.0000	A
4--Duration of delay	2.6739	A
2--Average traveling speed	2.6087	A
1--Distance/time to congested area	1.5870	B

Table 150. CVO Approach of Emergency Vehicle Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	4	82.409	20.302	10.77	0.0001
Subjects	45	5.043	0.112		
Subjects*Option	180	344.391	1.91		

Table 151. CVO Approach of Emergency Vehicle Information Question 1 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
3--Speed of approaching emergency vehicle	3.6087	A
5--Number of emergency vehicles	3.2826	A
4--Type of emergency vehicle	3.1304	A
1--Destination of emergency vehicle	3.0000	A
2--Relative location of approaching emergency vehicle	1.8478	B

Table 152. CVO Road Surface Condition Question 3 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	2	53.261	26.630	65.24	0.0001
Subjects	45	0.0000	0.0000		
Subjects*Option	90	36.739	0.408		

Table 153. CVO Road Surface Condition Question 3 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
2--Text only	2.5435	A
1--Sign only	2.3261	A
3--Text and sign	1.1304	B

Table 154 CVO Type of Roadway Information Question 1 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	10	929.043	92.904	19.50	0.0001
Subjects	45	130.374	2.897		
Subjects*Option	450	2143.866	4.764		

Table 155. CVO Type of Roadway Information Question 1 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
5--Number of intersections	7.7826	A
11--Uphill/downhill grade	7.3043	A B
4--Road's historical traffic flow	7.2609	A B
3--Surface conditions of roads	6.6304	A B C
7--Whether a road is a toll way	6.4565	B C
6--Whether there is construction	6.0435	C
2--Speed limits	5.9565	C
9--Allowable vehicle weight	4.8696	D
10--Allowable vehicle length	4.2609	D E
1--Type of road	4.8070	D E
8--Low overpasses	3.6739	E

Table 156. CVO Type of Roadway Information Question 2 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	10	391.826	39.183	9.75	0.0001
Subjects	45	0.0000	0.0000		
Subjects*Option	450	1808.174	4.018		

Table 157. CVO Type of Roadway Information Question 2 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
5--Number of intersections	7.1739	A
4--Road's typical traffic flow	6.9783	A B
11--Uphill/Downhill grade	6.8043	A B C
7--Whether road is a toll way	6.6304	A B C
3--Surface conditions of road	6.5870	A B C
6--Whether there is construction	6.0217	A B C D
2--Speed limits of roads	5.8478	B C D
10--Allowable vehicle length	5.6087	C D E
9--Allowable vehicle weight	5.1087	D E
8--Low overpasses	4.6957	E
1--Type of road	4.5435	F

Table 158. CVO Type of Roadway Information Question 3 ANOVA table for the main effect of Option.

Source	DF	SS	MS	F	Pvalue
Option	10	351.826	35.183	8.82	0.0001
Subjects	45	5.125	0.114		
Subjects*Option	450	1795.810	3.991		

Table 159. CVO Type of Roadway Information Question 3 SNK results for the main effect of Option.

Option	Mean	SNK Grouping
5--Number of intersections	7.0652	A
4--Road's typical traffic flow	6.8913	A
11--Uphill/downhill grade	6.8696	A
3--Surface conditions of road	6.5000	A B
7--Whether road is a toll way	6.3696	A B
2--Speed limits of road	6.1957	A B
6--Whether there is construction	5.8913	A B C
10--Allowable vehicle length	5.5217	B C D
9--Allowable vehicle weight	5.0000	C D
1--Type of road	4.9130	C D
8--Low overpasses	4.5435	D

APPENDIX L: SCREEN CAPTURES FROM THE ATIS INFORMATION USER CLINIC

Figure 2. Yellow pages, top level.

Figure 3. Yellow pages, second level.

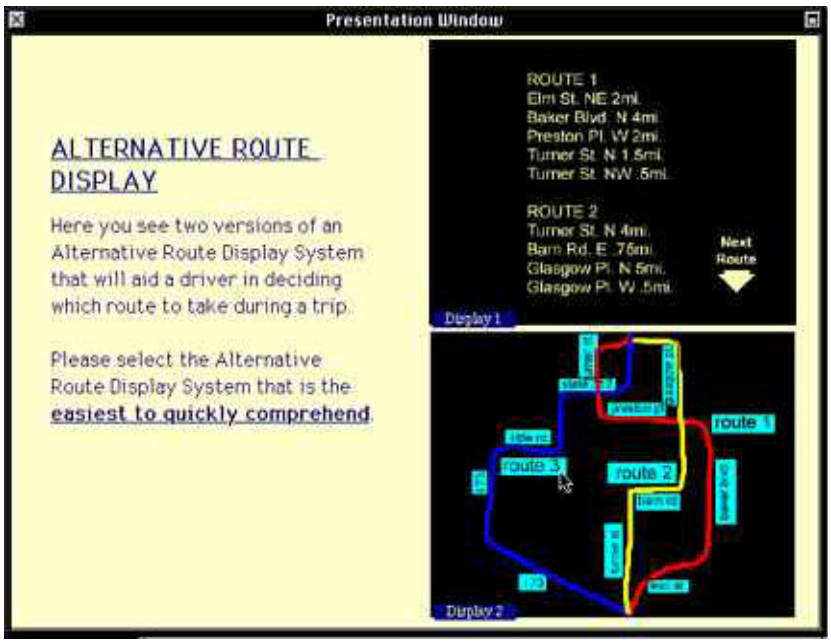


Figure 4. Alternate route display.

Figure 5. Accident alert (HUD).

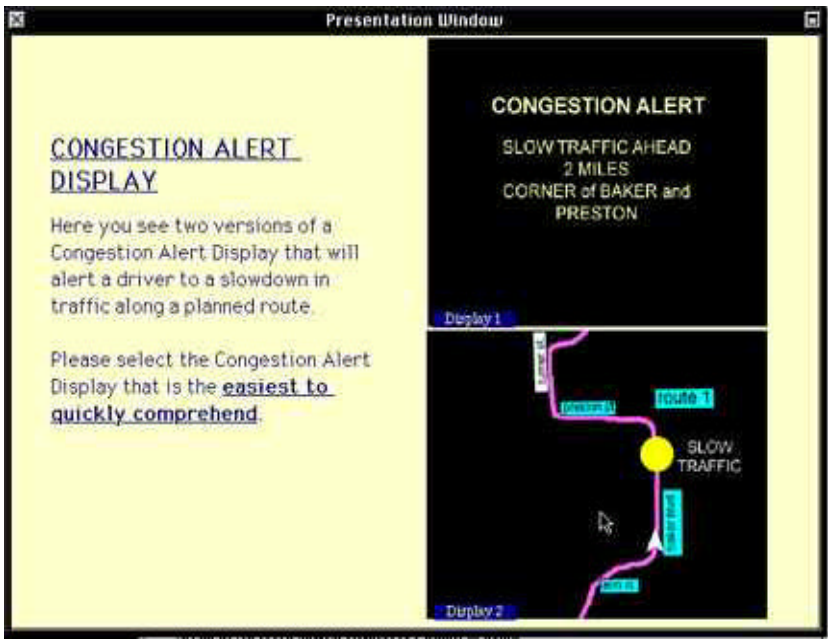


Figure 6. Congestion alert display.

Figure 7. Weather alert (HUD).

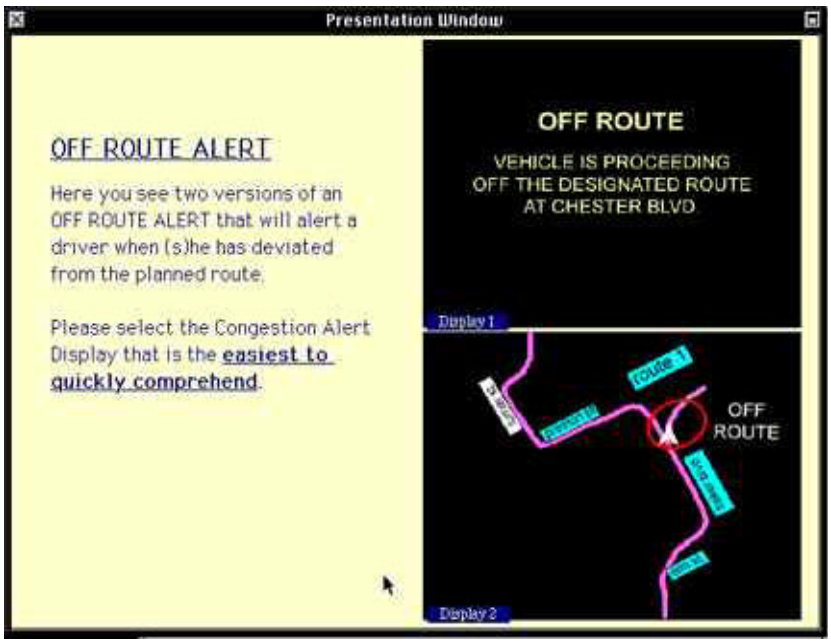


Figure 8. Off-route alert display.

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